United Nations
Climate Change

UNFCCC BTR REVIEW TRAINING: COURSE B

TECHNICAL REVIEW OF NATIONAL INVENTORY REPORTS OF ANTHROPOGENIC EMISSIONS BY SOURCES AND REMOVALS BY SINKS OF GHG

SUB COURSE B5: LAND USE, LAND-USE CHANGE AND FORESTRY SECTOR

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Greenhouse gas inventory review training course

Land use, land-use change and forestry sector

United Nations Framework Convention on Climate Change

Abbreviations and Acronyms

2006 IPCC Guidelines	Guidelines for National Greenhouse Gas Inventories
2019 Refinement to the 2006 IPCC Guidelines	2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories
AD	activity data
AFOLU	agriculture, forestry and other land use
BCEF	biomass conversion and expansion factor
BEF	biomass expansion factor
C	carbon
CO	carbon monoxide
CORINE	Coordination of Information on the Environment
CO_2	carbon dioxide
CH_4	methane
CMA	Conference of the Parties serving as the meeting of the Parties to the Paris Agreement
CRT	common reporting table(s)
CSC	carbon stock change
CSCF	carbon stock change factor
D	basic wood density
DOM	dead organic matter
EF	emission factor
ETF	enhanced transparency framework under the Paris Agreement
FAO	Food and Agriculture Organization of the United Nations
FAOSTAT	statistical database of the Food and Agriculture Organization of the United Nations
F_I	stock change factor for input of organic matter
F_{LU}	stock change factor for land-use systems or sub-system for a particular land-use
F_{MG}	stock change factor for management regime
GFRA	Global Forest Resource Assessment of the Food and Agriculture Organization of the United Nations
GHG	greenhouse gas
HWP	harvested wood products

ICSCF	implied carbon stock change factor
IE	included elsewhere
IEF	implied emission factor
IPCC	Intergovernmental Panel on Climate Change
IPCC good practice guidance for LULUCF	Good Practice Guidance for Land Use, Land-Use Change and Forestry
LULUCF	land use, land-use change and forestry
MPGs	modalities, procedures and guidelines for the transparency framework for action and support referred to in Article 13 of the Paris Agreement, set out in the annex to decision 18/CMA.1
N	nitrogen
N_2O	nitrous oxide
NA	not applicable
ND	natural disturbance
NE	not estimated
NFI	national forest inventory
NID	national inventory document
NMVOC	non-methane volatile organic compound
NO	not occurring
NO_x	nitrogen oxides
PA	Paris Agreement
QA/QC	quality assurance/quality control
SOC	soil organic carbon
SOC_{REF}	reference soil organic carbon stocks
SOM	soil organic matter
SWDS	solid waste disposal sites
TACCC	transparency, accuracy, completeness, consistency, comparability
TERR	technical expert review report
TERT	technical expert review team
UNFCCC	United Nations Framework Convention on Climate Change
Wetlands Supplement	2013 Supplement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories: Wetlands

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Lesson 1: Introduction

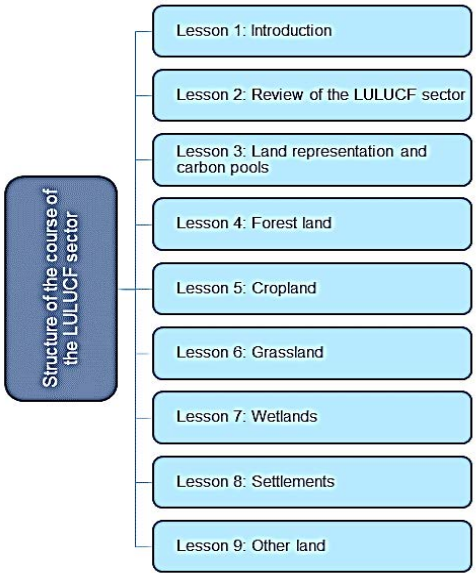
1. Overview and learning objectives

1.1. Course outline

This course covers the technical review of the LULUCF sector in the national GHG inventory. In a national GHG inventory, the LULUCF sector covers the GHG emissions by sources and removals by sinks from the use of land and the changes in the use of land in the national territory. This course will provide you with the background material for the technical review of information on CSC and associated CO_2 emissions and removals as well as on CH_4 and N_2O emissions from the LULUCF sector.

1.2. Course structure

The course contains nine lessons. Firstly, the general, cross-cutting and cross-sectoral aspects of the review of the LULUCF sector are discussed. A separate lesson is dedicated to the review of land representation and carbon pools, which are of utmost importance in a LULUCF GHG inventory. Afterwards, each of the remaining lessons provide the necessary information and guidance for the review of each of the main six IPCC land-use categories. In each lesson, exercises and quizzes are also provided to train you and test your knowledge. You must study all lessons in a sequential order, as indicated in figure 1-1, unless you feel confident about your knowledge, in which case you can follow the order of your choice for lessons 4–9. In either case, you must firstly study lessons 2 and 3 before continuing with the remaining lessons.



A. Figure 1-1. Structure of the land use, land-use change and forestry course

1.3. Learning objectives

This course provides you with background information on the main aspects that a review expert needs to comprehend and consider as a member of a TERT)=, as well as on GHG emissions and removals from the LULUCF sector, under the ETF under the PA. Completing the course will enable you to advance your skills as an expert reviewer of the LULUCF sector, in the sense that you will:

- Enhance your overall methodological background on GHG emissions and removals estimations from the LULUCF sector;
- Enhance your knowledge on cross-cutting issues relevant for the LULUCF sector;
- Be able, according to the MPGs, adopted by decision 18/CMA.1, to successfully assess the quality of information reported for the LULUCF sector in a Party's national GHG inventory, and conduct the technical review of its national inventory report, consisting of an NID and the set of CRT.

At the end of this lesson, you will be asked to take an initial quiz to test the level of your knowledge on the LULUCF GHG inventory and the 2006 IPCC Guidelines.

The expected time needed to complete lesson 1 depends on the level of your knowledge of LULUCF GHG inventories under the ETF and the 2006 IPCC Guidelines:

- For readers with experience: 15–30 minutes
- For readers with less experience: 30–50 minutes

2. Basic documentation

2.1. Reference documentation under the Paris Agreement

The main guidance and overarching principles related to the technical expert review of national GHG inventories according to the MPGs are discussed in the overview and cross-cutting course, in particular in lesson 1, topic 2, and lesson 2, topic 3.
Specific documentation for the LULUCF sector is included in decision 5/CMA.3, which contains the set of CRT (click here to open the CRT). Annex V to the same decision contains the outline of the NID, including a suggested outline for reporting on the LULUCF GHG inventory (chap. 6).

2.2. Methodological background

Volume 4 of the 2006 IPCC Guidelines (all chapters except chap. 10, "Emissions from livestock and manure management") provides the specific methodological background for the development of the LULUCF GHG inventory. General cross-cutting issues are covered in volume 1 of the 2006 IPCC Guidelines on general guidance and reporting and have been considered previously in the overview and cross-cutting issues course.
Furthermore, the Wetlands Supplement provides updated information, including additional methodologies and default factors relevant to the LULUCF GHG inventory for those Parties that choose to use it.
More information on the IPCC guidelines you need to consider when conducting the technical review of the LULUCF GHG inventory is provided in the next lesson.

B. Figure 1-2. LULUCF - Volume 4 of the 2006 IPCC Guidelines, 2013 IPCC Wetlands Supplement

Volumes 1 and 4 of the 2006 IPCC Guidelines, the Wetlands Supplement and the set of CRT can be downloaded from the following links:
www.ipcc-nggip.iges.or.jp/public/2006gl/vol1.html
www.ipcc-nggip.iges.or.jp/public/2006gl/vol4.html
www.ipcc-nggip.iges.or.jp/public/wetlands/index.html
https://unfccc.int/documents/311076
During the course we will refer many times to these IPCC guidelines and the CRT, therefore we suggest that you have them to hand and consult them as necessary.

Note that in addition to the originally published English version of the guidelines there are five other versions (Arabic, Chinese, French, Russian and Spanish); however the corrections (corrigenda) are mainly updated in the English version only, hence you are recommended to consult the English version when drawing up any final conclusions. Because the corrections are made from time to time, you should download the latest version of the 2006 IPCC Guidelines to ensure that you that reflect all corrigenda since 2007.

Note that technical knowledge of the methodologies in the 2006 IPCC Guidelines and the Wetlands Supplement is a prerequisite to taking part in the overview and cross-cutting course and this LULUCF sectoral course. These courses have been devised for technical expert reviewers of national GHG inventories who would like to become expert reviewers under the PA. Therefore, this course does not replace the need to be familiar with methods and guidance reported as good practice in the above-mentioned IPCC guidelines.

3. Initial quiz to test knowledge of the 2006 IPCC Guidelines

This initial quiz will serve to test your knowledge of the 2006 IPCC Guidelines. If you feel that you are not experienced enough in this field and you are still interested in becoming an expert reviewer, you will need to make an extra effort to study the methodological guidance in the 2006 IPCC Guidelines, in addition to studying this course. It is suggested that you take this initial quiz without consulting the 2006 IPCC Guidelines in order to assess the level of your knowledge.
After answering each question, you can consult the correct answer and the corresponding explanation (see section 3.1 below). For further information, a reference to the corresponding section(s) of the 2006 IPCC Guidelines is also provided.

Question 1

The 2006 IPCC Guidelines first stratify lands into six broad land-use categories that are used for estimating and reporting GHG emissions and removals to the UNFCCC (main categories in the CRT). These categories are:

Select one:

A. Forest land, cropland, grazing land, wetlands, settlements, other land
B. Forest land, agricultural land, revegetated land, wetlands, settlements, other land
C. Forest land, cropland, grassland, wetlands, settlements, other land
D. Forest land, cropland, grazing land, revegetation, wetlands, other land

Question 2

Conversion of land from one land-use category to another is an important driver of emissions/removals, in particular conversion of forest land to other land-use categories (deforestation), which is usually a source of emissions.
Where in the 2006 IPCC Guidelines is specific guidance provided on how to identify whether the conversion of forest land to other land-use categories is a key category?

Select one:

A. In chapter 4, volume 4 (Forest land)
B. In chapter 4, volume 1 (Methodological choice and identification of key categories)
C. In chapter 2, volume 4 (Generic methodologies applicable to multiple land-use categories)
D. In chapter 3, volume 4 (Consistent representation of lands)

Question 3

Which are the C pools defined in the 2006 IPCC Guidelines for which countries report GHG emissions/removals estimates from the LULUCF sector?

Select one:

A. Biomass of trees, biomass of understory vegetation, coarse woody debris, humus layer, SOM
B. Above-ground biomass, below-ground biomass, dead woody debris, dead roots, SOM
C. Above-ground biomass, below-ground biomass, deadwood, litter, SOM
D. Above-ground biomass, below-ground biomass, deadwood, litter, SOM, HWP

Question 4

Which part of the 2006 IPCC Guidelines contains the methods to ensure time-series consistency?

Select one:

A. Chapter 3, volume 4
B. Chapter 2, volume 4
C. The 2006 IPCC Guidelines do not provide methods for ensuring time-series consistency
D. Chapter 5, volume 1

Question 5

The 2006 IPCC Guidelines describe three tiers to choose from in estimating GHG emissions/removals. Which of the following statements is true?

Select one:

A. The tiers describe alternative methods for preparing GHG emissions/removals estimates, and there is no hierarchy among the methodological tiers
B. The tiers form a hierarchy with increasing methodological complexity and disaggregation of national data (both AD and parameters) at higher-tier levels

Question 6

In the LULUCF sector, AD are often collected periodically. Which of the following statements is true for the LULUCF sector GHG inventory?

Select one:

A. Parties can report emissions/removals from the sector periodically, corresponding to the period of data collection (maximum length of period is five years)
B. Parties can use periodically collected data as the basis for their estimates, but they are required to report GHG emissions and removals for all years of the time series, either on an annual basis (developed countries) or biennially (developing countries). Chapter 5, volume 1, of the 2006 IPCC Guidelines on time-series consistency provides relevant methods
C. According to the 2006 IPCC Guidelines, it is good practice to collect annual data, and use of periodic data as the basis of the estimates is discouraged
D. Under the PA, Parties have to collect data biennially and provide biennial GHG estimates in their national GHG inventory following the biennial cycle of the biennial transparency report

Question 7

Which sign rule is followed for the reporting of GHG emissions/removals for the LULUCF sector?

Select one:

A. Emissions are reported as positive and removals as negative values in the CRT. Hence, increases in C stocks are reported as negative and decreases in C stocks as positive values in the CRT
B. Emissions are reported as negative and removals as positive values in the CRT. Hence, increases in C stocks are reported as positive and decreases in C stocks as negative values in the CRT
C. Emissions are reported as positive and removals as negative values in the CRT. However, increases in C stocks are reported as positive and decreases in C stock as negative values in the CRT. The sign is changed when CSC are converted to emissions/removals in the summary tables
D. Emissions are reported as negative and removals as positive values in the CRT. However, increases in C stocks are reported as negative and decreases in C stocks as positive values in the CRT. The sign is changed when CSC are converted to emissions/removals in the summary tables

Question 8

In which IPCC sector should agricultural CSC and non-CO_2 emissions be reported in CRT?

Select one:

A. All agricultural non-CO_2 emissions are reported in the agriculture sector and changes in C stocks are reported in the LULUCF sector
B. All non-CO_2 emissions from agricultural soils are reported in the agriculture sector, but CH_4 emissions from drainage of organic soils, as well as N_2O emissions from N mineralization/immobilization of SOM in land converted to cropland and in land converted to grassland, as well as from wildfires, are reported in the LULUCF sector
C. All agricultural non-CO_2 emissions are reported in the LULUCF sector
D. Agricultural non-CO_2 emissions are reported in the LULUCF sector, if they are associated with land-use/management change; otherwise, they are reported in the agriculture sector

Question 9

Which of the following options includes all sources of non-CO_2 GHG emissions included in the LULUCF sectoral background CRT?

Select one:

A. Non-CO_2 emissions from N fertilization, drainage of soils and biomass burning for all land-use categories
B. Non-CO_2 emissions from drainage, rewetting, SOM CSC, N fertilization and biomass burning
C. N_2O emissions from N fertilization of forest land, drainage of soils and from disturbances associated with land-use conversion to cropland, as well as non-CO_2 GHG emissions from biomass burning
D. N_2O emissions from N fertilization of forest land and from disturbances associated with land-use conversion to cropland, as well as non-CO_2 GHG emissions from biomass burning

Question 10

Which of the following statements on flooded land (reservoirs) emissions/removals is true?

Select one:

A. The emissions should mandatorily be reported in the category wetlands
B. The emissions can be reported in the category wetlands but should not be included in the national totals because reporting is voluntary
C. The emissions should not be reported or included in the national totals because the methodologies given in the 2006 IPCC Guidelines are still under development
D. Reporting emissions/removals from land converted to flooded land is voluntary. If included in the reporting, the emissions/removals are included in national totals

Question 11

A Party reports emissions/removals from mangrove forests subject to management in a way that is not consistent with the methods provided in the Wetlands Supplement. The Party does not apply the Wetlands Supplement for developing its GHG inventory. How would you treat this in the review report?

Select one:

A. As it is not mandatory to apply the Wetlands Supplement when reporting, you will encourage the Party to apply the methods contained in the Wetlands Supplement or at least modify the methodology applied to make it consistent with the methods contained in the Wetlands Supplement
B. You note that the category is part of those for which the Wetlands Supplement provides a methodology. You will therefore recommend that the Party correct its method in order to make it consistent with the method provided in the Wetlands Supplement

Question 12

Parties must apply the same methodological tier to estimate GHG emissions/removals from source/sink categories over the entire national territory (e.g. the total area of a land-use category within the national territory).

Select one:

A. True
B. False

Question 13

Parties must apply the same approach for land representation (i.e. to identify land use, land-use change categories) over the entire national territory (e.g. the total area of a land-use category within the national territory).

Select one:

A. True
B. False

Question 14

A Party applies approach 2 for land representation. Choose the correct statement regarding the estimation of CSC in the DOM pool for land converted to other land.

Select one:

A. According to the IPCC default methodology, any CSC in the DOM pool must be estimated mandatorily, assuming a complete loss of C stocks when land is converted to other land
B. According to the IPCC default methodology, only CSC in litter for forest land converted to other land must be estimated mandatorily, because no default factors for dead wood are provided in the 2006 IPCC Guidelines
C. According to the IPCC default methodology, CSC must be estimated mandatorily only for those land-use categories for which DOM CSC have been reported
D. According to the IPCC default methodology, CSC must be estimated mandatorily in litter from forest land converted to other land and in dead wood and litter in cases where CSC have been reported in the previous land use (i.e. the land-use before the conversion to other land)

Question 15

A developing country Party reports uncertainties in the LULUCF sector calculated using a 90 per cent confidence interval, indicating the application of the flexibility for uncertainty following the provisions of the MPGs. Is the Party's method of estimating uncertainties consistent with 2006 IPCC Guidelines as implemented through the MPGs?

Select one:

A. Yes
B. No

3.1. Answer key to initial quiz

Question 1

The correct answer is (C).
The national GHG inventory for the LULUCF sector covers the GHG emissions and removals for the six top-level land uses forest land, cropland, grassland, wetlands, settlements and other land, and their subcategories and strata applied.

To learn more on the main land use categories in the national GHG inventory, consult section 3.2, chapter 3, volume 4 of the 2006 IPCC Guidelines (p.3.5).

Question 2

The correct answer is (B).
Footnote d to table 4.1, chapter 4, volume 1 of the 2006 IPCC Guidelines states: "In the quantitative key category analysis, conversion of forest land is spread out under the different land-use change categories. Countries should identify and sum up the emission estimates associated with forest conversion to any other land category and compare the magnitude to the smallest category identified as key. If its size is larger than the smallest category identified as key it should be considered key".

To learn more on the rules for identifying key categories in the national GHG inventory, consult section 4.2, chapter 4, volume 1 of the 2006 IPCC Guidelines (p.4.7).

Question 3

The correct answer is (D).
CSC and associated GHG emissions/removals from the LULUCF sector are reported for the above-ground biomass, below-ground biomass, dead wood, litter, SOM and HWP carbon pools.

To learn more on the C pools for the LULUCF sector, consult volume 4 of the 2006 IPCC Guidelines (chap. 1, sections 1.2.2 and 1.3 (p.1.8); and chap. 12, section 12.1 (p.12.5)).

Question 4

The correct answer is (D).
Methodological guidance on time-series consistency is provided in chapter 5, volume 1 of the 2006 IPCC Guidelines.

To learn more on time series consistency, consult chapter 5, volume 1 of the 2006 IPCC Guidelines.

Question 5

The correct answer is (B).
The tier levels provided by the 2006 IPCC Guidelines reflect a level of methodological complexity. While under tier 1 basic methods are given, tier 2 and tier 3 methods are more demanding in terms of complexity and data requirements.

To learn more on the tier methods, consult section 1.2, chapter 1, volume 1 of the 2006 IPCC Guidelines (p.1.6), and the relevant decision trees for the identification of the appropriate tier for the different C pools and source/sink categories in volume 4 of the same guidelines (e.g. chap. 2, figures 2.2 (p. 2.14), 2.3 (p.2.22), 2.4 (p.2.32), 2.5 (p. 2.33) and 2.6 (p. 2.44); and chap. 12, figure 12.1 (p.12.10)).

Question 6

The correct answer is (B).
Parties must report a consistent time series of annual GHG emissions/removals estimates irrespective of the period used for collecting data for their GHG inventory.

To learn more on the time series of the reported GHG emissions/removals estimates, consult paragraph 57 of the MPGs and chapter 2, volume 1 of the 2006 IPCC Guidelines. For methodological guidance on ensuring time-series consistency in national GHG inventories, consult chapter 5, volume 1 of the 2006 IPCC Guidelines.

Question 7

The correct answer is (C).
An increase in C stocks (i.e., positive change), represents a removal from the atmosphere (negative emissions), while a decrease in C stocks (i.e. negative change), represents a positive emission to the atmosphere. Therefore, there is always a change in the sign when converting from CSC to CO_2 emissions/removals.

To learn more on the rules applied to the sign for reporting CSC and CO_2 emissions/removals, consult section 2.2.3, chapter 2, volume 4 of the 2006 IPCC Guidelines (p.2.11).

Question 8

The correct answer is (B).
All non-CO_2 emissions from agricultural soils are reported in the agriculture sector. CH_4 emissions from drainage of organic soils, and N_2O emissions from N mineralization/immobilization of SOM in land converted to cropland and in land converted to grassland, as well as from wildfires, are reported in the LULUCF sector.

To learn more on the allocation of reporting of non-CO_2 emissions between LULUCF and agriculture, consult CRT 3.D, CRT 3(E), CRT 3(F), CRT4.(I), CRT 4(II), CRT 4(III), and CRT 4(IV).

Question 9

The correct answer is (B).
LULUCF sectoral background CRT 4(I)–(IV) cover non-CO_2 emissions associated with drainage, rewetting, SOM CSC, N fertilization and biomass burning.

To learn more on the sources of non-CO_2 GHGs covered by the LULUCF sectoral background CRT, consult CRT 4(I), CRT 4(II), CRT 4(III) and CRT 4(IV).

Question 10

The correct answer is (A).
In accordance with the 2006 IPCC Guidelines, GHG emissions/removals from flooded land (reservoirs) are reported under the wetlands land-use category.

To learn more about flooded land in the national GHG inventory, consult section 7.3, chapter 7, volume 4 of the 2006 IPCC Guidelines (p.7.19).

Question 11

The correct answer is (A).
Paragraph 20 of the MPGs states that "Each Party is encouraged to use the *2013 Supplement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories: Wetlands*". Since the Wetlands Supplement is not a requirement for Parties, you should include an encouragement in your TERR but not a recommendation.

To learn more about the mandatory and non-mandatory GHG inventory reporting requirements for Parties, consult the MPGs.

Question 12

The correct answer is (B).
Different methodological tiers can be applied to different portions of the territory, according to data availability.

To learn more on the tier methods, consult section 1.2, chapter 1, volume 1 of the 2006 IPCC Guidelines (p.1.6), and the relevant decision trees for the identification of the appropriate tier for the different carbon pools and source/sink categories in volume 4 of the same guidelines (e.g. chap. 2, figures 2.2 (p.2.14), 2.3 (p.2.22), 2.4 (p.2.32), 2.5 (p.2.33) and 2.6 (p.2.44); and chap. 12, figure 12.1 (p.12.10)).

Question 13

The correct answer is (B).
Different approaches for land representation can be applied to different portions of the national territory, according to data availability.

To learn more on land representation, consult chapter 3, volume 4 of the 2006 IPCC Guidelines.

Question 14

The correct answer is (D).
The 2006 IPCC Guidelines provide default factors only for litter in forest land, and therefore it is mandatory to report litter CSC only for forest land converted to other land. However, if the Party does report DOM CSC in other land uses before their conversion to other land, then CSC associated with the loss of DOM C stocks must be reported.

To learn more on the methods for estimating CSC in DOM in land converted to other land uses, consult section 2.3.2.2, chapter 2, volume 4 of the 2006 IPCC Guidelines (p.2.25).

Question 15

The correct answer is (B).
The flexibility provided with regard to the uncertainty assessment in the MPGs is not related to the confidence interval to be applied. Therefore, uncertainties must be reported calculated using the 95 per cent confidence interval as per the 2006 IPCC Guidelines.

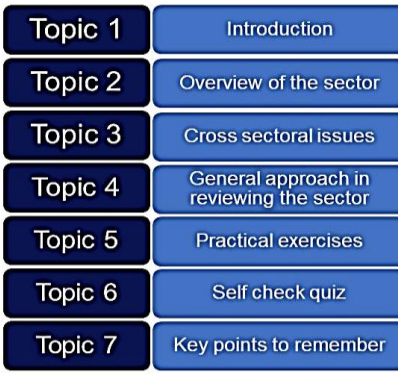
To learn more on the provisions regarding the uncertainty assessment, consult paragraphs 29 and 44 of the MPGs. To learn more on the methodological guidance for the confidence interval to be used in the uncertainty analysis, consult section 3.1.1, chapter 3, volume 1 of the 2006 IPCC Guidelines (p.3.6).

Lesson 2: Review of the LULUCF sector

1. Introduction

1.1. Lesson structure

Lesson 2 provides overview and generic background information that you need to be familiar with in order to conduct the technical review of the LULUCF GHG inventory of a Party. It covers basic concepts specific to the LULUCF GHG inventory, provides guidance on cross-cutting issues in relation to the LULUCF sector, and describes the interlinkages between the LULUCF and other IPCC sectors of the national GHG inventory. In addition, the lesson presents general review issues and illustrates how the overall approach for the technical review applies to the LULUCF sector. Practical exercises and a self-check quiz are provided at the end, aiming at enhancing and refreshing your knowledge.



C. Figure 2-1. Structure of lesson 2

1.2. Learning objectives

At the end of this lesson you should:

- Know the main steps in conducting the review of the LULUCF GHG inventory;
- Be able to understand the fundamental concepts and background information related to the development of GHG emissions/removals estimates for the LULUCF sector;
- Be able to understand the interlinkages between the LULUCF sector and other sectors of the GHG inventory;
- Know how the general and cross-cutting issues apply to the LULUCF sector.

The expected time needed to complete lesson 2 depends on the level of your knowledge of LULUCF GHG inventories under the ETF and the 2006 IPCC Guidelines:

- For readers with experience: 170–190 minutes
- For readers with less experience: 190–210 minutes

2. Overview of the sector

2.1. Guidelines on reporting and review under the ETF

As you have learned in the overview and cross-cutting issues course, complete knowledge and understanding of the requirements stipulated by the MPGs is a prerequisite to reviewing GHG inventories under the PA.
Therefore, before starting this course, you must understand all the provisions in the MPGs for preparing and reporting GHG inventories under the ETF.

2.2. IPCC guidelines for the LULUCF sector

In order to successfully perform a technical review of the LULUCF sector, you must have an adequate knowledge of the methodological guidance provided by the following:

- The 2006 IPCC Guidelines (vols. 1 and 4);
- The Wetlands Supplement;
- Any subsequent version or refinement of the IPCC guidelines agreed upon by the CMA.

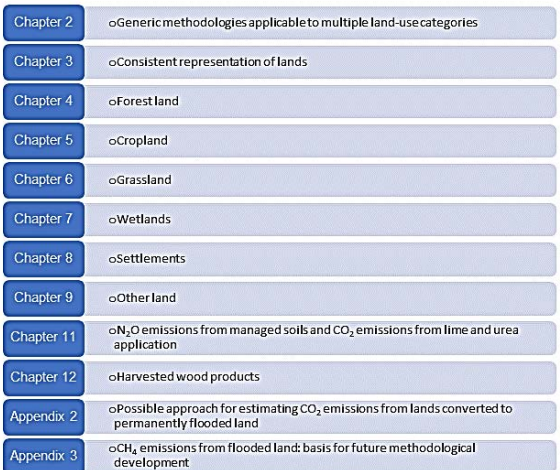
Remember that the IPCC guidelines support the development of GHG inventories that are transparent, accurate, complete, consistent over time, and comparable, by providing good practice guidance.

Please revisit the Glossary of the 2006 IPCC Guidelines to refresh your knowledge of the definition of “good practice”.

Note that at the time of developing this course, Parties to the PA are required to use the 2006 IPCC Guidelines, and encouraged to use the Wetlands Supplement, to develop and report their GHG inventories.

2006 IPCC Guidelines, volume 4

Volume 4 of the 2006 IPCC Guidelines provide methodologies for estimating GHG emissions and CO_2 removals from the AFOLU sector, which combines guidance on LULUCF and agriculture sectors with general guidance on reporting and documentation of the inventories. Click on figure 2-2 to refresh your knowledge about the chapters in volume 4 that are relevant to the LULUCF sector. CSC and associated GHG fluxes are also addressed in volume 4. Click here (https://unfccc.int/resource/tet/bl/bl2-01_u_l2_f3.pdf) to see the different types of C stocks and fluxes and the corresponding chapters as well as the relevant methodological guidance on estimating associated GHG emissions/removals.



D. Figure 2-2. 2006 IPCC Guidelines, volume 4

Wetlands Supplement

The Wetlands Supplement contains additional methodologies and default factors for estimating GHG emissions and CO_2 removals from wetlands and lands with organic soils.

The use of the Wetlands Supplement for the compilation of national GHG inventories under the ETF is encouraged by the MPGs (para. 20); therefore it is not mandatory for Parties to report GHG emissions and CO_2 removals from the categories for which methodologies are provided only in the Wetlands Supplement.

E. Figure 2-3. Wetlands Supplement

Furthermore, when reporting in line with the 2006 IPCC Guidelines on source/sink categories for which the Wetlands Supplement provides updated methodologies and default factors, Parties may, but do not have to, use the updated methodologies and EFs contained in the Wetlands Supplement.

However, if a Party does apply the Wetlands Supplement, then the Wetlands Supplement establishes the good practice to be followed by the Party in reporting its GHG inventory. As a reviewer, you must assess the Party's compliance with the good practice.

Note that:
When a Party uses methodologies and default factors contained in the 2006 IPCC Guidelines to report GHG estimates from categories for which the Wetlands Supplement provides updated methodologies and default factors and does not apply the Wetlands Supplement, you, as a reviewer, should assess whether the use of updated methodologies and default factors contained in Wetlands Supplement could enhance the accuracy of the reported estimates. If this is the case, you should encourage the Party to use the up-to-date methodology and/or default factors provided by the Wetlands Supplement.
When a Party applies the Wetlands Supplement, you, as a reviewer, should assess the TACCC of the Party's GHG inventory based on the methodological guidance and factors provided in the Wetlands Supplement.

2006 IPCC Guidelines, volume 1

When conducting your technical review of the LULUCF sector, you should always have at hand volume 1 of the 2006 IPCC Guidelines. Volume 1 provides general guidance on the cross-cutting issues applicable to all sectors in the GHG inventory. If you feel that you need to refresh your memory on general and cross-cutting issues it is suggested that you revisit the overview and cross-cutting issues course.
Click on figure 2-4 to see the relevant chapters from volume 1 of the 2006 IPCC Guidelines that you will need during the technical review.

F. Figure 2-4. 2006 IPCC Guidelines, Volume 1

Note that categories for which methods are provided in appendices to the 2006 IPCC Guidelines are not to be considered when checking the completeness of a Party's national GHG inventory.

2.3. Categories in the LULUCF sector

The LULUCF sector covers CSC and associated CO_2 emissions and removals, as well as other GHG emissions, as a result of the use and the changes in the use of land.

Most GHG emissions and CO_2 removals reported under the LULUCF sector are estimated based on information on land areas as AD. Therefore, the quality of the land area AD (land representation) of a Party's GHG inventory is of utmost importance for the quality of the GHG inventory estimates in turn. Consequently, you, as a reviewer, must always allocate sufficient time and effort in order to assess the inventory information related to the land representation against the IPCC principles (TACCC).

Table 2-1. Land-use categories

CRT category code	Top-level land-use category	Managed / unmanaged
4.A	Forest land	managed
		unmanaged
4.B	Cropland	
4.C	Grassland	managed
		unmanaged
4.D	Wetlands	managed
		unmanaged
4.E	Settlements	
4.F	Other land	

The reporting of GHG emissions and CO_2 removals is carried out for the six top-level land-use categories, as presented in table 2.1.

In accordance with the 2006 IPCC Guidelines, Parties are required to further subdivide the forest land, grassland and wetlands categories into:

- Managed land;
- Unmanaged land.

Note that Parties must report the total area of their territory, for **both managed and unmanaged land**, in order to ensure that the total land area is covered in the inventory and the consistency in the land representation. However, they do not have to report GHG emissions and removals from unmanaged lands, unless they are converted to managed land, for example, unmanaged forest land converted to forest plantation, unmanaged wetlands converted to cropland or unmanaged grassland converted to grazing land.

For each land-use category, the reporting is divided into two main subcategories, based on the current and previous use of the land under consideration. Information on the previous use is relevant only if the land is still within the **conversion period** to the current land use.

Table 2.2 describes the two main subcategories.

Table 2-2: Main land-use subcategories within each top-level land-use category

Land-use subcategory	Description
Land remaining under current use	Land that has not changed its use in the last 20 years or other longer conversion time period chosen by the Party, including the latest inventory year; 20 years is the default length of the conversion time period. For example, in 2015, all those lands whose land-use did not change since 1996 at least.
Land converted to current use	Land that has been converted from one land-use category to another in the last 20 years or other longer conversion time period chosen by the Party; 20 years is the default length of the conversion time period. For example, in 2015, all those lands that underwent land-use change at any time since 1996.

This structure of reporting was introduced in the IPCC good practice guidance for LULUCF and has been maintained in the 2006 IPCC Guidelines; therefore, it has to be followed for reporting GHG inventory information for the LULUCF sector under the ETF.

The CSC in the land categories given above are reported separately from the associated non-CO_2 emissions as well as other GHG emissions in the background data tables of the CRT. More information on the CRT is provided in the following lessons.

2.4. Conversion/transition time period

The conversion/transition time period is an important concept for LULUCF GHG inventory development. Click below for further information.

Conversion/transition time period

The conversion time period refers to the time frame applied for reporting land that has changed its use in the 'conversion' subcategory, that is, land use X converted to land use Y. After that period, the land is no longer reported under the 'conversion' subcategory and is reported under the 'remaining' subcategory, that is, land use Y remaining land use Y. The conversion period is set by the 2006 IPCC Guidelines to 20 years by default for each land-use category, although other longer periods may be used according to national circumstances. The application of this 20-year conversion period ensures comparability among countries. The transition time period refers to the time period needed for the C stock levels, and their dynamics, to transit from those specific to the previous land use/management to those associated with the current land use/management. The 2006 IPCC Guidelines set a default value of 20 years for the transition time period; however, a longer transition time period can be applied to any land-use category where evidence justifies such an extension of the period. Note that the conversion and transition periods are usually applied interchangeably. However, those concepts may differ. Further information can be found here: https://unfccc.int/resource/tet/bl/bl2-02_u_l2_att1.pdf.

It is important to note that the application of the conversion/transition period in the GHG inventory must be done consistently throughout the time series.

During the review, you must investigate and ensure that the Party provides in the NID transparent information on the conversion/transition period applied for all land-use categories, and in cases where the conversion/transition period is longer than the 20-year IPCC default that the Party provides adequate justification for such an extension.

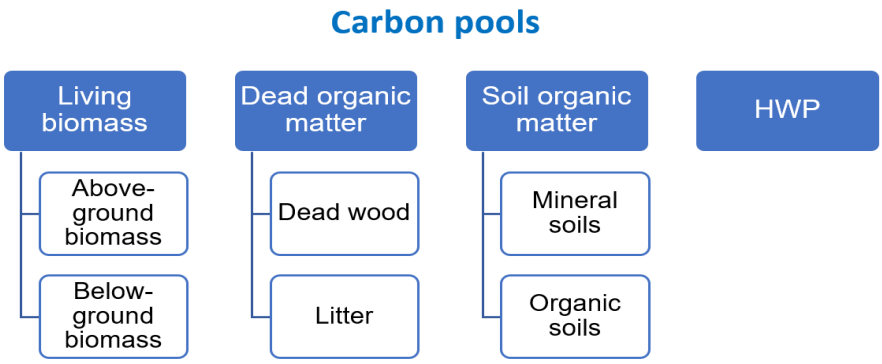
2.5. Carbon pools and gases

In the LULUCF sector, CSC in C pools are the proxy for estimating GHG emissions/removals.

The C pools for which Parties report CSC and associated GHG emissions/removals in their LULUCF GHG inventories are presented in figure 2-5.

C stocks are composed of organic matter, whose synthesis in the above-ground C pool removes CO_2 from the atmosphere and whose mineralization/redox, in all C pools, causes CO_2, N_2O and CH_4 emissions to the atmosphere.

C stock gains and **losses** are expressed as **positive** and **negative** quantities respectively. However, these signs are reversed when C stock gains and losses are expressed in terms of CO_2 emissions and removals. Consequently, **CO_2 emissions** are expressed as **positive** and **CO_2 removals** as **negative**. CSC are multiplied by **–44/12** to convert to CO_2 emissions and removals. In general, C stock gains and losses in C pools are considered as CO_2 removals from and emissions to the atmosphere, respectively; although C losses through transfers of carbon stocks to another pool and C gains from transfers of C stocks from another pool are not actual CO_2 emissions to and actual CO_2 removals from the atmosphere.



G. Figure 2-5. Carbon pools

C stocks may:

- Increase, thus causing a net CO_2 removal from the atmosphere;
- Decrease, thus causing a net CO_2 emission to the atmosphere;
- Be in equilibrium; in this case, C stock gains equal losses over a time period (e.g. a management cycle).

Furthermore, certain non-CO_2 GHG emissions are also associated with C stock losses:

- CH_4 and N_2O from combustion of organic matter (all C pools). Be aware that the IPCC default method calculates the GHG emissions by applying default factors directly to the mass of fuel burned (see the 2006 IPCC Guidelines, vol. 4, chap. 2, table 2.5). Parties may estimate these GHG emissions directly from the C stock loss using appropriate oxidation ratios and N/C ratios (for N_2O);
- N_2O emissions from N mineralization associated with loss of SOC in mineral soils, as well as N immobilization with SOC gain (measured as a net N_2O removal, although practically, this is an avoided emission). N_2O emissions caused by N mineralization associated with SOC loss in mineral soils due to changes in land use or management are estimated using the amount of mineralized N with appropriate EFs. The amount of mineralized N is estimated using the amount of SOC loss and the C/N ratio for the SOM. SOC gain in mineral soils results in immobilization of N. While the 2006 IPCC Guidelines do not provide default methods for N immobilization, Parties can estimate and report it using tier 3 methods. However, those methods need to be consistent with the methods and factors used for estimating N_2O emissions associated with SOC losses;
- CH_4 emissions from anaerobic decomposition of SOM.

In conclusion, the gases which Parties must report in the LULUCF GHG inventory are CO_2, N_2O and CH_4.

Note that NO_X, CO and NMVOCs are not considered in this course. Parties are encouraged to provide information on these gases in accordance with paragraph 51 of the MPGs. Further information can be found in volume 1, chapter 7 of the 2006 IPCC Guidelines.

2.6. Processes and carbon stock changes

When a land changes its use/management, the C stocks accordingly change from the equilibrium level of the previous use/management to the equilibrium level of the new use/management over a transition period that may be different for different C pools and different land uses. IPCC methods estimate CSC associated with two different processes related to the land-use/management change. Information on each of those processes is provided below.

An abrupt change occurring in a single year
An abrupt change can cause:

- C stock losses: this is usually associated with anthropogenic removal of C stocks from the land, for example, deforestation (tree biomass removed) or soil excavation (SOM removed);
- C stock gains: this is usually associated with transfer of C stocks from biomass pool to other pools and implies large biomass C stock losses, for example, deforestation (tree biomass transferred to DOM).

A continuous change occurring over a transition period

A continuous process can cause:

- C stock losses: this is usually associated with decay of SOM and DOM C stocks (IPCC default transition period for SOM stocks is 20 years);
- C stock gains: this is usually associated with C stock accumulation in all C pools (IPCC default transition period for DOM and SOM pools is 20 years).

2.7. Methods for estimating carbon stock changes

General
The 2006 IPCC Guidelines provide two general methods for estimating CSC:

1. The gain and loss method (IPCC default method);
2. The stock-difference method.

Both methods can be used to calculate accurate estimates of GHG emissions and removals. Countries sometimes also apply country-specific methodologies that are derived from, or are a mix of, these generic methods.

Gain-loss method
With the gain-loss method, CSC are estimated every year in a C pool by adding any carbon gains and subtracting all carbon losses occurring within the year. For instance, in biomass, carbon gains every year are the result of the biomass growth during the year, while carbon losses are those from harvestings (wood removals, fuelwood) and disturbances (e.g. fires) during the year.
The gain-loss method in its generic form is provided in equation 2.7, chapter 2, volume 4 of the 2006 IPCC Guidelines.
When a Party applies the gain-loss method, as a reviewer it is important to assess whether all processes leading to carbon gains and losses are taken into account in the C pools. As an example, you may identify that the methodology applied by the Party does not account for natural mortality of biomass

(e.g. it calculates the gross increment) or carbon losses due to fuelwood gathering. The Party must ensure the accuracy of the estimates of CSC in C pools by including all C stock gains and losses.
In addition, you must assess whether the method is applied for a C pool in a consistent way for C gains and losses. For instance, a Party included below-ground biomass in the annual C stock increment (i.e. gains) but did not include below-ground biomass C stock losses associated with harvesting, other disturbances and mortality (i.e. losses). Consequently, the estimate of the net CSC of the biomass pool is biased.
When the inclusion of below-ground biomass is optional (e.g., forest land remaining forest land, tier 1), if the below-ground biomass is included in any of the elements of equations 2.10, 2.11, 2.15 and 2.16, volume 4 of the 2006 IPCC Guidelines, it must also be included in the other elements of those equations.

Stock-difference method

The C stock-difference method needs C stock estimates at two different points in time, and it is generally applied when there are national monitoring systems for measuring C stocks in different pools. The stock-difference method in its generic form is provided in equation 2.8, chapter 2, volume 4 of the 2006 IPCC Guidelines.
Time and space are the two variables to be carefully considered when a Party applies the stock-difference method:

Time

- When the stock-difference method is applied to subsequent measurements, the annual CSC is obtained by dividing the difference in C stocks by the time period between the C stock estimates. For example, if C stocks are calculated using NFI data collected every five years, then a net CSC of 5 t C ha−1 means that the average annual CSC has been 1 t C ha−1 yr−1.
- When the stock-difference method is applied to two equilibrium C stock levels, the annual CSC is obtained by dividing the difference in C stocks by the time period needed for the C stocks to transition from the previous equilibrium level to the new one.

Space

- When applying the stock-difference method, comparison between C stocks is done for the same land area to avoid mere changes in area resulting in CSC. One way of ensuring that the stock-difference method is correctly applied is to calculate the CSC per unit of area (e.g. per hectare) between the two points in time and then expand it to the entire area for which the change is estimated.

HWP

In particular for the HWP C pool, the 2006 IPCC Guidelines provide guidance for estimating a set of seven variables that may be combined using different methodological approaches for estimating the HWP contribution. The four different approaches explored in the 2006 IPCC Guidelines that Parties may use are:

1. Stock change approach;
2. Atmospheric flow approach;
3. Production approach;
4. Simple decay approach.

Parties should report the HWP contribution by applying one of the three methodological tiers according to data availability and significance of the HWP contribution guided by the decision tree in the 2006 IPCC Guidelines (vol. 4, chap. 12, figure 12.1).

Further information on the set of variables needed for estimating CO_2 emissions/removals from HWP, and on the different methodological approaches, can be found in volume 4 of the 2006 IPCC Guidelines (chap. 12, table 12.1, and chap. 12, annex 12.A.1, respectively).

Note that in accordance with paragraph 56 of the MPGs, if a Party uses an approach other than the production approach to report the HWP contribution, it must also provide supplementary information on the HWP contribution using the production approach.

Note that a Party may report the HWP contribution as zero if the inventory compiler judges that the annual change in C in HWP stocks is insignificant. Insignificant in this context means that the annual net change in C in HWP stock is less than the size of any key category of the Party's inventory. Furthermore, the Party may separately judge if the annual C change of HWP in SWDS is insignificant, and if so, report it as zero, even though the HWP contribution is significant

2.8. Natural disturbances

ND) are non-anthropogenic events or non-anthropogenic circumstances, such as wildfires, insect outbreaks and extreme weather events, that result in significant emissions to the atmosphere and C transfer among C pools.

They are discrete events and are associated with abrupt changes in C stocks (e.g. fire kills total biomass in a forest). However, they may also be associated with continuous processes affecting C stocks for many years after the disturbance (e.g. decay of burnt trees remaining in the affected area).

In accordance with paragraph 55 of the MPGs, when a Party addresses emissions and subsequent removals from ND on managed land, then the Party must report in the NID:

- Information on the approach followed to address emissions and subsequent removals from ND;
- How the approach followed is consistent with IPCC guidance;
- Whether or not estimates of emissions and subsequent removals from ND are included in national totals.

Remember that the 2006 IPCC Guidelines maintain the managed land proxy, namely that Parties are required to report all GHG emissions and removals occurring on managed lands. The 2006 IPCC Guidelines also require Parties to report all GHG emissions and removals in the years in which they occur, including all emissions and subsequent removals stemming from ND.

General guidance on estimating GHG emissions and removals from disturbances is provided in the 2006 IPCC Guidelines (vol. 4, chap. 2). If the Party applies the gain-loss method, then the effects of disturbances on C stocks are identified separately as C losses from the pool under examination (e.g., C losses from living biomass to the atmosphere) and as C gains to the recipient pool (e.g. C transferred from biomass to the DOM pool), if any.

When the gain-loss method is applied, the equations to be applied in their generic form are equations 2.4, 2.7, 2.11, 2.14, 2.15, 2.18 and 2.20, chapter 2, volume 4 of the 2006 IPCC Guidelines.

If the Party applies the stock-difference method for estimating CSC in a pool, then C losses/gains from/to the C pool due to disturbances are not separately reported, rather they are included in the total net CSC.

When the stock-difference method is applied, the equations to be applied in their generic form are equations 2.5, 2.8, 2.19, 2.23 and 2.25, chapter 2, volume 4 of the 2006 IPCC Guidelines.

Specifically for non-CO_2 emissions from fires, section 2.4 of the 2006 IPCC Guidelines provides relevant methodology (equation 2.27).
When reviewing the estimation of emissions and removals due to ND, check whether:

- When tier 1 methods are applied all post-disturbance emissions are estimated as part of the disturbance event (in the year of the disturbance) as appropriate. When higher-tier methods are applied, establish how the Party estimates associated emissions from disturbances over a period of years, if applicable, and check whether transparent information is provided in the NID on the methods used and any assumptions;

- The Party correctly accounts as C loss from the biomass pool, all biomass lost in disturbances, regardless of the fate of the biomass after the disturbance (i.e. whether all biomass is assumed to be emitted to the atmosphere or whether a part of the killed biomass is transferred to DOM as a result of a fire);

- The Party experiences significant disturbances, especially in forest land, in which case the DOM pool may be significant. In such a case you should encourage the Party to move to higher-tier methods by collecting domestic data to estimate CSC and associated emissions and removals;

- The balance of emissions and removals estimated for a pool is ensured. For example, if the Party accounts for below-ground biomass growth then it must account for all below-ground biomass losses, including those from disturbances;

- CO_2 and non-CO_2 emissions from all fires (prescribed fires and wildfires) on managed land are reported, taking into account the 'synchrony' of emissions (i.e. CO_2 emissions from fires being equal to CO_2 removals in the same year);

- CO_2 and non-CO_2 emissions from ND on unmanaged land are estimated when they are followed by a conversion to managed land;

- CO_2 emissions from fires are reported on managed land, when synchrony of CO_2 emissions and removals cannot be assumed (i.e. CO_2 emissions from fires are not equal to CO_2 removals in the same year). For example, if a Party classifies treed areas under the grassland category, then synchrony is unlikely on these areas;

- The Party has estimated and reported GHG emissions from disturbances on an annual basis;

- The Party has developed a disturbance matrix (see the 2006 IPCC Guidelines, vol. 4, chap. 2, table 2.1) to use when it is using higher-tier methods.

Both the 2006 IPCC Guidelines and 2019 Refinement to the 2006 IPCC Guidelines recognize that emissions/removals on managed land may contain emissions/removals resulting from natural causes. Although the 2006 IPCC Guidelines do not provide further methodological guidance specific to ND, the 2019 Refinement to the 2006 IPCC Guidelines provides additional information and methodological guidance on ND in particular, including an explicit ND definition, optional approaches for reporting emissions and removals from ND, and how to report the contribution of ND to the GHG emissions/removals on managed lands.

Note that in accordance with decision 5/CMA.3, paragraph 28, Parties may use the 2019 Refinement to the 2006 IPCC Guidelines on a voluntary basis.

The 2019 Refinement to the 2006 IPCC Guidelines (vol. 4, chap. 2, section 2.6) provides an optional approach that a Party may use when choosing to further disaggregate the reported emissions and removals from managed land between those considered to be anthropogenic and those considered to result from ND, so as to identify the impact of natural causes to total GHG emissions/removals reported in the GHG inventory.

ND are defined in the 2019 Refinement to the 2006 IPCC Guidelines (vol. 4, chap. 2, section 2.6.1.2) as "non-anthropogenic events or non-anthropogenic circumstances that cause significant emissions and are beyond the control of, and not materially influenced by a country. These include wildfires, insect and disease infestations, extreme weather events and/or geological disturbances, beyond the control of, and not materially influenced by a country. ND exclude human activities such as harvesting, prescribed burning and fires associated with activities such as slash and burn".

Be aware that the methodological guidance provided in 2019 Refinement to the 2006 IPCC Guidelines is applicable only for ND occurring in forest land, woody grassland, undrained wetlands and undrained peatlands, while it is not applicable to other land categories.

A fundamental assumption associated with ND, as specified in both the 2006 IPCC Guidelines and the 2019 Refinement to the 2006 IPCC Guidelines, is that the natural background of GHG emissions and removals tends to average out over time and space. This means that emissions from all C pools from areas affected by ND are expected to be balanced by subsequent removals (a predetermined time period for this balancing is not provided since it depends on many factors, e.g. forest type, site conditions, ND type).

It is good practice for countries to report all emissions and removals occurring on managed lands, including those resulting from ND, on an annual basis.

When a Party chooses to apply the 2019 Refinement to the 2006 IPCC Guidelines to address the ND, the elements to be considered are:

1. Quantification of total emissions/removals on managed lands;
2. Reporting on the country-specific approach to apply the definition of ND, consistent with the definition provided in the 2019 Refinement to the 2006 IPCC Guidelines, including the types of disturbances;
3. Identification of emissions and subsequent removals resulting from ND;
4. Identification of emissions and subsequent removals from anthropogenic causes.

When the Party chooses to disaggregate emissions/removals between those from ND and those from the anthropogenic activities on managed land, check whether the Party:

- Provides a country definition of ND, and the ND types for which emissions/removals are identified, quantified and disaggregated;

- Erroneously includes under ND, emissions/removals from causes that do not fall under the ND definition consistently with the 2019 Refinement to the 2006 IPCC Guidelines (e.g., emissions from prescribed burning) and ensures that emissions/removals that are materially affected by human activities (e.g., harvesting, salvage logging) are not included in the emissions/removals from ND;

- Provides a country-specific ND definition that is consistent with that provided by the 2019 Refinement to the 2006 IPCC Guidelines, and applied consistently over time. In particular, check whether the criteria of “non-anthropogenic events” and/or “non-anthropogenic circumstances” are met by providing adequate justification that the disturbances were “not materially influenced by” and “beyond the control of” the Party;

- Provides, in order to justify the assertion that the disturbances were “not materially influenced by” and “beyond the control of” the Party it provides:

✓ Scientific reasoning or evidence; or

✓ Documentation on practicable efforts to prevent, manage or control the occurrences that led to ND, such as studies on the causes of fires, information on weather conditions related to the ND and information on preventive measures applied;

- Reports total emissions/removals from managed land, as well as emissions/removals for the two disaggregated components, ND and anthropogenic (direct and indirect emissions), together with transparent documentation on the methods, approaches and assumptions used. An example of how to report quantifiable information is provided in box 2.2i, chapter 2, volume 4 of the 2019 Refinement to the 2006 IPCC Guidelines;

- Provides information on the methods and criteria to identify land areas affected by each type of ND and for estimating associated emissions and subsequent removals from ND;

- Disaggregates subsequent removals between the two components (i.e. natural, anthropogenic) similarly to the emissions, together with any assumptions and methods implemented to disaggregate the subsequent CO_2 removals;

- Reports in the NID information on assumptions and methods implemented to disaggregate subsequent CO_2 removals

- When a land-use change follows the ND event, does not report emissions/removals from this under the ND component, and provides documentation on how subsequent land-use change to ND, if any, is identified, and how previously emissions/removals considered as being from ND are re-assigned to the anthropogenic component when a land-use change occurs;

- Ensures that the total emissions and removals from managed land equal the sum of anthropogenic emissions and removals from managed land plus emissions and removals due to natural causes;

- Provides information on how the method used to quantify the impact of ND on GHG emissions/removals is consistent with the expectation that the CO_2 emissions from ND will be balanced by subsequent removals in subsequent years.

2.9. Cross-cutting issues

Cross-cutting issues are generically addressed in detail in the overview and cross-cutting issues course. However, there are several sector-specific cross-cutting issues that need to be considered when you are reviewing a Party's LULUCF GHG inventory. In this section you will learn more about these.

Approaches to data collection

Typically, countries do not collect data on areas and C stocks for the LULUCF sector annually. Thus, for each data set used, you must check the timing of data collection and how a complete time series of annual data has been derived.

For instance, NFIs resample the same area periodically (e.g. every 5 or 10 years); therefore, changes measured are the result of C gains and losses occurring in the time period between two consecutive measurements. However, because annual information is needed for GHG inventory compilation (e.g. on biomass CSC), compilers employ different strategies for interpolating/extrapolating this information. Examples of the application of different approaches to data collection are provided below. You can also find relevant examples in topic 5 of this lesson.

Annual average net C stock change

An average annual net CSC rate in a C pool in a stratum is calculated as net CSC divided by the number of years between two consecutive measurements when interpolating and as the same average annual net CSC rate calculated for a future period when extrapolating. This assumes constant conditions for a given stratum. When estimated on a per hectare basis, this value of net CSC is multiplied by the total area within each stratum to obtain the total net CSC in a pool in the stratum. In this case, as a reviewer, you must check the consistency of GHG emissions/removals associated with related source-sink categories, for example, for biomass CSC in forest land, non-CO_2 emissions from forest fires and HWP CSC.

Extrapolating regional information to larger areas

Data collected from a part of the 'population' (e.g. data from a region) is sometimes utilized to derive statistics for larger areas (e.g. national statistics). In this case, estimates may have an artifact showing large inter-annual variability which is not justified by significant changes in disturbance events and/or harvesting rate in the larger area, but rather is the result of the choice of the part of the 'population' from which data are collected.

Sampling

For the preparation of a GHG inventory for the LULUCF sector, different kinds of data can be utilized. Often, data are generated through sampling of the population. One advantage of applying sampling procedures in comparison with other methods is that they allow inventory agencies to quantify uncertainty estimates based on statistical procedures, and thereby assess the reliability of the information.

To produce unbiased estimates, the sampling design should ensure that all the elements of the population to be sampled have the same probability of being sampled.

To produce precise and accurate estimates, the sample design and the sample size should be adequate to collect data representative of the entire population and to estimate the 'true' value with the desired level of confidence. Statistical random sampling errors are a source of uncertainty associated with data that are obtained from a random sample of finite size and typically depend on the variance of the population from which the sample is extracted and the size of the sample itself (i.e. number of sample points). Increasing the sample size and stratifying population are both effective means of reducing uncertainty, although increasing the sample size increases the cost of sampling.

The variance of a population of values is the average of the square of the difference between individual values in the population and the mean value. The variance of a sample drawn from a population is the sum of the squares of differences between values in the sample and the mean of the sample, divided by the sample size minus 1.

Models

Owing to the high variability across space and time of C stocks and other natural parameters and lack of availability of complete data sets, country-specific models are more frequently used in the LULUCF sector than in other sectors.

Note that, to ensure the accuracy of estimates, models do not remove the need for measured data from national monitoring systems, which are needed both for model calibration and verification of model outputs across space and time (see the 2006 IPCC Guidelines, vol. 4, chap. 2, section 2.5).

Uncertainties

Parties must report quantitative estimates of uncertainties associated with the estimates of emissions and removals **for all** source/sink categories. Parties must qualitatively discuss these uncertainties for at least the starting year and the latest reporting year, using at least approach 1 in accordance with the 2006 IPCC Guidelines, taking into account the flexibility provided in the MPGs (para. 29) for those developing country Parties that need it in the light of their capacities.

There is no predetermined level of precision, but uncertainties of the inventory should be reduced as far as is practicable.

For the purpose of uncertainty analysis of inventories, one is typically interested in uncertainty in the annual average at the national level, rather than the entire range of variability that might occur over shorter periods of time or small geographic scales. Larger sample sizes and stratification strategies will not reduce the inherent variability but will lead to narrower confidence intervals that are a basis for estimating the random component of uncertainty.

According to the 2006 IPCC Guidelines, quantitative uncertainty analysis is performed by estimating the 95 per cent confidence interval of the emission/removal estimates for individual categories and for the total inventory. For a normal distribution, the confidence interval is defined as $k\ \sigma$, where ***k*** is the coverage factor and ***σ*** is the standard deviation.

The true value of the quantity for which the interval is to be estimated is a fixed but unknown constant, such as the annual total emissions in a given year for a given country. The confidence interval is a range that encloses the true value of this unknown fixed quantity with a specified confidence (probability). Typically, a 95 per cent confidence interval is used in GHG inventories. From a traditional statistical perspective, the 95 per cent confidence interval has a 95 per cent probability of enclosing the true but unknown value of the quantity.

k is the coverage factor, and in a normal distribution, the value of k is 1.96 and it is obtained from Student's t-distribution.

σ is a measure that is used to quantify the amount of variation or dispersion of a set of data values, and corresponds to the square root of the variance.

In the LULUCF sector, the concepts of uncertainty and variability may get confused, and consequently lead to the uncertainty being miscalculated. See topic 5 below for practical examples.

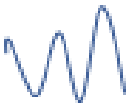
Remember that the 2006 IPCC Guidelines provide two approaches for the estimation of combined uncertainties.

For detailed general guidance on reviewing uncertainties revisit the overview and cross-cutting issues course.

To learn more on the key concepts and terms in relation to uncertainties, consult section 3.1.3, chapter 3, volume 1 of the 2006 IPCC Guidelines.

For causes of uncertainties and how to treat them in an analysis, consult table 3.1, chapter 3, volume 1 of the 2006 IPCC Guidelines.

Note that in the LULUCF sector, uncertainty in the annual average may be deeply affected by the method applied to derive annual data from measurements that cover only a portion of the year, as emissions are highly dependent on climatic conditions, which are typically significantly different between the growing period and the winter period.



Remember, that in accordance with paragraph 29 of the MPGs, developing country Parties that need flexibility in the light of their capacities are encouraged (not required), at a minimum, to provide a qualitative assessment of uncertainty for key categories in the NID, and are encouraged to provide quantitative estimates for all source and sink categories.

Methodological choice

In accordance with paragraph 25 of the MPGs, all Parties must identify their key categories for the starting year and the latest reporting year including and excluding LULUCF categories, using approach 1, for both level and trend assessment, with the developing country Parties that need it in the light of their capacity with respect to this provision having the flexibility to instead identify key categories using a threshold no lower than 85 per cent in place of the 95 per cent threshold defined in the 2006 IPCC Guidelines.

Remember that qualitative criteria could also be used to determine a key category in an inventory. In the case of the LULUCF sector such qualitative criteria may include an expected decrease or increase in the extent of a particular land-use category (e.g. forest land conversions to other land uses, land-use conversions to forest land) as part of mitigation activities implemented and/or changes in policies, expected biomass growth due to sustainable management practices.

Furthermore, for the key categories Parties must determine the significant subcategories and C pools of their national GHG inventories. Your review should focus then on these key categories and significant subcategories and C pools. This is done in order to enable using your time efficiently and not overlooking important issues whose impact could be significant in terms of emissions/removals.

This means that firstly you must review whether the identification of the key categories and significant subcategories/pools has been performed in accordance with the 2006 IPCC Guidelines, and secondly prioritize these categories, subcategories or C pools in your review against the TACCC principles.
Table 4.1, chapter 4, volume 1 of the 2006 IPCC Guidelines provides the disaggregation level at which the key category analysis is to be performed for various inventory categories (for further guidance see also lesson 3 of the overview and cross-cutting issues course).
In order to determine whether a Party has provided information on the key category analysis including LULUCF, you would need to check the information reported in CRT 7 "Summary overview for key categories" and in the NID using tables 4.1, 4.2, 4.3 and 4.4 in chapter 4, volume 1 of the 2006 IPCC Guidelines.

To learn more on the tier methods, consult section 1.2, chapter 1, volume 1 of the 2006 IPCC Guidelines (p.1.6), and the relevant decision trees for identifying the appropriate tier for the different carbon pools and source/sink categories in volume 4 of the 2006 IPCC Guidelines (e.g. chap. 2, figures 2.2 (p.2.14), 2.3 (p.2.22), 2.4 (p.2.32), 2.5 (p.2.33) and 2.6 (p.2.44); and chap. 12, figure 12.1 (p.12.10)).

In general, according to the 2006 IPCC Guidelines, the subcategories that contribute together more than 60 percent to the key category should be identified as particularly significant. Furthermore, specifically in LULUCF significant subcategories and C pools are those that account for 25–30 per cent of the emissions/removals for the overall category (see decision trees in the 2006 IPCC Guidelines, vol. 4, chap. 1, figures 1.2 and 1.3).
Therefore, for each key category (e.g. land converted to forest land), it is good practice for Parties to implement a 'significance analysis' and determine the significant subcategories (e.g. cropland converted to forest land) and C pools (e.g. biomass). This can be done, for example, by identifying those significant subcategories and C pools contributing more than 25–30 per cent to the key category (e.g. biomass in cropland converted to forest land for the land converted to forest land category) or examining and identifying sequentially, as a first step those significant subcategories contributing together more than 60 per cent to the key category and then determining the significant C pools within the significant subcategory by identifying those pools accounting for 25–30 per cent of the emissions/removals for the subcategory.

Note that because the conversion of forest land is spread over different land-use change categories, countries should identify and sum the estimates of net emissions associated with forest conversion to any other land category and compare the magnitude of the sum to that of the smallest category identified as key for the entire GHG inventory. If it is larger than the magnitude of the smallest category identified as key, deforestation should be considered to be key (2006 IPCC Guidelines, vol. 1, chap. 4, table 4.1, footnote d (p.4.12)).

For key categories and significant subcategories and C pools, it is good practice to apply higher-tier methods. However, the development of country-specific parameters and/or factors may take several years (depending on national circumstances), and this should be taken into account when assessing the Party's methodological choice for the LULUCF categories.

Time-series consistency and recalculations

The methods used in preparing inventory estimates should be consistent over time to allow an assessment of trends in the emissions and removals. Refinements or changes in methods and/or data over time should lead to recalculations of the inventory time series.

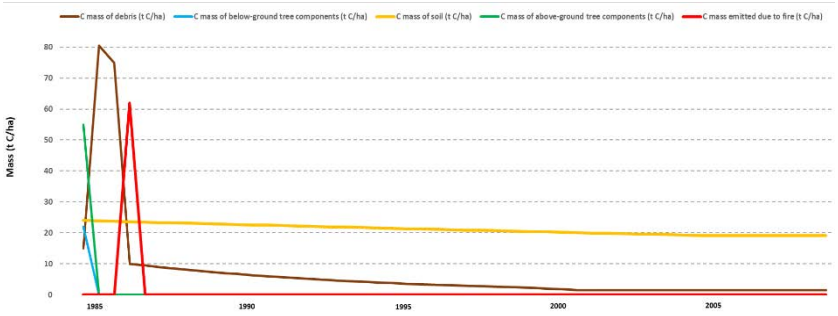
In general, obtaining a consistent time series of the LULUCF sector presents challenges to inventory compilers because AD are very often collected periodically and are not available on an annual basis. Sometimes, complex models and higher-tier methods are used in the LULUCF sector for dealing with the lack of annual data.

To learn more on ensuring time series consistency and approaches for addressing data gaps and recalculations, consult sections 5.2 and 5.3, chapter 5, volume 1 of the 2006 IPCC Guidelines (pp. 5.5–5.14).

In the LULUCF sector the trend of the ICSCF in land-use change categories may be influenced by:

- Changes in the per hectare annual average CSC;
- Changes in the area reported under the land-use change category.

See, for instance, in figure 2-6 the C stocks (and C stock losses) associated with deforestation (forest land converted to cropland). The figure reflects the fate of C stocks in a Party and shows the C dynamics in a deforested land. See how differently the C pools behave across time when a change occurs.



H. Figure 2-6. Example of carbon stocks and carbon stock losses associated with deforestation (forest land converted to cropland)

Considering that the category forest land converted to cropland comprises the total area converted for the last 20 years, the annual ICSCF will be the weighted average of the per hectare annual C stocks change in each land converted in each year of the time series, where the weight is the area of each converted land. Therefore, differences in both the areas of land converted annually and the annual average per hectare CSCFs corresponding to those areas will have an impact on the ICSCF.

In another example, in a 10-year period (e.g. 2006–2015) in a Party, forest land has been exclusively converted to cropland. The Party has applied a CSCF of 100 t C ha^{-1} across the entire time series, and all biomass is assumed to be instantaneously oxidized.

	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Area deforested (ha yr^{-1})	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000
CSC (t C ha^{-1})	100	100	100	100	100	100	100	100	100	100
Total area deforested (ha)	1,000	2,000	3,000	4,000	5,000	6,000	7,000	8,000	9,000	10,000
Total C stock loss (t C yr^{-1})	100,000	100,000	100,000	100,000	100,000	100,000	100,000	100,000	100,000	100,000
ICSCF (t C ha^{-1} yr^{-1})	100	50	33	25	20	17	14	13	11	10

I. Figure 2-7. Estimated implied carbon stock change factor associated with deforestation

Assuming a constant conversion rate of 1,000 ha yr^{-1}, see in figure 2-7 how the ICSCFs across the time series 2006–2015 are estimated.

You can see that although the process remains constant through the 10-year period in terms of annual intensity (i.e. same area deforested and the same C stock loss), the ICSCF has a decreasing trend.
The same considerations apply to all categories: land remaining under current use (e.g. cropland remaining cropland) if the management system (e.g. from annual crops to perennial crops) changes.
In both cases, to check the consistency of ICSCFs in the time series, the TERT has to check the time series of CSC estimated for each part of land included in the conversion category (i.e. for each area converted in the latest 20-year period). Information at this level of disaggregation cannot be reported in the CRT, and therefore should be provided in the NID. In the absence of this information in the NID, the TERT should ask the Party for such information to perform the necessary checks on the time series.
If a Party applies tier 3 methodologies, the time series of ICSCFs may also be affected by climate variability (precipitation and temperature). The impact of this additional element should be taken into account when assessing the consistency of time series prepared with tier 3 methods/models.

QA/QC and verification

QA, QC and verification are fundamental requirements for ensuring the quality of estimates and therefore the credibility of a GHG inventory.
Specifically, for LULUCF, in many cases, complex models and higher-tier methods are used with a view to improving the GHG emissions/removals estimation. Such advanced methods could include direct measurements (e.g. CSC) and/or modelling (e.g. process-based models to estimate non-CO_2 emissions). Therefore, QA/QC and verification activities applied by the Party with regard to these higher-tier methods must be part of your assessment as a reviewer.
As an example, NFIs, being direct measurements, are often used to provide input information for estimating CSC in forests. Since these measurements rely on a sampling approach, it is important that the sampling scheme is adequately and appropriately determined in order to ensure accurate and precise estimates.
Areas for review may include whether:

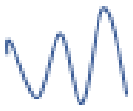
- The spatial and temporal variability has been adequately covered by the sampling scheme;
- A random scheme has been implemented and if so, whether any parts of the population have been excluded from the sampling;
- A stratification has been applied and, if so, the chosen stratification is appropriate for the national circumstances;
- A re-sampling has been implemented and if so, which time frequency has been applied, taking into account the biophysical properties of the system measured with regard to associated changes throughout time;
- A protocol/handbook for the sampling scheme and the field/laboratory measurements has been developed and, if so, whether it is publicly available at least in the form of summary information;
- A proper documentation is available that allows you to review properly the underlying processes behind the measurements and/or the model applied.

To learn more on tier 3 methods in LULUCF, consult the 2006 IPCC Guidelines (vol. 4, chap. 2, section 2.5 (p.2.50)).

A specific requirement regarding QC for the LULUCF sector, when the gain and loss method (or any derivation of it) is applied, is given in section 2.3.1.1, chapter 2, volume 4 of the 2006 IPCC Guidelines

(pp.2.18–2.19) , according to which, it is good practice to develop a disturbance matrix (https://unfccc.int/resource/tet/bl/bl2-03_u_l2_att2.pdf) to ensure that all C pool transfers to and transfers from the pool are considered. Such a table could summarize all C stock gains and losses from all C pools, including HWP, during a disturbance event. It is advisable for Parties to develop this matrix even under tier 1, although all biomass C is assumed to be emitted in the year of land conversion.

Note that frequently many Parties use models and higher-tier methods in their LULUCF inventory, such as for estimating CSC in SOM and associated GHG emissions/removals. In such cases, it is a good practice that Parties implement verification activities in order to ensure the reliability of the estimates.



Remember, that in accordance with paragraphs 34 and 35 of the MPGs, developing country Parties that need flexibility in the light of their capacities are encouraged (not required) to develop a QA/QC plan and are encouraged to provide in the NID information on general inventory QC procedures.

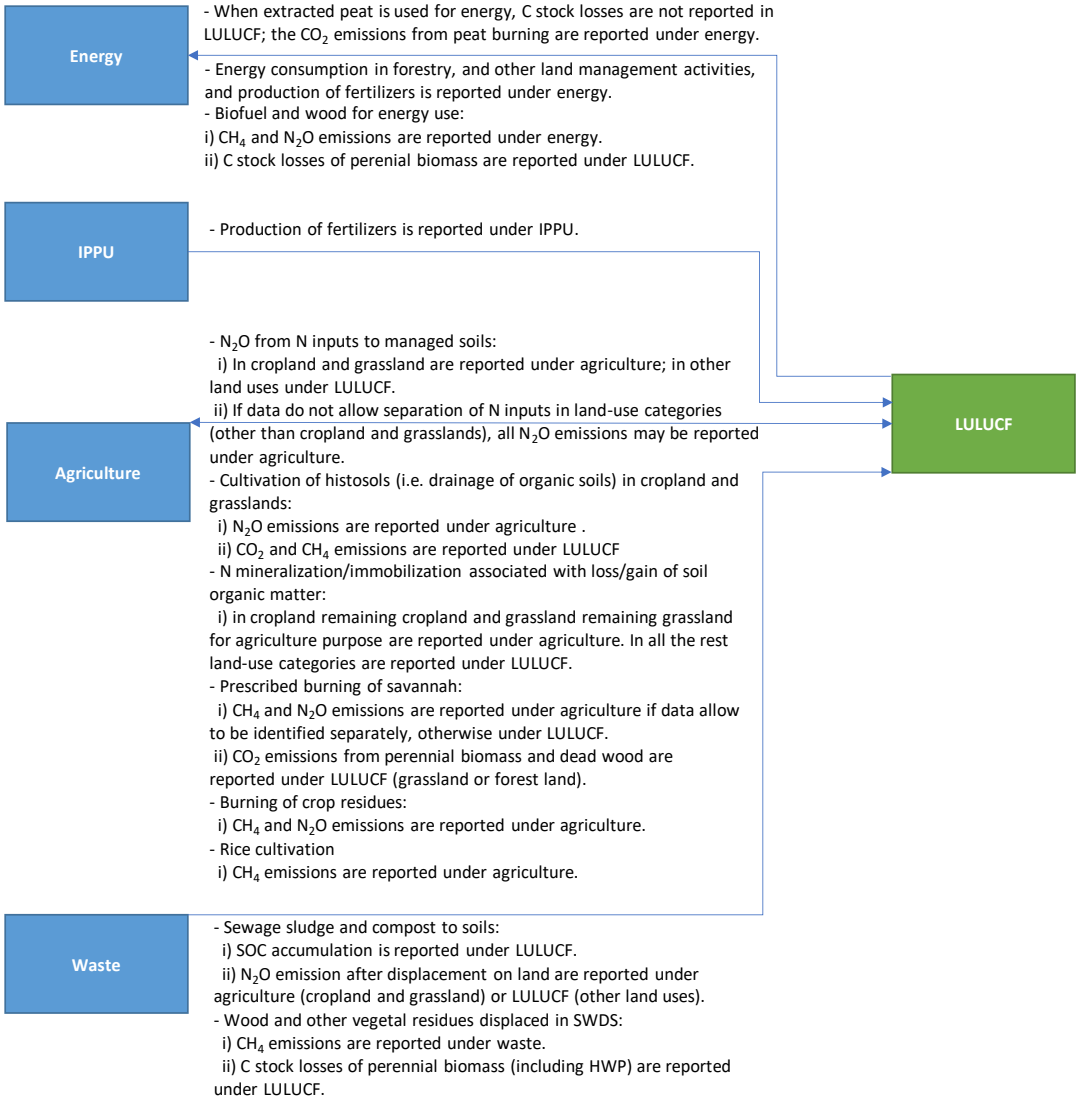
3. Cross-sectoral issues

The reporting of GHG emissions/removals in the LULUCF sector has linkages with other IPCC sectors in the national GHG inventory, especially with the agriculture sector. While CSC in agricultural soils are always reported under the LULUCF sector, some non-CO_2 emissions/removals, although associated with CSC, are reported under the agriculture sector (e.g. N_2O from cultivation of organic soils and from mineralization/immobilization associated with loss/gain of SOM in mineral soils in cropland remaining cropland and grassland remaining grassland).

Furthermore, CH_4 and N_2O emissions from burning:

- Of crop residues are reported under the agriculture sector, and
- From forest and grassland defined as savannah are reported under the agriculture sector if data allow to be identified separately, otherwise must be reported under in CRT 4.IV (in any case double counting or omission of reported emissions between CRT 3.E and CRT 4.IV should be avoided)

while CO_2 emissions from perennial biomass in cropland and grassland are reported under the LULUCF sector, whereas CO_2 emissions from crop residues burning and savannah burning are not estimated based on the annual equivalence or synchrony of emissions and removals.



J. Figure 2-8. Linkages between land use, land-use change and other IPCC sectors

Furthermore, all net CO_2 emissions/removals associated with HWP C stock losses/gains are reported in the LULUCF sector. CH_4 and N_2O emissions from HWP used for energy are reported in the energy sector (CO_2 emissions are reported as a memo item) and CH_4 emissions from HWP in SWDS are reported in the waste sector (although long-term C storage in SWDS is reported as a memo item).

During the review, you must collaborate with your colleagues reviewing the other sectors, especially the agriculture expert, in order to ensure that consistent information is reported in the GHG inventory among sectors, as necessary.

The best guidance to help your work during the review are the CRT, which define the allocation of emissions and removals in the different source/sink categories. For example, N_2O emissions from mineralization/immobilization associated with loss/gain of SOM in mineral soils in cropland remaining cropland are to be reported in the agriculture sector, whereas emissions in land converted to cropland are to be reported in the LULUCF sector (see footnotes 2 and 4, to CRT 4(III) and CRT 3.D respectively).

You can find a list of the various source/sink categories and the allocation in the reporting of associated GHG emissions/removals between the LULUCF and agriculture sectors following the CRT structure.

Figure 2-9 shows details on how emissions and removals from different sources and sink categories are allocated between the LULUCF and agriculture sector.

Source/sink category	Agriculture	LULUCF	
		Agricultural land	Non-agricultural land
Fertilization, liming, urea application	N_2O (cropland, grassland) and CO_2 emissions		N_2O emissions if disaggregated information is available ensuring consistency with agriculture sector, otherwise aggregated N_2O emissions from all land-use categories in agriculture
Drained and rewetted organic soils	N_2O emissions from drainage of soils (cultivation of cropland, grassland)	• CO_2 emissions from drainage of soils • (CH_4 emissions from drainage of soils) • (CO_2 removals from rewetting of soils) • (CH_4 emissions from rewetting of soils) • (N_2O emissions from rewetting of soils, higher tier)	
			N_2O emissions from drainage
N mineralization/ Immobilization associated with loss/gain of soil organic matter due to land-use/management changes	N_2O emissions/avoidance in agricultural land, except land converted to cropland and land converted to grassland	N_2O emissions/avoidance from land converted to cropland and land converted to grassland	N_2O emissions/avoidance
Biomass burning	• N_2O, CH_4 from crop residues burning • N_2O, CH_4 from prescribed burning of savannahs if data allow to be identified separately, avoiding double counting with LULUCF	• CO_2 emissions from burning of perennial biomass, DOM and SOM, if any • non-CO_2 emissions from burning of any C stocks, except from those reported under agriculture	• CO_2 emissions from burning of perennial biomass, DOM and SOM, if any • non-CO_2 emissions from burning of any C stocks
Rice cultivation	CH_4 emissions		

(When 2013 IPCC Wetlands Supplement is applied)

K. Figure 2-9. Allocation of emissions between LULUCF and agriculture sectors

4. General approach in reviewing the sector

Before starting your work on reviewing the Party's GHG inventory you should refresh your memory on the general approach to be followed, as you have learned in the overview and cross-cutting issues course.

As you can see in figure 2-10, several actions should be taken in the different steps of the review process (before, during and after the review week), in order to adequately implement your review.

It is important that you prepare yourself well in advance of the review week by refreshing your knowledge of the 2006 IPCC Guidelines, volumes 1 and 4, and the Wetlands Supplement; the latest decisions and lead reviewer conclusions. Furthermore, you should allocate sufficient time to study thoroughly the previous review reports and findings, the NID section on LULUCF and the respective CRT (section 4) before the review starts and you start your assessment of the LULUCF GHG inventory. This will allow you to prepare your questions to the Party early before the review week and give the Party sufficient time to respond to your questions. In turn you will have more time to raise any follow-up questions to the Party and to start drafting your review report, preferably even before the start of the review week.

Keep in mind that preparing and starting your review before the review week and developing an effective review strategy are key parameters that will help you perform a successful review. Your final questions to the Party ideally should be communicated early in the review week and the complete first draft of your review report should be submitted by the end of the review week.

	Prepare	Assess	Draft
Before review week	• Refresh knowledge of 2006 IPCC Guidelines, latest decisions and lead reviewers' conclusions • Read submission (CRT and NID) • Identify previous recommendations and encouragements • Familiarize self with latest review tools		• Draft preliminary questions, and follow-up questions as necessary • Begin drafting review report based on findings
During review week	• All preparations should be done prior to the review week	• Evaluate whether Party addressed findings contained in previous review report • Detailed analysis of submission against TACCC principles, including AD, EF and parameters, beginning with key categories and using review tools to facilitate work • Assess institutional arrangements for sector • Assess other cross-cutting issues (QA/QC, uncertainty, time-series consistency, recalculations, planned improvements) • If relevant, identify possible capacity-building needs • Discuss questions and issues with expert team, as needed	• Finalize questions to Party early in week • Draft assessment of implementation of previous recommendations • Draft new recommendations/ encouragements, as appropriate • Fully complete first draft of your report, responding to comments from team • If relevant, consult with Party to draft capacity-building needs
After review week			• Finalize draft report • Respond to UNFCCC and Party comments

L. Figure 2-10. General approach in reviewing the LULUCF sector

4.1. Common reporting tables

The GHG emissions and CO_2 removals and related information from the LULUCF sector are reported in 14 CRT (CRT 4, 4.1, 4.A–4.F, 4I–4IV and 4.Gs1–4.Gs2) (see figure 2-11). The complete set of CRT are available through a link in annex I to decision 5/CMA.3.

With the exception of developing country Parties that need it in the light of their capacities and apply the flexibility regarding the time series for GHG inventories, the GHG information reported in the CRT

will cover the whole time series from 1990, to the latest inventory year which is no more than two years prior to the submission of the GHG inventory.

CRT	CONTENT
Summary table	
4	Total GHG emissions & CO_2 removals for the sector by land-use category
Activity data for land categories	
4.1	Land transition matrix
Carbon stock changes by pool in each land-use category	
4.A	Forest land (carbon stock changes)
4.B	Cropland (carbon stock changes)
4.C	Grassland (carbon stock changes)
4.D	Wetlands (carbon stock changes)
4.E	Settlements (carbon stock changes)
4.F	Other land (carbon stock changes)
4(I)	Direct & indirect N_2O emissions from nitrogen N inputs to managed soils
4(II)	Emissions & removals from management of organic & mineral soils
4(III)	N_2O emissions from N mineralization/immobilization associated with SOM changes resulting from land-use or management changes in mineral soils
4(IV)	Biomass burning
Carbon stock changes in the HWP carbon pool	
4.Gs1	Harvested wood products
4.Gs2	Harvested wood products (activity data)

M. Figure 2-11. Relevant common reporting tables for the land use, land-use change and forestry sector

Remember that the MPGs provide two types of flexibility regarding the time series:

- The first refers to the initial year of the time series (para. 57). Developing country Parties that apply this flexibility may report GHG information at least for the reference year/period for their NDC under Article 4 of the Paris Agreement AND a consistent annual time series from at least 2020 onwards;
- The second refers to the last year of the time series (para. 58). Developing country Parties that apply this flexibility may have their latest inventory reporting year as three third year prior to the submission of their national inventory report.

For more information on the application of the flexibilities consult the overview and cross-cutting issues course.
In addition, the following information is reported in the CRT:

- Key category analysis, including and excluding the LULUCF sector, in CRT 7;
- Recalculations in CRT 8s1–8s2;
- Information on completeness and notation keys in CRT 9;
- Information on methods and EFs in CRT Summary3.

Note that the secretariat has prepared a reporting tool (software) for the electronic reporting of the CRT for all IPCC sectors, including the LULUCF.

4.2. National inventory document

All Parties must provide a NID. The NID chapter for the LULUCF sector should contain all necessary information that the reader needs in order to clearly understand how the GHG inventory has been developed. Your role as a reviewer is to assess whether the Party provides this information in a transparent manner in order also to review the accuracy, completeness, consistency and comparability of the GHG inventory report.
The Parties are encouraged to follow the NID outline included in annex V to decision 5/CMA.3.
During your review you must always assess whether the Party reports all the required information in the NID at a source/sink category level and gas, and at the most disaggregated level (i.e. ideally at the level at which the GHG emission/removal estimations have been done).

4.3. General review of the LULUCF sector

Note that general guidance on conducting the review of a national GHG inventory, along with the general reporting requirements, is provided in the overview and cross-cutting issues course, with which you should be familiar before undertaking the current course.

The key objectives of the review process are to review the consistency of the information submitted by the Party with the MPGs, to identify accordingly any areas of inconsistencies (i.e. potential issues) and areas of improvements and to provide guidance on how the Party could overcome these issues and improve its inventory preparation and reporting in future submissions. The technical review process also entails assisting those developing country Parties that need flexibility in the light of their capacities in identifying capacity-building needs.
In this context, as a reviewer, you must assess whether the Party's GHG inventory fulfils the requirements of TACCC principles and how the IPCC guidelines are implemented through the MPGs.

Note that you must have a clear understanding of the TACCC principles and how the IPCC guidelines are implemented through the MPGs in order to perform a successful technical review. Consult lesson 2 of the overview and cross-cutting issues course to refresh your knowledge if necessary.

General
Lessons 3–9 address identification of possible sectoral issues in more detail. However, before starting a thorough review of the methodologies applied for preparing the GHG estimates, you should proceed with a routine of general checks specific to the LULUCF sector as presented in the following slides.
Some general initial check points that you must consider when assessing the national inventory report of a Party, in addition to those you have learned in the overview and cross-cutting issues course are presented below.
Check whether:

- The Party has reported LULUCF-related information in all relevant CRT and included a chapter on LULUCF in its NID;
- The LULUCF chapter in the NID includes all relevant sections as encouraged in the NID outline contained in annex V to decision 5/CMA.3;
- The information reported on LULUCF source/sink categories is sufficiently transparent;
- For each CSC estimated, the corresponding GHG emissions and removals have been reported in the appropriate CRT.

Documentation
Check the information that should be included in the NID, taking into account the flexibility provided by the MPGs for those developing Parties that need it in the light of their capacities. In particular, check whether the Party has reported information on:

- The methodologies, the rationale for their choice, any assumptions, inferences made, AD, EFs and other parameters used in preparing the GHG emissions/removals estimates for the C pools in land-use categories, together with the sources of information;
- Uncertainty analysis results for LULUCF, methods used, underlying assumptions, uncertainty of the input data (AD, EFs, parameters), noting the flexibility provided to developing country Parties that need it in the light of their capacities (para. 29 of the MPGs);
- The reasons for any completeness issues, any methodological or data gaps, including the geographical coverage of the LULUCF sector as well as the relevant C pools and land-use categories and subcategories for which the Party has to provide estimates of emissions/removals according to the methodological choice;
- LULUCF-specific QA/QC and verification procedures implemented or planned to be implemented for the LULUCF sector, noting the flexibilities provided to developing country Parties that need it in the light of their capacities (paras. 34 and 35 of the MPGs).

GHG emissions/removals allocation and double counting

Check that the relevant GHG emissions and/or CO_2 removals have been reported under the correct category and that no double counting has occurred. For instance:

- CO_2 emissions from burning of perennial organic matter are reported either in CRT 4(IV) or in the CRT for the CSC of the relevant land-use category (CRT 4.A-4.F);

Note that if the stock-difference method has been applied to a C pool, the CO_2 emissions associated with combustion are included in the CSC estimated for the C pool, and consequently, these emissions must not be reported in CRT 4(V), where the notation "IE" has to be reported together with an explanation.

- CH_4 and N_2O emissions from burning of agricultural residues are reported in the agriculture sector CRT 3.F "Field burning of agricultural residues";
- CH_4 and N_2O emissions from forest and grassland defined as savannah are reported in the agriculture sector CRT 3.E "Prescribed burning of savannahs" if data allow to be identified separately, otherwise must be reported under in CRT 4.IV (while avoiding double counting or omission of reported emissions between CRT 3.E and CRT 4.IV) ;
- Direct and indirect N_2O emissions from fertilization of cropland and managed grassland are reported in the agriculture sector CRT 3.D 'Direct and indirect N_2O emissions from agricultural soils'. Direct N_2O emissions from fertilization of other land uses, if they cannot be separately identified, may be reported in CRT 3.D. Consistently, associated indirect N_2O emissions will also be reported in CRT 3.D;

- CH_4 emissions from wetlands rice fields are reported under agriculture in CRT 3.C "Rice cultivation". N_2O emissions from wetlands organic or mineral soils used for cultivation are reported under agriculture in CRT 3.D. Any other CH_4 and direct N_2O emissions from wetlands are reported in the LULUCF sector in CRT 4(II), including CH_4 emissions from ditches in drained organic soils, including in cropland and/or managed grassland;

- Net direct and indirect N_2O emissions from N mineralization/immobilization associated with loss/gain of SOM resulting from change of land use or management of mineral soils in managed forest land, managed grassland (for other than agricultural purposes), managed wetlands and settlements, including land-use change to cropland and grassland, are reported in CRT 4(III), while those occurring on cropland remaining cropland and grassland remaining grassland for agricultural purposes are reported under agriculture in CRT 3.D;

- Estimates of fuelwood consumption reported in the energy sector should be consistent with fuelwood collection/production reported for biomass and HWP estimates;

- All net CO_2 emissions/removals associated with HWP C stock losses/gains are reported in the LULUCF sector, including those from HWP displaced in SWDS and those for energy use. Note that the reporting of the HWP pool is limited to HWP in use in CRT 4.Gs1.

Consistent use of common information, AD

Check whether:

- Consistency among estimates for different GHG emissions and removals resulting from the same stock change has been ensured. For instance, ensure CO_2 and N_2O emissions resulting from loss of SOM in mineral and organic soils are consistent with each other based on the C/N ratio of the soil, particularly when different methodologies are applied for estimating different GHGs, such as when a Party is using a country-specific EF for N_2O emissions in the above-mentioned example and IPCC default parameters for CO_2 emissions (see a related exercise 4, in practical exercises in lesson 8);
- The Party has constructed consistent time series of annual data where non-annual measurements are used to estimate emissions.

Check that AD common to more categories are consistently used across CRT. In particular:

- The sum of areas of drained organic soils under cropland and managed grassland reported in CRT 4(II) as well as the sum of areas of drained organic soils under cropland and managed grassland reported in CRT.4B and CRT.4C match the area reported under "Cultivation of organic soils" under agriculture in CRT table 3.D;
- For organic soils, the IEFs of N (kg N_2O–N/ha) and C (t C/ha) are consistent with each other according to the C/N ratio of organic matter.

Note that the IEF for CO_2 emissions in CRT 4.A–4.F is in t C, and therefore has to be converted to kg C (by multiplying by 1,000) before being compared with the IEF for N_2O emissions in CRT 4(III) to verify their consistency with the C/N ratio. Also note that only a fraction of the N contained in the soil is emitted as N_2O (see table 11.1, volume 4 of the 2006 IPCC Guidelines) and that therefore the N_2O-N weight must be divided by the relevant EF_1 before being compared

- Quantities and estimates of fuelwood reported in the energy sector are consistent with harvesting statistics and with statistics on fuelwood production, import and export to ensure that no double counting or omissions have occurred.

Data collection and uncertainties

In many cases sampling techniques are applied in the LULUCF sector. When sampling procedures are used, biases are generated when the sample does not cover the entire variability of the population, or any elements of the population do not have the same probability to be sampled. Although calculated uncertainties may incorporate unknown biases, the inventory compiler must make every effort to identify and avoid potential biases to ensure that the calculated uncertainty represents only random errors and that, consequently, the reported average value is an unbiased estimator. Therefore, it is of utmost importance that you assess whether estimates using sampling procedures are unbiased. The following non-exhaustive list is intended to be merely a starting point to stimulate your thinking in order to assess the accuracy and precision of the estimates. Check whether:

- Sound statistical sampling surveys are applied for data collected to be used in the inventory (or a part of it) and whether description of sampling protocols has been provided;

- Samples are selected randomly (e.g. simple random samples located as part of an NFI);

- Data are collected homogeneously across the entire land category, or are at least representative of the entire variability in space and time of the population being sampled (e.g., all forest types are covered by the sampling scheme). If this is not the case then:

✓ First, you should identify whether there is likely to be a bias in the estimates (e.g., using evidence from scientific literature);

✓ Second, you should recommend that the Party remove the bias, along with suggestions on how to do so (e.g., by using published data, which may enable you to either quantify the likely bias, or at least provide a qualitative assessment);

- Sources of bias have been adequately identified and biases have been removed, to the extent possible;

- The Party has stratified the population sampled and assessed whether it could increase the sample size, taking into account national circumstances, in cases where estimates are associated by large uncertainty, in order to reduce the uncertainty of sampled variables;

- The paired sites comparison approach has been applied in line with the 2006 IPCC Guidelines (vol. 4, chap. 2, section 2.3.3.1; and vol. 4, chap. 4, section 4.2.3.2) with the paired sites differing only by a single factor, with all other factors being similar, if sampling collects data on the impact of a single factor on GHG emissions/removals;

- Any, and if so which, parts of the population have been excluded from sampling in the different land-use categories (e.g. if the entire forested area has not been used as the source population for sampling, which parts have been excluded?) Furthermore, you should check whether the population from which data have been collected corresponds to the population reported (e.g. does the forest area from which the data have been collected correspond to the forest definition applied for identifying forest land?);

- The estimation of areas of different land categories and of conversions between different land categories were based on direct estimation of area or on estimation of areas via proportions when sample surveys have been used (see guidance on sampling methods for area estimation in the 2006 IPCC Guidelines, vol. 4, chap. 3, annex 3A.3);

- The Party has provided information on the uncertainty of input data (AD, EFs, parameters) used in estimating GHG emissions/removals in LULUCF source/sink categories, taking into account the flexibility provision referred to in paragraph 29 of the MPGs;

- The uncertainty calculation captures a factor's variability when the factor is applied to the entire population for which it is derived, although a factor's variability also matters when the factor is applied to a subset of the entire population for which it is derived (see a relevant exercise 9 below in practical exercises);

- The Party's description of uncertainty analysis includes information on correlation of data. If this information is missing, you should ask the Party to provide it;

- Uncertainties of the input data are specified based on empirical data or on expert judgment, if empirical data are not available;

- Uncertainties associated with the use of expert judgment have been considered;

- Any models applied in the inventory have been calibrated and validated. Check whether a sensitivity analysis has been conducted and whether any references have been provided to publications (articles, journals, etc.) where tests of validity of model outputs and information on peer-review activities have been reported.

Methodological choice

Check whether:

- The key category analysis has been performed for each gas at the suggested aggregation level provided in the 2006 IPCC Guidelines (vol. 1, chap. 4, table 4.1). For example, for land-use categories, it has been performed for each gas at the level of land remaining in the same land-use category and land converted to another land-use category. If this level is different from that in table 4.1, check whether the Party has provided a rationale for the aggregation levels used;
- The Party has identified significant subcategories and C pools (significance analysis);
- The conversion of forest land (deforestation) has been properly addressed in the key category analysis;
- The methods used for estimating GHG emissions/removals of key categories and significant subcategories and C pools in the LULUCF sector are appropriate based on the decision trees in the 2006 IPCC Guidelines.

For key categories/significant subcategories and C pools (e.g. living biomass in forest land remaining forest land) when the Party uses tier 1 methods:

- Check whether the Party clearly documents why it was unable to follow the decision trees for the methodological choice. If not, you must recommend that the Party do so;
- Check whether region-specific or country-specific factors/parameters from neighbouring countries with similar conditions could be used, if it is demonstrated that their use enhances the accuracy of the estimate, until country-specific factors/parameters become available;
- Recommend that the Party apply a higher-tier method.

For non-key categories/insignificant subcategories and C pools , when the Party uses IPCC default factors check whether:

- The IPCC default factor/parameter represents the national circumstances appropriately for the category, and if not encourage the Party to develop country-specific factors/parameters;
- Each IPCC default factor has been correctly applied according to the IPCC default stratification in land use, climate zones, soil types, ecological zones, vegetation types (if any) and management type (if any). If a Party uses a country-specific stratification scheme that is different from the IPCC default stratification, you should evaluate the applicability of each IPCC default factor used to that country-specific stratification.

Check whether:

- There are activities ongoing, or under planning, to enhance the quality and completeness of AD used, as well as of methodologies applied;
- Planned improvements take into consideration the results of key category analysis (are improvements for key categories for which tier 1 is applied being prioritized?);
- Proper documentation on the values of country-specific parameters has been provided, and whether any country-specific values applied by the Party are within the range of IPCC defaults and comparable to those used by other countries with similar conditions, otherwise whether justification for any differences is reported;
- When a tier 3 method/model is applied, a description of the assumptions (principles, equations, etc.) and key parameters used in the model are provided, and whether information on any verification activities performed (e.g. by comparison with results of IPCC default methods) consistent with the 2006 IPCC Guidelines is reported. Remember that the use of a model cannot meet the need for monitoring systems to regularly provide input data for the model calibration and to verify model outputs across space and time with, for example, the IPCC default methodology (see the 2006 IPCC Guidelines, vol. 4, chap. 2, section 2.5).

If a Party uses information from an NFI check whether:

- Proper documentation on the forest inventory methodology, coverage and frequency is provided in the NID;
- The sampling procedure is appropriate and unbiased;
- Definitions used are the same throughout the time series;
- CSC are calculated at the plot level or calculated by taking the difference of average densities or total carbon stocks;
- CSC are calculated every X years with X being the time period between two complete successive NFIs across the entire area, or are calculated each year with data on parts of forest area collected in the two given years, and if the latter applies whether annual data are representative of the entire national forest area.

Time-series consistency and recalculations

Check whether:

- The Party has applied methods, AD and EFs to estimate the emissions/removals from the LULUCF sector in a consistent way through the time series;
- Methods and data availability have changed or improved over time, and if so, whether the Party has recalculated the LULUCF estimates for the whole time series using consistent data sets and the same methods, and whether it has applied splicing techniques to achieve consistency in time series in accordance with the 2006 IPCC Guidelines;
- The Party has provided documentation in the NID on how any inconsistencies between different data sets (e.g. coverage, definitions, etc.) have been addressed, and how consistent time series of annual data have been constructed from non-annual measurements;
- Equivalent CSCFs or EFs have been used for symmetric processes (e.g. conversion from/conversion to a land-use category);
- EFs of different GHGs related to a given stock change are consistent with each other (e.g. when a country-specific EF for N_2O emissions from N mineralization associated with loss of SOM (estimated using IPCC default methods) as a result of a land-use change is consistent with the C losses reported, taking into account the C/N ratio);
- CSCF and other factors and ancillary data applied for estimating CSC and other emissions and removals from a land category are consistent with the boundaries and definitions of that category.

QA/QC and verification

Check whether:

- The Party has provided, disturbance matrices to map C stock losses from and transfers between C pools for land-use categories;
- The land-use matrices for the complete time series (including for the years before the starting year of the inventory, that is, 20 years before if the 20-year IPCC default transition period is used) have been reported, and if not, ask the Party to report these matrices in the NID;
- The Party has applied stock-difference or gain-loss for the net CSC in a pool and whether a verification of the results by applying the other method has been done. If data are available, you should encourage the Party to do so;
- The data reported by the Party compare with international statistics (e.g. FAOSTAT/FAO GFRA) when applicable.

Processes and CSC methods

Check whether:

- The Party has estimated C stock gains and losses associated with both processes (abrupt and continuous) for each use/management change, where relevant, to ensure accuracy of emissions/removals estimates;
- Emissions and removals associated with the continuous process have been estimated according to the relevant time frames (e.g. biomass growth in perennial crops for the time period until maturity);
- The conversion period applied in reporting CSC and the transition periods applied for land-use/land-management changes are provided.

Gain-loss and stock-difference method application

When the gain-loss method is applied check whether:

- All C stock gains and losses have been estimated;
- For each C stock input reported in a pool, losses of C stock due to its subsequent decay or loss due to disturbances are also estimated:
  - If you find that gains and losses have not been completely estimated, recommend that the Party report complete CSC by using available national data or making efforts to collect them. If the pool is significant within a key category and no country-specific data on gains and losses are readily available, you should recommend that the Party collect national data and, in the meantime, apply IPCC default data together with methods reported in chapter 5, volume 1 of the 2006 IPCC Guidelines to derive the required data (in particular, by using as surrogate data the C stock gains or losses that occurred in other C pools) if necessary. If the pool is not significant within a key category and if the Party cannot collect the necessary data to estimate all the gains and losses, you could encourage the Party to collect relevant information and, in the meantime, apply IPCC default data and methods to estimate them;
- For each C stock loss that is transferred to another C pool, an equivalent C stock gain in the input pool occurs, unless the input pool is estimated to be at equilibrium by applying a tier 1 method. If you find an inconsistency, recommend that the Party address it, and suggest ways to do it. For instance, by considering the different data sets and methods used for estimating the same C stock as output from pool X and as input into pool Y, prioritizing the estimate prepared with higher-quality data/methods.

When the stock-difference method is applied check whether:

- The time period between two consecutive C stock estimates (at time t_1 and t_2) or the transition period between equilibrium stock levels are correctly applied in the estimation of CSC;
- The method has been correctly applied on the same area across a time period (i.e. area at time t_2 is equal to area at time $_1$);
- C stocks have been estimated by applying the same land-use and C pools definitions at the two points in time (t_1 and t_2) or a correction has been applied to ensure consistency between definitions.

4.4. Walk-through example

The following example will help you better understand how to review a Party's GHG inventory submission in practice. In particular, this example simulates the review of the latest GHG inventory (the submission year is 2026 in this example), in which you, as a member of the TERT, are required to review the information related to the LULUCF sector. You will work on a three-step example, starting from the analysis of the previous TERR and the current submission, through potential interaction with the Party, to drafting of your zero-order draft TERR.

Background information

You are reviewing the LULUCF sector of Party X's GHG inventory submission of 2026. During the review of the previous inventory cycle (2024), the previous TERT identified several issues and provided recommendations for the LULUCF sector. You have already learned that you should start your review by assessing the progress made by the Party in relation to the previous recommendations and whether or not those issues have been resolved. In this example, you will work on one example related to emissions from biomass burning. You can find the resource material you will need for the review of this example case below.

Download the copy of the previous TERT's recommendation as included in the previous TERR: https://unfccc.int/resource/tet/bl/bl2-04_u_l2_att4.pdf

Download CRT 4(IV) from the Party's 2026 submission: https://unfccc.int/resource/tet/bl/bl2-05_u_l2_att5.xlsx

Download the extract of the relevant part of the NID from the Party's 2026 submission: https://unfccc.int/resource/tet/bl/bl2-06_u_l2_att6.pdf

1. Analyse and identify all components of the previous recommendation

When you are reviewing the Party's submission against a previous recommendation, it is very important that you firstly understand clearly what the previous recommendation is about and what is required from the Party in order to resolve the issue identified by the TERT. Therefore, you should pay particular attention to both the description of the issue and the recommendation made by the previous TERT. For

this, you must read carefully the previous TERR. Note that typically, not all issues identified by a TERT are resolved by Parties in the next GHG inventory submission. Consequently, some previous recommendations in the previous TERR may relate to issues identified in reviews earlier than the previous one, which, if not resolved by the Party, are included in the latest TERR. Thus you may need to read all previous TERRs back to the original TERR that first identified the issue under analysis to fully understand it. While analysing the previous recommendation, it is important that you:

- Identify and assess all of its components;
- Do not omit any of its components;
- Do not expand the scope of the previous recommendation.

With the above in mind, try to identify all the components of the previous recommendation. Then compare with the results of your analysis with the document available here: https://unfccc.int/resource/tet/bl/bl2-07_u_l2_att7.pdf.

2. Assess Party X's progress in implementing the recommendation

Now that you have analysed the Party's inventory and the previous recommendation, do you consider that all the information you have is adequate to assess how the Party has progressed in relation to the previous recommendation and all of its components?

A. Yes
B. No

Would you ask the Party question in relation to this issue or would you choose not to spend more time because the review time is limited and it is evident that the Party has not resolved all the components of the previous recommendation?

A. I would request more information from the Party for the issue under assessment
B. There is no reason to communicate further with the Party on this specific issue, because it is evident that not all of the components of the previous recommendation have been addressed

3. Draft your TERR

After you have collected all the information you need in order to complete your assessment of the progress made by the Party regarding the previous recommendation, the next step is to draft the TERR. Please try to draft on your own a paragraph of the zero-order TARR for this issue by;

- Providing your final assessment about whether the issue identified by the previous TERT is 'resolved', 'not resolved' or 'addressing';
- Including the rationale for your assessment;
- Including any further information you would like to add in relation to your interaction with Party X during the review.

Then you can compare your draft TERR with a proposed text which you can find here: https://unfccc.int/resource/tet/bl/bl2-08_u_l2_att10.pdf

4. Additional considerations

Now let us suppose that you identified that the same issue occurs for all the years of the inventory times series and is not limited only to 2011. Or suppose that the Party has addressed all components of the previous recommendation but during the review of the methodology applied by Party X to estimate emissions from wildfires, you identified a finding in relation to the appropriateness of a parameter used (e.g. the value for the average biomass of lands affected by wildfires).

Would you take the above findings into account when assessing the progress of Party X against the previous recommendation?

A. Yes, I would definitely take these findings into consideration because they are related to the issue identified by the previous TERT
B. No, I would not take these findings into consideration because they are out of the scope of the previous recommendation

4.5. Answer key to walk-through example

Question 1

The correct answer is B (No). Download this document (https://unfccc.int/resource/tet/bl/bl2-09_u_l2_att8.pdf) to find more information on the reasons why the information you have on hand is not enough in order to come to a conclusion on how the Party has progressed regarding the previous recommendation.

Question 2

The correct answer is A (Yes). You definitely need to interact with the Party in order to collect all necessary information that will help you get a complete understanding of whether and how emissions from wildfires in land converted to forest land in 2011 have been reported in the national GHG inventory. Download this document (https://unfccc.int/resource/tet/bl/bl2-10_u_l2_att9.pdf) for more information about your possible interaction with the Party and a hypothetical feedback from Party X.

Question 3

The correct answer is B (No). Both findings are beyond the scope of the previous recommendation. For the first finding, remember that the previous recommendation is limited explicitly to 2011. Therefore, if the Party has addressed all components of the previous recommendation for 2011, you must consider that the issue is 'resolved'. For the second case, note that the previous recommendation is about an issue of completeness (i.e. missing estimate). Therefore, an issue of accuracy (e.g. the appropriateness of a parameter used in calculations) is beyond the scope of the previous recommendation. For both cases, as a reviewer, you must draft a new issue in the TERR.

5. Practical exercises

Approaches to data collection
Click on the tabs to find more information and example cases regarding NFI-based approaches to data collection for estimating CSC.

Exercise 1

Annual average net C stock change
A Party has calculated the net CSC (net increase) in biomass for 2000–2010 using the data sets from the last two forest inventories, that is, 2000 and 2010, and it applies the same constant rate of net CSC in biomass in 2011–2015. However, for the same period, 2011-2015, the Party reports significantly different annual area subject to disturbances compared with that of 2000–2010.

Question 1

Could you think of any potential issues that may arise from the approach applied by the Party?

Extrapolating regional information to nationwide
In order to report CSCs a Party uses data from its NFI collected from a part of the total forest area (e.g. the annual fraction of a continuous forest inventories) and derives nationwide statistics. In the different parts of the forest (strata), very different C dynamics occur due to management practices applied.

Question 2

Could you think of any potential issues that may arise from the approach applied by the Party?

Sampling, bias example
Below you will find examples related to the application of sampling for data collection. The examples are intended to provide you with an idea as to how you should approach each case and elements to take into account when reviewing a Party's inventory. However, it does not mean that in all such cases, the findings are related to an issue or such problems are common across all Parties.

Exercise 2

A Party applies the same forest definition to the source population from where the sample was extracted as for reporting its national GHG inventory. However, during the review, you find that for several reasons (e.g. difficult access to forest areas), some areas are excluded from sampling and/or their inclusion is biased (e.g., samples are taken only for locations with similar characteristics and very close to the roads).

Question 3

Could you think of any potential issues that may arise from the approach applied by the Party?

Exercise 3

For estimating CSC in mineral soils, a Party uses (i) country-specific stock change factors together with SOC reference values for some land-use categories and (ii) average country-specific SOC values for some other land-use categories (e.g., average SOC values of cropland use and of forest land use to estimate CSC associated with conversions from one of these land-use categories to the other). However, you cannot find any additional information in the NID on how the country-specific stock change factors and the average SOC values have been developed.

Question 4

Could you identify some areas that you should focus your review on?

Exercise 4

Data used for the estimates of a GHG inventory for the LULUCF sector are partly based on an NFI for which a statistically sound sampling strategy is applied. However, the sampled target population is based on the definition used for the NFI which is different from that used for the national GHG inventory. For example, for the national GHG inventory, the Party reports forest land using the FAO definition (10 per cent threshold for crown cover), but the target population from where the sample was extracted was forest land defined in accordance with a national definition, such as timber production >1 m^3 ha^{-1} yr^{-1}.

Question 5

What would you check during your review?

Exercise 5

A Party reports GHG emissions/removals from forest land using NFI data from 2000 and 2010. However, you detect that the 2000 NFI is stand-based (e.g. focusing on the actively managed forests) while the 2010 NFI is sample-based with samples being collected from the total forest area.

Question 6

What would you check during your review?

Uncertainties

Exercise 6

A Party reports uncertainties for all GHG source/sink categories, but uncertainties of various components of the estimate are not included, such as uncertainty of BEFs, or uncertainty of applied soil models, because they are not known.

Question 7

What would be your action as a reviewer? Would you include a recommendation or encouragement in the TERR on this? If so, what would your recommendation or encouragement be?

Exercise 7

A Party has estimated the uncertainty in the different source/sink categories using mainly expert judgment for the uncertainty associated with the different inventory components without providing any further information.

Question 8

What would be your action as a reviewer? Would you include a recommendation or encouragement in the TERR on this? If so, what would your recommendation or encouragement be?

Exercise 8

A developed country Party applies sampling methods for estimating land areas on land uses and land-use changes (e.g. via proportions); however, no information on uncertainties has been reported.

Question 9

What would be your action as a reviewer? Would you include a recommendation or encouragement in the TERR on this? If so, what would your recommendation or encouragement be?

Uncertainty versus variability

Exercise 9

A Party estimates the average C stock in above-ground biomass (t C ha^{-1}) in temperate continental forest land from the data collected from the NFI composed of 3,000 sample points. The mean value of biomass C stocks estimated is 47.1 t C ha^{-1}, with a sample standard deviation of ±13.3 t C ha^{-1}. The standard deviation of the distribution reflects the variability of biomass density across the country.

Question 10

Could you indicate the percentage uncertainty associated when the average C stock in above-ground biomass (t C ha^{-1}) is used for estimating:

1. C stock losses in deforestation to annual cropland?
2. CSC between two consecutive forest inventories (i.e. by comparing the two consecutive average C stock values)?

Exercise 10

A Party does not include all LULUCF categories as suggested in table 4.1, chapter 4, volume 1 of the 2006 IPCC Guidelines in the key category analysis.

Question 11

What would be your action as a reviewer?

Exercise 11

A developing country Party from East Asia identifies its key categories, but GHG emission/removal estimates from some of these key categories are based on an IPCC tier 1 methodology with the use of default parameters without any further information.

Question 12

What would be your action as a reviewer? Would you include a recommendation or encouragement in the TERR on this? If so, what would your recommendation or encouragement be?

Time-series consistency and recalculations

Exercise 12

A Party reported CSC of above-ground biomass in forest land only in earlier GHG inventories. In the most recent inventory, GHG emissions/removals from the other land-use categories, as well as from the SOM pool in forest land were reported but only for the latest inventory year. The Party has not applied any flexibility provisions for the time series.

Question 13

What would be your action as a reviewer? Would you include a recommendation or encouragement in the TERR on this? If so, what would your recommendation or encouragement be?

Exercise 13

A Party has developed the GHG inventory in accordance with the 2006 IPCC Guidelines. New country-specific AD have been developed and new models have been applied for the latest inventory submission. The emissions and removals of the LULUCF sector are recalculated, and the recalculated values are shown in CRT 8s1, but you cannot find sufficient information on the rationale for recalculations and improvements in the NID.

Question 14

What would be your action as a reviewer? Would you include a recommendation or encouragement in the TERR on this? If so, what would your recommendation or encouragement be?

Exercise 14

A Party has reported net removals from the LULUCF sector for 1990–2022. The 1990–2011 inventory provides estimates only for changes in the C stock from biomass and associated net emissions/removals in forest land. From 2012 onwards, the Party has also reported the DOM and SOM CSC, and the associated net emissions/removals. The Party has adopted good practices as far as practicable, but it has reported in the NID that the time series is not consistent because the data needed for recalculations are available only for 2008.

Question 15

What would be your action as a reviewer? Would you include a recommendation or encouragement in the TERR on this? If so, what would your recommendation or encouragement be?

Exercise 15

A Party has estimated C stocks in living biomass in forest land in two points in time, t_1 and t_2 and applied the stock-difference approach for estimating CSC. You identified during the review that the national forest definition has changed between t_1 and t_2 and that the Party has not taken any action in relation to that. During the review, you raised a question with the Party and it acknowledged the issue and stated that the change in definitions was not taken into account in its calculations.

Question 16

What would be your action as a reviewer? Would you include a recommendation or encouragement in the TERR on this? If so, what would your recommendation or encouragement be?

Cross-sectoral inconsistencies

Exercise 16

A Party has reported losses in biomass C stocks associated with fuelwood collection that amount to 10 per cent of the fuelwood consumption reported in the energy sector.

Question 17

What would be your action as a reviewer? Would you include a recommendation or encouragement in the TERR on this? If so, what would your recommendation or encouragement be?

5.1. Answer key to practical exercises

Question 1

This could potentially result in an inconsistency between estimates of biomass and biomass losses from disturbances, that you as a reviewer should further investigate. Although the Party reports a constant net annual CSC in 2011–2015 based on the net CSE estimated in the period 2000-2010, the annual C losses that occurred in the period 2011–2015 as a result of disturbances in the same forest area are significantly different. You should first request the Party to explain the reasons for the apparent inconsistency. Based on the Party's response, if you are able to establish that the net annual CSC in biomass assumed by the Party for 2011–2015 based on the 2000–2010 rate does not accurately reflect the actual trend, you should ask the Party to collect data to accurately calculate the net annual CSC in biomass. Pending the collection of such data, a way to address such inconsistencies is to use data sets additional to the NFIs as proxies for calculating a corrected rate of biomass net annual CSC using splicing techniques provided in the 2006 IPCC Guidelines (vol. 1, chap. 5). In this example, the data set on areas burned could be used for this exercise.
You can see that in such cases, if the inventory reports a constant net CSC for biomass while reporting C losses using actual data on the area burned, the estimates of the CSC may be inconsistent with each other. Thus, you should always check whether there are such inconsistencies and provide advice on how to avoid them.

Question 2

In this case, estimates may have an artifact showing large inter-annual variability not associated with significant changes in disturbance events and/or harvesting rate but with the changes occurring on the part being sampled, since the C dynamics in the part of the forests sampled are very different from those in the other parts. A way to address such an inconsistency in the time series is to ensure that data collected annually are representative of the entire forest area, or to use models that can predict national totals from partial measurements by using ancillary information.

Question 3

When all the elements of the population do not have the same probability of being sampled and when the sampling does not cover the total geographic area of the population, these are sources of bias. The Party must correct the approach, for example, by changing the sampling design to ensure that samples are selected randomly, and by extending the monitoring system to areas currently not covered (although data collected from a portion of a land category may be assumed to be representative of the entire category if there is no evidence that they are not representative). Another case where bias may arise from the sampling design is when data sampled from a larger population (e.g., the total forest area of a country) are applied to a portion (e.g. the managed forest area of the country). In this case, while for some area-related variables (e.g. burned area), the bias may be removed by scaling data (e.g., by using ancillary information from remote sensing maps or by apportioning the burned area based on the share of the portions), for other variables (e.g. average biomass C stock), the Party must demonstrate the representativeness of the sampling data collected from the entire population (e.g., the total forest area) for applying to a subset (e.g. managed forest). Since lack of representativeness is a potential source of bias, then you, as a reviewer, must assess whether the Party has demonstrated that

the estimated values of variables derived from the entire population are an unbiased estimate of those for the subset.

Question 4

Firstly, you must request the Party to provide you with all necessary information in order to properly review how the country-specific parameters have been developed.
For case (i) note that, when SOC stock change factors in mineral soils undergoing conversion of land use/management are developed, the impact on C stocks of factors other than land use/management should be excluded to calculate unbiased values. The 2006 IPCC Guidelines suggest using paired sites comparison to derive stock change factors where the paired sites differ only by the current land use/management, with all other factors and the history of the land remain the same.
For case (ii), when averaging SOC values, calculating an average SOC stock content across each land-use/land-management category and deriving the CSC as the difference between those averaged values may result in a biased estimate, as factors other than land use/management may have a prominent influence on the SOC stocks. For example, cropland is usually on the most fertile soils and in areas with a flat or hilly topography, while forests are on soils not suitable for agricultural production or with a mountainous topography. However, the country has used average SOC content of cropland use and of forest land use to estimate CSC associated with conversions from one land category to the other, and in the case of forest land conversion to cropland reported a positive dynamic of SOC content (i.e. net gain of carbon). In such a case, you should recommend that the Party verify the calculated CSCFs, for example by using data from paired sites, and if those data are not available in the country, use data from neighbouring countries with similar conditions as an intermediate solution.
You could further encourage the Party to establish sample plots in paired sites for obtaining data in the future. If a country has well-documented data for different forest types under different management regimes, it might be possible to derive SOC stock estimates for mineral soils directly without using reference C stocks and adjustment factors. These soil C stocks can be directly used for estimating the stock changes in the SOC pool. However, it is important to establish their relationship to the reference C stocks in order to compute the CSC in the case of land-use conversions.
In general, when a mix of country-specific and IPCC default factors is used, as a reviewer, it is important to assess consistency among various C stock values, CSCFs and adjustment factors (e.g. the land-use and the land-management factors for SOC). For instance, if a Party estimates changes in SOM in cropland converted to forest land by using a CSCF calculated using data from paired sites but uses default IPCC factors for calculating C stock losses associated with deforestation, the overall calculation of SOC stock changes could be biased. In this case, you should therefore recommend that the Party use the same CSCFs that were used in the case of afforestation of cropland, for estimating SOC stock changes in forest areas converted to cropland, although with an opposite sign.

Question 5

You must check whether the Party has provided information on the differences between the definitions applied, namely, the definition for forest land for reporting GHG emissions and removals in LULUCF and the definition for the sampling (including any thresholds), and how those differences have been taken into account in using the data collected from the NFI for reporting the LULUCF GHG inventory. For example, for reporting the national GHG inventory, the Party follows the FAO forest definition and as such information on CSC and associated GHG emissions must be reported for all managed forest land falling under this definition. If the national forest definition used for the NFI excludes forest areas that

would otherwise fall under the FAO definition, the Party must explain how the necessary information on estimating CSC from these 'excluded' lands have been obtained (e.g., by using data from a complementary project launched for this purpose). On the other hand, if larger areas of the territory are classified as forest land, following the national forest definition, as opposed to the FAO definition, the Party must provide information on how it was able to exclude the GHG emissions/removals estimates from this 'additional' area (e.g. by the use of forest maps overlaid by the sampling grid) from the forest land total.

Question 6

You must check the consistency between the two NFIs and provide guidance on how to correct possible inconsistencies identified, such as differences in the forest area and/or tree parameters measured (e.g. minimum diameter at breast height). In such cases, the consistency of the examples can be ensured by reconciling the oldest data based on the latest ones (e.g. using forest maps and yield tables or modelling approaches).

Question 7

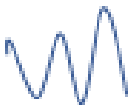
You must recommend that the Party revise the uncertainty analysis by including the uncertainties of all the parameters by collecting relevant data or, if that is not possible, by using IPCC default values or expert judgment.

Question 8

You must ask the Party a clarifying question before the review week about the source of the expert judgment and how the expert judgment was acquired (e.g. based on a stud/studies) or personal communication). In the TERR, you would recommend that the Party document this source of expert judgment in the NID to ensure transparency. If the expert judgment were based on personal communication, you should encourage the Party to use an appropriate protocol for obtaining the expert judgment. Information on such an elicitation protocol can be found in annex 2A.1, chapter 2, volume 1 of the 2006 IPCC Guidelines.

Question 9

You must recommend that the developed country Party report uncertainties associated with sampling and land-use classification (e.g., providing confusion/error matrices), in accordance with paragraph 29 of the MPGs.



Remember that in accordance with paragraph 29 of the MPGs, developing country Parties that need flexibility in the light of their capacities are encouraged (not required), at a minimum, to provide a qualitative assessment of uncertainty for key categories in the NID, and are encouraged to provide quantitative estimates for all source and sink categories.

Question 10

In case 1, the percentage uncertainty will be estimated from the standard deviation of the sample, as the variability of C density in above-ground biomass across the country determines the uncertainty around the true value of the above-ground biomass C stock present in an area being subject to deforestation (i.e. the uncertainty around the above-ground biomass C stock in an individual hectare). The uncertainty is therefore calculated as ±1.96 (k) multiplied by the standard deviation of the distribution divided by the mean, with the resulting percentage uncertainty being $\pm 1.96 * \frac{13.3}{47.1} * 100 = \pm 55.3$ per cent. This can be referred to as the uncertainty in an individual, that is, the uncertainty associated with using the average value of the population to qualify a single element of the population.
In case 2, the percentage uncertainty will be estimated from the standard deviation of the mean, which estimates the range of values within which the true value lies, that is, not the variability of the sample but that of the sample means if we were to take many samples from the population. The standard deviation of the mean corresponds to the standard deviation of the distribution divided by the square root of the sample size (i.e. $\sqrt{3{,}000}$). Therefore, the uncertainty is: $\pm 1.96 * \frac{13.3}{\sqrt{3{,}000}} * \frac{1}{47.1} * 100 = \pm 1$ per cent. This can be referred to as the uncertainty in the mean, that is, the uncertainty associated with using the estimated average value to express the true value.
If you would like more practice on uncertainties you can work with the exercises to be found here: https://unfccc.int/resource/tet/bl/bl2-11_u_l2_att11.pdf

The standard deviation of the sample or standard deviation of the distribution, is the square root of its variance. It is an estimator of the population standard deviation.

The mean is the sum of a collection of numbers divided by the number of numbers in the collection.

The standard deviation of the mean (or standard error of the mean) is the standard deviation of the sample divided by the square root of the number of observations in the sample. It measures the precision of the true mean of the population. It takes into account both the value of the standard deviation and the sample size. It is affected by the sample size

Question 11

You would work with the generalist to get their assessment of the Party's reporting of the key category analysis. Working with the generalist, you as the LULUCF expert must ask the Party for more information on the reasons for excluding any categories. You would assess the Party's response against good practice as outlined in chapter 4, volume 1 of the 2006 IPCC Guidelines, noting that footnote 1 to table 4.1 indicates that Parties may modify the list of IPCC categories to reflect particular national circumstances.

Question 12

You must ask the Party for more information on the reasons for using a tier 1 method for key categories. If the Party cannot justify it with its national circumstances (lack of resources to overcome barriers, lack of data), you should recommend that the Party move to higher tiers following the decision trees provided in volume 4 of the 2006 IPCC Guidelines for the methodological choice. If the Party justifies it in terms of barriers not yet overcome, that is, lack of data and/or lack of capacity, you should

recommend that the Party clearly document the reasons for not applying the methodological choice in line with the corresponding decision tree of the 2006 IPCC Guidelines. In addition, you should encourage the Party to prioritize actions for future improvement for these key categories for which the tier methods suggested by the 2006 IPCC Guidelines could not be applied. Finally, during your discussions with the Party you should identify any capacity-building needs related to the Party's estimation of GHG emissions/removals from these categories. You may include any such identified capacity-building needs in the TERR.

Question 13

A consistent time series has not been provided by the Party because estimates for earlier years have not been recalculated. Firstly, you must ask the Party why it was unable to provide a consistent time series. You must recommend in the TERR that the Party recalculate the whole time series by including GHG estimates for all land-use categories and for biomass and SOM pools in forest land in all years of the inventory time series, by collecting the necessary data, in order to ensure consistency in the emissions/removals trends. If necessary, the Party should use the alternative recalculation techniques set out in the 2006 IPCC Guidelines vol. 1, chap. 5, table 5.1). You must also include in the TERR the information on the reasons behind the time series inconsistency as provided by the Party during the review.

Question 14

You must request relevant information during the review from the Party, including explanatory information on the reasons and justifications for the recalculations and an indication of the relevant changes and their impact on emissions trends. You should assess the accuracy of the new estimates resulting from the updated AD/models. You must recommend in the TERR that the Party report all required information in the NID, namely an explanation of/the rationale for the recalculations together with justifications and an indication of relevant changes and their impact on the emission trends. If there are any concerns related to the accuracy of the revised estimates, you must also include a recommendation, accordingly.

Question 15

Firstly, you must ask the Party for more information about the data that are available for 2008 in order to assess their quality. In addition, you must ask the Party which actions, if any, it has taken to improve its inventory by ensuring the time series consistency. In any case, you must note in the TERR that the time series is not complete and consistent. You must recommend that the Party recalculate its emissions/removals estimations and provide a consistent time series. This can be done by providing estimates of the CSC and associated net emissions/removals in all the C pools for the whole time series 1990–2022 if you assessed that the actions put in place by the Party are sufficient. Otherwise, you should also provide guidance on how to resolve the issue. For example, the CSC in DOM and SOM C pools for 2008 could be estimated with the same methodology as that applied for 2012–2022. The CSC in DOM and SOM C pools for 2009–2011 could then be estimated by interpolation using the guidance provided in chapter 5, volume 1 of the 2006 IPCC Guidelines. The data splicing techniques provided in the 2006 IPCC Guidelines can be used for estimating the CSC in the DOM and SOM C pools for the other years (i.e. 1990–2007),. For example, biomass CSC may be used as a surrogate or proxy for deriving CSC

in DOM and SOM pools, where applicable. The Party could even consider using data from neighbouring countries with similar conditions. A mix of the two approaches (e.g. data from neighbouring countries scaled by using biomass CSC as a proxy) can also be used. The overlap approach provided in the 2006 IPCC Guidelines can be used to ensure consistency between the net emissions/removals calculated for 1990–2007 with those for 2008–2022. Note also that the interpolation of data for 2009–2011 could be guided using a proxy, for example, biomass CSC, to provide a more accurate trend than the simple linear interpolation.

Question 16

The Party must ensure consistency between definitions at time t_1 and t_2 and correct the CSC estimation. Therefore, you would recommend that the Party recalculate the CSC in forest land in accordance with the new definition to ensure that there are no CSC stemming from the differences in definitions. You should reflect this in the review report.

Question 17

You should investigate the amounts of fuelwood production, import and export reported by the Party's national statistics office and/or the data reported by the Party to FAOSTAT and collect information on the use of recycled wood (i.e. wood not originating from harvesting in the relevant year) in the energy sector. If you find inconsistencies in fuelwood figures reported in the LULUCF and energy sectors, you should question the Party prior to the review week to try to understand any possible reasons for this discrepancy. If the issue is not resolved during the review week you should recommend that the Party either explain in the NID the apparent inconsistency in the NID or revise the estimates to ensure consistency in the data used in the two sectors. Remember that in cases of a finding related to another sector of the inventory, you should discuss with the expert reviewing that sector, which in this example would be the expert reviewing the energy sector.

6. Self-check quiz

Question 1

The advantage of sampling-based surveys in comparison to other methods is that the reliability of the information can be assessed based on the data acquired. Which of the following statements is true?

Select one:

A. If information on administrative boundaries or maps distinguishing upland and lowland areas, or boundaries or different vegetation zones is available, it is not possible to use stratified sampling
B. If a large-scale survey is done applying random sampling, the assessment of uncertainties should be based on careful and objective expert judgment
C. Bias of the inventory can be avoided by using temporary plots, as they are more effective in estimating changes than permanent plots
D. Effective means to reduce uncertainty include increasing the sample size and stratifying the population

Question 2

A Party has reported emissions and removals for each of the years 1990–2022, but the key category analysis is prepared only for 2000. Is this correct?

Select one:

A. Yes
B. No

Question 3

A Party has applied different methodological tiers for estimating C stock changes in different C pools. For instance, for forest land remaining forest land, the Party uses a higher tier method for biomass. The Party estimates C stock transfers to DOM from biomass and treats them as C stock losses for estimating the C stock changes in biomass. At the same time the Party applies a tier 1 assumption (i.e. zero net CSC) to DOM. Is this consistent with good practice as provided in the 2006 IPCC Guidelines?

Select one:

A. Yes
B. No

Question 4

A Party applies a tier 1 methodology for DOM in forest land remaining forest land. However, when extraordinary disturbances occur, transfer of biomass to DOM caused by such extraordinary events is estimated for DOM and the following decay emissions are reported across the inventory time series. Is such reporting consistent with IPCC good practice?

Select one:

A. Yes
B. No

Question 5

In which chapter of the 2006 IPCC Guidelines are the methods for filling gaps in incomplete data set provided?

Select one:

A. Chapter 2, volume 1, "Approaches to data collection"
B. Chapter 2, volume 4, "Generic methodologies applicable to multiple land-use categories"
C. Chapter 5, volume 1, "Time series consistency"
D. Chapter 3, volume 4, "Consistent representation of lands"

Question 6

How should a country estimate and report its emissions/removals for a specific category for which methodology and data availability have improved considerably during the last three inventory years, but data for the years before that are very poor? The improved methodology requires detailed data that are not available for the previous years. The category is a key category for the country, but the Party has used a tier 1 method for the previous years.

Select one:

A. Use the improved methodology for the last three years and make no recalculations for the previous years
B. Use the previous methodology for all years to ensure consistency in the time series. The new methodology can be used for estimating the uncertainties of the estimates provided with the previous methodology
C. Estimate the emissions/removals for the whole time series using the improved methodology. For those years for which the data needed for the methodology are not available, recalculations should be done using the most appropriate approach(es) to obtain the estimates (e.g. trend extrapolation, overlap and surrogate approaches) described in chapter 5, volume 1 of the 2006 IPCC Guidelines
D. Recalculations should be done only in cases where the new methodology provides larger emissions or smaller removals. The recalculation should be made using the approaches described in chapter 5, volume 1 of the 2006 IPCC Guidelines

Question 7

A Party reports no CSC in SOM in cropland remaining cropland from 1990 to 1999, providing evidence that no crop management changes occurred until 1999. In 2000, a new policy for supporting organic farming is put in place, and data on conversion to organic farming are collected and associated SOC changes are estimated. Is the time series consistent?

Select one:

A. Yes
B. No

Question 8

In the previous question, the policy for supporting organic farming has been active from 2000 until 2010, and the Party reports SOC changes from 2000 to 2010 only. Is the time series consistent?

Select one:

A. Yes
B. No

Question 9

The Party reported that forest land remaining forest land is a key category and stated that emissions and removals of the other categories cancel each other out without reporting them. How should this be addressed in the review report?

Select one:

A. No specific action is needed because the emissions and removals cancel each other out
B. The reporting is not transparent and the reasoning for 'non-reporting' is not adequate. The issue should be addressed in the review report, and a recommendation to the Party should be made to provide all estimates in the CRT and NID for which the 2006 IPCC Guidelines provide methods, and include those categories in the key category analysis.

Question 10

A Party has two sets of remotely sensed images with different resolutions. The first set has a coarser resolution and contains data from 1990 to 2010, while the second set has a finer resolution and contains data from 2000 onwards. How should the country ensure a consistent land representation for 1990–2022?

Select one:

A. Use the first data set for 1990–2010 and the second from 2011 onwards, to ensure time-series consistency of the longest time series
B. Use the first data set for 1990–1999 and the second from 2000 onwards, to ensure the highest quality of time-series estimates possible
C. Use the second data set for 2000 onwards and then extrapolate back from 2000 to 1990, to ensure consistency of the time series
D. Use the second data set from 2000 onward to ensure the highest quality and consistency of time-series estimates possible and recalculate the data for 1990–1999 using the overlap technique with the data for 2000–2010

Question 11

How should the uncertainty of stock difference between two successive measurements be estimated?

Select one:

A. With equation 3.1, chapter 3, volume 1 of the 2006 IPCC Guidelines
B. The uncertainty of the trend should be applied

Question 12

According to the 2006 IPCC Guidelines, what are the three overall goals for verification?

Select one:

A. (i) Provide inputs to improve inventories; (ii) provide tools to estimate the accuracy of estimates; and (iii) provide tools to improve the comparison of inventories of different Parties
B. (i) Provide inputs to improve inventories; (ii) provide tools for Parties to estimate the uncertainty of the inventory; and (iii) provide methods to reduce the uncertainty of the inventory
C. (i) Provide inputs to improve inventories; (ii) provide tools to validate models used in the inventory preparation, and (iii) provide information on international data sets to be used in verification
D. (i) Provide inputs to improve inventories; (ii) build confidence on estimates and trends; and (iii) help in identifying weaknesses in the inventory development

Question 13

Although forest land is a key category, no category-specific QC procedures are in place. How should you address this issue in a review report?

Select one:

A. Recommend that the Party implement category-specific QC procedures because forest land is a key category
B. Encourage the Party to implement category-specific QC procedures because it is not a requirement to have category-specific QC procedures for key categories.

Question 14

For estimating net CO_2 emissions/removals from a given C pool, in terms of total cumulative net CO_2 emissions/removals can the Party apply either a constant value (i.e. a linear function of type $y = c$, where c = constant) or another function (e.g. first-order decay function), if the total cumulative net CO_2 emissions in both the cases are the same?

Select one:

A. Yes
B. No

Question 15

Background information for the forest land category is reported in CRT 4.A. Three columns (gains, losses and net change) are given for reporting on CSC in biomass. Which of the following statements is true?

Select one:

A. It is mandatory to report C stock gains and losses in the respective columns separately
B. Parties can report in the gains or losses column the net gains or net losses in C stocks if the methods applied do not permit reporting them separately

Question 16

For estimating the uncertainty of the CSC in biomass between two successive measurements (stock-difference method), a Party has applied equation 3.2, chapter 3, volume 1 of the 2006 IPCC Guidelines. Is this the best approach?

Select one:

A. Yes, error propagation is the best method for estimating uncertainty in the difference of stocks
B. No, error propagation is not the best method because the two C stock levels from the two forest inventories are temporally autocorrelated

Question 17

The Party has provided estimates indicating very large removals (C sinks) in the SOM pool, which, although based on measurements, are not comparable either with default values in the 2006 IPCC Guidelines or with those used by other Parties in the region. The Party has also reported very low uncertainties for these values in the NID. The uncertainty estimates are based on a very small sample size. How should this be addressed in the review report?

Select one:

A. You should not address this issue in the review report
B. You should state your lack of trust in the figures in the review report
C. You should check the method used to estimate the changes in the C stocks and uncertainties. It is possible that the uncertainties are underestimated and that the method used to estimate the CSC may also be incorrect. If that is true, you should clarify the issue with the Party and reflect this in the review report along with proposed improvements to solve the issue
D. You should calculate new estimates based on default values in the 2006 IPCC Guidelines and propose an adjustment to the inventory

Question 18

Which of the following approaches is appropriate to use when estimating net annual CSC in mineral SOM and DOM pools based on measurements at two points in time (t_1 and t_2) on a given area in a land-use category X?

Select one:

A. If neither the land-use nor the land-management system has changed, assume that there is no net change in C stocks as per tier 1 methods in the 2006 IPCC Guidelines
B. Estimate total net CSC by estimating gains and losses between the two points in time and divide it with the time interval (t2–t1) to estimate the net annual CSC
C. Estimate C stocks at time t1 and at time t2, and divide their difference by the time interval (t2–t1) to estimate the net annual CSC
D. All of the above

Question 19

The underlying science on non-CO_2 emissions in the LULUCF sector is well known, and the uncertainties in the estimates provided by Parties are expected to be small. Is this statement correct?

Select one:

A. Yes
B. No

Question 20

The uncertainty of the inventory is assessed to help prioritize efforts to improve the accuracy of the inventory in the future and to guide decisions on the methodological choice. Which of the following statements is true?

Select one:

A. The accuracy of the inventory should be improved to the extent that the relative standard error of the emission/removal estimates of the LULUCF sector is below 10 per cent
B. There is no predetermined level of precision, but the uncertainties of the inventory estimates should be reduced as far as practicable
C. If the category is identified as one of the key categories of the inventory, the percentage uncertainty of the estimate of this category should be reduced to lower than 10 per cent
D. Uncertainty estimates are needed for the tier 1 key category analysis

Question 21

For which of the following categories and GHGs is the reporting of non-CO_2 emissions in the LULUCF sector optional?

Select one:

A. N_2O emissions from fertilization of forests
B. CH_4 emissions from flooded lands
C. N_2O emissions from drained organic soils
D. N_2O emissions from SOM oxidation in mineral soils of cropland remaining cropland

6.1. Answer key to self-check quiz

Question 1

The correct answer is (D).
The purpose of stratifying the population is to reduce the variability and increase the precision, while at the same time better representing the population. Increasing the sample size, although increasing the cost of the sampling, helps increase the accuracy of estimates.

Question 2

The correct answer is (B).
In accordance with paragraph 25 of the MPGs, Parties must identify their key categories for the starting year and the latest reporting year.

Question 3

The correct answer is (A).
Although DOM is estimated at equilibrium, C stock losses from biomass associated with C stock transfers to DOM must be estimated.

Question 4

The correct answer is (A).
It is possible to subdivide a pool into sub-pools to which different methodological tiers are applied. In this case, the Party is in practice subdividing the DOM pool into two sub-pools, one containing DOM originated by non-extraordinary events/processes and one containing DOM originated by extraordinary events. In any case, it is essential to estimate in any DOM sub-pools C stock losses when gains are reported and vice versa.

Question 5

The correct answer is (C).
Chapter 5, volume 1 of the 2006 IPCC Guidelines provide the guidance for time-series consistency including methods for gap filling.

Question 6

The correct answer is (C).
The Party must ensure a consistent time series of GHG emissions/removals estimates while using the most refined methods possible subject to availability of data. For this, the Party should use the same improved methodology for the whole time series by making efforts to collect relevant data, or otherwise use methods described in chapter 5, volume 1 of the 2006 IPCC Guidelines to fill data gaps for the years to which the new methodology cannot be applied owing to unavailability of data.

Question 7

The correct answer is (A).
Emissions and removals must reflect the management practices applied. So, even though CSC associated with a specific activity (organic farming) are not reported for earlier years (1990–1999), the time series is still consistent because the CSC have been reported for all the years in which the specific activity has been implemented.

Question 8

The correct answer is (B).
SOC changes do not all occur in a single year, rather they take time (i.e. a transition period) to reach equilibrium levels after a land-use/land-management change. Therefore, SOC changes must be reported even after the end of the activity, until the SOC reach the equilibrium level corresponding to the new use/management of the land.

Question 9

The correct answer is (B).
Parties must report GHG estimates in the CRT and the NID for all source/sink categories in their territory for which the 2006 IPCC Guidelines provide methods. Cancelling out of emissions and removals is an incorrect justification for not including categories in the key category analysis. If data are available, the analysis should be done separately for emissions and removals within a category. If methods applied to estimate emissions and removals do not allow separating emissions from removals, then an effort should be made to identify more disaggregated subcategories to be included in the key category analysis with a view to addressing the emissions and removals separately. The key category analysis including LULUCF must be done at least following the disaggregation level suggested in table 4.1, chapter 4, volume 1 of the 2006 IPCC Guidelines.

Question 10

The correct answer is (D).
The Party must ensure the time-series consistency when improved methodologies or data are introduced into the inventory. To do this, it must perform recalculations of the time series and when needed must apply the methods provided in chapter 5, volume 1 of the 2006 IPCC Guidelines for ensuring time series consistency. Note that while using the overlap technique, it is preferable to compare multiple years because comparing only a single year may lead to bias and makes it impossible to evaluate trends.

Question 11

The correct answer is (B).
As the stocks at time 1 and time 2 are measurements of the same variable at two points in time, the trend between the two measurements is the biomass CSC whose uncertainty we wish to calculate.

Question 12

The correct answer is (D).
The goals of verification are to provide inputs to improve inventories, build confidence on estimates and trends and help in identifying weaknesses in the inventory development.

To learn more on verification, consult section 6.10, chapter 6, volume 1 of the 2006 IPCC Guidelines.

Question 13

The correct answer is (B).
Implementing category-specific QC procedures is not a mandatory requirement for Parties, but Parties are encouraged to do so.

To learn more on category-specific QC procedures, consult paragraph 35 of the MPGs.

Question 14

The correct answer is (A). The Party can apply either approach.
The linear function means a constant level of annual net CO_2 emission up to the limit set by the total net CSC. The first-order decay function means a decreasing trend of annual emissions, with the limit equal to zero, but an increasing trend of total cumulative emissions, with a limit equal to the total CSC. Of course, annual values would differ.

Question 15

The correct answer is (B).
When the methods applied do not allow reporting C stock gains and losses separately (e.g. the stock-difference method is applied), Parties may report net C stock gains or losses in the gains or losses column, respectively, using the "IE" notation key in the other column and providing the necessary information in the documentation box and in the NID.

Question 16

The correct answer is (B).
In accordance with the 2006 IPCC Guidelines the error propagation approach is not suggested when correlation exists in AD or EFs. In the supplemental material provided in the practical exercise 9 above you can find an example of how the correlation of the data together with the application of the error propagation approach affect the estimation of uncertainties.

To learn more on key assumptions of the approaches to combine uncertainties, consult section 3.2.3, chapter 3, volume 1 of the 2006 IPCC Guidelines (p.3.27).

Question 17

The correct answer is (C).
As a reviewer you should check the method used to estimate the changes in the C stocks and uncertainties by seeking clarification and requesting all necessary information/data from the Party in order to clearly understand the issue during the review. If you identify an issue of accuracy of the estimates or of incorrect uncertainty assessment, you must reflect that in the review report together with a proposal on how to solve the issue(s).

Question 18

The correct answer is (D).
Tier 1 methods are usually applied to a non-key category. Also, both the gain-loss and the stock-difference method can be used for estimating CSC in the pools. When the stock-difference method is applied, annual change in C stock can be estimated by dividing the difference in actual C stocks of DOM/SOM at times t_2 and t_1 by the time interval (t_2–t_1). Alternatively, it can also be estimated by dividing the difference of equilibrium level C stocks corresponding to the two states by the transition period.

Question 19

The correct answer is (B).
The uncertainties of non-CO_2 EFs are typically large. Furthermore, measurements do not generally cover the entire variability, so that EFs applied may not represent the mean/median of the actual distribution.

Question 20

The correct answer is (B).
There is no predetermined level of precision, but the uncertainties of the inventory should be reduced as far as practicable.

To learn more on the key concepts and terms regarding uncertainty, consult section 3.1.3, chapter 3, volume 1 of the 2006 IPCC Guidelines (p.3.7).

Question 21

The correct answer is (B).
Methods and EFs for CH_4 emissions from flooded land are contained in appendix 3, volume 4 of the 2006 IPCC Guidelines and as such reporting of these emissions is optional. The 2019 Refinement to the 2006 IPCC Guidelines (chapter 7, volume 4) provides methods and EFs to estimate CH_4 and CO_2 emissions from flooded land and a Party may voluntarily decide to use this guidance and include these emissions in its GHG inventory.

7. Key points to remember

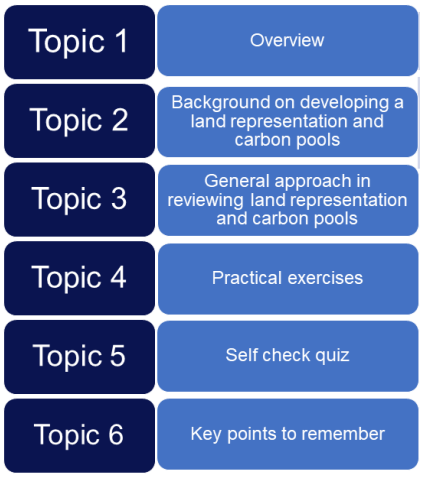
- The technical review should assess the TACCC of the LULUCF sector GHG inventory and the implementation of the 2006 IPCC Guidelines through the MPGs.
- The preparation for the review should start well in advance before the review week in order to effectively perform the review and to provide the Party with adequate time to respond to the questions of the TERT.
- It is mandatory for Parties to apply the 2006 IPCC Guidelines for preparing their LULUCF sector GHG inventory, while the application of the Wetlands Supplement is encouraged.
- When a Party applies the Wetlands Supplement, then the Wetlands Supplement defines the good practice that the Party must follow. Therefore, the review must assess the TACCC of the LULUCF sector GHG inventory against the Wetlands Supplement guidance.
- General and cross-cutting issues covered in volume 1 of the 2006 IPCC Guidelines, such as data collection approaches, time-series consistency and recalculations, uncertainties, methodological choice, QA/QC and verification have a prominent role in the LULUCF sector. Due to the specificities of the LULUCF inventory related to cross-cutting issues, adequate time should be allocated in reviewing those.
- The LULUCF GHG inventory must cover the total Party's territory (managed and unmanaged land). GHG emissions/removals must be reported for managed land and do not have to be reported for unmanaged lands, unless they are converted to managed land.
- GHG emissions and CO_2 removals are estimated for the six top-level land-use categories and their reporting is divided into two main subcategories, based on the current and historical use/management of land (i.e. land remaining in the same land use, land converted to another land use).
- It is important that Parties report the conversion period applied in reporting CSC and the transition periods applied for land-use/land-management changes.
- The LULUCF GHG inventory must cover the following GHGs: CO_2, N_2O and CH_4.
- The proxy for estimating GHG emissions/removals from the LULUCF sector is the CSC in the C pools living biomass, DOM, SOM and HWP.
- C stock gains are indicated as positive quantities and C stock losses as negative quantities. CO_2 emissions are expressed as positive and CO_2 removals as negative.
- The 2006 IPCC Guidelines provide two general methods for estimating CSC, the gain and loss method and the stock-difference method. All C stock gains and all C stock losses should be taken into account in estimating CSC in C pools, both those resulting from abrupt changes and those resulting from continuous changes.
- For HWP, the 2006 IPCC Guidelines explore four different approaches for estimating the C pool contribution.
- The LULUCF sector has linkages with other IPCC sectors of the GHG inventory, for example with energy, waste and, in particular, agriculture. The review should assess whether omissions or double counting occur in a Party's GHG inventory and that the consistency of reported information is ensured among the sectors as necessary. For that purpose, a close cooperation with the respective expert of the TERT is a prerequisite.

Lesson 3: Land representation and carbon pools

1. Overview

1.1. Lesson structure

Information on land areas is needed to estimate CSC and GHG emissions/removals associated with the LULUCF sector. The 2006 IPCC Guidelines provide specific guidance on how to ensure consistency in the reporting and to avoid overlaps or gaps in the land-area data. The guidance outlines systematic approaches to categorize land and to identify and report areas of land categories. We have also seen in the previous lesson that CSC in C pools are the proxy for estimating GHG emissions/removals.
This lesson provides basic background information on the identification and reporting of land areas in national GHG inventories and on C pools. It also presents information on specific aspects in relation to the review of information for land representation and C pools. The lesson concludes with practical exercises and a self-check quiz, which will help you enhance and refresh your knowledge (see figure 3-1).



N. Figure 3-1. Structure of lesson 3

1.2. Learning objectives

At the end of this lesson you should:

- Know the most important aspects of land representation that a Party's GHG inventory should take into account;
- Understand the background information related to the C pools and the processes associated with them resulting in GHG emissions and/or removals;
- Understand how to review the TACCC in relation to the land representation and C pools.

The expected time needed to complete lesson 3 depends on the level of your knowledge of LULUCF GHG inventories under the ETF and the 2006 IPCC Guidelines:
For readers with experience: 180–200 minutes
For readers with less experience: 200–230 minutes

2. Background on developing a land representation and on carbon pools

2.1. Land-use categories

The 2006 IPCC Guidelines provide six top-level land-use categories to be used as the basis for the representation of any country's territory for estimating and reporting their GHG inventories to the UNFCCC. The land-use categories are:
Forest land, cropland, grassland, wetlands, settlements, other land.
Further stratification of land is good practice and is always considered a means to increase the accuracy of GHG estimates.

O. Figure 3-2. Land use categories

You should be thoroughly familiar with definitions of the different land-use categories. For more information, consult section 3.2, chapter3, volume 4 of the 2006 IPCC Guidelines (p.3.5)

2.2. Land-use categories: fundamental elements

The following elements should be noted:

- The definitions of land categories in the 2006 IPCC Guidelines encompass a mixture of land cover (e.g. forest land, grassland, wetlands) and land use (e.g. cropland, settlements);
- There is a hierarchical order in the classification of land into the IPCC land categories definitions, with forest land being the highest and other land the lowest in the order. The hierarchical order embedded within the 2006 IPCC Guidelines is: forest land > cropland > grassland > settlements > wetlands > other land. The hierarchical order ensures that no double counting of land occurs. However, Parties may choose a different hierarchical order in the land category classification in accordance with their national definitions ;
- The land category other land includes all lands that do not contain significant C stocks and do not meet the definition of any of the other land categories. This category ensures that the land classification does not exclude any land in the country. Therefore, to avoid gaps in the land classification and irrespective of the country-specific definitions, the category other land will have the lower hierarchical order and will be defined in a way that includes all lands without significant C stocks and which cannot be classified under any other land category;
- The definition of a category, as well as the classification system, should be based on objective criteria consisting of quantitative elements in order to avoid subjectivity in land classification.

2.3. Land-use categories: subcategories for reporting

As a reviewer, you should first assess whether the country-specific definitions satisfy the above-mentioned requirements. If this is not the case, you should then assess whether those country-specific definitions impact the completeness, accuracy and consistency of land classification.

Land areas of a land category reported in the CRT are subdivided into:

- Land remaining under the same land use (e.g. CRT 4.A.1, forest land remaining forest land);
- Land converted to another land use (e.g. CRT 4.A.2.1, cropland converted to forest land).

Any land converted to a new category (e.g. cropland converted to forest land) will be reported under the new category (e.g. CRT 4.A forest land) in the subcategory land converted to another land use (i.e. CRT 4.A.2, 4.B.2, 4.C.2, 4.D.2, 4.E.2, 4.F.2), either:

- For a conversion time period of 20 years (this is the IPCC default length for the transition period). Such guidance is contained in section 2.3.2.2, chapter 2, volume 4 of the 2006 IPCC Guidelines. In this case if the length of the transition period assumed by the Party for the C pools to reach equilibrium levels is longer than 20 years, it is good practice to keep in a subdivision (e.g. under forest land remaining forest land) the lands that have not yet achieved the C stock equilibrium level of the new land use; or
- For the conversion time period longer than 20 years selected by the Party (based on the transition period for C pools to reach equilibrium levels). Such guidance, relating to forest land, cropland, grassland, settlements and other land is contained in volume 4 of the 2006 IPCC Guidelines.

For more information on the conversion/transition period you can revisit lesson 2 of this course. Depending on the length of the transition time period, Parties have to take into account land-use conversions that have occurred within the 19 years (or the corresponding time period if a country-specific transition time period is chosen) before the starting year of their GHG inventory, in order to identify, track and properly report land use and land-use conversions and the associated CSC. This means that for Parties which report 1990 as the starting year of the time series in the CRT, land-use conversions occurring since 1971 must be considered in the GHG inventory (when the IPCC default 20 years transition period is applied).

Note that in some cases, for estimating GHG emissions/removals for 1990 a Party may erroneously include land-use conversions that have occurred since 1970 instead of 1971.

Note that land converted to other land must be kept in the conversion category for the length of the transition period selected, even if it is longer than 20 years, because the CRT do not allow the reporting of emissions and removals in the category other land remaining other land. Therefore, the option of reporting any subcategory under other land remaining other land is not applicable.

Note that chapter 3, volume 4 of the 2006 IPCC Guidelines, including the annexes, provide guidance on the representation of land. It is of utmost importance that you, as a reviewer, familiarize yourself with that guidance to be able to provide the Party with correct technical advice to address issues related to consistent land representation.

As per paragraph 57 of the MPGs, developing country Parties that need flexibility in the light of their capacities may report a time series starting later than 1990. In such cases, they need to track land use and land-use conversions for the 19 years (or the corresponding time period if a country-specific transition time period is chosen) before the start of the inventory time series.

2.4. Stratification

To promote accuracy, the 2006 IPCC Guidelines provide guidance on stratification of AD according to several criteria, including:

- Six land-use and 30 land-use change categories;

***Land-use**: The type of activity being carried out on a unit of land.*

- The managed land proxy for identifying anthropogenic emissions/removals;

***Managed land**: Managed land is land where human interventions and practices have been applied to perform production, ecological or social functions.*
All significant sinks/sources occurring on a managed land for which 2006 IPCC Guidelines methods allow GHG emissions and removals to be estimated must be reported in the national GHG inventory.

- Climate zones;

***Climate zones**: IPCC methods subdivide the Earth into 12 climate zones. The classification is based on elevation, mean annual temperature, mean annual precipitation, mean annual precipitation to potential evapotranspiration ratio, and frost occurrence. Geographic information system information can be downloaded from the European Soil Data Centre Portal (http://eusoils.jrc.ec.europa.eu/projects/RenewableEnergy/).*

- Soil types;

***Soil types**: The IPCC classification system subdivides soils into seven soil types: organic soils and six different types of mineral soils. Geographic information system information on soil types can be downloaded from the FAO Soils Portal at http://www.fao.org/soils-portal/soil-survey/soil-maps-and-databases/harmonized-world-soil-database-v12/en/*
Organic soils are subdivided into those that are nutrient rich and those that are nutrient poor.

In addition, the Wetlands Supplement stratifies land firstly into inland and coastal land and then into drained mineral soil, wet mineral soil, wet organic soil and drained organic soil.

Consult the Wetlands Supplement for more information on definitions of wet soil, dry soil, coastal land and inland.

- Ecological zones and vegetation types;

***Ecological zones**: The FAO ecological zones refer to 'area with broad, yet relatively homogeneous natural vegetation formations that are similar, but not necessarily identical, in physiognomy'. There are 20 ecological zones, depending on broad vegetation type. Many IPCC defaults (e.g., biomass and litter stocks in forest land) are provided according to ecological zones. Geographic information system information on FAO ecological zones is available at https://data.apps.fao.org/map/catalog/srv/eng/catalog.search#/metadata/2fb209d0-fd34-4e5e-a3d8-a13c241eb61b.*
https://www.fao.org/3/ap861e/ap861e00.pdf.

***Vegetation zones**: Stratification by vegetation type may be used for most land-use categories including forest land (broadleaves versus conifer), cropland and grassland, where crops/vegetation should be first subdivided into perennial and annual, and then may be further stratified according to crop type.*

- Management practices (including drainage conditions for organic soils);

***Management practices**: Land categories are stratified according to management practices as follows:*
Forest land: natural forests and forest plantation. Furthermore, at the tier 2 level, the disturbance regime is used for stratifying forest land when estimating SOM stock changes. Cropland: perennial and annual crops and according to the status of cultivation, tillage and organic inputs. Grassland: according to the degree of degradation/improvement of the land. Wetlands: managed peatlands and managed flooded lands. In addition, the Wetlands Supplement stratifies, among a number of additional management activities occurring in different ecosystems: rewetting, excavation of coastal wetlands, restoration (rewetting and revegetation)/creation of coastal wetlands and aquaculture.

Drainage conditions: Default factors for undrained organic soils are not reported in the 2006 IPCC Guidelines. In addition, the Wetlands Supplement stratifies between drained, undrained and rewetted organic soils and mineral soils (undrained soil is a soil that has been subject to neither drainage nor rewetting). Furthermore, the depth of drainage is an additional element of stratification.

- Age class;

***Age class**: Age class is used to estimate C stocks and CSC in forest land (older than 20 years, younger than 21 years), perennial cropland and settlements.*

- Biomass density.

***Biomass density**: Biomass density is the average per hectare biomass content (expressed in either cubic metres or tonnes dry matter) and is used to estimate BCEFs in forest land.*

Owing to the multiplicity of stratifications that vary by land category and C pool, it is extremely important that as a reviewer, you carefully assess the consistency of land representation for each year and across the time series. Click on the tabs below to see a list of checks to perform for that purpose:

Area transfer

If land areas are transferred among land categories according to the previous and current year land use (e.g. in a year, the total area converted from forest land to other land uses is equal to the loss of area counted in the category forest land)

Managed/unmanaged land

If the Party subdivides areas under forest land, grassland and wetlands into managed and unmanaged lands, if applicable.

Special consideration with regard to managed and unmanaged lands and conversion between them include:

- If a managed land is subsequently left unmanaged within the same land category, the land is reported in a subdivision within the land remaining category, and its CSC and associated emissions/removals are reported for the entire time series until the land reaches the new equilibrium level of C stocks characteristic of unmanaged land.
- If a managed land is subsequently left unmanaged while under conversion to a new land category, that land is reported in a subdivision of land converted to a new land-use category, and its CSC and associated emissions/removals are reported for the entire time series until the land reaches the new equilibrium level of C stocks characteristic of unmanaged land. If it takes longer than the conversion time period (typically 20 years) for the land left unmanaged to reach the equilibrium level of C stocks of unmanaged land, the land will continue to be reported as a subdivision of the land remaining category corresponding to the new land-use category.
- If an unmanaged land is subsequently managed without changing its land category (e.g. an unmanaged forest land that becomes subject to forest management activities) then the land is reported within the land remaining category, although in a subdivision, and the CSC, and associated GHG emissions/removals, are recalculated for the complete inventory time-series including this area in managed land. C stocks on unmanaged lands can be assumed to remain at equilibrium (i.e. no CSC) until the year the land is converted to managed land.

Country-specific classification system versus IPCC

If the Party's land classification system does not match the six broad land categories given in the 2006 IPCC Guidelines, the Party should have established a clear correspondence between the two systems (e.g. by combining and/or disaggregating its own land categories) so that it can use the IPCC categories for estimating and reporting GHG emissions/removals.

It is a good practice for Parties to apply their preferred classification scheme suited to their national circumstances, for ensuring and enhancing accuracy of inventory estimates. However, whenever a Party applies a country-specific classification scheme you should check whether it has assessed the appropriateness of default factors provided by the IPCC to the country-specific classification scheme and made suitable adjustments to the factors as necessary, including checking the quantitative or qualitative evidence justifying the use of IPCC default factors and/or reporting any adjustment of them. Furthermore, you should encourage the Party to provide any missing information and to correct any inappropriate use of the IPCC default factors.

Classification for climate, soil, vegetation, management, age class and biomass density

If a Party has applied a classification system for climate, soil, vegetation, management, age class and biomass density that is different from the default provided in the 2006 IPCC Guidelines, then you should check:

- Whether the classification system is properly described in the NID (including citation of relevant peer-reviewed literature and of any background data published), so that its replicability is ensured (transparency);
- Whether the classification system covers the entire variability of the population (the Party's territory and ecosystem classes) to be classified (completeness);
- For each level of stratification, the classification system classifies any element of the population under one and only one stratum, which is to be achieved by establishing a hierarchical order (accuracy/comparability);
- What measures (e.g. verification or reclassification of previous years' data) are applied to ensure consistency in classification across time series (consistency).

Download this document to see an example of a land stratification:
https://unfccc.int/resource/tet/bl/bl3-01_u_l3_att1.pdf

Note that a land that is no longer managed should be tracked through the entire time series and emissions/removals should be reported until C stocks on the land achieve the equilibrium level of the unmanaged land (i.e. C stock gains and losses average out across time).

Note that if the Party uses the Wetlands Supplement for reporting, it is good practice to clearly define the concept of "coastal land" and its sea and landward limits in accordance with its national circumstances, and to apply that definition consistently across the entire national land area and over time.

Note that the 2006 IPCC Guidelines (vol. 4, chap. 4, section 4.1), requires the reporting of unmanaged land (i.e. unmanaged forest land) that is subsequently managed (i.e. managed forest land) under the land converted to forest land. However, because reporting such a subcategory under a conversion category is not feasible with the current structure of the CRT, Parties may report such converted land as a subdivision under the land remaining under the same land-use category (e.g. forest land remaining forest land).

Note that the CRT should also give information on the specific subdivisions within each land category (e.g. classified according to climatic zone, vegetation type, management type) used for the inventory preparation, and that:

- The choice of subdivisions reflects national circumstances and the level at which the estimates are calculated;
- The subdivisions are applied consistently over time.

2.5. TACCC principles

It is important that you review the Party's land representation against all TACCC principles.

Transparency

Land representation is transparent when all related information has been provided in the NID. You, as a reviewer, will recommend that the Party provide any missing information, that is, methods, including assumptions, and data used for preparing the AD. Such documentation may include, but be not limited to the information on the land-use definitions applied together with any thresholds (including for any subcategories); any differences between country land-use definitions and those suggested by the 2006 IPCC Guidelines and on how the mapping with the IPCC main land-use categories has been done; the stratification scheme applied; any updates on the AD monitoring/collection systems and how consistency in the time series has been ensured; land-use changes occurred before the starting year of the GHG inventory according to the transition period applied by the Party; whether statistical, sampling or wall-to-wall mapping data sources have been used, when sampling approaches have been used information on the sampling size, design and scheme, and how representativeness has been ensured; how different data sources have been harmonized and/or combined to develop the land representation, etc.).

Accuracy

Land representation is accurate if the following conditions are met:

- There is neither overestimation nor underestimation of the country's total area across the entire time series;
- There is no systematic misclassification of land.

For more information on these conditions, potential aspects you should be aware of and possible actions that you may take as a reviewer click here:
https://unfccc.int/resource/tet/bl/bl3-02_u_l3_att2.pdf

Completeness

Land representation is complete when, for every year of the time series, the sum of areas reported under each category (stratum) is equal to the whole country's territory area. For testing completeness as a reviewer, compare the sum of areas reported in the CRT (including unmanaged lands) with the total area of the country, which you may find in national statistical yearbooks or from the United Nations Statistics Division website (http://data.un.org/).
If the total official area of the country is larger than the sum of the areas reported under the different land-use categories, it means that there is some missing land area, that is, the land representation is incomplete. In contrast, if the sum of the areas reported under the different land-use categories is larger than the official area of the country, it means that there is likely to be a double counting of land

areas. In both cases, as a reviewer, you should consider that the Party has not reported a consistent representation of land; therefore, associated GHG emissions/removals estimates may be biased. Incompleteness could be the result of gaps in raw data used for the land classification or errors in the classification methodology. For example, this could be the case when definitions of categories do not cover the entire variability of land types in the country, which can usually be resolved by revising the definitions of categories and using additional data sets, as necessary.
Double counting could possibly be the result of errors in the classification methodology or the use of multiple data sets and/or revision of the definitions of categories. In this case, a thorough review of the methodology is needed to detect potential inconsistencies arising from the use of multiple data sets. Establishing a hierarchical order among data sets based on their reliability may address the issue. For instance, based on the sum of forest areas from national forest statistics, cropland areas from the agriculture census, wetlands from a national map and areas of other land categories from the national statistical yearbook, the total national area reported is 4 per cent larger than the official area. Establishing a hierarchy among data sets, for example, NFI > agriculture census > wetlands map > national statistical yearbook, would allow rescaling of data sets to match the national total area.

Consistency

Land representation is consistent if definitions of land-use categories/subcategories/subdivisions and methodologies for area data collection (including spatial and/or spectral resolution of data) and classification systems are consistent across all years of a time series and changes in land-category areas over time are not the result of differences in methodologies used for collecting area data and/or classifying them over time. Whenever these are not the same across the time series, you, as reviewer, should recommend that the Party recalculate the time series using the same definitions and methodologies across the time series to ensure consistency.
In cases where it may not be possible for the Party to use the same definitions and methodologies, you should recommend that the Party use the splicing techniques provided in the 2006 IPCC Guidelines (vol. 1, chap. 5) to reconstruct a consistent time series of data on areas under different land-use categories/subcategories. For instance, if the forest definition used for forest inventories changes across the time series and it has been estimated that applying the old forest definition to the latest forest inventory would result in a reduction of the current forest area by 3 per cent, the time series of forest area compiled from previous forest inventories could be corrected by increasing it by 3 per cent based on the overlap technique provided in the 2006 IPCC Guidelines (vol. 1, section 5.3.3.1). This will address the inconsistency across the time series due to the increase in the forest area as a result of the change in the forest definition.
Furthermore, land representation is consistent when the total area of the territory (managed plus unmanaged lands) does not change over the time series. This does not mean that the country's area cannot change over time. In fact, countries' land areas do sometimes change over time, for example for geological reasons (changes in coastline). It only means that whenever the country's area changes, then the time series need to be recalculated accordingly, that is, by recalculating the land areas under various land categories and strata (e.g. by projecting backwards from the latest areas) for the entire time series so that the total area of the country remains equal to the current area.

Note that when a land subcategory is further stratified (subdivided), the consistency of land representation needs to be ensured/checked at the lowest level of stratification.

Comparability

Land representation is comparable if the stratification in land categories applied is consistent with the six IPCC land use categories, which implies, for example, that treed lands are generally included under forest land and that other land includes land without any significant C stocks only. Furthermore, land categories should be stratified in land remaining in the same land-use category or land converted to a new land-use category to enhance comparability in the C stock dynamic and associated GHG emissions and removals reported.

2.6. Development of land databases for GHG inventories

The 2006 IPCC Guidelines (vol. 4, chap. 3, annex 3A.2) elaborate on the development of the various types of land-use databases.

AD used for GHG inventories should, in general, be:

Adequate	Capable of representing land-use categories, and conversions between land-use categories, as needed to estimate CSC and GHG emissions/removals
Consistent	Capable of representing land-use categories consistently over time, without being unduly affected by artificial discontinuities in time-series data
Complete	All land within a country should be included, with increases in areas of some land categories balanced by decreases in others, recognizing the biophysical stratification of land (as can be supported by data) for estimating and reporting GHG emissions/removals
Transparent	Data sources, definitions, methodologies and assumptions should be clearly described

The three broad sources of data for the land-use databases for GHG inventories given in the 2006 IPCC Guidelines are as follows:

- Collection of data by sampling methods (vol. 4, chap. 3, section 3A.2.2 and annex 3A.3), including the NFI;
- Collection of data through complete inventories (vol. 4, chap. 3, section 3A.2.3), including the agricultural census;
- Use of data prepared for other purposes (vol. 4, chap. 3, section 3A.2.1), for example:

✓ Forests: FAO CFRA (http://www.fao.org/forest-resources-assessment/en/);
✓ Crops: FAOSTAT (http://www.fao.org/faostat/en/#data);
✓ Grazing: Gridded Livestock of the World (https://unfccc.int/resource/tet/bl/bl3-03_u_l3_att3.pdf).

Note that land areas in FAOSTAT are classified according to the FAO definitions and that national definitions may differ from those in international statistical data sets. National definitions should be prioritized, although the Party must be able to explain any differences among data reported to different international bodies.

2.7. Approaches for land-area representation

The 2006 IPCC Guidelines outline three approaches for representing land areas. These approaches are not presented as hierarchical tiers and are not mutually exclusive. The mix of approaches selected by an inventory agency should reflect calculation needs and national circumstances.

Approach 1

Approach 1 allows only estimation of net changes in areas of land categories. With approach 1, neither the kind of conversions in land categories occurring across time nor the gross amount of such conversions can be identified and quantified.

Land representation requires certain methodological modifications when using approach 1. For example, because approach 1 data does not support reporting of gross land-use conversion, all emissions/removals from a land-use category may be reported under land remaining under the same land-use category. This might result in an overestimation or underestimation of emissions or removals for specific categories, but these could be balanced in the complete inventory. However, it is desirable that Parties still categorize land area in land remaining under the same land-use category and land converted to a new land-use category, even if this is done using expert judgment. Therefore, as a reviewer, you should encourage any Party that applies approach 1 to report land remaining in the same land-use category and land converted to a new land-use category separately.

The estimation methodology for SOM C stocks of mineral soils for approach 1 will also be different (e.g. see the 2006 IPCC Guidelines, vol. 4, boxes 2.1 and 2.2) and will yield slightly different annual results as compared with those estimated using approaches 2 and 3, although differences average out over the transition period.

With approach 1, a combination of land-area data sets (likely prepared for other purposes) such as forestry and agricultural statistics) is usually used. When several databases are to be combined, overlaps and/or omissions might occur. In such cases, see the section on the TACCC principles above to learn how you, as a reviewer, can provide guidance to the Party on how to resolve issues when multiple databases are used and when definitions used in the various databases differ from the IPCC land-use categories, and how to avoid double counting and omissions.

Approach 2

In addition to the information for approach 1, approach 2 includes information regarding the conversions among land categories (i.e. type and amount of conversion), although this information is provided between two points in time only. Approach 2 allows initial C stocks associated with the different land categories to be assigned and therefore also allows CSCFs or parameters to be selected to reflect the different rates of changes corresponding to conversions between any two land categories. When approach 2 is implemented, land-use categories can be further subdivided between land use remaining in the same land use and land use converted to a new land-use categories, taking into account the stratification scheme applied by the country and the transition period applied (i.e. IPCC default of country-specific). The result of approach 2 can be presented as a land-transition matrix representing the areas where land use did not change and the areas that have undergone conversions between all possible land-use category combinations. However, approach 2 does not allow the land use/management of specific parcels of land to be tracked across the entire time series and therefore does not allow GHG emissions/removals associated with, for instance, particular management systems with rotational land-use/management on the same parcel of land to be tracked. Common review issues arising from the application of approach 2 are associated with the fact that usually countries use data from different data sources which have not necessarily been developed for GHG inventory purposes (e.g. NFI, agricultural statistics, project statistics, environmental statistics). Thus, issues that may arise

when data are combined to apply approach 2, are associated with the lack of harmonization of the different data sources, incomplete coverage of the country area or overlapping/double counting of areas between land uses and inconsistencies between the data sources (e.g. definitional, statistical).

Approach 3

Approach 3 tracks cover, use and management of lands across the inventory time series on a spatially explicit basis. It is therefore capable of providing spatially explicit information on conditions on specific land areas including specific management activities, temporal sequence of practices and disturbance events occurring on such land areas. Approach 3 can be implemented either through sampling geographically located points across time or by wall-to-wall mapping, for example, by using spatially explicit remotely sensed data sets, or by a combination of the two. The main potential sources of errors when using approach 3 is the lack of consistency in the information provided by the sampling iterations or in the methodologies applied across time. For example, when sampling is used, sources of errors may be associated with changes in definitions (land-use categories/subcategories), methodological changes in data collection, changes in the sampling design, lack of representativeness or classification errors; when wall-to-wall mapping is used, sources of errors may be associated with the land-use classification approaches and/or protocols, the quality of the remote sensing data applied (e.g. spatial/spectral resolution), the consistency of the data across time, or the definitions of the land-use categories/subcategories applied, the main purpose for which the wall-to-wall product has been developed. So, as a reviewer, you should check the sources of data, the classification methodology used, and the QA/QC and verification procedures applied (e.g. to avoid subjectivity in classification) throughout the time series, as well as the methods that a Party has applied to ensure time-series consistency.

The choice of which of the three approaches to use (or a combination of them) will depend on the national circumstances (e.g. total area of the country, land-use types, accessibility of areas), availability of data and resources.

Countries may use different approaches over different geographical regions, although it is technically not practicable to apply different approaches to different land-use categories within the same region or along a time series.

2.8. Examples

Example 1

The following are examples relating to lack of consistency between country-specific and IPCC definitions:

A. A Party used the category other land as a buffer category where it reported all unmanaged lands. This resulted in large inaccuracies in estimates because the conversion from, for example, managed grassland to unmanaged land was reported as a conversion from grassland to other land with the consequent large loss of C stocks. Similarly, management of a formerly unmanaged grassland was reported as a conversion from other land to grassland with the consequent large gain of C stocks. As a reviewer, you should recommend that the Party report unmanaged land under the appropriate land-use category based on land-cover elements; for example, an unmanaged land with tree cover that exceeds the forest definition thresholds should be classified as unmanaged forest land. If this is not possible, the Party may report all such unmanaged lands under total unmanaged land.

B. A developed country Party has reported under settlements military areas covered with forests, although based on the forest cover characteristics, these would be classified as forest land.

Those areas have been subsequently released from military use, and consequently, the Party has reported these areas under settlements converted to forest land, although no changes in the land-cover elements, and therefore in C stocks, have occurred.

C. A Party has reported under the category forest land, land classified by law as forest although it is not covered by trees and is subject to other uses, such as cultivation or grazing. As a result, the Party has not reported as land converted to forest land the subsequent afforestation of some of these treeless lands.

D. A Party has classified farmyards covered by grasses under the category settlements in one data set/map and under the category grassland in a subsequent data set/map. Therefore, following a combination/overlap between the two data sets, it has reported these areas under settlements converted to grassland, although no changes in the land cover, and therefore in C stocks, have occurred.

In cases B–D, you, as a reviewer, must recommend that the Party use consistent national definitions of land-use categories according to both land-cover elements and associated land uses, establishing a hierarchical classification scheme among land-use categories and stratifying land-use categories according to land-cover elements.

This would enable the Party to report CSC that are associated with actual changes in the land cover and land use consistent with its national definitions.

Example 2

The following is an example on the SOC change estimation in relation to the approach applied for the representation of land.

No tillage impacts SOC in the land across time, so that if implemented on the same land, the SOC contained in the land grows from the equilibrium level it had with full tillage to the new equilibrium level it will have with no tillage. If 10 per cent of the cropland area is subject to no tillage and assuming that no tillage determines a total net SOC gain of +2 t C ha^{-1} across the 20-year transition period, that is, +0.1 t C ha^{-1} yr^{-1}, look at the difference between the two cases on a cropland area of 100,000 ha.

Case A
No tillage is implemented across the 20-year period always on the same land every year.
Calculations show the following net C stock gain in cropland across the 20-year period: **+ 0.1 t C ha^{-1} yr^{-1} * 100,000 ha * 0.10 * 20 yr = + 20,000 t C**

Case B
No tillage is implemented with rotation across the entire agricultural land (i.e. each year, a different portion of the agricultural land is not tilled, which means that each hectare is subject only twice to no tillage within a 20-year period).

Calculations shows the following total SOC gain in cropland across the 20-year period:

+ 0.1 t C ha^{-1} yr^{-1} * 10,000 ha * (2 * 10 yr cycle) = +20,000 t C

Assuming an equivalent C stock loss (-–0.1 t C ha^{-1} yr^{-1}) in the year with full tillage following the year in which no tillage has been implemented, and noting that in the first year of the 20-year period there is no loss because no tillage was not implemented before that year, the total SOC loss over the 20-year period is:

–0.1 t C ha^{-1} yr^{-1} * 10,000 ha * 19 yr = - 19,000 t C

So, the net SOC change over the 20-year period is:

+20,000 t C + (-19,000 t C) = +1,000 t C

By applying approach 2, it is not possible to discriminate between case A and case B. Therefore, as a reviewer, you should encourage Parties that aim at reporting the impact of no tillage on SOC stock (or of any other management practice in rotation) to implement approach 3, adding new activities for data collection where needed.

Example 3

The following is an example on applying the IPCC default stock-difference method in SOM using approach 3 (full tracking of land across time).

A country in a cold temperate moist climate zone reports a total net SOC change in mineral soils of ***Δsoc*** t C ha^{-1} in forest land converted to cropland (long-term cultivated cropland with full tillage and medium input) occurring linearly with an annual CSC of (***Δsoc*** /20) t C ha^{-1} yr^{-1} for the transition period of 20 years. However, if the land is transferred to another category *X* before the end of the transition period, then its SOC is not equal to that of a cropland at SOC equilibrium. This difference will be considered in calculating subsequent CSC, as shown below:

The forest land SOC is assumed to equal SOC_{REF} (i.e., SOC under native vegetation), which is 85 t C ha^{-1} (from the 2006 IPCC Guidelines, vol. 4, table 2.3), and the cropland SOC is calculated by applying factors corresponding to long-term cultivated cropland with full tillage and medium input from the 2006 IPCC Guidelines (vol. 4, table 5.5), as 85 t C ha^{-1} (SOC_{REF}) * 0.69 (F_{LU}) * 1 (F_{MG}) * 1 (FI) = 58.65 t C ha^{-1}.This means there is a net CSC of 58.65 - 85 = -26.35 t C ha^{-1} over a time period of 20 years or -1.32 t C ha^{-1} yr^{-1}.

After 10 years, the SOC is 85 + (-1.32 * 10) = 71.83 t C ha^{-1}, and then this cropland is converted to improved grassland with high input of organic matter.

The SOC at equilibrium of improved grassland (from the 2006 IPCC Guidelines, vol. 4, table 6.2) is 85 t C ha^{-1} (SOC_{REF}) * 1 (F_{LU}) * 1.14 (F_{MG}) * 1.11 (F_I) = 107.56 t C ha^{-1}.

Considering that the land was converted to cropland from forest land 10 years earlier, due to which the C stock is not at equilibrium at the time of conversion to grassland, the correct calculation for the net CSC of this land is SOC_{AFTER} – SOC_{BEFORE} = 107.56 - 71.83 t C ha^{-1} = 35.73 t C ha^{-1} or 1.79 t C ha^{-1} yr^{-1} over a time period of 20 years following conversion to grassland.

You should note that without considering the history of this particular piece of land, the net CSC following conversion of cropland to grassland would be estimated as a total gain of 107.56 t C ha^{-1} – 58.65 t C ha^{-1} = 48.91 t C ha^{-1}, and an annual gain of 2.45 t C ha^{-1} yr^{-1} over a time period of 20 years following conversion to grassland.

2.9. Uncertainties

As a reviewer, you should check the impact of various sources of uncertainty on a Party's land representation and suggest ways to reduce it.
Area estimates made using unbiased statistical sampling may be more accurate than those made by wall-to-wall mapping, because samples may be analysed with higher accuracy; furthermore, when sampling co-registration errors are made insignificant.

***Co-registration errors**: Co-registration in image processing is a procedure that minimizes shifts between images at a sub-pixel scale, and thus minimizes errors in the analysis of the images owing to the displacement between the data sets.*

In both cases (i.e. statistical sampling and wall-to-wall mapping), verification must be made by using statistical sampling techniques and ground truth data, with estimates consequently adjusted by proportion.
See these four examples (https://unfccc.int/documents/632055) showing how uncertainties of areas of land categories of a land-use classification (**example 1**) and of a land use and land-use change classification (**example 3**) are calculated when areas are estimated by proportion. The impact of a verification on uncertainties on areas of a land-use classification (**example 2**) and of a land use and land-use change classification (**example 4**) is also presented.

To learn more on the uncertainties associated with the approaches for land representation, consult section 3.5, chapter 3, volume 4 of the 2006 IPCC Guidelines.

2.10. Reporting

Data on land areas using appropriate subcategories are reported in the sectoral background CRT for the LULUCF sector. These must be complemented by information on data in the NID, in particular on:

- Land-use definitions, the systems of classification used and their correspondence to the six IPCC land categories;
- Approaches used for representing land areas;
- Land databases used for the inventory preparation.

Areas remaining in a land-use category and areas converted to a land-use category from other land-use categories should be reported in kilohectares (1,000 ha) in the CRT, with the exception of CRT 4(IV), biomass burning, where area values are input in hectares. Be aware that area of organic soils is reported in hectares in CRT 3.D in the agriculture sector, so it has to be converted to kilohectares before being compared with areas of organic soils reported under cropland and managed grassland (CRT 4.C and CRT 4.D). Subdivision of land areas depends on the national circumstances and on the data availability within the country. The IPCC default classification scheme used for providing default EFs is based on climatic zones, soil, vegetation and management types. CRT 4.1 contains the annual land transition matrix with annual changes between land-use categories.
Country-specific categories can be reported under category 4.H other in CRT 4 (no table for background data on CSC is available for category 4.H).

Note that emissions/removals do not have to be reported for all reported land areas (e.g. no GHG estimates need be reported for unmanaged lands). It is, however, mandatory to **provide** for all categories **land areas covering the Party's entire national territory** (for QC purposes) in accordance with the completeness principle, which requires "full geographical coverage" of the sources and sinks of a Party's territory. See also the 2006 IPCC Guidelines (vol. 1, chap. 1, section 1.1), according to which "national inventories should include greenhouse gas emissions and removals taking place within national territory and offshore areas over which the country has jurisdiction".

2.11. Carbon pools

To promote the accuracy of the GHG inventory, the 2006 IPCC Guidelines stratify ecosystem C stocks into C pools, **namely above-ground biomass, below-ground biomass, litter, deadwood, SOM and HWP**. Although CSC for all C pools are to be reported separately for each land-use category and subcategory, the contribution of the HWP pool is reported aggregated, including HWP coming from all land-use categories, in CRT 4.G.

To learn more on the definitions of the C pools, consult the 2006 IPCC Guidelines (vol. 4, chap. 1, table 1.1, and chap. 12, section 12.1).

Note that when the simple decay approach for HWP is used, carbon transferred to the HWP pool is to be reported as additional information in column W in CRT 4.A and in column U in CRT 4.B–4.F.

National circumstances may require modifications to the IPCC definitions. Where this is the case, as a reviewer, you should check whether the Party has transparently reported information on the modified definitions, ensuring that such modifications do not result in either omission of CSC and associated GHG emissions and removals that in accordance with good practice have to be estimated, or in a double counting of CSC and associated GHG emissions and removals.
In particular, ensure that:

- Definitions are used consistently across time and categories;
- No portion of the C stocks considered by the IPCC definitions is excluded or any portion of C stocks included in more than one C pool.

2.12. Carbon stock transfers among pools and GHG emissions/removals from/to C pools

Remember that the methodologies in the 2006 IPCC Guidelines allow the complete and accurate estimation of:

- Net CO_2 uptake associated with photosynthesis and respiration through estimation of CSC in the biomass pool;
- C stock transfers among pools associated with mortality and decay of organic matter, including C transfers to/from the HWP pool;
- CO_2 emissions associated with decomposition and burning of organic matter (oxidation processes);
- CH_4 emissions associated with decomposition and burning of organic matter (reduction processes);
- N_2O emissions associated with nitrification and denitrification in soils and burning of organic matter (redox processes).

Note that the 2006 IPCC Guidelines do not include methods to estimate N immobilization associated with an increase in SOM C stocks. Countries may, however, apply country-specific methods and data for estimating it under tier 3 only.

To learn more on the carbon cycle and associated fluxes into and out of the system as well as all possible C stock transfers between the pools, consult the 2006 IPCC Guidelines (vol. 4, chap. 2, section 2.2).

It is important to check the completeness and consistency of C stock transfers among pools, particularly when different methods are applied for estimating CSC in different pools and different land-use categories.

Note that the 2006 IPCC Guidelines provide a disturbance matrix (vol. 4, chap. 2, table 2.1) that must be used to track C stock transfers, as well as GHG emissions to the atmosphere as a result of a disturbance event for higher-tier methods

CSC in the HWP pool are mandatorily to be reported as methods as provided in the 2006 IPCC Guidelines. The HWP contribution may be assumed to be zero, if judged insignificant (i.e. annual net CSC in the HWP pool is less than the size of any key category), otherwise default tier 1 methods are provided in the 2006 IPCC Guidelines.

Remember that the 2006 IPCC Guidelines provide default half-life values for the HWP in use and the associated decay rates in table 12.2, chapter 12, volume 4. Note also that if data are available Parties are encouraged to report emissions/removals at the disaggregated level provided in CRT 4.Gs1. In these cases, as per footnote 5 to the same table, the default half-life values for sawnwood, wood panels and paper and paperboard are 35, 25, and 2 years, respectively (based on table 3a.1.3 of the IPCC good practice guidance for LULUCF), otherwise the default half-life values provided in the 2006 IPCC Guidelines (vol. 4, chap. 12, table 12.2) of 30 years for solid wood and 2 years for paper products are to be applied.

Note that import and export of wood as well as of HWP may be counted as a C stock gain and loss, respectively, according to the methodological approach used (see 2006 IPCC Guidelines, vol. 4, chap. 12).

Note that the MPGs (para. 56) make mandatory the reporting of emissions/removals from the HWP pool using the production approach as provided in the 2006 IPCC Guidelines. Therefore, if a Party uses another methodological approach to estimate the HWP contribution, it must, in addition, provide information on the HWP contribution estimated with the production approach in line with the 2006 IPCC Guidelines.

Figure 3-3 below shows the GHG fluxes from the C pools and the C transfer among the C pools.

2.13. Carbon balance of carbon pools

General

C pools are ecosystem reservoirs of carbon. Various ecosystem processes in these pools result in the redox of organic matter resulting in turn in fluxes of direct GHGs as CO_2, CH_4 and N_2O, as well as precursors gases such as NO_X, nitrogen trifluoride, NMVOCs and CO.

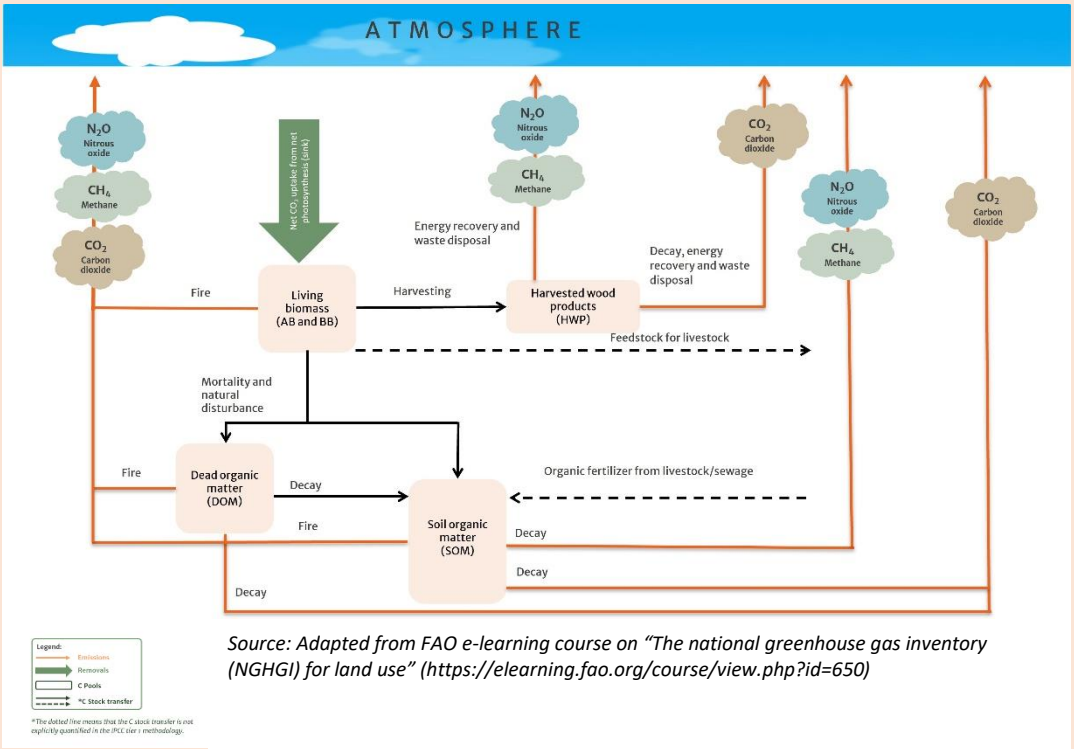
C pools have limited capacity for C sequestration. Consequently, C stocks in C pools may range from zero up to a maximum level determined by various biophysical and environmental factors, as well as human activities and other disturbances. For instance, the above-ground biomass C stock of tropical rainforest is typically more than four times the C stock of subtropical steppe (see 2006 IPCC Guidelines, vol.4, table 4.7).

Remember that the 2006 IPCC Guidelines (vol. 4, chap. 4, section 4.5) provides a number of tables for various default parameters and EFs for forest land.

For more background information on the C pools and the relevance of C residence time in pools to national GHG inventories see below.

Apart from biophysical and environmental factors, human activities impact C stock levels in C pools. For example, secondary forests contain, on average, lower C stocks than primary forests. SOM of organic soils is the sole exception, as it may accumulate C for very long periods in water-saturated conditions, which, upon aeration, is released, for a long period as well, until the soil is reclassified as mineral soil.

A larger figure is available here:
https://unfccc.int/resource/tet/bl/bl3-12_u_l3_f3.3_GHG_C_fluxes.pdf



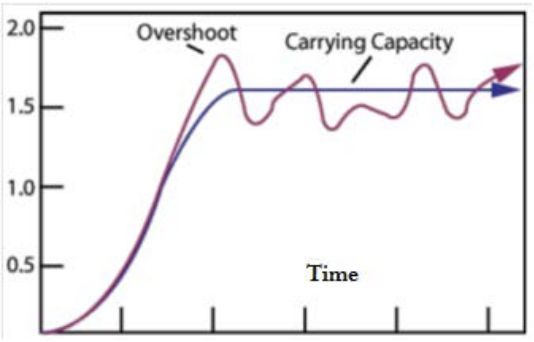
Source: Adapted from FAO e-learning course on "The national greenhouse gas inventory (NGHGI) for land use" (https://elearning.fao.org/course/view.php?id=650)

P. Figure 3-3. General scheme of C stock transfers and GHG emissions and removals in LULUCF

C has different residence time in the different C pools, which depends on natural, as well as anthropogenic factors. As the time frame of GHG inventories is a single year, the annual CSC in a pool for a land remaining in the same land use is considered to be zero if the residence time of C stocks in a pool is shorter than a year (e.g. biomass C pool in annual crops that are cyclically cultivated). However, the average C stocks across the year in the biomass pool in annual crops are taken into account in the CSC estimation in the case of a land converted to other use/management categories.

C stock equilibrium

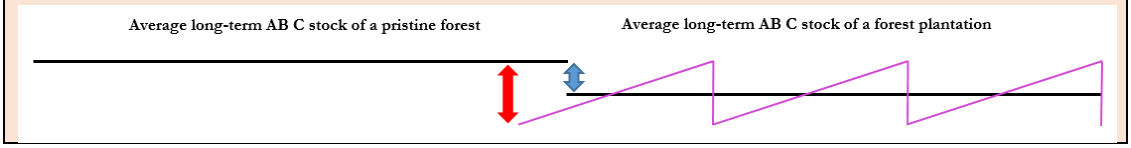
As a consequence of environmental factors and human activities, C stocks in an ecosystem C pool tend towards an equilibrium or steady-state level (e.g. the blue line in figure 3-4), although it moves around it depending on annual disturbances and land-use/land-management practices. In this context, past C stock losses and gains have a legacy effect that affect current trends of CSC (e.g. two forest land areas planted with the same species that are not subject to harvest in the current year have significantly different net C stock gains if one area was harvested 20 years ago while the other was harvested just the previous year).



Q. Figure 3-4. General overview of carbon stock evolution in a C pool

Once a C pool is at equilibrium, its net CSC can be assumed to be zero (i.e. across the management cycle, C stock gains equal C stock losses) if there is no change in the land use or management. At equilibrium, the pool is assumed to contain a long-term average C stock.

Long-term average C stock: the long-term average C stock is the average C stock in a land under given land-use/land-management and environmental conditions. For example, the figure shows (solid black line) the long-term average above-ground biomass (AB) C stocks on lands under two different types of management. While their maximum C stocks are almost the same, the long-term average C stock of one is almost half that of the other.



According to the 2006 IPCC Guidelines, this default (tier 1) assumption applies to all pools and land-use categories except:

- SOC of organic soils, as discussed previously;
- Woody above-ground biomass on forest land, for which at the tier 1 level, the annual CSC must be reported;
- When a change in the land use/land-management has occurred, and thus the C pool cannot be considered to be at equilibrium during the transition period.

Converting dry organic matter to C stocks

C stocks in C pools are usually measured as organic matter stock. To review the appropriateness in the conversion of dry organic matter into C by Parties, the 2006 IPCC Guidelines provide default C fraction values in different sections. To refresh your knowledge, see the summary table of these default C fraction values for the different C pools (https://unfccc.int/resource/tet/bl/bl3-05_u_l3_att6.pdf).

2.14. 2006 IPCC Guidelines and carbon pools

The 2006 IPCC Guidelines provide default methods, parameters and EFs for estimating and reporting some CSC in C pools and other GHG emissions. Figure 3-5 shows which C pools and GHG have to be reported at tier levels 1 and 2 in accordance with the 2006 IPCC Guidelines.

Tier 1			Land use													
			FL		CL		GL		WL			SL		OL	
Carbon pool – GHG			FL-FL	L-FL	CL-CL	L-CL	GL-GL	L-GL	WL-WL	L-WL		SL-SL	L-SL	OL-OL	L-OL
									PL-PL	L-PE	L-FlL				
Living biomass		Above-ground	M	M	M [a]	M [b,c]		M [b,c]		M [c]	M [c]		M [c]		M [c]
		Below-ground		M		M [b,c]		M [b,c]		M [c]	M [c]		M [c]		M [c]
Dead organic matter		Dead wood		M [c]		M [c]		M [c]					M [c]		M [c]
		Litter		M		M [c]		M [c]					M [c]		M [c]
Soil organic matter		Mineral		M	M	M	M	M					M		M [d]
		Organic	M	M	M	M	M	M	M [f]				M		
HWP			M (may be assumed 0 if net carbon stock change is judged insignificant)												
N_2O	Direct	Fertilization [e]	M	M					M	M	M	M	M		
		N mineralization		M		M	M [g]	M					M		M
		Drainage	M	M					M			M	M		
		Burning	M	M	M	M	M	M	M	M		M	M		M
	Indirect	Fertilization [e]	M	M					M	M	M	M	M		
		N mineralization		M		M	M [g]	M					M		M
CH_4		Burning	M	M	M	M	M	M	M	M		M	M		M

Tier 2			Land use												
			FL		CL		GL		WL			SL		OL	
Carbon pool – GHG			FL-FL	L-FL	CL-CL	L-CL	GL-GL	L-GL	WL-WL	L-WL		SL-SL	L-SL	OL-OL	L-OL
									PL-PL	L-PE	L-FlL				
Living biomass		Above-ground	M	M	M [a]	M [b]	M	M [b]		M	M	M	M		M
		Below-ground	M	M	M [a]	M [b]	M	M [b]		M	M	M	M		M
Dead organic matter		Dead wood	M	M	M	M	M	M		M		M	M		M
		Litter	M	M	M	M	M	M		M		M	M		M
Soil organic matter		Mineral	M	M	M	M	M	M				M	M		M
		Organic	M	M	M	M	M	M	M	M		M	M		
HWP			M												
N_2O	Direct	Fertilization [e]	M	M					M	M	M	M	M		
		N mineralization	M	M		M	M [g]	M				M	M		M
		Drainage	M	M					M	M		M	M		
		Burning	M	M	M	M	M	M	M	M		M	M		M
	Indirect	Fertilization [e]	M	M					M	M	M	M	M		
		N mineralization	M	M		M	M [g]	M				M	M		M
CH_4		Burning	M	M	M	M	M	M	M	M		M	M		M

Notes: grey shading = not applicable, blank = not mandatory.

Abbreviations: M = mandatory, GHG = greenhouse gas, FL = forest land, CL = cropland, GL = grassland, WL = wetlands, SL = settlements, OL = other land, PL = peatland, PE = peat extraction, FlL = flooded land, HWP = harvested wood products
FL–FL, CL-CL, GL-GL, WL-WL, PL-PL, SL-SL, OL-OL = indicate land category remaining under the current land use
L–FL, L-CL, L-GL, L-WL, L-PE, L-FlL, L-SL, L-OL = indicate land category converted to the current land use

[a] To be reported only for perennial crops.

[b] Net carbon stock gain in biomass pool for annual crops is to be reported only once in the year after conversion.

[c] Only applicable if the Party has reported carbon stock changes or the IPCC provides default carbon stock values for the biomass or DOM carbon stock for the previous land use. In such a case carbon stock is to be reported as instantaneously oxidized in the year of conversion.

[d] Carbon stock level after conversion is to be set at 0.

[e] N_2O emissions from N fertilization in forest land and settlements are to be reported under the LULUCF sector and those in cropland and managed grassland are to be reported in the agriculture sector. If the Party is not able to separate emissions from N fertilization in different land-use categories, all emissions are to be reported under the agriculture sector.

[f] Under tier 1 the activity data do not distinguish between peatlands under peat extraction and those being converted for peat extraction.

[g] N_2O emissions from grassland remaining grassland for agriculture purpose are reported under the agriculture sector.

Figure 3-5. Pools and greenhouse gases to be reported at tier levels 1 and 2 in accordance with the 2006 IPCC Guidelines

2.15. Wetlands Supplement and carbon pools

The Wetlands Supplement contains additional default methodologies and default parameters and EFs to be applied at the tier 1 level for estimating CSC and associated GHG emissions and removals from a number of human activities.

Remember that at the time of developing this course, Parties to the PA are required to use only the 2006 IPCC Guidelines to develop and report their GHG inventories. In addition, Parties to the PA are encouraged to use the Wetlands Supplement.

Figure 3-6 shows the C pools and GHGs together with the associated activities that are covered by the Wetlands Supplement at tier 1 and tier 2 levels.

TIER 1			Any Land Use and/or Land-Use change category							
			Drained Inland Organic Soils		Rewetted Organic Soils		Coastal Wetlands		Inland Wetlands Mineral Soils	
C pool- GHG			On site	Off site	On site	Off site	On site	Off site	On site	Off site
LB	CO_2	Forest management [2]					Y			
		Drainage [3]					Y			
		Extraction [4]					Y			
		Rewetting/Restoration [5]								
DOM	CO_2	Forest management [2]					Y			
		Drainage [3]					Y			
		Extraction [4]					Y			
		Rewetting/Restoration [5]								
SOM [1]	CO_2	Drainage [3]	Y	Y			Y		Y	
		Extraction [4]					Y			
		Rewetting/Restoration [5]			Y	Y	Y		Y	
		Burning	Y		Y		Y			
	N_2O (direct)	Drainage [3]	Y							
		Extraction [4]					Y			
		Rewetting/Restoration [5]								
		Aquaculture use					Y			
		Burning								
	CH_4	Drainage [3]	Y							
		Extraction [4]								
		Rewetting/Restoration [5]			Y		Y		Y	
		burning	Y		Y		Y			

Y Default method and factors provided

grey Not Applicable

blank Default method and factors not provided

1 It may include DOM as well as LB of non-tree wooden vegetation

2 Forest management practices in mangroves

3 Conversion from saturated to drained soils by establishing a net of ditches and removing original vegetation

4 Excavation to enable port, harbour and marina construction including aquaculture and salt production

5 Conversion from drained to saturated soils by restoring hydrology and reestablishment of vegetation

Figure 3-6. Pools and greenhouse gases for which the Wetlands Supplement provides default methods and factors at tier level 1 and 2

Importantly, the Wetlands Supplement provides new and revised EFs for estimating GHG emissions/removals from the SOM C pool. To help you review the appropriateness of the EFs when a Party applies the Wetlands Supplement click here to see the table summarizing the sources of these EFs for each GHG and indicates whether they are new or revised EFs compared to the 2006 IPCC Guidelines.

Status	Gas	Table/Chapter	EF description
Revised	CO_2	Table 2.1	Drained organic soils
		Table 5.2 and 5.3	Inland wetland mineral soils
	N_2O	Table 2.5	Drained organic soils
New	CO_2	Table 2.2, Table 3.2	Dissolved organic carbon from drained and rewetted organic soils
		Table 3.1	Rewetted organic soils
		Chapter 4	CSC in all C pools in coastal wetlands
	CH_4	Table 2.3	Drained organic soils
		Table 2.4	Drainage ditches
		Table 3.3	Rewetted organic soils
		Table 4.14	Rewetted soils and created mangroves and tidal marshes
		Table 5.4	Inland wetland mineral soils
	N_2O	Table 4.15	Aquaculture use in mangroves, tidal marshes and seagrass meadows
	CO_2, CH_4	Table 2.7	Fires in organic soils

3. General approach in reviewing land representation and carbon pools

General

During a review you will have to assess several aspects of a Party's representation of land areas and CSC in C pools and identify issues in relation to those. You should first assess the information reported in the CRT for the LULUCF sector (CRT 4.1, CRT 4.A–4.F and CRT 4(I)-(IV)), and the related information included in the NID. You should request from the Party any additional information you might need in order to adequately assess the TACCC of the land representation.

Possible omissions or double counting of land areas, and consistency in reporting

Check whether:

- The country area and the different land-use categories are overestimated or underestimated;
- The classification methodology avoids any misclassification of the land-use categories;
- The total country area and variability of climate, soil, ecosystem classes are covered by the land representation;
- AD, EFs and emissions and removals are reported for all land-use categories; otherwise proper notation keys are used in the CRT in cases when numerical data are not used;
- The Party stratified the land-use categories according to IPCC default stratification; it has applied a country-specific classification; and the stratification applied is consistent with national circumstances;
- The total area reported, corresponding to the total national territory, is constant across the time series;
- The land representation is consistent across the time series, including whether lands have been correctly stratified into managed and unmanaged lands;
- The areas are reported for each land-use category and a description of how they compare with the respective areas reported in earlier submissions is provided. In the case of large changes compared with previous submissions, check whether the Party has provided adequate explanations in its NID. If not, you should request such information from the Party during the review;
- The Party has provided in its NID the land-transition matrices similar to that of CRT 4.1, for all years for the time series as well as for the period n - 1 through to n - (T - 1); where n is the starting year (taking into account the flexibility provided in para. 57 of the MPGs for those developing country Parties that need it in the light of their capacities) and T is the transition period applied (the IPCC default transition period is 20 years, so usually n - 1, n - (T - 1) with 1990 as a starting year corresponds to 1989–1971). Such information is needed for checking the consistency of land representation for the period n, n + (T - 1). For example, with 1990 being the starting year of the inventory, 1990–2009 in land converted to other category includes also areas converted before the starting year;
- A gross increase in a land-use category X (e.g. forest land) corresponds to an identical gross increase in the area of its subcategory land converted to land-use category X (e.g. land converted to forest land);

- A gross increase in the subcategory land-use category X remaining land-use category X (e.g. forest land remaining forest land) corresponds to an identical gross decrease in the subcategory land converted to land-use category X (e.g. land converted to forest land);
- A gross decrease in land-use category X (e.g. forest land) corresponds to an identical aggregate gross increase in the areas of the subcategories of land-use category X converted to other land-use categories (e.g. forest land converted to cropland + forest land converted to grassland + forest land converted to settlements + forest land converted to wetlands + forest land converted to other land);
- In any reported year *y*:
    - The total final area of each land-use category as reported in CRT 4.1 is equal to the respective total area as reported in CRT 4.A-4.F in the same year;
    - The initial area of each land-use category as reported in CRT 4.1 is equal to the final area of the same land-use category as reported in CRT 4.1 in the year *y-1*?;
    - The Party reports annual areas in CRT 4.1 and cumulative areas in CRT 4.A-4.F;
    - The total area under each land-use change category is equal to the sum of areas reported (in CRT 4.1 and in the NID for years before the starting year) as converted to that land category during a time period equivalent to the transition period, minus the areas under land-use conversion categories further converted to other land-use categories (if countries track land-transition in a way that allows gathering this information. Be aware that in such a case, the IPCC default method for estimating DOM and SOM CSC should be applied with care because those track linearly CSC across a transition period);
    - The total area of a land-use category X remaining land-use category X is equal to the area of the previous year plus the areas converted to that category in the year *y* - T (e.g. for 1991, the year 1971) minus the areas of that land-use category converted to other categories in the year *y*.

Carbon pools

Check whether:

- Definitions of C pools are used consistently across time and categories;
- When modified definitions of C pools are applied rather than those proposed by the 2006 IPCC Guidelines, neither omission of CSC and associated GHG emissions and removals nor double counting occurs (i.e. no portion of the C stocks considered by the 2006 IPCC Guidelines definitions is excluded or portion of C stocks included in more than one C pool);
- Completeness, accuracy and consistency of calculation of C stock transfers among pools is ensured;
- Significant C pools in key categories have been determined (significance analysis) and reported;
- Each C stock input to a pool is tracked through time until its eventual transfer to other pools and/or emissions to the atmosphere;
- The reported CSC in a pool or a subpool represent the correct net CSC from that pool, and are prepared accounting for all C stock gains and losses (i.e. if carbon stock gains are estimated for a pool carbon stock losses (e.g. from decay or disturbances) are also estimated and vice versa) and complete C balance is reported;

- If there is a change in land use/management, both processes have been reported, namely the abrupt change that occurs in a single year where it occurs and the continuous change that occurs over a transition period;
- For equivalent but inverse processes (e.g. equal areas of grassland converted to cropland and cropland converted to grassland within the same land stratum), total net CSC across the transition period are equal in magnitude but opposite in sign;
- Net CSC is assumed to be zero only in cases where the carbon stocks can be assumed to be at the long-term average;
- The Party reports the transition period(s) applied in C pools;
- Estimates for mineral and organic soils are reported separately.

When the carbon stock gain and loss method is applied check whether the following elements required for estimating CSC have been considered:

For biomass

- C increment: either net increment (increment net of natural mortality) or the gross increment (excluding natural mortality) can be used. If the gross increment (excluding natural mortality) is used, C losses due to natural mortality have to be added to C stock losses;
- C losses due to harvest;
- C losses due to fuelwood collection;
- C losses due to other disturbances (e.g. fires, pest outbreaks);

Note that consistent with the methodologies and default assumptions for the different land-use categories in the 2006 IPCC Guidelines, CSC in both above- and below-ground biomasses are estimated. When the inclusion of below-ground biomass is optional (e.g. forest land remaining forest land in the tier 1 methodology), if the below-ground biomass is included in any of the elements of equations 2.10, 2.11, 2.15 and 2.16, chapter 2, volume 4 of the 2006 IPCC Guidelines, it must also be included in the other elements of those equations.

For deadwood

- C stock transfers from the biomass pool into the deadwood pool due to turnover/natural mortality;
- C stock transfers from the biomass pool into the deadwood pool due to any disturbances;
- C stock losses from the deadwood pool due to any disturbances;
- C stock losses from the deadwood pool due to decomposition;

For litter

- C stock transfers from the biomass pool into the litter pool due to turnover/natural mortality;
- C stock transfers from the biomass pool into the litter pool due to any disturbances;
- C stock transfers from the deadwood pool into the litter pool due to decomposition;
- C stock transfers from the deadwood pool into the litter pool due to any disturbances;
- C stock losses from the litter pool due to any disturbances;
- C stock losses from the litter pool due to decay;

Note that disturbances include all ND and all anthropogenic disturbances, including any harvest of wood (including fuelwood).

For SOM mineral soils

- C stock transfers from the biomass pool into the SOM pool due to turnover/natural mortality;
- C stock transfers from the biomass pool into the SOM pool due to disturbances;
- C stock transfers from the DOM pool into the SOM pool due to decomposition;
- C stock transfers from the DOM pool into the SOM pool due to disturbances;
- C stock losses from the SOM pool due to disturbances;
- C stock losses from the SOM pool due to decomposition;

Note that the 2006 IPCC Guidelines default method for SOM mineral soils is a stock-difference method. The above elements should be examined if a country-specific method based on the gain-loss method is applied, for example, a process-based model.

For HWP

- C stock transfers from the biomass pool into the HWP pool (HWP in use) due to harvest (including fuelwood collection);
- HWP production from biomass, recycled wood and deadwood if any;
- C stock losses from the HWP pool due to energy use;
- C stock losses due to HWP discard and wood recycling if any.

Check whether:

- The Party reports the HWP contribution applying at least tier 1;
- The Party reports the HWP contribution as zero, and if so, whether it provides evidence that annual C change in HWP stocks is insignificant (i.e. less than any key category);
- The HWP contribution has been estimated using an approach other than the production approach, and if so, whether the Party additionally provided information on emissions/removals estimates by using the production approach since it must do so as per the MPGs;
- All HWP have been included;
- The Party has computed the HWP contribution by correctly combining different variables according to the approach selected;
- The Party applies a country-specific method and, if so:
    - Have all HWP relevant for the approach selected been included?
    - Are input data consistent with the methodology applied?
    - Are estimates comparable with tier 1 estimates and, if that is not the case, has the Party reported justification for the discrepancies?
- Estimates of fuelwood consumption reported in the energy sector are consistent with fuelwood collection/production reported for biomass and HWP estimates;
- All CO_2 emissions associated with HWP carbon stock losses are reported in the LULUCF sector, including those from HWP disposed of in SWDS and those used for energy;
- The Party reports the half-life values applied for estimating the HWP contribution in CRT 4.Gs1 in case it applies a method using half-lives of HWP and whether they are consistent with the default values in the 2006 IPCC Guidelines and, if not, whether the Party has provided transparent information on their deviations therefrom and their sources;
- Consistency is ensured between AD used for the HWP contribution and data reported in the NID and CRT 4.A-4.F as well as with HWP data reported to FAOSTAT and the NID provides transparent information on any discrepancies between the two datasets,;
- CSC in HWP have been correctly reported in CRT 4.Gs1 depending on the approach followed by the Party taking into account footnotes (2) (8), and (10).

Note that some HWP may be produced with recycled wood. Therefore, comparison between harvest quantities used for estimating biomass C stock losses and those used in reporting HWP C stock gains should only be done for the variable domestic harvest only (carbon in annual harvest of roundwood for products – wood removed from harvest sites in the reporting country, including fuelwood).

Check whether:

- The Party has applied correct factors for the conversion of dry organic matter into carbon and, when country-specific values have been applied, indicated how they compare with default values in the 2006 IPCC Guidelines (vol. 4, chap. 12, table 12.4).

Note that for some C pools under some land categories, the net CSC is assumed to be zero, or equilibrium, that is, no gains and losses reported when a tier 1 methodology is applied.

Documentation

Documentation on the definitions of land-use categories and land classification system

Check whether:

- The Party reported information on the national land-use categories definitions and on the system of classification applied and how these correspond to definitions and good practice contained in the 2006 IPCC Guidelines:
  - Are there differences in the definitions used by the Party as compared with the six land-use categories provided in the 2006 IPCC Guidelines? If no, how did the Party reconcile the national data to these six land-use categories?
  - Has the Party stratified between managed and unmanaged lands areas under forest land, grassland and wetlands, and if so, has it provided information on how unmanaged lands are identified? Is the Party tracking appropriately the unmanaged land and reporting land area information?
  - Does the Party provide GHG estimates separately for land remaining in the same land-use category and land converted to another land-use category?
  - Are the land-use subcategories consistent with the stratification provided by the IPCC (i.e. climate, soil, vegetation, management)? If there are differences, has the Party explained how those subcategories are appropriate to its national circumstances?
  - Has the Party reported on the hierarchical order in the land classification?
  - Does the Party ensure that under the category other land lands with no significant C stocks are classified?
  - Has the Party included in the inventory CSC and associated emissions/removals for managed land left unmanaged for the entire transition period (i.e. until the carbon stocks reach the new equilibrium level characteristic of the unmanaged land), preferably as a subdivision (under either managed or unmanaged land)?
  - Has the Party included in the inventory the entire area and CSC and associated emissions/removals for unmanaged land subsequently managed for the entire time series (C stocks on unmanaged lands can be assumed to remain constant until the year in which land is classified as a managed use)?

Documentation on approaches to representing land areas and land databases
Check whether:

- The Party has provided information on the approaches used for representing land areas in its NID;
- The Party has provided information on the land databases used for inventory preparation:
  - Are the sources of information provided?
  - If sampling has been used, are sampling routines described?
  - How have inconsistencies between different databases been harmonized?

Data on uncertainties and other cross-cutting issues
Check whether:

- The Party has verified its land-area estimation:
  - Does it cover all land-use categories/subcategories and the changes? How many years of the time series have been verified?
- The Party can explain differences in its land-area data when compared with international statistics (e.g. FAOSTAT/FAO GFRA) or other official data;
- The Party has provided information on the uncertainties and the methodologies used for uncertainty assessment related to the land-area estimation.

Information on C pools
Check whether:

- The Party has reported definitions of all C pools, and how these correspond to the definitions and defaults in the 2006 IPCC Guidelines, including:
  - Any differences in the definitions of the C pools as compared with those provided in the 2006 IPCC Guidelines;
  - Consistency of the definitions with the stratification applied by the country and their appropriateness to national circumstances;
- The Party has reported information that clearly documents any country-specific definition of C pool, to ensure that the modified definitions:
  - Do not omit or double count CSC;
  - Are used consistently over time and across categories.

4. Practical exercises

Exercise 1

Forest area in national inventory submissions and in international data sets

See below the forest areas of a Party as reported in its latest 2024 national inventory report and in the FAO GFRA 2020 country reports (http://www.fao.org/forest-resources-assessment/fra-2020/country-reports/en/). The Party applies the FAO forest definition for its LULUCF GHG inventory. The FAO forest definition includes all forests with tree crown cover of more than 10 per cent and area of more than 0.5 ha. The trees should be able to reach a minimum height of 5 m at maturity in situ. Land areas that are predominantly under agricultural or urban land use are not included.

Source	1990	2000	2010	2020	2022
Party's NID 2024 (kha)	7 590	8 369	9 032	9 526	9 531
FAO GFRA 2020 (kha)	7 590	8 369	9 032	9 530	-

Question 1

What is the reason for the difference in the forest land area in 2020?

A. The FAO GFRA is more reliable, especially for 2020, since it is the report of that specific year;
B. The latest GHG inventory submission is more recent, with updated data.
C. Different forest definitions are applied.

Exercise 2

Reporting a consistent land representation

The tables here have been included by a Party in its NID for 1971–1989, which reports areas (in kilohectares) of land uses and of annual land-use changes in a country with a land area of 30,133,601 ha: https://unfccc.int/resource/tet/bl/bl3-06_u_l3_att7.xlsx
For 1990 and 1991 the Party reports in CRT 4.A-4.F the areas for each land category as presented in NID table 2: https://unfccc.int/resource/tet/bl/bl3-07_u_l3_att8.pdf
For 1990 and 1991, the Party reports in CRT 4.1 the information as presented in NID table 3: https://unfccc.int/resource/tet/bl/bl3-08_u_l3_att9.pdf

Question 2

1. Knowing that the transition period applied by the Party is 20 years for all land categories, is the Party's land representation consistent?
2. Why or why not?

In 1992, 1,000 kha of unmanaged mangrove forests, a coastal wetlands (which is reported under forest land as it meets the national definition of forest land and owing to the precedence in the hierarchy over wetlands) is converted to shrimp ponds, another type of coastal wetlands. However, the Party does not classify shrimp ponds in its wetlands definition, and therefore, the total area of land has changed from 30,133.601 kha to 30,132.601 kha. Consequently, the country recalculates the time series of AD for forest land, removing 1,000 kha from its land representation. https://unfccc.int/resource/tet/bl/bl3-09_u_l3_att11.pdf

Question 3

1. Is the recalculated time series a correct set of AD for estimating anthropogenic GHG emissions/removals from the LULUCF sector? Why or why not?
2. How would you treat this situation in a review, and where should the Party report C stock losses, and associated emissions, caused by the deforestation of the 1,000 kha of unmanaged mangrove forests?

In 1992, 0.100 kha of unmanaged other land emerges from the coastal sea because of a volcano eruption, so that the total area of land, including inland waters, changes from 30,133.601 kha to 30,133.701 kha. Therefore, the country recalculates the time series of AD for other land adding 0.100 kha to its land representation from 1992 onwards.

Question 4

1. Is the recalculated time series consistent?
2. What should a Party report in 1992 to ensure a consistent land representation?

Exercise 3

Classification of land – review of subcategory definitions and of reported GHG emissions/removals
A Party has extensive apple, peach and other fruit tree plantations (i.e. orchards). The plantations cover 5 per cent of the total country land area. The crown cover and the tree height for the plantations exceed, on average, the thresholds of the national forest definition. However, orchards are classified under the land-use category cropland because, according to the national forest land definition, the dominant land use in a land classified as forest land should be forestry.

Question 5

Should the classification of orchards as cropland be addressed in the review report? If so, then how? In which cases could the classification be linked to an inventory problem?

Exercise 4

A Party has big 'green cities' with extensive areas of city parks with tree crown cover and tree height exceeding the thresholds defined in the national forest definition. The Party has, however, classified these city parks under settlements according to the national definitions, which have been applied consistently. The Party states in its NID that the urban parks are likely to be significant sinks and have increased in area by approximately 10 per cent since 1990. However, the Party reports as "NO" CSC and associated GHG emissions/removals from the city parks following tier 1 methodology from the 2006 IPCC Guidelines.

Question 6

How should this issue be addressed in the review report?

Exercise 5

A Party has areas of grazed lands where the woody vegetation meets the forest thresholds definition. However, because the predominant use of these lands is the grazing of grass and they are covered by shrubby vegetation, the country decided to classify them as grassland. The Party has not applied any hierarchy to its land classification.

Question 7

Should the classification of grazed lands be addressed in the review report? If so, then how? In which cases could the classification be linked to an inventory problem?

Exercise 6

Consistency in the definition of a C pool among land-use categories

A developed country Party does not provide clear definitions on the C pools in the NID. During the review, you identified that the Party's definition of living biomass in forest land (i.e. includes stem and main branches) differs from that applied in woody grassland (i.e. includes stem, main branches and fine branches) and the Party reports CSC from forest land conversions to grassland.

Question 8

How would you treat that in the review report?

Exercise 7

Reporting C stock gains and losses in DOM

A Party has included C increases in the DOM pool resulting from the C transfer due to mortality and disturbances in above-ground biomass and has included C losses from the DOM resulting only from decay.

Question 9

Has the estimation of CSC in DOM been implemented in accordance with the 2006 IPCC Guidelines?

Exercise 8

Inconsistency in reporting C stock transfers

A Party has estimated the fraction of biomass C stock that is transferred to DOM and HWP as a consequence of harvesting and/or any other disturbances but has not counted this as a C stock loss from the biomass pool.

Question 10

Have the CSC in the biomass pool been estimated in accordance with the 2006 IPCC Guidelines?

Exercise 9

Inconsistency arising from the use of country-specific model

A Party has applied the stock-difference method to the biomass C pool and has reported a net C stock loss. In the NID it has justified this net C stock loss as being the result of increased harvesting and mortality due to pest outbreaks, and provided information that fires are not a significant source of GHG emissions. The Party has applied a process-based country-specific model to the DOM C stock pool and has reported a net C stock loss as well, although not justified by any collection of DOM for energy or other uses.

Question 11

Do you have any observation on the overall approach followed by the country that you would try to investigate further during the review and through your communication with the Party?

Exercise 10

Inconsistencies in statistical data used for estimating CSC

A Party has reported losses in biomass C stocks and DOM associated with harvesting and fuelwood gathering that are lower than the sum of fuelwood and industrial roundwood production (including bark) reported for calculating the HWP contribution (i.e. variable H) after expanding such sum to include slash and woody debris.

Question 12

Do you have any observation on the overall approach followed by the country that you would try to investigate further during the review and through your communication with the Party?

Exercise 11

Higher methodological tier: models

A Party applies a model (tier 3) for estimating and reporting CSC in a C pool. In the NID the Party reports only brief information on the name of the model and its description.

Question 13

Which elements would you consider in your review?

Exercise 12

Inconsistency in CSCF for specular land-use conversions

A Party has reported different absolute values of annual net CSCF for land-use conversions that involve the same land-use categories with the same climate/soil/management combination and the same transition period but are opposite in direction. For example, for the same soil and climate types, the Party reports a different absolute value of SOC CSCF for the conversion of grassland to cropland from that used for the conversion of cropland to grassland, although the management systems of cropland and grassland are the same for both types of conversion. The Party has used the same methodological tier for calculating the stock changes of SOM in cropland converted to grassland and grassland converted to cropland.

Question 14

Is the Party estimating CSC in accordance with the 2006 IPCC Guidelines?

Exercise 13

Historical AD for HWP

A Party has reported HWP CSC by using a time series of historical data on HWP production, import and export from 1990 onwards. No data on HWP for the years before 1990 have been used. Consequently, the HWP pool is a sink with a decreasing trend.

Question 15

What would be your finding as a reviewer?

Exercise 14

Insignificant C stock changes in HWP pool

Party X from Latin America has reported zero CSC in the HWP pool claiming that these are insignificant. In the NID the Party does not provide more information to substantiate the assumption of zero CSC in the HWP.

Question 16

How would you address this in your review?

4.1. Answer key to practical exercises

Question 1

The correct answer is (B). The GHG inventory data are to be considered as the most up-to-date compared with those of FAO. Note that the FAO GFRA report is from 2020 while the GHG inventory was submitted in 2024 with updated data for the whole time series. Also, it is important to note that data are submitted to FAO by countries one year before their publication in the GFRA report, consequently even in years when both the GHG inventory is submitted and the FAO GFRA report is published differences in the areas between the two may exist. In these cases, the GHG inventory is generally considered as the one containing the most up-to-date information. You should also be aware that in some cases, the national entity reporting to FAO may differ from the entity compiling or submitting the GHG inventory. You may need to work with the Party to better understand the national circumstances and help clarify any findings in your report.
From this exercise you can see that forest areas from different sources may differ for the same country. In all cases, when such differences are found between the GHG inventory and other authoritative data sources (remember that countries submit the data to FAO) the Party should be able to explain those differences.
When national definitions use higher threshold values than those used in FAO definitions for tree crown cover and tree height, then areas reported to FAO will be larger than those reported using these national definitions. Moreover, additional rules referring to dominant land uses (e.g. agroforestry plantations being considered cropland despite meeting the forest definition thresholds) can affect the land classification and comparison with international data sets, especially in countries where agroforestry is a significant land use or in countries with extensive tree areas that are classified as settlements.

Question 2

1. Yes, the land representation is consistent.
2. The total area reported is constant across the time series, see NID table 4:
https://unfccc.int/resource/tet/bl/bl3-10_u_l3_att10.xlsx
The area of a land remaining under category X in 1990 is the area that was under land remaining under category X in 1971 minus all areas of category X that have been converted to other categories from 1972 to 1990 (please note that area transfers from unmanaged to managed land (and vice versa) of the same category do not affect such calculations).
For instance, the area of forest land remaining forest land in 1990 is the sum of the areas reported in cells B5, C5, B27 and C27 in NID table “Forest land” minus the area of forest land converted to settlements (this is the only conversion reported in NID tables) from 1972 to 1989 reported in NID table “Settlements” in columns D–E and rows 5–22, minus the area of forest land reported as converted to other land uses in CRT 4.1 for 1990 in columns D–J and rows 3–4.
The area of a land remaining under category X in 1991 is the area that was under land remaining under category X in 1990 (as calculated previously) minus the sum of all areas converted to other categories in 1991 plus all areas of other categories that have been converted to category X in 1971 (Please note that area transfers from unmanaged to managed land (and vice versa) of the same category do not affect such a calculation).
For instance, the area of forest land remaining forest land in 1991 is the area that was under forest land remaining forest land in 1990 (as calculated previously) minus the area of forest land reported as

converted to other land uses in CRT 4.1 for 1991, in columns D–J and rows 3–4, plus the sum of the areas reported in NID table "Forest land" in columns D–K and rows 5 and 27.
The area of a land converted to category X is the sum of areas converted to that category X during a time period of 20 years. For example, since 1971 for 1990, since 1972 for 1991 and so on.
For instance, the area of land converted to forest land in 1991 is the sum of areas converted to forest land since 1972 reported in NID table "Forest land", in columns D–K, rows 6–23 and 28–45, plus the area reported as land converted to forest land in CRT 4.1 for 1990 and 1991, in columns B–C and rows 5–11.

Question 3

1. No, it is not correct, because the recalculated time series does not count the loss of mangrove forest area and, consequently, the C stock loss associated with that forest loss is not reported.
2. In a consistent time series, the loss of mangrove forest will be reported as a conversion of unmanaged forest land (unmanaged mangrove forests) to managed wetlands (coastal wetlands), and the total area of the country reported will remain constant and equal to 30,133.601 kha. As a reviewer, you must recommend that the Party include the shrimp pond in its wetlands definition, not change the total country area reported, and report the C stock loss caused by the conversion of the unmanaged mangrove forest to the managed shrimp ponds as a CSC in the subcategory forest land converted to other wetlands.

Question 4

1. No, it is not consistent because the total area of the country changes across the time series.
2. The Party should report, for 1992, the conversion of unmanaged wetlands to other land. This implies that the entire time series of the land representation is revised by adding an area of 0.100 kha to the unmanaged wetlands category from 1971 to 1991. Note that in this case, applying both the consistent and the inconsistent land representations would result in the same trend of anthropogenic GHG emissions/removals reported in the national GHG inventory because the new land area is unmanaged and free of C stock. Alternatively, the country may consider the coastal sea in the other land category so that although the time series is recalculated backward adding to the other land category the 0.100 kha of new volcanic land, no land use change is reported. This second option may be perceived as less transparent since, in fact, the land significantly changes from sea to volcanic rock. However, reporting of subdivisions in other land would make reporting transparent.

Question 5

The classification of plantation as cropland consistent with the national definitions should normally not be raised as an inventory issue. However, as a reviewer, you should assess whether this definition has been applied consistently by the country across time and over the entire country and whether emissions/removals from fruit plantations are included in cropland. Any lack of consistency or gaps in reporting of emissions/removals should be addressed through a recommendation to the Party including guidance on how to address the issue.

Question 6

Consistently with its national definitions, the Party can classify its urban parks under settlements despite the fact that these exceed the thresholds of the national forest definition, provided that it applies the national definition consistently across time and space. So, you, as a reviewer, should not raise this as an issue in the review report.
However, because city parks are likely to be significant sinks, and bearing in mind that they have increased in area, the 2006 IPCC Guidelines (vol. 4, chap. 8) requires reporting of CSC and associated GHG emissions/removals using higher-tier methods, and provides tier 2 methodologies and associated default factors for reporting. As a reviewer, you should therefore recommend that the Party assess whether settlements remaining settlements is a key category, and if so, whether the biomass pools is a significant pool. In such a case the Party should report on the CSC and associated GHG emissions/removals from these parks in future submissions, using one of the IPCC tier 2 methods or any other higher-tier methods subject to the availability of country-specific data. If country-specific EFs and parameters are not available, you should further recommend that the Party use the tier 2 defaults provided in the 2006 IPCC Guidelines while making the development of country-specific factors one of the priorities for future improvement of the national inventory.

Question 7

The classification as such does not appear to be fully consistent with the six broad IPCC land categories, as defined in the 2006 IPCC Guidelines (vol. 4, chap. 2), where it is recognized that they are a mixture of land-cover (e.g. forest, grassland, wetlands) and land-use (e.g. cropland, settlements) classes. According to the 2006 IPCC Guidelines (vol. 4, chap. 3), while the definitions of land-use categories may incorporate land cover and land use or combine the two, inferring land use from the land cover characteristics and vice versa should be done carefully. Indeed, given that the C stocks of the woody vegetation and their changes are the most important determinant of GHG emissions/removals in these lands, it would be better to classify the lands as forest land in order to ensure that proper methods are applied for preparing estimates. However, Parties can choose their own land-use definitions that better address national circumstances, although in the absence of a country-specific hierarchy among categories the one embedded in the IPCC definitions applies. Therefore, as a reviewer, you must firstly check whether this definition is used consistently by the country, and whether proper methods and factors have been applied by the Party for estimating GHG emissions/removals from those lands that contain a tree cover which exceeds the forest definition thresholds (for which methods provided for forest land are more suitable). Nevertheless, you should recommend that the Party reclassify these lands under forest land (likely as a subcategory) since forest land is higher than grassland in the hierarchical order of land-use categories because of the particular management practices applied that affect both the long-term average C stocks and the temporal dynamic of C stocks across the management cycle.

Question 8

Calculation of CSC in conversion of forest land to woody grassland must be based on a single national definition of biomass pool. Otherwise, inconsistency in definitions will impact the accuracy of the CSC. Therefore, you must recommend that the Party apply the same definition for the living biomass carbon pool in forest land and woody grassland.

Question 9

No, the estimate of the net CSC in the DOM pool is biased. The Party must ensure the accuracy of the estimates of CSC in the DOM pool by including all C stock gains and losses, including DOM losses due to disturbances.

Question 10

No, the estimate of the net CSC in the biomass pool is biased. The Party must include in the biomass C stock losses any C stock being transferred to other C pools, regardless of whether the net CSC in the other C pool to which the biomass C stock is being transferred (e.g. DOM or HWP) is calculated or is assumed to be at equilibrium (e.g. zero CSC under the tier 1 assumption).

Question 11

Contrary to what has been reported by the Party, logically there should have been an increased transfer of biomass C stocks to the DOM pool and a consequential increase in DOM C stocks (i.e. a net C stock gain). This apparent inconsistency could have resulted from issues in the country-specific model such as underestimation of C stock transfer from biomass to DOM, or higher than actual decay rates. The Party should ensure consistency between biomass and DOM CSC estimates. One way to accomplish this is to verify biomass estimates by comparing them with estimates prepared with the gain-loss method. The estimates calculated with the gain-loss method could also be used for calibrating the biomass C stocks annually transferred to DOM into the country-specific model. You should therefore try to obtain the necessary explanation from the Party on the identified inconsistency.

Question 12

Such a discrepancy could be a source of bias in the estimates. Therefore, you, as a reviewer, should check whether the Party has ensured consistency between statistical data used for estimating biomass and DOM C stock changes and those used for estimating HWP C stock changes. The data source with lower uncertainty should be prioritized when recalculating the time series.

Question 13

During the review, you must assess the model against the TACCC principles. Therefore, you should request from the Party all the information you need to assess the model's accuracy, completeness, consistency and comparability. This includes, for example, the model's conceptual framework and its basis and type; the main equations/processes and any assumptions used and how these compare with the IPCC methods; information on any parameters used, inputs needed, validation, verification and calibration implemented in the model; and any related source of information for the methods, parameters and data used and/or peer-review literature. Along with ensuring the accuracy, completeness and consistency of the results you should also check the comparability of the estimates reported under the pool with the estimates reported by other Parties for the same pool. You must recommend that the Party report the relevant information in the NID to enhance the transparency of reporting. In addition, you must recommend that the Party correct any potential accuracy, completeness and consistency issues you identify during the review. For more information on good

practice guidance in applying model-based estimation methods see section 2.5.2, chapter 2, volume 4 of the 2006 IPCC Guidelines.

Question 14

No, since there is an inconsistency in how the Party estimates CSC between the two 'opposite' land-use conversions, which is a source of bias in the estimates and therefore must be removed. The Party must ensure consistency between the two CSCFs by having the same absolute value and opposite sign as the two conversion processes are symmetric although opposite in direction. In the case of conversions between land-use categories with the same soil/climate and management in either direction but over different transition periods in the two directions (e.g. CL-GL having a different transition period from GL-CL) the total CSC calculated across the entire transition periods instead of annual CSCFs should be the same.

Question 15

To estimate the HWP contribution using the methods in the 2006 IPCC Guidelines, HWP data must be extrapolated backward to 1900. You must recommend that the Party ensure a consistent time series of historical data that avoids false trends in the inventory time series. If data pre-1990 are not available, the methods provided in the 2006 IPCC Guidelines (vol. 4, chap. 12, equation 12.6) or any other country-specific method that best suits national circumstances should be applied. Note also that FAOSTATs contain data on HWP from 1961 onward that you, as a reviewer, can consult when reviewing the HWP estimations reported by Parties.

Question 16

You must request from the Party further information about the assumption of the insignificant CSC. For example, you may ask whether the Party has implemented methodologies to prepare provisional or approximated estimates of CSC using available approximated AD in order to confirm that the CSC from HWP are insignificant. If the Party responds that AD are not available you may further check alternative data sources such as FAOSTAT and assess whether the Party could use those to apply the tier 1 method. You could also check whether the HWP contribution is insignificant for the Party under review by estimating CSC by applying the tier 1 methods in the 2006 IPCC Guidelines together with FAOSTAT data. As an exercise, download the HWP worksheet developed by the IPCC Task Force on National Greenhouse Gas Inventories: https://unfccc.int/resource/tet/bl/bl3-11_u_l3_att12.xls The file contains the AD for Party X in the worksheet "Data 1" of the IPCC tool obtained from FAOSTAT (https://www.fao.org/faostat/en/#data/FO) for the hypothetical Party X located in Latin America. In the worksheet "Parameters" in the "Country" field choose "Party X" and in the "Region" field for estimating the growth rate of HWP consumption choose "Latin America". Do not check to include other industrial roundwood and enter the latest available year, that is, 2015. The tool automatically runs the calculations and provides in the "Parameters" sheet the different graphs where you can see the CSC in the HWP pool according to the different approaches applied. You can see, for example, that in this specific case the atmospheric flow approach results in the largest sink for HWP. With this information and with the results of the key category analysis made by the Party you can verify whether or not the HWP contribution is insignificant (i.e. if it is less than any key category). If it is insignificant, you may consider that the Party's reporting is in line with the 2006 IPCC Guidelines, but you must recommend

that the Party provide the necessary justification in the NID to support that the CSC in HWP are insignificant. Otherwise, you must recommend that the Party reports CSC in HWP by applying any of the approaches contained in the 2006 IPCC Guidelines (vol. 4, chap. 12) or an alternative methodology, which should be in line with the 2006 IPCC Guidelines. You must also recommend that the Party provide supplementary information on CO_2 emissions/removals from HWP using the production approach if it applies a different approach.

Note that you can use this worksheet with AD for any country in order to estimate CSC from HWP using the tier 1 method with the different approaches provided by the 2006 IPCC Guidelines.

Note that a number of Parties are using data from FAOSTAT in order to report emissions/removals from the HWP pool.

5. Self-check quiz

Question 1

A land area of a Party has tree cover of more than 40 per cent, average tree height of 3 m and the dominant land use is agriculture (fruit plantation). The Party's national land classification system lists cropland higher than forest in the hierarchical order. The thresholds for a land area to be classified as forest land are a minimum of 30 per cent tree crown cover and 2 m tree height. How should the land area be classified in the national GHG inventory reporting?

Select one:

A. A Party specifies in the NID national definitions and thresholds of land categories. The reporting of land areas is consistent with the national definitions and thresholds. In this case, the Party should report the land area as agricultural land (cropland) in accordance with the national definition since although tree vegetation meets the forest land thresholds cropland is the predominant land use
B. The Party should report the land area as forest land because the land meets the thresholds used in the definition of forest land. The thresholds data should supersede the dominant land-use criteria

Question 2

Subcategories used in the preparation of the LULUCF inventory should be defined in the NID. Which of the following statements is true?

Select one:

A. The subcategories should be chosen based on the data available in the country (or data that can be made available) to produce the best possible estimates of the emissions/removals for the sector, taking available resources into account for the whole GHG inventory
B. The subcategories must explicitly be only those determined in chapter 3, volume 4 of the 2006 IPCC Guidelines
C. The way subcategories are defined does not affect the final net GHG emissions/removals estimates
D. The available data on land areas and parameters do not need to match the subcategories

Question 3

Which is the hierarchy among the mainland-use categories embedded within the 2006 IPCC Guidelines?

Select one:

A. Forest land, cropland, grassland, wetlands, settlements, other land
B. Cropland, forest land, grassland, settlements, wetlands, other land
C. Forest land, cropland, grassland, settlements, wetlands, other land
D. Settlements, cropland, forest land, grassland, wetlands, other land

Question 4

According to the 2006 IPCC Guidelines definitions for the six top-level land-use categories, land-area information on rivers and natural lakes is included in which of the following?

Select one:

A. Managed wetlands
B. Unmanaged wetlands
C. Managed other land
D. Other land

Question 5

Why do lands need to be stratified into strata that are internally homogeneous as far as possible?

Select one:

A. Homogeneity of strata reduces the uncertainty of estimates because the higher the homogeneity in a stratum the lower the average distance between sampled data and the average value
B. Stratification reduces the variability of parameters associated with the land, because units with similar characteristics are aggregated within a single stratum
C. Stratification of data allows proper consideration to be given in estimates to small subpopulations with large differences from the average GHG balance
D. All of the above

Question 6

Based on national available data, a Party has applied a country-specific stratification for some land-use categories (e.g. in forest land, the ecological zones of temperate oceanic and temperate continental are not separated for the forest) different from those proposed in the 2006 IPCC Guidelines. Nevertheless, for those land categories, IPCC default factors for estimating CSC and associated GHG emissions/removals have been applied (e.g. above-ground biomass growth applicable for temperate oceanic forests). Is the reporting consistent with good practice?

Select one:

A. Yes
B. No

Question 7

A Party did not provide definitions of the six IPCC land-use categories in its NID although it reported its emissions/removals according to those land-use categories. The NID includes a summary table on land areas for the six top-level land-use categories, and conversions between them. Is the reporting consistent with the guidance in the 2006 IPCC Guidelines?

Select one:

A. Yes, the Party has reported emissions/removals for the mandatory categories and therefore the reporting of land areas is appropriate
B. No, transparent reporting of definitions used for the land-use categories is important for the review of land areas, as well as the estimated emissions/removals

Question 8

To ensure consistency, must the data set for land representation be compiled from a single source of information for the whole territory and the entire time series?

Select one:

A. Yes
B. No

Question 9

Why does a land representation need to be complete?

Select one:

A. A complete land representation ensures that you have the AD that you need for estimating complete GHG emissions/removals from land
B. A complete land representation avoids reporting increases or decreases in GHG emissions and removals for some land categories merely because of an increase or decrease of the total area inventoried, instead of changes in land use or land management
C. A complete land representation is likely to reduce uncertainties in the estimates of the land categories
D. All of the above

Question 10

Which of the following issues need(s) to be addressed to achieve consistency in land representation?

Select one:

A. Definitions of land-use categories need to be consistent among different data sets used
B. Methodologies for land-use data collection and analysis need to be consistent among different data sets used
C. The total area of the country needs to be included and kept constant. If, for any reason, it changes, the entire time series of land data must be recalculated according to the current area of the country for the latest inventory year
D. All of the above

Question 11

How can accuracy of land representation be assessed and ensured?

Select one:

A. By comparison with independent data sets, including through verification by sampling
B. By ensuring there is neither overestimation nor underestimation of a country's total area across the entire time series
C. By ensuring that there is no systematic misclassification of land
D. All of the above

Question 12

Land-area data are often obtained from sample surveys. Which of the following statements is true?

Select one:

A. In most cases, sampling (e.g. systematic or random) produces more precise estimates of land-use changes than wall-to-wall mapping
B. Wall-to-wall data always produce better estimates on land areas than sample surveys and in addition ensure completeness
C. Permanent plots are generally less efficient in estimating changes than temporary plots

Question 13

Land-area data can also be obtained from international databases. When comparing data reported in the national GHG inventory with data in international databases, which of the following statements is true?

Select one:

A. Information reported to international organizations is more reliable, since QA/QC checks are ensured
B. The national definitions often better reflect the national circumstances than those used in reporting to international databases. The use of the national definitions should therefore be prioritized in GHG inventories to produce results that are more accurate, although differences from those used for international databases need to be explained
C. The FAO definitions are always more stringent than national definitions
D. The use of national definitions for the land-use categories in national GHG inventories increases the comparability of reporting among Parties

Question 14

A Party has provided estimates of SOC changes (net SOC increase) associated with implementation of no tillage in cropland. The Party reports that 10 per cent of cropland area is subject to no tillage across the entire time series 1990–2022 without reporting any information on tracking of those lands. Is the reporting enough to assess the actual CSC in SOM?

Select one:

A. Yes, the Party has reported emissions/removals for the mandatory categories, and therefore the reporting provides all necessary information for assessing the accuracy of the estimates
B. No, the SOC change estimates are deeply affected by the continuity of the specific management operation. The Party should provide information on how the no tillage is implemented, that is, as part of a management cycle or continuously on the same land

Question 15

It may be the case that approach 1 does not provide all AD needed for reporting a key category, as for instance for forest land conversion to other land uses (i.e. deforestation)

Select one:

A. True
B. False

Question 16

Remote sensing is a useful tool in land-area identification and classification. Which of the following statements is false?

Select one:

A. Aerial photographs, satellite images and radar imagery are different remote-sensing products
B. Remotely sensed data never need to be complemented with reference data
C. The reliability of maps generated from remote sensing may vary from one land-use category to another
D. Remote-sensing data can be used to guide the selection of sampling schemes for more detailed information on land-use categories

Question 17

The advantage of sampling-based surveys in comparison with other methods is that the reliability of each single piece of information can be assessed. Which of the following statements is true?

Select one:

A. If information on administrative boundaries, or maps distinguishing upland and lowland areas, or boundaries or different vegetation zones is available, it is not possible to use stratified sampling
B. If a large-scale survey applies random sampling, the assessment of uncertainties should be based on careful and objective expert judgment
C. Bias of the inventory can be avoided by using temporary plots, and permanent sample plots are less effective in estimating changes than temporary plots
D. Permanent sample plots are generally more efficient in estimating changes than temporary plots

Question 18

A developing country Party has provided quantitative uncertainty estimates based on expert judgment only. The Party has not identified the need in its NID to apply flexibility for the reporting of uncertainties. The estimates of the land areas, as well as on biomass C stock gains and other parameters, are based on sample plots. Which of the following statements is true?

Select one:

A. The Party's reporting on uncertainty is consistent with guidance in the 2006 IPCC Guidelines, as implemented through the MPGs
B. When statistical methods are used to estimate emissions/removals, uncertainties have to be estimated using statistical methods, unless the Party elects to report uncertainty applying the flexibility provision in paragraph 29 of the MPGs

Question 19

The information on (i) the national approach to distinguishing between managed and unmanaged land; (ii) the approaches used for representing land areas (iii) land-use databases used for the inventory preparation; and (iv) land-use definitions and the classification system used and their correspondence to the LULUCF categories should be included in which of the following?

Select one:

A. The CRT
B. The NID
C. Both A and B

Question 20

A Party applies approach 2 for land representation. In year T, 20 per cent of the 50,000 ha reported under land converted to grassland aged 21 years after conversion. In the same year, 10,000 ha of grassland had been converted to other land-use categories while 5,000 ha of land were converted to grassland. In year T − 1, the Party reported 800,000 ha under grassland remaining grassland.
The Party has reported the following areas under each category in year T:
Grassland remaining grassland: 800,000 ha
Land converted to grassland: 45,000 ha
Grassland: 845,000 ha
Has the Party correctly reported the areas under each of the categories in year T?

Select one:

A. Yes
B. No

Question 21

A Party has reported no subdivisions of the six land-use categories in the CRT. In the NID, the Party reports that the estimates have been made using different sets of country-specific parameters for biomass growth and losses for the two climatic zones (temperate and boreal) within the country. The growth (increment) values are given by climatic zone and tree species (three different types) in a table in the NID with appropriate references. Is the reporting consistent with the 2006 IPCC Guidelines as implemented through the MPGs?

Select one:

A. Yes
B. No

Question 22

A Party has applied revised definitions of C pools to match data availability and methods used for data collection and preparation of estimates. This also involves merging some of the IPCC pools, for example, litter and SOM. Is the Party's reporting consistent with the 2006 IPCC Guidelines as implemented through the MPGs?

Select one:

A. Yes
B. No

Question 23

Do C stock losses from C pools always correspond to CO_2 emissions to the atmosphere?

Select one:

A. Yes
B. No

Question 24

Under forest land remaining forest land, a Party did not report biomass C stock losses associated with slash from harvesting with the justification that those C stocks are transferred to DOM for which no emissions/removals are estimated (i.e. tier 1 is applied to DOM). Is the reporting in accordance with the 2006 IPCC Guidelines?

Select one:

A. Yes
B. No

Question 25

Which GHG are reported in the GHG inventory associated with the decay of organic matter?

Select one:

A. C
B. CO_2
C. CO_2 and CH_4
D. CO_2, CH_4 and N_2O

Question 26

What is the default depth of the SOM pool in accordance with 2006 IPCC Guidelines and what should a Party ensure if a different depth is applied?

Select one:

A. 40 cm, default factors should be revised
B. 40 cm, default factors should be revised and the same depth of SOM should be applied to every land-use category to ensure consistency among CSCFs to be applied to land-use conversions
C. 30 cm, default factors should be revised and the same depth of SOM should be applied to every land-use change category to ensure consistency among CSCFs to be applied to land-use conversions
D. 30 cm, default factors should be revised

Question 27

Should the CSC in litter and deadwood be estimated together under DOM?

Select one:

A. Yes
B. No

Question 28

At the tier 1 level, the C stocks of DOM are assumed to be at equilibrium in accordance with the 2006 IPCC Guidelines.

Select one:

A. True for lands where there has been a land-use change and lands where no changes have occurred.
B. False in any case.
C. False for forest-related conversions and true for lands where no changes have occurred.
D. True for lands where there has been a land-use change and false for lands where no changes have occurred.

Question 29

The default assumption given in the 2006 IPCC Guidelines is that of instantaneous oxidation of harvested wood for the HWP pool.

Select one:

A. True
B. False

Question 30

For estimating the HWP contribution Parties must use the production approach only as provided in the 2006 IPCC Guidelines.

Select one:

A. True
B. False

5.1. Answer key to self-check quiz

Question 1

The correct answer is (A).
The Party may use their own definitions for land-use categories and thresholds to be applied. In this case the Party has provided clear national thresholds and a hierarchy between the definitions. It should be ensured during the review that these definitions are applied consistently across time and space. Note that fruit trees have C stock levels and dynamics that are different from those of trees in forest land. They tend to achieve an equilibrium level at which C stock gains equal C stock losses at an earlier stage

Question 2

The correct answer is (A).
Parties should apply an appropriate stratification when representing their land with the aim of producing the best possible estimates of emissions/removals for the sector, taking into account the available resources and/or data that can be made available in the future.

Question 3

The correct answer is (C).

Question 4

The correct answer is (B).
In accordance with the 2006 IPCC Guidelines, natural rivers and lakes fall under unmanaged wetlands.

Question 5

The correct answer is (D).
The stratification does indeed greatly increase the accuracy of the GHG emissions/removals estimates for all the reasons mentioned.

Question 6

The correct answer is (B).
If the IPCC stratification is not applied, the appropriateness of each IPCC default factors to the country-specific stratification should be assessed and, where needed, default values should be replaced with country-specific values or recalculated.

Question 7

The correct answer is (B).
The provision of transparent information on definitions of land-use categories along with any thresholds applied for the land representation (e.g. for classifying forest land) is crucial for assessing the accuracy, completeness, consistency and comparability of GHG estimates.

Question 8

The correct answer is (B).
Ideally, the same data set would be used for the entire territory and time series. However, different data sources can be integrated to build a consistent land representation. Care should be taken to ensure that differences in definitions, quality (e.g. resolution) and methodologies do not result in artificial changes in land use/land cover/land management over space and/or time.

Question 9

The correct answer is (D).
Completeness ensures that no false trends in emissions/removals occur because of differences in the area used for GHG estimates and that AD needed for preparing the entire land-related GHG estimates are available. Furthermore, completeness helps in reducing uncertainties in land representation.

Question 10

The correct answer is (D).
All points indicated should be ensured in order to achieve consistency in land representation.

Question 11

The correct answer is (D).
Accuracy can be assessed by comparison with independent data sets (assumptions, rules and inferences are usually applied to raw data for elaborating a land representation). Verification tests the accuracy of outputs of such an elaboration process.

Question 12

The correct answer is (A).
For the same cost, sample surveys produce better-quality area estimates of land-use changes than wall-to-wall mapping. Permanent plots allow tracking of land use/management of units of land over time, so providing spatially explicit data on land-use/land-management changes. Remember also that an advantage of sampling procedures is that they allow quantifying uncertainty estimates based on statistical procedures, and thereby assessing the reliability of the information.

Question 13

The correct answer is (B).
The use of national information, including definitions, should be the priority in Parties' GHG inventories to produce results that are more accurate. Party must be able to explain any differences with data from international databases.

Question 14

The correct answer is (B).
The rotation of management change over a piece of land affects the final estimates in CSC.

Question 15

The correct answer is (A).
With approach 1 only net changes in land-use categories are known, while the information about from which land use and to which land use the changes occur is unavailable.

Question 16

The correct answer is (B).
The verification and accuracy assessment using reference data must be implemented for land area data produced from remote sensing techniques.

Question 17

The correct answer is (D).
Permanent sample plots are generally more efficient in estimating changes than temporary plots because it is easier to distinguish actual trends from differences that are only due to changed plot selection.

Question 18

The correct answer is (B).
The Party uses statistical methods to estimate emissions/removals; thus it must provide associated uncertainties estimated using statistical methods as well, unless it elects to apply flexibility. In this case, the Party is recommended to provide at least a qualitative discussion of uncertainty for the key categories and is encouraged to provide quantitative assessment of uncertainty for all source and sink categories.

Question 19

The correct answer is (B).
The information on the national approach to distinguishing between managed and unmanaged land, approaches used for representing land areas, land-use databases used for inventory preparation, and land-use definitions and the classification system used and their correspondence to the LULUCF categories should be provided in the NID. The CRT contain the information on GHG emission/removal estimates.

Question 20

The correct answer is (A).
The Party's reporting of the areas under each category in year T is correct. The areas are estimated as:

- Grassland remaining grassland = 800,000 + 1/5 * 50,000 – 10,000 = 800,000 ha;
- Land converted to grassland = 50,000 - 1/5 * 50,000 + 5,000 = 45,000 ha;
- Grassland = 800,000 + 45,000 = 845,000 ha.

Question 21

The correct answer is (B).
Reporting in CRT should be complemented with an appropriate subdivision of the broad categories in the CRT. Data on areas under different subcategories are needed for reconstructing the estimates. It also enhances comparability of estimates between countries, through the IEFs. The issue with the reporting is the lack of transparency. Although estimates may be accurate, these are not transparent.

Question 22

The correct answer is (B).
Merging pools would compromise the comparability of estimates.

Question 23

The correct answer is (B).
C stock transfers to other C pools are accounted as C stock losses from the pool from which they are being transferred, although they do not correspond to emissions to the atmosphere.

Question 24

The correct answer is (B).
When the net CSC of a pool is estimated, any transfer of C stock from that C pool must be estimated as a C stock loss, although the C stock gain in the receiving pool may be omitted when the C stock in that pool is assumed to be at equilibrium (i.e. a C stock is at equilibrium when C stock gains equal C stock losses; consequently, net CSC equals zero).

Question 25

The correct answer is (D).
GHG emissions from the decay of organic matter are CO_2 (with aerobic conditions), CH_4 (with anaerobic conditions) and N_2O (under both conditions).

Question 26

The correct answer is (C).
The default depth of the SOM pool as provided in the 2006 IPCC Guidelines is 30 cm. Whenever a depth other than the default depth is selected, all default values from the 2006 IPCC Guidelines associated with C stocks and CSC should be revised because they have been calculated for the 30 cm depth. The same depth of SOM should be applied to all land-use change categories to ensure consistency in the CSCFs to be applied to land-use conversions. If data for different land-use categories have been collected at different depths, they need to be recalculated according to the standard depth selected for land-use changes in the GHG inventory. Such a recalculation could be done on the basis of the information on the profile of C density in the soil (e.g. if data on SOC have been collected for forest land at 40 cm and for cropland at 60 cm, the cropland C stock should be recalculated to the 40 cm depth). For instance, if the profile of C density in soil in cropland is 1/2 of C stock within 0–20 cm, 1/3 of C stock within 21–40 cm and 1/6 of C stock within 41–60 cm, the revised C stock for cropland at a depth of 40 cm will be equal to 5/6 of the C stock measured at 60 cm.

Question 27

The correct answer is (B).
Litter and deadwood are two separate pools, whose CSC should be estimated separately according to the 2006 IPCC Guidelines methods, although they can be reported together under DOM in the CRT for categories other than forest land (4.A).

Question 28

The correct answer is (C).
DOM C stocks are assumed to be constant at the tier 1 level for any lands where the land use has not changed. However, CSC in the DOM pool need to be estimated for all forest-related land-conversion categories at the tier 1 level, in accordance with 2006 IPCC Guidelines. The tier 1 assumption is that DOM in non-forest land categories after conversion is zero and that when forest land is converted to another land-use category, all DOM carbon stock losses are assumed to be emitted in the year of conversion and there is no further accumulation of DOM stocks. Conversely, when there is a land-use conversion to forest land, DOM accumulates linearly from zero over the transition period (the IPCC default transition period is 20 years).

Question 29

The correct answer is (B).
Instantaneous oxidation can be applied to HWP only if the inventory compiler judges that the annual change in C in HWP stocks is insignificant (i.e. it is less than any key category) and provides evidence to support it.

Question 30

The correct answer is (B).
Parties may use any approach contained in the 2006 IPCC Guidelines or a country-specific methodology consistently with the 2006 IPCC Guidelines to report their emissions and removals from HWP. However, if the Party does not use the production approach, as per the MPGs (para. 56), it is mandatory for this Party to report additional information on CO_2 emissions and removals from the HWP pool by applying the production approach. In practice, that means that all Parties must otherwise apply the production approach when estimating the HWP contribution.

6. Key points to remember

- Having an adequate knowledge of land representation of a LULUCF GHG inventory and on the C pools and the related processes resulting in emissions/removals associated with them is fundamental to conducting a successful review of the LULUCF sector. CSC in C pools are a proxy for estimating GHG emissions/removals in LULUCF. Also, GHG estimates in the LULUCF sector are based mainly on land area, and consequently any issues related to the TACCC in relation to both land area and C stocks affect the final GHG estimates.
- The technical review should assess in detail the TACCC of the land representation and of all CSC in at least the significant C pools in key categories reported in the inventory.
- GHG emissions/removals estimates must be reported for the six top-level IPCC land-use categories following a stratification scheme reflecting national circumstances and for the C pools in accordance with the 2006 IPCC Guidelines.
- Parties must stratify their land between land remaining in the same land-use category and land converted to another land-use category based on the history of the land use and management (e.g. managed and unmanaged), as well as on the climate/soil/ecological/vegetation zone and management regime.
- GHG emissions/removals must be reported for managed land and do not need to be reported for unmanaged land, unless the unmanaged land is under conversion from a formerly managed land for which emissions/removals must be reported until they reach the equilibrium level of unmanaged land.
- The land representation should be complete in the sense that the total territorial area is included and tracked over time, covering all land-use categories occurring in the country and including both managed and unmanaged land.
- The classification methodology must avoid any misclassification, omission and/or double counting of land among land-use categories.

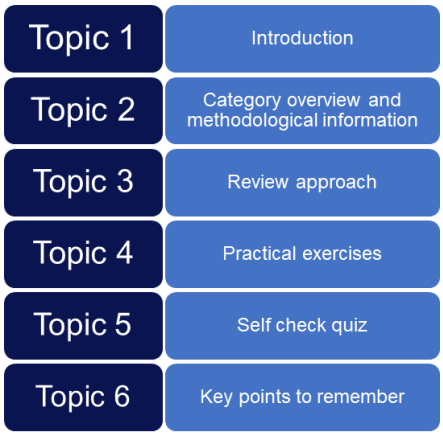
- The NID should contain all necessary information (transparency) to facilitate the review of the accuracy, completeness, consistency and comparability of the land representation and CSC in carbon pools.
- Parties can apply their own definitions for the six land-use categories and the C pools. However, Parties must report clearly the definitions of the land-use categories and carbon pools applied in the inventory and apply those definitions consistently across time and space.
- All transfers to and from a C pool must be taken into account in the GHG estimates (all C gains and all C losses).
- For some C pools in some land categories, the net CSC can be assumed to be zero at the tier 1 level (no net gains or losses reported).
- The completeness and consistency of C stock transfers among pools, particularly when different methods are applied for estimating CSC in different pools and different land-use categories should be ensured.
- When a Party uses an approach other than the production approach to report the HWP contribution, as per the MPGs (para. 56), they must in addition provide information on the HWP contribution estimated with the production approach in line with the 2006 IPCC Guidelines.
- Significant C pools (significance analysis) in key categories must be identified and CSC from these pools should be reported in accordance with the suggested IPCC methodology.

Lesson 4: Forest land

1. Introduction

1.1. Lesson structure

Lesson 4 provides guidance on the review of information for the forest land category within the LULUCF GHG inventory. Forest land is one of the six land-use categories given in the 2006 IPCC Guidelines, and is also the first in the hierarchy of land-use categories provided in the same guidelines (see figure 4-1).



R. Figure 4-1. Structure of lesson 4

The 2006 IPCC Guidelines provide guidance on how to estimate and report CSC and associated GHG emissions/removals from forest land in chapter 4, volume 4. Furthermore, the Wetlands Supplement provides additional and updated methodologies, EFs and AD, some of which could be applied to forest land. Remember that the 2006 IPCC Guidelines consider it good practice for countries to use higher-tier methods for key categories and the significant C pools within them. While all Parties should be able to prepare an inventory using the tier 1 methodology, Parties usually use higher-tier methods for the biomass pool in this category; they sometimes also use higher-tier methods for other pools. Thus, most inventories are likely to include estimates prepared using a mix of tiers. For most Parties, forest land categories are identified as key. Therefore, typically forest land is expected to require much of your attention during a review.

This lesson provides background information on the estimation and reporting of CSC and associated GHG emissions and removals from forest land. It also presents category-specific guidance for reviewing the estimates of GHG emissions/removals and related information submitted by Parties on the forest land category. Similarly, to the previous lessons, the lesson ends with practical exercises and a self-check quiz to help you enhance and refresh your knowledge.

It is suggested that you have the CRT readily available when you study this lesson, because it contains several references to them (highlighted in red text).

Finally, note that the review of the forest land category in a Party's LULUCF GHG inventory is also related to what you have learned in the previous lessons. Therefore, you must always use your knowledge of how to review cross-cutting and cross-sectoral issues, the land representation, C pools and other aspects found in lessons 2 and 3.

1.2. Learning objectives

At the end of this lesson you should:
Know the requirements for reporting emissions/removals from forest land by Parties in the CRT and the NID;
Be able to understand specifically how the methods for collecting AD and EF and estimating CSC methods are applied to the forest land category;
Be able to understand the key areas for reviewing the GHG inventory information on the forest land category.

The expected time needed to complete lesson 4 depends on the level of your knowledge of LULUCF GHG inventories under the MPGs and the 2006 IPCC Guidelines:

- For readers with experience: 80–100 minutes
- For readers with less experience: 95–115 minutes

2. Category overview and methodological information

2.1. Reporting overview

According to the 2006 IPCC Guidelines (vol. 4, chap. 3), forest land includes all land with woody vegetation consistent with thresholds used to define forest land in the national GHG inventory. It also includes systems with a vegetation structure that currently falls below, but in situ could potentially reach, the threshold values used by a country to define the forest land category.
The annual GHG emissions/removals from forest land are reported separated into two main subcategories:

1. Forest land remaining forest land;
2. Land converted to forest land.

Emissions/removals from forest land converted to other land-use categories are reported under the final land-use category.

S. Figure 4-2. Forest land

For a detailed explanation, including methodological guidance on forest land, consult chapter 4, together with chapter 2, volume 4 of the 2006 IPCC Guidelines.

Remember that the Wetlands Supplement contains updated information on forest land, including EFs for drained and rewetted organic soils in forest land in chapter 2 and chapter 3, respectively, updated SOC_{REF} for inland wetland mineral soils in chapter 5 and default factors for mangrove forests in chapter 4. Parties are not required to use the Wetlands Supplement, but may choose to do so.

Forest land must be first stratified into managed and unmanaged forest land (if applicable). For unmanaged forest land no GHG emissions/removals are to be reported although the area must be reported.
For increasing the accuracy of GHG emissions/removals, stratification of land is used according to the national circumstances and the data used for preparing the GHG inventory.

Revisit lesson 3 for guidance about how to review the information in relation to the land representation, including the treatment of managed and unmanaged land in the LULUCF GHG inventory.

Note that the IPCC default stratification is based on climate domain zones, soil types, ecological zones/forest types, management types and age classes.

2.2. Pools and gases to be reported in forest land

CSC in forest land are reported in CRT 4.A for the following pools:

- Living biomass (i.e. above-ground and below-ground);
- DOM (i.e. deadwood and litter);
- SOM (i.e. mineral soils and organic soils).

Increases and decreases in C stocks in biomass should be reported separately, except in cases where it may be technically impossible to separate between increases and decreases owing to the methodology applied, for example, when using the stock-difference method. In such a case, the net gain or net loss of C must be reported in the relevant column of the CRT and "IE" reported for the other column, together with the necessary explanatory information in the documentation box and the NID.
Net CO_2 emissions/removals are also reported in CRF 4.A.

Remember that although CSC for all C pools are to be reported separately for the forest land category and its subcategories, the contribution of the HWP pool, AD and C fraction values for HWP, are reported aggregated covering HWP originating from all land-use categories in CRT 4.Gs1 and CRT 4.Gs2. For more information on the HWP pool, revisit lesson 3 of this course.

In addition, when the simple decay approach is used for HWP, carbon transferred to the HWP pool should be reported as additional information (in column W).
Direct and indirect N_2O emissions from N inputs (fertilization) in forest land are reported in CRT 4(I). Parties that cannot separate fertilizer application in different land categories can report the total emissions under the agriculture sector in CRT 3.D.
CO_2, N_2O and CH_4 emissions/removals from drainage and rewetting of organic and mineral soils in forest land are reported in CRT 4(II); CO_2 emissions/removals may also be reported with information reported in CRT 4.A, while avoiding double counting.
Direct and indirect N_2O emissions from N mineralization/immobilization associated with loss/gain of SOM resulting from change of land use or management of mineral soils in forest land are reported in CRT 4(III).
N_2O and CH_4 emissions from biomass burning in forest land are reported in CRT 4(IV); CO_2 emissions may also be reported in the same table, but if reported in CRT 4(IV), they must not be reported within C stock losses in CRT 4.A. However, N_2O and CH_4 emissions from savannah burning are reported in CRT 3.E under the agriculture sector if data allow to be identified separately, otherwise must be reported under in CRT 4.IV (while avoiding double counting or omission of reported emissions between CRT 3.E and CRT 4.IV).

Note that in CRT 4(IV) emissions from burning also include burning of DOM and, if methods provided in the Wetlands Supplement are used, SOM in organic soils. While CO_2 emissions from DOM burning are expected to be reported as C stock losses in CRT 4.A, as already seen for biomass, the CO_2 emissions from on-site peat burning are reported in CRT 4(IV).

2.3. Methods and pools

The methodological tier to be applied for estimating CSC and other GHG emissions/removals depends on the significance of the reporting category and of the C pool, as well as the national circumstances. For this the respective decision trees contained in the 2006 IPCC Guidelines are to be followed by the Parties.

To learn more on the methodological tiers, consult section1.3.3 (figures 1.2 and 1.3), chapter 1, volume 4; figures 2.2, 2.3, 2.4, 2.5 and 2.6, chapter 2, volume 4; and figure 12.1, chapter 12, volume 4 of the 2006 IPCC Guidelines.

You have already learned in the previous lessons that Parties must provide GHG emissions/removals estimates for categories, pools and gases for which the 2006 IPCC Guidelines provide methodologies and EFs. Figure 4-3 shows the pools and gases for which emissions/removals estimates must be reported in the forest land category when tier 1 or tier 2 methods are applied.
Figure 4-4 summarizes the tier 1 and 2 methods to be applied, along with references to relevant equations in the 2006 IPCC Guidelines and the Wetlands Supplement.

Tier 1			Land use													
			FL		CL		GL		WL			SL		OL	
Carbon pool – GHG			FL-FL	L-FL	CL-CL	L-CL	GL-GL	L-GL	WL-WL	L-WL		SL-SL	L-SL	OL-OL	L-OL
									PL-PL	L-PE	L-FIL				
Living biomass		Above-ground	M	M	M [a]	M [b, c]		M [b, c]		M [c]	M [c]		M [c]		M [c]
		Below-ground		M		M [b, c]		M [b, c]		M [c]	M [c]		M [c]		M [c]
Dead organic matter		Dead wood		M [c]		M [c]		M [c]					M [c]		M [c]
		Litter		M		M [c]		M [c]					M [c]		M [c]
Soil organic matter		Mineral		M	M	M	M	M					M		M [d]
		Organic	M	M	M	M	M	M	M [f]				M		
HWP			M (may be assumed 0 if net carbon stock change is judged insignificant)												
N_2O	Direct	Fertilization [e]	M	M					M	M	M	M	M		
		N mineralization		M		M	M [g]	M					M		M
		Drainage	M	M						M		M	M		
		Burning	M	M	M	M	M	M	M	M		M	M		M
	Indirect	Fertilization [e]	M	M					M	M	M	M	M		
		N mineralization		M		M	M [g]	M					M		M
CH_4		Burning	M	M	M	M	M	M	M	M		M	M		M

Tier 2			Land use												
			FL		CL		GL		WL			SL		OL	
Carbon pool – GHG			FL-FL	L-FL	CL-CL	L-CL	GL-GL	L-GL	WL-WL	L-WL		SL-SL	L-SL	OL-OL	L-OL
									PL-PL	L-PE	L-FIL				
Living biomass		Above-ground	M	M	M [a]	M [b]	M	M [b]		M	M	M	M		M
		Below-ground	M	M	M [a]	M [b]	M	M [b]		M	M	M	M		M
Dead organic matter		Dead wood	M	M	M	M	M	M		M		M	M		M
		Litter	M	M	M	M	M	M		M		M	M		M
Soil organic matter		Mineral	M	M	M	M	M	M				M	M		M
		Organic	M	M	M	M	M	M	M	M		M	M		
HWP			M												
N_2O	Direct	Fertilization [e]	M	M					M	M	M	M	M		
		N mineralization	M	M		M	M [g]	M				M	M		M
		Drainage	M	M					M	M		M	M		
		Burning	M	M	M	M	M	M	M	M		M	M		M
	Indirect	Fertilization [e]	M	M					M	M	M	M	M		
		N mineralization	M	M		M	M [g]	M				M	M		M
CH_4		Burning	M	M	M	M	M	M	M	M		M	M		M

Notes: grey shading = not applicable, blank = not mandatory.

Abbreviations: M = mandatory, GHG = greenhouse gas, FL = forest land, CL = cropland, GL = grassland, WL = wetlands, SL = settlements, OL = other land, PL = peatland, PE = peat extraction, FIL = flooded land, HWP = harvested wood products
FL–FL, CL-CL, GL-GL, WL-WL, PL-PL, SL-SL, OL-OL = indicate land category remaining under the current land use
L–FL, L-CL, L-GL, L-WL, L-PE, L-FIL, L-SL, L-OL = indicate land category converted to the current land use

[a] To be reported only for perennial crops.

[b] Net carbon stock gain in biomass pool for annual crops is to be reported only once in the year after conversion.

[c] Only applicable if the Party has reported carbon stock changes or the IPCC provides default carbon stock values for the biomass or DOM carbon stock for the previous land use. In such a case carbon stock is to be reported as instantaneously oxidized in the year of conversion.

[d] Carbon stock level after conversion is to be set at 0.

[e] N_2O emissions from N fertilization in forest land and settlements are to be reported under the LULUCF sector and those in cropland and managed grassland are to be reported in the agriculture sector. If the Party is not able to separate emissions from N fertilization in different land-use categories, all emissions are to be reported under the agriculture sector.

[f] Under tier 1 the activity data do not distinguish between peatlands under peat extraction and those being converted for peat extraction.

[g] N_2O emissions from grassland remaining grassland for agriculture purpose are reported under the agriculture sector.

Figure 4-3. Carbon pools and gases to be reported in the forest land category under tier 1 and 2

Carbon stock changes in pools and associated GHG emissions/removals that must be estimated for forest land

Carbon stock changes in pools and associated GHG emissions/removals that must be estimated at Tier 1

0 indicates that the tier 1 methodology assumes no net carbon stock change

The IPCC equations to be applied are provided in parentheses (*those from the Wetlands Supplement are given in italics*)

Note that where activity data on land-use categories do not allow for the separation of FL-FL and L-FL, for the IPCC default, L-FL does not apply

Note that in land under conversion from categories for which the IPCC does not provide default values for the biomass or DOM pools, reporting of carbon stock changes is nevertheless mandatory (to ensure accuracy) in case the Party has reported C stock changes in the pool under the previous land use

	Biomass (B)		Dead organic matter (DOM)		Soil organic matter (SOM)		Harvested wood products (HWP)	Non-CO_2 emissions
	Above (AB)	Below (BB)	Dead wood (DW)	Litter (L)	Mineral soils (MS)	Organic soils (OS)	HWP	
FL-FL	Net C stock change (2.7) C stock gain (2.9, 2.10) C stock losses (2.11, 2.12, 2.13, 2.14)	0	0		0	CO_2 emissions from drained organic soils (2.26) *CO_2 emissions from drained organic soils (2.2)* *On-site CO_2 emissions from drained organic soils (2.3)* *Off-site CO_2 emissions from drained organic soils (2.4, 2.5, 2A.1)* *CO_2 emissions from burning of drained organic soils (2.8)* *CO_2 emissions from rewetted organic soils (3.3)* *On-site CO_2 emissions from rewetted organic soils (3.4)* *Off-site CO_2 emissions from rewetted organic soils (3.5, 3.6)* *CO_2 emissions from burning of rewetted organic soils (2.8)* *CO_2 emissions for rewetting/ revegetation/ creation of mangroves (4.7)*	Assumed 0, if judged insignificant (i.e. annual net C stock change in HWP pool, is less than the size of any key category), otherwise default tier 1 methods provided in the 2006 IPCC Guidelines (volume 4, chapter 12) apply Note that HWP are reported altogether regardless of the land of origin of wood	CH_4 and N_2O emissions from biomass burning (2.27) N_2O emissions from drained organic soils (11.1) N_2O emissions from N inputs (11.1 11.3) N_2O emissions from SOM mineralization (11.8)(3) Indirect N_2O emissions (11.9, 11.10) *CH_4 emissions from drained organic soils (2.6)* *N_2O emissions from drained organic soils (2.7)* *CH_4 emissions from burning of drained organic soils (2.8)*(2) *CH_4 emissions from rewetted organic soils (3.8)* *N_2O emissions from rewetted organic soils (3.9)* *CH_4 emissions from burning of rewetted organic soils (2.8)*(2) *CH_4 emissions from rewetting of drained inland wetland mineral soils, and created wetlands on managed lands with mineral soils (5.1)* *CH_4 emissions for revegetation/ creation of mangroves (4.9)* *N_2O emissions from aquaculture in mangroves (4.10)*
L-FL	Net C stock change (2.4) C stock gain (2.9, 2.10) C stock losses (2.11, 2.12, 2.13, 2.14)(1)		0(0)	Net carbon stock change (2.23)	Net carbon stock change (2.25)			

Carbon stock changes in pools and associated GHG emissions/removals that must be estimated at Tier 2

FL-FL	As tier 1, ***plus*** below-ground biomass C stock changes estimated	Net C stock change (2.17, 2.18) or (2.17, 2.19) C stock gain (2.20, 2.21, 2.22, 2.14)	Net C stock change (2.25)	As tier 1 *As tier 1*	As tier 1, ***but*** instantaneous oxidation not applicable	CH_4 and N_2O emissions from biomass burning (as tier 1) N_2O emissions from drained organic soils (as tier 1) N_2O emissions from N inputs (as tier 1) N_2O emissions from SOM mineralization (as tier 1) Indirect N_2O emissions (11.10, 11.11) *As tier 1, plus N_2O emissions from burning of SOM in organic soils estimated*
L-FL	Net C stock change (2.15, 2.16) C stock gain (as tier 1) C stock losses (as tier 1)	As tier1, ***plus*** dead wood C stock changes estimated				

(0) Tier 1 does not provide for forest dead wood default values in the 2006 IPCC Guidelines, volume 4, table 2.2, although the Wetlands Supplement, table 4.7, does provide default values for dead wood in mangrove forests.

(1) Where IPCC default values are available for the two land use categories in conversion (i.e. cropland converted to forest land and grassland converted to forest land), equations 2.15 and 2.16 apply.

(2) Note that N_2O emissions from fires on organic soils are not estimated at tier 1, because the Wetlands Supplement does not provide default EFs.

(3) Only in case a SOC loss is reported.

Figure 4-4. Coverage of carbon pools and greenhouse gas emissions in the forest land category in the 2006 IPCC Guidelines (tier 1 and 2)

3. Review approach

General review considerations

When reviewing forest land estimates, you should always apply the guidance on general review issues for the LULUCF sector provided in lesson 2 and the guidance on the review of the land representation and C pools provided in lesson 3.

The following is a summary of general review considerations to refresh your memory:

- Check whether categories, subcategories and subdivisions for which estimates are prepared are appropriate and correspond to the national circumstances. The review should be performed at the level of subdivisions reported;
- Assess the consistency of the land representation;
- Assess which C pools are to be mandatorily reported as per the 2006 IPCC Guidelines, bearing in mind that at the tier 1 level, for some C pools in some categories, the 2006 IPCC Guidelines assume zero net CSC (e.g. DOM and SOM in forest land remaining forest land);
- Assess whether all gains and losses have been estimated for each C pool reported (e.g. for biomass, gains from growth and losses from harvesting, natural mortality, disturbances, fires, pests);
- Assess whether all GHG emissions/removals associated with CSC have been estimated and the GHG fluxes are consistent with each other;
- Check whether the Party has reported uncertainties, noting the flexibility available to those developing country Parties that need it in the light of their capacities, including information on uncertainties of the input data;
- Identify, in consultation with the Party concerned, potential areas of capacity-building needs, for those developing country Parties that need the flexibilities provided in the MPGs in the light of their capacities.

Review of methods, AD and parameters

Assess the appropriateness of the Party's choice of methodological tiers, AD, EFs and other parameters according to the significance of categories/subcategories/pools and national circumstances and their proper documentation in the submission. Check also the completeness and time-series consistency of the estimates. The level of the review should be based on the level of disaggregation in the subcategories reported and the methods used by the Party. Focus your review (time/resources) mainly on the key subcategories/significant pools that are likely to contribute the most to GHG emissions and removals from the forest land category. The following points may help you structure your review work.

Check whether:

- The Party has reported information on monitoring and identification of forest area;
- The national forest area is subdivided into managed and unmanaged forest land;
- The total forest land area is monitored and reported;
- Transition matrices for the years before the starting year of the inventory equal to the transition period applied are reported in the NID;
- The documentation on each methodology, including assumptions, AD, EFs and parameters, provided in the NID is transparent enough to allow the assessment of the accuracy, completeness, consistency and comparability of the estimates;
- The significant subcategories and carbon pools within the key categories have been identified;
- Methodologies are consistent with guidance in the 2006 IPCC Guidelines on completeness, consistency, comparability and accuracy of CSC estimates;
- The methods, AD, EFs and parameters are appropriate to national circumstances and correctly applied. If so, you should consider the following questions:
    - Has the Party applied higher-tier methods for key categories? If not, are there national circumstances to justify the choice, and has the Party clearly explained in the NID why the methodology applied is not in line with the one suggested by the decision trees in the 2006 IPCC Guidelines and does the Party plan to collect the data needed for implementing higher tiers (prioritization)?
    - Has the Party used tier 1 methods in preparing the GHG estimates? If so:
        - ✓ Has the Party used appropriate default EFs and parameters from the 2006 IPCC Guidelines consistent with the information provided on the climate zone, ecozone, forest/tree types and soil types in the country?
        - ✓ Could country-specific values be developed based on national or regional data and research?
    - Has the Party used higher-tier methods? If so:
        - ✓ Has proper documentation on the values of these country-specific parameters been provided?
        - ✓ Are the country-specific values within the range of defaults in the 2006 IPCC Guidelines and comparable to those used by other countries with similar conditions? If not, is adequate justification provided?
    - Has the Party used any models? If so:
        - ✓ Has the Party described the assumptions (principles, equations, etc.) and key parameters used in the model and provided information on any validation and/or peer review of the model and verification of the model outputs in the NID?
- The Party applied the equations correctly for estimating CSC and GHG emissions/removals;
- The Party reported GHG emissions/removals estimates separately for forest land remaining forest land and land converted to forest land;
- The Party has further categorized the area of forest land remaining forest land into country-specific forest types:
    - If the Party has not applied any stratification, you should encourage the Party to apply a country-specific stratification or, if that is not possible, to apply the default stratification in the 2006 IPCC Guidelines to improve the accuracy of estimates;

- If the Party has used default EFs and parameters from the 2006 IPCC Guidelines along with a country-specific stratification, you should check their applicability to the country-specific classification;

To learn more about the default stratification for forest land in the 2006 IPCC Guidelines, consult table 4.1, chapter 4, volume 4 of the 2006 IPCC Guidelines

- The Party has further categorized the land converted to forest land from other land-use categories during the last 20 years, such as cropland and grassland, and whether the Party applies the same subdivisions as applied for the category forest land remaining forest land:
  - If not, you should note that such inconsistency could result in time-series inconsistency arising from transition of forest land from the category land converted to forest land to forest land remaining forest land (there are likely to be issues in maintaining consistency in areas, as well as CSC because, in any piece of land, CSC and other factors may not be consistently applied across time);
  - Furthermore, it may also result in overestimation or underestimation of CSC because of inappropriate assignment of CSCFs and other parameters;
- A transition period for C pools longer than the conversion time period (20 years by default) has been assumed, and if so, whether the Party has reported, in subdivisions of forest land remaining forest land, those lands converted to forest land, stratified by forest type or any other national classification applying the 2006 IPCC Guidelines on land representation for the time it takes for those lands to reach the equilibrium level of C stocks;
- Disturbance matrices for significant CSC have been reported in the NID.

Review of methods, AD and parameters for biomass

If the Party has used the default methods provided in the 2006 IPCC Guidelines, check whether:

- The Party has used the gain-loss method or stock-difference method provided in the 2006 IPCC Guidelines;
- The Party has applied the gain-loss method, and if so, check whether:
  - The Party has calculated the annual change in carbon stocks in biomass using equations 2.7 (tier 1 and 2 methods for land remaining in the same land-use subcategories and tier 1 for land conversion subcategories) or 2.15 (tier 2 method for land conversion subcategories);
  - The Party has calculated biomass gain (ΔC_G) in forest land using estimates of area and biomass growth, for each stratum using the 2006 IPCC Guidelines equations 2.9 and 2.10;
  - The Party has used a tier 2 method for land conversion subcategories, and if so, whether the Party has calculated initial biomass change ($\Delta C_{CONVERSION}$) associated with the land conversion using estimates of area and biomass density ($t\ d.m.\ ha^{-1}$) for each stratum and for each subcategory (e.g. cropland converted to forest land) using equation 2.16 from the 2006 IPCC Guidelines;
  - The Party has estimated the annual C loss due to wood removals ($L_{wood-removals}$) correctly using equation 2.12 from the 2006 IPCC Guidelines. In particular, check whether harvest

data include 'informal' harvesting, that is, harvesting not captured by official statistics (e.g. small harvests for domestic purposes, illegal logging);

Note that, sometimes, Parties are not able to disaggregate the harvest quantities between forest land remaining forest land and land converted to forest land. In such a case, apportioning harvest proportionally to the area of forest land remaining forest land and land converted to forest land may not be accurate because young forests typically account for a significantly lower share of total harvest. Alternative methods for apportioning harvest data, for example, on the basis of the growing stock and/or of the current increment, can be used to enhance the accuracy of estimates.

  - The Party has estimated annual C loss due to fuelwood removal ($L_{fuelwood}$) correctly using equation 2.13 from the 2006 IPCC Guidelines. In particular, check whether C stock loss due to fuelwood removals covers only the removal of living biomass (whole trees or tree parts) for use as fuelwood and does not include fuelwood from DOM (e.g. slash collected and used as fuelwood which should be treated as a loss for the DOM pool), to avoid double counting of emissions between biomass and DOM pools;
  - The Party has estimated annual C loss due to disturbances ($L_{disturbance}$) correctly using equation 2.14 from the 2006 IPCC Guidelines. In particular, check whether the Party has not double counted losses already covered in wood removals and fuelwood removals (i.e. salvage logging);
  - The Party has reported a disturbance matrix for at least the year(s) with high biomass C stock losses from disturbances, if biomass has been identified as a significant C pool;
- The Party has applied the stock-difference method and, if so, check whether:
  - The Party has calculated the annual change in carbon stocks in biomass using equation 2.8 in the 2006 IPCC Guidelines applying the appropriate set of parameters (e.g. growing stock values, BCEF, ratio of below-ground biomass to above-ground biomass) according to the strata;
  - The area of land at time t_1 and t_2 is identical to avoid artificial CSC associated with the area changes.

If the Party applies a country-specific method, check whether:

- C stock increment is a net gain (i.e. increment net of natural mortality) or a gross gain. In the first case, check whether C stock losses due to natural mortality have been double counted by separately including them in the C stock losses, and in the second case, check whether mortality losses have been omitted by not including them separately in the C stock losses;
- The Party has reported gains and losses in biomass C stocks separately;
- The subcategories (based on climate zone, forest type, tree species, etc.) are appropriate. You should consider the following questions:
  - Is the average net annual biomass or volume increment per area unit (growth rate) within the range of the defaults given in the 2006 IPCC Guidelines (vol. 4, chap. 4, tables 4.9–4.11)?

  - If values differ significantly from the 2006 IPCC Guidelines defaults, has the Party provided any justification for that?

- The Party has applied biomass equations (allometric equations) to tree-level data or applied BCEF/BEFD factors to volume estimates to estimate biomass stocks. You should consider the following questions:
  - If the Party has applied biomass equations, are they representative of the area for which they are applied?
  - If the Party has applied BCEF/BEF*D factors, are the values within the default range of the 2006 IPCC Guidelines or do they differ from the IPCC defaults? If BCEF/BEF*D values for different tree species or species classes (e.g. conifers) differ significantly and/or systematically from the default given in the 2006 IPCC Guidelines, has the Party provided any justification for any differences (references, measurements, etc.)?
  - Are the BCEF/BEF*D values used based on local measurements and if so, are they representative of the subcategory/class to which they are applied?
  - Are different values of BCEF/BEF*D for stock, increment and removals used?
- The growing stock volume reported in the NFI includes non-commercial volume, and if not, whether this has been taken into account by modifying the BEF/BCEF or using a separate factor;
- The growing stock volume reported in the NFI includes bark, and if not, whether it has been taken it into account by modifying the BEF/BCEF or using a separate factor;
- All biomass stocks affected by disturbances have been reported as a C stock loss in the biomass pool (i.e. released to the atmosphere or transferred to DOM/SOM) and as a C stock gain in the DOM/SOM pools (unless C stock in DOM/SOM is reported to be at equilibrium);
- The values of biomass density (i.e. biomass per hectare) used are consistent across the inventory, that is, the biomass stock values used to calculate C stock losses from different types of disturbances, as well as for conversion of forest land to other land-use categories, are consistent. For example, Parties sometimes apply the default values from the 2006 IPCC Guidelines for estimating GHG emissions from forest fires, although they use average per hectare biomass values derived from the NFI for estimating, for example, C stock losses associated with deforestation. In such a case, you should recommend that the Party use consistent values (i.e. those derived from the NFI) for estimating C stock losses associated with disturbances and with forest conversion;
- The Party has used the default values from the 2006 IPCC Guidelines for C content, and if other values that differ significantly from the default values are used, whether a justification for the differences (references, measurements, etc.) is provided;
- There is any verification of biomass estimates, for example by comparison with data reported by the country to the FAO GFRA , or with estimates made using the stock-difference method (or vice versa);
- The inventory methodology is based on an NFI (tier 2 or tier 3), and if so, see review guidance and review checks provided in lesson 3 and the section below for the review of methods, AD and parameters related to the use of models and measurements;

- Below-ground biomass has been included or excluded symmetrically for C stock gains and losses regardless of the methodology applied for estimating CSC (because its inclusion only in either C stock gains or C stock losses would lead to biases in the net CSC estimates).

Note that the 2006 IPCC Guidelines provide default factors for BCEF that integrate the BEF and the basic wood density (D) as contained in the previous methodology provided in the IPCC good practice guidance for LULUCF (BCEF = BEF*D). As a reviewer, you should check whether the methodology applied by the Party consistently applies BCEF or BEF*D.
Note that while BEF values were provided for two variables (i.e. growing stock and biomass increment) and stratified by climate zone/forest type, the BCEF values in the 2006 IPCC Guidelines are provided for three variables (i.e. growing stock, biomass removal and biomass increment) and stratified by climate zone, forest type and growing stock per hectare (i.e. biomass density).

Remember that, according to the tier 1 method contained in the 2006 IPCC Guidelines, reporting of CSC in below-ground biomass is not mandatory for the category forest land remaining forest land.

Review of methods, AD and parameters for DOM and SOM

The general considerations provided for biomass on the review of country-specific methods also apply to DOM and SOM pools. Check whether:

- The Party has reported on the length of the transition periods applied for DOM and SOM pools. Check also whether it is appropriate to its national circumstances, how it compares with the time period of conversion (20 years by default) and is consistently applied in land representation, as well as across methods for estimating CSC in various pools;
- The Party has provided a transparent description of the methodology used;
- The methodology is consistent with guidance in the 2006 IPCC Guidelines on completeness, consistency, comparability and accuracy of CSC estimates;
- The Party has applied the same stratification of forest land for estimating DOM, SOM and biomass CSC. In many cases, Parties use a coarser stratification for SOM estimation compared with that for biomass and DOM, although a process-based model (e.g. a model that derives SOM CSC from C stock inputs and outputs) typically requires information on forest type/management system/disturbance regime that also characterizes the stratification used for biomass and DOM;
- The values of DOM density ($t\ d.m.ha^{-1}$) are consistent across the inventory, that is, whether the DOM stock values used to calculate C stock losses from different types of disturbances and for conversion of forest land to other land-use categories are consistent. For example, sometimes Parties apply 2006 IPCC Guidelines default values for estimating GHG emissions from forest fires, although they use average per hectare DOM values derived from the NFI for estimating C stock losses associated with deforestation. In such a case, you should recommend

that the Party use consistent values (i.e. those derived from the NFI) for estimating C stock losses associated with disturbances and with forest conversion;

- The Party has reported separate estimates for mineral and organic soils;
- The Party has used country-specific equilibrium C stock values of SOM or IPCC default or country-specific SOC_{REF} values (i.e. SOM C stocks under native vegetation, typically forest and unmanaged grassland) together with stock change factors and, if so, whether it has calculated the SOC_{REF} value according to the stratification applied by the country (e.g. climate, geographical and/or administrative regions);
- The Party has used a country-specific modelling approach for DOM or SOM and, if so:
  - Has it validated it, taking into consideration measurements of litter and deadwood production from above-ground (for DOM) and below-ground (for SOM) biomass along with decomposition parameters?
  - Have N_2O emissions from drainage of organic soils and mineralization of organic matter been calculated by taking into consideration the C/N ratio of organic matter, stratifying SOM according to the N content (i.e. nutrient rich versus nutrient poor)?
  - Are all assumptions and key parameters used in the models transparently described in the NID? Have model outputs been verified across time by comparison with independent measurements?

Note that a model does not replace the need for monitoring CSC with direct measurements, although it significantly reduces costs and increases accuracy of estimates.

Be reminded that the Wetlands Supplement provides methods and revised default factors for drainage and rewetting of organic and mineral soils:

- CO_2, CH_4 and N_2O emissions from drainage of organic soils;
- CO_2 and CH_4 from rewetting of organic soils;
- CO_2, (drainage, rewetting, revegetation and creation on organic and mineral soils), CH_4 (rewetting, revegetation and creation of mangroves, tidal marshes and seagrass meadows) and N_2O (during aquaculture use) emissions on coastal soils;
- CH_4 emissions from rewetting drained inland wetland mineral soils, and created wetlands on managed lands with mineral soils;
- CO_2 and CH_4 (N_2O at tier 1 are not estimated, as no default factors are provided) emissions from burning of organic soils;
- Revised SOC_{REF} for inland wetlands mineral soils and new SOC stock change factors for land-use for long-term cultivation, and rewetting of drained inland wetland mineral soils.

Check whether the Party applies the correct EFs, and if it does not, and if the EFs provided in the Wetlands Supplement better reflect country circumstances, encourage the Party to use them.

Remember that in accordance with the MPGs (para. 20), the application of the 2013 IPCC Wetlands Supplement is not mandatory but encouraged.

For more details on the different source/sink categories and where to find the related factors see figure 4-5.

To estimate	Information	2006 IPCC Guidelines	2013 IPCC Wetlands Supplement
C stock changes in mineral soils of land converted to a new category	Default reference values for organic C content under native vegetation in mineral soils	Table 2.3	
	Revised values of inland wetlands mineral soils		Table 5.2
CO_2 emissions/removals from drained organic soils	Default values	Table 4.6	
	Revised values		Tables 2.1 and 2.2
CH_4 emissions/removals from drained organic soils	Default values		Tables 2.3 and 2.4
CH_4 emissions/removals from rewetted mineral wetlands soils	Default values		Table 5.4
N_2O emissions/removals associated with mineralization of SOM in mineral soils	Default values	Table 11.1	
N_2O emissions/removals from drained organic soils	Default values	Table 11.1	
	Revised values		Table 2.5
CO_2 emissions/removals from rewetted organic soils	Default values		Tables 3.1 and 3.2
CH_4 emissions/removals from rewetted organic soils	Default values		Table 3.3
CO_2 and CH_4 emissions from burning of SOM of organic soils	Default values for fuel and emissions		Tables 2.6 and 2.7
CO_2, CH_4 and N_2O from drainage, rewetting, and revegetation on coastal organic and mineral soils	Default values for fuel and emissions		Tables 4.11–4.15

Figure 4-5. Wetlands Supplement default values

Review of methods, AD and parameters related to the use of models and measurements

The estimation and reporting of CSC in forest land is challenging, complex and requires a lot of data (AD, EFs and parameters), as well as calculations. Therefore, it is very likely that errors are committed. Specifically:

- Parties may not use the best available data in the inventories in order to avoid complicated calculations. This may affect the completeness and accuracy of estimates in some subcategories;
- Parties may use detailed calculations but report only aggregated values;

- When information from forest inventories are being used in GHG inventories, their quality significantly impacts on the inventory estimates. While reviewing GHG estimates, you should bear in mind that:
    - Forest inventories are constantly being improved, as methods and sampling techniques are further developed. You should therefore always check whether and how consistency has been ensured;
    - A good forest inventory should have a statistically sound design;
    - A forest inventory may or may not have the same forest definition as the GHG inventory, and may or may not collect data on the same area reported as managed forest land in the GHG inventory;
    - The forest inventory may either collect data from the entire forest area at once, or from a fraction of the total area every year within a continuous cycle. When deriving annual CSC using inventory data from these two inventory designs, it is important to take into account the differences between the two designs. Also, when deriving national estimates from the second design by extrapolating CSC to the national level, it is important to consider the representativeness of data collected from a portion of the total forest area. Further information on possible approaches on using NFI information to report CSC in the GHG inventory is available here: https://unfccc.int/resource/tet/bl/bl4-01_u_l4_att1.pdf.

When information from forest inventories is being used in GHG inventories check whether:

- A proper documentation or reference to relevant documentation on the forest inventory methodology, coverage (complete or a subset) and frequency has been provided in the NID;
- The sampling procedures are sound and unbiased. For example, check whether a systematic grid has been applied;
- The same methodologies and definitions are used throughout the time series and, if not, appropriate adjustments have been made to the data to ensure time-series consistency. For example, when forest land area does not coincide with the forest area of the NFI (i.e. if it is either larger or smaller), check whether NFI data used in the inventory are representative of the entire forest land. Check whether the NFI data need to be corrected for the portion of forest land area missing/included in the NFI;
- The reported forest area matches data from other sources of information;
- The estimated growing stock is of a comparable magnitude to that in previous submissions;
- The values of increment are of a comparable magnitude for the period from the starting year (e.g. 1990) to the latest inventory year. If not, check whether there is a trend in the values and if the trend is explained in the NID;
- The CSC is calculated at a plot level. Otherwise, check whether it is calculated by taking the difference of average densities (on a per hectare basis) or by comparing the total C stocks;
- The uncertainties have been estimated and reported.

Review of TACCC of information reported in CRT

The following checks will help you in structuring your work towards assessing the TACCC of the reported information in CRT 4.A, CRT 4(I), CRT 4(II), CRT 4(III) and CRT 4(IV). Check each tab below to see a non-exhaustive list of checks.

General

Check whether:

- The Party correctly uses the signs in CRT (i.e. the sign is reversed when C stock gains/losses are expressed in CO_2 removals/emissions);
- The completeness of the reporting in CRT 4.A, CRT 4(I), CRT 4(II), CRT 4(III) and CRT 4(IV) is ensured or otherwise appropriate notation keys have been used when numerical values are not reported.

CRT 4.A

Check whether:

- The Party has provided separate estimates for forest land remaining forest land and land converted to forest land;
- The Party has provided estimates for land converted to forest land by the previous land-use category, or whether it has provided only an aggregate value for the total area of land converted to forest land. In the latter case, check whether the Party has provided information on which type of conversions comprise the aggregate value, in the documentation box in CRT 4.A and in the NID;
- The Party has provided estimates for all C pools. If not, check whether it has provided the rationale for excluding any C pools in the documentation box in CRT 4.A or in the NID;
- The Party has provided separate estimates for gains and losses in the biomass pool; if not (e.g. when using the stock-difference method), the Party has reported net annual carbon stock increase in gains and the notation key "IE" under losses, providing the respective information in the documentation box on the use of the “IE” notation key.

CRT 4(I)

Check whether:

- The Party has provided separate estimates for N_2O emissions from fertilization of forest land or whether it has reported those under the agriculture sector (CRT 3.D).

CRT 4(II)

Check whether:

- The areas of drained/rewetted organic soils reported in CRT 4.A and CRT 4(II) are consistent with each other and whether the CO_2, CH_4 and N_2O emissions/removals are consistent with each other.

CRT 4(III)

Check whether:

- The EFs for N mineralization/immobilization reported are consistent with the C/N ratios;
- The Party has reported indirect N_2O emissions from N fertilization and N mineralization (from SOM).

CRT 4.A–4.F and CRT 4(IV)
Check whether:

- The Party has included estimates of CO_2 emissions from burning in CRT 4.A–4.F or in CRT 4(IV). Check whether this is clearly documented in the NID and in the documentation box in CRT 4(IV) and double counting or omission of emissions has been avoided;
- The Party has reported separate estimates for controlled burning and wildfires. If not, check whether it has described this in a transparent manner in the NID or in the documentation box in CRT 4(IV);
- The mass of fuel available includes DOM stock;
- The mass of fuel available includes SOM of organic soils;
- CO_2 emissions/removals associated with burning of forest land defined as savannah (from woody vegetation) are included in CRT 4(IV) while CH_4 and N_2O emissions are reported under the agriculture sector (CRT 3.E) if data allow to be identified separately.

4. Practical exercises

Exercise 1

A Party is reporting in the NID the gains and losses of biomass C stocks it has used to calculate a total net increase in biomass C stocks for estimating GHG emissions/removals (i.e. it reports an increase in biomass C stocks). The annual values reported for year X are: gross increase = 20 Mt C yr^{-1}, natural mortality = 1 Mt C yr^{-1}, fuelwood gathering = 1.5 Mt C yr^{-1}, commercial fellings = 18.5 Mt C yr^{-1}.

Question 1

Would you have any observation on the information reported by the Party? Is the Party's reporting consistent with the 2006 IPCC Guidelines?

Exercise 2

Question 2

Please calculate the net change in biomass C stocks based on the description of exercise 1.

Exercise 3

A Party applies the tier 1 methodology and assumptions provided in the 2006 IPCC Guidelines for estimating CSC for stratum X under forest land remaining forest land, which has not been identified as a significant subcategory in the significance analysis. The Party reports CSC only in above-ground biomass and organic soils for stratum X.

Question 3

Are the estimates of CSC reported by the Party consistent with the 2006 IPCC Guidelines?

Exercise 4

A Party reported non-CO_2 emissions from forest fires for 1990–2022 in its 2024 submission. The emissions in 2022 were only about 40 per cent of those in 1990. According to the information provided by the Party, the number of fires was approximately the same, but the area of fires decreased in recent years. The source of the AD is the national statistics authority in the country.

Question 4

How should you address this in your review? Which considerations would you make as a reviewer to determine whether the Party's reporting is consistent with the 2006 IPCC Guidelines?

Exercise 5

A Party reports in its NID an average net annual increment of 2 m^{-3} ha^{-1} yr^{-1}, a BEF of 1.5 (dimensionless) and a wood density of 370 kg d.m m^{-3} for a subcategory of boreal Scots pine.

Question 5

Can you estimate how much the average annual above-ground biomass growth (t d.m. ha^{-1} yr^{-1}) would be?

Exercise 6

During your review, you want to compare the average annual above-ground biomass growth value from the previous exercise as reported by the Party with the default values in the 2006 IPCC Guidelines (vol. 4, chap. 4, table 4.9).

Question 6

Considering that the forests are located in Northern Europe and are less than 20 years old, is the value reported higher than, lower than, or within the range of the 2006 IPCC Guidelines default values?

Exercise 7

A Party does not have country-specific $BCEF_R$ values for estimating CSC in biomass in the forest land remaining forest land category and therefore uses the default $BCEF_R$ values from the 2006 IPCC Guidelines (vol, 4, chap 4, table 4.5) to convert and expand merchantable harvested wood under bark in cubic metres to dry matter in metric tonnes.

Question 7

Is the Party's reporting consistent with the methods in the 2006 IPCC Guidelines?

Exercise 8

A Party estimated the area of forest land remaining forest land at time t equal to 980,000 ha, and the biomass C stock per unit area equal to 90 t C ha^{-1}, based on its latest NFI. The area of forest land remaining forest land at time t − 5 from the previous NFI, conducted at time t − 5, was 1,000,000 ha, and the biomass C stock per unit area at that time was 85 t C ha^{-1}.

Question 8

Which of the below is the correct total annual CSC in biomass in forest land remaining forest land?

A. 980 kt C yr^{-1}
B. 640 kt C yr^{-1}

Exercise 9

The area reported under forest land remaining forest land at the beginning of year t is 10,000,000 ha, and during the year it varies because new forest land (land converted 21 years ago) is added (+100,000 ha) and because of conversion of forest land to cropland (100,000 ha). The above-ground biomass C stocks per hectare measured at the beginning (t_1) and at the end (t_2) of the year in the portion of area under forest land remaining forest land since the beginning of the year (i.e. 9,900,000 ha) are 101 t C ha^{-1} and 100 t C ha^{-1}, respectively. The above-ground biomass C stocks measured at the beginning (t_1) and at the end (t_2) of the year in the portion of area of forest land remaining forest land added in the year (i.e. 100,000 ha) are 80 t C ha^{-1} and 81 t C ha^{-1}, respectively.

Question 9

Which of the below is the correct total annual net CSC in the above-ground biomass of the category forest land remaining forest land?

A. –11.9 Mt C
B. –11.8 Mt C
C. –9.8 Mt C
D. –9.9 Mt C

4.1. Answer key to practical exercises

Question 1

No. Based on the information reported by the Party in the NID, the biomass C stocks are decreasing in year X, since the losses are more than the gains. Therefore, it is not correct for the Party to report a net gain for year X. The Party either has reported wrong values in the NID regarding the gains and losses in biomass C stocks for year X or has erroneously calculated a net increase in biomass C stocks. You must ask the Party a clarifying question during the review to better understand the source of the error and provide the necessary recommendation accordingly in your review report, namely, either that the Party report the correct gains and losses in biomass C stocks or correct the GHG estimates.

Question 2

The net change is calculated as:
Net change in biomass C stocks = 20 (increase) – 1 (natural mortality) – 1.5 (fuelwood gathering) – 18.5 (commercial fellings) = - 1.0 Mt C yr^{-1}.

Question 3

Yes. Because forest land remaining forest land is not a significant subcategory, the reporting of CSC in stratum X by the Party is in accordance with the 2006 IPCC Guidelines. The tier 1 methodology for forest land remaining forest land in the 2006 IPCC Guidelines requires only reporting CSC in above-ground biomass and organic soils.

Question 4

You should consider that a decreasing trend in emissions is not an indication of an inventory problem. The fact that official statistics are used for the areas also suggests that the AD are of a reliable data source. Forest fires can vary greatly from year to year, both in the number and area burned. The emissions are proportional to the area burned, not to the number of fires. However, background information on the observed trend of emissions should be provided in the NID. You must recommend therefore in the review report that the Party provide such information to support the decreasing trend in the area burned for example, that an improvement in the fire suppression system has increased the timeliness of intervention and therefore reduced the area burned per fire.

Question 5

The average annual above-ground biomass growth is calculated as follows:
2 (m^{-3} ha^{-1} yr^{-1}) * 1.5 * 370 (kg d.m. m^{-3})/1,000 = 1.11 t d.m. ha^{-1} yr^{-1}.
You can revisit equation 2.10, chapter 2, volume 4 of the 2006 IPCC Guidelines to refresh your knowledge on how the average annual increment in biomass is estimated.

Question 6

The value is within the range of the default value for boreal coniferous forest provided in the 2006 IPCC Guidelines (0.1-2.1 t d.m.yr^{-1}). Note that for boreal coniferous forest, the default values provided in the 2006 IPCC Guidelines are not further stratified based on the age.

Question 7

No. The $BCEF_R$ converts and expands merchantable wood over bark in cubic metres to tonnes dry matter and not under bark. Therefore, the Party must first adjust the wood volumes to include the bark and then apply the $BCEF_R$ values.
Note also that if a Party uses harvested wood data from FAOSTAT these must be multiplied by 1.15 to expand to over-bark volume.

Question 8

The correct answer is A (980 kt C/yr). Assuming that the biomass density is homogeneous across the entire forest land area the correct estimation of CSC in biomass is:

- Annual biomass CSC per unit area = (90 – 85)/5 = 1 t C ha^{-1} yr^{-1}; and
- Total net CSC in biomass = 1 t C ha^{-1} yr^{-1} * 980,000 ha = 980,000 t C yr^{-1}.

A commonly erroneous way of applying the stock-difference method is as follows:

- Net CSC in biomass = (90 t C ha^{-1} * 980,000 ha – 85 t C ha^{-1} * 1,000,000 ha)/5 = 640,000 t C yr^{-1}.

When data from permanent sample plots are available, another correct way to apply the stock-difference method is to apply it at the level of each plot.

Question 9

The correct answer is –9.8 Mt C. Click here (https://unfccc.int/resource/tet/bl/bl4-02_u_l4_att2.pdf) to see the analysis of the calculation steps.

5. Self-check quiz

Question 1

Do default values of biomass growth provided by the 2006 IPCC Guidelines for forest land (vol. 4, tables 4.9, 4.10 and 4.11A) include biomass losses associated with natural mortality?

Select one:

A. Yes
B. No

Question 2

Do biomass losses associated with natural mortality include losses caused by disturbances?

Select one:

A. Yes
B. No

Question 3

Chapter 4, volume 4 of the 2006 IPCC Guidelines provides guidance on estimating and reporting emissions and removals from managed forest land only. Which of the following statements is true?

Select one:

A. Managed and unmanaged forest land occurs in all Parties; consequently, Parties must transparently report those forest land subcategories separately in the GHG inventory
B. National definitions of forest land and how managed land is distinguished from unmanaged land should be applied in the reporting. The definitions must be applied consistently over time
C. Definitions of forest land should be the same as those used for reporting to the FAO GFRA
D. Unmanaged forest land consists of those forest lands where emissions and removals can be assumed to cancel each other out

Question 4

Which of the following statements is true?

Select one:

A. Annual change in HWP C stocks may be reported for each land category, in the respective CRT
B. Annual change in HWP C stocks must be reported for each land category, in the respective CRT
C. The land category from which HWP originate does not matter when reporting HWP
D. HWP reporting is mandatory only for forest land

Question 5

Is it mandatory to include the biomass of understory vegetation (shrubs, bryophytes, etc.) in the reported C pools of forest biomass even if it is considered to be a minor component?

Select one:

A. Yes
B. No

Question 6

A Party's GHG inventory on LULUCF is based on its NFI. The NFI covers only commercial forests which cover approximately 40 per cent of the total forest land area and the living biomass pool. The Party's NID mentions that data for the DOM and SOM pools are not available. How should the Party improve its inventory (i.e. which improvement should be prioritized)?

Select one:

A. Non-commercial forests should be included in the inventory (taking into account the national forest definition)
B. All pools should be included in the inventory
C. There is no need for the Party to improve its inventory

Question 7

A Party has informed the TERT that the reporting does not cover CO_2 emissions from wildfires on managed forest land, because the methods applied do not capture removals from regrowth after ND events. Is the Party's approach in accordance with the 2006 IPCC Guidelines?

Select one:

A. Yes
B. No

Question 8

A Party's GHG inventory for forest land is based on the NFI. Changes in C stocks are estimated using the stock-difference method by comparing the total C stock at the current NFI with that of NFI conducted T years earlier. Is this correct?

Select one:

A. Yes
B. No
C. Yes, but only if the area of forest land did not change between the two successive NFIs

Question 9

Can N_2O emissions from fertilization of forest soils be reported in the agriculture sector if the Party is unable to separate fertilizer applied to forest land from that applied to agriculture?

Select one:

A. Yes
B. No

Question 10

Drainage of organic soils in forest land and wetlands causes changes in CO_2, N_2O and CH_4 emissions and removals. The 2006 IPCC Guidelines provide methods and default factors for estimating some of those GHGs. The GHGs are:

Select one:

A. CO_2 and CH_4
B. N_2O and CH_4
C. CO_2 and N_2O
D. CO_2, N_2O and CH_4

Question 11

Reporting of non-CO_2 emissions from forest land is required for the following subcategories if they occur in the country.

Select one:

A. Direct N_2O emissions from N fertilization, drainage of forest soils, biomass burning
B. Direct N_2O emissions from N fertilization, drainage of forest organic soils and soil disturbance caused by conversion from another land-use category or from management practices, indirect N_2O emissions from N fertilization and soil disturbance caused by conversion from another land-use category or from management practices and CH_4 and N_2O emissions from biomass burning
C. Direct and indirect N_2O emissions from N fertilization, soil disturbance caused by logging and biomass burning
D. Direct and indirect N_2O emissions from N fertilization, drainage of forest soils, soil disturbance caused by logging and biomass burning

Question 12

AD for biomass burning is to be reported in the CRT 4(IV) for the following.

Select one:

A. Land areas burned
B. Amount of biomass burned
C. Amount of C in biomass burned
D. Either A or B

Question 13

The Wetlands Supplement provides the following methods and default factors for emissions/removals in coastal wetlands.

Select one:

A. DOM C stocks and CSC in mangrove forests
B. Biomass CSC in mangrove forests
C. Ratio of below-ground biomass to above-ground biomass in mangrove forests
D. SOC stocks and stock changes in mangrove forests
E. N_2O emissions from aquaculture in mangrove forests
F. CH_4 emissions from rewetted mangrove forests
G. All of the above

Question 14

A Party has information from its monitoring system about C stocks and areas of forest land. The total biomass C stock of forest land is 1,300 Mt C at time t and 1,250 Mt C at time t+5. The C densities at times t and t+5 are identical at 100 t C ha^{-1}.

Please input the correct figure for each question (*input only the numerical values without decimal or thousands separator*):

A. How much forest area (ha) has been lost between time t and t+5?

Input the value here=>

B. What is the annual rate of deforestation in kilohectares (kha yr^{-1})?

Input the value here=>

Question 15

Do the 2006 IPCC Guidelines definitions differentiate between forest land and woody grassland on the basis of tree canopy cover that, in grassland, is lower than the threshold used for forest land?

Select one:

A. Yes
B. No

Question 16

What does merchantable volume include?

Select one:

A. The entire above-ground volume of a tree
B. The entire above-ground volume of a tree that is not used for fuelwood
C. The stem volume
D. The stem volume from the stump up to a minimum diameter

Question 17

The area reported under forest land remaining forest land at year *T* is 7,370,000 ha, and the forest inventory of year *T*, yields an average biomass density of 77 t C ha^{-1} for that forest area. At year *T*+5, the total area under forest land remaining forest land is 7,346,000 ha, and the forest inventory conducted in year *T*+5 yields an average biomass density of 76 t C ha^{-1} for that forest area. During the five years, the area varies because new forest land (land transferred from land converted to forest land remaining forest land) was added (+67,000 ha) and because of conversion to cropland (−32,000 ha) and to settlements (−59,000 ha). The Party reported under forest land remaining forest land annual net CO_2 emissions from biomass of 26,935.3 kt CO_2.

1. Is the calculation of CO_2 emissions correct?

Select one:

A. Yes
B. No

Now, consider that the Party reported that the area transferred under forest land remaining forest land has an average C stock of 108.6 t C ha^{-1}.

2. How much did the average biomass density change in areas that were under forest land remaining forest land at both time T+5 and time T?

Select one:

A. −1.3 t C ha^{-1}
B. −2 t C ha−1
C. −2.2 t C ha^{-1}

5.1. Answer key to self-check quiz

Question 1

The correct answer is (A).
Tables 4.9, 4.10 and 4.11A present above-ground net biomass and volume growth rates, which correspond to the gross increment minus losses by natural mortality.

Question 2

The correct answer is (B).
Losses caused by disturbances constitute a distinct component of biomass losses from those due to natural mortality.

Revisit equations 2.11–2.14, chapter 2, volume 4 of the 2006 IPCC Guidelines to refresh your knowledge of the estimation of carbon losses from biomass.

Question 3

The correct answer is (B).
A Party may apply a national definition of forest land and must report in the NID how managed land is distinguished from unmanaged land in the GHG inventory. The definitions must be applied consistently for the national land area over time and space. Parties do not need to apply the same definitions as used for the FAO GFRA; however, they should be able to explain significant differences. Unmanaged lands are assumed not to result in anthropogenic GHG emissions and removals, and therefore (D) is not correct. Finally, it is not mandatory that all Parties divide their forest land between managed and unmanaged land. For example, Parties may consider all their forest land as being managed land.

Question 4

The correct answer is (C).
Annual change in HWP C stocks and related information (e.g. AD) for all land-use categories are reported together in CRT 4.Gs1 and 4.Gs2 and not in CRT 4A-F for individual land-use categories. Reporting the annual change in HWP C stocks (comprising HWP from all land-use categories) is mandatory unless it is not significant (i.e. less than any key category).

Question 5

The correct answer is (B).
Where forest understory is a relatively small component of the above-ground biomass C pool, it is acceptable for the methodologies and data used to exclude it, provided the methodological tiers are applied in a consistent manner throughout the inventory time series.

Question 6

The correct answer is (A) as this would have the largest impact on improving the accuracy of the LULUCF inventory for forest land, especially given that the area of non-commercial forests is significant. If forest land is a key category, you should also recommend that the Party collect data on DOM and SOM and report estimates for CSC, and associated GHG emissions/removals, for those pools as well. Note that while all mandatory C pools must be reported, where resources are limited, the country efforts should focus first on the most significant categories/subcategories/pools.

Question 7

The correct answer is (B).
In accordance with the 2006 IPCC Guidelines, CO_2 emissions from burning are to be estimated, as well as CO_2 removals from the following regrowth, if any.

Question 8

The correct answer is (C).
However, it is very unlikely that the area has not changed. In general, the stock-difference method must be applied on the same forest area from which biomass stocks have been assessed at two successive points in time.

Question 9

The correct answer is (A).
If a Party is not able to separate the N inputs applied to land-use categories, other than cropland and grassland, it may report all N_2O emissions from N inputs to managed soils in the agriculture sector (CRT 3.D).

To learn more on the allocation of N_2O emissions from fertilization read footnotes 2, 6, 8, 9 and 10 in CRT 4(I) and footnote 3 in CRT 3.D.

Question 10

The correct answer is (C).
The 2006 IPCC Guidelines provide methods and default factors for estimating CO_2 and N_2O from drained organic soils.

Question 11

The correct answer is (B).
Direct N_2O emissions associated with N fertilization, drainage of forest organic soils, soil disturbance caused by conversion from another land-use category or from management practices, indirect N_2O emissions associated with N fertilization, and soil disturbance caused by conversion from another land-use category or from management practices and CH_4 and N_2O emissions from biomass burning must be reported in the GHG inventory when they occur in the Party.

Question 12

The correct answer is (D).
The AD for biomass burning to be reported in CRT 4(IV) are either the area burned or the amount of biomass burned.

Question 13

The correct answer is (G).

Question 14

A. In order to calculate the total forest lost between t and t+5:
Firstly, we calculate the forest area at both times t and t+5, and then we calculate the forest area loss between t and t+5.
Forest area at time t: 1,300 Mt C/100 t C ha^{-1} = 13,000,000 ha.
Forest area at time t+5: 1,250 Mt C/100 t C ha^{-1} = 12,500,000 ha.
Total forest loss between t and t+5: 12,500,000 ha - 13,000,000 ha = -500,000 ha.
B. The annual deforestation rate which is calculated as the total change in the area divided by the time period between the two measurements (i.e. five years) equals:
500,000 ha/5 yr = 100 kha yr^{-1}.

Question 15

The correct answer is (A).
In accordance with the 2006 IPCC Guidelines, the grassland category includes rangelands and pasture land that are not considered cropland but also systems with woody vegetation and other non-grass vegetation such as herbs and brushes that fall below the threshold values used in the forest land category.

Question 16

The correct answer is (D).
The stem volume from the stump up to a minimum diameter is included in the merchantable volume.

Question 17

1. The correct answer is (A).

Based on the available data, the correct procedure to calculate annual net CSC is: $Area_{T+5}$ * (BCD_{T+5} – BCD_T). Then, tonnes of C are converted in kt CO_2 by multiplying by (−44/12)/1,000.

Furthermore, you may notice that the decrease in C stock in forest land remaining forest land could be due to the fact that: 1) either deforested areas had very high C stocks and/or; 2) areas from land converted to forest land that are transferred to forest land remaining forest land between T and T +5 had very low C stocks.

In such cases, the Party should improve transparency by reporting in its NID information on CSC from deforested areas and from areas transferred to forest land remaining forest land during the period T and T+5. Moreover, the Party should verify its estimates of CSC by calculating the overall CSC from the NFI data and compare it with the sum of CSC reported under the categories associated with forest land (i.e. forest land remaining forest land, land converted to forest land, and all categories of forest land converted to other land uses).

2. The correct answer is (A).

The area of forest land remaining forest land at year T+5 that was under forest land remaining forest land at time T also is: 7,346,000 ha –67,000 ha = 7,279,000 ha. At year T+5, the total C stock of forest land remaining forest land is 7,346,000 ha * 76 t C ha^{-1} = 558,296,000 t C, including the C stock of the 'new' forest area (transferred) under forest land remaining forest land, which is 67,000 ha * 108.6 t C ha^{-1} = 7,276,200 t C. Consequently, the average biomass density of land that was under forest land remaining forest land at both year T+5 and year T is (558,296,000 t C - 7,276,200 t C)/7,279,000 ha = 75.7 t C ha^{-1}. Thus, the average biomass decreased by: 75.7 t C ha^{-1} – 77 t C ha^{-1} = -1.3 t C ha^{-1}.

6. Key points to remember

- In order to successfully review the forest land category you must have adequate knowledge of the general LULUCF review considerations covered in lesson 2 and of how to review the land representation and information related to C pools covered in lesson 3.
- Forest land is the first land-use category in the hierarchy provided in the 2006 IPCC Guidelines.
- Forest land may be subdivided into managed and unmanaged land.
- Forest land is a key category in most Parties and as such requires much attention during the review.
- Significant C pools (significance analysis) within key categories in forest land must be identified and CSC from these pools should be reported using higher-tier methodologies in accordance with the decision trees provided in the 2006 IPCC Guidelines.
- The technical review should assess in detail the TACCC of the estimates related to forest land.
- Parties must report their GHG emissions/removals separately for forest land remaining forest land and land converted to forest land. In addition, Parties must further stratify their forest land based on the climate/soil/ecological/vegetation zone, management regime and age of forests or any other stratification scheme tailored to national circumstances.
- All gains and losses must be taken into account for each C pool reported (e.g. for biomass, increase due to growth and losses due to harvesting, natural mortality, disturbances, fires and pests).
- In forest land remaining forest land, CSC in the DOM and SOM (mineral) pools are assumed to be zero for the tier 1 methodology.
- Parties may use models (tier 3) in order to report CSC and associated emissions/removals from forest land, and therefore particular attention is required to review the TACCC of the models, especially during an in-country review.
- National forest inventories are a valuable source of information for forest land estimates in many Parties, and as such the review should focus on the quality of the NFI processes and results.

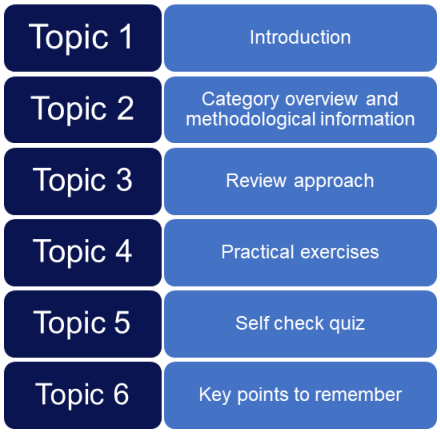
Lesson 5: Cropland

1. Introduction

1.1. Lesson structure

Lesson 5 provides guidance on the review of information for the cropland category within the LULUCF GHG inventory. Cropland is one of the six land-use categories given in the 2006 IPCC Guidelines, and the second in the hierarchy provided in the same guidelines.

The 2006 IPCC Guidelines provide guidance on how to estimate and report CSC and associated GHG emissions/removals from cropland in chapter 5, volume 4. Furthermore, the Wetlands Supplement provides additional and updated methodologies, EFs and AD, which could be applied for estimating emissions and removals from lands with organic soils and wet and drained mineral soils in cropland.



T. Figure 5-1. Structure of lesson 5

Remember that the 2006 IPCC Guidelines consider it good practice for countries to use higher-tier methods for key categories and significant C pools. While all Parties should be able to prepare an inventory using the tier 1 methodology, Parties usually use higher-tier methods for this land-use category, including tier 3 methods for some pools (e.g. SOM in cropland). Thus, most inventories are likely to include estimates prepared using a mix of tiers. For many Parties, cropland categories may be identified as key and its subcategories/pools as significant.

This lesson provides background information on the estimation and reporting of CSC and associated GHG emissions and removals from cropland. It also presents category-specific guidance for reviewing the estimates of GHG emissions/removals and related information submitted by Parties for the cropland category. Similarly to the previous lessons, this lesson ends with practical exercises and a self-check quiz to help you enhance and refresh your knowledge.

It is suggested that you have the CRT readily available when you study this lesson, because it contains several references to them (highlighted in red text).

Finally, note that the review of the cropland category in a Party's LULUCF GHG inventory is related to the review considerations you have learned in the previous lessons. Therefore, you must always apply the knowledge of how to review cross-cutting and cross-sectoral issues, the land representation, C pools and other aspects acquired in lessons 2 and 3.

1.2. Learning objectives

At the end of this lesson you should:

- Know the requirements for reporting emissions/removals from cropland by Parties in the CRT and the NID;
- Be able to understand how CSC methods, AD, EFs and methods for collecting these apply to the cropland category;
- Be able to understand the key areas for reviewing the GHG inventory information on the cropland category.

The expected time needed to complete lesson 5 depends on the level of your knowledge of LULUCF GHG inventories under the MPGs and the 2006 IPCC Guidelines:
For readers with experience: 60–80 minutes
For readers with less experience: 80–100 minutes

2. Category overview and methodological information

2.1. Reporting overview

According to the 2006 IPCC Guidelines, cropland includes cropped land, including rice fields and agroforestry systems where the vegetation structure falls below the thresholds used for the forest land category. Of course, cropland areas are by definition managed land.

U. Figure 5-2. Cropland

Methodologies to estimate the GHG emissions and removals from cropland and grassland categories are basically similar. There are, however, important differences between the categories that should be taken into consideration during the review; these are highlighted throughout this section.
The annual GHG emissions/removals from cropland are reported separately in two main subcategories:

1. Cropland remaining cropland;
2. Land converted to cropland.

For a detailed explanation, including the methodological guidance for cropland, consult chapter 5, together with chapter 2, volume 4 of the 2006 IPCC Guidelines.

GHG emissions/removals from cropland converted to other land-use categories are reported under the final category.

2.2. Pools and gases to be reported in cropland

For reporting GHG emissions/removals, subcategories should be used according to the national circumstances. The default classification used in the 2006 IPCC Guidelines is based on climate zones, soil type, management practices, crop species and age classes (for woody crops). The CSC in soils in cropland are likely to be significant. In the default methodologies provided in the 2006 IPCC Guidelines, changes in biomass are estimated and reported only for perennial woody crops, except in land-conversion subcategories. In the land converted to cropland subcategories, the biomass CSC of annual crops are estimated and reported only in the year of conversion. For annual crops, annual increase in biomass stocks is assumed equal to biomass losses from harvest and mortality in that same year, thus resulting in no net accumulation of biomass carbon stocks.

The CSC in biomass (above-ground and below-ground), DOM (deadwood and litter) and SOM in cropland are estimated and reported in CRT 4.B.

Increases and decreases in C stocks in living biomass should be reported separately, except in cases where, due to the methodology used, it may be technically impossible to separate the information between increases and decreases, such as when using the stock-difference method. In such cases, the net gain or loss of C must be reported in the relevant column of the CRT and "IE" reported for the other column, together with the necessary explanatory information in the documentation box in CRT 4.B and the NID.

Although HWP are expected to be produced from forest land, some secondary productions can originate from wood harvested in cropland according to national land categories definitions. In any case, CS in HWP originating from all land-use categories are reported together in CRT 4.Gs1 and CRT 4.Gs.2.

Most of the non-CO_2 emissions from management of cropland (i.e. N_2O from fertilization and from SOM mineralization from changes in management in cropland remaining cropland, CH_4 and N_2O from rice cultivation, N_2O from drainage of organic soils in cropland and CH_4 and N_2O from burning of crop residues), as well as CO_2 emissions from liming and urea application are reported in the agriculture sector.

CO_2 and CH_4 emissions/removals from drainage and rewetting of soils are reported in CRT 4(II), while avoiding double counting with the information reported in CRT 4.B.

Direct N_2O emissions/removals from N mineralization/immobilization of SOM in mineral soils associated with land conversion to cropland are reported in CRT 4(III).

N_2O and CH_4 emissions from biomass burning in cropland are reported in CRT 4(IV), while avoiding double counting with emissions from crop residues reported in CRT 3.E. CO_2 emissions from biomass burning may also be reported in CRT 4.B while avoiding double counting with information reported in CRT 4(IV). Be aware that only CO_2 emissions emitted by redox of woody biomass must be reported, whereas CO_2 emissions from annual biomass must not be reported because the CO_2 emissions are absorbed in the same year.

Note that biomass burning also includes any burning of DOM, and, if methods provided in the Wetlands Supplement are used, SOM in organic soils.

Indirect N_2O emissions from cropland are reported in CRT 4(III). Be aware that according to the structure of the CRT provided by annex II to decision 5/CMA.3, only N mineralization associated with SOM losses in land converted to cropland is an N source for which indirect N_2O emissions in cropland are reported in CRT 4(III). All other indirect N_2O emissions from cropland are reported under agriculture in CRT 3.D.

2.3. Methods and pools

The methodological tier to be applied for estimating CSC and other GHG emissions/removals depends on the significance of the reporting category and of the C pool, as well as the national circumstances. For this, the respective decision trees contained in the 2006 IPCC Guidelines are to be followed by Parties.

To learn more on the methodological tiers, consult volume 4 of the 2006 IPCC Guidelines (chap. 1, figures 1.2 and 1.3; chap. 2, figures 2.2, 2.3, 2.4, 2.5 and 2.6; and chap. 12, figure 12.1).

You have already learned in the previous lessons that Parties must provide GHG emissions/removals estimates for categories, pools and gases for which the 2006 IPCC Guidelines provide methodologies and EFs. Click on figure 5-3 to see the pools and gases for which emissions/removals estimates must be reported when tier 1 or tier 2 methods are applied.
Figure 5-4 summarizes the tier 1 and 2 methods to be applied, along with references to relevant equations in the 2006 IPCC Guidelines and in the Wetlands Supplement.

Tier 1			Land use													
			FL		CL		GL		WL			SL		OL		
Carbon pool – GHG			FL-FL	L-FL	CL-CL	L-CL	GL-GL	L-GL	WL-WL	L-WL		SL-SL	L-SL	OL-OL	L-OL	
									PL-PL	L-PE	L-FIL					
Living biomass		Above-ground	M	M	M [a]	M [b, c]		M [b, c]		M [c]	M [c]		M [c]		M [c]	
		Below-ground		M		M [b, c]		M [b, c]		M [c]	M [c]		M [c]		M [c]	
Dead organic matter		Dead wood		M [c]		M [c]		M [c]					M [c]		M [c]	
		Litter		M		M [c]		M [c]					M [c]		M [c]	
Soil organic matter		Mineral		M	M	M	M	M					M		M [d]	
		Organic	M	M	M	M	M	M	M [f]				M			
HWP			M (may be assumed 0 if net carbon stock change is judged insignificant)													
N_2O	Direct	Fertilization [e]	M	M					M	M	M	M	M			
		N mineralization		M		M	M [g]	M					M			M
		Drainage	M	M					M			M	M			
		Burning	M	M	M	M	M	M	M	M		M	M			M
	Indirect	Fertilization [e]	M	M					M	M	M	M	M			
		N mineralization		M		M	M [g]	M					M			M
CH_4		Burning	M	M	M	M	M	M	M	M		M	M			M

Tier 2			Land use												
			FL		CL		GL		WL			SL		OL	
Carbon pool – GHG			FL-FL	L-FL	CL-CL	L-CL	GL-GL	L-GL	WL-WL	L-WL		SL-SL	L-SL	OL-OL	L-OL
									PL-PL	L-PE	L-FIL				
Living biomass		Above-ground	M	M	M [a]	M [b]	M	M [b]		M	M	M	M		M
		Below-ground	M	M	M [a]	M [b]	M	M [b]		M	M	M	M		M
Dead organic matter		Dead wood	M	M	M	M	M	M		M		M	M		M
		Litter	M	M	M	M	M	M		M		M	M		M
Soil organic matter		Mineral	M	M	M	M	M	M				M	M		M
		Organic	M	M	M	M	M	M	M	M		M	M		
HWP			M												
N_2O	Direct	Fertilization [e]	M	M					M	M	M	M	M		
		N mineralization	M	M		M	M [g]	M				M	M		M
		Drainage	M	M					M	M		M	M		
		Burning	M	M	M	M	M	M	M	M		M	M		M
	Indirect	Fertilization [e]	M	M					M	M	M	M	M		
		N mineralization	M	M		M	M [g]	M				M	M		M
CH_4		Burning	M	M	M	M	M	M	M	M		M	M		M

Notes: grey shading = not applicable, blank = not mandatory.

Abbreviations: M = mandatory, GHG = greenhouse gas, FL = forest land, CL = cropland, GL = grassland, WL = wetlands, SL = settlements, OL = other land, PL = peatland, PE = peat extraction, FIL = flooded land, HWP = harvested wood products
FL–FL, CL-CL, GL-GL, WL-WL, PL-PL, SL-SL, OL-OL = indicate land category remaining under the current land use
L–FL, L-CL, L-GL, L-WL, L-PE, L-FIL, L-SL, L-OL = indicate land category converted to the current land use

[a] To be reported only for perennial crops.

[b] Net carbon stock gain in biomass pool for annual crops is to be reported only once in the year after conversion.

[c] Only applicable if the Party has reported carbon stock changes or the IPCC provides default carbon stock values for the biomass or DOM carbon stock for the previous land use. In such a case carbon stock is to be reported as instantaneously oxidized in the year of conversion.

[d] Carbon stock level after conversion is to be set at 0.

[e] N_2O emissions from N fertilization in forest land and settlements are to be reported under the LULUCF sector and those in cropland and managed grassland are to be reported in the agriculture sector. If the Party is not able to separate emissions from N fertilization in different land-use categories, all emissions are to be reported under the agriculture sector.

[f] Under tier 1 the activity data do not distinguish between peatlands under peat extraction and those being converted for peat extraction.

[g] N_2O emissions from grassland remaining grassland for agriculture purpose are reported under the agriculture sector.

V. Figure 5-3. C pools and gases to be reported in the cropland category under tier 1 and 2

Carbon stock changes in pools and associated GHG emissions/removals that must be estimated for cropland and grassland

Carbon stock changes in pools and associated GHG emissions/removals that must be estimated at Tier 1

0 indicates that the tier 1 methodology assumes no net carbon stock change

The IPCC equations to be applied are provided in parentheses (*those from the Wetlands Supplement are given in italics*)

Note that where activity data on land-use categories do not allow for the separation of CL-CL and L-CL or GL-GL and L-GL, for the IPCC default, the latter category does not apply

Note that in land under conversion from categories for which the IPCC does not provide default values for the biomass or DOM pools, reporting of carbon stock changes is nevertheless mandatory (to ensure accuracy) in case the Party has reported C stock changes in the pool under the previous land use

	Biomass (B)		Dead organic matter (DOM)		Soil organic matter (SOM)		Harvested wood products (HWP)	Non-CO_2 emissions
	Above (AB)	Below (BB)	Dead wood (DW)	Litter (L)	Mineral soils (MS)	Organic soils (OS)	HWP	
CL-CL GL-GL	Net C stock change (2.7)(0) C stock gain (2.9, 2.10) C stock losses (2.12)(1)	0	0		Net carbon stock change (2.25)	CO_2 emissions from drained organic soils (2.26) *CO_2 emissions from drained organic soils (2.2)* *On-site CO_2 emissions from drained organic soils (2.3)* *Off-site CO_2 emissions from drained organic soils (2.4, 2.5, 2A.1)* *CO_2 emissions from burning of drained organic soils (2.8)* *CO_2 emissions from rewetted organic soils (3.3)* *On-site CO_2 emissions from rewetted organic soils (3.4)* *Off-site CO_2 emissions from rewetted organic soils (3.5, 3.6)* *CO_2 emissions from burning of rewetted organic soils (2.8)*	Assumed 0, if judged insignificant (i.e. annual net C stock change in HWP pool, is less than the size of any key category), otherwise default tier 1 methods provided in the 2006 IPCC Guidelines (volume 4, chapter 12) apply Note that HWP are reported altogether regardless of the land of origin of wood	Non-CO_2 emissions from biomass burning (2.27) N_2O emissions from SOM mineralization (11.8)(4) Indirect N_2O emissions (11.10)(6) *CH_4 emissions from drained organic soils (2.6)* *CH_4 emissions from burning of drained organic soils (2.8)(5)* *CH_4 emissions from rewetted organic soils (3.8)* *N_2O emissions from rewetted organic soils (3.9)* *CH_4 emissions from burning of rewetted organic soils (2.8)(5)* *CH_4 emissions from rewetting of drained inland wetland mineral soils, and created wetlands on managed lands with mineral soils (5.1)*
L-CL L-GL	Net C stock change (2.15-2.16)(2) C stock gain (2.9, 2.10) C stock losses (2.12)(1)		0	Net carbon stock change (2.23)(3)				

Carbon stock changes in pools and associated GHG emissions/removals that must be estimated at Tier 2

CL-CL GL-GL	C stock change (2.7) C stock gain (2.9, 2.10) C stock losses (2.11, 2.12, 2.13, 2.14)	C stock change (2.18) or (2.19) C stock gain (2.20, 2.21, 2.22, 2.14)	Net C stock change (2.25)	As tier 1 *As tier 1*	Default methods provided in Chapter 12	As Tier 1 *As tier 1, plus N_2O emissions from burning of SOM in organic soils estimated*
L-CL L-GL	C stock change (2.15, 2.16) C stock gain (as tier 1) C stock losses (as tier 1)					

(0) Changes in biomass pools are calculated only for perennial crops.
(1) All biomass harvested is assumed to be oxidized in the year of removal.
(2) The Tier 1 method assumes belowground biomass C stocks in cropland to be constant and only accounts for losses from the previous land use for L-CL categories.
(3) The Tier 1 method assumes DOM stocks to be constant for cropland and grassland and only accounts for losses from previous land use for the conversion categories from forest land (FL-CL and FL-GL).
(4) Note that for CL-CL and for GL-GL for agriculture purpose, N_2O emissions are reported in the Agriculture sector (CRT 3.D)
(5) Note that N_2O emissions from fires on organic soils are not estimated at Tier 1.
(6) Limited to N mineralization associated with loss of soil organic matter resulting from change of land use or management on mineral soils in all land use categories except for cropland remaining cropland and grassland remaining grassland for agriculture purpose.

W. Figure 5-4. Coverage of carbon pools and greenhouse gas emissions/removals in the cropland category in the 2006 IPCC Guidelines (tier 1 and 2) and the Wetlands Supplement

Methods and pools: cropland remaining cropland

For cropland remaining cropland, the CSC in woody biomass are estimated following the same methodology as in forest land remaining forest land. The 2006 IPCC Guidelines provide default values only for above-ground woody biomass (stocks and growth rates) for perennial species and agroforestry systems, while no values are given for below-ground biomass. The tier 1 assumption in the 2006 IPCC Guidelines is that there is no change in below-ground biomass of perennial trees in agricultural systems.

To learn more about default values for above-ground woody biomass for perennial species consult, tables 5.1 and 5.3, chapter 5, volume 4 of the 2006 IPCC Guidelines. For potential C storage for agroforestry systems in different ecoregions of the world, consult table 5.2, chapter 5, volume 4.

The IPCC tier 1 assumption is that for cropland remaining cropland, DOM C stocks are either insignificant or unchanged (as in the case of agroforestry systems).

Methods and pools: land converted to cropland

The 2006 IPCC Guidelines provide default above-ground biomass stocks present on cropland in the year following conversion.

For default above-ground biomass stocks present on cropland in the year following conversion consult table 5.9, chapter 5, volume 4 of the 2006 IPCC Guidelines.

At the tier 1 level for land converted to cropland, all the DOM in the previous land-use category is assumed to be lost following conversion. DOM losses in the year of conversion are calculated only for forest land converted to cropland. DOM C stocks in land converted to cropland therefore are assumed to be zero following conversion and remain at that level. However, the 2006 IPCC Guidelines provide default values only for litter C stocks (see vol. 4, chap. 2, table 2.2), while no default data for deadwood C stocks are provided, and hence Parties have to use country-specific values as available, with the exception of mangrove forests, for which a default value of deadwood stock is provided in the Wetlands Supplement (chap. 4, table 4.7).

Note that many countries assume that woody biomass is at equilibrium across the cultivation cycle in cropland due to the C stock losses being equivalent to the C stock gains over a cultivation cycle, so that they report net only CSC in land converted to cropland. In such cases, you should recommend that the Party calculate and report **actual annual biomass CSC** instead of averaging them (as zero in this case) over the cultivation cycle, which implies that the Party needs to know the age class structure of its woody vegetation, as well as the cultivation cycle (e.g. after how many years is the woody crop harvested and replanted, if any), so that a net accumulation rate of biomass C stocks is estimated from planting until the year of maturity and a complete biomass C stock loss is estimated the year of harvesting.

An alternative method, as applied for settlements, is to estimate the net accumulation until annual gains equal annual losses, and thereafter just report zero net changes, which means in practice reporting the net accumulation until the long-term average C stock is achieved then report zero until the final harvest where the losses correspond to the entire C stocks.

Maturity

Maturity here means at the time of harvesting. Note that the long-term average C stock of a plantation is significantly different from the C stock of the plantation at 'maturity'. While for example the above-ground biomass C stock at harvest (i.e. at maturity) in a temperate climate is 63 t C ha^{-1}, with a net C stock growth rate of 2.1 t C ha^{-1} yr^{-1} across a harvesting cycle of 30 years, the long-term average C stock, that is the C stock averaged on the land across the management cycle differs (i.e. 32.6 versus 63 t C ha^{-1}).

Years	1	2	3	4	5	6	7	8	9	10
Total C stock (t C ha^{-1})	2.1	4.2	6.3	8.4	10.5	12.6	14.7	16.8	18.9	21

Years	11	12	13	14	15	16	17	18	19	20
Total C stock (t C ha^{-1})	23.1	25.2	27.3	29.4	31.5	33.6	35.7	37.8	39.9	42

Years	21	22	23	24	25	26	27	28	29	30	average
Total C stock (t C ha^{-1})	44.1	46.2	48.3	50.4	52.5	54.6	56.7	58.8	60.9	63	**32.55**

Methods and pools: SOM

As in the case of forest land and other land-use categories, the default methodology provided in the 2006 IPCC Guidelines for estimating changes in SOC in cropland assumes a linear change in SOC across the transition period for land converted to cropland, as well as for cropland remaining cropland due to changes in management.

The default transition period provided in the 2006 IPCC Guidelines for SOC to reach the equilibrium level following land-use or management changes within the same land-use category is 20 years.

Default factors for estimating changes in SOC under different land uses and management systems are provided for cropland in the 2006 IPCC Guidelines.

To learn more about default parameters for estimating changes in SOC under different land uses and management systems in cropland (reference SOC and stock change factors), consult volume 4 of the 2006 IPCC Guidelines (chap. 2, table 2.3; and chap. 5, table 5.5)

	Note that emissions from drained organic soils in cropland are to be reported at all tier levels.
	To learn more about default EFs for CO_2 emissions from drained organic soils in cropland, consult table 5.6, chapter 5, volume 4 of the 2006 IPCC Guidelines.
	Note that the Wetlands Supplement provides methods and revised default factors for emissions/removals from soils in cropland as follows: CO_2, CH_4 and N_2O emissions from drained organic soils (chap. 2, tables 2.1–2.5); CO_2 and CH_4 emissions/removals from rewetted organic soils (chap. 3, tables 3.1–3.3); CH_4 emissions from rewetted inland wetlands mineral soils and created wetlands on managed land with mineral soils (chap. 5, table 5.4); CO_2 and CH_4 (no default factors provided for N_2O at tier 1) emissions from burning of organic soils (chap. 2, table 2.7); Revised SOC_{REF} for inland wetlands mineral soils (chap. 5, table 5.2); Revised stock change factors for inland wetlands mineral soils in cropland (for long-term cultivated cropland with inland wetlands mineral soils and rewetting of cropland with inland wetlands mineral soils) (chap. 5, table 5.3). For rewetting of cropland with inland wetlands mineral soils, two different F_{LU} factors should be used according to the number of years after rewetting (0–20 years and 20–40 years); New methodologies, parameters and EFs in chapter 4 for coastal wetlands (if land is classified under the cropland category).

Collection of AD

AD on agricultural land are available from national statistics, as well as from international data sets of FAOSTAT (http://www.fao.org/faostat/en/#data).

As discussed in lesson 3, cropland and managed grassland may include subcategories that are part of a specific rotation system. As a reviewer, you should carefully check whether inconsistencies between definitions of categories/subcategories of AD collected from various sources generate artifacts of land conversions or result in double counting of land. Parties sometimes consider rotation systems as a single subdivision of cropland or grassland to avoid inconsistencies and double counting between those two land-use categories. The SOC of the rotation system is then calculated by taking into consideration the soil stock change factors (for land use (F_{LU}), management regime (F_{MG}) and input of organic matter (F_I)) of the various rotation phases and the length of these phases. Thus, during the review you should carefully assess how the Party utilizes the different data sources (e.g. definitions, harmonization of the different subcategories in the different data sources, hierarchy between data sources) for subcategories that are involved in rotation systems and/or those that can be easily misclassified.

It is worth noting that while the total CSC is correctly calculated when applying AD prepared using approaches 1, 2 or 3 for land representation, the temporal dynamics of CSC do vary somewhat, as explained in the 2006 IPCC Guidelines (vol. 4, chap. 2, box 2.2).

While accuracy across the time series may be achieved by using any of the approaches, the accuracy of single year estimates increases when applying approach 2 and increases further with AD enabling the application of approach 3. As a reviewer, where data are available, you should encourage the Party to consider applying approach 2 or 3, as practicable. Where data are not available, you should encourage

the Party to collect data depending on the significance of categories and the temporal dynamic of changes in land use and management (e.g. in a country with significant cropland areas subject to no tillage, the tracking of tillage across the national territory and across the time series is important for an accurate estimate of SOC changes associated with no tillage).
For the developing country Parties that need flexibility in the light of their capacities, you may want to explore whether there are any capacity-building needs related to collection of AD.

3. Review approach

General review considerations
When reviewing cropland estimates, you should always apply the guidance on general review issues for the LULUCF sector provided in lesson 2 and the guidance on the review of the land representation and C pools provided in lesson 3.
The following is a summary of general review considerations to refresh your memory:

- Assess whether categories, subcategories (e.g. grassland converted to cropland) and subdivisions (e.g. annual crop) for which estimates are prepared are appropriate and correspond to the national circumstances. The review should be implemented at the level of subdivisions reported;
- Assess the consistency of the land representation;
- Assess whether emissions/removals are reported separately for cropland remaining cropland and land converted to cropland;
- Assess whether non-reporting or incomplete reporting of the emissions and removals in C pools occur. Assess which C pools are covered by the GHG inventory, taking into consideration that for some C pools under some categories (e.g. DOM in cropland remaining cropland) the 2006 IPCC Guidelines tier 1 assumes zero net CSC;
- Assess whether all GHG emissions associated with CSC have been estimated and if the GHG fluxes are consistent with each other (e.g. CH_4, N_2O emissions from biomass burning);
- Check whether the Party has reported uncertainties associated with the estimates for CSC, including information on uncertainties of the input data, noting the flexibility available to those developing country Parties that need it in the light of their capacities;
- Identify, in consultation with the Party concerned, potential areas of capacity-building needs, for those developing country Parties that need the flexibilities provided in the MPGs in the light of their capacities.

Review of methods, AD and parameters
Assess the appropriateness of the Party's choice of methodological tiers, AD, EFs and other parameters according to the significance of categories/subcategories and national circumstances and their proper documentation in the submission. Check also the transparency, accuracy, completeness and consistency of the estimates. The level of review should be based on the level of disaggregation in the subcategories reported and the methods used by the Party. Focus your review (time/resources) mainly on the key pools/subcategories that are likely to contribute the most to GHG emissions and removals from the cropland categories. The following points may help you structure your review work.

Check whether:

- The Party has reported information on the monitoring and identification of cropland area. Note that because most of the Parties have long-lasting agricultural statistics (e.g. agricultural censuses, surveys, sampling) and the last decades even remote-sensing information, in most of the cases Parties are expected to have available data for reporting CSC in cropland using at least approach 1 for land representation;
- The total cropland area is monitored and reported and the areas, crop types and other AD match the information from other documents or sources. For example, in some cases Parties base their GHG emissions/removals estimation on detailed data sources on cropland areas and practices, as part of projects and/or measures that financially incentivize specific agricultural actions/practices. However, these data sources may not cover cropland areas which are not covered by the specific projects, measures and which may be significant in terms of the country area they cover and/or emissions/removals;
- Land transition matrices for the years before the starting year of the inventory equal to the transition period applied are reported in the NID;
- Documentation on each methodology, including assumptions, AD, EFs and parameters, provided in the NID is transparent enough to allow the assessment of the accuracy, completeness, consistency and comparability of the estimates;
- The methodologies and definitions are used consistently over the complete time series. Note that it is likely that the methodologies and definitions applied in the agricultural censuses, surveys and samplings improve and change over time, thus ensuring consistency is crucial in avoiding emissions/removals estimations being affected by such changes;
- The methods and equations are correctly applied consistently with the 2006 IPCC Guidelines, and that all gains and losses have been estimated for each C pool reported (e.g. for woody biomass, gains due to growth and losses due to fuelwood gathering, harvesting, fires);
- The values for the parameters are within the same range for the period from the starting year of the inventory to the most recent inventory year. If not, check whether there is a trend within the reported values and whether the trend is explained in the NID;
- Disaggregated AD of perennial and annual crop types are available;
- AD ensure that inconsistencies or double counting are avoided for subcategories involved in rotation systems (e.g. between cropland and grassland);
- CSC in biomass are reported only for perennial crops, while biomass CSC of annual crops are reported only for land converted to cropland in the year of conversion;
- CSC in mineral soils are reported for both perennial and annual crops (e.g. due to changes between perennial and annual crops and due to management changes within perennial and annual crops);
- Emissions from drainage of organic soils are reported regardless of the tier level applied;
- C stock gains are reported separately from C stock losses, when the gain-loss method is applied;
- The estimation is based on the 2006 IPCC default methodologies, and if so:
    - Is the category a key category? If so, is the choice of method appropriate according to the significance of the subcategory, pool and national circumstances (assess data and resources available)? Note that the SOM is likely to be significant in the cropland category (mineral

and/or organic soils). The biomass pool is likely to be significant when large areas of perennial crops and/or agroforestry systems exist in the country;
  - Has the Party used 2006 IPCC Guidelines default parameters in preparing the estimates? If so, is the choice of default factors consistent with the information reported on the crop type, region, climate region, ecoregion, management practices and age class (for perennial crops)?
  - Has the Party applied an age class structure for estimating CSC in perennial crops? If not, has it provided information in the NID on how biomass growth and losses have been estimated taking into account the harvest/maturity cycle?
  - Are emissions/removals from all mandatory C pools included in the GHG inventory? For example, under tier 1 in accordance with the 2006 IPCC Guidelines, estimating and reporting CSC from mineral soils in cropland remaining cropland is mandatory;
  - Are emissions/removals from SOM in mineral soils as a result of changes from perennial to annual crops, and vice versa, estimated?
  - If the Party assumes that CSC in the SOM pool in mineral soils are zero, does it provide evidence that management changes do not occur for the years covering the transition period applied, including changes between perennial and annual crops? Note that very often changes between perennial and annual crops occur as part of the management changes within cropland remaining cropland;
  - Could country-specific values be developed based on national or regional data and research?

- The estimation is based on higher tiers (tier 2 or 3) together with country-specific parameters, and if so:
  - Has the Party provided proper documentation in the NID on the methodologies applied and country-specific parameter values, such as assumptions, principles, equations, and key parameters and data sources?
  - In particular when a model is used, has the Party reported transparent information on the model structure, including on whether and how the model has been peer reviewed, verified and/or validated? If the model is used for estimating SOM CSC, has the model been calibrated and validated by using data collected in paired sites?
  - Are the country-specific values (e.g. increment estimates per area unit (growth rates) for perennial crops and SOC values and stock change factors) within the range of the default values provided in the 2006 IPCC Guidelines and values reported by Parties with similar climatic and management conditions in the region?
  - If significant deviations between country-specific parameters and the default values in the 2006 IPCC Guidelines are identified, has a proper explanation and justification been provided in the NID?
  - Does the Party include below-ground biomass in the estimation of emissions/removals and does it consistently account for both C biomass gains and C biomass losses?
  - Does the Party report emissions/removals from the DOM pool? If so, does it account for all C losses, including those from burning?

- The method for mineral soils uses a time series of data of 20 years (or more if the country has applied a longer transition time period). The AD for the whole period may not be available, and Parties may need to apply different techniques for estimating the missing data and for ensuring consistency in the time series as provided in the 2006 IPCC Guidelines (vol. 1, chap.

5). The availability of AD and CSC factors relating to different management systems and land uses is important for the accuracy of estimates;

- AD on the areas of organic soils drained for cultivation are available and comparable to international data sets. For identifying potential omissions in the reporting of emissions in this category, consult table 3a.3.3 in the IPCC good practice guidance for LULUCF on estimates of peatland areas in different countries and especially the column on peatlands drained for agriculture (noting that default data are not available for all countries) for comparison purposes. Check also information reported in international databases, such as those from FAOSTAT (http://www.fao.org/faostat/en/#data/GV);
- N_2O and CH_4 emissions from biomass burning in cropland reported in CRT 4(IV) do not include any emissions from agricultural residues (which are to be reported in CRT 3.F).

Review of TACCC of information reported in the CRT

The following questions could help you in structuring your work towards assessing the TACCC of the reported information in the NID and CRT 4.B, CRT 4.(II), CRT 4.(III), and CRT 4.(IV). Check each tab below to see a non-exhaustive list of checks.

General

Check whether:

- The Party correctly uses the signs in CRT (i.e. the sign is reversed when C stock gains/losses are expressed in CO_2 removals/emissions);
- The completeness of the reporting in CRT 4.B, CRT 4(II), CRT 4(III) and CRT 4(IV) is ensured, with appropriate notation keys being used when numerical values are not reported.

CRT 4.B

Check whether:

- The Party has provided estimates for CSC in biomass for both perennial woody crops and SOM;
- The Party has reported estimates for each previous land-use subcategory (e.g. forest land converted to cropland) in land converted to cropland or has reported only the total aggregated value for land converted to cropland. In the latter case:
  - Has the Party provided information on which types of conversions are included in land converted to cropland in the documentation box?
- For perennial crop species, the Party has reported separate estimates for increases and decreases in the biomass pool, and if not, whether it has applied proper notation keys for the missing values (e.g. ”IE” for included elsewhere).

CRT 4(II)

Check whether:

- The Party has reported CO_2 and CH_4 emissions/removals estimates for drained and rewetted soils;
- The areas of drained/rewetted organic soils reported in CRT 3.D, CRT 4.B and CRT 4(II) are consistent, and whether the EFs for CO_2 and CH_4 emissions/removals are consistent with each other.

CRT 4(III)
Check whether:

- The Party has reported estimates of direct and indirect N_2O emissions from SOM mineralization in land converted to cropland;
- Estimates of direct and indirect N_2O emissions from SOM mineralization in cropland remaining cropland are reported in the agriculture sector;
- The EFs for N mineralization and N immobilization reported (if reported) are consistent with each other.

CRT 4(IV)
Check whether:

- The Party has provided estimates of CO_2 from combustion of woody biomass either in CRT 4.B or in CRT 4(IV), and if so, whether the Party has clearly documented where it has reported such estimates in the NID and in the documentation box in the CRT;
- The Party has provided separate estimates for controlled burning and wildfire and, if not, whether this has been described in a transparent manner in the documentation box or in the NID;
- The mass of fuel available includes SOM of organic soils, as applicable.

	Note that methods and EFs for calculating CH_4 emissions from drained soils and CO_2 and CH_4 from rewetted organic soils are provided only in the Wetlands Supplement, whose use is encouraged but not required by the MPGs, and thus it is not mandatory to report these emissions.
	Note that N_2O emissions from drained organic soils in cropland have to be reported under the agriculture sector in CRT 3.D rather than the LULUCF sector .
	Note that N_2O emissions as a result of SOM mineralization from cropland remaining cropland are not reported under the LULUCF sector, but under the agriculture sector in CRT 3.D.
	Biomass burning is mainly associated with conversions of forest land to cropland. Biomass cleared and combusted for energy purposes should be reported under the energy sector (check for possible double counting of emissions). Non-CO_2 emissions from burning of agricultural residues are included under the agriculture sector, while CO_2 emissions are not to be reported unless they are not included in the biomass CSC reported in CRT 4.B. For annual biomass, any burning is not considered as a net source of CO_2 because the C released is absorbed during the growing season and thus there is no net C stock gain or loss.

4. Practical exercises

Exercise 1

A Party reports GHG emissions/removals from cropland in CRT 4.B (aggregated values) and states in the NID that it has not applied any stratification for estimating CSC and associated emissions/removals, and that the methodologies, EFs and parameters used were common for the entire territory.

Question 1

What would be your recommendation to the Party in terms of the variables that should be considered for stratifying cropland?

Exercise 2

A Party did not provide estimates of CO_2 emissions from cultivation of organic soils under cropland, reporting them as "NO" in CRT 4.B. According to table 3a.3.3 of the IPCC good practice guidance for LULUCF, as well as data from FAOSTAT, a large area of peatland is drained for agriculture in the country in question.

Question 2

How would you review this specific issue?

Exercise 3

A Party reported all emissions from N fertilization of agricultural and forest soils in the agriculture sector. The Party reported in the NID and in the documentation box in CRT 4(I) that only data on total use of N fertilizer in the country were available.

Question 3

Is the Party's reporting consistent with the 2006 IPCC Guidelines as implemented through the MPGs?

Exercise 4

A Party has reported N_2O emissions from N mineralization associated with the loss of SOM resulting from change of land use or management of mineral soils in CRT 4(III). In the NID the Party stated that it reported N_2O emissions from cropland in the country in CRT 4(III). The Party also reported emissions from mineralization/immobilization associated with loss/gain of SOM in CRT 3.D under the agriculture sector, which are 30 per cent less than the emissions reported in CRT 4(III).

Question 4

How would you address this during the review and, if applicable, in the review report?

4.1. Answer key to practical exercises

Question 1

The cropland area of the country should be stratified based on the climate zone, crop type, soil type, management system and, if data are available, C inputs and manure applied.

Question 2

Your review should also cover the source/sink categories reported as "NO" or "NE".
Firstly, you should check whether the Party has reported N_2O emissions from cultivation of organic soils in the agriculture sector, and if so, you would ask the Party why it has not included CO_2 emissions to ensure consistency among the sectors. In addition, you should ask the Party to explain the differences between the reporting in the GHG inventory ("NO") and the international data sets.
If drainage of organic soils does indeed occur in the country, then the Party must report all associated emissions (CO_2 and N_2O, and also CH_4 if the Party is applying methodologies contained in the Wetlands Supplement), by either collecting relevant country-specific data as a first choice, or using data from alternative sources (e.g. international data sets) and/or IPCC documents. You would include a corresponding recommendation in the TERR.

Question 3

Yes. As per footnote 3 to CRT 3.D and footnote 6 to CRT 4(I), Parties can include the application of fertilizers to the other land categories under agriculture if it cannot be identified separately. Given that the Party has fulfilled the minimum reporting requirements and transparently described the allocation in the CRT and the NID, its reporting is consistent with the 2006 IPCC Guidelines as implemented through the MPGs. However, if the fertilization of forest soils represents a significant proportion of the total fertilizer applied, you should encourage the Party to collect AD for this category to enable reporting fertilization of agricultural and forest soils separately in the agriculture and LULUCF sectors respectively.

Recall footnotes (3) in CRT 3.D and footnote 6 in CRT 4(I) on the allocation of emissions from N fertilization.

Question 4

In CRT 4(III), only N_2O emissions from N mineralization associated with loss of SOM resulting from change of land use or management of mineral soils in land converted to cropland must be reported, while N_2O emissions from management changes in cropland remaining cropland must be reported in CRT 3.D under the agriculture sector. It is likely that the Party has included emissions from cropland remaining cropland in CRT 4(III), resulting in double counting of emissions (with the emissions reported in CRT 3.D). You should clarify this during the review and if that is the case you must recommend that the Party correct its reporting by allocating the N_2O emissions from mineralization/immobilization associated with loss/gain of SOM, as appropriate.

5. Self-check quiz

Question 1

Reporting of GHG emissions related to agricultural land is divided between the agriculture sector and the LULUCF sector. Which of the following statements is true?

Select one:

A. CO_2 emissions from liming of forests and/or agricultural soils can be included in estimates of SOC stock changes reported in LULUCF when soil models that do not apportion SOC stock losses among sources of C inputs are applied
B. Direct and indirect N_2O emissions from fertilization of forests can be reported in the agriculture sector
C. Direct and indirect N_2O emissions from N mineralization/immobilization in entire area under cropland are reported in the agriculture sector
D. Direct N_2O emissions from drained organic soils in all land-use categories are reported in the agriculture sector

Question 2

Cropland is an important inventory category in all countries. Which pool is likely to be the most important in cropland in most countries?

Select one:

A. Below-ground living biomass
B. Above-ground living biomass
C. SOC in mineral soils
D. HWP

Question 3

The 2006 IPCC Guidelines default values for carbon stocks in cropland and grassland are the same.

Select one:

A. True
B. False

Question 4

In accordance with the 2006 IPCC Guidelines, the default assumption for CSC in biomass in cropland remaining cropland is that there is no change in the C stocks it contains.

Select one:

A. True
B. False

Question 5

Estimates for CSC in cropland are reported in CRT 4.B. For which of the following C pools at a minimum are Parties required to report CSC for perennial crops?

Select one:

A. Biomass, DOM and SOM
B. Biomass and SOM
C. DOM and SOM

Question 6

For which C subpool(s) must Parties provide, at a minimum, estimates for biomass CSC in cropland?

Select one:

A. Above-ground and below-ground biomass
B. Above-ground biomass
C. Below-ground biomass

Question 7

Emissions from burning of agricultural residues on cropland remaining cropland are reported in the agriculture sector.

Select one:

A. True
B. False

Question 8

The tier 1 assumption for land converted to cropland is that the C stocks in living biomass are zero immediately after the conversion. This means that:

Select one:

A. Land is assumed to be cleared of all vegetation, and that all C in the cleared biomass is assumed to be oxidized the same year
B. Land is assumed to be cleared of all vegetation, but the release of the C in the cleared biomass is estimated based on the default values of biomass burning and decay on-site and off-site

Question 9

When land is converted to perennial cropland, the biomass gain is estimated only in the year after conversion.

Select one:

A. True
B. False

Question 10

Which of the following emissions from management of cropland are reported under agriculture?

Select one:

A. N_2O from fertilization
B. N_2O from fertilization and from SOM mineralization from changes in management in cropland remaining cropland
C. CH_4 from rice cultivation
D. N_2O from rice cultivation
E. N_2O from drainage of organic soils in cropland
F. CH_4 and N_2O from burning of crop residues
G. CO_2 emissions from liming
H. CO_2 emissions from urea application
I. All of the above

Question 11

Which of the following statements is not correct?

Select one:

A. CH_4, N_2O and CO_2 emissions/removals from drainage and rewetting of soils in cropland and grassland are reported in CRT 4(II), while avoiding double counting with the information reported in CRT 4.B and CRT 4.C
B. N_2O emissions/removals from N mineralization/immobilization of SOM in mineral soils associated with land conversion to cropland are reported in CRT 4(III)
C. N_2O and CH_4 emissions from biomass burning in cropland and grassland are reported in CRT 4(IV), while avoiding double counting with emissions from crop residues and savannah burning reported in CRT 3.E and CRT 3.F. CO_2 emissions may also be reported while avoiding double counting with information reported in CRT 4.B and CRT 4.C. N_2O and CH_4 emissions from biomass burning also include any burning of DOM, and, if methods provided in the Wetlands Supplement are used, SOM in organic soils
D. Indirect N_2O emissions from fertilizers applied in agricultural land are reported under agriculture in CRT 3.D

Question 12

The Wetlands Supplement provides methods and revised default parameters and EFs for estimating the following for cropland:

Select one or more:

A. Revised SOC_{REF} for inland wetlands mineral soils
B. Revised stock change factors for cropland with inland wetlands mineral soils
C. CO_2, CH_4 and N_2O emissions from burning of organic soils
D. CO_2, CH_4 and N_2O emissions from drained organic soils
E. CO_2 and CH_4 emissions from rewetted organic soils
F. CH_4 emissions from rewetted mineral soils (if not from rice cultivation)

5.1. Answer key to self-check quiz

Question 1

The correct answer is (B).
If a Party is not able to separate the N inputs applied to land-use categories, other than cropland and grassland, it may report all N_2O emissions from N inputs to managed soils in the agriculture sector. CO_2 emissions from liming, regardless of the land-use category, must be reported in the agriculture sector in CRT 3.G-J. Note that in the same CRT, CO_2 emissions from urea application and other carbon-containing fertilizers are also to be reported. In the agriculture sector, direct and indirect N_2O emissions from N mineralization/immobilization in cropland remaining cropland are also to be reported, whereas the associated direct and indirect N_2O emissions from land converted to cropland are reported in the LULUCF sector in CRT 4(III). N_2O emissions from drained cropland and grassland are reported in the agriculture sector in CRT 3.D.

Question 2

The correct answer is (C).
SOC in mineral soils is likely to be the most significant pool in cropland. Note also that organic soils have a higher CSC per hectare.

Question 3

The correct answer is (B).
Different default values for biomass C stocks, as well as different parameters to be applied for calculating changes in SOC stocks, are provided for the cropland and grassland categories in volume 4 of the 2006 IPCC Guidelines (chaps. 5 and 6 respectively).

Question 4

The correct answer is (B).
In accordance with the 2006 IPCC Guidelines, under tier 1 methodology, changes in woody biomass must be reported.

Question 5

The correct answer is (B).
In accordance with the 2006 IPCC Guidelines, Parties must, at a minimum, provide estimates of CSC in woody biomass and SOM.

Question 6

The correct answer is (B).
Remember that the 2006 IPCC Guidelines do not provide default values for below-ground biomass for cropland.

Question 7

The correct answer is (A).
Emissions from field burning of agricultural residues are reported in the agriculture sector in CRT 3.F.

Question 8

The correct answer is (A).
Under the tier 1 methodology of the 2006 IPCC Guidelines, land is assumed to be cleared of all vegetation, and all C in the cleared biomass is assumed to be oxidized in the same year as when the land is converted to cropland.

Question 9

The correct answer is (B).
The statement is true for annual crops, but in the case of perennial crops, biomass CSC must be estimated for the following years as well.

Question 10

The correct answer is (I).
All emissions from the sources listed above are reported in the agriculture sector.

Question 11

The correct answer is (A).
N_2O emissions from drainage in cropland and grassland are reported under agriculture in CRT 3.D.

Question 12

The correct answer is (A), (B), (D), (E) and (F).
No default factors are provided at the tier 1 level for N_2O emissions for burning of organic soils.

6. Key points to remember

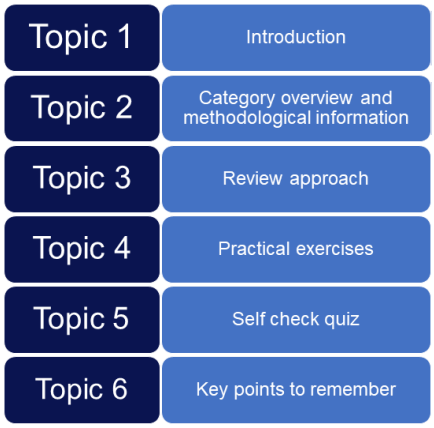
- In order to successfully review the cropland category, you must have adequate knowledge of the general LULUCF aspects covered in lesson 2 and of how to review the land representation and information related to carbon pools covered in lesson 3.
- Cropland is the second land-use category in the hierarchy provided in the 2006 IPCC Guidelines.
- Cropland is by definition managed land.
- For many Parties cropland may be identified as key and as such requires much attention during the review. SOC in mineral soils is very likely to be the most significant pool in cropland.
- Significant C pools (significance analysis) must be identified and CSC from these pools should be reported in accordance with the suggested IPCC methodology.
- The 2006 IPCC Guidelines default subcategorization is based on climate zones, soil type, management practices, crop species and age classes (for woody crops).
- All gains and losses must be taken into account for each C pool reported (e.g. for biomass in perennial woody crops, gains due to growth and losses due to harvesting, gathering, fires, other disturbances).
- Following the default methodologies in the 2006 IPCC Guidelines, CSC in biomass are estimated and reported only for woody biomass, except in land-conversion subcategories.
- In cropland remaining cropland, CSC in woody biomass and SOM must be reported under the tier 1 methodology, while in the DOM pool they are either insignificant or at equilibrium under tier 1.
- Parties may use models (tier 3) in order to report CSC and associated emissions/removals from cropland, and therefore particular attention is required in reviewing the TACCC of the models, particularly during an in-country review.

Lesson 6: Grassland

1. Introduction

1.1. Lesson structure

Lesson 6 provides guidance for the review of information for the grassland category within the LULUCF GHG inventory (see figure 6-1). Grassland is one of the six land-use categories in the 2006 IPCC Guidelines and the third in the hierarchy provided in the same guidelines.



X. Figure 6-1. Structure of lesson 6

The 2006 IPCC Guidelines provide specific guidance on how to estimate and report CSC and associated GHG emissions/removals from grassland in chapter 6, volume 4. Furthermore, the Wetlands Supplement provides additional and updated methodologies, EFs and AD, which could be applied to grassland for estimating emissions and removals from lands with organic soils and wet and drained mineral soils.

Remember that the 2006 IPCC Guidelines consider it good practice for countries to use higher-tier methods for key categories and significant C pools. While all Parties should be able to prepare an inventory using the tier 1 methodology, in some cases depending on their significance in the national inventory, Parties may use higher-tier methods for key categories, including using tier 3 methods for some pools (e.g. in SOM in grassland). Thus, most inventories are likely to include estimates prepared using a mix of tiers. For some Parties, grassland categories may be identified as key and their subcategories/pools as significant.

This lesson provides background information on the estimation and reporting of CSC and associated GHG emissions and removals from grassland. It also presents category-specific guidance for reviewing the estimates of GHG emissions/removals and related information submitted by Parties for the grassland category. Similarly to the previous lessons, this lesson ends with practical exercises and a self-check quiz to help you enhance and refresh your knowledge.

It is suggested that you have the CRT readily available when you study this lesson, because it contains several references to them (highlighted in red text).

Finally, note that the review of the grassland category in a Party's LULUCF GHG inventory is related to the review considerations you have learned in the previous lessons. You must always apply the knowledge of how to review cross-cutting and cross-sectoral issues, the land representation, C pools and other aspects acquired in lessons 2 and 3.

1.2. Learning objectives

At the end of this lesson you should:

- Know the requirements for reporting emissions/removals from grassland by Parties in the CRT and the NID;
- Be able to understand how CSC methods, AD, EFs and methods for collecting these apply to the grassland category;
- Be able to understand the key areas for reviewing the GHG inventory information on the grassland category.

The expected time needed to complete lesson 6 depends on the level of your knowledge of LULUCF GHG inventories under the MPGs and the 2006 IPCC Guidelines:

- For readers with experience: 50–70 minutes
- For readers with less experience: 70–90 minutes

2. Category overview and methodological information

2.1. Reporting overview

Y. Figure 6-2. Grassland

According to the 2006 IPCC Guidelines, grassland includes rangelands and pasture land that are not considered cropland. It also includes systems with woody vegetation and other non-grass vegetation such as herbs and brushes that fall below the threshold values used for the forest land category. The category also includes all grassland from wild lands to recreational areas as well as agricultural and silvipastural systems, subdivided into managed and unmanaged lands according to national definitions. Methodologies to estimate the GHG emissions and removals from grassland and cropland categories are basically similar. There are, however, important differences between the categories, which are highlighted in this section.

The annual GHG emissions/removals from grassland are reported separated into two main subcategories:

1. Grassland remaining grassland
2. Land converted to grassland

For the detailed explanation, including the methodological guidance for grassland, consult chapter 6, together with chapter 2, volume 4 of the 2006 IPCC Guidelines.

GHG emissions/removals from grassland converted to other land-use categories are reported under the final category.

2.2. Pools and gases to be reported in grassland

For reporting GHG emissions/removals, subcategories should be used according to the national circumstances. The default subcategories in the 2006 IPCC Guidelines are based on climate zones, soil type, management practices and vegetation type. The CSC in soils in grassland are likely to be significant.

In the tier 1 methodology provided in the 2006 IPCC Guidelines, changes in biomass carbon stocks in grassland remaining grassland are assumed to be zero (i.e. an approximate steady state). However, in cases where management changes occur over time in grassland (e.g. introduction of silvipastoral systems), stock changes can be significant and therefore it is good practice for Parties to use higher-tier methods.

The CSC in the biomass (above-ground and below-ground biomass), DOM (deadwood and litter) and SOM in grassland are reported in CRT 4.C.

Increases and decreases in C stocks in living biomass should be reported separately, except in cases where, owing to the methodology used, it may be technically impossible to separate the information between increases and decreases, such as when using the stock-difference method. In such a case, the net gain or loss of C must be reported in the relevant column of the CRT and "IE" reported for the other column, together with the necessary explanatory information in the documentation box and the NID.

Although HWP are expected to be produced from forest land, some secondary productions can originate from wood harvested in grassland according to national land categories definitions. In any case, CSC in HWP originating from all land-use categories are reported together in CRT 4.Gs1 and CRT 4.Gs1.

A portion of non-CO_2 emissions from management of grassland (i.e. N_2O from fertilization, N_2O from N mineralization from management changes in grassland remaining grassland for agricultural purposes, N_2O from drainage of organic soils in grassland, and CH_4 and N_2O from savannah burning if data allow to be identified separately) and CO_2 emissions from liming and urea application are reported in the agriculture sector.

CO_2 and CH_4 emissions/removals from drainage and rewetting of soils are reported in CRT 4(II), while avoiding double counting with the information reported in CRT 4.C.

Direct and indirect N_2O emissions/removals from N mineralization/immobilization of SOM in mineral soils associated with management changes in grassland remaining grassland (other than those for agricultural purposes) and land conversion to grassland are reported in CRT 4(III).

N_2O and CH_4 emissions from biomass burning in grassland are reported in CRT 4(IV), while avoiding double counting with emissions from savannah burning reported in CRT 3.E. CO_2 emissions may also be reported in CRT 4.C while avoiding double counting with the information reported in CRT 4(IV). Be aware that only CO_2 emissions from CSC in woody biomass must be reported, whereas CO_2 emissions from CSC in non-woody biomass (e.g. grass) does not have to be reported.

Note that biomass burning also includes any burning of DOM and, if methods provided in the Wetlands Supplement are used, SOM in organic soils.

Indirect N_2O emissions from grassland are reported in CRT 4(III). Be aware that according to the structure of the CRT provided by annex II to decision 5/CMA.3, N mineralization associated with SOM losses in grassland remaining grassland (other than those for agricultural purposes) and land converted to grassland is the only N source for which indirect N_2O emissions in grassland are reported in CRT 4(III). All other indirect N_2O emissions from grassland are reported under agriculture in CRT 3.D.

2.3. Methods and pools

The methodological tier to be applied for estimating CSC and other GHG emissions/removals depends on the significance of the reporting category and of the C pool, as well as the national circumstances. For this, the respective decision trees contained in the 2006 IPCC Guidelines are to be followed by Parties.

To learn more on the methodological tiers, consult volume 4 of the 2006 IPCC Guidelines (chap. 1 figures 1.2 and 1.3; chap. 2, figures 2.2, 2.3, 2.4, 2.5 and 2.6; and chap. 12, figure 12.1).

You have already learned in the previous lessons that Parties must provide GHG emissions/removals estimates for categories, pools and gases for which the 2006 IPCC Guidelines provide methodologies and EFs. Click on figure 6-3 to see the pools and gases for which emissions/removals estimates must be reported when tier 1 or tier 2 methods are applied.
Figure 6-4 summarizes the tier 1 and 2 methods to be applied, along with references to relevant equations in the 2006 IPCC Guidelines and in the Wetlands Supplement.
For grassland, the above-ground component (woody biomass) is usually small, and the below-ground C stocks are much larger and more sensitive to management changes. The default assumption is that there is no change in the C stocks in biomass in grassland remaining grassland. For land converted to grassland, for the tier 1 method, it is assumed that all biomass is lost from the previous ecosystem immediately after conversion (i.e. the land is cleared of all vegetation before grassland vegetation is established).

Note that the assumption of no change in the C stocks in biomass in grassland remaining grassland is not valid where there is evidence that changes in the management systems affect the C stock content of biomass.

Default values for the ratio of below-ground biomass to above-ground biomass as well as default woody biomass stocks present on grassland after conversion are provided in the 2006 IPCC Guidelines.

To learn more about default values for the ratio of below-ground biomass to above-ground biomass, consult volume 4 of the 2006 IPCC Guidelines (chap.6, tables 6.1). For default woody biomass stocks present on grassland after conversion, consult table 6.4 in chapter 6 of the same volume.

Tier 1		Land use												
		FL		CL		GL		WL			SL		OL	
Carbon pool – GHG		FL-FL	L-FL	CL-CL	L-CL	GL-GL	L-GL	WL-WL	L-WL		SL-SL	L-SL	OL-OL	L-OL
								PL-PL	L-PE	L-FlL				
Living biomass	Above-ground	M	M	M [a]	M [b, c]		M [b, c]		M [c]	M [c]		M [c]		M [c]
	Below-ground		M		M [b, c]		M [b, c]		M [c]	M [c]		M [c]		M [c]
Dead organic matter	Dead wood		M [c]		M [c]		M [c]					M [c]		M [c]
	Litter		M		M [c]		M [c]					M [c]		M [c]
Soil organic matter	Mineral		M	M	M	M	M					M		M [d]
	Organic	M	M	M	M	M	M	M [f]				M		
HWP		M (may be assumed 0 if net carbon stock change is judged insignificant)												
N_2O Direct	Fertilization [e]	M	M					M	M	M	M	M		
	N mineralization		M		M	M [g]	M					M		M
	Drainage	M	M					M			M	M		
	Burning	M	M	M	M	M	M	M	M		M	M		M
N_2O Indirect	Fertilization [e]	M	M					M	M	M	M	M		
	N mineralization		M		M	M [g]	M					M		M
CH_4	Burning	M	M	M	M	M	M	M	M		M	M		M

Tier 2		Land use												
		FL		CL		GL		WL			SL		OL	
Carbon pool – GHG		FL-FL	L-FL	CL-CL	L-CL	GL-GL	L-GL	WL-WL	L-WL		SL-SL	L-SL	OL-OL	L-OL
								PL-PL	L-PE	L-FlL				
Living biomass	Above-ground	M	M	M [a]	M [b]	M	M [b]		M	M	M	M		M
	Below-ground	M	M	M [a]	M [b]	M	M [b]		M	M	M	M		M
Dead organic matter	Dead wood	M	M	M	M	M	M		M		M	M		M
	Litter	M	M	M	M	M	M		M		M	M		M
Soil organic matter	Mineral	M	M	M	M	M	M				M	M		M
	Organic	M	M	M	M	M	M	M	M		M	M		
HWP								M						
N_2O Direct	Fertilization [e]	M	M					M	M	M	M	M		
	N mineralization	M	M		M	M [g]	M				M	M		M
	Drainage	M	M					M	M		M	M		
	Burning	M	M	M	M	M	M	M	M		M	M		M
N_2O Indirect	Fertilization [e]	M	M					M	M	M	M	M		
	N mineralization	M	M		M	M [g]	M				M	M		M
CH_4	Burning	M	M	M	M	M	M	M	M		M	M		M

Notes: grey shading = not applicable, blank = not mandatory.

Abbreviations: M = mandatory, GHG = greenhouse gas, FL = forest land, CL = cropland, GL = grassland, WL = wetlands, SL = settlements, OL = other land, PL = peatland, PE = peat extraction, FlL = flooded land, HWP = harvested wood products
FL–FL, CL-CL, GL-GL, WL-WL, PL-PL, SL-SL, OL-OL = indicate land category remaining under the current land use
L–FL, L-CL, L-GL, L-WL, L-PE, L-FlL, L-SL, L-OL = indicate land category converted to the current land use

[a] To be reported only for perennial crops.
[b] Net carbon stock gain in biomass pool for annual crops is to be reported only once in the year after conversion.
[c] Only applicable if the Party has reported carbon stock changes or the IPCC provides default carbon stock values for the biomass or DOM carbon stock for the previous land use. In such a case carbon stock is to be reported as instantaneously oxidized in the year of conversion.
[d] Carbon stock level after conversion is to be set at 0.
[e] N_2O emissions from N fertilization in forest land and settlements are to be reported under the LULUCF sector and those in cropland and managed grassland are to be reported in the agriculture sector. If the Party is not able to separate emissions from N fertilization in different land-use categories, all emissions are to be reported under the agriculture sector.
[f] Under tier 1 the activity data do not distinguish between peatlands under peat extraction and those being converted for peat extraction.
[g] N_2O emissions from grassland remaining grassland for agriculture purpose are reported under the agriculture sector.

Figure 6-3. Carbon pools and gases to be reported in the grassland category under tier 1 and 2

Carbon stock changes in pools and associated GHG emissions/removals that must be estimated for cropland and grassland

Carbon stock changes in pools and associated GHG emissions/removals that must be estimated at Tier 1

0 indicates that the tier 1 methodology assumes no net carbon stock change

The IPCC equations to be applied are provided in parentheses (*those from the Wetlands Supplement are given in italics*)

Note that where activity data on land-use categories do not allow for the separation of CL-CL and L-CL or GL-GL and L-GL, for the IPCC default, the latter category does not apply

Note that in land under conversion from categories for which the IPCC does not provide default values for the biomass or DOM pools, reporting of carbon stock changes is nevertheless mandatory (to ensure accuracy) in case the Party has reported C stock changes in the pool under the previous land use

	Biomass (B)		Dead organic matter (DOM)		Soil organic matter (SOM)		Harvested wood products (HWP)	Non-CO_2 emissions
	Above (AB)	Below (BB)	Dead wood (DW)	Litter (L)	Mineral soils (MS)	Organic soils (OS)	HWP	
CL-CL GL-GL	**Net C stock change (2.7)(0)** **C stock gain (2.9, 2.10)** **C stock losses (2.12)(1)**	0	0		**Net carbon stock change (2.25)**	**CO_2 emissions from drained organic soils (2.26)** *CO_2 emissions from drained organic soils (2.2)* *On-site CO_2 emissions from drained organic soils (2.3)* *Off-site CO_2 emissions from drained organic soils (2.4, 2.5, 2A.1)* *CO_2 emissions from burning of drained organic soils (2.8)* *CO_2 emissions from rewetted organic soils (3.3)* *On-site CO_2 emissions from rewetted organic soils (3.4)* *Off-site CO_2 emissions from rewetted organic soils (3.5, 3.6)* *CO_2 emissions from burning of rewetted organic soils (2.8)*	**Assumed 0, if judged insignificant (i.e. annual net C stock change in HWP pool, is less than the size of any key category), otherwise default tier 1 methods provided in the 2006 IPCC Guidelines (volume 4, chapter 12) apply** **Note that HWP are reported altogether regardless of the land of origin of wood**	**Non-CO_2 emissions from biomass burning (2.27)** **N_2O emissions from SOM mineralization (11.8)(4)** **Indirect N_2O emissions (11.10)(6)** *CH_4 emissions from drained organic soils (2.6)* *CH_4 emissions from burning of drained organic soils (2.8)(5)* *CH_4 emissions from rewetted organic soils (3.8)* *N_2O emissions from rewetted organic soils (3.9)* *CH_4 emissions from burning of rewetted organic soils (2.8)(5)* *CH_4 emissions from rewetting of drained inland wetland mineral soils, and created wetlands on managed lands with mineral soils (5.1)*
L-CL L-GL	**Net C stock change (2.15-2.16)(2)** **C stock gain (2.9, 2.10)** **C stock losses (2.12)(1)**		0	**Net carbon stock change (2.23)(3)**				

Carbon stock changes in pools and associated GHG emissions/removals that must be estimated at Tier 2

CL-CL GL-GL	**C stock change (2.7)** **C stock gain (2.9, 2.10)** **C stock losses (2.11, 2.12, 2.13, 2.14)**	**C stock change (2.18) or (2.19)** **C stock gain (2.20, 2.21, 2.22, 2.14)**	**Net C stock change (2.25)**	**As tier 1** *As tier 1*	**Default methods provided in Chapter 12**	**As Tier 1** *As tier 1, plus N_2O emissions from burning of SOM in organic soils estimated*
L-CL L-GL	**C stock change (2.15, 2.16)** **C stock gain (as tier 1)** **C stock losses (as tier 1)**					

(0) Changes in biomass pools are calculated only for perennial crops.
(1) All biomass harvested is assumed to be oxidized in the year of removal.
(2) The Tier 1 method assumes belowground biomass C stocks in cropland to be constant and only accounts for losses from the previous land use for L-CL categories.
(3) The Tier 1 method assumes DOM stocks to be constant for cropland and grassland and only accounts for losses from previous land use for the conversion categories from forest land (FL-CL and FL-GL).
(4) Note that for CL-CL and for GL-GL for agriculture purpose, N_2O emissions are reported in the Agriculture sector (CRT 3.D)
(5) Note that N_2O emissions from fires on organic soils are not estimated at Tier 1.
(6) Limited to N mineralization associated with loss of soil organic matter resulting from change of land use or management on mineral soils in all land use categories except for cropland remaining cropland and grassland remaining grassland for agriculture purpose.

Figure 6-4. Coverage of carbon pools and greenhouse gas emissions/removals in the grassland category in the 2006 IPCC Guidelines (tier 1 and 2) and the Wetlands Supplement

2.4. Methods and pools: tier 1

The tier 1 assumption is that for grassland remaining grassland, DOM C stocks are at the equilibrium level.

At the tier 1 level for land converted to grassland, all the DOM in the previous land-use category is assumed to be lost following conversion. DOM losses in the year of conversion are calculated only for forest land converted to grassland. DOM C stocks in land converted to grassland therefore are assumed to be zero following conversion and remain at that level. However, given that IPCC default values are provided only for litter C stocks (see the 2006 IPCC Guidelines, vol. 4, chap. 2, table 2.2), and no default data for deadwood C stocks provided, Parties must use country-specific values as available, with the exception of mangrove forests, for which a default value of deadwood stock is provided in the Wetlands Supplement (chap. 4, table 4.7). Countries where the above-mentioned default assumption for DOM does not apply are encouraged to use a higher tier for estimating CSC in the DOM pool in land converted to grassland.

2.5. Methods and pools: SOM

As in the case for forest land, the IPCC default methodology for estimating changes in SOC in grassland assumes a linear change in SOC across the transition period for land converted to grassland, as well as for grassland remaining grassland due to changes in management.

The 2006 IPCC Guidelines default transition period for SOC to reach the equilibrium level following land-use/management changes within the same land-use category is 20 years.

Default stock change factors and reference SOC stocks to be used for estimating changes in SOM under different management systems are provided for grassland in the 2006 IPCC Guidelines.

	To learn more about default parameters for estimating changes in SOC under different management systems in grassland, consult volume 4 of the 2006 IPCC Guidelines (chap. 6, table 6.2 (stock change factors); and chap 2, table 2.3 (reference SOC)).
	Note that emissions from drained organic soils in grassland are to be reported at all tier levels.
	To learn more about default EFs for CO_2 emissions from drained organic soils in grassland, consult table 6.3, chapter 6, volume 4 of the 2006 IPCC Guidelines.

Note that the Wetlands Supplement provides methods and revised default factors for emissions/removals from soils in grassland as follows:
CO_2, CH_4 and N_2O emissions from drained organic soils (chap. 2, tables 2.1–2.5);
CO_2, and CH_4 emissions/removals from rewetted organic soils (chap. 3, tables 3.1–3.3);
CH_4 emissions from rewetted inland wetland mineral soils and created wetlands on managed land with mineral soils (chap. 5, table 5.4);
CO_2 and CH_4 (no default EFs provided for N_2O at tier 1) emissions from burning of organic soils (chap. 2, table 2.7);
Revised SOC_{REF} in inland wetlands mineral soils (chap. 5, table 5.2);
New methodologies, parameters and EFs in chapter 4 for coastal wetlands (if land is classified under the grassland category).

Collection of AD

AD on agricultural land are available from national statistics, as well as from international data sets of FAOSTAT (http://www.fao.org/faostat/en/#data).

As discussed in lesson 3, managed grassland and cropland may include subcategories that are part of a specific rotation system. As a reviewer, you should carefully check whether inconsistencies between definitions of categories/subcategories of AD collected from various sources generate artifacts of land conversions or result in double counting of land. Parties sometimes consider rotation systems as a single subdivision of grassland or cropland to avoid inconsistencies and double counting between those two land-use categories. The SOC of the rotation system is then calculated by considering the soil stock change factors (for land use (F_{LU}), management regime (F_{MG}) and input of organic matter (F_I)) of the various rotation phases and the length of these phases. Thus, during the review you should carefully assess how the Party utilizes the different data sources (e.g. definitions, harmonization of the different subcategories in the different data sources, hierarchy between data sources) for subcategories that are involved in rotation systems and/or can be easily misclassified.

It is worth noting that while the total CSC is correctly calculated when applying AD prepared using approaches 1, 2 or 3 for land representation, the temporal dynamics of CSC do vary somewhat, as demonstrated in the 2006 IPCC Guidelines (vol. 4, chap. 2, box 2.2).

While accuracy across the time series may be achieved by all approaches, the accuracy of single year estimates increases when applying approach 2 and increases further with AD enabling the application of approach 3. As a reviewer, where data are available, you should encourage the Party to apply approaches 2 and 3, as practicable. Where data are not available, you should encourage the Party to collect data depending on the significance of categories and the temporal dynamic of changes in land use and management (e.g. in a country with significant grassland areas under sustainable/improvement management practices, there is a need to better track those practices across the national territory and across the time series as compared with areas not being sustainably managed to obtain an accurate estimate of SOC changes associated with the management practices applied).

For the developing country Parties that need flexibility in the light of their capacities you may wish to explore whether there are any capacity-building needs related to collection of AD.

3. Review approach

General review considerations

When reviewing grassland estimates, you should always apply the guidance on general review issues for the LULUCF sector provided in lesson 2 and the guidance on the review of the land representation and carbon pools provided in lesson 3.

The following is a summary of general review considerations to refresh your memory:

- Assess whether categories, subcategories (e.g. cropland converted to grassland) and subdivisions (e.g. treed grassland) for which estimates are prepared are appropriate and correspond to the national circumstances. The review should be implemented at the level of subdivisions reported;
- Assess the consistency of the land representation;
- Assess whether emissions/removals are reported separately for grassland remaining grassland and land converted to grassland;
- Assess whether non-reporting or incomplete reporting of the emissions and removals in C pools occurs. Assess which C pools are covered by the GHG inventory, bearing in mind that for some C pools under some categories (e.g. biomass in grassland remaining grassland), the 2006 IPCC Guidelines tier 1 assumes zero net CSC;
- Assess whether all GHG emissions associated with CSC have been estimated and if the GHG fluxes are consistent with each other (e.g. CH_4 and N_2O emissions from biomass burning);
- Check whether the Party has reported uncertainties associated with the estimates for CSC, including information on uncertainties of the input data, noting the flexibility available to those developing country Parties that need it in the light of their capacities;
- Identify, in consultation with the Party concerned, potential areas of capacity-building needs, for those developing country Parties that need the flexibilities provided in the MPGs in the light of their capacities.

Review of methods, AD and parameters

Assess the appropriateness of the Party's choice of methodological tiers, AD, EFs and other parameters according to the significance of categories/subcategories and national circumstances and their proper documentation in the submission. Check also the transparency, accuracy, completeness and consistency of the estimates. The level of review should be based on the level of disaggregation in the subcategories reported and the methods used by the Party. Focus your review (time/resources) mainly on the significant pools/subcategories that are likely to contribute the most to GHG emissions and removals from the grassland categories assessed as key categories. The following points may help you structure your review work.

Check whether:

- The Party has reported information on the monitoring and identification of the grassland area;
- The total grassland area is monitored and reported, the grassland types and areas and other AD match the information from other national and/or international documents or sources (e.g. agricultural statistics/maps, national land-use/cover maps, FAOSTAT) and the national grassland area is subdivided into managed and unmanaged land, if applicable;

- Land transition matrices for the years before the starting year of the inventory equal to the transition period applied are reported in the NID;
- Documentation on each methodology, including assumptions, AD, EFs and parameters, provided in the NID is transparent enough to allow the assessment of the accuracy, completeness, consistency and comparability of the estimates;
- The methodologies and definitions are used consistently over the complete time series;
- The methods and equations are correctly applied consistently with the 2006 IPCC Guidelines, and that all gains and losses have been estimated for each C pool reported (e.g. for woody biomass, gains due to growth, and losses due to harvesting, fuelwood gathering, fires);
- Whether there is a trend within the reported parameter values and whether the trend is explained in the NID;
- Disaggregated AD according to grassland type, vegetation type and coverage, and management practices are available (e.g. grasslands predominantly covered by non-woody vegetation, savannahs, treed grasslands);
- AD have been derived ensuring that inconsistencies or double counting is avoided for subcategories involved in rotation systems (e.g. between cropland and grassland);
- CSC in biomass are reported if significant management changes occur over time and/or for grassland areas covered by trees. In the latter case, methodologies from chapter 4, volume 4 of the 2006 IPCC Guidelines may be applied;
- CSC in mineral soils are reported for both grassland remaining grassland and land converted to grassland (e.g. due to management changes);
- Emissions from drainage of organic soils are reported regardless of the tier level applied;
- C stock gains are reported separately from C stock losses, when the gain-loss method is applied;
- The estimation is based on the 2006 IPCC Guidelines default methodologies, and if so:
    - Is the category a key category? If so, is the choice of method appropriate according to the significance of the category/subcategory/pool and national circumstances (assess data and resources available)? Note that the SOM is likely to be significant in the grassland category (mineral and/or organic soils). The biomass pool is likely to be significant in the case when large areas with perennial (tree) vegetation exist in the Party;
    - Are emissions/removals from all mandatory C pools included in the GHG inventory? For example, under the tier 1 method in the 2006 IPCC Guidelines, estimating and reporting CSC from mineral soils in grassland remaining grassland is mandatory;
    - If the Party assumes that CSC in SOM mineral pool are zero, does it provide evidence that management changes have not occurred in the transition period applied?
    - Could country-specific values be developed based on national or regional data and research?
- The estimation is based on higher tiers (tier 2 or tier 3) together with country-specific parameters, and if so:
    - Is the choice of method appropriate to the significance of the category/subcategory/pool and national circumstances?

- Has the Party provided proper documentation in the NID on the methodologies applied and country-specific parameter values, such as assumptions, principles, equations, and key parameters and data sources?
- When a model is used, has the Party reported transparent information on the model structure, on whether and how the model has been peer reviewed, verified and/or validated? If the model is used for estimating SOM CSC, has the model been calibrated and validated by using data collected in paired sites?
- Are the country-specific values (e.g. increment estimates per area unit (growth rates) for perennial vegetation and SOC values and stock change factors) reasonable and within the range of the default values provided in the 2006 IPCC Guidelines and those reported by Parties with similar conditions in the region?
- If significant deviations between country-specific parameters and the 2006 IPCC Guidelines default values are identified, has a proper explanation and justification been provided in the NID?
- Does the Party include below-ground biomass in the estimation of emissions/removals and does it consistently account for both C biomass gains and C biomass losses?
- Does the Party report emissions/removals from the DOM pool? If so, does it account for all C losses, including those from burning?

- The method for mineral soils uses a time series of data of 20 years (or more if the country has applied a longer transition time period). The AD for the whole period may not be available, and Parties may need to apply different techniques for estimating the missing data and for ensuring consistency in the time series as provided in chapter 5, volume 1 of the 2006 IPCC Guidelines. The availability of AD and C stock factors relating to different management systems and land uses is important for the accuracy of estimates;
- The adequacy of statistical information on the areas of organic soils drained is ensured. For identifying potential omissions in reporting emissions in this category, consult table 3a.3.3 in the IPCC good practice guidelines for LULUCF on estimates of peatland areas in different countries and especially the column on peatlands drained for agriculture (noting that default data are not available for all countries) for comparison purposes. Check also information reported in international databases, such as those from FAOSTAT (http://www.fao.org/faostat/en/#data/GV);
- N_2O and CH_4 emissions from prescribed burning of savannahs are reported in the agriculture sector in CRT 3.E if data allow to be identified separately and are not double counted with emissions reported in CRT 4(IV).

Review of TACCC of information reported in the CRT

The following questions could help you in structuring your work towards assessing the TACCC of the reported information in the NID and CRT 4.C, CRT 4.(II), CRT 4.(III) and CRT 4.(IV). Check each tab below to see a non-exhaustive list of checks.

General

Check whether:

- The Party correctly uses the signs in CRT (i.e. the sign is reversed when C stock gains/losses are expressed in CO_2 removals/emissions);
- The completeness of the reporting in CRT 4.C, CRT 4(II), CRT 4(III) and CRT 4(IV) is ensured or otherwise appropriate notation keys have been used when numerical values are not reported.

CRT 4.C

Check whether:

- The Party has provided estimates for CSC in SOM and in biomass for perennial woody vegetation;
- The Party has reported estimates for each previous land-use subcategory (e.g. forest land converted to grassland) in land converted to grassland, or it has reported only the total aggregated value for land converted to grassland. In the latter case:
  - Has the Party provided information on which types of conversions are included in land converted to grassland in the documentation box?
- If CSC in biomass are reported, have these been reported separately for increases and decreases in biomass pool, and if not, whether it has applied proper notation keys for the missing values (e.g. "IE" for included elsewhere).

CRT 4(II)

Check whether:

- The Party has reported CO_2, and CH_4 emission/removal estimates for drained and rewetted soils;
- The areas of drained/rewetted organic soils reported in CRT 3.D, CRT 4.C and CRT 4(II) are consistent, and whether the EFs for CO_2 and CH_4 emissions/removals are consistent with each other.

CRT 4(III)

Check whether:

- The Party has reported estimates of direct and indirect N_2O emissions from SOM mineralization in grassland remaining grassland (for other than agricultural purposes) and land converted to grassland;
- Estimates of direct and indirect N_2O emissions from SOM mineralization in grassland remaining grassland for agricultural purposes are reported in the agriculture sector;
- The EFs for N mineralization and N immobilization reported (if reported) are consistent with each other.

CRT 4(IV)

Check whether:

- The Party has provided estimates of CO_2 from combustion of woody biomass in CRT 4.C or CRT 4(IV), and if so, whether the Party has clearly documented where it has reported such estimates in the NID and in the documentation box in the relevant CRT;
- The Party has provided separate estimates for controlled burning and wildfires and, if not, whether this has been described in a transparent manner in the documentation box or the NID;
- The mass of fuel available includes SOM of organic soils, as applicable.

	Note that methods and EFs for calculating CH_4 emissions from drained soils and CO_2 and CH_4 from rewetted organic soils are provided only in the Wetlands Supplement, whose use is encouraged but not required by the MPGs, and thus it is not mandatory to report these emissions.
	Note that N_2O emissions from drained organic soils in grassland have to be reported under the agriculture rather than the LULUCF sector in CRT 3.D
	Note that N_2O emissions from SOM mineralization from grassland remaining grassland for agricultural purposes are reported under the agriculture rather than the LULUCF sector in CRT 3.D
	Biomass burning in grassland remaining grassland is commonly associated with savannah burning, but GHG emissions from biomass burning can be associated with conversions of forest land to grassland. Biomass cleared and combusted for energy purposes should be reported under the energy sector (check for possible double counting of emissions). Non-CO_2 emissions from burning of savannah are included under the agriculture sector if data allow to be identified separately, otherwise must be reported under in CRT 4.IV (while avoiding double counting or omission of reported emissions between CRT 3.E and CRT 4.IV), while CO_2 emissions are reported only in the case of perennial woody biomass. For annual non-woody biomass, any burning is not considered as a net source of CO_2 emissions because the C released is absorbed during the growing season and thus not reported as a C stock gain.

4. Practical exercises

Exercise 1

A Party states in the NID that CSC in all C pools in grassland remaining grassland are reported based on the tier 1 assumption in accordance with the 2006 IPCC Guidelines, and therefore reports CSC as "NA" (i.e. C pools are in equilibrium).

Question 1

Would you have any clarifying question to ask the Party during the review? If there are any issues, what would be your recommendation/encouragement to the Party during the review?

Exercise 2

A Party did not provide estimates of CO_2 emissions from drained organic soils under grassland, reporting them as "NO" in CRT 4.C. According to information from international databases such as FAOSTAT, an important area of grassland is reported under drained organic soils in the country in question.

Question 2

Would you have any clarifying question to ask the Party during the review? If there are any issues, what would be your recommendation/encouragement to the Party during the review?

Exercise 3

A Party reports N_2O and CH_4 from biomass burning in grassland for several years in the time series in CRT 4(IV) and for some of these years the emissions are significant. The Party also reports in the NID that extensive savannah areas exist in the country but emissions from biomass burning are reported as "NO" in CRT 3.E. In the NID the Party provides information only on the equation used for estimating associated emissions from biomass burning.

Question 3

Would you have any clarifying question to ask the Party during the review? If there are any issues, what would be your recommendation/encouragement to the Party during the review?

Exercise 4

A Party reports SOC changes in mineral soils for the different land-use categories using AD based on approach 1 for land representation of the 2006 IPCC Guidelines. However, you identified during the review that the Party has available data to support land representation following approach 3 of the 2006 IPCC Guidelines.

Question 4

How would you review this issue?

4.1. Answer key to practical exercises

Question 1

In accordance with the 2006 IPCC Guidelines, under tier 1, while the biomass and DOM pools can be assumed to be in equilibrium, the SOM pool in grassland remaining grassland cannot be assumed to be in equilibrium (i.e. zero CSC) unless the Party provides evidence that management practices (including C inputs) have not changed in the last 20 years. Furthermore, the tier 1 assumptions cannot be applied if grassland remaining grassland is a key category. As a reviewer, you should check whether grassland remaining grassland could be a key category (e.g. by checking whether there is woody biomass present in grassland and by making approximate calculations using 2006 IPCC Guidelines defaults and AD from international sources, as necessary) and identify significant subcategories/pools. Prior to or during the review, you should ask the Party for an explanation for reporting the CSC in mineral soils as zero and for using tier 1 assumptions for CSC in significant pools, if you find that grassland remaining grassland could be a key category. If the Party does not provide sufficient evidence for carbon stocks in mineral soils being in equilibrium, as a reviewer, you must recommend that the Party either provide such evidence or report CSC in the SOM pool. If you consider that grassland remaining grassland could be a key category, you should also encourage the Party to use higher-tier methods to estimate and report CSC in significant pools.

Question 2

Remember that your review should cover the source/sink categories reported as “NO” or “NE”.
Firstly, you should check whether the Party has reported N_2O emissions from cultivation of organic soils in the agriculture sector, and if so, whether it included drained managed grassland areas. In such a case you must ask the Party why it has not included CO_2 emissions to ensure consistency among the sectors. Otherwise, you should ask the Party to explain the differences between the reporting in the GHG inventory (”NO”) and the international data sets.
If drainage of organic soils does indeed occur in the country, then the Party must report associated emissions (CO_2 and N_2O, and also CH_4 if the Party is applying methodologies contained in the Wetlands Supplement), by either collecting relevant country-specific data as a first choice or using data from alternative sources (e.g. international data sets) and/or IPCC documents. You would include a corresponding recommendation in the TERR.

Question 3

Firstly, you must request from the Party information on how it defines savannah and how it is able to distinguish savannah areas from grassland areas. You must ensure that the Party is capable of tracking these land areas separately and that the definitions are consistently applied through space and time. You must also ask the Party whether fires affect savannahs in the country (it is very likely since fires often occur in the country). If you identify that the monitoring system of the Party is not capable of tracking savannahs and grassland areas separately then you would encourage the Party to improve its data collection (monitoring) system in order to appropriately identify the areas defined as savannah separately from grassland and report N_2O and CH_4 from biomass burning as appropriate in CRT 3.E or CRT 4(IV), avoiding double counting of emissions. Until the Party collects AD separately for savannah areas, you would recommend that the Party report all N_2O and CH_4 from biomass burning in grassland,

including from grassland defined as savannah, in CRT 4(IV), use the "IE" notation in CRT 3.E and provide detailed information in the documentation box in both CRT 4(IV) and CRT 3.E, and in the NID.

Recall footnote (2) in CRT 3.E on the allocation of emissions from burning of savannahs.

Question 4

As a reviewer, you should firstly clarify with the Party its reasons for not using approach 3 for the land representation for estimating CSC in mineral soils. You should also point out to the Party that if different approaches for land representation (for estimating SOC changes in this case) are used in the country, different results of annual CSC in the time series may occur, and that although under certain circumstances, the total net SOC change across the entire time series may be equal as estimated by the different approaches, this is not always the case.
You should therefore encourage the Party to use approach 3 because it results in more accurate estimates of annual CSC.
Click here (https://unfccc.int/resource/tet/bl/bl6-01_u_l6_att1.pdf) to see an example of how to calculate the annual net SOC change using the formulations of equation 2.25, chapter 2, volume 4 of the 2006 IPCC Guidelines for approach 1 land representation (formulation A of equation 2.25) and for approach 2 and 3 land representation (formulation B, equation 2.25).

5. Self-check quiz

Question 1

The reporting requirements regarding non-CO_2 emissions in the CRT in relation to cropland remaining cropland and grassland remaining grassland are the same.

Select one:

A. True
B. False

Question 2

The 2006 IPCC Guidelines default values for carbon stocks present in land converted to grassland and land converted to cropland are the same.

Select one:

A. True
B. False

Question 3

In accordance with the 2006 IPCC Guidelines, the default assumption for CSC in biomass in grassland remaining grassland is that there is no change in the C stocks it contains.

Select one:

A. True
B. False

Question 4

The tier 1 assumption for land converted to grassland is that the C stocks in living biomass are zero immediately after the conversion. This means that:

Select one:

A. Land is assumed to be cleared of all vegetation, and that all C in the cleared biomass is assumed to be oxidized the same year
B. Land is assumed to be cleared of all vegetation, but the release of the C in the cleared biomass is estimated based on the default values of biomass burning and decay on-site and off-site

Question 5

Which of the following emissions from management of grassland are reported under agriculture?

Select one:

A. N_2O from fertilization
B. N_2O from drainage of organic soils in managed grassland
C. CH_4 and N_2O from savannah burning
D. CO_2 emissions from liming
E. CO_2 emissions from urea application
F. All of the above

Question 6

The Wetlands Supplement provides methods and revised default parameters and EFs for the following for grassland:

Select one or more:

A. Revised SOC_{REF} in inland wetlands mineral soils
B. CH_4 emissions from rewetted inland wetland mineral soils and created wetlands on managed lands with mineral soils
C. CO_2, CH_4 and N_2O emissions from drained organic soils
D. CO_2 and CH_4 emissions from rewetted organic soils
E. CO_2, CH_4 and N_2O emissions from burning of organic soils

Question 7

Non-CO_2 emissions from prescribed savannah burning are reported in CRT 4(IV) even when the monitoring system is capable to identify separately fires in savannah.

Select one:

A. True
B. False

Question 8

Non-CO_2 emissions from controlled burning of grassland outside the tropics are reported in CRT 4(IV).

Select one:

A. True
B. False

Question 9

Above-ground biomass is typically the most significant pool in grassland.

Select one:

A. True
B. False

Question 10

Agricultural non-CO_2 emissions are reported in the LULUCF sector (under cropland or grassland) and in the agriculture sector as follows when using the 2006 IPCC Guidelines:

Select one:

A. Agricultural non-CO_2 emissions are reported in the agriculture sector, with the exception of N_2O emissions from N mineralization/immobilization associated with loss/gain of SOM in grassland remaining grassland for other than agricultural purposes, in land converted to cropland and grassland
B. Non-CO_2 emissions from enteric fermentation and manure management are reported in the agriculture sector and non-CO_2 emissions from fertilization and other management of agricultural soils are reported in the LULUCF sector
C. Agricultural CO_2 emissions are reported in the LULUCF sector
D. Agricultural non-CO_2 emissions are reported in the LULUCF sector if associated with land-use or land-management change, otherwise they are reported in the agriculture sector

5.1. Answer key to self-check quiz

Question 1

The correct answer is (B).
The reporting requirements for non-CO_2 emissions from cropland remaining cropland and grassland remaining grassland, although largely similar, are not entirely the same. N_2O emissions from N mineralization/immobilization associated with loss/gain of SOM (direct and indirect) are reported differently. For cropland remaining cropland, these emissions are reported under the agriculture sector (CRT 3.D), while for grassland remaining grassland, emissions are normally reported under the LULUCF sector (CRT 4(III)), unless for grassland used for agricultural purposes, in which case they are reported under the agriculture sector (CRT 3.D). In addition, for cropland remaining cropland, non-CO_2 emissions from in situ above-ground woody biomass burning is reported in the LULUCF sector (CRT 4(IV)), while agricultural residue burning is reported in the agriculture sector (CRT 3.F). For grassland remaining grassland, non-CO_2 emissions associated with burning of grassland defined as savannah are to be reported under the agriculture sector (CRT 3.E) if data allow to be identified separately, while those associated with burning of other types of grassland are reported in the LULUCF sector (CRT 4(IV)).

Question 2

The correct answer is (B).
Different default values for biomass C stocks, as well as different factors to be applied for calculating SOC stocks, are provided for the cropland and grassland categories in volume 4 of the 2006 IPCC Guidelines (chaps. 5 and 6 respectively).

Question 3

The correct answer is (A).
In accordance with the 2006 IPCC Guidelines, the tier 1 assumes no change in biomass C stocks in grassland remaining grassland.

Question 4

The correct answer is (A).
Following tier 1 of the 2006 IPCC Guidelines, land is assumed to be cleared of all vegetation, and all C in the cleared biomass is assumed to be oxidized in the same year that the land is converted to grassland.

Question 5

The correct answer is (F).
All emissions from the sources listed above are reported in the agriculture sector.

Question 6

The correct answer is (A), (B), (C) and (D).
No default EFs are provided at the tier 1 level for N_2O emissions for burning of organic soils.

Question 7

The correct answer is (B).
Non-CO_2 emissions from prescribed burning of savannahs are reported in the agriculture sector in CRT 3.E if data allow to be identified separately.

Question 8

The correct answer is (A).
All non-CO_2 emissions from controlled burning of grassland are reported under the LULUCF sector in CRT 4(IV). Controlled burning of grassland should not be confused with prescribed burning of savannahs, for which the non-CO_2 emissions are reported under the agriculture sector (CRT 3.E) if data allow to be identified separately. Note that controlled burning of grassland is not common in developed country Parties.

Question 9

The correct answer is (B).
Below-ground C contained in below-ground biomass and SOM are typically the most significant C pools in grassland. Note, however, that grassland burning can result in significant GHG emissions from above-ground biomass as well (e.g. woody grassland).

Question 10

The correct answer is (A).
Agricultural non-CO_2 emissions are reported in the agriculture sector; however, N_2O emissions from N mineralization/immobilization associated with loss/gain of SOM in grassland remaining grassland for other than agricultural purposes in land converted to cropland and in land converted to grassland are reported in the LULUCF.

6. Key points to remember

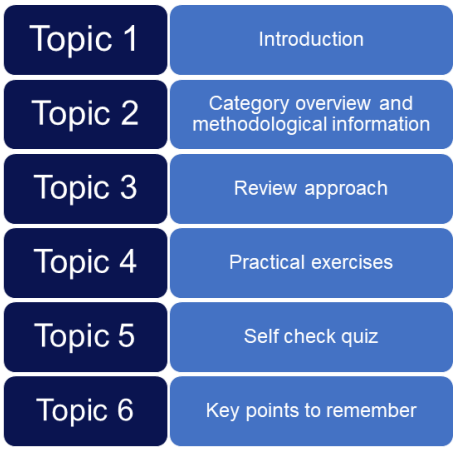
- In order to successfully review the grassland category, you must have adequate knowledge of the general LULUCF review considerations covered in lesson 2 and of how to review the land representation and information related to C pools covered in lesson 3.
- Grassland is the third land-use category in the hierarchy provided in the 2006 IPCC Guidelines.
- Grassland may be subdivided into managed and unmanaged land.
- For some Parties, grassland categories may be identified as key and as such may require much attention during the review. Usually, below-ground C contained in below-ground biomass and SOM are the most significant C pools in the grassland categories.
- Significant C pools (significance analysis) must be identified and CSC from these pools should be reported using the suggested methodologies in accordance with the decision trees provided in the 2006 IPCC Guidelines.
- The default subcategorization of grassland provided in the 2006 IPCC Guidelines is based on climate zones, soil type, management practices and vegetation type.
- All gains and losses from grassland must be taken into account for each C pool reported (e.g. for biomass, gains from growth, and losses due to harvesting, natural mortality, disturbances, fires, pests) unless the C pools are assumed to be in equilibrium.
- In grassland remaining grassland, CSC in SOM must be reported under tier 1, while the biomass and DOM pools are assumed to be at equilibrium under tier 1.
- Where there is evidence that changes in the management systems affect the C stocks of biomass the assumption of no change in C stocks in biomass in grassland remaining grassland is not valid.
- Parties may use models (tier 3) in order to report CSC and associated emissions/removals from grassland, and therefore particular attention is required in reviewing the TACCC of the models, particularly during an in-country review.

Lesson 7: Wetlands

1. Introduction

1.1. Lesson structure

Lesson 7 provides guidance for the review of information for the wetlands category within the LULUCF GHG inventory (see figure 7-1). Wetlands is one of the six land-use categories given in the 2006 IPCC Guidelines, and the fifth in the hierarchy provided in the same guidelines.



Z. Figure 7-1. Structure of lesson 7

The 2006 IPCC Guidelines provide guidance on how to estimate and report CSC and associated GHG emissions/removals from wetlands in chapter 7, volume 4. Furthermore, the Wetlands Supplement provides additional and updated methodologies, EFs and AD.

Remember that the 2006 IPCC Guidelines consider it good practice for countries to use higher-tier methods for key categories and significant C pools. While all Parties should be able to prepare an inventory using the tier 1 methodology, Parties usually use higher-tier methods for some pools (e.g. biomass). Thus, most inventories are likely to include estimates prepared using a mix of tiers. Although not very common across Parties, wetlands categories may be identified as key and/or may be of particular interest owing to their contribution in the GHG balance, such as emissions/removals from the management of peatlands.

This lesson provides background information on the estimation and reporting of CSC and associated GHG emissions and removals from wetlands. It also presents category-specific guidance for reviewing the estimates of GHG emissions/removals and related information submitted by Parties for the wetlands category. Similarly to the previous lessons, this lesson ends with practical exercises and a self-check quiz to help you to enhance and refresh your knowledge.
It is suggested that you have the CRT readily available when you study this lesson, because it contains several references to them (highlighted in red text).

Finally, note that the review of the wetlands category in a Party's LULUCF GHG inventory is related to the review considerations you have learned in the previous lessons. Therefore, you must always apply the knowledge of how to review cross-cutting and cross-sectoral issues, the land representation, C pools and other aspects acquired in lessons 2 and 3.

1.2. Learning objectives

At the end of this lesson you should:

- Know the requirements for reporting emissions/removals from wetlands by Parties in the CRT and the NID;
- Be able to understand how CSC methods, AD, EFs and methods for collecting these apply to the wetlands category;
- Be able understand the key areas for reviewing the GHG inventory information on the wetlands category.

The expected time needed to complete lesson 7 depends on the level of your knowledge on LULUCF GHG inventories under the MPGs and the 2006 IPCC Guidelines:
For readers with experience: 50–70 minutes
For readers with less experience: 70–90 minutes

2. Category overview and methodological information

2.1. Reporting overview

According to the 2006 IPCC Guidelines, wetlands include areas of peat extraction and land that is covered or saturated by water for all or part of the year (e.g. peatlands) and that do not fall into the forest land, cropland, grassland or settlements categories. It includes reservoirs as a managed subdivision and natural rivers and lakes as unmanaged subdivisions.
Methodological guidance for wetlands is provided in chapter 7, volume 4 of 2006 IPCC Guidelines.
The annual GHG emissions/removals from wetlands are reported separated into two main subcategories:

AA. Figure 7-2. Wetlands

1. Wetlands remaining wetlands, which includes peatlands remaining peatlands (2006 IPCC Guidelines, vol. 4, chap. 7, section 7.2.1) and flooded land remaining flooded land (2006 IPCC Guidelines, vol. 4, chap. 7, section 7.3.1);
2. Land converted to wetlands, which includes land being converted for peat extraction (2006 IPCC Guidelines, vol. 4, chap. 7, section 7.2.2) and land converted to flooded land (2006 IPCC Guidelines, vol. 4, chap. 7, section 7.3.2).

GHG emissions/removals from wetlands converted to other land-use categories are reported under the final land-use category.
For reporting GHG emissions/removals, wetlands subcategories should be used according to the national circumstances and data used for preparing the inventory. While the 2006 IPCC Guidelines

provide methodological guidance on the default wetlands reporting subcategories (peatlands and flooded lands), the Wetlands Supplement provides methodological guidance on wetlands according to ecosystems and management (i.e. inland wetlands mineral soils, drained inland organic soils, rewetted organic soils and coastal wetlands) and does not provide additional default reporting wetlands subcategories. Countries can report these lands under the different land-use categories according to their national definitions.

Remember that the use of the Wetlands Supplement for the compilation of national GHG inventories under the ETF is encouraged by the MPGs (para. 20). Consequently, is not mandatory for Parties to use the methods, EFs, parameters contained in the Wetlands Supplement.
However, if a Party applies the Wetlands Supplement, then the Wetlands Supplement establishes the good practice to be followed by the Party in reporting its GHG inventory.

Increases and decreases in C stocks in living biomass should be reported separately, except in cases where, due to the methodology used, it may be technically impossible to separate the information between increases and decreases, such as when using the stock-difference method. In such a case, the net gain or loss of C must be reported in the relevant column of the CRT and "IE" reported for the other column, together with the necessary explanatory information in the documentation box and the NID.

2.2. Pools and gases to be reported in wetlands

Parties must report estimates of CSC in biomass (above-ground and below-ground biomass), DOM (deadwood and litter) and SOM in wetlands in CRT 4.D. Estimates of CSC in the HWP pool are to be reported in CRT 4.Gs1 and CRT 4.Gs2.
Direct and indirect N_2O emissions from N inputs (fertilization) to wetlands are reported in CRT 4(I). Parties that cannot separate fertilizer application in different land categories can report total emissions under agriculture in CRT 3.D.
N_2O and CH_4 emissions/removals from drainage and rewetting of organic soils and from rewetting of mineral soils in wetlands are reported in CRT 4(II). CO_2 emissions/removals may also be reported in CRT 4(II), while avoiding double counting with information reported in CRT 4.D.
Direct and indirect N_2O emissions from N mineralization/immobilization associated with loss/gain of SOM in wetlands are reported in CRT 4(III).
N_2O and CH_4 emissions from biomass burning in wetlands are reported in CRT 4(IV). Parties may also report CO_2 emissions in this table while avoiding double counting with the information reported in CRT 4.D.

Note that biomass burning also includes any burning of DOM and, if methods provided in the Wetlands Supplement are used, SOM in organic soils.

2.3. Science background in wetlands

Similar to other ecosystems, in wetlands, a net C flux to or from the atmosphere is a result of the balance between net C uptake from the atmosphere by photosynthesis/respiration and its release as a result of decomposition of organic matter. Rates of C uptake and losses are influenced by climate, nutrient availability, water saturation or oxygen availability. In aerobic conditions (abundant oxygen), which are prevalent in most upland ecosystems, decomposition of organic matter releases CO_2. CH_4 emissions are high in anaerobic conditions, which are prevalent in wetlands (water saturation in wetlands leads to low oxygen levels in soils).

***Decomposition**: Process of decomposition of organic matter, which results in GHG emissions. Decomposition may occur under oxic (oxidation, with release of CO_2 and N_2O) or anoxic (reduction, with release of CH_4 and N_2O) conditions, or both.*

Thus, the level of the water table has a direct impact on the GHG emissions and removals from wetlands. In summary, wetlands drainage results in an increase in CO_2 and N_2O emissions due to increased oxidation of SOM and a reduction in CH_4 emissions in wetlands. Conversely, raising the water table and creating wetlands through flooding alters the pattern of GHG emissions towards greater CH_4 emissions and less CO_2 and N_2O emissions. Depending on climate and reservoir characteristics, both CO_2 and CH_4 can be emitted from the decomposition of submerged biomass, DOM, SOM and other dissolved organic matter particles.

2.4. Methods and pools

The methodological tier to be applied for estimating CSC and other GHG emissions/removals depends on the significance of the reporting category and of the C pool, as well as the national circumstances. For this, the respective decision trees contained in the 2006 IPCC Guidelines are to be followed by the Parties.

To learn more on the methodological tiers, consult volume 4 of the 2006 IPCC Guidelines (chap. 1, figures 1.2 and 1.3; chap. 2, figures 2.2, 2.3, 2.4, 2.5 and 2.6; and chap. 12, figure 12.1).

You have already learned in the previous lessons that Parties must provide GHG emissions/removals estimates for categories, pools and gases for which the 2006 IPCC Guidelines provide methodologies and EFs. Click on figure 7-3 to see the pools and gases for which emissions/removals estimates must be reported when tier 1 or tier 2 methods are applied.
Figure 7-4 summarizes the tier 1 and 2 methods to be applied, along with references to relevant equations in the 2006 IPCC Guidelines and in the Wetlands Supplement for peatlands and flooded land. Click on figure 7-5 to see the coverage of C pools and GHG emissions and removals from activities in wetlands in the Wetlands Supplement under tier 1 and tier 2.

Tier 1			Land use													
			FL		CL		GL		WL			SL		OL	
Carbon pool – GHG			FL-FL	L-FL	CL-CL	L-CL	GL-GL	L-GL	WL-WL	L-WL		SL-SL	L-SL	OL-OL	L-OL
									PL-PL	L-PE	L-FIL				
Living biomass		Above-ground	M	M	M [a]	M [b, c]		M [b, c]		M [c]	M [c]		M [c]		M [c]
		Below-ground		M		M [b, c]		M [b, c]		M [c]	M [c]		M [c]		M [c]
Dead organic matter		Dead wood		M [c]		M [c]		M [c]					M [c]		M [c]
		Litter		M		M [c]		M [c]					M [c]		M [c]
Soil organic matter		Mineral		M	M	M	M	M					M		M [d]
		Organic	M	M	M	M	M	M		M [f]			M		
HWP			M (may be assumed 0 if no carbon stock change is judged insignificant)												
N_2O	Direct	Fertilization [e]	M	M					M	M	M	M	M		
		N mineralization		M		M	M [g]	M					M		M
		Drainage	M	M						M		M	M		
		Burning	M	M	M	M	M	M	M	M		M	M		M
	Indirect	Fertilization [e]	M	M					M	M	M	M	M		
		N mineralization		M		M	M [g]	M					M		M
CH_4		Burning	M	M	M	M	M	M	M	M		M	M		M

Tier 2			Land use												
			FL		CL		GL		WL			SL		OL	
Carbon pool – GHG			FL-FL	L-FL	CL-CL	L-CL	GL-GL	L-GL	WL-WL	L-WL		SL-SL	L-SL	OL-OL	L-OL
									PL-PL	L-PE	L-FIL				
Living biomass		Above-ground	M	M	M [a]	M [b]	M	M [b]		M	M	M	M		M
		Below-ground	M	M	M [a]	M [b]	M	M [b]		M	M	M	M		M
Dead organic matter		Dead wood	M	M	M	M	M	M		M		M	M		M
		Litter	M	M	M	M	M	M		M		M	M		M
Soil organic matter		Mineral	M	M	M	M	M	M				M	M		M
		Organic	M	M	M	M	M	M	M	M		M	M		
HWP			M												
N_2O	Direct	Fertilization [e]	M	M					M	M	M	M	M		
		N mineralization	M	M		M	M [g]	M				M	M		M
		Drainage	M	M					M	M		M	M		
		Burning	M	M	M	M	M	M	M	M		M	M		M
	Indirect	Fertilization [e]	M	M					M	M	M	M	M		
		N mineralization	M	M		M	M [g]	M				M	M		M
CH_4		Burning	M	M	M	M	M	M	M	M		M	M		M

Notes: grey shading = not applicable, blank = not mandatory.

Abbreviations: M = mandatory, GHG = greenhouse gas, FL = forest land, CL = cropland, GL = grassland, WL = wetlands, SL = settlements, OL = other land, PL = peatland, PE = peat extraction, FIL = flooded land, HWP = harvested wood products
FL–FL, CL-CL, GL-GL, WL-WL, PL-PL, SL-SL, OL-OL = indicate land category remaining under the current land use
L–FL, L-CL, L-GL, L-WL, L-PE, L-FIL, L-SL, L-OL = indicate land category converted to the current land use

[a] To be reported only for perennial crops.

[b] Net carbon stock gain in biomass pool for annual crops is to be reported only once in the year after conversion.

[c] Only applicable if the Party has reported carbon stock changes or the IPCC provides default carbon stock values for the biomass or DOM carbon stock for the previous land use. In such a case carbon stock is to be reported as instantaneously oxidized in the year of conversion.

[d] Carbon stock level after conversion is to be set at 0.

[e] N_2O emissions from N fertilization in forest land and settlements are to be reported under the LULUCF sector and those in cropland and managed grassland are to be reported in the agriculture sector. If the Party is not able to separate emissions from N fertilization in different land-use categories, all emissions are to be reported under the agriculture sector.

[f] Under tier 1 the activity data do not distinguish between peatlands under peat extraction and those being converted for peat extraction.

[g] N_2O emissions from grassland remaining grassland for agriculture purpose are reported under the agriculture sector.

BB. Figure 7-3. Carbon pools and gases to be reported in the wetlands category under tier 1 and 2

Carbon stock changes in pools and associated GHG emissions/removals that must be estimated for wetlands

Peatlands

Carbon stock changes in pools and associated GHG emissions/removals that must be estimated at Tier 1

0 indicates that the tier 1 methodology assumes no net carbon stock change
The IPCC equations to be applied are provided in parentheses *(those from the Wetlands Supplement are given in italics)*
Note that where activity data on land-use categories do not allow for the separation of WL-WL and L-WL, for the IPCC default, the latter category does not apply
Note that in land under conversion from categories for which the IPCC does not provide default values for the biomass or DOM pools, reporting of carbon stock changes is nevertheless mandatory (to ensure accuracy) in case the Party has reported C stock changes in the pool under the previous land use

	Biomass (B)		Dead organic matter (DOM)		Soil organic matter (SOM)	Non-CO_2 emissions
	Above (AB)	Below (BB)	Dead wood (DW)	Litter (L)		
WL-WL	0		0[2]		**CO_2 emissions from managed peatlands (7.3)** **On-site CO_2 emissions from managed peatlands (7.4)** **Off-site CO_2 emissions from managed peatlands (7.5)[3]** *CO_2 emissions from drained organic soils (2.2)* *On-site CO_2 emissions from drained inland organic soils (2.3)* *Off-site CO_2 emissions from drained inland organic soils (2.4, 2.5, 2.A.1)[4]* *CO_2 emissions from burning of drained inland organic soils (2.8)* *CO_2 emissions from rewetted organic soils (3.3)* *On-site CO_2 emissions from rewetted organic soils (3.4)* *Off-site CO_2 emissions from rewetted organic soils (3.5, 3.6)* *CO_2 emissions from burning of rewetted organic soils (2.8)* *CO_2 emissions/removals from rewetting of coastal wetlands (4.7)* *CO_2 emissions/removals from drainage of coastal wetlands (4.8)*	**N_2O emissions from peatlands (7.7)** **Non-CO_2 emissions from fires (2.27)** *CH_4 emissions from drained inland organic soils (2.6)* *N_2O emissions from drained inland organic soils (2.7)* *CH_4 emissions from burning of drained inland organic soils (2.8)[5]* *CH_4 emissions from rewetted organic soils (3.8)* *N_2O emissions from rewetted organic soils (3.9)* *CH_4 emissions from burning of rewetted organic soils (2.8)[5]* *CH_4 emissions from rewetted soils and created tidal marshes and mangroves (4.9)*
L-WL	**C stock losses from biomass clearing only (2.16)[1]**					

Carbon stock changes in pools and associated GHG emissions/removals that must be estimated at Tier 2

WL-WL	0	0	**CO_2 emissions from managed peatlands (7.3)** **On-site CO_2 emissions from managed peatlands (7.6)** **Off-site CO_2 emissions from managed peatlands (7.5)[3]** *As Tier 1*	**As Tier 1** *As tier 1, plus N_2O emissions from burning of SOM in organic soils (2.8)*
L-WL	**CO_2 emission from peatland being drained for peat extraction (7.8)** **C stock losses from biomass clearing (2.16; ΔBconversion)**	**CO_2 emission from peatland being drained for peat extraction (7.8)** **C stock losses from DOM (2.23; ΔBconversion)**	**CO_2 emissions from peatland being drained for peat extraction (7.8)** **On-site CO_2 emissions from managed peatlands (7.9)** **Off-site CO_2 emissions from managed peatlands (7.5)[3]** *As Tier 1*	**As Tier 1** *As tier 1, plus N_2O emissions from burning of SOM in organic soils (2.8)*

(1) Note that Tier methodology considers only emissions from biomass clearing. C stock changes in biomass in managed peatlands are assumed to be zero.
(2) Note that Tier 1 does not consider C stock changes in DOM pool.
(3) All carbon in horticultural peat is assumed to be emitted during the extraction year. All CO_2 emissions from peat used for energy are reported in the Energy sector.
(4) Does not include carbon losses associated with horticultural use of peat.
(5) Note that Tier 1 does not estimate N_2O emissions from peatlands burning.

Carbon stock changes in pools and associated GHG emissions/removals that must be estimated for wetlands

Flooded lands							
Carbon stock changes in pools and associated GHG emissions/removals that must be estimated at Tier 1 0 indicates that the tier 1 methodology assumes no net carbon stock change The IPCC equations to be applied are provided in parentheses (*those from the Wetlands Supplement are given in italics*) Note that where activity data on land-use categories do not allow for the separation of WL-WL and L-WL, for the IPCC default, the latter category does not apply Note that in land under conversion from categories for which the IPCC does not provide default values for the biomass or DOM pools, reporting of carbon stock changes is nevertheless mandatory (to ensure accuracy) in case the Party has reported C stock changes in the pool under the previous land use							
	Biomass (B)		Dead organic matter (DOM)		Soil organic matter (SOM)		Non-CO_2 emissions
	Above (AB)	Below (BB)	Dead wood (DW)	Litter (L)	Mineral soils (MS)	Organic soils (OS)	
WL-WL	2006 IPCC Guidelines do not provide guidance on C stock changes in flooded land remaining flooded land						2006 IPCC Guidelines do not provide guidance on CH_4 emissions in flooded land remaining flooded land(1)
L-WL	Carbon stock change (7.10)		2006 IPCC Guidelines do not provide guidance on C stock changes in DOM and SOM pools in land converted to flooded land				N_2O emissions from flooded land are considered negligible and included in the estimates of indirect N_2O emissions from agricultural or other run-off and wastewater
Carbon stock changes in pools and associated GHG emissions/removals that must be estimated at Tier 2							
WL-WL	2006 IPCC Guidelines do not provide guidance on C stock changes in flooded land remaining flooded land						As Tier 1
L-WL	As Tier 1		As Tier 1				As Tier 1

(1) Methodology provided in the 2006 IPCC Guidelines, volume 4, appendix 3.

CC. Figure 7-4. Coverage of carbon pools and greenhouse gas emissions/removals in peatlands and flooded land categories in the 2006 IPCC Guidelines and the Wetlands Supplement (tier 1 and 2)

Tier 1			Any land use and/or land-use change category							
			Drained inland organic soils		Rewetted organic soils		Coastal wetlands		Inland wetlands mineral soils	
Carbon pool – GHG			On site	Off site	On site	Off site	On site	Off site	On site	Off site
LB	CO_2	Forest management [2]					Y			
		Drainage [3]					Y			
		Extraction [4]					Y			
		Rewetting/restoration [5]								
DOM	CO_2	Forest management [2]					Y			
		Drainage [3]					Y			
		Extraction [4]					Y			
		Rewetting/restoration [5]								
SOM [1]	CO_2	Drainage [3]	Y	Y			Y		Y	
		Extraction [4]					Y			
		Rewetting/restoration [5]			Y	Y	Y		Y	
		Burning	Y		Y		Y			
	N_2O (direct)	Drainage [3]	Y							
		Extraction [4]					Y			
		Rewetting/restoration [5]								
		Aquaculture use					Y			
		Burning								
	CH_4	Drainage [3]	Y							
		Extraction [4]								
		Rewetting/restoration [5]			Y		Y		Y	
		Burning	Y		Y		Y			

Y = Default method and factors provided
Grey shading = Not applicable
Blank = Not mandatory
1 It may include dead organic matter as well as living biomass of non-tree wooden vegetation.
2 Forest management practices in mangroves.
3 Conversion from saturated to drained soils by establishing a net of ditches and removing original vegetation.
4 Excavation to enable port, harbour and marina construction, including aquaculture and salt production.
5 Conversion from drained to saturated soils by restoring hydrology and reestablishment of vegetation.

Tier 2			Any land use and/or land-use change category							
			Drained inland organic soils		Rewetted organic soils		Coastal wetlands		Inland wetlands mineral soils	
Carbon pool – GHG			On site	Off site	On site	Off site	On site	Off site	On site	Off site
LB	CO_2	Forest management [2]					Y			
		Drainage [3]					Y			
		Extraction [4]					Y			
		Rewetting/restoration [5]								
DOM	CO_2	Forest management [2]					Y			
		Drainage [3]					Y			
		Extraction [4]					Y			
		Rewetting/restoration [5]								
SOM [1]	CO_2	Drainage [3]	Y	Y			Y		Y	
		Extraction [4]					Y			
		Rewetting/restoration [5]			Y	Y	Y		Y	
		Burning	Y		Y		Y			
	N_2O (direct)	Drainage [3]	Y							
		Extraction [4]					Y			
		Rewetting/restoration [5]			Y					
		Aquaculture use					Y			
		Burning	Y		Y		Y			
	CH_4	Drainage [3]	Y						Y	
		Extraction [4]								
		Rewetting/restoration [5]			Y		Y		Y	
		Burning	Y		Y		Y			

Y = Default method provided
Grey shading = Not applicable
Blank = Not mandatory
1 It may include dead organic matter as well as living biomass of non-tree wooden vegetation.
2 Forest management practices in mangroves.
3 Conversion from saturated to drained soils by establishing a net of ditches and removing original vegetation.
4 Excavation to enable port, harbour and marina construction, including aquaculture and salt production.
5 Conversion from drained to saturated soils by restoring hydrology and reestablishment of vegetation.

DD. Figure 7-5. Coverage of carbon pools and greenhouse gas emissions/removals from activities in wetlands in the Wetlands Supplement (tier 1 and tier 2)

2.5. Reporting GHG emissions/removals from wetlands

In the 2006 IPCC Guidelines, managed wetlands are restricted to wetlands where the water table is artificially changed (e.g. drained or raised) or those created through human activity (e.g. damming a river). The 2006 IPCC Guidelines provide guidance on two subcategories of wetlands:

- Peatlands: include peatlands cleared and drained for production of peat for energy, horticultural and other uses;
- Flooded lands: include flooded lands as reservoirs or impoundments, for energy production, irrigation, navigation or recreation.

Unmanaged wetlands that are brought under management for peat cultivation should enter the inventory and be included in the category peat extraction.

Note that rice fields are not included in flooded lands because they are classified as cropland, and associated non-CO_2 emissions are reported under the agriculture sector.

Note that associated off-site emissions from the use of peat for energy should be reported under the energy sector (peat combustion) rather than the LULUCF sector. The emissions from non-energy use of peat (horticultural) are included in the emissions from peat extraction (off-site emissions) and reported under the LULUCF sector.

2.6. Methods and pools: peat extraction

Peat accumulates in wetlands when the annual generation of DOM exceeds the amount of decay. The pattern of peat deposit development varies with climate and hydrology, and the succession of peatland types on any area may be complex. Most peat deposits have been accumulating for several thousands of years and many have been accumulating since the last ice-age glacial retreat more than 8,000 years ago.
The production cycle on a peatland area has three phases. A description of the phases is available here (https://unfccc.int/resource/tet/bl/bl7-01_u_l7_att1.pdf).

Figure 7-6. Peat extraction

2.7. Methods and pools: flooded land

Flooded lands may emit CO_2, CH_4 and N_2O in significant quantities, depending on a variety of characteristics, such as age, land use prior to flooding, climate and management practices. Emissions vary spatially and over time, and no default factors are provided in the 2006 IPCC Guidelines. The 2006 IPCC Guidelines do not provide methodologies for flooded land remaining flooded land, providing the default methodology only for estimating CO_2 emissions from loss of biomass due to flooding for land converted to flooded land.
At the tier 1 level, only CO_2 emissions from loss of biomass in the land before conversion to flooded land are estimated by applying equation 7.10, chapter 7, volume 4 of the 2006 IPCC Guidelines, which

assumes complete and instantaneous oxidation of all biomass before conversion in the year of conversion (i.e. flooding).
N_2O emissions from flooded lands are included in the estimates of indirect N_2O emissions from agricultural or other run-off, and wastewater, which are covered elsewhere in the 2006 IPCC Guidelines (vol. 5, chaps. 6 and 11). The 2006 IPCC Guidelines also provide a methodology for estimating CH_4 emissions from flooded land as an area of future methodological development (vol. 4, appendix 3). However, because the methodology for this category is provided in an appendix to the guidelines, it is not mandatory to report these emissions in the GHG inventory.

2.8. Methods and pools: Wetlands Supplement

The Wetlands Supplement provides additional methods and updated and more disaggregated emission/removal factors covering lands with wet and drained soils in all land-use categories, except other land. It provides new guidance for GHG emissions and removals from flooded lands.
Table 1.1, chapter 1 of the Wetlands Supplement provides a summary of the different soil types in different land-use categories along with the relevant chapters, which provide methods for estimating GHG emissions/removals.
In particular, the guidance provided in the Wetlands Supplement covers the following categories:

- New and updated methodological guidance and default EFs for drained inland organic soils (chap. 2), including:
    - New methodological guidance and default EFs for off-site CO_2 emissions via loss of C: dissolved organic C (section 2.2.1.2, table 2.2);
    - New methodological guidance and default EFs for CH_4 emissions, including from drainage ditches (section 2.2.2.1, tables 2.3 and 2.4);
    - Updated and more disaggregated EFs for on-site CO_2 and N_2O emissions (e.g. including the impact of drainage depth (water table level)) (sections 2.2.1.1 and 2.2.2.2, tables 2.1 and 2.5);
    - Updated methodological guidance and new default EFs for CO_2 and CH_4 emissions from fires on organic soils (section 2.2.2.3, table 2.7);
- New methodological guidance and default EFs for rewetted organic soils (chapter 3):
    - Methodological guidance and default EFs for on-site and off-site CO_2 emissions/removals from rewetted organic soils (section 3.2.1, tables 3.1 and 3.2);
    - Methodological guidance and default EFs for CH_4 emissions/removals from rewetted organic soils (section 3.2.2, table 3.3);
    - Methodological guidance on estimating N_2O emissions from rewetted organic soils (section 3.2.3); no default EFs are provided because N_2O emissions are assumed to be negligible;
- New methodological guidance and default EFs for CSC and associated CO_2, CH_4 and N_2O emissions and removals from specific activities on managed coastal wetlands (aquaculture, salt production, extraction, drainage, rewetting, revegetation, and creation and management of mangrove forests) (chap. 4);
- New and updated methodological guidance and default EFs for managed inland wetland mineral soils:

- New methodological guidance and default EFs for CH_4 emissions, including from drained inland wetland mineral soils subject to rewetting and created wetlands on managed lands (section 5.2.2 and table 5.4);
- Updated default reference values for SOC stocks for wetland mineral soils and new default stock change factors for long-term cultivation of croplands and rewetted cropland on inland wetland mineral soils.

Areas of peat extraction can be obtained from national statistics, peat mining industries or agencies/ministries responsible for land use or can be estimated from the peat production data as a proxy.

Areas of flooded land can be obtained from national agencies/ministries responsible for land use or for water resources, or from hydroelectric companies.

Additional information needed includes data on climate zones in the country and peatland type (nutrient rich or nutrient poor) and information on specific management practices and other activities that may be relevant for country-specific methodologies. Such information may include data on coastal wetlands, for example, areas of managed mangrove forests, areas where extraction activities occur by vegetation type (e.g. mangroves), climate and soil type (i.e. organic, mineral), areas that are rewetted or on which coastal wetlands are created or areas that are drained; and data on inland wetland mineral soils, for example rewetted cropland found on inland wetland mineral soils stratified by management, climate and time since rewetting. In general, these data could be provided as specific areas or as percentages/fractions of the total area.

Descriptions on subcategories used in preparing the estimates as well as uncertainties of the land area estimates should be provided in the NID, noting the flexibility available to those developing country Parties that need it in the light of their capacities.

3. Review approach

General guiding review considerations

When reviewing wetlands estimates, you should always apply the guidance on general review issues for the LULUCF sector provided in lesson 2 and the guidance on the review of the land representation and carbon pools provided in lesson 3.

The following is a summary of general review considerations to refresh your memory:

- Assess whether categories, subcategories (e.g. forest land converted to flooded land) and subdivisions (e.g. nutrient-rich soil peatlands remaining nutrient-rich soil peatlands) for which estimates are prepared are appropriate and correspond to the national circumstances. The review should be implemented at the level of subdivisions reported;
- Assess whether emissions/removals are reported separately for wetlands remaining wetlands and land converted to wetlands, taking into account the tier level applied (e.g. under tier 1 land converted for peat extraction is not distinguished from peatlands remaining peatlands);
- Assess the consistency of the land representation;
- Assess whether non-reporting or incomplete reporting of the emissions and removals in C pools occurs. Assess which C pools are covered by the GHG inventory, bearing in mind that for some C pools under some categories, the 2006 IPCC Guidelines do not provide guidance for estimating CSC and therefore it is not mandatory to report them (e.g. CSC in DOM and SOM in land converted to flooded lands);
- Assess whether all GHG emissions/removals associated with CSC have been estimated and if the GHG fluxes are consistent with each other (e.g. CO_2 and N_2O emissions from peat extraction);
- Check whether the Party has reported uncertainties associated with the estimates for CSC, including information on uncertainties of the input data, noting the flexibility available to those developing country Parties that need it in the light of their capacities;
- Identify, in consultation with the Party concerned, potential areas of capacity-building needs, for those developing country Parties that need the flexibilities provided in the MPGs in the light of their capacities.

Review of methods, AD and parameters

Assess the appropriateness of the Party's choice of methodological tiers, AD, EFs and other parameters according to the significance of categories/subcategories and national circumstances and their proper documentation in the submission. Check also the transparency, accuracy, completeness and consistency of the estimates. The level of review should be based on the level of disaggregation in the subcategories reported and the methods used by a Party. Focus your review (time/resources) mainly on the key pools/subcategories that are likely to contribute the most to GHG emissions and removals from wetlands categories. The following points may help you structure your review work.

Check whether:

- The Party has reported information on the monitoring and identification of the wetlands area;
- The total wetlands area is monitored and reported, the wetlands types, their areas and other AD (e.g. peat production) match the information from other national and/or international documents or sources (e.g. national land-use/cover maps, IPCC good practice guidance for

LULUCF) and the national wetlands area is subdivided into managed and unmanaged land, if applicable;

- The wetlands areas are disaggregated into peatlands and flooded lands;
- Transition matrices for the years before the starting year of the inventory equal to the transition period applied are reported in the NID;
- Documentation on each methodology, including assumptions, AD, EFs and parameters, provided in the NID is transparent enough to allow the assessment of the accuracy, completeness, consistency and comparability of the estimates;
- The methodologies and definitions are used consistently over the complete time series;
- The methods and equations are correctly applied consistently with the 2006 IPCC Guidelines, and all CSC for each C pool for which methods and EFs are provided in the 2006 IPCC Guidelines (e.g. for biomass in land converted to flooded land and for biomass and SOM in managed peatlands) are reported;
- There is a trend within the reported parameter values and the trend is explained in the NID;
- AD are appropriately stratified, for example for managed peatlands by climate zone and nutrient soils status and for flooded land by the land-use category converted to flooded land;
- AD are derived ensuring that inconsistencies or double counting is avoided between wetlands subcategories;
- GHG emissions from managed peatlands have been estimated separately for on-site and off-site emissions;
- Emissions from the off-site use of peat for energy purposes have not been included in the LULUCF sector (these emissions are reported in the energy sector) but emissions from the non-energy use of peat (horticultural) are included in the LULUCF sector (as off-site emissions from peat extraction);
- The estimation is based on the 2006 IPCC default methodologies, and if so:
    - Is the choice of default parameters consistent with the information provided on climate zones and wetland types (e.g., for peat extraction from nutrient-rich or nutrient-poor organic soils) present in the country?
    - Is the category a key category? If so, is the choice of method appropriate according to the significance of the category/subcategory/pool and national circumstances (based on data and resources available)? Note that the SOM is likely to be significant for Parties with peatlands managed for peat extraction;
    - Does the Party estimate for biomass only emissions from biomass clearing and assume other CSC in biomass on managed peatlands to be zero?
    - Are emissions/removals from all mandatory C pools included in the GHG inventory? For example, under tier 1, in accordance with the 2006 IPCC Guidelines, estimating and reporting CSC from biomass clearing in managed peatlands is mandatory;
    - Does the Party include in the estimation of emissions/removals below-ground biomass and does it do this consistently across land-use categories? For example, if below-ground biomass is included when estimating CSC in forest land remaining forest land, it must be included when estimating CSC in forest land converted to flooded land;
    - Could country-specific values be developed based on national or regional data and research?

- The estimation is based on higher tiers (tier 2 or tier 3) together with country-specific parameters, and if so:
    - Is the choice of method appropriate to the significance of the category/subcategory and national circumstances?
    - Has the Party provided proper documentation in the NID on the methodologies applied and country-specific parameter values, such as assumptions, principles, equations, and other key parameters and sources?
    - In particular when a model is used, has the Party reported transparent information on the model structure, on whether and how the model has been peer reviewed, verified and/or validated?
    - Are the country-specific values within the range of values reported by Parties with similar conditions in the region and comparable with the 2006 IPCC Guidelines default?
    - If significant deviations between country-specific parameters and the 2006 IPCC Guidelines default values are identified, has a proper explanation been provided in the NID?
    - Does the Party report separate GHG estimates for peatlands being converted for peat extraction and peatlands remaining peatlands? Does the Party ensure that double counting of CO_2 emissions from biomass clearing from these two phases is avoided?
    - Does the Party separate GHG estimates from abandoned peatlands?
    - Is the biomass density (biomass per area unit) for perennial vegetation used for estimating CSC in the biomass pool (e.g. for land converted to flooded land) reasonable, and does it differ from the values used in other land-use categories (e.g. forest land) and/or from other countries in the region?
    - Does the Party report emissions from the DOM pool for peatlands being converted for peat extraction?
- AD are consistent with information from other reliable sources. For identifying potential omissions in the reporting of emissions in this category, you may consult table 3a.3.3 in the IPCC good practice guidance for LULUCF on estimates of peatlands areas in different countries and peat extraction (noting that default data are not available for all countries) for comparison purposes. Check whether the Party has applied and/or reported estimates from additional categories in the Wetlands Supplement (noting this is not required but encouraged), and if so:
    - Does the Party provide a definition of coastal land (if applicable) and information on how this definition is applied consistently across space and time and how coastal wetlands are distinguished from inland wetlands?
    - Does the Party provide a classification of coastal wetlands subcategories (if applicable) into the six main land-use categories of the 2006 IPCC Guidelines?
    - Has the Party ensured that double counting of areas of coastal wetlands reported under different land-use categories (e.g. mangrove forests reported under wetlands and forest land) does not occur?
    - Are the estimates consistent with methodologies provided in the Wetlands Supplement?
    - Has the Party used updated EFs according to the Wetlands Supplement?
    - Are C stock gains reported separately from C stock losses, when the gain-loss method is applied?
    - Is the completeness of the inventory ensured, taking into account the methodologies and EFs provided in the Wetlands Supplement? For example, if the Party applies the Wetlands Supplement, then it must report CO_2 and CH_4 emissions from burning of organic soils,

and/or off-site CO_2 emissions from C losses from drained/rewetted organic soils through water pathways in accordance with the Wetlands Supplement, if such emissions occur in the country;

- Is consistency in the AD ensured when estimating CSC in the different C pools? For example, the same AD are to be used for estimating CSC in biomass and DOM due to extraction activities in coastal wetlands.

Review of TACCC of information reported in the CRT

The following questions could help you in structuring your work towards assessing the reported information in the CRT.

General

Check whether:

- The Party correctly uses the signs in CRT (i.e. the sign is reversed when C stock gains/losses are expressed in CO_2 removals/emissions).

CRT 4.D

Check whether:

- The Party has provided estimates for land converted to wetlands by previous land-use categories (e.g. forest land converted to wetlands). If it has reported only the total value of land converted to wetlands:
  - Has the Party provided information on which type of conversions are included in land converted to wetlands in the documentation box in CRT 4.D and in the NID?
- The Party has reported estimates for CSC in living biomass for land converted to flooded land; and CSC from biomass clearing and GHG emissions and SOM losses in peat extraction lands in CRT 4.D (considering that these sources do not occur in all Parties), and if not:
  - Has the Party provided a justification for this exclusion in the documentation box in CRT 4.D and in the NID? (Note that the tier 1 method for flooded land assumes instantaneous oxidation of biomass C stocks, and therefore, these are to be estimated only in the year in which an area is flooded).

CRT 4(I)

Check whether:

- The Party has provided separate estimates for N_2O emissions from fertilization of wetlands (if applicable) in the LULUCF sector (CRT 4(I)), or has included all N_2O emissions from fertilization under the agriculture sector (CRT 3.D).

CRT 4(II)

Check whether:

- The areas of peat extraction sites (drained peatlands) reported in CRT 4.D and CRT 4(II) are consistent with each other, and the EFs of CO_2, CH_4 and N_2O are consistent with each other;
- The areas of rewetted organic soils reported in CRT 4.D and CRT 4(II) are consistent with each other, and the EFs of CO_2, CH_4 and N_2O are consistent with each other.

CRT 4(III)
Check whether:

- EFs for N mineralization/immobilization for wetlands reported in CRT 4(III) are consistent with each other;
- The Party has reported indirect N_2O emissions from N mineralization in wetlands (from SOM) in CRT 4(III).

CRT 4(IV)
Check whether:

- The Party has reported estimates of CO_2 emissions from burning in wetlands in CRT 4.D or in CRT 4(IV), and whether this is clearly documented in the NID and the documentation box in CRT 4(IV);
- The mass of fuel available for on-site burning in wetlands includes SOM of organic soils.

4. Practical exercises

Exercise 1

A Party reported in the NID that it uses a combination of the following equations for estimating off-site CO_2 emissions from lands being converted to peat extraction:

- $CO_2 - C_{LW_{peat_{on-site}}} = \frac{A_{peatRich} * EF_{CO_2 peatRich} + A_{peatPoor} * EF_{CO_2 peatPoor}}{1.000} - \Delta C_{WW_{peat_g}} - \Delta C_{WW_{peat_{DOM}}}$.
- $CO_2 - C_{WW_{peat_{on-site}}} = \frac{A_{peatRich} * EF_{CO_2 peatRich} + A_{peatPoor} * EF_{CO_2 peatPoor}}{1.000} + CO_2 - C_{WW_{peat_{stockpiling}}} + CO_2 - C_{WW_{peat_{post}}}$.
- $CO_2 - C_{WW_{peat_{off-site}}} = \frac{Wt_{dry\_peat} * CF_{wt\_peat}}{1.000}$ or $\frac{Vol_{dry\_peat} * CF_{vol\_peat}}{1.000}$.

Question 1

What is your observation regarding the methodology applied by the Party in estimating off-site CO_2 emissions from lands being converted to peat extraction?

Exercise 2

A Party does not report emission estimates from peat extraction in the GHG inventory, reporting them as "NO" in CRT 4.D. However, during the review you identified that in table 3a.3.3 in the IPCC good practice guidance for LULUCF, an area of peat extraction is provided for this specific Party.

Question 2

How would you address this in the review?

Question 3

How would you address this category in the review if eventually it is identified as a key category based on estimations made using the default AD values?

Exercise 3

A Party has reported significant gain in C stocks (net CO_2 removals) in the category wetlands remaining wetlands. The Party has used methods and default parameters provided in the Wetlands Supplement.

Question 4

How would you address in the review?

4.1. Answer key to practical exercises

Question 1

No peat is produced during land conversion in preparation for the peat extraction phase, and therefore no off-site emissions occur.

To refresh your knowledge of the methodology for estimating CO_2 emissions from lands being converted to peat extraction, consult the 2006 IPCC Guidelines (vol. 4, chap. 7, equation 7.8).

Question 2

As a reviewer, during the review you should ask the Party about the occurrence of peat extraction in the country. In consultation with the Party you should identify whether the value presented in the IPCC good practice guidance for LULUCF accurately represents the area under peat extraction for the Party. Then you should recommend that the Party prepare estimates of GHG emissions from peat extraction by collecting relevant nationally available data and, if national data are not readily available, using as an interim measure the default EFs in the 2006 IPCC Guidelines along with AD available from international data sets, including the IPCC good practice guidance for LULUCF.

Question 3

You must follow the guidance in the answer to question 2 above, and in addition, you must recommend that the Party collect country-specific data, in order to be able to apply a tier 2 (or higher) method in preparing the estimates. If this is not possible owing to lack of resources, the Party should prioritize in its improvement plan activities for collecting these country-specific data.

Question 4

Undrained wetlands (most often unmanaged natural wetlands) as well as rewetted wetlands are likely to be C sinks and drained wetlands (managed land) are likely to be C sources.
The Wetlands Supplement provides methodologies and/or emission/removal factors for rewetted wetlands and managed undrained wetlands subject to other management activities (e.g. revegetation), which result in net removals of CO_2 from the atmosphere in many cases. Therefore, it is possible that wetlands remaining wetlands is a net sink and this by itself should not necessarily be raised as an issue. You should, however, clarify with the Party the specific nature of activities being undertaken on those wetlands and the methodology and EFs used for estimating the emissions and removals, if not reported in the NID.
In addition, if wetlands remaining wetlands is a significant net sink (i.e. it is a key category), you should recommend that the Party use available country-specific factors or, in the case of lack of country-specific factors, prioritize in its improvement plan the development of country-specific emissions/removals factors. This is because according to the 2006 IPCC Guidelines and the MPGs, it is good practice to apply higher-tier methods for key categories.

Please note that for non-key categories, it is appropriate to use the 2006 IPCC Guidelines or the Wetlands Supplement default factors unless there is evidence that they are not appropriate for the specific national conditions. However, if the Party was unable to adopt a tier higher than tier 1 for a key category, for example due to national constraints and data unavailability, you must recommend that the Party clearly explain in the NID the reasons for not using the methodological guidance in accordance with the 2006 IPCC Guidelines or the Wetlands Supplement if applied, and you should encourage the Party to prioritize the development of country-specific EFs or a country-specific method in its improvement plan as a future improvement.

5. Self-check quiz

Question 1

GHG emissions/removals from flooded land (reservoirs) are reported as follows:

Select one:

A. The emissions/removals are to be reported under the category wetlands, and reporting is mandatory
B. The emissions/removals may be reported under the category wetlands, and the reporting is voluntary
C. The emissions/removals should not be reported or included in the national totals because the methodologies are given in an appendix to the 2006 IPCC Guidelines
D. Apart from CSC in the biomass pool in land converted to flooded land, which must be reported as the 2006 IPCC Guidelines provide a default method for it, reporting of emissions/removals from flooded land is voluntary. If reported, emissions/removals from flooded land must be reported under wetlands and included in the national total

Question 2

Methods for estimating and reporting CH_4 emissions in drained and undrained/rewetted wetlands are not given in the 2006 IPCC Guidelines. Can a Party choose to report on these emissions using the methods and parameters from the Wetlands Supplement?

Select one:

A. Yes
B. No

Question 3

Do the 2006 IPCC Guidelines provide methodologies for estimating emissions from all three GHGs, namely CO_2, N_2O and CH_4, from flooding of land?

Select one:

A. Yes
B. No

Question 4

Is peat extraction a common activity for most Parties?

Select one:

A. Yes
B. No

Question 5

Is reporting emissions and removals from wetlands required for the subcategories peat extraction lands and land converted to flooded land, where those occur?

Select one:

A. Yes
B. No

Question 6

Are peat extraction lands sinks of C for most Parties?

Select one:

A. Yes
B. No

Question 7

The 2006 IPCC Guidelines provide methodologies to estimate emissions and removals from peat extraction lands for the following C pools:

Select one:

A. Living biomass, DOM, SOM
B. Living biomass and SOM
C. DOM and SOM

Question 8

The 2006 IPCC Guidelines and the Wetlands Supplement provide methodologies to estimate CSC in peat extraction land for the following activities/practices:

Select one:

A. Drainage, extraction, stockpiling and rewetting
B. Drainage, extraction and stockpiling
C. Drainage and extraction
D. Drainage

Question 9

Are emissions from peat use for energy purposes reported in the LULUCF sector?

Select one:

A. Yes
B. No

Question 10

Does the tier 1 method for estimating changes in C stocks in land converted to flooded land (reservoirs) assume that the C stock prior to conversion is lost immediately following the conversion?

Select one:

A. Yes
B. No

5.1. Answer key to self-check quiz

Question 1

The correct answer is (D).
The 2006 IPCC Guidelines provide methodological guidance for estimating only CSC in the biomass pool in land converted to flooded land, for which, when occurring in the country, associated emissions must be reported under wetlands and included in the national total GHG emissions.

Question 2

The correct answer is (A).
In accordance with paragraph 20 of the MPGs, the use of the Wetlands Supplement is encouraged. Thus, Parties may use the methodologies and EFs it contains in preparing the national GHG inventory.

Question 3

The correct answer is (B).
The 2006 IPCC Guidelines do not provide default methods for estimating N_2O and CH_4 emissions from flooded land. A method for estimating CH_4 emissions is provided as a basis for future methodological development in an appendix to the 2006 IPCC Guidelines (vol. 4, appendix 3), which, however, is not a default method. N_2O emissions from flooded land are typically very low, unless there is a significant input of organic or inorganic N from the watershed. It is likely that such inputs would result from anthropogenic activities such as land-use change, wastewater treatment or fertilizer application in the watershed. In order to avoid double counting of N_2O emissions already captured in the GHG budget (indirect N_2O emissions) of these anthropogenic sources, and in the light of the very limited contribution of N_2O emissions from flooded lands reported in the literature, the methods in the 2006 IPCC Guidelines do not consider these emissions.

Question 4

The correct answer is (B).
Peat extraction is not a common activity in Parties, but as a reviewer you should always investigate whether this activity occurs in the Party under review in case the Party reports this category as ”NO”. For this, you can search for country-specific information (e.g. publications, research papers) and/or consult table 3a.3.3 in the IPCC good practice guidance for LULUCF.

Question 5

The correct answer is (A).
Reporting of emissions/removals from peat extraction and from land conversion to flooded land (only from biomass removal) is mandatory when those categories occur in the country.

Question 6

The correct answer is (B).
Peat extraction is a net source of CO_2 emissions.

Question 7

The correct answer is (A).
The 2006 IPCC Guidelines provide methodological guidance for lands subject to peat extraction (both peatlands undergoing extraction (i.e. peatlands remaining peatlands) and land being converted for peat extraction) which covers the living biomass and the DOM and SOM pools. However, at the tier 1 level, the 2006 IPCC Guidelines do not distinguish between the two subcategories and as such, emissions and removals from land being converted for peat extraction should be separately estimated and reported only at the tier 2 level following the methodological guidance provided in the 2006 IPCC Guidelines.

Question 8

The correct answer is (A).
Methodologies for CSC from drainage, extraction and stockpiling are provided in the 2006 IPCC Guidelines and the Wetlands Supplement, and CO_2 emissions/removals from rewetting could be estimated with methods and parameters provided in the Wetlands Supplement (chap. 3).

Question 9

The correct answer is (B).
Emissions from peat used for energy purposes are reported in the energy sector.

Question 10

The correct answer is (A).
In accordance with the tier 1 method of the 2006 IPCC Guidelines for land converted to flooded land, it is assumed that all carbon in biomass that existed prior to flooding is emitted as a result of the conversion.

6. Key points to remember

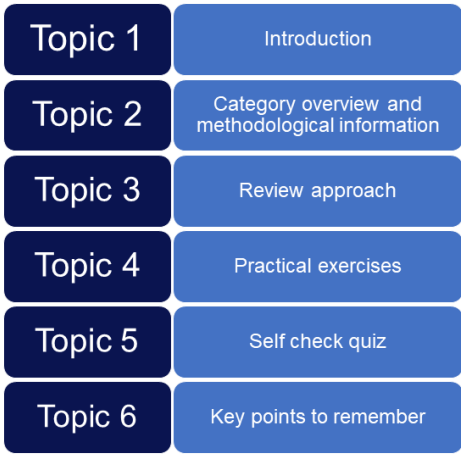
- In order to successfully review the wetlands category you must have adequate knowledge of the general LULUCF review aspects covered in lesson 2 and of how to review the land representation and information related to C pools covered in lesson 3.
- Wetlands is the fifth land-use category in the hierarchy provided in the 2006 IPCC Guidelines.
- Wetlands may be subdivided into managed and unmanaged, with reservoirs being a managed subdivision and natural rivers and lakes an unmanaged subdivision.
- Significant C pools (significance analysis) must be identified within wetlands key categories and CSC from these pools should be reported in accordance with the suggested IPCC methodology.
- Drainage of wetlands results in an increase in CO_2 and N_2O emissions, and a reduction in CH_4 emissions. Raising the water table and creating wetlands through flooding results in greater CH_4 emissions and less CO_2 and N_2O emissions.
- GHG emissions from managed peatlands include on-site and off-site emissions.
- Emissions from land being converted for peat extraction are estimated together with those from peatlands undergoing extraction (i.e. peatlands remaining peatlands) at the tier 1 level. They are to be estimated separately only at tier 2 level following the guidance provided in the 2006 IPCC Guidelines (vol. 4, chap. 7, section 7.2.2).
- The default subcategorization of peatlands in the 2006 IPCC Guidelines is based on climate zones, soil type and nutrient availability.
- Non-CO_2 emissions from rice fields are reported in the agriculture sector rather than the LULUCF sector.
- Off-site emissions from the use of peat for energy are reported in the energy sector rather than the LULUCF sector. Emissions from non-energy use of peat (horticultural) are reported in the LULUCF sector.
- At tier 1, only CO_2 emissions from loss of biomass in land converted to flooded land are to be reported.
- Parties may use models (tier 3) to report CSC and associated emissions/removals from wetlands, and therefore particular attention is required in reviewing the TACCC of the models, particularly during an in-country review.

Lesson 8: Settlements

1. Introduction

1.1. Lesson structure

Lesson 8 provides guidance for the review of information for the settlements category within the LULUCF GHG inventory (see figure 8-1). Settlements is one of the six land-use categories given in the 2006 IPCC Guidelines, and the fourth in the hierarchy provided in the same guidelines.



EE. Figure 8-1. Structure of lesson 8

The 2006 IPCC Guidelines provide specific guidance on how to estimate and report CSC and associated GHG emissions/removals from settlements in chapter 8, volume 4. Furthermore, the Wetlands Supplement provides additional and updated methodologies, EFs and AD which could be applied to settlements for estimating emissions and removals from lands with organic soils and wet and drained mineral soils.

Remember that the 2006 IPCC Guidelines consider it good practice for countries to use higher-tier methods for key categories and significant C pools.

While all Parties should be able to prepare an inventory using the tier 1 methodology, they usually use higher-tier methods and sometimes use tier 3 for certain pools (e.g. biomass). Thus, most inventories are likely to include estimates prepared using a mix of tiers. Although relatively less common, settlements categories may be identified as key and within them some subcategories/pools may be identified as significant. It is good practice to use higher-tier methods for those subcategories/pools.

This lesson provides background information on the estimation and reporting of CSC and associated GHG emissions and removals from settlements. It also presents category-specific guidance for reviewing the estimates of GHG emissions/removals and related information submitted by Parties for the settlements category. Similarly to the previous lessons, this lesson ends with practical exercises and a self-check quiz to help you enhance and refresh your knowledge.

It is suggested that you have the CRT readily available when you study this lesson, because it contains several references to them (highlighted in red text).

Finally, note that the review of the settlements category in a Party's LULUCF GHG inventory is related to the review considerations you have learned in the previous lessons. Therefore, you must always apply your knowledge of how to review cross-cutting and cross-sectoral issues, the land representation, C pools and other aspects gained in lessons 2 and 3.

1.2. Learning objectives

At the end of this lesson you should:

- Know the requirements for reporting of emissions/removals from settlements by Parties in the CRT and the NID;
- Be able to understand how CSC methods, AD, EFs and methods for collecting these apply to the settlements category;
- Be able to understand the key areas for reviewing the GHG inventory information on the settlements category.
-

The expected time needed to complete lesson 8 depends on the level of your knowledge of LULUCF GHG inventories under the MPGs and the 2006 IPCC Guidelines:
For readers with experience: 30–45 minutes
For readers with less experience: 50–70 minutes

2. Category overview and methodological information

2.1. Reporting overview

According to the 2006 IPCC Guidelines, settlements include all developed land, including transportation infrastructure and human settlements of any size, unless they are already included under other categories, according to national definitions.
Parties are required to report GHG emissions and removals from settlements separated into two main subcategories:

1. Settlements remaining settlements;
2. Land converted to settlements.

The contribution of the latter category to the GHG emissions caused by deforestation (or other nationally important land conversions) may be significant for some Parties.

FF. Figure 8-2. Settlements

For a detailed explanation, including the methodological guidance for settlements, consult the 2006 IPCC Guidelines (chap. 8, together with chap, 2, volume 4).

2.2. Pools and gases to be reported for settlements

For reporting of GHG emissions/removals from settlements, any subcategories should be defined according to the national circumstances and the data used in preparing the inventory. As an example, 2006 IPCC Guidelines default factors are based on tree species.
The annual CSC in biomass (above-ground and below-ground), DOM and SOM in settlements are reported in CRT 4.E. CSC in the HWP pool are to be reported in CRT 4.Gs1 and CRT 4.Gs2.
The 2006 IPCC Guidelines provide a tier 2 methodology with default factors for biomass C stock net accumulation for the 20-year period after planting of trees. When using the tier 2 methodology provided in the 2006 IPCC Guidelines to estimate CSC in settlements remaining settlements, the net change is to be reported in the column "Gains" and the notation key "NO" should be used for the column "Losses" in the CRT. In the case of land converted to settlements, the loss in biomass C stocks following conversion must be reported in the "Losses" column, even when using the tier 2 methodology provided in the 2006 IPCC Guidelines.
Direct and indirect N_2O emissions from N inputs (fertilization) in settlements are reported in CRT 4(I). Parties that cannot separate fertilizer application into different land categories can report the total emissions under agriculture in CRT 3.D.
Emissions from drained/rewetted organic soils under settlements are reported in CRT 4(II).
Direct and indirect N_2O emissions from N mineralization/immobilization associated with loss/gain of SOM in settlements are reported in CRT 4(III).
N_2O and CH_4 emissions from biomass burning in settlements are reported in CRT 4(IV). CO_2 emissions may also be reported in this table while avoiding double counting with the information reported in CRT 4.E.

Note that biomass burning also includes any burning of DOM and, if methods provided in the Wetlands Supplement are used, SOM in organic soils.

2.3. Methods and pools

The methodological tier to be applied for estimating CSC and other GHG emissions/removals depends on the significance of the reporting category and of the C pool, as well as the national circumstances. For this, the respective decision trees contained in the 2006 IPCC Guidelines are to be followed by the Parties.

To learn more on the methodological tiers, consult volume 4 of the 2006 IPCC Guidelines (chap. 1, figures 1.2 and 1.3; chap. 2, figures 2.2, 2.3, 2.4, 2.5 and 2.6; and chap. 12, figure 12.1).

You have already learned in the previous lessons that Parties must provide GHG emissions/removals estimates for categories, pools and gases for which the 2006 IPCC Guidelines provide methodologies and EFs. Click on figure 8-3 to see the pools and gases for which emissions/removals estimates must be reported when tier 1 or tier 2 methods are applied.
Figure 8-4 summarizes the tier 1 and 2 methods to be applied, along with references to relevant equations in the 2006 IPCC Guidelines and the Wetlands Supplement.

As you can see, at the tier 1 level, net CSC in all pools are assumed to be zero for settlements remaining settlements, while they need to be estimated for land converted to settlements.

Tier 1			Land use											
			FL		CL		GL		WL			SL		OL	
Carbon pool – GHG			FL-FL	L-FL	CL-CL	L-CL	GL-GL	L-GL	WL-WL	L-WL		SL-SL	L-SL	OL-OL	L-OL
									PL-PL	L-PE	L-FlL				
Living biomass		Above-ground	M	M	M [a]	M [b, c]		M [b, c]		M [c]	M [c]		M [c]		M [c]
		Below-ground		M		M [b, c]		M [b, c]		M [c]	M [c]		M [c]		M [c]
Dead organic matter		Dead wood		M [c]		M [c]		M [c]					M [c]		M [c]
		Litter		M		M [c]		M [c]					M [c]		M [c]
Soil organic matter		Mineral		M	M	M	M	M					M		M [d]
		Organic	M	M	M	M	M	M	M [f]				M		
HWP			M (may be assumed 0 if net carbon stock change is judged insignificant)												
N_2O	Direct	Fertilization [e]	M	M					M	M	M	M	M		
		N mineralization		M		M	M [g]	M					M		M
		Drainage	M	M					M			M	M		
		Burning	M	M	M	M	M	M	M	M		M	M		M
	Indirect	Fertilization [e]	M	M					M	M	M	M	M		
		N mineralization		M		M	M [g]	M					M		M
CH_4		Burning	M	M	M	M	M	M	M	M		M	M		M

Tier 2			Land use											
			FL		CL		GL		WL			SL		OL	
Carbon pool – GHG			FL-FL	L-FL	CL-CL	L-CL	GL-GL	L-GL	WL-WL	L-WL		SL-SL	L-SL	OL-OL	L-OL
									PL-PL	L-PE	L-FlL				
Living biomass		Above-ground	M	M	M [a]	M [b]	M	M [b]		M	M	M	M		M
		Below-ground	M	M	M [a]	M [b]	M	M [b]		M	M	M	M		M
Dead organic matter		Dead wood	M	M	M	M	M	M		M		M	M		M
		Litter	M	M	M	M	M	M		M		M	M		M
Soil organic matter		Mineral	M	M	M	M	M	M				M	M		M
		Organic	M	M	M	M	M	M	M	M		M	M		
HWP			M												
N_2O	Direct	Fertilization [e]	M	M					M	M	M	M	M		
		N mineralization	M	M		M	M [g]	M					M		M
		Drainage	M	M					M	M		M	M		
		Burning	M	M	M	M	M	M	M	M		M	M		M
	Indirect	Fertilization [e]	M	M					M	M	M	M	M		
		N mineralization	M	M		M	M [g]	M					M		M
CH_4		Burning	M	M	M	M	M	M	M	M		M	M		M

Notes: grey shading = not applicable, blank = not mandatory.

Abbreviations: M = mandatory, GHG = greenhouse gas, FL = forest land, CL = cropland, GL = grassland, WL = wetlands, SL = settlements, OL = other land, PL = peatland, PE = peat extraction, FlL = flooded land, HWP = harvested wood products
FL–FL, CL-CL, GL-GL, WL-WL, PL-PL, SL-SL, OL-OL = indicate land category remaining under the current land use
L–FL, L-CL, L-GL, L-WL, L-PE, L-FlL, L-SL, L-OL = indicate land category converted to the current land use

[a] To be reported only for perennial crops.

[b] Net carbon stock gain in biomass pool for annual crops is to be reported only once in the year after conversion.
[c] Only applicable if the Party has reported carbon stock changes or the IPCC provides default carbon stock values for the biomass or DOM carbon stock for the previous land use. In such a case carbon stock is to be reported as instantaneously oxidized in the year of conversion.
[d] Carbon stock level after conversion is to be set at 0.
[e] N_2O emissions from N fertilization in forest land and settlements are to be reported under the LULUCF sector and those in cropland and managed grassland are to be reported in the agriculture sector. If the Party is not able to separate emissions from N fertilization in different land-use categories, all emissions are to be reported under the agriculture sector.
[f] Under tier 1 the activity data do not distinguish between peatlands under peat extraction and those being converted for peat extraction.
[g] N_2O emissions from grassland remaining grassland for agriculture purpose are reported under the agriculture sector.

Figure 8-3. Carbon pools and gases to be reported for the settlements category under tier 1 and 2

Carbon stock changes in pools and associated GHG emissions/removals that must be estimated for settlements

Carbon stock changes in pools and associated GHG emissions/removals that must be estimated at Tier 1

0 indicates that the tier 1 methodology assumes no net carbon stock change

The IPCC equations to be applied are provided in parentheses (*those from the Wetlands Supplement are given in italics*)

Note that where activity data on land-use categories do not allow for the separation of SL-SL and L-SL, for the IPCC default, the latter category does not apply

Note that in land under conversion from categories for which the IPCC does not provide default values for the biomass or DOM pools, reporting of carbon stock changes is nevertheless mandatory (to ensure accuracy) in case the Party has reported C stock changes in the pool under the previous land use

	Biomass (B)		Dead organic matter (DOM)		Soil organic matter (SOM)		Harvested wood products (HWP)	Non-CO_2 emissions
	Above (AB)	Below (BB)	Dead wood (DW)	Litter (L)	Mineral soils (MS)	Organic soils (OS)	HWP	
SL-SL	0	0	0		Net carbon stock change (2.25)	CO_2 emissions from drained organic soils (2.26) *CO_2 emissions from drained organic soils (2.2)* *On-site CO_2 emissions from drained organic soils (2.3)* *Off-site CO_2 emissions from drained organic soils (2.4, 2.5, 2A.1)* *CO_2 emissions from burning of drained organic soils (2.8)* *CO_2 emissions from rewetted organic soils (3.3)* *On-site CO_2 emissions from rewetted organic soils (3.4)* *Off-site CO_2 emissions from rewetted organic soils (3.5, 3.6)* *CO_2 emissions from burning of rewetted organic soils (2.8)*	Assumed 0, if judged insignificant (i.e. annual net C stock change in HWP pool, is less than the size of any key category), otherwise default tier 1 methods provided in the 2006 IPCC Guidelines (volume 4, chapter 12) apply Note that HWP are reported altogether regardless of the land of origin of wood	Non-CO_2 emissions from biomass burning (2.27) N_2O emissions from drained organic soils (11.1) N_2O emissions from N inputs (11.2, 11.3) N_2O emissions from SOM mineralization (11.8)(2) Indirect N_2O emissions (11.9, 11.10)(2) *CH_4 emissions from drained organic soils (2.6)* *N_2O emissions from drained organic soils (2.7)* *CH_4 emissions from burning of drained organic soils (2.8)(3)* *CH_4 emissions from rewetted organic soils (3.8)* *N_2O emissions from rewetted organic soils (3.9)* *CH_4 emissions from burning of rewetted organic soils (2.8)(3)* *CH_4 emissions from rewetting of drained inland wetland mineral soils, and created wetlands on managed lands with mineral soils (5.1)*
L-SL	Net C stock change (2.4)(5)		0	Net carbon stock change (2.23)(1)				

Carbon stock changes in pools and associated GHG emissions/removals that must be estimated at Tier 2

SL-SL	C stock change (2.4, 8.1) C stock gain (8.2 or 8.3)(4)	C stock change (2.17, 2.18 or 2.17, 2.19) C stock gain (2.20, 2.21, 2.22, 2.14)	Net C stock change (2.25)	As tier 1 *As tier 1*	As tier 1	Non-CO_2 emissions from biomass burning (as Tier 1) N_2O emissions from drained organic soils (as Tier 1) N_2O emissions from N inputs (as Tier 1) N_2O emissions from SOM mineralization (as Tier 1) Indirect N_2O emissions (11.10, 11.11) *As tier 1, plus N_2O emissions from burning of SOM in organic soils estimated*
L-SL	C stock change (2.15, 2.16, 8.1) C stock gain (8.2 or 8.3)	As Tier 1				

(1) The Tier 1 method assumes DOM stocks to be constant for settlements and only accounts for losses from previous land use for the conversion category from forest land to settlements.
(2) N_2O emissions from N mineralization in mineral soils in settlements remaining settlements are assumed to be zero as the C stock change is also assumed to be zero. Therefore, N_2O emissions from N mineralization only occur in land converted to settlements.
(3) Note that N_2O emissions from fires on organic soils are not estimated at tier 1, because the Wetlands Supplement does not provide default EFs.
(4) For average age of the tree population less than or equal to 20 years, Tier 2 assumption is that the biomass C stock losses are equal to zero. Over tree population over 20 years gains and losses are assumed to be equivalent and biomass net C stock changes are equal to 0.
(5) Carbon gains are assumed to be zero.

Figure 8-4. Coverage of carbon pools and greenhouse gas emissions for the settlements category in the 2006 IPCC Guidelines (tier 1 and 2)

2.4. Methods and pools: tier 2

The 2006 IPCC Guidelines provide two tier 2 methods and default parameters to estimate net CSC in biomass in settlements remaining settlements, including annual C accumulation per hectare with tree crown cover area by region, and for annual C accumulation per tree by broad species class:

- Tier 2a method (crown cover area method) based on area of tree canopy cover (vol. 4, chap. 8, equation 8.2 and table 8.1);
- Tier 2b method (individual plant growth method) based on the number of trees (vol. 4, chap. 8, equation 8.3 and table 8.2).

In addition, default AD by potential natural vegetation type for deriving percentage tree cover are provided (vol. 4, chap. 8, table 8.3).
For both settlements subcategories (settlements remaining settlements and land converted to settlements), the tier 2 methodology assumes a net C stock accumulation in biomass up to the average age of the tree population of 20 years and a net equilibrium thereafter (so net CSC are reported as zero).

3. Review approach

General review points
When reviewing settlements estimates, you should always apply the guidance on general review issues for the LULUCF sector provided in lesson 2 and the guidance on the review of the land representation and C pools provided in lesson 3.
The following is a summary of general review considerations to refresh your memory:

- Assess whether categories, subcategories (e.g. forest land converted to settlements) and subdivisions (e.g. parks, turfgrass under settlements) for which estimates are prepared are appropriate and correspond to the national circumstances. The review should be implemented at the level of the subdivisions reported;
- Assess the consistency of the land representation;
- Assess whether emissions/removals are reported separately for settlements remaining settlements and land converted to settlements;
- Assess whether non-reporting or incomplete reporting of the emissions and removals in C pools occur. Assess which C pools are to be mandatorily reported as per the 2006 IPCC Guidelines, bearing in mind that for some C pools under some categories (e.g. biomass, DOM, SOM in settlements remaining settlements), the 2006 IPCC Guidelines tier 1 assumes zero net CSC;
- Assess whether all GHG emissions associated with CSC have been estimated and if the GHG fluxes are consistent with each other (e.g. CH_4, N_2O emissions from biomass burning);
- Check whether the Party has reported uncertainties associated with the estimates for CSC, including information on uncertainties of the input data, noting the flexibility available to those developing country Parties that need it in the light of their capacities;
- Identify, in consultation with the Party concerned, potential areas of capacity-building needs, for those developing country Parties that need the flexibilities provided in the MPGs in the light of their capacities.

Review of methods, AD and parameters

Assess the appropriateness of the Party's choice of methodological tiers, AD, EFs and other parameters according to the significance of categories/subcategories and national circumstances and their proper documentation in the submission. Check also the transparency, accuracy, completeness and consistency of the estimates. The level of review should be based on the level of disaggregation in the subcategories reported and the methods used by a Party. Focus your review (time/resources) mainly on the key pools/subcategories that are likely to contribute the most to GHG emissions and removals from the settlements categories. The following points may help you structure your review work.
Check whether:

- The Party has reported information on the monitoring and identification of the settlements area;
- The total settlements area is monitored and reported and the settlements subdivisions (if applicable), their areas and other AD are consistent with the information from other reliable documents or sources (e.g. for Parties that are member States of the European Union, CORINE land cover programme (https://land.copernicus.eu/pan-european/corine-land-cover) of the Copernicus Land Monitoring Service may be used for comparison purposes);
- Transition matrices for the years before the starting year of the inventory equal to the transition period applied are reported in the NID;
- Documentation on each methodology, including assumptions, AD, EFs and parameters, provided in the NID is transparent enough to allow the assessment of accuracy, completeness, consistency and comparability of the estimates;
- The methodologies and definitions used consistently over the complete time series (e.g. treed parks, land areas covered by grass classified under settlements);
- The methods and equations are correctly applied consistently with the 2006 IPCC Guidelines, and that all gains and losses have been estimated for each C pool reported (e.g. for the DOM pool under tier 2 in settlements remaining settlements);
- There is a trend within the reported parameter values and the trend is explained in the NID;
- AD separating different settlements types according to the land surface coverage and management practices, if applicable, are available (e.g. parks with treed or wooded vegetation, cultivated soil within settlements);
- AD are derived ensuring that inconsistencies or double counting is avoided, for example in the wildland-urban interface, peri-urban forests or the urban-cropland interface. In these zones, misclassification of land as more than one land-use category or its exclusion from being classified as any land-use category can easily occur, especially when various data sources are used;
- Emissions from drainage of organic soils are reported regardless of the tier level applied;
- The estimation is based on the 2006 IPCC Guidelines default methodologies, and if so:
    - Is the category a key category? If so, is the choice of method appropriate to the significance of the category/subcategory/pool and national circumstances (assess data and resources available)? Note that the SOM may be significant in the land converted to settlements category (mineral and/or organic soils);
    - Are emissions/removals from all mandatory C pools included in the GHG inventory? For example, under tier 1 in accordance with the 2006 IPCC Guidelines, estimating and

reporting on land converted to settlements CSC from mineral soils and living biomass and DOM is mandatory if the Party has reported CSC from living biomass and DOM in the previous land-use category. Remember that the 2006 IPCC Guidelines provide default biomass C stocks for forest land, cropland, grassland (vol. 4. chap. 8. table 8.4) and litter C stocks for forest land (vol. 4, chap. 8, table 2.2) before the conversion to settlements;
  - Does the Party apply the appropriate default stock change factors for estimating CSC in mineral soils in land converted to settlements found in the 2006 IPCC Guidelines (vol. 4, chap. 8, section 8.3.3.2)? Note that the 2006 IPCC Guidelines provide different stock change factors for the different types of settlements;
  - Could country-specific values be developed based on national or regional data and research?

- The estimation is based on higher tiers (tier 2 or tier 3) together with country-specific parameters, and if so:
  - Is the choice of method appropriate to the significance of the category/subcategory and national circumstances?
  - Has the Party provided proper documentation in the NID on the methodologies applied and country-specific parameter values, such as assumptions, principles, equations and other key parameters, and data sources?
  - In particular when a model is used, has the Party reported transparent information on the model structure, on whether and how the model has been peer reviewed, verified and/or validated? If the model is used for estimating SOM CSC, has the model been calibrated and validated by using data collected in paired sites?
  - Has the Party applied the 2006 IPCC Guidelines default biomass factors in settlements remaining settlements and has it correctly applied for the tier 2 method either the annual C accumulation per hectare tree crown cover area or the average annual accumulation per tree? Has the Party applied country-specific biomass growth values and if so, how do they compare with the 2006 IPCC Guidelines defaults?
  - If significant deviations between country-specific parameters and the 2006 IPCC Guidelines default values are identified, has a proper explanation been provided in the NID?
  - When using the 2006 IPCC Guidelines defaults for biomass growth in settlements remaining settlements have C stock gains been estimated for the active growing period (20 years), and assumed to be zero thereafter?
  - Are C stock gains reported separately from C stock losses, when the gain-loss method is applied?
  - Does the Party include below-ground biomass in the estimation of emissions/removals and does it consistently account for both C biomass gains and C biomass losses? For example, if below-ground biomass is included in forest land, does the Party also include it in forest land converted to settlements?
  - Does the Party report emissions/removals from the DOM pool? If so, does it account for all C losses, including those from burning?
  - Are the SOC values and relative stock change factors for land-use, management and organic C inputs comparable with the 2006 IPCC Guidelines default values, taking into account the different settlement types found in the Party?

- The method for mineral soils uses a time series of data of 20 years (or more if the country has applied a longer transition time period). The AD for the whole period may not be available,

and Parties may need to apply different techniques for estimating the missing data and for ensuring consistency in time series as provided in the 2006 IPCC Guidelines (vol. 1, chap. 5). The availability of AD and C stock factors corresponding to different management systems and land uses is important for the accuracy of estimates.

Review of TACCC of information reported in CRT

The following questions could help you in structuring your work towards assessing the TACCC of the reported information in the NID and CRT 4.E, CRT 4(I), CRT 4(II), CRT 4(III) and CRT 4(IV). Check each tab below to see a non-exhaustive list of checks.

General

Check whether:

- The Party correctly uses the signs in CRT (i.e. the sign is reversed when C stock gains/losses are expressed in CO_2 removals/emissions);
- The completeness of the reporting in CRT 4.E, CRT 4(I), CRT 4(II), CRT 4(III) and CRT 4(IV) is ensured or otherwise appropriate notation keys have been used when numerical values are not reported.

CRT 4.E

Check whether:

- The Party has provided estimates for land converted to settlements by the previous land-use category or it has reported only the total value of land converted to settlements. In the latter case:
  - Has the Party provided information on which type of conversions are included in the documentation box and in the NID?
- The Party has reported estimates for CSC in all C pools for land converted to settlements, and if not, whether it has provided the reasoning for any exclusion in the documentation box and in the NID.

CRT 4(I)

Check whether:

- The Party has provided separate estimates for N_2O emissions from fertilization of settlements in CRT 4(I), or has included it in the total estimate provided under agriculture (CRT 3.D).

CRT 4(II)

Check whether:

- The drained/rewetted organic soils areas in settlements reported in CRT 4.E and CRT 4(II) are consistent with each other, and the EFs for CO_2, CH_4 and N_2O emissions are consistent with each other.

CRT 4(III)

Check whether:

- The Party has reported estimates of direct and indirect N_2O emissions from SOM mineralization in settlements.

CRT 4(IV)
Check whether:

- The Party has reported emissions from biomass burning in settlements, and if so, whether it has included estimates of CO_2 emissions from burning under CRT 4.E, or has reported them in CRT 4(IV), and whether proper documentation has been provided in the NID and the documentation box in CRT 4(IV).

4. Practical exercises

Exercise 1

A Party has not provided estimates for land converted to settlements (no land areas, no emission/removal estimates are reported) in CRT 4.E, and the NID contains no information on the category. However, the Party has reported an increase of 5 per cent in the area of settlements remaining settlements across the time series.

Question 1

How would you review this specific issue?

Exercise 2

For the same case as described in exercise 1 above, consider that deforestation (forest land converted to other land-use categories) has been identified as a key category by the Party, using the qualitative criteria described in the 2006 IPCC Guidelines (vol. 1, chap. 4, section 4.3.3).

Question 2

How would you review this specific issue?

Exercise 3

A Party reports in year X of the GHG inventory period that an area of 100 ha urban park under settlements remaining settlements has been burned. Accordingly, the Party reports only CH_4 and N_2O emissions from biomass burning in CRT 4(IV), explaining that CO_2 emissions are already included in the net C stock loss of biomass reported in CRT 4.E (thus reporting "IE" in CRT 4(IV)). All the biomass C stock has been assumed lost, either oxidized or transferred to DOM. The Party does not report net CSC in DOM for settlements under the assumption that they are insignificant. For the following years, the Party does not report any net CSC in biomass under the assumption that areas of settlements remaining settlements are older than 20 years and therefore the biomass C stock is at equilibrium (C stock gains equal C stock losses).

Question 3

Is the Party's reporting consistent with the 2006 IPCC Guidelines, as implemented through the MPGs?

Exercise 4

In year *Y*, a Party in the boreal climate zone with nutrient-rich organic soils (C/N ratio = 17) applied country-specific EFs for estimating N_2O emissions from drainage of organic soils of 22,000 ha settlements (11.7 kg N_2O–N ha^{-1} yr^{-1}).

Question 4

A. Could you reconstruct the calculation for the total amount of N_2O emissions (kt N_2O yr^{-1}) from drainage of organic soils?
B. Could you assess whether the country-specific values are significantly different (i.e. lying outside the confidence interval) from the default factors provided in the Wetlands Supplement? (Note that for drainage of organic soils of settlements the respective EF for cropland was applied.)

The same country also estimated CO_2 emissions from drainage of organic soils by applying default EFs from the Wetlands Supplement. Again, for settlements, the IPCC default EF for cropland was applied.

Question 5

Could you reconstruct the calculation for the total amount of CO_2 emissions (kt CO_2 yr^{-1}) from drainage of organic soils?

The Party has calculated its country-specific EFs for N_2O–N emissions by applying a fraction of 5 per cent of N mineralized because of drainage (derived as the median value of the range reported by Bouwman (1996) (see p.56)[1].

Question 6

Could you check the consistency between the two estimates (i.e. N2O versus CO2) and suggest methods, where needed, to ensure consistency?

[1] Bouwman, A.F. Direct emission of nitrous oxide from agricultural soils. Nutr Cycl Agroecosyst 46, 53–70 (1996). https://doi.org/10.1007/BF00210224

4.1. Answer key to practical exercises

Question 1

There is no apparent issue with the Party's reporting if it has applied approach 1 for land representation, because in such a case, owing to the lack of information on specific land-use conversions, all land is reported as remaining in the same land-use category. However, even in this case, SOC losses are likely to occur as a result of the conversion to settlements at some point in the time series and therefore you would expect CO_2 and N_2O emissions to be reported from the SOM pool. Depending on the type of conversions, losses in other C pools could possibly occur as well. Furthermore, you must carefully check the reasons for the area increase and check the areas of other land-use categories to ensure that net increases across land-use categories are offset by net decreases. However, if the Party has applied approach 2 or 3 for land representation, the increase can only be due to some area reported under land converted to settlements in past years which is now reported under settlements remaining settlements (after 20 years). In this case, you should ask the Party during the review to confirm your assumptions and, assuming that an error has occurred, you must recommend that the Party report relevant areas under land converted to settlements across the time series, as well as estimating and reporting CSC for this subcategory.

Question 2

With deforestation being a key category, as a reviewer you must ask the Party to clarify whether it has implemented a significant analysis for the key categories as well as detailed information on forest land converted to settlements. If the Party has not done so, you must recommend that the Party consider the significance of forest land converted to settlements within deforestation and if found significant (please revisit lesson 2 to refresh your knowledge of the significance of subcategories/pools), consider the significance of the C pools within it. You must recommend that the Party prepare and report estimates by applying higher-tier methods for the significant C pools within forest land converted to settlements by collecting detailed data and developing country-specific parameters following the decision trees for the methodological guidance provided in the 2006 IPCC Guidelines. You must also recommend that the Party enhance the transparency of reporting by providing detailed information on forest land converted to settlements.

To learn more on the tier methods, consult section 1.3.2 of chapter 1, volume 1 of the 2006 IPCC Guidelines (p.1.10)) and the relevant decision trees for the identification of the appropriate tier for the different C pools and source/sink categories in volume 4 (e.g. vol. 4, chap. 2, figures 2.2 (p.2.14), 2.3 (p.2.22), 2.4 (p.2.32), 2.5 (p.2.33) and 2.6 (p.2.44); chap. 2, figure 12.1 (p.12.10); and chap. 12).

Question 3

The Party's reporting may be considered to be consistent with the 2006 IPCC Guidelines as implemented through the MPGs for the inventory year X, that is, it has reported all GHG emissions while avoiding double counting between information reported in CRT 4(IV) and CRT 5.E. However, the Party has not reported the regrowth of the woody vegetation of the urban parks after the fire. Therefore, as a reviewer, you must check in consultation with the Party the following points in relation to the use/management of the burnt area:

- If the land use has changed, check whether associated emissions/removals have been reported. In any case, the reporting of settlements can be considered complete
- If the settlement lands subject to burning have changed to settlements without woody vegetation, the reporting of settlements can be considered complete
- If there is regrowth of woody vegetation on the burnt areas in the urban park, which has not been reported for 20 years after the fire when applying the IPCC default methodology the reporting is not complete. Indeed, the Party may choose not to report CO_2 emissions from burning of settlements, because of the tier 2 assumption of C stock in equilibrium after 20 years (and therefore neither CO_2 emissions nor CO_2 removals are reported for settlements wooden vegetation older than 20 years), but when it reports the CO_2 emissions from biomass burning, it must report the subsequent CO_2 removals from regrowth.

Questions 4, 5 and 6

The answers can be found here: https://unfccc.int/resource/tet/bl/bl8-01_u_l8_att1.pdf

5. Self-check quiz

Question 1

Do Parties have to provide estimates for settlements in CRT 4.E?

Select one:

A. Yes
B. No

Question 2

Is it likely that the category land converted to settlements is an important component in national estimates of deforestation?

Select one:

A. Yes
B. No

Question 3

Do the 2006 IPCC Guidelines provide guidance for estimating CSC in all C pools (biomass, DOM and SOM) in settlements?

Select one:

A. Yes
B. No

Question 4

A Party may classify as settlements parks in cities that meet the national thresholds for the forest land category.

Select one:

A. True
B. False

Question 5

The 2006 IPCC Guidelines provide two different types of default tree biomass C accumulation for settlements remaining settlements.

Select one:

A. True
B. False

5.1. Answer key to self-check quiz

Question 1

The correct answer is (A).
GHG emissions/removals from settlements are reported in CRT 4.E. The reporting of the settlements category is done at a minimum separately between settlements remaining settlements and land converted to settlements.

Question 2

The correct answer is (A).
Indeed, in some cases, the land conversion to settlements may represent a significant amount of emissions/removals from deforestation for a Party. Therefore, if deforestation is found to be a key category in a Party's GHG inventory, the Party must further identify the significant subcategories (significant analysis).

Question 3

The correct answer is (A).
However, note that C pools in settlements remaining settlements are assumed to be at equilibrium at the tier 1 level.

Question 4

The correct answer is (A).
Yes, a Party may classify parks in cities that meet the national thresholds for the forest land as settlements. It depends on how the Party classifies those areas according to national definitions. What you, as a reviewer, must check is whether the definition has been applied consistently across the time series, to avoid reporting false CSC associated with land-use conversions, even though the tree cover and management system of the area does not change; and whether EFs and stock change factors associated with the treed vegetation in the park are applied appropriately.

Question 5

The correct answer is (A).
The 2006 IPCC Guidelines (vol. 4, chap. 8, section 8.2.1.2) provide two different default biomass C accumulation factors to be used for settlements remaining settlements under tier 2: one based on the crown cover area and the second based on the number of urban trees.

6. Key points to remember

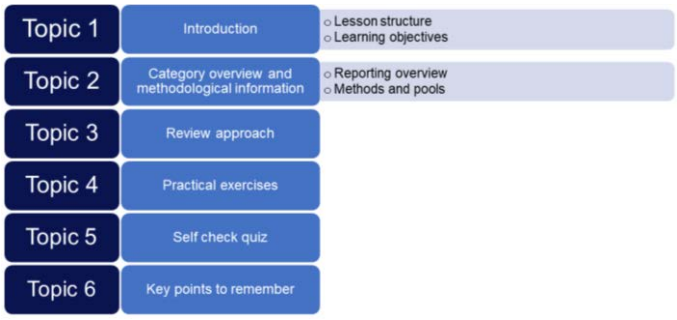
- In order to successfully review the settlements category you must have adequate knowledge of the general LULUCF aspects covered in lesson 2 and how to review the land representation and information related to C pools covered in lesson 3.
- Settlements is the fourth land-use category in the hierarchy provided in the 2006 IPCC Guidelines.
- Settlements is by default managed land.
- For some Parties the settlements category may be identified as key and as such requires much attention during the review.
- Significant C pools (significance analysis) must be identified within settlements key categories and CSC from these pools should be reported in accordance with the suggested methodology in the 2006 IPCC Guidelines.
- The default subcategorization in the 2006 IPCC Guidelines is based on climate zones, soil type, management practices, vegetation species and age classes.
- All gains and losses must be taken into account for each C pool reported (e.g. for biomass, growth rate, harvesting, natural mortality, disturbances, fires, pests).
- In settlements remaining settlements net CSC in all pools are assumed to be zero under tier 1.
- The 2006 IPCC Guidelines provide a tier 2 methodology with default factors for estimating net CSC in biomass in settlements remaining settlements.
- Parties may use models (tier 3) in order to report CSC and associated emissions/removals from settlements, and therefore particular attention is required in reviewing the TACCC of the models, particularly during an in-country review.

Lesson 9: Other land

1. Introduction

1.1. Lesson structure

Lesson 9 provides guidance for the review of information for the other land category within the LULUCF GHG inventory (see figure 9-1). Other land is one of the six land-use categories given in the 2006 IPCC Guidelines, and the last in the hierarchy provided in the same guidelines.



GG. Figure 9-1. Structure of lesson 9

The 2006 IPCC Guidelines provide guidance on how to estimate and report CSC and associated GHG emissions/removals from other land in chapter 9, volume 4. Furthermore, the Wetlands Supplement provides additional and updated methodologies, EFs and AD, which could be applied for estimating emissions and removals from lands with organic soils and wet and drained mineral soils relevant to land converted to other land.

Remember that the 2006 IPCC Guidelines considers it good practice for countries to use higher-tier methods for key categories and significant C pools. While all Parties should be able to prepare an inventory using the tier 1 methodology, Parties usually use higher-tier methods for some pools (e.g. biomass). Thus, most inventories are likely to include estimates prepared using a mix of tiers. The other land category and its subcategories/pools are not commonly identified as a key (i.e. for land converted to other land). But it may happen in cases, for example, of deforestation with subsequent severe degradation and release of carbon.

This lesson provides background information on the estimation and reporting of CSC and associated GHG emissions and removals from other land. It also presents category-specific guidance for reviewing the estimates of GHG emissions/removals and related information submitted by Parties in the other land category. Similarly to the previous lessons, this lesson ends with practical exercises and a self-check quiz are to help you enhance and refresh your knowledge.

It is suggested that you have the CRT readily available when you study this lesson, because it contains several references to them (highlighted in red text).

Finally, note that the review of the other land category in a Party's LULUCF GHG inventory related to the review considerations you have learned in the previous lessons. Therefore, you must always apply your knowledge of how to review cross-cutting and cross-sectoral issues, the land representation, C pools and other aspects found in lessons 2 and 3.

1.1. Learning objectives

At the end of this lesson you should:

- Know the requirements for reporting emissions/removals from other land by Parties;
- Be able to understand how CSC methods, AD, EFs and methods for collecting these apply to the other land category;
- Be able to understand the key areas for reviewing the GHG inventory information on the other land category.
-

The expected time needed to complete lesson 9 depends on the level of your knowledge of LULUCF GHG inventories under the MPGs and the 2006 IPCC Guidelines:
For readers with experience: 20–30 minutes
For readers with less experience: 30–50 minutes

2. Category overview and methodological information

2.1. Reporting overview

According to the 2006 IPCC Guidelines, other land includes bare soil, rock, ice and all land areas that do not fall into any of the other five categories. It allows the total of the identified land areas to match the national area, where data are available.
The reporting of land areas under other land in every year of the GHG inventory period is done in two main subcategories:

1. Other land remaining other land;
2. Land converted to other land.

HH. Figure 9-2. Other land

However, because other land includes lands with no significant C stocks, neither emissions nor removals are reported for the category other land remaining other land. For the category land converted to other land, the 2006 IPCC Guidelines default assumption is that all C stocks are oxidized as a consequence of the land conversion, and that there is no subsequent accumulation of C stocks.
As the 2006 IPCC Guidelines methods assume no significant C stocks in any lands classified under other land, the reviewer should pay particular attention to whether the Party is classifying under other land areas (managed and/or unmanaged) which contain significant C stocks that meet the definition of one of the other land-use categories.
The annual CSC in biomass (above-ground and below-ground), DOM and SOM pools from land converted to other land are reported in CRT 4.F. CSC in HWP are reported in CRT 4.Gs1 and CRT 4.Gs2, although it is less likely that HWP will originate from other land. For example, in rare cases, it could potentially originate from, for example, forest land converted to other land.

CRT 4(I) does not contain a dedicated section for reporting direct and indirect N_2O emissions from N inputs to managed soils for land converted to other land. However, the Party may report such emissions in the table section "H. Other", although it is rather unlikely that such a source category will occur.
Emissions from drainage of organic soils from land converted to other land are reported in CRT 4(II), although it is unlikely for land with organic soils to be converted to other land.
Direct and indirect N_2O emissions from N mineralization associated with loss of SOM in land converted to other land are reported in CRT 4(III).
N_2O and CH_4 emissions from biomass burning in land converted to other land are reported in CRT 4(IV).
CO_2 emissions may also be reported in CRT 4(IV) while avoiding double counting with the information reported in CRT 4.F.

Note that biomass burning also includes any burning of DOM and, if methods provided in the Wetlands Supplement are used, SOM in organic soils.

2.2. Methods and pools

The methodological tier to be applied for estimating CSC and other GHG emissions/removals depends on the significance of the reporting category and of the C pool, as well as the national circumstances. For this, the relevant decision trees contained in the 2006 IPCC Guidelines are to be followed by Parties.

To learn more on the methodological tiers, consult section 1.3.3 (figure 1.2 and figure 1.3), chapter 1, volume 4; figures 2.2, 2.3, 2.4, 2.5 and 2.6, chapter 2, volume 4; and figure 12.1, chapter 12, volume 4 of the 2006 IPCC Guidelines.

You have already learned in the previous lessons that Parties must provide GHG emissions/removals estimates for categories, pools and gases for which the 2006 IPCC Guidelines provide methodologies and EFs. Click on figure 9-3 to see the pools and gases for which emissions/removals estimates must be reported when tier 1 or tier 2 methods are applied.
Figure 9-4 summarizes the tier 1 and 2 methods to be applied, along with references to relevant equations in the 2006 IPCC Guidelines and the Wetlands Supplement.
As you can see, no CSC and GHG emissions/removals are reported for other land remaining other land category.
In accordance with the 2006 IPCC Guidelines, biomass and DOM stocks after conversion to other land are assumed to be zero under tier 1 and that there is no accumulation of C thereafter. For mineral soils, the reference C stock for other land when land is converted to other land is assumed to be zero as well under tier 1.

Tier 1			Land use													
			FL		CL		GL		WL			SL		OL	
Carbon pool – GHG			FL-FL	L-FL	CL-CL	L-CL	GL-GL	L-GL	WL-WL	L-WL		SL-SL	L-SL	OL-OL	L-OL
									PL-PL	L-PE	L-FIL				
Living biomass		Above-ground	M	M	M [a]	M [b, c]		M [b, c]		M [c]	M [c]		M [c]		M [c]
		Below-ground		M		M [b, c]		M [b, c]		M [c]	M [c]		M [c]		M [c]
Dead organic matter		Dead wood		M [c]		M [c]		M [c]					M [c]		M [c]
		Litter		M		M [c]		M [c]					M [c]		M [c]
Soil organic matter		Mineral		M	M	M	M	M					M		M [d]
		Organic	M	M	M	M	M	M	M [f]				M		
HWP			M (may be assumed 0 if net carbon stock change is judged insignificant)												
N_2O	Direct	Fertilization [e]	M	M					M	M	M	M	M		
		N mineralization		M		M	M [g]	M					M		M
		Drainage	M	M					M			M	M		
		Burning	M	M	M	M	M	M	M	M		M	M		M
	Indirect	Fertilization [e]	M	M					M	M	M	M	M		
		N mineralization		M		M	M [g]	M					M		M
CH_4		Burning	M	M	M	M	M	M	M	M		M	M		M

Tier 2		Land use											
		FL		CL		GL		WL			SL		OL	
Carbon pool – GHG		FL-FL	L-FL	CL-CL	L-CL	GL-GL	L-GL	WL-WL	L-WL		SL-SL	L-SL	OL-OL	L-OL
								PL-PL	L-PE	L-FIL				
Living biomass	Above-ground	M	M	M [a]	M [b]	M	M [b]		M	M	M	M		M
	Below-ground	M	M	M [a]	M [b]	M	M [b]		M	M	M	M		M
Dead organic matter	Dead wood	M	M	M	M	M	M		M		M	M		M
	Litter	M	M	M	M	M	M		M		M	M		M
Soil organic matter	Mineral	M	M	M	M	M	M				M	M		M
	Organic	M	M	M	M	M	M	M	M		M	M		
HWP		M												
N_2O	Direct	Fertilization [e]	M	M					M	M	M	M	M		
		N mineralization	M	M		M	M [g]	M				M	M		M
		Drainage	M	M					M	M		M	M		
		Burning	M	M	M	M	M	M	M	M		M	M		M
	Indirect	Fertilization [e]	M	M					M	M	M	M	M		
		N mineralization	M	M		M	M [g]	M				M	M		M
CH_4	Burning		M	M	M	M	M	M	M	M		M	M		M

Notes: grey shading = not applicable, blank = not mandatory.

Abbreviations: M = mandatory, GHG = greenhouse gas, FL = forest land, CL = cropland, GL = grassland, WL = wetlands, SL = settlements, OL = other land, PL = peatland, PE = peat extraction, FIL = flooded land, HWP = harvested wood products
FL–FL, CL-CL, GL-GL, WL-WL, PL-PL, SL-SL, OL-OL = indicate land category remaining under the current land use
L–FL, L-CL, L-GL, L-WL, L-PE, L-FIL, L-SL, L-OL = indicate land category converted to the current land use

[a] To be reported only for perennial crops.

[b] Net carbon stock gain in biomass pool for annual crops is to be reported only once in the year after conversion.

[c] Only applicable if the Party has reported carbon stock changes or the IPCC provides default carbon stock values for the biomass or DOM carbon stock for the previous land use. In such a case carbon stock is to be reported as instantaneously oxidized in the year of conversion.

[d] Carbon stock level after conversion is to be set at 0.

[e] N_2O emissions from N fertilization in forest land and settlements are to be reported under the LULUCF sector and those in cropland and managed grassland are to be reported in the agriculture sector. If the Party is not able to separate emissions from N fertilization in different land-use categories, all emissions are to be reported under the agriculture sector.

[f] Under tier 1 the activity data do not distinguish between peatlands under peat extraction and those being converted for peat extraction.

[g] N_2O emissions from grassland remaining grassland for agriculture purpose are reported under the agriculture sector.

II. Figure 9-3. Carbon pools and gases to be reported in the other land category under tier 1 and 2

Carbon stock changes in pools and associated GHG emissions/removals that must be estimated for other land

Carbon stock changes in pools and associated GHG emissions/removals that must be estimated at Tier 1 0 indicates that the tier 1 methodology assumes no net carbon stock change The IPCC equations to be applied are provided in parentheses Note that where activity data on land-use categories do not allow for the separation of OL-OL and L-OL, for the IPCC default, the latter category does not apply Note that in land under conversion from categories for which the IPCC does not provide default values for the biomass or DOM pools, reporting of carbon stock changes is nevertheless mandatory (to ensure accuracy) in case the Party has reported C stock changes in the pool under the previous land use								
	Biomass (B)		Dead organic matter (DOM)		Soil organic matter (SOM)		Harvested wood products (HWP)	Non-CO_2 emissions
	Above (AB)	Below (BB)	Dead wood (DW)	Litter (L)	Mineral soils (MS)	Organic soils (OS)	HWP	
OL-OL								
L-OL	Net C stock change (2.16)[1]		0	Net carbon stock change (2.23)[3]	Net carbon stock change (2.25)[1]	0[1],[2]	Assumed 0, if judged insignificant (i.e. annual net C stock change in HWP pool, is less than the size of any key category), otherwise default tier 1 methods provided in the 2006 IPCC Guidelines (volume 4, chapter 12) apply Note that HWP are reported altogether regardless of the land of origin of wood	Non-CO_2 emissions from biomass burning (2.27) N_2O emissions from SOM mineralization (11.8)[2] Indirect N_2O emissions (11.10)
Carbon stock changes in pools and associated GHG emissions/removals that must be estimated at Tier 2								
OL-OL								
L-OL	C stock change (2.16)[1]		C stock change (2.23)[3]		As tier 1	As tier 1	As tier 1	As tier 1

(1) Both Tier 1 and Tier 2 methods assume complete loss of biomass and DOM carbon stocks following conversion while only Tier 1 method assumes complete loss of SOM (although default SOC stock for organic soils are not provided by IPCC).

(2) Stock changes in organic soils are assumed to be insignificant as drainage is unlikely on other land. In case such assumption is not proven true, CO_2 and N_2O emissions have to be estimated and also CH_4 emissions are estimated if the Party applies the 2013 IPCC Supplement on Wetlands.

(3) The Tier 1 method assumes DOM stocks are insignificant for other land and only accounts for losses from previous land use for the conversion category from forest land.

JJ. Figure 9-4. Coverage of carbon pools and greenhouse gas emissions in the other land category in the 2006 IPCC Guidelines (tier 1 and 2)

3. Review approach

General review considerations

When reviewing other land estimates, you should always apply the guidance on general review issues for the LULUCF sector provided in lesson 2 and the guidance on the review of the land representation and C pools provided in lesson 3.

The following is a summary of general review considerations to refresh your memory:

- Assess whether categories, subcategories (e.g., forest land converted to other land) and subdivisions (e.g. coniferous forest land converted to other land) for which estimates are prepared are appropriate and correspond to the national circumstances. The review should be implemented at the level of subdivisions reported;
- Assess the consistency of the land representation;
- Assess whether non-reporting or incomplete reporting of the emissions and removals in C pools occur. Assess which C pools are to be mandatorily reported as per the 2006 IPCC Guidelines;
- Assess whether all GHG emissions associated with CSC have been estimated and if the GHG fluxes are consistent with each other (e.g. CH_4, N_2O emissions from biomass burning);
- Check whether the Party has reported uncertainties associated with the estimates for CSC, including information on uncertainties of the input data, noting the flexibility available to those developing country Parties that need it in the light of their capacities;
- Identify, in consultation with the Party concerned, potential areas of capacity-building needs, for those developing country Parties that need the flexibilities provided in the MPGs in the light of their capacities.

Review of methods, AD and parameters

Assess the appropriateness of the Party's choice of methodological tiers, AD, EFs and other parameters according to the significance of categories/subcategories and national circumstances and their proper documentation in the submission. Check also the transparency, accuracy, completeness and consistency of the estimates. The level of review should be based on the level of disaggregation in the subcategories reported and the methods used by a Party. Focus your review (time/resources) mainly on the key pools/subcategories that are likely to contribute the most to GHG emissions and removals from the other land category. The following points may help you structure your review work.

Check whether:

- The Party has reported information on the monitoring and identification of other land area;
- The total other land area is monitored and reported and AD match the information from other reliable national and/or international documents or sources (e.g. land-use/cover maps);
- Transition matrices for the years before the starting year of the inventory equal to the transition period applied are reported in the NID;
- Documentation on each methodology, including assumptions, AD, EFs and parameters, provided in the NID is transparent enough to allow the assessment of accuracy, completeness, consistency and comparability of the estimates;
- The methodologies and definitions are used consistently over the complete time series;

- The Party classifies areas containing significant C stocks or areas containing C stocks that meet the definition of other land-use categories as other land. If so, recommend that the Party reclassify those lands under forest land, cropland, grassland, settlements or wetlands; otherwise, inaccurate C stock gains and losses could be reported from land converted to/from other land. This is particular important when Parties use the other land category to include all unclassified land in order to match the total national area. Also, be aware that when this occurs for lands classified as unmanaged other land, the land under question has to be reclassified as unmanaged forest land, or as unmanaged grassland or as unmanaged wetlands, as appropriate according to national definitions;
- The methods and equations are correctly applied consistently with the 2006 IPCC Guidelines, and all gains and losses have been estimated for each C pool reported;
- There is a trend within the reported parameter values and the trend is explained in the NID;
- The estimation is based on the 2006 IPCC Guidelines default methodologies, and if so:
    - Is the category a key category? If so, is the choice of method appropriate to the significance of the category/subcategory/pool and national circumstances (assess data and resources available)?
    - Are emissions/removals from all mandatory C pools included in the GHG inventory? For example, under the tier 1 method, in accordance with the 2006 IPCC Guidelines, it is mandatory to estimate and report for land converted to other land CSC from mineral soils and living biomass and DOM in cases where the Party has reported CSC from living biomass and DOM in the previous land-use category;
    - Are the C stocks after the conversion to other land in all C pools taken as zero?
    - Does the estimation method ensure that no subsequent accumulation of C stocks in all C pools is included?
- The estimation is based on higher tiers (tier 2 or tier 3) together with country-specific parameters, and if so:
    - Has the Party provided proper documentation in the NID on the methodologies applied and country-specific parameter values, such as assumptions, principles, equations, and other key parameters, and data sources?
    - Are the C stocks after the conversion to other land in biomass and DOM pools taken as zero?
    - Has the Party used country-specific reference C stock values and stock change factors for mineral soils in other land, and if so, are they reasonable and verified? Has the Party taken the C stock in mineral soils in land converted to other land at the end of the transition period as zero?

Review of TACCC of information reported in the CRT

The following questions could help you in structuring your work towards assessing the TACCC of the reported information in the NID and CRT 4.F, CRT 4(II), CRT 4(III) and CRT 4(IV). Check each tab below to see a non-exhaustive list of checks.

General

Check whether:

- The Party correctly uses the signs in CRT (i.e. the sign is reversed when C stock gains/losses are expressed in CO_2 removals/emissions);
- The completeness of the reporting in CRT 4.F, CRT 4(II), CRT 4(III), and CRT 4(IV) is ensured or otherwise appropriate notation keys have been used when numerical values are not reported.

CRT 4.F

Check whether:

- The Party has reported estimates for land converted to other land by land-use category, or it has provided only the total value for land converted to other land. In the latter case:
  - Has the Party provided information on which type of conversions are included in the documentation box and in the NID?
- The Party has reported estimates for CSC in all C pools for land converted to other land, and if not, whether it has provided a justification for any exclusion in the documentation box and in the NID.

CRT 4(II)

Check whether:

- The Party has reported emissions from drainage of organic soils in land converted to other land, noting that it is rather unlikely for this source to occur in other land.

CRT 4(III)

Check whether:

- The Party has reported estimates of direct and indirect N_2O emissions associated with mineralization of SOM in mineral soils in other land.

CRT 4(IV)

Check whether:

- The Party has reported emissions from biomass burning in other land and if so, it has reported estimates of CO_2 from burning in CRT 4.F or in CRT 4(IV) and proper documentation has been provided in the NID and the documentation box in CRT 4(IV).

4. Practical exercises

Exercise 1

A Party includes all unmanaged land under other land, claiming that no data are available for classifying the unmanaged land under the different land-use categories. The Party applies the 2006 IPCC Guidelines default methods for estimating CSC and associated emissions, in land converted to and from other land. In particular, you noted that in year X, the Party reclassifies as unmanaged land an area of formerly managed degraded grassland, thereby transferring that land to the grassland converted to other land category. The Party reports, under grassland converted to other land, loss of the entire biomass and SOC present on the degraded grassland in the year of conversion.

Question 1

How would you address this specific issue in your review?

4.1. Answer key to practical exercises

Question 1

You should consider the following issues:
Firstly, when a managed land is converted to unmanaged land, CSC need to be reported until the new equilibrium level of C stocks is achieved. Therefore, SOC changes need to be reported for a time series of years equivalent to the transition period (default period in the 2006 IPCC Guidelines is 20 years). Secondly, the 2006 IPCC Guidelines default assumption of zero C stocks in other land is not valid for all unmanaged lands in this case, and therefore the reported C stock loss for land converted to other land by the Party is inaccurate, especially considering that the conversion from managed degraded grassland to unmanaged grassland is likely to result in an increase of SOC in that land. Therefore, during the review you must request from the Party relevant information to clarify the above situation. As a reviewer, you must recommend that in order to accurately estimate emissions and removals, the Party classify managed grassland converted to unmanaged grassland as a subcategory of grassland remaining grassland, instead of other land for the transition period.

5. Self-check quiz

Question 1

The land-use category other land includes all unmanaged lands that do not fall into any of the other land-use categories.

Select one:

A. Yes
B. No

Question 2

Lakes and rivers should be included in other land.

Select one:

A. True
B. False

5.1. Answer key to self-check quiz

Question 1

The correct answer is (A).
The other land category includes bare soil, rock, ice and all land areas that do not fall into any of the other five land-use categories.

Question 2

The correct answer is (B).
According to the 2006 IPCC Guidelines land-use definitions, lakes and rivers should be included in unmanaged wetlands.

6. Key points to remember

- In order to successfully review the other land category, you must have adequate knowledge of the general LULUCF aspects covered in lesson 2 and how to review the land representation and information related to C pools covered in lesson 3.
- Other land is the last land-use category in the hierarchy provided in the 2006 IPCC Guidelines.
- The reviewer should pay particular attention to which lands are classified under other land.
- In cases where the Party classifies areas containing significant C stocks or C stocks that meet the definition of other land-use categories as other land, it must revise its approach by reclassifying those lands under one of the other land-use categories, as appropriate.
- Other land is often unmanaged land.
- Other land includes lands with no significant C stocks, and as such neither emissions nor removals are reported for the category other land remaining other land.
- Biomass and DOM stocks after the conversion to other land are assumed to be zero under tier 1 with no accumulation of C thereafter. The reference C stock of mineral soils for other land when land is converted to other land is assumed to be zero under tier 1.
- If land converted to other land is identified as key (which is rather unlikely), its significant subcategories and C pools (based on significance analysis) must be identified and CSC from these pools should be reported in accordance with the suggested methodology as per the 2006 IPCC Guidelines.

References

List of references (please choose Style "Normal" and please have one space between references as shown below).

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United Nations Statistics Division. Available at: <http://data.un.org/>