2013 REVISED SUPPLEMENTARY METHODS AND GOOD PRACTICE GUIDANCE ARISING FROM THE KYOTO PROTOCOL

OVERVIEW

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1 INTRODUCTION

The 2013 Revised Supplementary Methods and Good Practice Guidance Arising from the Kyoto Protocol *(KP Supplement)* provides supplementary methods and *good practice* guidance for measuring, estimating and reporting anthropogenic greenhouse gas emissions and removals resulting from land use, land-use change and forestry (LULUCF) activities under Article 3.3 and Article 3.4 of the Kyoto Protocol (KP) for the second commitment period, 2013-2020.

The *KP Supplement* was requested by the Decision[1] on LULUCF of the UNFCCC Conference of the Parties Serving as the Meeting of the Parties to the KP, taken in Durban in 2011. The *KP Supplement* updates Chapter 4 of the Good Practice Guidance for Land Use, Land-Use Change and Forestry[2] (*GPG-LULUCF)*, which provides supplementary methods for LULUCF activities for the first commitment period, 2008-2012. The structure and wording of Chapter 4 have been maintained wherever possible. Consistent with the decision of the IPCC Plenary[3], the *KP Supplement* does not update Section 4.3 of *GPG-LULUCF*, which concerns LULUCF projects hosted by Parties listed in Annex B of the Kyoto Protocol (Joint Implementation projects), and Afforestation or Reforestation projects hosted by Parties not listed in Annex I of the UNFCCC (Clean Development Mechanism projects).

Under the provisions of Article 7.1 of the KP, Parties include, in their annual greenhouse gas inventories and national inventory reports, supplementary information relating to anthropogenic emissions by sources and removals by sinks of CO_2 and other greenhouse gases associated with LULUCF activities under Articles 3.3 and 3.4 of the KP. [4] The activities included under Article 3.3 are Afforestation (A), Reforestation (R) and Deforestation (D) since 1990. For the second commitment period activities under Article 3.4 are Forest Management (FM), which is mandatory, and elective activities, namely Revegetation, Cropland Management, Grazing Land Management, and Wetland Drainage and Rewetting.[5]

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[1] Decision 2/CMP.7 (Land use, land-use change and forestry) contained in document FCCC/KP/CMP/2011/10/Add.1.

[2] Intergovernmental Panel on Climate Change (IPCC) (2003). Penman J., Gytarsky M., Hiraishi T., Krug, T., Kruger D., Pipatti R., Buendia L., Miwa K., Ngara T., Tanabe K., and Wagner F (Eds). *Good Practice Guidance for Land Use, land-Use Change and Forestry* IPCC/IGES, Hayama, Japan.

[3] Decision of the IPCC Panel at its 35th Session.

[4] See Articles 3.3, 3.4, 3.7, 6 and 12 of the Kyoto Protocol (http://unfccc.int/resource/docs/convkp/kpeng.pdf) and Decisions 16/CMP.1, 18/CMP.1, 22/CMP.1 as contained in FCCC/KP/CMP/2005/8/Add.3, and 2/CMP.7 contained in FCCC/KP/CMP/2011/10/Add.1.

[5] LULUCF related requirements are contained in Decision 16/CMP.1 (Land use, land-use change and forestry) and Decision 2/CMP.7 (Land use, land-use change and forestry) contained in documents FCCC/CP/2001/13/Add.1, and FCCC/KP/CMP/2011/10/Add.1, p.13 respectively. Decision 2/CMP.6 establishes that for the second commitment period *definitions of forest, afforestation, reforestation, revegetation, forest management, cropland management and grazing land management shall be the same as in the first commitment period under the Kyoto Protocol*. The activities are defined as follows:

"Afforestation" is the direct human-induced conversion of land that has not been forested for a period of at least 50 years to forested land through planting, seeding and/or the human-induced promotion of natural seed sources.

"Reforestation" is the direct human-induced conversion of non-forested land to forested land through planting, seeding and/or the human-induced promotion of natural seed sources, on land that was forested but that has been converted to non-forested land. For the first commitment period, reforestation activities will be limited to reforestation occurring on those lands that did not contain forest 31 December 1989.

"Deforestation" is the direct human-induced conversion of forested land to non-forested land.

"Forest management" is a system of practices for stewardship and use of forest land aimed at fulfilling relevant ecological (including biological diversity), economic and social functions of the forest in a sustainable manner.

"Cropland management" is the system of practices on land on which agricultural crops are grown and on land that is set aside or temporarily not being used for crop production.

"Grazing land management" is the system of practices on land used for livestock production aimed at manipulating the amount and type of vegetation and livestock produced.

"Revegetation" is a direct human-induced activity to increase carbon stocks on sites through the establishment of vegetation that covers a minimum area of 0.05 hectares and does not meet the definitions of afforestation and reforestation contained here.

The *KP Supplement* builds on methods and guidance provided by the 2006 IPCC Guidelines for National Greenhouse Gas Inventories (*2006 IPCC Guidelines*). The *2006 IPCC Guidelines* were themselves prepared in response to an invitation from the Parties to the UNFCCC, and are now agreed for use for reporting from 2015 by Annex I Parties to the UNFCCC and the KP[6]. The *2006 IPCC Guidelines* build upon IPCC's previously developed Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories[7] (*1996 IPCC Guidelines*) which, together with the Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories[8] *(GPG2000)* and the *GPG-LULUCF*, provide the internationally agreed[9] methodologies that countries currently use to estimate greenhouse gas inventories to report under the UNFCCC and the KP.

2 BACKGROUND

The UNFCCC Conference of the Parties serving as the Meeting of the Parties to the Kyoto Protocol at its seventh session (CMP 7), held in December 2011 in Durban, South Africa, invited the IPCC to:

> *…review and, if necessary, update supplementary methodologies for estimating anthropogenic greenhouse gas emissions by sources and removals by sinks resulting from land use, land-use change and forestry activities under Article 3, paragraphs 3 and 4, of the Kyoto Protocol, related to the annex to this decision, on the basis of, inter alia, chapter 4 of its Good Practice Guidance for Land Use, Land-Use Change and Forestry*[10].

The Subsidiary Body for Scientific and Technological Advice at its thirty-sixth session (SBSTA 36) invited the IPCC to consider completing the work on the *KP Supplement* within a revised time frame, by October 2013, to allow for adoption of a decision on this matter by the CMP at its ninth session (CMP 9).

In response to the UNFCCC's invitation, the need to update Chapter 4 was considered at the IPCC Scoping Meeting to consider the Invitation from UNFCCC CMP 7 that took place in Geneva in May 2012[11]. The Scoping Meeting concluded that, whilst much of the structure and the content of Chapter 4 remains relevant and useful, there was a need for significant updating to take account of the Decision 2/CMP.7 (LULUCF), other relevant decisions by COP and CMP, the *2006 IPCC Guidelines*, IPCC's work on wetlands[12], and other IPCC products, and developments in the scientific literature.

The IPCC at its 35th Session decided to produce the *KP Supplement* by the revised target date of October 2013 and agreed Terms of Reference, a Table of Contents and a Workplan[13]. The Workplan envisaged completion in

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"Wetland drainage and rewetting" is a system of practices for draining and rewetting on land with organic soil that covers a minimum area of 1 hectare. The activity applies to all lands that have been drained since 1990 and to all lands that have been rewetted since 1990 and that are not accounted for under any other activity as defined above, where drainage is the direct human-induced lowing of the soil water table and rewetting is the direct human-induced partial or total reversal of drainage.

[6] Decision 15/CP.17 contained in document FCCC/CP/2011/9/Add.2 and Decision 4/CMP.7 contained in document FCCC/KP/CMP/2011/10/Add.1.

[7] Intergovernmental Panel on Climate Change (IPCC) (1997). Houghton J.T., Meira Filho L.G., Lim B., Tréanton K., Mamaty I., Bonduki Y., Griggs D.J. and Callander B.A. (Eds). *Revised 1996 IPCC Guidelines for National Greenhouse Inventories*. IPCC/OECD/IEA, Paris, France.

[8] Intergovernmental Panel on Climate Change (IPCC) (2000). Penman J., Kruger D., Galbally I., Hiraishi T., Nyenzi B., Emmanuel S., Buendia L., Hoppaus R., Martinsen T., Meijer J., Miwa K., and Tanabe K. (Eds). *Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories*. IPCC/OECD/IEA/IGES, Hayama, Japan.

[9] See the Report of the Fourth Session of the Subsidiary Body for Scientific and Technological Advice (FCCC/SBSTA/1996/20), paragraph 30; decisions 2/CP.3 and 3/CP.5 (UNFCCC reporting guidelines for preparation of national communications by Parties included in Annex I to the Convention, part I: UNFCCC reporting guidelines on annual inventories), decision 18/CP.8, revising the guidelines adopted under decisions 3/CP.5, and 17/CP.8 adopting improved guidelines for the preparation of national communications from Parties not included in Annex I to the Convention, and subsequent decisions 13/CP.9 and Draft Decision /CP.10.

[10] See paragraph 8 of Decision 2/CMP.7 in FCCC/KP/CMP/2011/10/Add.1 (http://unfccc.int/resource/docs/2011/cmp7/eng/10a01.pdf)

[11] See http://www.ipcc-nggip.iges.or.jp/newsdoc/120611TORetc.pdf

[12] IPCC TFI is also producing The 2013 Supplement to the *2006 IPCC Guidelines* for National Greenhouse Gas Inventories: Wetlands (*Wetlands Supplement*) that provides methods for estimating anthropogenic emissions and removals of greenhouse gases from wetlands (lands that are saturated by water for all or part of the year). This work is due to be completed in October 2013 (http://www.ipcc-nggip.iges.or.jp/home/wetlands.html).

[13] See http://www.ipcc-nggip.iges.or.jp/home/2013KPSupplementaryGuidance_inv.html.

time for adoption and acceptance at the 37th session of the IPCC, in October 2013, in accordance with the revised timeframe as requested by SBSTA 36. The Terms of Reference specified that the revision of Chapter 4 of the *GPG-LULUCF* should be consistent with the *2006 IPCC Guidelines* and with decisions of the COP and CMP. It should not revise or replace the *2006 IPCC Guidelines* and maintain the structure and content of the existing Chapter 4 of the *GPG-LULUCF*.

3 THE NEED TO UPDATE CHAPTER 4 OF GPG LULUCF

Chapter 4 of the *GPG-LULUCF* provides supplementary methods and *good practice* guidance related to LULUCF activities based on the general greenhouse gas inventory guidance provided in other chapters of the *GPG-LULUCF* and the rules governing the treatment of LULUCF activities in the first commitment period of KP[14]. The need to review and update Chapter 4 of the *GPG-LULUCF* arises because:

firstly, the rules for LULUCF for the second commitment period under the KP differ in some respects from the rules for the first commitment period.

secondly, since Chapter 4 of *GPG-LULUCF* was intended to be used with the latest IPCC guidance on LULUCF, updating is needed in the light of the CMP decision to use the *2006 IPCC Guidelines* for the second commitment period under the KP[15].

The new rules for the treatment of LULUCF in the second commitment period of KP agreed by CMP 7 contain, amongst other things, new provisions on Forest Management, emissions associated with natural disturbances in forests, harvested wood products (HWP), and Wetland Drainage and Rewetting, which are not covered in the existing Chapter 4 of the *GPG-LULUCF*. Table 1 provides details of the important changes in the treatment of LULUCF activities in the second commitment period of the Kyoto Protocol under Decision 2/CMP.7.

The changes required for *KP Supplement* can be classified as follows:

- *Changes stemming from the use of the 2006 IPCC Guidelines.* These include the changes needed to make the general GHG inventory-related guidance in Chapter 4 consistent with the *2006 IPCC Guidelines.*
- *Changes pursuant to Decision 2/CMP.7.* These include:

  (i) General consequential changes such as:

  - Making reference to the "second commitment period" and updating references to CMP decisions;
  - Changes reflecting the mandatory nature of FM activity; inclusion of wetlands drainage and rewetting (WDR) as an elective activity under Article 3.4; and inclusion of HWP pool for mandatory reporting.

  (ii) Substantive changes reflecting the revised rules governing the treatment of LULUCF in the second commitment period of KP. These are summarized in Table 1. The changes involve adding new guidance and updating the existing guidance including decision trees and figures.

TABLE 1
CHANGES IN THE TREATMENT OF LULUCF IN THE SECOND COMMITMENT PERIOD OF THE KYOTO PROTOCOL PURSUANT TO DECISION 2/CMP.7

Element	2/CMP.7	16/CMP.1
Forest management (FM)	• FM shall be mandatorily accounted for along with Art. 3.3 activities and Art. 3.4 activities elected in the first commitment period. • Accounting for FM shall be done on the basis of the reference level (FMRL) given in the appendix to the Decision 2/CMP.7. • Annex I Parties shall demonstrate methodological consistency between the FMRL	• FM is an elective activity under Article 3.4. • Accounting of FM is to be done on a "gross-net" basis.

[14] Decision 16/CMP.1 (Land use, land-use change and forestry) contained in document FCCC/KP/CMP/2005/8/Add.3.

[15] Decision 4/CMP.7 contained in document FCCC/KP/CMP/2011/10/Add.1.

	and reporting for FM during the second commitment period, including in area accounted for; the treatment of HWP and accounting of any emissions from natural disturbances. • Parties shall make technical corrections, if necessary, to ensure consistency between FMRL and reporting of FM in the commitment period, including applying IPCC methods for ensuring time-series consistency. • Technical corrections shall be applied after adoption of the FMRL if the reported data used to establish the reference level are subject to recalculations, to include in accounting the effect of the recalculations.	
Accounting of harvested wood products (HWP)	• HWP from a Party's forest shall be accounted for by the Party itself and imported HWP shall not be accounted by the Party. • Accounting of HWP shall be on the basis of instantaneous oxidation. • Notwithstanding the above, if transparent and verifiable activity data (AD) for the specified categories is available, accounting of HWP shall be using first-order decay (FOD) with default half-lives provided in the Decision 2/CMP.7 (based on *GPG-LULUCF*). In the case of projected FMRL, instantaneous oxidation is not applicable. • Parties may also use country-specific half-lives (if transparent and verifiable AD is available) or methodologies and definitions from the most recently adopted IPCC Guidelines if transparent and verifiable AD is available and these are at least as detailed and accurate as the above. • HWP resulting from deforestation, solid waste disposal sites (where accounted separately) and wood used for energy purposes shall be accounted for on the basis of instantaneous oxidation. • Emissions from HWP in the second commitment period from HWP removed from forests in the first commitment period shall also be accounted for but excluding those already accounted for using instantaneous oxidation in the first commitment period. • For FM, Parties can choose not to account for HWP from forests before the second commitment period if FMRL is based on projections but consistency of treatment between FMRL and the reporting of FM shall be maintained.	• HWP pool not accounted, or equivalently assumed to be instantaneously oxidised.
Treatment of natural disturbances	• *Natural disturbances are non-anthropogenic events or non-anthropogenic circumstances. For the purposes of this decision, these events or circumstances are those that cause significant emissions in forests and are beyond the control of, and not materially influenced by, a Party. These may include wildfires, insect and disease infestations, extreme weather events*	• All emissions and subsequent removals from natural disturbances on (units of) lands subject to an activity (ARD or FM) are to be accounted for under that activity[16].

[16] The emissions and subsequent removals from natural disturbances are to be estimated using relevant methodological guidance provided in GPG LULUCF.

	and/or geological disturbances, beyond the control of, and not materially influenced by, a Party. These exclude harvesting and prescribed burning.
	Parties can choose to exclude from accounting of ARD and FM (either annually or at the end of second commitment period) emissions from natural disturbances that in any single year exceed the FM background-level **(**including margins if any) of emissions. (In the case of FM, this background level is to be included in its FMRL).
	• Background level has to be derived without expectation of net debits or credits including the use of margins, if needed.
	• Subsequent removals from lands affected by the natural disturbance shall also be excluded.
	• Parties shall provide country-specific information in their National Inventory Report (NIR) for 2015 on estimation of their background level and how the expectation of net credit/debit has been avoided including the use of margins.
	• Parties shall account for emissions from salvage logging and shall not exclude the emissions from natural disturbances if followed by land-use change.
	• Parties shall provide transparent information on:
	  • Identification of the lands subject to natural disturbance (geo-referenced location, year and types of natural disturbance);
	  • Estimation of annual emissions resulting from natural disturbance.
	• Parties shall also provide transparent information demonstrating:
	  • No land-use change has occurred and methods and criteria for identifying any future land use changes;
	  • Occurrences were beyond the control of and not influenced by the Party;
	  • Efforts made to rehabilitate the lands;
	  • Inclusion of salvage logging emissions.	

Treatment of emissions from harvest and conversion of forest plantations to non-forests[17]	• Parties may include in its accounting under Article 3.4 (FM) emissions/removals from harvest and conversion of forest plantations provided the following conditions are met:
	  • The plantation was first established before 1 January 1990 or re-established after 1 January 1960 by direct human-induced planting and/or seeding of non-forest land;
	  • A new forest of at least equivalent area and the potential to reach equivalent C stocks in the normal harvesting cycle as the harvested plantation at the time of harvest is established on a non-forested land by direct human-induced planting and/or seeding on land that did not contain forest on 31 December 1989.
		• Emissions/removals from harvest and conversion of forest plantations are to be accounted for under deforestation (D) activity.

[17] The Carbon Equivalent Forest Conversion provisions

	• A debit under Art 3.4 is generated if the newly established forest does not reach at least the equivalent carbon stock. • All lands and pools associated with the provisions continue to be identified, monitored, reported (including geo-referenced location and the year of conversion) and accounted for under FM.	
Inclusion of wetland drainage and rewetting (WDR) as an elective activity under Article 3.4	• WDR was added as a new elective activity under Art. 3.4 by Decision 2/CMP.7. • "*Wetland drainage and rewetting" is a system of practices for draining and rewetting on land with organic soil that covers a minimum area of 1 hectare. The activity applies to all lands that have been drained since 1990 and to all lands that have been rewetted since 1990 and that are not accounted for under any other activity as defined in this annex where drainage is the direct human-induced lowering of the soil water table and rewetting is the direct human-induced partial or total reversal of drainage.* • Estimation methodology for WDR shall be based on the most recently adopted IPCC guidelines and any subsequent clarifications. • Accounting for WDR shall be done on a "net-net" basis.	• WDR is not part of the elective activities under Article 3.4[18].
Other changes	• Parties shall report and account for all emissions from conversion of natural forests to planted forests.	• Reporting and accounting for all emissions from conversions of natural forests to planted forests is to be included under FM activity.

4 STRUCTURE AND CONTENT OF THE KP SUPPLEMENT

KP Supplement maintains the structure and general content of Chapter 4 in *GPG-LULUCF*. Wherever necessary it replaces references to the *GPG-LULUCF* by those to *2006 IPCC Guidelines*, and adds additional material to existing sections or adds new sections where required by the new rules. It updates Chapter 4 of the *GPG-LULUCF* to be consistent with the *2006 IPCC Guidelines* but does not revise or replace the *2006 IPCC Guidelines*.

There are two chapters in the *KP Supplement* corresponding to the first two main sections of Chapter 4 of the *GPG-LULUCF*:

Chapter 1: Introduction

This chapter deals with overview of steps to estimate and report supplementary information for Article 3.3 and 3.4 activities; general rules for categorisation of lands under Articles 3.3 and 3.4 activities; and relationship between Annex I national inventories and Article 6 projects. Updates include:

(i) Changes to steps for reporting supplementary information and the general rules for categorisation of lands under Articles 3.3 and 3.4 lands including the reporting hierarchy of activities, due to FM being made a mandatory activity and inclusion of WDR as an elective activity under Article 3.4;

(ii) Updating all decision trees and figures to reflect Decision 2/CMP.7.

Chapter 2: Methods for estimation, measurement, monitoring and reporting of LULUCF activities under Articles 3.3 and 3.4

[18] Wetlands subject to drainage and rewetting since 1990 could potentially be included in any other Article 3.3 or 3.4 activity under the rules in the first commitment period (see Sections 1.1, 1.2 and 2.12).

This chapter includes generic and activity-specific methodological guidance on area identification, stratification and reporting; and estimation of carbon stock changes and non-CO_2 emissions and removals. Some new sections have been added and the existing guidance in Chapter 4 of *GPG LULUCF* has been extensively revised and expanded to reflect the changes stemming from Decision 2/CMP.7 and the use of the *2006 IPCC Guidelines*. Main changes include:

(i) Revision of the section on "Disturbances" (Section 2.3.9; Section 4.2.3.6 in Chapter 4 of *GPG-LULUCF*) in the light of the new rules regarding the treatment of emissions from natural disturbances in ARD and FM lands;

(ii) Addition of new sections on Forest Management Reference Levels (FMRL) (Section 2.7.5), Technical Corrections (Section 2.7.6) and Carbon Equivalent Forests (Section 2.7.7);

(iii) Addition of a new section on Harvested Wood Products (HWP) (Section 2.8);

(iv) Addition of a new section on Wetland Drainage and Rewetting (WDR) (Section 2.12).

Table 2 shows the Table of Contents of the *KP Supplement*. The new sections are shown by an asterisk (*).

TABLE 2
TABLE OF CONTENTS OF THE *KP SUPPLEMENT*

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Chapter1: Introduction	1.1 Introduction 1.2 Overview of steps to estimating and reporting supplementary information for activities under Articles 3.3, 3.4 and 6 1.2 General rules for categorisation of land areas under Articles 3.3 and 3.4 1.3 Relationship between Annex I Parties' national inventories and Article 6 LULUCF projects
Chapter 2: Methods for estimation, measurement, monitoring and reporting of LULUCF activities under Articles 3.3 and 3.4	2.1 Relationship between UNFCCC land-use categories and Kyoto Protocol (Articles 3.3 and 3.4) land-use categories 2.2 Generic methodologies for area identification, stratification and reporting 2.2.1 Reporting requirements 2.2.2 Reporting Methods for Lands subject to Article 3.3 and Article 3.4 activities 2.2.3 Reporting Methods for Lands subject to Additional Accounting Provisions for CP2 and beyond* 2.2.4 Relationship between Approaches in Chapter 3, Volume 4 of the *2006 IPCC Guidelines* and Reporting methods in Section 2.2.2 2.2.5 Choice of Reporting Method 2.2.6 How to identify lands in general 2.3 Generic Methodological Issues for Estimating Carbon Stock Changes and Non-CO_2 Greenhouse Gas Emissions 2.3.1 Pools to be reported 2.3.2 Years for which to estimate carbon stock changes and non-CO_2 greenhouse gas emissions 2.3.3 Correct implementation of C stock change estimation methods when areas are changing* 2.3.4 Relationship between measurement and reporting intervals 2.3.5 Interannual Variability* 2.3.6 Choice of method 2.3.7 Factoring out indirect, natural and pre-1990 effects 2.3.8 Reference Levels* 2.3.9 Disturbances 2.4 Other generic methodological issues 2.4.1 Developing a consistent time series 2.4.2 Recalculation of Time Series* 2.4.3 Uncertainty assessment 2.4.4 Reporting and documentation 2.4.5 Quality assurance and quality control

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*New sections added to the *KP Supplement.*

5 POLICY RELEVANCE

For Kyoto Protocol reporting, *KP Supplement* aims to provide policy-neutral scientific operationalization of the agreement set out in Decision 2/CMP.7. On some specific points, the *KP Supplement:*

- Provides guidance on *estimating* and reporting anthropogenic *emissions and removals.* It does not deal with *accounting*, which covers the rules by which the UNFCCC uses reported information to assess how Parties are complying with commitments, except in so far as accounting rules need to be reflected in guidance on emissions and removals estimation and reporting. The *Supplement* aims to be consistent with Decisions of the CMP but not to extend them. The word *shall* is therefore only used when Decisions are quoted directly.

- Combines the concepts of *units of land* and *land*. Chapter 4 of the *GPG-LULUCF* uses the former in the context of Art 3.3 activities and the latter in the context of Art 3.4. This reflects the usage in Decisions 15/CMP.1 and 16/CMP1, but the methodological treatment of land identification in Chapter 4 of the *GPG-LULUCF* is the same in both cases, so uniting the concepts simplifies the text and avoids the impression that Parties need to treat the cases differently, which would increase costs.

- Recognises that whilst the definition of forest adopted by 16/CMP.1 and taken over by 2/CMP.7 for the second commitment period, is based on area, tree height and canopy cover thresholds, in implementing this definition many countries, consistent with information that they report to FAO, do not count as forested, land which meets these definitions but is predominantly under agricultural or urban land use. The *KP Supplement* provides guidance in the case that a pure threshold definition is applied, and also in the case that predominant land use is taken into account. This guidance is to ensure transparency in the criteria adopted for land identification, consistency in their application, and consistency with categories reported previously.

- Also on definitions, the *KP Supplement* continues to use the date of 31 December 1989 in the definition of Reforestation for the second commitment period, but recognises there are continuing discussions on this question. The methodologies are flexible enough to accommodate possible outcomes of discussions on this question.

- Clarifies the guidance on hierarchies between Art 3.3 and 3.4 activities, but maintains the prioritisation in the ordering of Deforestation under Art 3.3. This has the consequence (revealed by secondary classification) that Deforestation land can contain trees, if it has been subsequently reforested. The approach shows transparently the sequences that have occurred.

- On the disturbance provisions, provides guidance that all emissions and removals on land affected would need to be removed from accounting unless there is land-use change or salvage logging. This is consistent with Decision 2/CMP.7 and reflects the difficulty in practice of separating on any particular land the emissions and removals due to a disturbance from other emissions and removals.

- Avoids making judgements about rules beyond the second commitment period, for example concerning land use change occurring after the end of the second commitment period on land to which natural disturbance provisions were applied, and hence emissions excluded, during the second commitment period.

CHAPTER 1

INTRODUCTION

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1.1 INTRODUCTION

This document describes the supplementary methods and *good practice* guidance for measuring, estimating and reporting of anthropogenic greenhouse gas (GHG) emissions and removals resulting from land use, land-use change and forestry (LULUCF) activities covered by the Kyoto Protocol (KP) for the second commitment period. The document addresses activities under Article 3.3, Forest Management and elected activities under Article 3.4. The supplementary methods and *good practice* guidance of this document apply to each Party included in Annex I that have ratified the KP for the second commitment period. This document does not deal with accounting, which covers the rules by which the United Nations Framework Convention on Climate Change (UNFCCC) uses reported information to assess how Parties are complying with commitments, except where accounting rules need to be reflected in guidance on emissions estimation and reporting. This document also does not provide good practice guidance for LULUCF projects hosted by Parties listed in Annex B (Article 6 projects) and Afforestation/Reforestation projects hosted by Parties not listed in Annex B of the KP (Article 12, Clean Development Mechanism or CDM projects), which are addressed in Section 4.3 of the Good Practice Guidance for Land Use, Land-Use Change and Forestry (*GPG-LULUCF*).

Under the KP, Parties are to report emissions by sources and removals by sinks of CO_2 and other specified greenhouse gases resulting from LULUCF activities. These include activities for which reporting is mandatory under Article 3.3, i.e. Afforestation (A), Reforestation (R) and Deforestation (D) that occurred since 1990; and under Article 3.4, Forest Management (FM), and any human-induced activities elected by the Party. These can include: Cropland Management (CM), Grazing land Management (GM), Revegetation (RV), and Wetland Drainage and Rewetting (WDR).[1] To ensure compliance with emission-limitation and reduction commitments in the commitment period, Parties are required to provide in addition to the annual National Inventory Reports (NIR) using Common Reporting Format (CRF) tables to report greenhouse gas emissions by sources and removals by sinks, supplementary information related to LULUCF under the provisions of the KP[2]. The annual reporting requirement does not imply a need for annual measurements, but Parties are expected to develop systems that combine measurements, models and other tools that enable them to report on an annual basis. Although the rules under the KP require annual reporting, they allow for accounting either annually or over the entire commitment period.

This supplementary methods and *good practice* guidance document builds on methods and guidance provided by the 2006 IPCC Guidelines for National Greenhouse Gas Inventories (*2006 IPCC Guidelines*) and it replaces

[1] LULUCF related requirements are outlined in Decision 16/CMP.1 and Decision 2/CMP.7 (Land use, land-use change and forestry) contained in document FCCC/CP/2001/13/Add.1, p.58 and FCCC/KP/CMP/2011/10/Add.1, p.13 respectively:

"Afforestation" is the direct human-induced conversion of land that has not been forested for a period of at least 50 years to forested land through planting, seeding and/or the human-induced promotion of natural seed sources.

"Reforestation" is the direct human-induced conversion of non-forested land to forested land through planting, seeding and/or the human-induced promotion of natural seed sources, on land that was forested but that has been converted to non-forested land. For the first commitment period, Reforestation activities will be limited to Reforestation occurring on those lands that did not contain forest on 31 December 1989.

"Deforestation" is the direct human-induced conversion of forested land to non-forested land.

"Forest management" is a system of practices for stewardship and use of forest land aimed at fulfilling relevant ecological (including biological diversity), economic and social functions of the forest in a sustainable manner.

"Cropland management" is the system of practices on land on which agricultural crops are grown and on land that is set aside or temporarily not being used for crop production.

"Grazing land management" is the system of practices on land used for livestock production aimed at manipulating the amount and type of vegetation and livestock produced.

"Revegetation" is a direct human-induced activity to increase carbon stocks on sites through the establishment of vegetation that covers a minimum area of 0.05 hectares and does not meet the definitions of Afforestation and Reforestation contained here.

"Wetland drainage and rewetting" is a system of practices for draining and rewetting on land with organic soil that covers a minimum area of 1 hectare. The activity applies to all lands that have been drained since 1990 and to all lands that have been rewetted since 1990 and that are not accounted for under any other activity as defined above, where drainage is the direct human-induced lowering of the soil water table and rewetting is the direct human-induced partial or total reversal of drainage.

[2] See Articles 3.3, 3.4, 3.7, 6 and 12 of the Kyoto Protocol (http://unfccc.int/resource/docs/convkp/kpeng.pdf) and Decisions 16/CMP.1, 15/CP.17, 4/CMP.7, 2/CMP.7, and 2/CMP.8.

Chapter 4 (except Section 4.3 on projects) of the *GPG-LULUCF*. The structure and general content of Chapter 4 of the *GPG-LULUCF* have been maintained wherever possible for reasons of consistency.

By definition *good practice* GHG inventories are those which contain neither over- nor underestimates so far as can be judged, and in which uncertainties are reduced, so far as is practicable. When we write "it is *good practice* to..." we mean that the guidance that follows contributes to producing GHG inventories consistent with *good practice*.

Relationship between UNFCCC and Kyoto Protocol reporting:

The information to be reported under the KP is supplementary to the information reported under the UNFCCC. A Party included in Annex I does not need to submit two separate annual inventories but should provide supplementary information under the KP, within the inventory report.[3] Each Party included in Annex I to the Convention which is also a Party to the KP will be subject to the review of submitted information in accordance with relevant decisions under Article 8 of the KP.

National circumstances, and specifically the technical details of the greenhouse gas reporting systems put into place by each country, will determine the sequence in which the reporting information is compiled. In practice, it is possible to start with the UNFCCC inventory (with the additional spatial information required for KP reporting) and expand it to the KP inventory, or it is possible to use a national system that generates the information for both UNFCCC and KP reporting.

For example when a Party that has elected Cropland Management under Article 3.4 prepares its UNFCCC inventory for croplands, it is efficient to use the same geographical boundaries for stratification (Section 2.2.2). When preparing the supplementary information to be reported under the KP, the Party would delineate those UNFCCC cropland areas that originated from forests since 1990 (Chapter 5.3, Volume 4, of 2006 IPCC Guidelines, Land converted to cropland), report these under Deforestation according to Article 3.3, with the exception of those lands that have been cleared under the provision of Carbon Equivalent Forest Conversion (CECF)[4] which should be reported under FM. All remaining croplands will be reported under Cropland Management (Article 3.4).

This document covers supplementary estimation and inventory reporting requirements needed for accounting under the KP in the second commitment period. Estimation refers to the way in which inventory estimates are calculated, reporting refers to the presentation of estimates in the tables or other standard formats used to transmit inventory information, and accounting refers to the way the reported information is used to assess compliance with commitments under the KP. This document does not address the implementation of accounting rules as agreed in relevant decisions[5] of the Conference of the Parties serving as the Meeting of the Parties (CMP) of the KP (such as caps, annual vs. commitment period accounting and other specific provisions related to accounting). Accounting is a policy matter that is not included in the UNFCCC request to the IPCC to prepare guidance documents.

In this supplement the terms units of land and land are combined. Chapter 4 of the *GPG-LULUCF* uses the former in the context of Article 3.3 activities and the latter in the context of Article 3.4. This reflects the usage in Decisions 15/CMP.1 and 16/CMP1, but the methodological treatment of land identification in Chapter 4 of the *GPG-LULUCF* was the same in both cases, so uniting the concepts simplifies the text and avoids the impression that Parties need to treat the cases differently, which is not required and would increase costs.

This document uses the terms "mandatory" and "elective". Mandatory refers to activities defined under Article 3.3, namely A/R, and D, as wells as FM and those 3.4 activities that were elected by a country in the previous commitment period. Elective refers to those 3.4 activities that can be elected by a country for the commitment period, namely for the second commitment period CM, GM, RV and WDR.

Parties should harmonize UNFCCC and KP reporting in order to increase transparency, accuracy and consistency and to reduce costs. For the second commitment period Parties are required to use the same

[3] Article 7, paragraph 1 of the Kyoto Protocol: Each Party included in Annex I shall incorporate in its annual inventory […] the necessary supplementary information for the purposes of ensuring compliance with Article 3 […].

Article 7, paragraph 2 of the Kyoto Protocol: Each Party included in Annex I shall incorporate in its national communication, submitted under Article 12 of the Convention, the supplementary information necessary to demonstrate compliance with its commitments under this Protocol.

[4] See decision 2/CMP.7, paragraphs 37 – 39.

[5] CMP decisions relevant for LULUCF accounting for the second commitment period: decision 2/CMP.6, decision 2/CMP.7,…

definition of forest that they selected for the first commitment period[6]. It is *good practice* to apply the same forest definition for both UNFCCC and KP reporting. Under the KP Parties are requested to apply a forest definition, within the thresholds of the forest parameters defined by the KP, that is consistent with that used to submit historical information to the Food and Agriculture Organization of the United Nations (FAO) and other international bodies, including the UNFCCC. Where the definitions differ for KP reporting and other reporting, Parties shall provide *an explanation of why and how such values were chosen, in accordance with decisions 16/CMP.1 and 2/CMP.7.*

Estimation and reporting of greenhouse gas emissions and removals from activities defined under Article 3.3 and Article 3.4 is in accordance with Decision 2/CMP.8 on "Implications of the implementation of decisions 2/CMP.7 to 5/CMP.7 on the previous decisions on methodological issues related to the KP, including those relating to Articles 5, 7 and 8 of the KP", and should be consistent with methods set out in volumes 1 and 4 of the *2006 IPCC Guidelines* and in the 2013 Supplement to the *2006 IPCC Guidelines for National Greenhouse Gas Inventories: Wetlands (Wetlands Supplement)*[7], any future elaboration of those guidelines, or parts of them, in accordance with relevant decisions of the Conference of the Parties and the CMP. It is *good practice* that for KP estimation and reporting, methods be applied at the same or higher tier as used for UNFCCC reporting.

1.2 OVERVIEW OF STEPS TO ESTIMATING AND REPORTING SUPPLEMENTARY INFORMATION FOR ACTIVITIES UNDER ARTICLES 3.3 AND 3.4

This section gives an overview of the steps required to measure, estimate and report carbon stock changes and emissions of non-CO_2 greenhouse gases for LULUCF activities covered by Articles 3.3, 3.4 and 6 of the KP. This overview is summarized as a flowchart in Figure 1.1. Detailed methods and *good practice* guidance for each individual activity are provided in subsequent Chapters and Sections of this document.

STEP 1: Definitions and parameter values of forests, and hierarchical order of elected Article 3.4 activities.

Parties that have elected any eligible activity under Article 3.4 in a previous commitment period should report the activity during subsequent commitment periods, consistently applying the definition of Article 3.4 activities to their national circumstances as was done in a previous commitment period. Parties decide and report which, if any, activities under Article 3.4 they elect. It is *good practice* that Parties document, for each elected activity and for Forest Management, how the definitions will be applied to national circumstances. It is *good practice* to choose criteria on how to apply definitions in such a way as to avoid overlap and to be consistent with the guidance provided in the decision tree in Figure 1.2 in Section 1.3.

STEP 1.1: Decide the numerical values of parameters to define "forest" for AR and D activities under Article 3.3 and for FM activity under Article 3.4, if applicable.[8]

[6] Paragraph 1(f) of annex I to decision 2/CMP.8.

[7] The IPCC is currently preparing the 2013 Supplement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories: Wetlands (the 2013 IPCC Wetlands Supplement) in parallel to this document. The 2013 IPCC Wetlands Supplement provides guidance on estimating emissions and removals on lands with drained and rewetted organic soils in Chapters 2, 3 and 4 and general issues on wetlands are addressed in Chapters 1 and 7. The guidance given here will be updated to reflect the development of the 2013 IPCC Wetlands Supplement through its review by experts and governments and its approval by the IPCC. The Government and Expert Review of the 2013 IPCC Wetlands Supplement will be held between 11th February and 7th April, 2013 (see http://www.ipcc-nggip.iges.or.jp/home/wetlands.html).

[8] According to decision 16/CMP.1, paragraph 1(f), "forest" is a minimum area of land of 0.05 – 1.0 hectares with tree crown cover at maturity in situ (or equivalent stocking level) of more than 10 – 30 per cent with trees with the potential to reach a minimum height of 2 – 5 metres at maturity in situ. A forest may consist either of closed forest formations where trees of various storeys and undergrowth cover a high proportion of the ground, or open forest. Young natural stands and all plantations which have yet to reach a crown density of 10 – 30 per cent or tree height of 2 – 5 metres are included under forest, as are areas normally forming part of the forest area which are temporarily unstocked as a result of human intervention such as harvesting or natural causes but which are expected to revert to forest.

330 **Figure 1.1 Flowchart of the activities outlined in this chapter**

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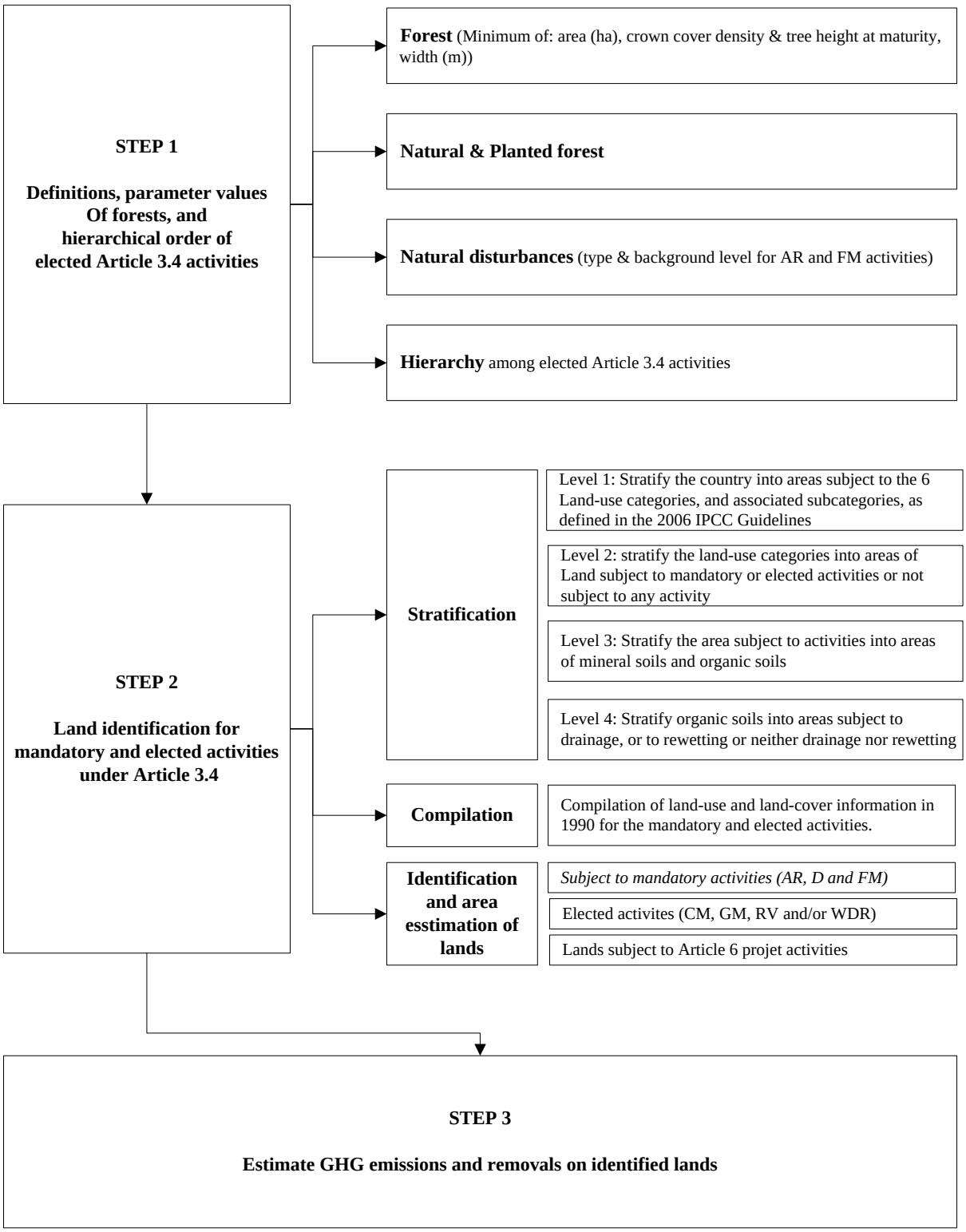

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Parties that have already selected the parameters of the forest definition in the first commitment period should apply this definition consistently in the second and subsequent commitment periods. Parties that have not yet done so need to select the parameters that define forest, i.e., the minimum area (0.05 – 1 ha), the minimum crown density at maturity (10 – 30%), and the minimum tree height at maturity (2 – 5 m). Areas that meet these minimum criteria are considered forest, as are recently disturbed forests or young forests that are expected to reach these parameter thresholds at maturity. The numerical values selected for those parameters cannot be changed during or between commitment periods. Each Party has to demonstrate in its reporting that selected values are consistent with the information that has historically been reported to the FAO or other international bodies, including the UNFCCC, and if they differ, explain how and why differing values were chosen.

In addition to the minimum area of forest, it is *good practice* that countries specify the minimum width that they will apply to define forest and land subject to AR, D and FM activities, as explained in Section 2.2.6.

In applying the 16/CMP.1 definition of forest during the first commitment period, some countries excluded certain types of land e.g. fruit orchards, grazed savannas, urban trees, and some types of plantations, and included these in non-forest land-use categories (i.e., Cropland, Grassland, Settlement), even if the land in question would otherwise meet the thresholds for forest. This practice has been accepted during the UNFCCC review process. Recognizing that the forest definition is threshold based, in order to achieve consistency with established practice during the first commitment period, countries can continue to report taking account of predominant land use, as reviewed under the provisions of the KP.

In cases where countries apply these exclusions, it is *good practice*:

- To document the rationale of criteria used to exclude from forested land areas which would otherwise meet the thresholds for forest (e.g., consistency with national forest inventories, with reporting to FAO, etc.), and how these criteria are applied consistently across space and time;
- To document how the consistency is achieved with categories reported previously; and
- To report the extent of the area which would otherwise meet the threshold for forest, but is excluded from forested land.

Countries that chose to classify land that would otherwise meet the definition of forest as a non-forest land-use category, and this land is reported under an elected Article 3.4 activity, still have to report, and account, loss of carbon associated with removal of tree cover below the forest threshold.

STEP 1.2: Define natural forest and planted forest. It is *good practice* that Parties, according to their national circumstances (a) provide their definition of natural forest and planted forest (which include forest plantation as defined in the *2006 IPCC Guidelines*, (b) define when a transition from natural forest to planted forest occurs; and (c) apply these definitions consistently throughout the commitment periods.

STEP 1.3: If applicable, consistent with Section 2.3.9 (Disturbances), define, for AR and FM activities, natural disturbances in terms of type, and calculate background level of emissions associated with disturbances and a margin, where a margin is needed.

STEP 1.4: A hierarchy among reported activities is useful to create a framework for consistent attribution. The CMP decisions define 3 rules that create this framework.

- Article 3.3 activities are mandatory and take precedence over 3.4 activities;
- Once land has been reported and accounted under the KP it should remain so and the hierarchy needs to recognise this; and
- Double counting should be avoided.

In addition to the framework established by the CMP decisions it is *good practice* to establish a hierarchy among elected Article 3.4 activities: CM, GM, and/or RV. It is also *good practice* to apply the same hierarchy among elected activities under Article 3.4 across commitment periods.

Thus the overall hierarchy among mandatory and elected activities is established as follows:

- Land subject to D activities takes precedence in the reporting hierarchy over land subject to AR activities. Land that was reported under Deforestation to non-forest land, on which subsequent regrowth of forests occurs continues to be reported under Article 3.3 (Deforestation) and it is *good practice* to report it as a subcategory to indicate that this previously deforested land can be acting as a carbon sink.
- AR and D activities take precedence in the reporting hierarchy over FM activities.
- AR, D and FM activities take precedence in the reporting hierarchy over any other elected Article 3.4 activity, because they are mandatory activities.

- Forest land that is subject to Forest Management (Article 3.4) is reported under FM.
- Parties elect the reporting hierarchy among elected activities of CM, GM and RV.
- Since Wetland Drainage and Rewetting is limited to lands that are not accounted for under any other activity[9], lands not already included in any of the above reporting categories, on which drainage and rewetting of peatlands take place are reported under WDR, if elected by the Party.

In addition to these general guidelines, decision 2/CMP.7 also provides for the following circumstances:

- Land subject to direct human-induced conversion from forest to non-forest is reported under Deforestation (Article 3.3) unless a Party chooses to use the provision for Carbon Equivalent Forest Conversion (see Section 2.7.7) and keeps reporting under FM the emissions and removals associated with the harvest and conversion to non-forest land of forest plantations. Parties have this option only if the harvested forest plantation was established or re-established after 1 January 1960 and before 1 January 1990 and if a new forest of at least equivalent area as the harvested forest plantation is established through direct human-induced planting and/or seeding of non-forested land that did not contain forest on 31 December 1989[10]. If such harvest and conversion to non-forest land is reported under FM, then it is also required to identify, monitor and report, including the georeferenced location and year of conversion, the harvested land and the newly established plantation as subdivisions of land subject to FM (see section General and paragraphs 37 to 39 of the Annex to decision 2/CMP.7);
- Land afforested or reforested, is reported under AR (Article 3.3) unless this land is used to compensate the harvest of forest plantations and conversion to non-forest land, in which case it is reported under FM as explained in the previous paragraph (see Section 2.7.7).

Where elected activities under Article 3.4 overlap, it is *good practice* that the country specifies a hierarchy among activities prior to the commitment period, rather than deciding on a case-by-case basis. It is *good practice* to apply consistently the specified hierarchy to determine under which activity the land is to be reported. For example, if land could fall into both CM and RV (such as for new orchards), then it is good practice to report over time that land under one and only one activity according to the established hierarchy.

Agricultural land use at times rotates between cropland and grassland associated with grazing. Where a Party has elected both CM and GM activities, to reduce reporting complexity and to avoid artefacts or inaccuracies in CM and GM reporting associated with rotation of land between cropland and grassland use, a Party may report all land subject to CM and GM under a single activity[11], either CM or GM. Where a Party has elected either CM or GM (Article 3.4), it is *good practice* to keep reporting the land subject to rotation under the elected activity.

STEP 2: Land identification for mandatory and elected activities under Article 3.4

The second step of the inventory assessment is to determine the areas on which the activities have taken place since 1990 (and for which emissions and removals will be estimated). This step builds on the approaches described in Chapter 3, Volume 4 of the *2006 IPCC Guidelines*.

STEP 2.1: Stratify the country into areas of land for which the geographic boundaries will be reported, as well as the areas of land subject to Article 3.3 and the areas of land subject to Article 3.4 within these geographic boundaries (see Section 2.2). This step can be omitted if Reporting Method 2 (see Section 2.2.2) is used. Stratification of the country should occur at the following four levels:

- Level 1: stratify the country into areas subject to the six land-use categories, and associated subcategories, as defined in the *2006 IPCC Guidelines*;
- Level 2: stratify the land-use categories into areas of land subject to mandatory or elected activities or not subject to any activity (e.g., unmanaged lands);
- Level 3: stratify the area subject to activities into areas of mineral soils and organic soils;
- Level 4: where such activities do occur, stratify areas with organic soils into areas subject to drainage or rewetting.

[9] See definition of WDR of decision 2/CMP.7, para (1b)

[10] The area planted should be at least equivalent to the area of harvested plantation and should be expected to reach at least the equivalent carbon stock that was contained in the harvested forest plantation at the time of harvest, within the normal harvesting cycle of the harvested forest plantation (see paragraph 37 of the Annex to decision 2/CMP.7)

[11] Reporting requirements and accounting rules for CM and GM are identical

STEP 2.2: Compile land-use and land-cover information for 31 December 1989 for the mandatory and elected activities.

Using the selected definitions of forest determine forest and non-forest areas on 31 December 1989 and update the dataset in subsequent time periods. This can be accomplished with a map that identifies all areas considered forest or with statistical data derived from a national land survey as time-series of a national forest inventory. All forest-related land-use change activities since 1 January 1990 can then be determined with reference to either those maps or statistical sets of data (see Section 2.2.2).

STEP 2.3: Identify lands that, since 1 January 1990, are subject to mandatory and elected activities, and estimate the total area of these lands within each geographic boundary. Under Reporting Method 2 (Section 2.2.2) the estimation of land areas will be carried out individually for each land.

STEP 2.3.1: Mandatory activities (AR, D and FM)

Identify lands that, since 1 January 1990, are subject to activities that are mandatory for reporting (AR, D and FM), and estimate the total area of these lands within each geographic boundary. Under Reporting Method 2 (Section 2.2.2) the estimation of land areas will be carried out individually for each land.

It is *good practice* to identify the land area subject to FM in each inventory year of the commitment period. A country could interpret the definition of forest management in terms of specified forest management practices undertaken since 1990, such as fire suppression, harvesting or thinning (narrow interpretation). Alternatively, a country could interpret the definition of forest management in terms of a broad classification of land subject to a system of forest management practices, without the requirement that a specified forest management practice has occurred on each land (broad interpretation). (For details see Sections 2.7.1).[12]

Parties are required[13] to estimate and report the area of lands that have been subject to AR and D and the area of lands subject to FM within the boundaries mentioned in STEP 2 above (for details see Sections 2.2.2, 2.5 and 2.6). Furthermore, each Party is required to estimate and report areas of lands that fall into categories defined by decision 2/CMP.7: It is therefore *good practice* to identify and report, for each year in the commitment period:

- lands with natural forests that have been converted to planted forests;
- those lands affected by natural disturbances in the commitment period for which Parties chose to exclude from the accounting emissions and subsequent removals;[14]; and
- where Parties chose to implement and meet the provision of the Carbon Equivalent Forest Conversion, lands of forest plantation which have been converted to non-forest land as well as those lands that have been converted to forest to compensate for harvesting of forest plantation.

STEP 2.3.2: Elected activities (CM, GM, RV, and/or WDR)

Identify and estimate the area of lands subject to elected activities under Article 3.4 within each geographic boundary. Under Reporting Method 2 (Section 2.2.2) the estimation of areas of land is carried out individually for each land subject to elected Article 3.4 activities.

For CM, GM, or RV, as is discussed in more depth in Sections 2.9 –2.11, each Party identifies the land area subject to the activity in each inventory year of the commitment period as well as in 1990 (or the applicable base year), because associated greenhouse gas emissions and removals in the base year have to be used in the accounting.

For WDR, each Party identifies the land area subject to either drainage or rewetting in each inventory year of the commitment period as well as in 1990 (or the applicable base year), because associated greenhouse gas emissions and removals in the base year are used in the accounting. A country could interpret the definition of WDR in terms of specified practices undertaken since 1990 (narrow interpretation). Alternatively, a country could interpret the definition of WDR in terms of a broad classification of land subject to a system of drainage and rewetting practices, in 1990 and in the commitment period years, without the requirement that a specified practice is started in 1990 (broad interpretation). (For details see Sections 2.12.1).

[12] Possible issues related to unbalanced accounting resulting from selective inclusion of Forest Management and Revegetation are addressed in the IPCC Report on *Definitions and Methodological Options to Inventory and Report Emissions from Direct Human-Induced Degradation of Forests and Devegetation of Other Vegetation Types.*

[13] By decisions of the Conference of the Parties serving as Meeting of the Parties (CMP) of the Kyoto Protocol

[14] An issue that could arise for the third CP is that if the disturbance occurs near the end of the second CP (and emissions are not accounted) and LUC then occurs early in the third CP, the accounting of the disturbance emissions needs to be decided?

STEP 2.3.3: Lands subject to Article 6 project activities

Some lands subject to Article 3.3 or Article 3.4 activities can also be projects under Article 6 of the KP. These have to be reported under Article 3.3 or Article 3.4. In addition, these lands need to be delineated and the greenhouse gas emissions and removals reported separately as part of project reporting (see Section 4.3 of the *GPG-LULUCF*). The relationship between estimation and reporting of activities under Articles 3.3 and 3.4, and projects under Article 6, is discussed in Section 1.4.

STEP 3: Estimate greenhouse gas emissions and removals on lands identified under Step 2 above.

STEP 3.1: Estimate greenhouse gas emissions and removals for each year of the commitment period, on all areas subject to the mandatory and elected activities (as identified in steps 2.3 and 2.4) while ensuring that there are no gaps and no double counting.

The estimation of greenhouse gas emissions and removals for an activity begins with the onset of the activity or the beginning of the commitment period (including the applicable base year), whichever comes later.

Table 1.1 provides an overview of the LULUCF activities in the KP, and the accounting rules. Accounting in the LULUCF sector is done by comparing greenhouse gas emissions and removals during the commitment period with a benchmark under either a base year or a business-as-usual scenario, which could be a scenario in which emissions and removals are assumed to balance to zero.

TABLE 1.1
SUMMARY OF THE LULUCF ACTIVITIES UNDER THE KYOTO PROTOCOL AND THE ASSOCIATED ACCOUNTING RULES

Activities	Benchmark	Cap on Credits[15]
Afforestation, Reforestation (Article 3.3)	Zero	No
Deforestation (Article 3.3)	Zero	No
Forest Management (Article 3.4)	Business-As-Usual scenario, Zero, or Base Year	Yes
All other activities under Article 3.4	Base Year	No

[15] See paragraph 13 of the Annex to decision 2/CMP.7 (Land use, land-use change and forestry).

1.3 GENERAL RULES FOR CATEGORISATION OF LAND AREAS UNDER ARTICLES 3.3 AND 3.4

Chapter 3 (Consistent representation of lands) of the *2006 IPCC Guidelines* describes approaches to classifying and representing land areas associated with Agriculture, Forestry and Other Land Use (AFOLU) activities. This is the basis for the *good practice* guidance in this Supplementary Guidance to the *GPG-LULUCF* for identifying all relevant lands, for KP reporting and for avoiding double counting of lands. It is *good practice* to follow the decision tree in Figure 1.2 for each reporting year of the commitment period in order to:

- Distinguish between Afforestation/Reforestation and Deforestation activities under Article 3.3, and Forest Management, Cropland Management, Grazing land Management, Revegetation, and Wetland Drainage and Rewetting activities under Article 3.4, as well as to remove potential overlaps and gaps between them; and to

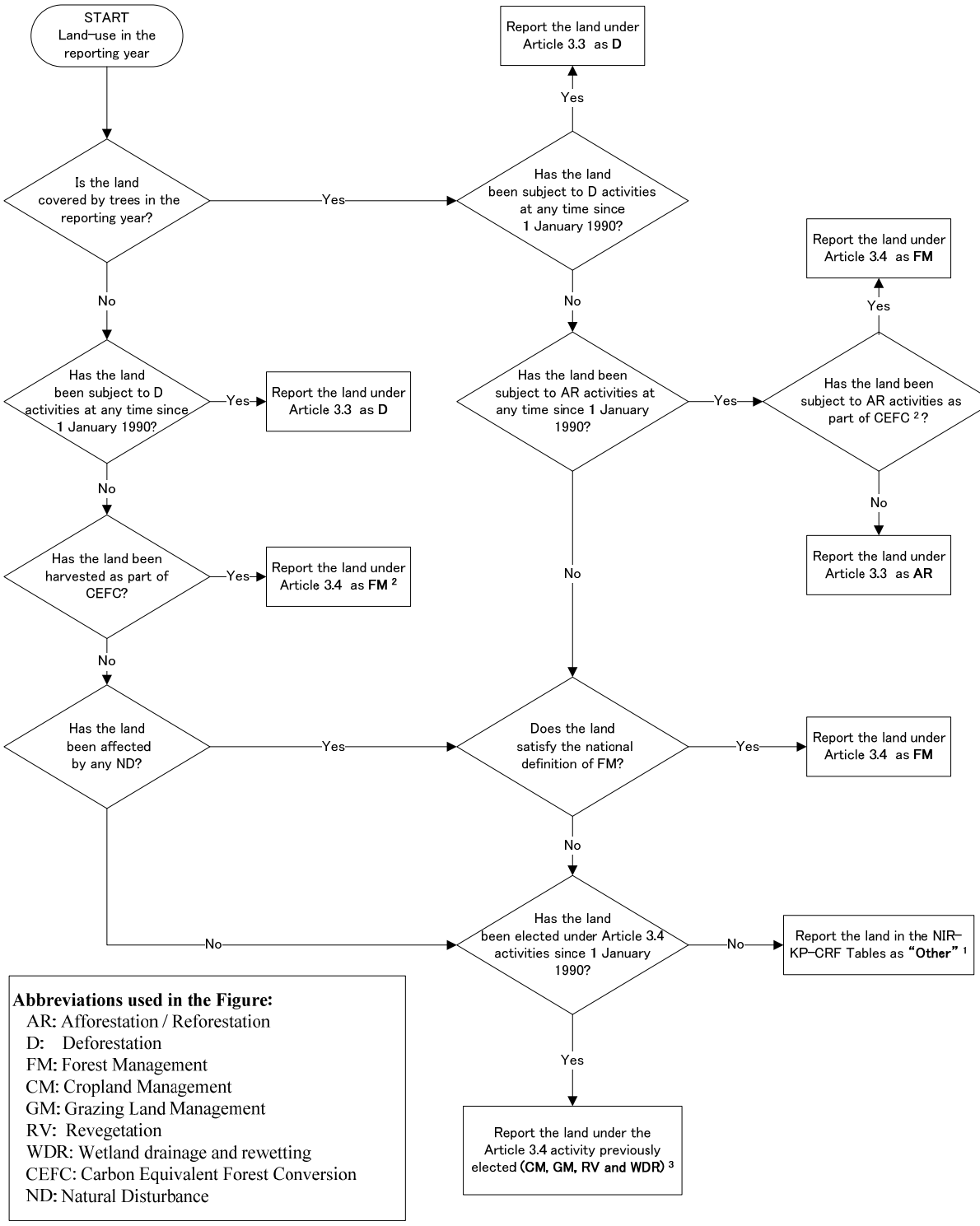
- Assign lands, where activities occurred, to a single activity at any given point in time (i.e., for the base year and each year of the second commitment period from 2013 onwards). This is required because of the possible changes in land use or activity which can lead to double counting of lands subject to mandatory and elective activities. Guidance on how to deal with shifts in land use over time is exemplified in Box 1.1 at the end of this section.

The decision tree in Figure 1.2 is based on the definitions given in Decision 16/CMP.1 and in the annex to 2/CMP.7. It identifies a single activity for a given year X of the commitment period under which the land should be reported. The decision tree recognises that a given piece of land could be reported under different activities over time, subject to certain conditions explained below. The decision tree is to be applied annually during the commitment period in order to update the allocation of lands to activities, thus taking into account shifts in land use that may have occurred. This may be achieved by annual tracking of land or by interpolation of two different periods.

There are two main branches in the decision tree in Figure 1.2. If land is covered by trees in the reporting year, then the questions in the "centre" branch should be answered to determine whether the land was subject to activities under Article 3.3 or FM. If land is not covered by trees in the reporting year, then the questions in the "left" branch should be answered to determine whether the land was subject to Deforestation at any time since 1st January 1990, or subject to any other activities which could be classified as Article 3.3 and 3.4 activities. This is required to fulfil the reporting needs stated in decision 16/CMP.1 and in the annex to 2/CMP.7, and to demonstrate that there is no double counting, which could occur if full enumeration was not applied. More detailed decision trees and examples to determine whether or not land is subject to specific activities under Articles 3.3 and 3.4 are presented in Sections 2.5 through 2.12.

For land that is subject to an Article 3.4 activity, it is necessary to know whether it was subject to any other mandatory or elected activity in the previous year. If the land was subject to a mandatory activity it should be kept under that activity, otherwise it is *good practice* to assign it to the elected activity that is higher in the hierarchical order, using the hierarchy established in Step 1.4 above. Similarly, if land is subject to more than one Article 3.4 activity, it is *good practice* to assign it to the elected activity that is higher in the hierarchical order.

Figure 1.2 Decision tree for classifying land in the reporting year under Article 3.3 (A/R, D), FM, another elected Article 3.4 activity (CM, GM, RV and WDR), or not at all ("other"). Secondary classifications are not shown in the Figure.



1. "Other" can include managed and unmanaged lands not reported under mandatory or elected under elected activities.
2. Can only be reported as FM if the land has been harvested as part of CEFC and if all other conditions of the CEFC provision are also met.
3. If land was reported under an elected Art. 3.4 activity in the previous reporting year, it is *good practice* to continue reporting it in the same category to assure consistency, unless the new activity is higher in hierarchy of elected 3.4 activities.

The definitions in the annex of Decision 2/CMP.7 specify that

- *A Party included in Annex I may include in its accounting of forest management under Article 3, paragraph 4, anthropogenic greenhouse gas emissions by sources and removals by sinks resulting from the harvest and conversion of forest plantations, accounted for under forest management, to non-forest land, provided that all of the requirements below are met:*

  (a) The forest plantation was first established through direct human-induced planting and/or seeding of non-forest land before 1 January 1990, and, if the forest plantation was re-established, that this last occurred on forest land through direct human-induced planting and/or seeding after 1 January 1960;
  (b) A new forest of at least equivalent area as the harvested forest plantation is established through direct human-induced planting and/or seeding of non-forested land that did not contain forest on 31 December 1989;
  (c) This newly established forest will reach at least the equivalent carbon stock that was contained in the harvested forest plantation at the time of harvest, within the normal harvesting cycle of the harvested forest plantation, and, if not, a debit would be generated under Article 3, paragraph 4.

The implications of the Carbon Equivalent Forest Conversion discussed in the previous paragraph are further elaborated in Section 2.7.2.

In addition, note that:

- The decision tree in Figure 1.2 is not sufficient to identify all lands that fall under each activity. For the reporting of these lands, it is *good practice* to follow the methodological guidance provided under Section 2.2 on "Generic Methodologies for Area Identification, Stratification and Reporting", and in the activity-specific sections on land identification in Section 2.5-2.12.
- For the subsequent and contiguous commitment periods, Article 3.3 applies to land that is subject to an Afforestation/Reforestation or Deforestation activity at any time between 1 January 1990 and 31 December of the last year of each commitment period.
- For reporting during subsequent and contiguous commitment periods, Article 3.4 applies to land that is subject to FM or an elected activity of CM, GM RV, or WDR during the commitment period or in any year of the previous commitment period[16]. Article 3.4 also applies to land subject to RV, and when a narrow approach to their definitions is applied to FM and WDR since 1 January 1990.[17].
- Once land is accounted for and therefore reported under Article 3.3 or Article 3.4, all anthropogenic greenhouse gas emissions from sources and removals by sinks on this land must be reported during the first and throughout subsequent and contiguous commitment periods[18], except where the country chooses not to report a pool that has been shown not to be a source as explained in Section 2.3.1. Therefore, the total land area included in the reporting of Article 3.3 and 3.4 activities can never decrease.
- If certain activities occur during the commitment period, it is possible, under certain circumstances, that land can be reported under different activities in Article 3.3 and/or Article 3.4 over time during the commitment period. However, it is *good practice* to report the land for each year only under a single activity to avoid double counting.
- In order to avoid the reporting of land under more than one activity in any year during the commitment period, the following should be applied:

[16] Conversely, for base year reporting, Article 3.4 applies to land that was subject to an elected CM, GM, RV, or WDR activity in the base year.

[17] As stated in STEP 1.3 above, it is *good practice* to apply the definitions of Article 3.4 activities to national circumstances. In doing so, there may be Article 3.4 activities where an individual practice triggers the land to be reported ("narrowly defined activities"). This is likely to apply to RV, and possibly to FM and WDR, and requires reporting all lands that are subject to the activity since 1990 (as for AR and D). On the other hand, there will be Article 3.4 activities where the mere classification of the land, without a concrete practice, will suffice for the land to be reported ("broadly defined activities"). This is most likely for CM and GM. Here it is sufficient to report the lands subject to the activity in the reporting year of the commitment period.

[18] Paragraph 19 of the Annex to Draft decision 16-/CMP.1 (Land use, land-use change and forestry), contained in document FCCC/KP/CMP/2005/8/Add.3,CP/2001/13/Add.1, p.8.

(i) Land subject to activities under Article 3.3 which would otherwise be subject to FM and/or an elected activity under Article 3.4[19] are to be identified as lands that are both subject to Article 3.3 and 3.4 activities by using secondary classifications (these are not shown in the decision tree in Figure 1.2). The decision tree implies that A/R, D and FM have precedence over the other activities for land classification and reporting purposes not only in a given year, but for entire subsequent and contiguous commitment periods.

(ii) For lands that are subject to more than one activity under Article 3.4, it is *good practice* to apply the national criteria that establish the hierarchy among Article 3.4 activities (see STEP 1.4 in Section 1.2 above).

- Land subject to loss or gain of forest cover can move between categories in the following cases:
  - A/R land that is subsequently deforested is reclassified as D land (Section 2.5 describes specific provisions for units of land subject to afforestation/reforestation activities since 1990, and Section 2.6 describes specific provisions for land subject to deforestation activities since 1990).
  - Land under an elected Article 3.4 activity that becomes subject to an Article 3.3 activity needs subsequently to be reported under the latter. For the second commitment period, land subject to forest management (and established as forest plantation after 1 Jan 1960 and before 1 Jan 1990) that is cleared of forest can be reported as FM, if certain conditions are met (see decision tree in Figure 1.2).
- On the other hand, the following transitions are not possible. Note that these restrictions apply to reporting under the KP (but do of course not affect the actual management that a country applies to its lands):
  - Land cannot be transferred from FM (mandatory under Article 3.4) to another elected Article 3.4 activity.
  - Land cannot be transferred from an elected to an unelected Article 3.4 activity.
  - Land cannot leave the Article 3.3 reporting.
  - D land cannot become A/R land. It is *good practice* to report carbon stock increases associated with forest regrowth on previously deforested land as a subcategory of D to demonstrate why D land acts as a carbon sink[20] (See Section 2.6). In such cases it is *good practice* to estimate emissions and removals using the methodology for lands converted to forest land as described in the *2006 IPCC Guidelines*.
- Boundaries between FM and cropland or grazing land systems where these are applied on the same area should be defined using the national forest definition applied consistently with past reporting practice as described at Step 1.1 above.

In summary, this means that the area under Article 3.3 (A/R and D) will grow from 0 hectares on 1 January 1990 up to a certain value at the end of subsequent and contiguous commitment periods. At any given point in time, it is *good practice* that the A/R and D categories should contain all areas of land that have been afforested, reforested or deforested since 1 January 1990. The land area under Article 3.3 D will increase in size or stay constant during the subsequent and contiguous commitment periods. The land area in the A/R category will typically increase, but could decrease if A/R lands are subject to deforestation activities.

The amount of lands under elected Article 3.4 categories, i.e. FM, CM, GM, RV and WDR categories can fluctuate because of various land-use changes. It is unlikely that those areas will stay constant over time for the purpose of reporting because:

- Deforestation can transfer land from FM to D under Article 3.3;
- Afforestation or reforestation can transfer land from any non-forest Article 3.4 category the Article 3.3 A/R category;
- Grazing lands can become croplands and vice versa, and are reported in the category of most recent land use;
- Revegetated lands can become croplands or grazing lands or vice versa, and are reported in the category of most recent land use; and

[19] See Paragraph 6 (b), bullet (ii) in the Annex to draft decision 16/CMP.1 (Article 7), contained in document FCCC/CP/2001/13/Add.3, p.22

[20] see also paragraph 22 of the annex to Decision 2/CMP.7

638 • Forest management areas can increase, for example, as countries expand the road infrastructure to areas
639 previously unmanaged and initiate harvest and other FM activities.

640

641 Box 1.1 provides several examples that summarise the considerations that apply for lands subject to activities
642 under Articles 3.3 and 3.4 of the KP. For more detailed explanations of the rationale behind the examples in Box
643 1.1, the reader is referred to the more detailed explanations in the remaining sections of this *Supplementary*
644 *Guidance*.

BOX 1.1
EXAMPLES FOR THE ASSIGNMENT OF UNITS OF LAND TO ARTICLE 3.3 ACTIVITIES AND LANDS TO ARTICLE 3.4 ACTIVITIES OVER TIME

The following examples are intended to show, conceptually and in accordance with the decision tree in Figure 1.2, how different land-use transitions would be categorised in different inventory years of the KP. This does not necessarily imply that the land-use transition can be directly measured on an annual basis. For croplands and grazing lands only carbon stock changes are discussed in the examples below, since non-CO_2 greenhouse gas emissions for such lands are in most cases reported under agriculture. (Note that N_2O emissions from conversion of forest land to cropland are reported under D).

Example 1: Land under Forest Management is deforested in 1995 and turned into cropland.

Carbon stock changes on this land are reported under Deforestation from 2008 onwards during all commitment periods. CO_2 emissions from liming and urea application as well as non-CO_2 emissions on this land are reported under the Agriculture sector.

Carbon stock changes on this land will not be reported under Cropland Management, even if Cropland Management was elected, because Deforestation takes precedence over Cropland Management. The decision tree in Figure 1.2 therefore assigns this land to Deforestation. It is recommended that this area be included within a sub-division of the deforested area as forest land converted to cropland, which will improve the transparency of reporting. .

Should trees be re-established on this land after the end of the first commitment period, for example in 2014, the unit of land does not transition from one Art 3.3 category to another (from D to A/R). The land continues to be reported under Deforestation. However, to improve transparency and consistency, it is recommended to report such land within a sub-division of the deforested area, as deforested land converted to forest. In this way there is a clear link between land reported under Deforestation and observed land use in the reporting year. Estimates of changes in emissions and removals may be based on the methodology for land converted to forest land.

Example 2: Land under FM is deforested on 1 January 2015 and turned into cropland.

Carbon stock changes and non-CO_2 greenhouse gas emissions on this land during the second commitment period are reported under Deforestation starting in 2015. The methodology for croplands that were previously forest should be used to estimate carbon stock changes. Non-CO_2 greenhouse gas emissions directly resulting from the Deforestation, that is direct N_2O emissions from nitrogen mineralization/immobilization associated with loss/gain of soil organic matter, should be reported under the Deforestation category. Non-CO_2 greenhouse gas emissions resulting from subsequent agricultural practices are estimated using methods described in Volume 4 of the *2006 IPCC Guidelines*, but are to be reported in the national inventory within the Agriculture sector and LULUCF sector as appropriate while avoiding double counting. CO_2 emissions from liming and urea application are reported in the Agriculture sectors.

Carbon stock changes and non-CO_2 emissions on this land will not be reported under Cropland Management, even if Cropland Management has been elected, because Deforestation takes precedence over Cropland Management. The decision tree in Figure 1.2 therefore assigns this land to Deforestation. It is recommended that this area be included within a sub-division of the deforested area as forest land converted to cropland, which will improve the transparency of reporting.

The following examples illustrate how Article 3.3 or 3.4 land-use activities are to be reported during the second commitment period (CP2). For each example a brief scenario is presented and the correct land management activity for reporting identified as the “Reporting solution” is provided in a table with additional explanation in the comment row.

More than one solution may be acceptable after the conversion or management change depending on the nationally defined hierarchy of elected 3.4 activities established at the start of the commitment period.

BOX 1.1 (CONTINUED)

Example 3:

Scenario; An area of cropland was converted to grazing land in 2010. FM, CM and GM were elected in CP1.							
Activity	D	AR	FM	CM	GM	RV	WDR
Status in CP1	M	M	E	E	E	NE	N/A
Status in CP2	M	M	M	M	M	NE	NE
Reporting solution				for only 2008 and 2009 of CP1	for all years 2010 onwards including CP2		
Comments	It is mandatory to continue to report the GM activity elected for CP1 into CP2						

D-Deforestation; AR- Afforestation and Reforestation; FM- Forest Management; CM- Cropland Management; GM:- Grazing Land Management; RV- Revegetation; WDR- Wetland Drainage and Rewetting

M-Mandatory reporting obligation; E- Elected activity; NE- Not Elected; N/A- Not Applicable in this reporting period.

CP1- First Commitment period 2008-2012 inclusive

Example 4:

Scenario: A cropland is converted into a grassland in 2015, CM, GM **and** RV were elected in CP2.							
Activity	D	AR	FM	CM	GM	RV	WDR
Status in CP1	M	M	NE	NE	NE	NE	N/A
Status in CP2	M	M	M	E	E	E	NE
Reporting solution				Report for only 2013 and 2014	Report for all years 2010 onwards	**OR** Report for all years 2010 onwards	
Comments	Two reporting scenarios are possible. The converted land can be classified as Grazing land or Revegetation. The reporting is done based on the definitions for classifying lands under the activities. The Party is required to provide the definitions of activities which will be classified under each KP Activity when communicating the decision to elect the KP Activity for CP2 and the hierarchy of elected activities which it will apply. Note that accounting will not be affected by which option is chosen.						

Example 5:

Scenario: A cropland was turned into a grazing land in 2015, GM was elected in CP2 and CM is not elected in CP2							
Activity	D	AR	FM	CM	GM	RV	WDR
Status in CP1	M	M	E	NE	NE	NE	N/A
Status in CP2	M	M	M	NE	E	NE	NE
Reporting Solution					For period 2015 onwards		
Comments	Only report for the period after conversion to GM.						

Example 6:

Scenario: A cropland was turned into a grazing land in 2015, CM was elected in CP2.							
Activity	D	AR	FM	CM	GM	RV	WDR
Status in CP1	M	M	E	NE	NE	NE	N/A
Status in CP2	M	M	M	E	NE	NE	NE
Reporting solution				For all year from 2013 onwards including period following conversion to grazing land			
Comments	Continue to report area converted to grazing land under Cropland Management. Once land has been reported under any Article 3.3 or 3.4 activity it must continue to be reported. For transparency and consistency, it is recommended to include this land under a sub-division of CM as cropland converted to GM.						

Example 7:

Scenario: A cropland was turned into a Settlement in 2015, CM was elected in CP2							
Activity	D	AR	FM	CM	GM	RV	WDR
Status in CP1	M	M	E	NE	NE	NE	N/A
Status in CP2	M	M	M	E	E	NE	NE
Reporting solution				As in Example 6, report this land as CM from 2103 onwards.			
Comments	Continue to report area converted to settlement under Cropland Management. Once land has been reported under any Article 3.3 or 3.4 activity, it must continue to be reported. For transparency and consistency, it is recommended to include this land under a sub-division of CM as cropland converted to Settlement.						

Example 8:

Scenario: From 2013 onwards, under the influence of natural forces, an area of FM becomes water saturated and the forest dies back. WDR has been elected for CP2							
Activity	D	AR	FM	CM	GM	RV	WDR
Status in CP1	M	M	E	NE	NE	NE	N/A
Status in CP2	M	M	M	NE	NE	NE	E
Reporting solution			Continue to report emissions and removals under FM				
Comments	FM is higher in the reporting hierarchy than the elected activities. The land must continue to be reported under FM.						

Example 9:

Scenario: An area of land afforested in 1995 is deforested in 2015							
Activity	D	AR	FM	CM	GM	RV	WDR
Status in CP1	M	M	E	NE	NE	NE	N/A
Status in CP2	M	M	M	NE	NE	NE	E
Reporting solution	Report as D from 2015 onwards	Report under AR to 2014					
Comments	D takes precedence over AR.						

1.4 RELATIONSHIP BETWEEN ANNEX I PARTIES' NATIONAL INVENTORIES AND ARTICLE 6 LULUCF PROJECTS

Emissions or removals resulting from projects under Article 6 will be part of the host country's annual inventory under the UNFCCC and KP reporting[21]. The methods for estimating, measuring, monitoring and reporting greenhouse gas emissions and removals resulting from LULUCF project activities are addressed in Section 4.3 of the *GPG-LULUCF* (LULUCF Projects).

When estimating the greenhouse gas emissions and removals of Article 3.3 and 3.4 activities, it is possible to use the information that is reported for, or is meeting the standards of, Article 6 LULUCF projects on these lands (but not *vice versa*). Two options exist for Article 3.3 and Article 3.4 estimation, both of which are considered *good practice*:

Option 1: Carry out Article 3.3 and Article 3.4 assessment without consideration of information reported for Article 6 projects (which are reported separately as outlined in Section 4.3 of the *GPG-LULUCF*). This assumes that a properly designed national system will also automatically include the effects of Article 6 projects. This approach is consistent with the approaches taken in the other emission sectors. For example, an Article 6 project that reduces emissions from fossil fuels is not *individually* considered in the national emissions inventory, but will *implicitly* be included due to the project's impacts in the national statistics for fossil fuels.

Option 2: Consider all changes of carbon stocks as well as greenhouse gas emissions and removals at the project level as a primary data source for Article 3.3 and/or Article 3.4 estimation and reporting, for example by considering projects as a separate stratum. Any Article 3.3 and 3.4 activities that are not projects need to be monitored separately. In this case, the design of the monitoring must ensure that projects are explicitly excluded from the remaining lands under Articles 3.3 and 3.4, to avoid double counting.

One important difference between project and national (Articles 3.3 and 3.4) accounting is that projects have a baseline scenario (i.e., only **additional** carbon stock changes and non-CO_2 greenhouse gas emissions due to the project are accounted) and a project boundary, while A/R, D, CM, GM, RV and WDR do not have a baseline scenario. After the first commitment period, FM does have a FM reference level. Therefore, when using project-level information for reporting under different categories of Articles 3.3 and 3.4, countries must take into account the projects' total contribution to reported overall carbon stock changes and non-CO_2 greenhouse gas emissions and not just the change relative to the projects' baseline scenario.

[21] Paragraph 11 of Annex to decision 15/CMP.1 (Guidelines for the preparation of the information required under Article 7 of the Kyoto Protocol), Each Party included in Annex I shall report, in a standard electronic format, the following information on ERUs, CERs, tCERs, lCERs, AAUs and RMUs from its national registry for the previous calendar year (based on Universal Time), distinguishing between units valid for different commitment periods.

Paragraph 11 (C) of Annex to decision 15/CMP.1 (Guidelines for the preparation of the information required under Article 7 of the Kyoto Protocol), The quantity of ERUs issued on the basis of Article 6 projects and the corresponding quantities of AAUs and RMUs that were converted to ERUs

CHAPTER 2

METHODS FOR ESTIMATION, MEASUREMENT, MONITORING AND REPORTING OF LULUCF ACTIVITIES UNDER ARTICLES 3.3 AND 3.4

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2 METHODS FOR ESTIMATION, MEASUREMENT, MONITORING AND REPORTING OF LULUCF ACTIVITIES UNDER ARTICLES 3.3 AND 3.4

Chapter 2 of this supplementary guidance provides a description of generic methodological issues concerning all possible land use, land-use change and forestry (LULUCF) activities under Kyoto Protocol (KP) Articles 3.3 and 3.4. Section 2.1 deals with the relationship between land-use categories in reporting under the UNFCCC and the KP, Section 2.2 deals with land areas, Section 2.3 with estimating carbon stock changes and non-CO_2 greenhouse gas emission, including those from natural disturbances (Section 2.3.9), and Section 2.4 with other generic methodological issues. This is followed by specific methodologies related to Afforestation and Reforestation (treated together), Deforestation, Forest Management, Harvested Wood Products, Cropland Management, Grazing land Management, Revegetation, Wetlands Drainage and Rewetting (Sections 2.5 – 2.12). Readers should refer to both the generic and the specific issues for any one of the activities.

2.1 RELATIONSHIP BETWEEN UNFCCC LAND-USE CATEGORIES AND KYOTO PROTOCOL (ARTICLES 3.3 AND 3.4) ACTIVITIES

This section provides an overview of how the activities under Articles 3.3 and 3.4 relate to the land-use categories introduced in Volume 4, Chapter 2 of the 2006 IPCC Guidelines for National Greenhouse Gas Inventories (*2006 IPCC Guidelines*).

Land-use systems are classified in Volume 4 of the *2006 IPCC Guidelines* into:

(i) Forest Land (Chapter 4)

(ii) Cropland (Chapter 5)

(iii) Grassland (Chapter 6)

(iv) Wetlands (Chapter 7)

(v) Settlements (Chapter 8)

(vi) Other Land (Chapter 9)

The relationships between the basic land-use categories (i) to (vi) described in Chapter 3, Volume 4 of the *2006 IPCC Guidelines* and the activities of the KP (Articles 3.3 and 3.4) are summarised in Table 2.1.1. Land subject to KP activities should be identified as a subcategory of one of these six main categories. There are no reporting requirements for emissions from unmanaged land categories under the KP or the UNFCCC. However, for completeness of reporting and consistency of time series, it is *good practice* to report the total area of the country including those areas not subject to any activity as well as the area of lands classified as unmanaged lands under the UNFCCC.

Using categories (i) to (vi) as a basis for estimating the effects of Articles 3.3 and 3.4 activities helps meet *good practice* requirements and will be consistent with the national land categorization used for preparing LULUCF greenhouse gas inventories under the Convention. For example: Forest Land could be partitioned into: a) Forest Land under Article 3.3; b) Forest Land under Article 3.4, c) Other managed Forest Land (only if the definition of "managed forests" differs from the definition of "lands subject to forest management"); and d) Unmanaged Forest Land. More information on the relationship between "managed forests" and "forest management" can be found in Section 2.7, Figure 2.7.1.

Many of the methods described in subsequent sections of this Chapter build on methodologies that appear in Chapters 1 and Section 2.1 to 2.4 of this supplementary guidance or in Volume 4 of the *2006 IPCC Guidelines*. It is also recommended to refer to relevant sections of the 2013 Supplement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories: Wetlands (*Wetlands Supplement*).[19] For continuity and clarity, cross-references to these descriptions appear periodically in Boxes. Direct references to the reporting tables in Chapter 3 of the *GPG-LULUCF* is not possible because, for KP reporting, additional spatial stratification is required that cannot be inferred from those Reporting Tables, and for the second Commitment Period, additional reporting categories have been introduced. See Section 2.4.4 for discussion of the additional reporting requirements and the Annex to this document for draft reporting tables.

TABLE 2.1.1
SUMMARY OF THE RELATIONSHIP BETWEEN UNFCCC LAND USE CATEGORIES AND ACTIVITIES UNDER THE KYOTO PROTOCOL

Transitions are from the "initial" to the "final" land use category, indicating which KP Article 3.3 or 3.4 activities may have occurred on that land. Bold font indicates mandatory reporting categories; regular font indicates elective categories where the classification depends on the election of Article 3.4 activities by a country. Note that all possible LULUCF transitions have not been included in this table, only those which can be reported under Art 3.3 or 3.4 activities.

Final / **Initial**	**Managed Forest land**	**Cropland**	**Grassland**	**Wetland**	**Settlements**	**Other land**
Managed Forest land	FM	D**	D	D	D	D
Unmanaged Forest land**	FM	D**	D	D	D	D
Cropland	A/R*	CM, RV, WDR***	GM, RV, WDR***	RV, WDR***	RV	CM****
Grassland	A/R*	CM, RV, WDR***	GM, RV, WDR***	GM, RV, WDR***	RV	GM****
Wetland	A/R*	CM, RV, WDR***	GM, RV, WDR***	GM, RV, WDR***	RV, WDR***	WDR****
Settlements	A/R*	CM, RV, WDR***	GM, RV, WDR***	GM, RV, WDR***	RV	
Other land	A/R*	CM, RV	GM, RV	RV, WDR***	RV	

Notes

A/R: Afforestation / Reforestation, D: Deforestation, FM: Forest Management, CM: Cropland Management, GM: Grazing Land Management, RV: Revegetation, WDR: Wetland Drainage and Rewetting.

* A/R takes precedence over FM, and therefore the land is subject to FM, but not reported in the FM category.

** D takes precedence over cropland/grassland categories.

*** WDR only applies when none of the other elective activities under Article 3.4 have been elected by the country.

**** Once included within a reported activity, land cannot be removed from reporting obligation

[19] The IPCC is currently preparing the 2013 Supplement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories: Wetlands (*Wetlands Supplement*) in parallel to this document. The *Wetlands Supplement* provides guidance on estimating emissions and removals on lands with drained and rewetted organic soils in Chapters 2, 3 and 4 and general issues on wetlands are addressed in Chapters 1 and 7. The guidance given here will be updated to reflect the development of the 2013 IPCC Wetlands Supplement through its review by experts and governments and its approval by the IPCC. (see http://www.ipcc-nggip.iges.or.jp/home/wetlands.html).

Figures 2.1.1 and 2.1.2 exemplify the relationship between these land-use categories reported in national inventories under the UNFCCC and those under Articles 3.3 and 3.4 of the KP in any single reporting year. The outer rectangle represents the boundaries of a hypothetical country. Figure 2.1.1 shows the reporting categories for the UNFCCC national inventory according to Volume 4 of the *2006 IPCC Guidelines*, and Figure 2.1.2 includes additional categories resulting from reporting requirements under the KP.

Figure 2.1.1 Land Use Categories in the national inventories under the UNFCCC for a hypothetical country in year X of the commitment period[20]

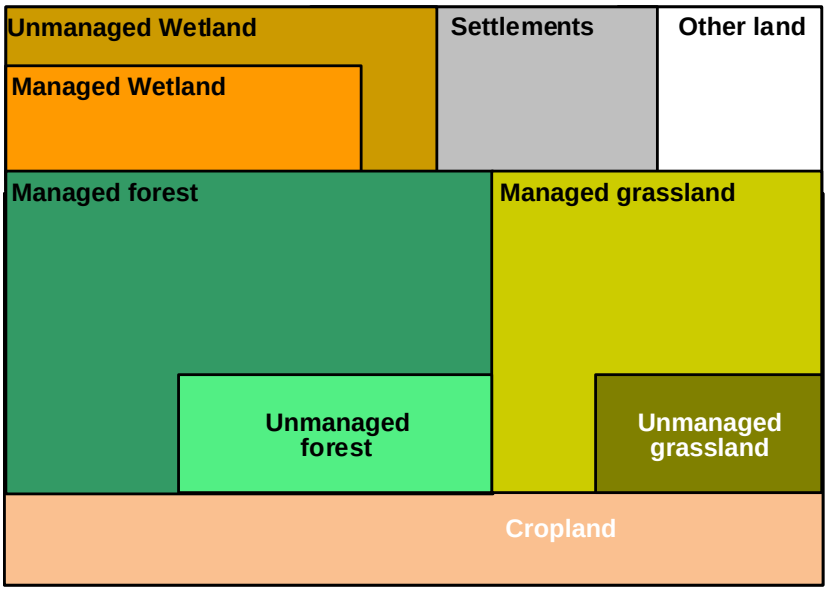
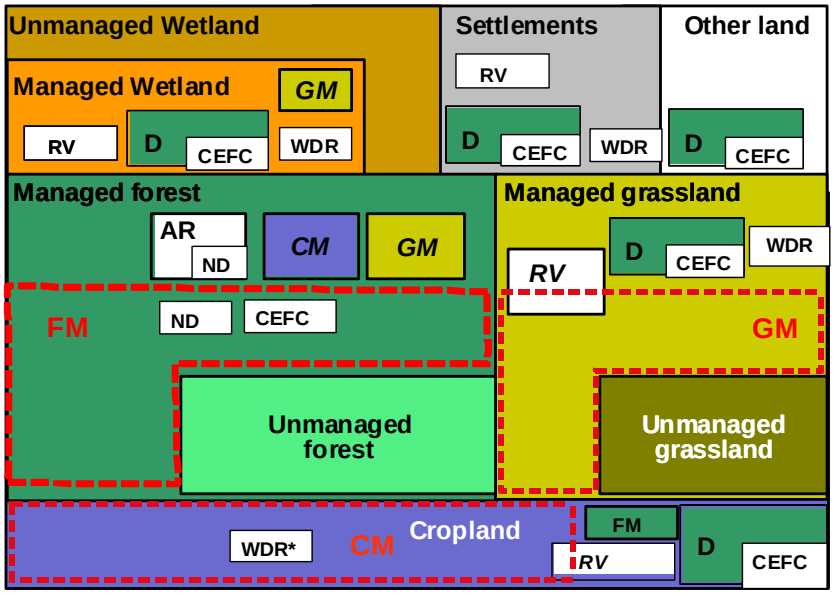


Figure 2.1.2 Land in Article 3.3 and 3.4 Activities for Kyoto Protocol reporting for a hypothetical country in year X of the commitment period. This classification corresponds to the "final" status in Table 2.1.1[21]. See text for further explanations



* WDR on cropland can only occur if CM is not elected, otherwise the associated emissions have to be reported under CM.

[20] Unmanaged forests and unmanaged grasslands are not reported in UNFCCC inventories.

[21] A- Afforestation; R- Reforestation; D- Deforestation; FM- Forest Management; CM- Cropland Management; GM- Grazing land Management; RV- Revegetation; WDR- Wetland Drainage and Rewetting; ND- Natural Disturbance, CEFC- Carbon Equivalent Forest Conversion;

It is worth noting, from Figure 2.1.1, that reporting under UNFCCC for LULUCF attempts to assign a land use category to all land within the country, while in Figure 2.1.2, KP Article 3.3 and 3.4 activities cover a sub-set of the total land area. KP reporting is complicated by two additional issues:

(i) KP reporting is backward looking, because the history of land use may be important in the determination of the activity under which a given land area should be reported

(ii) Parties are allowed some flexibility in the definitions of which land use type is to be included within a given Article 3.4 activity. For example, it is conceivable that a land use such as fruit orchards might fulfil the LULUCF definition of forest, but it is defined by the Party as Cropland Management, consistent with past practice. In such cases it is *good practice* to document the rationale of criteria used to exclude from forested land areas which would otherwise meet the area and vegetation thresholds for forest (e.g., consistency with national forest inventories, with reporting to FAO, etc.), and how these criteria are applied consistently across space and time (See also Section 1.2).

In Figure 2.1.2, dashed lines delineate areas subject to Forest Management (FM), and two of the elective activities under Article 3.4, Cropland Management (CM) and Grazing Land Management (GM). Revegetation (RV) can occur on various land categories. By definition, Wetland Drainage and Rewetting (WDR) can only occur on lands that are not already subject to one of the other Article 3.4 categories. The area subject to FM can be smaller than the area of managed forest under UNFCCC reporting because (i) countries could use different thresholds for defining forests for the KP and UNFCCC reporting, (ii) Article 3.4 requires that the management activity took place since 1990. Parties are encouraged to adopt definitions of land use and Article 3.4 activities which are consistent with each other, however, it is acknowledged that may not be possible in all circumstances. For further discussion of this possible definitional difference see Figure 2.7.1 and accompanying text in Section 2.7.2 (Choice of Methods for identifying lands subject to Forest Management). Emissions and removals on unmanaged forests that remain unmanaged are not included in the UNFCCC or the KP reporting. However, the area of unmanaged land is reported under UNFCCC, and should a human-induced deforestation event occur in unmanaged forests, the associated emissions would be reported as Deforestation event under Article 3.3. Lands for which emissions from natural disturbances are not reported (see Section 2.3.9.6 for additional requirements) need to be identified separately for both FM and AR lands ("ND" in Figure 2.1.2). Lands that are used to establish a Carbon Equivalent Forest Conversion (CEFC) to compensate for harvesting of plantations established after Jan 1, 1960 and before Jan 1st 1990, that are re-established in a different location are shown in Figure 2.1.2 as "CEFC". Such lands are reported and accounted as a subcategory within FM and but they need to be identified separately. They include both the land area that was cleared, CEFC that would be reported as D if the CEFC provision were not used and the previously non-forest land on which the equivalent plantation was established, CEFC within FM, (see Section 2.7.7 for additional requirements).

Although, for KP reporting lands subject to cropland management are largely identical to Cropland/arable/tillage lands in UNFCCC reporting, flexibility exists especially with regard to woody crops. In cases where there is conversion of forest land to cropland, these are reported under Article 3.3 Deforestation. Where GM is elected and CM is not, land subject to conversion from GM to cropland has to be continued to be reported under GM because land cannot transition from an elected to an unelected Article 3.4 activity.

Grazing land management usually occurs on lands classified as grasslands in the UNFCCC inventory. However, grazing land management can also occur in managed forests, and not all grasslands are necessarily grazing lands. Emissions and removals of greenhouse gases on unmanaged grasslands are excluded from both the UNFCCC and the KP reporting, however it is *good practice* to include the area of unmanaged lands in the KP reporting together with all other lands not subject to any activity under UNFCCC.

Afforested and reforested (A/R) lands are always managed forests. Carbon stock changes and non-CO_2 greenhouse gas emissions are to be reported under Article 3.3 only.

Deforested lands are usually managed (thus, for instance, there is no "D" box in the unmanaged grasslands).

2.2 GENERIC METHODOLOGIES FOR AREA IDENTIFICATION, STRATIFICATION AND REPORTING

2.2.1 Reporting requirements

Decision 2/CMP.7 states that areas of land subject to Article 3.3 and 3.4 activities must be identifiable[22], adequately reported[23] and tracked over time.[24] Section 2.2.2 discusses two land reporting methods that can be applied to all Article 3.3 and 3.4 activities. Section 2.2.4 discusses how these reporting methods can draw on the three approaches presented in Chapter 3, Volume 4 of the *2006 IPCC Guidelines,* Section 2.2.5 provides a decision tree for selecting one of the two reporting methods, and Section 2.2.6 includes a more detailed discussion of how lands subject to Articles 3.3 and 3.4 can be identified, so that the requirements of either reporting method can be satisfied.

2.2.2 Reporting Methods for Lands subject to Article 3.3 and Article 3.4 activities

The reporting requirements set out in Decision 2/CMP.8 (which replaced Decision15/CMP1) seek to ensure that there is no double counting of land areas, completeness in land identification, and consistency in reporting. The general information to be reported on activities under Articles 3.3 and 3.4 shall include the geographical boundaries of areas encompassing units of land subject to Afforestation/Reforestation, Deforestation, Forest Management and lands subject to elected activities among Cropland Management, Grazing land Management, Revegetation and Wetland Drainage and Rewetting activities. To achieve this, and based on national circumstances such as the characteristics of existing forest inventory systems and the size of the country, a Party may choose one of two methods (Figure 2.2.1):

Reporting Method 1 uses a spatially-referenced approach that delineates the geograpphic areas that include multiple land polygons subject to Article 3.3 or 3.4 activities. The geographic areas could be defined using georeferenced legal, administrative, or ecosystem boundaries. Information about activities within these areas is derived from (grid-based or other) sampling techniques using remote sensing or ground-based data or from administrative statistics. However, the location of each land polygon within these geographic areas may not be known,. See Section 2.2.3 for additional georeferenced reporting requirements arising from Decision 2/CMP.7 for those countries that choose additional accounting provisions.

Reporting Method 2 is based on the spatially-explicit and complete geographical identification of all land polygons subject to Article 3.3 and Article 3.4 activities.

[22] Paragraph 25 of the Annex to Decision 2/CMP.7:*National inventory systems established under Article 5, paragraph 1, shall ensure that areas of land subject to land use, land-use change and forestry activities under Article 3, paragraphs 3 and 4, are identifiable, and information on these areas shall be provided by each Party included in Annex I in their national inventories in accordance with Article 7. Such information will be reviewed in accordance with Article 8.*

[23] Decision 2/CMP.8 Annex II, paragraph 2

General information to be reported for activities under Article 3, paragraph 3, forest management under Article 3, paragraph 4, and any elected activities under Article 3, paragraph 4, shall include: […]

(b) The geographical location of the boundaries of the areas that encompass:

(i) Units of land subject to activities under Article 3, paragraph 3, of the Kyoto Protocol;

(ii) Units of land subject to activities under Article 3, paragraph 3, of the Kyoto Protocol which would otherwise be included in land subject to forest management or elected activities under Article 3, paragraph 4, of the Kyoto Protocol under the provisions of decision 2/CMP.7, annex, paragraph 9;

(iii) Land subject to forest management under Article 3, paragraph 4, in the second commitment period and to any elected activities under Article 3, paragraph 4; […]

(c) The spatial assessment unit used for determining the area of accounting for afforestation, reforestation and deforestation;

[24] Paragraph 24 of the Annex to the Decision 2/CMP.7: *Once land is accounted for under Article 3, paragraphs 3 and 4, this land must be accounted for throughout subsequent and contiguous commitment periods.*

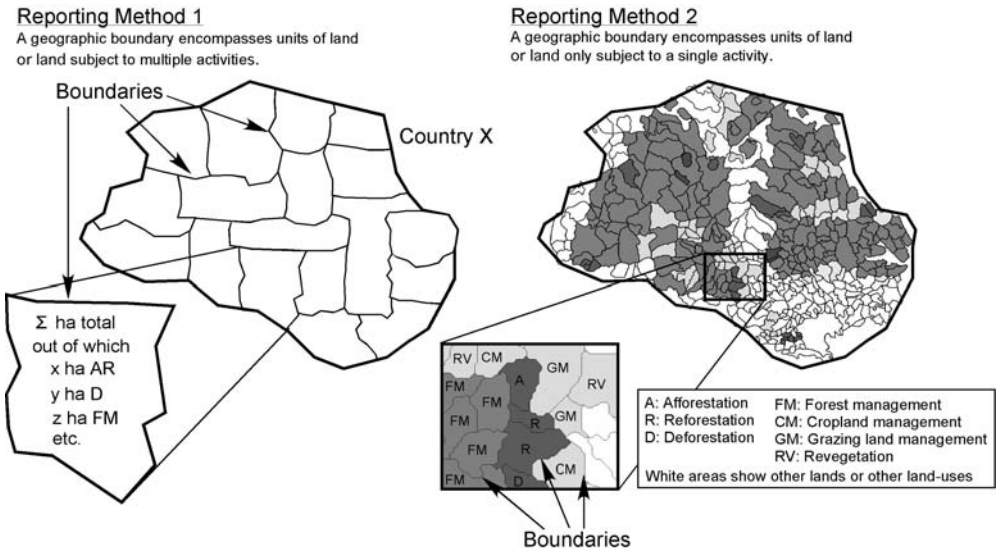
For Reporting Method 1, depending on the size of the country and the ecological and climate variability within the country, it is *good practice* to select the number of geographic areas for which the geographic boundaries of land are defined with the goals to reduce heterogeneity and to increase accuracy and reporting transparency. Thus, unless the country is relatively small it is *good practice* to define the boundaries of more than one geographic area and for relatively large countries it is *good practice* to limit the number of geographic areas to maintain transparency and reduce uncertainty. The choice of the number of reporting areas affects uncertainty estimates.

To implement Reporting Method 1, it is *good practice* to define and report the geographic boundaries to ensure complete coverage without gaps or overlaps. Criteria for delineating reporting regions within the country could include statistical considerations for the sampling intensity or sampling approaches, considerations of the type and amount of land-use change activities (Article 3.3), Forest Management, and elected activities (Articles 3.4), as well as ecological or administrative considerations. Within each resulting geographic boundary lands subject to Article 3.3 or Article 3.4 activities (if elected) will then be quantified using the approaches described in Volume 4, Chapter 3 (Section 3.3 Representing land-use areas) of the*2006 IPCC Guidelines*, in accordance with the guidance in Section 2.2.3, as well as the methods in Sections 2.2.6 (generic methods) and 2.5 to 2.12 (activity-specific methods).

To implement Reporting Method 2, a Party should identify and report the spatial location of all lands and units of land based on a complete mapping of all areas within its national boundary. This is described in Chapter 3 of the *2006 IPCC Guidelines* as the wall-to-wall mapping version of Approach 3 (see also Section 2.2.4.3). This reporting method uniquely identifies lands and enables activities to be reported without the risk of double counting. To put this reporting method fully into practice requires large-scale data collection and analysis, and the preparation of statistics, which summarise the detailed, polygon or pixel-level information, to ensure that reporting is transparent yet concise. Digital maps, which in practice will not be included in the National Inventory Reports, can be made available to Expert Review Teams who can then verify completeness of timeseries and of spatial coverage.

Examples of national implementations of these Reporting Methods 1 and 2 are Canada and Australia respectively. In Canada the land area is stratified into 18 reporting zones based on the Terrestrial Ecozone classification system. Eleven of these zones contain some 230 million hectares of Managed Forest for which emissions and removals are estimated (Stinson et al. 2011). The underlying analyses of C stocks are based on forest inventory and activity data compiled for over 500 forest management units, but within each of these the exact location of each forest polygon is not included in the analyses. Australia's National Carbon Accounting System uses a wall-to-wall, spatially-explicit approach to estimating carbon stock changes and non-CO_2 emissions. Time time-series of Landsat images are used to determine land cover and land-use changes and to inform estimates of carbon stocks and stock changes (Richards and Brack 2004; Waterworth and Richards, 2008).

Figure 2.2.1 Two reporting methods for land subject to Articles 3.3 and 3.4 activities



With either reporting method, once land is reported as being subject to activities specified under the KP, it should be traceable for the first and subsequent commitment periods. Therefore, if a Party chooses Reporting Method 1, it is *good practice* to record the information needed to identify the sample locations and the lands identified in the samples, and to use the same sample locations for any future monitoring. This ensures that changes in the status of land covered by sample plots (Reporting Method 1) or in the entire country (Reporting Method 2) can be tracked and monitored from 1990 to the end of the commitment period and beyond.

The geographic boundaries resulting from the stratification of the country should be reported using printed or digital maps, as described in Section 2.4.4.1 (Reporting).

2.2.3 Reporting Methods for Lands subject to Additional Accounting Provisions for CP2 and beyond

This section is only applicable to countries that choose the special accounting provisions of Decision 2/CMP.7 and exclude emissions from natural disturbances or make use of the Carbon Equivalent Forest Conversion provision. Decision 2/CMP.7 introduced additional reporting requirements for (1) the georeferenced locations of forest areas subject to natural disturbances for which emissions and subsequent removals are excluded from the accounting[25] and (2) the georeferenced locations of forest plantations converted to other land uses for which a carbon equivalent forest was established on non-forest land and the georeferenced locations of these carbon equivalent forests[26].

Georeferenced locations of areas affected by natural disturbances are required to ensure that subsequent removals from these areas are excluded from the accounting and to track whether or not these areas have been converted to non-forest land uses (deforestation) in the years after the natural disturbance. Countries can meet this requirement either by monitoring post-disturbance land-use change on disturbed areas for which emissions were excluded from the accounting or by demonstrating for all units of forest lands subject to deforestation that these are not lands previously affected by natural disturbances for which emissions were excluded from the accounting. If land-use change does occur then the emissions from the natural disturbance also have to be reported and accounted.

Decision 2/CMP.7 also states that countries need to demonstrate that emissions associated with salvage logging, i.e. the harvest of dead or dying trees affected by a natural disturbance (see Box 2.3.5 in Section 2.3.9.3 for the definition of salvage logging) of these areas were not excluded from the accounting. It is *good practice* to estimate, report and account emissions from all salvage logging, which includes emissions associated with salvage logging on lands affected by natural disturbances for which emissions were excluded from the accounting. See Section 2.3.9 for additional requirements associated with the natural disturbance provision.

Decision 2/CMP.7 requires that the georeferenced locations are reported for cases where plantations are harvested and converted to non-forest land and subsequently non-forest land in another location is planted to establish a carbon equivalent forest. The georeferenced locations of both the converted plantation and the newly established plantation are to be reported. The associated emissions and removals are reported under Forest Management (Article 3.4). See Section 2.7.7 for additional requirements associated with the establishment of carbon-equivalent forests.

These new reporting requirements imply that Reporting Method 1 can only meet the reporting requirements for the second commitment period for countries that make use of the additional accounting provisions (exclusion of ND emissions and CEFC) if additional, georeferenced information about specific land areas within the geographic boundaries is provided. For example, mapping and ongoing monitoring of activities on lands subject to the ND and CEFC providions may be required. Alternative, all lands that are subject to deforestation events need to be assessed to determine whether these lands were previously affected by natural disturbace and if yes, whether the emissions from those disturbances had been excluded from the accounting on the basis of the ND provision.

[25] Paragraph 34 (a) in the Annex to Decision 2/CMP.7 establishes the requirement to report the georeferenced location of these areas. See also Decision -/CMP.8.

[26] Paragraphs 37 – 39 in the Annex to Decision 2/CMP.7 outline all requirements that must be met for this provision. See also Decision -/CMP.8.

2.2.4 Relationship between Approaches in Chapter 3, Volume 4 of the 2006 IPCC Guidelines and Reporting methods in Section 2.2.2

Chapter 3, Volume 4 of the *2006 IPCC Guidelines* (Consistent representation of lands) describes three approaches to representing land area. The detailed reporting requirements of Articles 3.3 and 3.4 of the KP as elaborated in Chapter 3 are met by the two reporting methods given in this chapter, and underpinned by the approaches described in Chapter 3. This section, summarised in Table 2.2.1, discusses which of the three approaches are suitable for identifying units of lands subject to Article 3.3 activities or lands subject to selected activities under Article 3.4. Note that even the most data-intensive Approach 3 outlined in Chapter 3 can only be sufficient without supplemental information if the spatial resolution at which land-use changes are tracked is consistent with the size parameter selected by a country to define forest, i.e., polygon sizes of 0.05 to 1 ha or pixels of 20 to 100 m (see STEP 1.1 in Section 1.2). Land cover and land-use mapping using, for example, 1 km^2 (100 ha) pixel resolution does not meet the Protocol's requirements because land-use change at finer resolution may not be detected. A well designed sample-based approach (Magnussen et al. 2005) at the appropriate spatial resolution may therefore yield more accurate estimates than a wall-to-wall map at 1 km^2 resolution which may miss many small land-use change events. Sample based approaches can provide the required supplemental information.

This section describes three Approaches that may be used to represent areas of land use using the categories as defined and explained in more detail in Chapter 3 of the *2006 IPCC Guidelines*. Approach 1 identifies the total change in area for each individual land-use category within a country, but does not provide information on the nature and area of conversions between land uses. Approach 2 introduces tracking of land-use conversions between categories (but is not spatially explicit), therefore does not allow to track such conversions over time. Approach 3 is characterized by spatially-explicit observations of land-use categories and land-use conversions.

2.2.4.1 APPROACH 1: TOTAL LAND-USE AREA, NO DATA ON CONVERSIONS BETWEEN LAND USES

Approach 1 described in Chapter 3 of the *2006 IPCC Guidelines* provides information that is not spatially explicit and it only reports the net changes in the areas of different land-use categories. Hence, this approach does not meet the land identification requirements of Decisions 16/CMP.1 and 2/CMP.7. National inventory databases are often compiled from detailed spatial inventories that can be based, for example, on sampling approaches that involve a grid or sample plot system. In countries where this is the case, it may be possible to re-analyse the detailed inventory information with reference to the geographical boundaries, which have resulted from the stratification of the country, to meet the reporting requirements of the KP. This means that Approach 1 can only be applied to Reporting Method 1 if additional spatial data at the required spatial resolution are available as a result of re-analysing the inventory information or from other sources, and if additional information is available to quantify the gross land-use transitions (rather than the net changes in land-use categories).

2.2.4.2 APPROACH 2: TOTAL LAND-USE AREA

Approach 2 focuses on land-use transitions and provides an assessment of both the net losses or gains in the area of specific land-use categories and what these conversions represent (i.e., changes both from and to a category). The final result of this Approach can be presented as land-use conversion matrix that is not spatially explicit. Thus, Approach 2 differs from Approach 1 in that it includes information on conversions between categories, but is still only tracking those changes without spatially-explicit location data, which means that the approach does not allow tracking land changes over time. Hence, additional spatial information at the required spatial resolution is necessary to meet the reporting requirements of Decisions 16/CMP.1 and 2/CMP.7. This approach can therefore only be used to identify lands subject to activities under Articles 3.3 and 3.4 if additional data are available that allow tracking lands, and land-use changes, over time. As with Approach 1, it may be possible to apply Approach 2 to Reporting Method 1 if additional spatial data at the required spatial resolution become available from re-compiling the inventory information.

2.2.4.3 APPROACH 3: SPATIALLY-EXPLICIT LAND-USE CONVERSION DATA

Approach 3 is characterized by spatially-explicit observations of land-use categories and land-use conversions, often tracking patterns at specific point locations and/or using gridded map products, such as derived from remote sensing imagery. The data may be obtained by various sampling, wall-to-wall mapping techniques, or combination of the two methods. This approach is applicable to Reporting Methods 1 and 2 (Section 2.2.2), as long as the spatial resolution is fine enough to represent the minimum forest area as defined by the Party under Decision 2/CMP.7 and its precursors.

TABLE 2.2.1
RELATIONSHIP BETWEEN APPROACHES IN CHAPTER 3 OF 2006 IPCC GUIDELINES AND REPORTING METHODS IN THIS REPORT

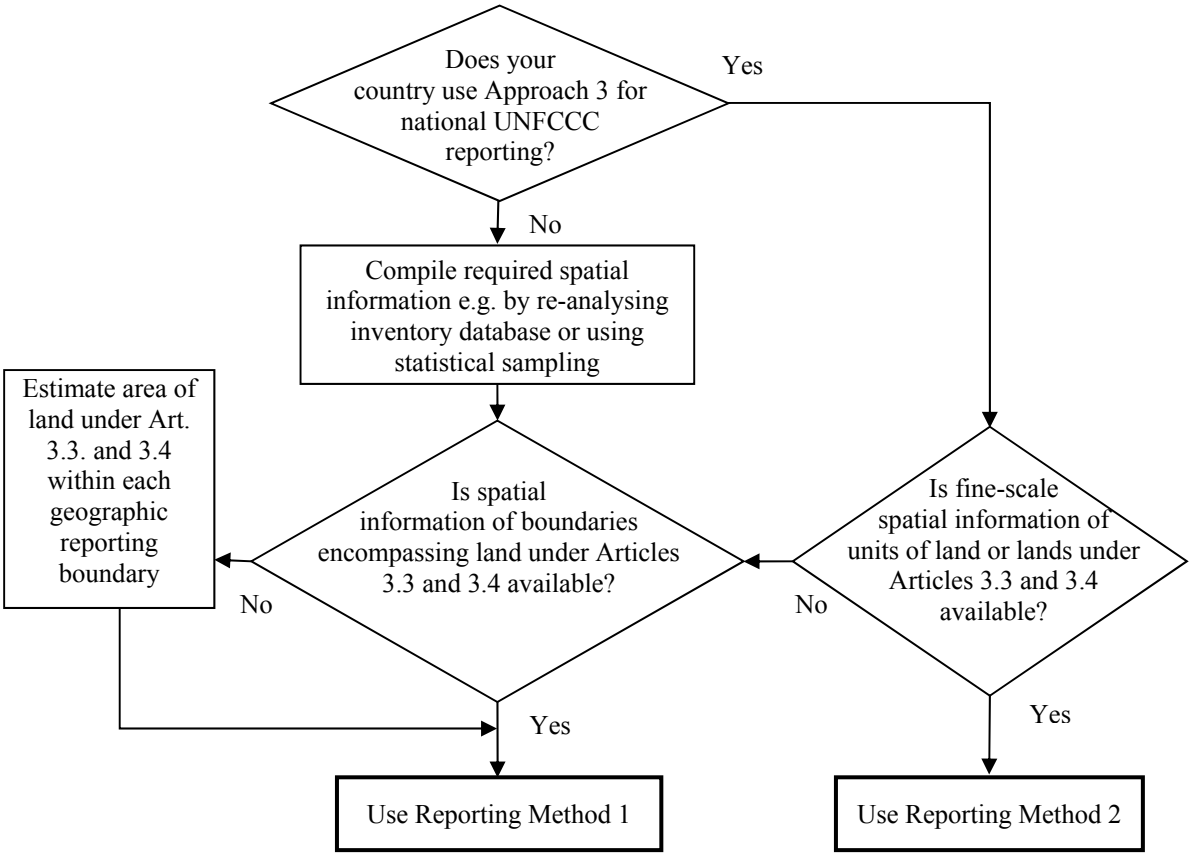
Chapter 3 Approaches	Reporting Method 1 (Broad area identification)	Reporting Method 2 (Complete identification)
Approach 1 Total land-use area, no data on conversions between land uses	Can only be used if additional spatial information is available by re-analysing existing inventories with reference to boundaries of geographic areas or from sampling programs.	Not applicable
Approach 2 Total land-use area, including changes between categories	Can only be used if additional spatial information is available by re-analysing existing inventories with reference to boundaries of geographic areas or from sampling programs .	Not applicable
Approach 3 Spatially explicit land-use conversion data	*Good practice* If spatial resolution is fine enough to represent minimum forest area. Involves aggregating data within the reported geographic boundaries.	*Good practice* If spatial resolution is fine enough to represent minimum forest area.

2.2.5 Choice of Reporting Method

It is *good practice* to choose an appropriate reporting method using the decision tree in Figure 2.2.2. National circumstances may enable a country to use a combination of both reporting methods. In such a case, it is good practice to first stratify the entire country and then to quantify and report the area of land using Reporting Method 1. Within those geographical boundaries where data for complete spatial identification of lands are available, Reporting Method 2 can then be applied.

As outlined in section 2.2.3, additional georeferenced information is required for areas subject to natural disturbances for which emissions and subsequent removals are excluded from the accounting as well as for the locations of forest plantations converted to other land uses for which a Carbon Equivalent Forest was established on non-forest land lands. For either Reporting Method, this additional information could to be reported using time series of maps or tables containing the georeferenced information about the location of these lands. See also the Reporting Tables presented in the Annex to this Chapter.

Figure 2.2.2 Decision tree for choosing a reporting method for land subject to activities under Articles 3.3 and 3.4



When using Method 1 it is usually *good practice* to use the same geographical boundaries for all activities. This will greatly facilitate the identification, quantification, and reporting of land-use changes. However, national circumstances may provide justification for different choices of geographic boundaries for different activities. For example, different geographic boundaries may be chosen to reduce the variance of estimates for one activity within a given boundary. When a Party uses more than one set of geographic boundaries (i.e., more than one stratification system is used), lands subject to Article 3.3 or 3.4 activities that moved from one category to another must be appropriately assigned to the correct geographical boundary. This might require proportional allocation of the units of land to each stratification system in use.

2.2.6 How to identify lands in general

2.2.6.1 SPATIAL CONFIGURATION OF FORESTS AND AFFORESTATION, REFORESTATION OR DEFORESTATION EVENTS

Each Annex I Party to the KP has chosen country-specific parameters within the definition of forest as an integral part of their KP reporting. This required selecting values for the following three parameters: the size of the minimum area of land that can constitute a forest, ranging between 0.05 and 1 ha, and parameters for crown cover (or equivalent stocking level) of more than 10 – 30% and tree height at maturity (2 – 5 m). The parameter for the minimum area of land that constitutes a forest effectively also specifies the minimum area on which land-

use change events occur (i.e.: Afforestation/Reforestation, Deforestation, conversion of natural forests to planted forests, or Carbon Equivalent Forest Conversion). Thus a country that selects, for example 0.5 ha as the minimum area of forest land, must also identify all land-use change events that occur on lands that are 0.5 ha or larger. The identification of lands on which land-use changes occur, such as deforestation, requires the detection of a direct human-induced reduction in tree crown cover from above to below the country-specific threshold of forest, accompanied by a change in land-use.

The CMP decisions do not specify the shape of areas, neither for forest, nor for those areas on which land-use change events occur. Square areas that meet the 0.05 to 1 ha range would be 22.36 m to 100 m on each side. But a rectangle that is 10 m wide and 1,000 m long is also 1 ha in area, as is a 5 m wide and 2,000 m long rectangle. Therefore, a treed shelterbelt or any other strip of trees that exceeds these sizes could be considered a forest. But if such "linear forests" are included in a Party's definition of forest, it is *good practice* to also consider as non-forest any areas being cleared from trees by "linear deforestation events", such as roads, transmission right-of-ways, or pipeline corridors. When such corridors have resulted from cuts since 1990, they should be treated as deforestation events under Article 3.3.

For example, if a country selects 1 ha as the minimum area of forests and further specifies that these areas are square, then a 20 m wide corridor cut through a forest with 100% tree crown cover, will reduce tree crown cover to 80%. This is higher than the range of tree crown cover (10 – 30%) that could be selected by a Party. Therefore the residual area is defined as forest, and even when this corridor through the forest is cut since 1990, it would not constitute a deforestation event. If this "only" 20 m wide corridor is part of a long corridor, which stretches for many kilometres, such as a transmission right-of-way or a pipeline corridor, the total corridor area is much greater than 1 ha. Therefore the definitional criteria applied to specify the shape of the forests of the area of land-use change events can have a large impact on the amount of land reported under Article 3.3 and FM.

It is therefore *good practice* for countries to include, within their report on the choice of forest definitions, a description of the definitional criteria which are used to identify forests and areas on which land-use change occur. It is also *good practice* to apply these criteria consistently to the identification of land-use change events that have occurred since 1990, or the start of the second commitment period for conversion of natural forests to planted forests and CEFC. For instance, these criteria can simply be defined as the minimum width that will be accepted for a forest and an area subject to a land-use change event. Then the minimum length of the area follows from the combination of width and the chosen parameter for minimum area which can constitute a forest. For example, if the size were defined as 1 ha, with a minimum width of 20 m, then a rectangle of minimum width has to be at least 500 m long to meet the 1 ha size requirement.

It is *good practice* to report in the FM land category the impacts on carbon stock changes of "linear clearing events" narrower than the selected minimum width criterion for deforestations events. Examples of such clearing events can include skid sites, forest roads, or seismic lines. Similarly, it is *good practice* to report the carbon stock changes in shelterbelts that are narrower than the selected minimum width criterion and are therefore not forest, if these shelterbelts are within lands subject to Cropland Management, Grazing land Management, Revegetation or Wetland Drainage and Rewetting activities, where the Party has elected the respective Article 3.4 activity.

2.2.6.2 SOURCES OF DATA FOR IDENTIFYING LANDS AND ADDITIONAL NEW REPORTING REQUIREMENTS FOR THE SECOND AND SUBSEQUENT CPS

The needs for the reporting of lands subject to activities under Articles 3.3 and 3.4 and other reporting requirements have been outlined in the previous sections. The data and information available to a country to meet these needs will depend largely on national circumstances, including the investments made into the appropriate GHGI national systems, for monitoring reporting and verifying emissions and removals. These include the land and forest inventory systems already in place and the additional measures a country chooses to implement to meet the reporting requirements. The data and the acquisition methods must ensure that they are reliable, well documented methodologically, at an appropriate scale, and from reputable sources.

In very general terms there are three major options and their combinations that can be taken to meet the information needs:

- To use information from existing national statistics, land-use and forest inventory systems.
- To implement a monitoring and measurement system to obtain information on land-use conversions, forest management, natural disturbances and other relevant activity data.

- To implement a system by which land management activities are reported to government agencies, e.g. an incentive program could be established that encourages land managers to report afforestation activities that are difficult to detect through remote sensing, in particular in regions with slow growth rates, such as boreal forests. To ensure integrity, such a reporting system should include verification and auditing procedures.

It is likely that in most countries the existing forest inventory systems will be combined with additional sources of information and in-country monitoring activities to meet all the land reporting requirements of the KP, and that, with varying degrees of incremental efforts, additional information will need to be obtained through monitoring or in-country reporting systems. The optimum approach to obtaining the required data may involve combinations of the three options. For example, national forest inventory systems with 5 to 10-year periodic re-measurement intervals may not be adequate to meet the reporting needs on annual area disturbed by wildfires, and the associated non-CO_2 emissions. Data from fire monitoring systems could be used to augment the information obtained from forest inventories. Or a country could determine that it would be most efficient to combine an activity reporting system to identify units of lands subject to Afforestation/Reforestation (which can be difficult to detect using remote sensing in regions with slow growth rates), and a monitoring system to identify lands subject to Deforestation (which are more readily detected).

Remotely sensed data are increasingly contributing to land-use monitoring, to forest inventory systems, , and to activity reporting systems as data for certain sensors become cheaper or freely available, and as computing power and algorithms are improving. Nevertheless, considerable efforts, infrastructure and expertise are required to process the large volumes of remote sensing data and to derive estimates of carbon stock changes and non-CO_2 greenhouse gas emissions and removals from the remotely sensed data on land cover and land-use changes. In particular estimates of GHG emissions and removals associated with belowground biomass, dead organic matter, soil organic matter, including peat, carbon pools that cannot be directly inferred from remote sensing of land surface characteristics will require additional efforts and investment.

[Consider adding a box outlining additional information sources in the literature such as GOFC-GOLD source book, GEO-FCT and GFOI, descriptions of models and other tools available to conduct such analyses]. Short paragraphs can discuss following topics : open image and reference data archives freely available (NASA, ESA), new methods (time-series analysis), new global land cover map products (China, ESA) necessity of robust validation and quantification of uncertainty of estimates. Literature that could be cited: GOFC-GOLD Sourcebook, GFOI Method and Guidance Document, and Japanese REDD-plus Cookbook. "Also consider the meeting report: Datasets for use in the IPCC Guidelines FAO data and how it can be used in the IPCC Agriculture and Land Use Guidelines IPCC Expert Meeting Report 20-22 October, 2009, IFAD, Rome, ITALY, http://www.ipcc-nggip.iges.or.jp/public/mtdocs/pdfiles/0910_FAO-IFAD-IPCC-Meetingreport.pdf" While this is not strictly methodological guidance specific to the KP, it is relevant information for the community likely to read this report.

USE OF EXISTING INVENTORIES

Countries that maintain detailed forest and other land-use inventories or collect annual or periodic spatial land statistics may be able to identify lands affected by Article 3.3 and 3.4 activities since 1990 from their inventories. This, however, will only be possible if the national inventory and data collection systems meet stringent technical requirements. The systems must be able to define the land use and forest area in 1990, have an update cycle that is sufficiently short to capture land-use change events between relevant periods (1990-2007, 2008-2012, and 2013-2020) and be of sufficient spatial resolution to identify events of the size of the minimum forest area chosen by the country, i.e., 1 ha or smaller. Also, the sample plots within a “boundary” need to be georeferenced and used repeatedly during future monitoring to allow tracking of land over time. If the latter is not possible, e.g., because monitoring procedures were changed, it is *good practice* to develop computational procedures, which allow conversion of data between the sampling schemes or, at least to have a method, which allows to map the data from a previous to a successor sampling scheme (see also Sections 2.4.1 Developing a consistent time series and 2.4.2 Recalculation).

If countries use Approach 3 to carry out inventories, with spatially explicit and complete geographical information of land use and land-use change, the inventories will be sufficient to meet the reporting requirements provided that the minimum grid or mapped polygon meets the area criterion selected to define forest. Forest inventories in large countries often do not record polygons (i.e. the minimum mapping unit) less than, for example, 3 ha in size. The requirement to identify afforestation, reforestation, deforestation or natural forests to planted forest conversion events at a resolution of 0.05 to 1 hectares can be met, however, with additional statistical analyses to establish the area subject to afforestation, reforestation, deforestation or conversion of natural forests to planted forests events that occurred in units less than 3 ha in size. One possible approach could be to determine the size-class distributions of afforestation/reforestation and of deforestation events in the country, using a statistical sampling approach. The proportion of the area of afforestation/reforestation and of

deforestation events that is between 0.05 – 1 ha and the minimum mapping unit in the inventory (in this example 3 ha) can then be applied to estimate the area of afforestation/reforestation and deforestation events from the 3-ha resolution inventory. For example, if the 3-ha resolution inventory shows that there have been 1,000 ha of afforestation/reforestation events in units of 3 ha or larger, and the sample-based size-class distribution of afforestation/reforestation events shows that on average 5% of the afforestation/reforestation events is in areas of size between 0.05 – 1 ha and 3 ha, then the 1,000 ha represent 95% of the total afforestation/reforestation area (and the total is estimated to be 1,000 • 100/95 = 1,052.6 ha). It is *good practice* to document the statistical validity of the sample-based size-class distribution, and its regional and temporal variation. Note that this approach to augmenting existing inventory information also has implications for the determination of carbon stock changes: since these 5% of the area are not geographically referenced, only statistical methods such as regional averages can be used to determine their carbon stock changes and trace their fate, once they are included under Article 3.3 or 3.4, over time. An alternative approach would be to collect the data regarding afforestation, reforestation, deforestation or conversion of natural forests to planted forests in areas of size between 0.05 – 1 ha and 3 ha through activity reporting but countries would need to ensure completeness and collect georeferenced information (see below).

Additional monitoring and data compilation may be required to meet the reporting requirements for land-use changes, conversion of natural forests to planted forests, wetland drainage and rewetting, and activities such as salvage logging and land-use conversion of lands affected by natural disturbances for which the emissions were not included in the accounting.

Countries that choose an inventory-based approach for the identification of lands subject to afforestation/reforestation activities can face the challenge that non-forest areas are not usually included in the forest inventory. In this case, countries must ensure that their inventory system detects land-use transitions from non-forest to forest and expands the forest inventory into the newly created forest area. Some countries monitor changes from non-forest to forest by means of remote sensing of lands not previously covered by the forest inventory or by maintaining inventory plots on non-forest land.

MONITORING AND MEASUREMENT OF ACTIVITIES

To meet the reporting requirements of Articles 3.3 and 3.4, countries may have to develop and implement a monitoring system for the identification and recording of land use and land-use change. Such a monitoring system could combine a base map (or other sources of spatial information) on forest area and land use on 31 December 1989 with spatial data on land-use and forest area in subsequent years. Changes in land-use and forest area can then be inferred from a time series of spatial data. This may require interpolation, for example where a base map has been derived from composite satellite images obtained over several years, as is often the case where cloud cover, sensor failures, or other technical reasons make it impossible to obtain complete national coverage for a single point in time.

Some events, such as the conversion of natural forest to planted forest, or logging following natural disturbances, are rarely spatially and temporally explicitly documented in inventories. The monitoring of these events is important, and the monitoring time interval should be short enough to capture relevant changes. Remote sensing monitoring can be useful, especially in large or remote areas, due to its potentially high temporal resolution and cost-effectiveness. However, remote sensing data and their results need to be validated against in-situ data to reduce uncertainties.

In many countries repeated complete (wall-to-wall) coverage of the entire country is not feasible on an annual basis. When implementing temporal and spatial sampling strategies, it is *good practice* to ensure that the sampling methods are statistically sound, well-documented and transparent, and that estimates of uncertainty are provided (Section2.4.3 Uncertainty assessment). Appropriate pre-stratification of the country for which sample estimates will be developed may reduce the uncertainty.

Recent advances, such as the release of the complete freely available Landsat archives, developments of new image processing algorithms, and vast increases in computing power may enable the production of annual land-cover change products at national, continental and global scales. However, given that land-use change often occurs on only a small fraction of the areas affected by land-cover change, additional information and/or inferences may be required to ascertain whether a land-cover change represents a land-use change. Moreover, special requirements such as the reporting of conversion of natural forests to planted forests will require additional data, for example to determine whether cover loss occurred in ‘natural forests’ and whether the regenerated forest is the result of planting. These and other special requirements can be met through activity reporting (see below).

Where the monitoring system generates georeferenced data for natural disturbance events, this information can also be used to track subsequent events with reporting obligations, such as salvage logging of disturbed areas or the conversion to non-forest land of disturbed areas for which emissions were not accounted.

ACTIVITY REPORTING

Identification of lands that are subject to activities under Articles 3.3 and 3.4 can be achieved through the implementation of an activity reporting system. For example, since afforestation events are often difficult to detect through remote sensing and often occur outside the area of existing forest inventories, a country may choose to identify these lands through an activity reporting system that encourages land managers who afforested non-forest land to report such activities to the appropriate national agency. Instead of trying to detect afforestation events from inventory or monitoring systems, countries can request those individuals or agencies to report the afforestation/reforestation activities.

Activity reporting may also be most efficient where information about land use is required that may not be readily determined from remote sensing, such as Cropland Management, or Grazing land Management. Activity reporting may also be important for the attribution of land cover change, including Revegetation, and to identify where observed conversions to and from forest are linked through the provision of carbon equivalent forest conversions. Reporting systems can usefully include spatial databases that facilitate the compilation of the pertinent activity information. It is *good practice* to include the location and the area of the activity, and information relevant to the estimation of carbon stock changes, such as site preparation methods, tree species planted, and the actual as well as the expected volume growth function for the land.

Activity reporting may be necessary for the identification of afforestation, reforestation, deforestation, conversion of natural forests to planted forests or conversion to carbon equivalent forests in areas of size below the forest inventory minimum unit, when such minimum unit is larger than the minimum area selected for the forest definition under KP. Coupled with high resolution remote sensed images, activity reporting can provide geo-referenced information and detailed description of land cover change for small areas and sample plots.

It is *good practice* for Parties that rely on activity reporting systems, to put into place methods for internal auditing and verification to ensure that activities are neither over- nor underreported. Administrative information on programmes or subsidies for afforestation activities alone may not include information on plantation establishment success. Spatially explicit information, i.e., either the delineation of the units of lands, or references to a country's national map grid coordinates (e.g., UTM, Universal Transverse Mercator) or legal description of the units of land subject to an activity, are required for the domestic audit and verification procedures applied to a reporting system.

It is *good practice* to report GHGs emissions and removals associated with drainage and rewetting of organic soils in forest land. Detailded guidance for identifying lands is provided in the following section, section 2.5.2 (Afforestation/Reforestation), section 2.6.2 (Deforestation), section 2.7.2 (Forest Management), section 2.3.9.2 (natural disturbance), section 2.7.7.2 (Carbon Equivalent Forest Conversion), section 2.9.2 (Cropland Management), section 2.10.2 (Grazing land Management), section 2.11.2 (Revegetation), section 2.12.3 and *Wetlands Supplement* (Wetland Drainage and Rewetting).

2.3 GENERIC METHODOLOGICAL ISSUES FOR ESTIMATING CARBON STOCK CHANGES AND NON-CO_2 GREENHOUSE GAS EMISSIONS

Once the areas subject to activities under Articles 3.3, and 3.4 have been determined, the carbon stock changes and non-CO2 greenhouse gas emissions on these areas must be estimated following the methods outlined in the *2006 IPCC Guidelines*, the *Wetlands Supplement* and this Supplementary Guidance.

Coverage of activities under Articles 3.3 and 3.4 requires an estimation of all carbon stock changes, and emissions and removals of non-CO2 greenhouse gases from all lands subject to the included activities and for all carbon pools with discretionary omission of those that are not a source of carbon, with higher-tier methods used for key categories. Parties do not have discretion in the exclusion of the Harvested Wood Products Pool[27]. The GHG emissions and removals will be estimated regardless of their cause, such as growth, decomposition, harvest, natural disturbances, or the establishment of equivalent forest. In the case of natural disturbances on AR or FM

[27] Paragraph 26 of the Annex to Decision 2/CMP.7

lands, the emissions and removals shall be estimated and reported[28] but countries can elect to exclude these emissions and subsequent removals from the accounting in years where the emissions from disturbances are above the background level plus the margin (See Section 2.3.9.6 for details). The carbon stock changes, and emissions and removals of non-CO2 greenhouse gases for which a Party elected to apply the 'Carbon Equivalent Forest Conversion', need to be accounted and reported under Forest Management.

The methodology used to estimate carbon stock changes and greenhouse gas emissions and removals for any particular year depends on the land use in the current and in prior years, because shifts in categories or land uses can occur over time. Therefore, differenct methodologies may be applied to different lands reported within one Article 3.3 or Article 3.4 activity.[29] The methodology used to calculate greenhouse gas emissions or removals associated at a given year should correspond to the actual land use on that land in that year, supplemented by additional methodologies to account for past land uses and changes in land use, where appropriate. If the land in the current year is not subject to an Article 3.3 activity, FM or an elected Article 3.4 activity, and if a reporting requirement was not established through such activities in prior years, then the emissions and removals for that land are not reported under the KP.

The generic methods of estimating the carbon stock changes, for all pools to be reported (see below), are described in Chapter 2 of the *2006 IPCC guidelines*. This section provides supplementary guidance applicable to all activities under Articles 3.3 and 3.4. Guidance for specific activities can be found in Sections 2.5 to 2.12. Methodological updates for mineral and organic soils that are recently published [or forthcoming] include:

Mineral Soils

The inventory calculations are based on land area and lands that can be stratified by climate regions and default soils types as shown in Table 2.3, Chapter 2, Volume 4, *2006 IPCC Guidelines*. This table presents default reference (under native vegetation) soil organic C stocks for mineral soils (tonnes C ha-1 in 0-30 cm depth). Countries following Tier 2 method may also refer to data provided in Batjes (2011). It is *good practice* whenever possible to verify soil carbon stock reference values by comparison with results from field measurements.

Organic soils

The *Wetlands supplement* contains updated and new methodological guidance for estimating GHG emissions and removals from drained and rewetted peatlands, organic soils, as well as from specific human-induced changes in coastal, inland mineral soil, and constructed wetlands.

2.3.1 Pools to be reported

The *2006 IPCC Guidelines* provide methodologies for the estimation of the carbon stocks and stock changes in five carbon pools: above and belowground biomass, dead wood, litter and soil organic carbon. (Table 1.1, Chapter 1, Volume 4, *2006 IPCC Guidelines*). Decision 2/CMP.7 introduced the additional requirement to report and account for the storage of carbon in harvested wood products (see Section 2.8). Decreases in one pool may be offset by increases in another pool, e.g., biomass pools decline after a disturbance but litter and dead wood pools can increase. Thus the change in a single pool can be greater than the net change in the sum of the pools.

Once the individual pools have been estimated and reported for a specific area, the sum of the carbon stock increases or decreases in the five pools and HWP is calculated. Any net decrease in carbon stocks is converted to the equivalent CO_2 emission in the reporting tables (see the Annex to this Chapter) and any net increase is reported as the equivalent CO_2 removal. Carbon stock changes are converted to CO_2 emissions and removals by multiplying the net carbon stock change by 44/12 (the stochiometric ratio of CO_2 and C) and by changing the sign: a decrease in carbon stocks (negative sign) leads to an emission to the atmosphere (positive sign) and vice versa. Chapter 1 in Volume 4 in *2006 IPCC Guidelines* provides clear definitions of carbon pools (see Table 1.1). If national circumstances require modifications to those definitions, rationale and documentation should be provided for these modifications and on the criteria used to distinguish between carbon pools. It is *good practice*

[28] Decision 2/CMP.7, paragraph 33

[29] For example, two units of land may both be in the cropland management category. However, one of them may have resulted from grassland conversion into cropland, the other from continuing cropland management, so that the greenhouse gas assessment methods need to take account of differing values of soil carbon resulting from their different management histories.

to provide such information on both the individual pools included in the reporting, and on the total carbon stock change of the six pools, including HWP.

Decision 2/CMP.7 specifies that a Party may choose not to account for a given pool in a commitment period, if transparent and verifiable information is provided that the pool is not a source.[30] *Good practice* in providing verifiable information, which demonstrates that excluded pools, if any, are not a net source of greenhouse gases, can be achieved by:

- Representative and verifiable sampling and analysis to show that the pool has not decreased. It is *good practice* under this approach to measure the pool at enough sites, within regions, to provide statistical confidence, and to document the sampling and research methods;
- Reasoning based on sound knowledge of likely system responses. For instance, if an established cropland without litter or dead wood carbon pools, i.e. not orchards or agroforestry systems, is converted to forest land by afforestation or reforestation, the dead wood pool cannot decrease, because there is no deadwood in that cropland; as is typically the case in areas with annual crops;
- Surveys of peer-reviewed literature suitable for the activity, ecosystem type, region and pool in question (for example, showing that in the climatic situation and with the soil types of the region, afforestation or reforestation of cropland leads to increases in soil organic carbon stocks); or
- Combined methods.

It is *good practice* to report, wherever it is applicable, levels of confidence in estimates that led to the exclusion of a pool, and how this level of confidence was established (see also Section 2.4.3 Uncertainty Assessment). When two or more pools are combined in the reporting, then it is *good practice* to report carbon stock changes for the combined pool unless a country can demonstrate that the aggregate of all pools is not a source.

2.3.2 Years for which to estimate carbon stock changes and non-CO_2 greenhouse gas emissions

Decision 2/CMP.7 specifies that the carbon stock changes and non-CO_2 emissions for land subject to Article 3.3 activities, Forest Management and any elected activities under Article 3.4 be reported for each year of the commitment period[31], beginning with the start of the commitment period, or with the start of the activity, whichever is later. [32] Decision 2/CMP.7 also requires that each area that was subject to reported activities during the first commitment period has to be reported during subsequent commitment periods and the associated emissions and removals estimated, even if the area is no longer subject to any Article 3.3 or 3.4 activity.

This means that if the activity started during the commitment period, the carbon stock changes and non-CO_2 emissions should be reported for the year of the onset of the activity and for each of the remaining years of the commitment period. If the activity started after 1990 but before 1 January 2013, reporting of the carbon stock changes and non-CO_2 emissions for the commitment period should cover each year of the commitment period.

In summary, the area and associated carbon stocks changes and non-CO_2 emissions to be reported by Parties, each year, under each activity are:

- For A/R, D, RV, and for FM and WDR, when a "narrow" approach (see section 1.1) to the implementation of their definition is applied, the area to be reported under the activity is the cumulative area of lands subject to the activity since 1990; although for each land carbon stock changes and non-CO_2 emissions have to be reported only since the year of the onset of the activity or the start of the commitment period, whichever comes later.

[30] See paragraph 26 in the Annex to the decision 2/CMP.7 (Land use, land-use change and forestry), contained in document FCCC/KP/CMP/2011/10/Add.1

[31] See paragraph 2(d) of Annex II to decision 2/CMP.8 (Implications of the implementation of decisions 2/CMP.7 to 5/CMP.7 on the previous decisions on methodological issues related to the Kyoto Protocol, including those relating to Articles 5, 7 and 8 of the Kyoto Protocol).

[32] See paragraph 23 in the Annex to decision 2/CMP.7.

BOX 2.3.1
EXAMPLE

A Party had three deforestation events reported between 1990 and the last year of the second commitment period:

• the first occurred in 2005, i.e. before the start of the first commitment period - and it was 1,000 ha in size,

• the second in 2010, i.e. during the first commitment period, and it was 2,000 ha in size,

• the third in 2015, i.e. during the second commitment period, and it was 4,000 ha in size.

This Party will report during the second commitment period:

• for the first two years, i.e. 2013 and 2014, the total area deforested until that date, i.e. 1,000 + 2,000 = 3,000 ha, and carbon stock changes and non-CO_2 emissions that occurred on those lands since the start of the second commitment period, i.e. 1 January 2013.

• for the remaining years of the second commitment period, the total area deforested until that date, i.e. 1,000 + 2,000 + 4,000 = 7,000 ha, and carbon stock changes and non-CO_2 emissions that occurred since the start of the second commitment period, i.e. 1 January 2013, on the 3,000 ha deforested before the start of the second commitment period plus carbon stock changes and non-CO_2 emissions that occurred since 2015 on the additional 4,000 ha deforested in that year.

- For A/R, D, and for FM and WDR, when a "broad" approach (see section 1.1) to the implementation of their definition is applied, the area to be reported under the activity is the cumulative area of lands reported under the activity since the start of the first commitment period - i.e. 1 January 2008- minus the area that, for each activity, has been transferred to another mandatory activity or, according with the hierarchical order implemented by the Party, to another elected activity. Although for each land carbon stock changes and non-CO_2 emissions have to be reported only since the year of the onset of the activity or the start of the second commitment period, i.e. 1 January 2013, whichever comes later.

BOX 2.3.2
EXAMPLE

A Party is reporting the entire national forest area as subject to FM. While there is no deforestation the area subject to FM is continuously increasing during the three first years of the second commitment period due to expansion of forest over the current timberline, adding 1,000 ha annually. The area reported subject to FM activity at the beginning of the second commitment period, i.e. 1 January 2013, is equal to 1,000,000 ha.

This Party will report during each year of the second commitment period an additional 1,000 ha of area subject to FM, so that at the end of:

• 2013 the area reported will be equal to 1,001,000 ha and associated carbon stocks changes and non-CO_2 emissions, since the beginning of the year, will be reported;

• 2014 the area reported will be equal to 1,002,000 ha: an initial area, 1,001,000 ha, subject to FM since 2013 and 1,000 ha of new forest area subject to FM for the first time in this year. For the initial area associated carbon stocks changes and non-CO_2 emissions, since 2013, will be reported. For the new area associated carbon stocks changes and non-CO_2 emissions, since the beginning of the year, will be reported;

• 2015 the area reported will be equal to 1,003,000 ha: an initial area, 1,001,000 ha, subject to FM since 2013, an additional area of 1,000 ha subject to FM for the first time in 2014 and a new forest area subject to FM for the first time in this year. For the initial area associated carbon stocks changes and non-CO_2 emissions, since 2013, will be reported. For the area added in 2014 associated carbon stocks changes and non-CO_2 emissions, since 2014, will be reported. For the new area associated carbon stocks changes and non-CO_2 emissions, since the beginning of the year, will be reported;

For each following year the Party will report lands and associated carbon stock changes and non-CO_2 emissions since the year in which have been reported under FM for the first time.

Countries must avoid any double counting of lands, and associated carbon stocks changes and non-CO_2 emissions. Therefore, if transfers of land among categories occur, the transferred area of lands has to be subtracted from the old category and added to the new category, and the associated carbon stocks changes and non-CO_2 emissions be reported under the new activity. Note that there are constraints that limit acceptable transfers of land among reporting categories as outlined in Section 1.3. ,

Each activity (A/R, D, FM, CM, GM, RV, WDR) may consist of a suite of practices and may begin with one or several of these. For instance, an afforestation program may begin with planning, land purchase, producing propagation material, etc. Practices like site preparation can also precede the planting or seeding (as a result of which the land actually becomes a "forest"). Some of these practices do not affect carbon stocks (e.g. planning), while others like site preparation may result in significant carbon, nitrous oxide or methane emissions. It is *good practice* to interpret the beginning of an activity as the start of *in situ* carbon stock change and/or non-CO_2 emissions due to any of the suite of practices. For example, if an afforestation activity includes site preparation, then it is *good practice* to include carbon stock changes caused by site preparation. In order to do that, one can either a) measure the carbon stocks on the site prior to the start of any operations related to the activity (in case carbon stock changes are estimated using multiple stock measurements), or b) make sure that the estimate of the stock change includes an estimate of the emissions resulting from these initial practices.

2.3.3 Correct implementation of C stock change estimation methods when areas are changing

The carbon stock-difference method outlined by the *2006 IPCC Guidelines*[33] requires carbon stock inventories for a given land area, at two points in time. When using this method for a specific activity, it is important to ensure that the area of land in that activity at times t_1 and t_2 is identical, to avoid confounding changes in stock caused by area changes. Per unit of area at time t_2, the annual stock change is the difference between the carbon stock at time t_2 and time t_1, divided by the number of years between the inventories. If the forest area is changing, for example as a result of deforestation, afforestation, or both, then carbon stock changes can occur as a result of the transfer of land between UNFCCC or Kyoto Protocol reporting categories (see Figure 11 in Kurz et al. 2009 for an example). Examples of possible approaches that can be implemented to address this issue are provided below.

Countries that use the IPCC stock-difference method for the calculation of stock changes[34] need to ensure that actual carbon stock changes are reported, and not artefacts resulting from changes in area over time. One example that represents *good practice* is to implement the calculations of annual carbon stock changes when using any stock difference method in the following sequence: for any carbon pool of each activity, for each land, the annual carbon stock change should first be calculated for the year of interest on the area at time t_2, and these stock changes should then be summed for all areas subject to the activity. The inverse sequence, i.e., first summing up carbon stocks across all areas of the activity at times t_1 and t_2 and then calculating the difference in carbon stocks, can result in errors if the total area at times t_1 and t_2 is not the same; it is therefore *good practice* that area of land used in the calculation at times t_1 and t_2 is identical. Indeed, if the area subject to an activity increases from the beginning to the end of the reporting year, then the reported carbon stocks reflect the transfer of area (and the associated carbon stocks) into the land category; similarly, carbon stocks will decrease, if area is removed from a land category[35]. The issue is of particular concern when areas outside the reporting system enter into the reporting system, such as unmanaged land areas, or areas subject to activities not elected by a country. For example the C stock increase in AR lands afforested on a land category not included in the reporting will yield an apparent increase in soil C stocks but this C was transferred from the other land category and does not contribute to C removals from the atmosphere.

It is therefore *good practice* to ensure that when using the stock difference method that the area for the calculations of carbon stock differences for each activity at times t_1 and t_2 is identical. Furthermore it is *good practice* to conduct all calculations of annual carbon stock changes and non-CO_2 greenhouse gas emissions for the area of the activity at the end of the inventory year - i.e. the area at time t_2 in equation 2.5 of Chapter 2, Volume 4, *2006 IPCC Guidelines*- and to use this approach consistently through time.

[33] *2006 IPCC Guidelines*, Section 4.2.1.1.

[34] *2006 IPCC Guidelines*, Section 4.2.1.1.

[35] Because of the obligation to keep reporting any area subject to any Article 3.3 or Article 3.4 activity at any point in time during commitment periods, a decrease of the area reported under an activity may only happen as a consequence of a transfer of area to another activity, e.g. decrease of area reported under Forest Management because of deforestation.

BOX 2.3.3
EXAMPLE

During a year of the commitment period the area of land reported under FM varies because new forest land is added to the FM area and because of deforestation activities:

	At the start of year	At the end of year
Area of forest lands that was subject to FM in the previous year	1,000,000 ha	990,000 ha
Area of lands subject to FM converted to non-forest land	0 ha	10,000 ha
Area of **new** forest lands subject to FM	0 ha	10,000 ha
Total area subject to FM	1,000,000 ha	1,000,000 ha

The carbon stocks measured at times t_1 and t_2 in those lands are:

	At the start of year	At the end of year
Average per hectare biomass carbon stock of forest lands subject to FM	100 tC ha^{-1}	105 tC ha^{-1}
Average per hectare biomass carbon stock of **new** forest lands subject to FM	80 tC ha^{-1}	84 tC ha^{-1}
Average per hectare biomass carbon stock in deforested lands	100 tC ha^{-1}	20 tC ha^{-1}

A correct procedure will calculate stock changes in the three land categories:
- forest lands that were subject to FM since the beginning of the year,
- forest lands were the FM activity started during the year,
- forest lands subject to FM that were deforested and converted to cropland in the year.

Then, the sum of stock changes calculated for the two types of lands subject to FM will be reported under the FM activity, while the change in stock calculated for deforested land will be reported under D (Article 3.3).

A. Total stock-change in area subject to FM that was subject to FM in the previous year	990,000 ha * (105 – 100) tC ha^{-1} = 4,950,000 tC
B. Total stock-change in area subject to FM for the first time in this year	10,000 ha * (84 – 80) tC ha^{-1} = 40,000 tC
C. Total stock-change in deforested areas	10,000 ha * (20 – 100) tC ha^{-1} = -800,000 tC
Total stock-change in FM areas (A+B)	4,950,000 + 40,000 = 4,990,000 tC
Stock change reported in Forest Land converted to Crop Land under UNFCCC and in D under Article 3.3 (C)	-800,000 t C

It would be incorrect, for instance, to calculate the total aboveground biomass carbon stock on the total land subject to FM at times t_1 and t_2 and then subtract C_1 from C_2 e.g.:

C_1 Total stock in land subject to FM at the start of year	1,000,000 ha * 100 tC ha^{-1} = 100,000,000 tC
C_2 Total stock in land subject to FM at the end of year	990,000 ha * 105 tC ha^{-1} + 10,000 ha * 84 tC ha^{-1} = 103,950,000 + 840,000 = 104,790,000 tC
C_2 - C_1 – yields the incorrect result	104,790,000 – 100,000,000 = 4,790,000 tC

When land-use change events occur, the associated fluxes are reported in the new land-use category. When using Tier 3 models and the IPCC default (Gain-Loss) method for the calculation of stock changes[36] it is *good practice* to ensure that the land-category attribute in the model is updated to reflect the subsequent land-use change **prior** to estimating any C stock impacts from the land-use change event. This ensures that all carbon stock changes and non-CO_2 emissions that occur during a year will be reported in the new category. (See Box 1 in Kurz et al. (2009) as an example of a Tier 3 modelling approach that implements the required change in the land-use category at the start of the year, i.e. prior to estimating any carbon stock changes and non-CO_2 emissions associated with land-use changes during that year).

2.3.4 Relationship between measurement and reporting intervals

The CMP decisions specify that all emissions by sources and removals by sinks caused by Article 3.3, Forest Management and elected Article 3.4 activities be reported annually.[37] A number of methods are available to obtain annual estimates of emissions and removals and the annual reporting requirement does not imply that annual measurements are necessary. This would be neither feasible nor cost-effective. In fact, although more frequent measurement will generally decrease uncertainties, the opposite can also happen because of short-term variability, as discussed in Section 2.3.5 (Interannual Variability). Carbon stock changes for pools with high uncertainties in stock estimates, e.g., soil organic carbon, are usually not detectable on an annual or short-term basis.

Broadly speaking, when countries are developing and selecting methods to meet their reporting requirements, it is *good practice* to seek a balance which is affordable, makes best use of data that are already available, allows stock changes to be verified consistently with the approaches set out in Chapter 6, Volume 1, of the *2006 IPCC Guidelines* (Section 6.10 Verification), and does not make greenhouse gas inventories susceptible to the impacts of annual fluctuations in weather which can mask the impacts of changes in anthropogenic activities. Although Section 2.3.5 suggests that field data collection on a five-year cycle may represent a reasonable compromise, the re-measurement interval also depends on the pool and the magnitude of the expected changes relative to the spatial variability in the pool and the uncertainties involved in pool size assessments. For example, changes in soil carbon can often only be detected over longer time periods (Saby et al. 2008). Data already available annually, such as planting or harvest statistics, may be combined with measurements conducted over longer time periods – which are less affected by annual fluctuations – or with data based on a five-year running mean.

2.3.5 Interannual Variability

The two largest causes of actual interannual variability in greenhouse gas emissions and removals in the LULUCF sector are natural disturbances (such as fire, insects, windthrow, and ice storms) and climate variability (e.g., temperature, precipitation, drought, and extreme events). Natural disturbances have large impacts per hectare in the areas where they occur, while climate variability typically causes small changes per hectare but can affect large areas (Griffis *et al.,* 2003; Kurz 2010; Richards 2010; Li et al., 2011; Yasuda et al., 2012). Consequently, the rate of net greenhouse gas emissions or removals in a given area may vary from year to year, and can shift between a net source and a net sink in successive years.

The third cause of interannual variability in greenhouse gas emissions and removals is the variation in the rate of human activities, including forest harvesting, land use, and land-use change. Variations and trends in these human activities are of interest because they can demonstrate the benefits of climate mitigation efforts. Estimation of the impacts of human activities and their trends over time is therefore the main purposes of national greenhouse gas inventories.

The 'signal' of the impact of human activities, including mitigation measures, on emissions and removals in the LULUCF sector, may not be discernible against the 'noise' of large interannual variability in emissions originating from natural or indirect-human causes, because the impacts of natural disturbances and climate variability can obscure trends in the impacts of human activities. The ability to discern the signal of changes in human activities from the noise of the interannual variability is, however, important when inventory estimates

[36] *2006 IPCC Guidelines*, Section 4.2.1.1.

[37] Note that although annual reporting is required, countries have the option to account either annually or over the entire commitment period (see paragraph 1(h) of Annex I and Paragraph 1 of Annex II to Decision -/CMP.8).

1823 are used to monitor the impacts of mitigation measures (IPCC, 2010). The provision in decision 2/CMP.7 that
1824 enables countries to exclude from the accounting emissions from natural disturbances (see Section 2.3.9)
1825 removes some of the variability from indirect-human and natural factors.

1826 The methodology used to calculate reported emissions and removals affects the extent to which these causes of
1827 variability are captured in the reporting. Lower Tier methods are typically less affected by interannual variability
1828 in non-anthropogenic drivers of greenhouse gas emissions and removals than higher Tier methods. Lower Tier
1829 methods in which estimates of emissions and removals are insensitive to variation or trends in climate or other
1830 environmental conditions (such as atmospheric CO_2 concentrations or N-deposition rates) are likely to estimate
1831 lower interannual variability in emissions and removals than actually occurs. This is because IPCC default data
1832 (including those contained in the Emissions Factor Database[38]) have been calculated by averaging data collected
1833 over time and space to estimate representative global, regional, and ecological factors. By averaging out time and
1834 space variability Tier 1 methods that use these IPCC factors do not reflect interannual variability from natural
1835 and indirect-human induced factors.

1836 In contrast, Tier 3 methods that use process models to calculate net primary production (NPP) and heterotrophic
1837 respiration (Rh) as a function of environmental variability can report very high interannual variability in
1838 emissions and removals as a result of climate variability because these two fluxes (NPP and Rh) are very large.
1839 This can introduce fluctuations in annual greenhouse gas inventories that can completely mask impacts of
1840 changes in human activities (Richards 2010). Forest inventory-based modelling approaches that implement the
1841 IPCC default approach (Gain- Loss Method)[39] and that use empirical yield tables, which are not affected by
1842 interannual variability in climate, report lower interannual variability in greenhouse gas emissions and removals.
1843 Inventory-based modelling approaches represent interannual variability due to natural disturbances and human
1844 activity (e.g. Stinson et al. 2011 show high interannual variability in emissions and removals due to variations in
1845 annual area burned and insect infestations). Estimates of greenhouse gas emissions and removals derived from
1846 the stock difference method (calculating the difference in C stocks estimated from forest inventories at two
1847 points in time) report the average annual net balance over the period between the first and second forest
1848 inventory. This approach averages interannual variability and, without additional information, may not be able
1849 to attribute observed emissions and removals to the drivers of emissions such as natural disturbances,
1850 environmental change or human activities. Additional information could be derived from a continuous forest
1851 inventory design in which some data are collected each year, or from supplementary statistics on area annually
1852 affected by disturbances.

1853 Interannual variability can decrease as the geographical area considered increases. For example, the effects of
1854 local weather patterns may partially offset each other across a large country, but may be more pronounced in a
1855 small country or within a small region of a country. There are, however, climatic processes that can synchronize
1856 variations in weather over large regions, such as global climate change or El Niño Southern Oscillation (ENSO)
1857 events which typically occur on time scales of 3 to 7 years. Within limits, the longer the measurement or
1858 estimation interval the more likely it is that the results will capture the true long-term average value but averages
1859 can mask trends.

1860 In addition to greenhouse gas emissions and removals during the commitment period, Decision 2/CMP.8 also
1861 requires estimation and reporting of greenhouse gas emissions and removals during the base year (1990 in most
1862 cases) for those elected activities for which net-net accounting applies (Table 1.1). The impact of this estimate
1863 for a single year could be large because it will be compared against the estimates for each year in the
1864 commitment period in which this activity occurred. The direction and magnitude of the impact depends on how
1865 the year 1990 deviated from the long-term emissions averages, e.g. as a result of variability in natural
1866 disturbances or climate. Where environmental conditions in the base year (e.g., 1990) caused major deviations in
1867 greenhouse gas emissions and removals from their longer-term (e.g., 5-year) averages, it is *good practice* to use
1868 longer-term averages of emissions and removals to represent the base year.

1869 Because of interannual variability in environmental conditions, extrapolation from a single year may result in
1870 incorrect conclusions about long-term trends. Conversely, interpolation of long-term trends in, e.g. forest growth
1871 rates may result in under- or overestimation of the actual growth in a single year. Forest growth functions and
1872 yield tables used in countries with forest management planning systems are based on measurements of periodic
1873 growth (e.g., over 5 or 10-year re-measurement intervals) and therefore incorporate and average the impacts of
1874 past interannual variability of environmental conditions. One approach that meets *good practice* to reduce
1875 interannual variability is to use such growth functions to estimate biomass growth rates, because they represent
1876 the average annual growth rates and are therefore influenced little by short-term fluctuations in environmental
1877 conditions.

[38] Emissions Factor data base: http://www.ipcc-nggip.iges.or.jp/EFDB/main.php

[39] *2006 IPCC Guidelines*, Section 4.2.1.1.

Where empirical growth and yield functions are used to estimate stand growth, it is *good practice* to evaluate the potential influences of interannual variability in environmental conditions, for example through comparisons of predicted and actual growth on a set of regionally distributed permanent sample plots. Where the periodic (e.g., 5-year) increment is consistently under- or over-predicted, it is *good practice* to adjust growth estimates accordingly, and to incorporate the new data in updated empirical functions. Countries that use process-based models to simulate annual variability in stand growth and other stock changes need to also evaluate these predictions against measurements of periodic stock changes on permanent sample plots and adjust the predictions, and underlying models, where necessary. Steps outlining the appropriate use of models in greenhouse gas inventories are further outlined in the IPCC expert meeting report on the subject (IPCC 2010).

It is *good practice* at Tier 3 to assess and document clearly the extent to which natural and indirect-human factors influence the time series of reported annual greenhouse gas emissions and removals in the LULUCF sector. While such factoring out has been recognised as difficult (IPCC 2003b), new methods are becoming available that can help inform the policy community about the relative contributions of natural and indirect-human factors compared to direct human factors (Smith 2010). Measures to reduce the reported impacts of environmental variability (including climate, trends in atmospheric CO_2 concentration or N deposition) can include time-averaging of environmental data over 5-10-year or longer periods when using such data in higher-tier process models.

Methods used to reduce interannual variability also can help isolate the impacts of changes in human activities relative to a baseline. This can be achieved by calculating two time series of emissions and removals in which only the rate of human activities differ. For example, using Tier 3 models that are responsive to climate variability, two time series can be calculated *ex post*: first, the baseline emissions (with actual climate data, actual natural disturbance rates and baseline human land use and land-use change and forest management data – the baseline could be based on historic averages or business-as-usual assumptions); and second the actual emissions (with actual climate data, actual natural disturbance rates but actual human land use, land-use change and forest management data). The difference between these two time series reports the impacts of changes in human activities because the impacts of interannual variability in climate and natural disturbances are the same in both scenarios and cancel each other out when calculating the difference between scenarios (Kurz 2010).

Reference levels and the provision to exclude emissions from natural disturbances introduced for Forest Management in Decision 2/CMP.7 can affect the extent to which interannual variability is reflected in the accounted estimates of greenhouse gas emissions and removals. Countries that elect to exclude emissions from natural disturbances will reduce the interannual variability in accounted emissions.

The impact on accounting of the use of reference levels on interannual variability will depend on the methods used to calculate the reference level and the actual reported emissions. Countries could introduce large bias due to interannual variability in reported emissions if they use a reference level that was calculated with methods that are not responsive to environmental variability or with average climate parameters, but then calculate actual emissions with methods that are responsive to environmental variability (including long-term trends) or with actual climate parameters. If a Party uses Tier 3 models responsive to environmental parameters, it is therefore *good practice* to use consistent methods, including the same environmental and climate data, to calculate both the estimated reference level and the estimated actual emissions. For example, if a technical adjustment to the reference level calculations using Tier 3 methods used the same time series of climate parameters that are used in the calculation of the actual emissions, then the impacts of interannual climate variability on forest productivity (NPP) and respiration would cancel out in the difference between the two time series.

It is *good practice* to document whether the methods selected for the estimation of greenhouse gas emissions and removals are sensitive to interannual variability of environmental conditions during the commitment period, and to report how interannual variation was addressed in the inventory calculations.

2.3.6 Choice of method

It is *good practice* to estimate carbon stock changes and non-CO_2 greenhouse gas emissions from Articles 3.3 or Article 3.4 activities using the methods set out in Volume 4 of the *2006 IPCC Guidelines.* For all land under Articles 3.3 or 3.4, it is *good practice* to use the same tier or a higher tier for estimating stock changes and greenhouse gas emissions as the one that was used for the corresponding land use in the UNFCCC inventory, following the guidance on methodological choice and identification of key categories included in Chapter 4, Volume 1, of the *2006 IPCC Guidelines*.

Whenever a category is identified as key in the UNFCCC inventory, it is *good practice* that the associated activity under the KP also be treated as a key category[40]. In the identification and documentation of key categories under the KP it is also *good practice* to include a qualitative assessment, because there is not always an unambiguous correspondence between the UNFCCC categories and KP activities. A country may also undertake Approach 2 for key category analysis (see Section 4.3.2, Volume 1 of the *2006 IPCC Guidelines*) to identify the key categories of their inventory including the KP activities.

Table 2.3.1 can be used to establish the relationship between land categories and KP activities for purposes of identifying key categories under Articles 3.3 and 3.4 of the KP.

TABLE 2.3.1
RELATIONSHIP BETWEEN POTENTIAL KYOTO PROTOCOL ACTIVITIES AND IPCC LAND CATEGORIES FOR LULUCF

Land categories of the *2006 IPCC Guidelines*	**Potential Kyoto Protocol activities**
FOREST LAND	
Forest land remaining forest land (managed)	FM
Land converted to forest land (managed)	AR
CROPLAND	
Cropland remaining cropland	CM, RV, WDR
Land converted into cropland	D, RV, CM, WDR
GRASSLAND	
Grassland remaining grassland (managed)	GM, RV, WDR
Land converted to grassland (managed)	D, RV , GM, WDR
WETLANDS	
Wetlands remaining wetlands (managed)	RV, WDR
Land converted to wetlands	D, RV, WDR
SETTLEMENTS	
Settlements remaining settlements	RV
Land converted to settlements	D, RV
OTHER LANDa c	
Other land remaining other land	WDR
Land converted to other land	D, WDR

[a] Article 3.4 activities only when elected (except FM, which is mandatory)

FM: forest management, AR: afforestation and reforestation, CM: cropland management, D: deforestation, RV: revegetation,
GM: grazing land management, WDR: wetland drainage and rewetting

The left column lists the land categories of the *2006 IPCC Guidelines* that may have been used in the key category analysis of the UNFCCC inventory[41]. If any of these are identified as key, the KP activities in the corresponding right column could initially be considered key. However, as in some cases several KP activities potentially can be key, it is *good practice* to examine qualitatively which of the possible activities actually are key. For example, if land converted to grassland was identified as key, this can involve D, RV, GM, WDR, or land-use changes not covered by the KP. The land area affected by RV or WDR may be much smaller than the land area of the land use category in which it occurs and in which other activities may also occur. If this is the

[40] This applies also when there only are partial overlaps with the UNFCCC inventory

[41] If the analysis was based on the IPCC source/sink categories (1996) the transformation will be less precise. The mapping is shown in Chapter 3, Section 3.1 of *GPG-LULUCF*.

case, and if RV is identified as potentially key according to Table 2.3.1, then countries may separately assess the importance of greenhouse gas emissions and removals in RV compared to the other activities which occur in the same land-use category. It is *good practice* to explain and document which of the potential key categories are identified as key for KP reporting.

In addition, it is *good practice* to take into account the following considerations in the key category determination for estimates prepared under Articles 3.3 and 3.4 of the KP:

- As shown in Table 2.3.1, several activities under the KP can occur in more than one land category of the UNFCCC inventory. In such cases, it is *good practice* to consider the total emissions and removals from the activity for purposes of the key category analysis. When this approach is needed, an activity is considered key if the emissions or removals from the sum are greater than the emissions from the smallest category that is identified as key in the UNFCCC inventory (including LULUCF).
- If, when using the quantitative methods, a category is not identified as key for the present year but it is anticipated to increase strongly in the future, it is *good practice* to identify it as key. This could, for example, occur with a large-scale afforestation program producing only small sinks in initial years, but with the expectation of larger sinks in future years.
- In some cases, it is possible that the emissions or removals from an activity under the KP could exceed the emissions or removals of the associated category in the UNFCCC inventory. In such a case it is *good practice* to identify the KP activity as key if its emissions/removals exceed the emissions of the smallest category that is identified as key in the UNFCCC inventory (including LULUCF).

It is *good practice* to determine for each key category, where relevant (see Table 4.1 in Volume 1 of the *2006 IPCC Guidelines*), whether any subcategories are particularly significant. Usually, for this purpose, the subcategories are ranked according to their contribution to the aggregate key category. Those subcategories that contribute together more than 60 percent to the key category are considered particularly significant. For example, if cropland management has been elected and is identified as key, it is *good practice* to identify which pools and subcategories are significant. It may be appropriate to focus efforts towards methodological improvements of these most significant subcategories or pools.

Tier 1 as elaborated in Chapter 4, Volume 4 of the *2006 IPCC Guidelines* assumes for forest land remaining forest land that the net change in the carbon stock for litter (forest floor), dead wood and soil organic carbon pools is zero. However, paragraph 26 of the annex of decision 2/CMP.7 specifies that all changes be accounted in the following carbon pools: above-ground biomass, below-ground biomass, litter, dead wood, soil organic carbon and harvested wood products. With the exception of harvested wood products, a Party may choose not to account for a given pool in a commitment period, if transparent and verifiable information is provided that demonstrates that the pool is not a source. Therefore Tier 1 can only be applied if the litter, dead wood and soil organic carbon pools can be shown not to be a source using the methods outlined in Section 2.3.1. Tier 1 can also only be applied if forest management is not considered a key category, which can only be the case if "forest land remaining forests land" in Chapter 4 of the *2006 IPCC Guidelines* is not a key category.

2.3.7 Factoring out indirect, natural and pre-1990 effects

CMP decisions specify that information needs to be provided on whether or not anthropogenic greenhouse gas emissions by sources and removals by sinks from activities under Articles 3.3 and 3.4 factor out removals from three processes: (1) elevated carbon dioxide concentrations above pre-industrial levels, (2) indirect nitrogen deposition, and (3) the dynamic effects of age structure resulting from activities prior to 1 January 1990.[42] In addition to the requirement to report whether or not these effects are factored out, those Parties that choose factoring out are expected to also report the methods they used. For the purpose of accounting under the Kyoto Protocol "factoring out" has been addressed through a so-called net-net approach where net change in GHG emissions and removals are accounted by comparing GHG emissions and removals during the commitment period with a benchmark under either a base year or a business-as-usual scenario, which could also be a scenario in which emissions and removals are assumed to balance to zero (see also section 2.3.5 and its discussion on reducing impacts of interannual variability).

2.3.8 Reference Levels

Decision 2/CMP.6 requests each Annex I Party to submit information on its Forest Management Reference Level (FMRL) and provides guidelines for the submission and review of information on FMRLs. Technically the

[42] See Paragraph 3 of Annex II of Decision 2/CMP.8

FMRL is a level of greenhouse gases emissions and removals against which the emissions and removals reported for forest management during the second commitment period will be compared for accounting purposes.

It is *good practice* to construct the FMRL taking into account historical data from greenhouse gas inventory (GHGI) submissions, age-class structure and the need to exclude removals from accounting in line with decision 16/CMP.1, paragraph 1. It is also *good practice* to take into account forest management activities which were already undertaken, projected forest management activities under a 'business as usual' scenario, and continuity with the treatment of forest management in the first commitment period where relevant. Finally, in the construction of the FMRL it is *good practice* to include pools and gases consistent with historic reporting and to also treat natural disturbances consistently. Details of the methodology for determining the FMRL can be found in Section 2.7.5 of this document.

The Annex of decision 2/CMP.7 paragraph 14 requests methodological consistency between the FMRL and reporting for forest management during the second commitment period when accounting for Forest Management. According to paragraph 15 of the Annex of decision 2/CMP.7 a technical correction shall be applied if the reported data on Forest Management or forest land remaining forest land used to establish the reference level are subject to recalculations. The standard method for ensuring consistency of time series is to recalculate the estimates using the same method for all inventory years. Thus, to ensure methodological consistency of the accounting of Forest Management, a technical correction may be needed to ensure that the same method and data (climate, model parameters, etc. but not forest management activity data) are used for the construction of the FMRL and the reporting during the commitment period, or at least to remove the impact of any methodological inconsistency when accounting. Section 2.7.6 of this document describes how to detect the need for a technical correction, as well as when and how to apply a technical correction.

2.3.9 Disturbances[43]

Under the UNFCCC, and in the first commitment period under the Kyoto Protocol, emissions from natural disturbances on managed land are included in reporting and accounting. Emissions from natural disturbances on unmanaged lands are not included in reporting so long as these lands continue to be unmanaged. Decision 2/CMP.7 introduced a modification to this approach by which under certain conditions the emissions from natural disturbances that occur on managed land may be excluded from accounting under the Kyoto Protocol during the second commitment period[44].

The size, intensity and frequency of the natural disturbance may depend significantly on the type of disturbance[45]. While fire, wind and ice storms usually kill or directly damage vegetation, drought can reduce tree productivity (net primary production, or NPP) and CO_2 removals, and increase the vulnerability to other types of disturbance. For example, drought-related tree mortality increases forest flammability (for examples see Martin *et al*., 2011; Perry *et al*., 2011; Xaio and Zhuang, 2007). Insect outbreaks, which may be the major agent of natural disturbance in some regions, may be quasi-periodic, but the frequency and size are often erratic, and influenced by multiple factors (Fleming *et al*., 2002; McCullough, 2000; Rouault *et al*., 2006).

The impacts of natural disturbances of interest here include those that cause direct releases of carbon and non-CO_2 greenhouse gases to the atmosphere (e.g., from fires), those that redistribute carbon between ecosystem carbon pools (e.g., live biomass transferred to dead wood and litter (i.e. the dead organic matter, or DOM)), those that result in post-disturbance emissions (e.g., through the decay of DOM after a disturbance), and post-disturbance removals of carbon from the atmosphere. In addition, some types of natural disturbance change the structure and dynamics of the ecosystem in a way that influences greenhouse gas dynamics of the different pools. For instance, decay dynamics and carbon stock changes in both the soil organic matter and litter pools may change when mineral soil and litter are mixed as a result of a disturbance (e.g., wind-throw).

[43] References in this section are to paragraphs of Annex to Decision 2/CMP.7, unless indicated otherwise.

[44] Paragraph 33 of the Annex to Decision 2/CMP.7 (Land use, land-use change and forestry) contained in document FCCC/KP/CMP/2011/10/Add.1, p. 17-18.

[45] Type of disturbance refers to the list of disturbances in the definition given in Paragraph 1(a) of the Annex to Decision 2/CMP.7 (Land use, land-use change and forestry) contained in document FCCC/KP/CMP/2011/10/Add.1, p. 13.

2.3.9.1 DEFINITIONAL ISSUES

For reporting and accounting under the second commitment period of the Kyoto Protocol, Decision 2/CMP.7[46] provides the following definition of natural disturbances:

Natural Disturbances are non-anthropogenic events or non-anthropogenic circumstances. For the purposes of this decision, these events or circumstances are those that cause significant emissions in forests and are beyond the control of, and not materially influenced by, a Party. These may include wildfires, insect and disease infestations, extreme weather events and/or geological disturbances, beyond the control of, and not materially influenced by, a Party. These exclude harvesting and prescribed burning.

The list of examples provided in the Decision 2/CMP.7 may be understood as follows:

- **Wildfires**: wildfires affect the ecological functioning of many forests. Wildfires can also have undesirable environmental, social and economic impacts. Fire regimes can have significant impacts on forest carbon stocks across considerable spatial and temporal scales (King *et al*., 2011). Recent studies on wildfires and forest include: Hirsch and Fuglem (2006); Williams and Bradstock (2008); Swetnam and Anderson (2008); Girardin *et al*. (2010).

- **Insect and disease infestations**: diseases and pest insects can play a role in ecological processes and substantially affect large-scale regional greenhouse gas balances (Kurz *et al*., 2008; Hicke *et al*., 2012). Outbreaks of forest diseases and pest insects can also have significant negative economic, social and environmental impacts on forested lands. Recent studies on insect and disease infestations in forest include: Canadian Council of Forest Ministers (2012a, 2012b and 2012c); Raffa *et al*. (2008); Bentz *et al*. (2010).

- **Extreme weather events**: extreme weather events include droughts, floods, snow (Fujimori et al. 1987), avalanches, ice, and strong winds (Lindner *et al*., 2010; Yamashita *et al*., 2002; Allen *et al*., 2010; Kramer *et al*., 2008; Bebi *et al*., 2009; Phillips *et al*., 2009; Chambers *et al*., 2007). Besides causing emissions by their own, extreme weather events can negatively affect forests and make them more susceptible for other natural disturbances, e.g. wildfires following droughts.

- **Geological disturbances**: geological disturbances include, for example, volcanic eruptions, landslides, tsunamis, and earthquakes (Kamijo and Hashiba, 2003; Viña *et al*., 2011).

Decision 2/CMP.7 requires Annex I Parties that apply the provisions for natural disturbance to Forest Management under Article 3.4, and/or to Afforestation and Reforestation under Article 3.3 of the Kyoto Protocol to provide transparent information, inter alia, *that demonstrates that the occurrences were beyond the control of, and not materially influenced by, the Party in the commitment period, by demonstrating practicable efforts to prevent, manage or control the occurrences that led to the application of the provisions contained in paragraph 33* of the Annex to the Decision 2/CMP.7[47].

Such practicable efforts could include, but will not necessarily be limited to:

- Reducing the likelihood of the disturbance occurring, by preventive measures modifying factors related to the occurrence or propagation of the disturbance. Actions taken in this regard may themselves have an negative initial impact, e.g. thinning to increase stand stability against storm damages, prescriptive burning to reduce the amount of combustible material, introduction of firebreaks to make the spread of fire less likely;

- Managing or controlling the disturbance during its occurrence. This may be facilitated by the implementation of monitoring programs and early warning systems, integrated coordination with the fire squads, etc.

Depending on national circumstances, examples of transparent and verifiable information that demonstrates these efforts could include but will not necessarily be limited to:

[46] Paragraph 1 (a) of the Annex to Decision 2/CMP.7 (Land use, land-use change and forestry) contained in document FCCC/KP/CMP/2011/10/Add.1, p. 13.

[47] Paragraph 34(d) of the Annex to Decision 2/CMP.7 (Land use, land-use change and forestry) contained in document FCCC/KP/CMP/2011/Add.1, p. 18.

- A national level policy statement, such as a national forest policy or fire management policy, which defines a national strategy for managing the types of natural disturbance which led the Party to apply the provision for natural disturbance[48];
- Information which shows that the Party took practicable efforts to manage or control the individual disturbances included under the natural disturbance provision (for example, expenditure on the fire suppression effort and/or the incident management plans for the disturbance);
- Sub-national management plans or policy statements, which define a strategy for managing the types of natural disturbance, and valid and in force for the region where the disturbance occurred which led the Party to apply the natural disturbance provision.

It is *good practice* to demonstrate that the strategy has been implemented, or is in the process of implementation, when a Party indicates its intention to apply the natural disturbance provision.

In some instances it may not be practicable to prevent, manage or control the disturbance. Where such events or circumstances are included by a Party under the natural disturbance provision, it is *good practice* to provide transparent and verifiable information that no practical action could be taken to prevent, manage or control the occurrences of the event or circumstance.

2.3.9.2 CHOICE OF METHODS FOR IDENTIFYING LAND SUBJECT TO NATURAL DISTURBANCE

This section provides guidance and examples to help Parties in their choice of approach for identifying lands subject to natural disturbance. It has linkages with Section 2.2 that addresses the area identification, stratification and reporting.

Annex I Parties that choose to apply the natural disturbance provision outlined in Decision 2/CMP.7 need to be able to meet all the requirements set out in paragraph 34, (a) to (f) of the Annex to the Decision 2/CMP.7. This includes providing transparent information "*Showing that all lands subject to paragraph 33(a) and (b) … are identified, including their geo-referenced location, year and types of disturbances*" (paragraph 34 (a)); "*Showing how annual emissions resulting from disturbances and the subsequent removals in those areas are estimated*" (paragraph 34(b)); "*Showing that no land-use change has occurred on lands for which the provisions in paragraph 33 … are applied and explaining the methods and criteria for identifying any future land-use changes on those land areas during the commitment period*" (paragraph 34(c)); "*That demonstrates that the occurrences were beyond the control of, and not materially influenced by, the Party in the commitment period, by demonstrating practicable efforts to prevent, manage or control the occurrences that led to the application of the provisions contained in paragraph 33…*" (paragraph 34 (d)); "*That demonstrates efforts taken to rehabilitate, where practicable, the land for which the provisions in paragraph 33 …are applied*" (paragraph 34(e)); "*Showing that emissions associated with salvage logging were not excluded from accounting*" (paragraph 34 (f)). Parties also need to be able to reflect the treatment of emissions and removals on these lands in LULUCF accounting for subsequent commitment periods (paragraph 36 of the Annex to the Decision 2/CMP.7[49]). All these requirements are linked in some way to identifying land affected by disturbances.

For lands subject to Articles 3.3 and 3.4, Section 2.2.2 outlines Reporting Method 1 and Reporting Method 2. As discussed in Section 2.2.4 these reporting methods are not the same as the underlying methods used to identify land areas for greenhouse gas inventory purposes, though there are linkages between them. Reporting Method 1 entails delineating areas that include multiple land units, assessing the respective contribution of relevant activities (or conditions) to the total emissions from these lands, and is often associated with the application of statistical sampling approaches to land identification. Reporting Method 2 is based on the spatially explicit and complete geographical identification of all units of land subject to a single activity (or condition) and entails wall-to-wall mapping, which is frequently associated with the application of remote sensing[50] techniques. Similarly to both reporting methods, identification of lands subject to natural disturbance can be undertaken with

[48] Paragraph 33 of the Annex to Decision 2/CMP.7 (Land use, land-use change and forestry) contained in document FCCC/KP/CMP/2011/Add.1, p. 17-18

[49] Contained in document FCCC/KP/CMP/2011/Add.1, p. 18.

[50] Remote sensing includes satellite imagery and aerial photography. For general guidance on sampling and land identification issues, please refer to the *2006 IPCC Guidelines* (Volume 1, Chapter 2; Volume 4, Chapter 3 and Annex 3.A.3).

statistical sampling approaches, or via wall-to-wall mapping and ground-based surveys, solely or in combination, and may be supported by relevant ancillary data[51].

Estimation of the area affected by the disturbance requires, for each disturbance type, that the:

i. Proportion of area affected is assessed accurately if Reporting Method 1 is used and that each area affected can be identified as being disturbed when Reporting Method 2 is used, and

ii. Methods and algorithms used for disturbance and disturbance type detection be suitable for the identification of disturbances affecting the minimum area as defined by the Party (e.g. selected minimum area for the forest definition used for reporting under the Kyoto Protocol); and that respective area or areas of land be identified in subsequent years. General guidance on this topic is provided in Chapter 3, Volume 4 of the *2006 IPCC Guidelines* and Fuller *et al*. (2003) discuss possible issues related to this.

Statistical sampling schemes do not provide delineation of disturbed areas directly, but rather an estimate of the total disturbed area by means of representative sample plots affected by the disturbance (refer to Chapter 3, Volume 4 of the *2006 IPCC Guidelines* for guidance on sampling and area estimation). Identification and geographical location of disturbance events are performed on a per-plot basis. Such sampling schemes may be based e.g. on National Forest Inventory sampling grids if these provide sufficient information to meet the requirements in Decision 2/CMP.7, in particular those set out in paragraphs 33 and 34. Depending on the type of disturbance and associated characteristics (e.g., area size distribution), intensification of sampling may be necessary to make the estimated uncertainty comparable with the uncertainty in estimating Articles 3.3 and 3.4 forest related emissions overall.

When using remotely sensed data to detect changes triggered by the occurrence of natural disturbances, a Party needs to identify the appropriate temporal, spatial, and spectral resolutions of the data, and to assess the need for complementary ancillary and/or ground truth data. Identification and assessment are specific to types of individual natural disturbance events or circumstances that a Party intends to consider. While for some types of disturbance, less frequent but more detailed data might provide better estimates (e.g., identification of areas affected by pest infestation), for others, more frequent but less detailed data might be better (e.g., when identifying fire hot spot areas). The decision on the features of the data source (e.g., spatial resolution of satellite imagery) to be used should take into account specific characteristics of the type of disturbance (e.g., percent loss in forest crown cover due to pest infestation). In addition, the timing of the surveying and of the analysis of the data are also relevant to ensure that the data captures the effect of natural disturbance and not seasonal changes. For instance, if the analysis of the data occurs shortly after the occurrence of a discrete disturbance event or circumstance, it is very likely that the changes on the ground will result from the event itself. Otherwise, the data may be confounded with land-use change, with annual phenological and climatic differences, and/or other factors that may influence the pre- and post-disturbance conditions. It is therefore *good practice* that the Party indicate how the remotely sensed data is used to identify the changes due to the actual disturbance event or circumstance, and not to other phenomena.

Considered individually, any approach may present advantages and challenges. For example, wall-to-wall approaches based on remotely sensed data may not discriminate clear-cut harvest from salvage logging, while systematic sampling grids of existing forest inventories may not have an adequate sample size, design and frequency to identify reliably the year of disturbance or the affected area with the desired level of precision and accuracy. For both wall-to-wall mapping and statistical sampling techniques, existing national approaches for land identification may need adjustment and improvement in order to fulfill the requirement for identification of lands subject to natural disturbance including their geo-referenced location, year and types of disturbances. Hybrid approaches, using a set of different types of data, may facilitate meeting the relevant requirements in Decision 2/CMP.7. The choice of approach and data to be used by a Party for land identification will depend on national conditions in land under Forest Management and/or Afforestation and Reforestation, the inventories and surveys already in place, and the type and magnitude of the disturbance(s) to be assessed (see Box 2.3.4 for further examples). It is *good practice* for Parties to present information justifying the suitability of the methods and approaches used to identify lands affected by natural disturbance, and on how the provisions concerning salvage logging and land-use change following such disturbances are monitored. It may also be possible to achieve the desired outcomes by other means, e.g., by systems to collect event-based supplementary information, by amending an existing inventory scheme tailored to detect deforestation events in a way that it also assesses whether land-use change has occurred on previously disturbed lands, or by incorporating the detection of salvage logging in harvest records.

[51] E.g. supplementary data providing direct delineation of disturbed areas

BOX 2.3.4

EXAMPLES OF APPROACHES FOR IDENTIFYING LANDS AFFECTED BY NATURAL DISTURBANCE

Example 1: Permanent sample plots with repeated measurements

A Party conducts a national forest inventory based on a set of permanent sample plots distributed following a regular sampling design, and estimates both emissions and area of land-use changes using information and data collected on the sample plots.

Requirements: Design-based inference that uses a set of permanent sample plots with regular measurement intervals. Guidance on sampling approaches, including sample size is provided in Volume 1, Chapter 2 and Volume 4, Chapter 3 (Annex 3.A.3) of the *2006 IPCC Guidelines*. Measurements need to allow the estimation of the parameters of interest, including disturbance type and year of occurrence.

Estimation method: The annual area affected by disturbances of a particular type is estimated as the product between the fraction of plots affected (calculated as ratio by dividing the number of sample plots disturbed and the total number of sample plots) and the total geographical area covered by the sample plots (refer to Section 3A.3.5 in Annex 3.A.3 in Chapter 3, Volume 1 of the *2006 IPCC Guidelines*). The associated total annual emission is estimated multiplying the area affected and the area-specific emissions (CO_2 and non-CO_2) per unit area. Area-specific CO_2 emissions may be estimated from plot data before and after the disturbance. The uncertainty of the area affected by disturbance can be estimated following standard sampling theory (refer to Chapter 2, Volume 1 of the *2006 IPCC Guidelines*). In case of large variations among the area-specific emissions, Parties should stratify the area according with emission intensities and then generate the average emission accordingly.

The potential challenges: The potential challenges of this approach include a large percentage sampling error associated with disturbance events (e.g., hurricanes, volcanic eruptions) that are under-represented in the proposed sampling scheme, unless the sampling grid is intensified. When the regular inventory return interval is not sufficient to assign a year (e.g. for wind-throw), additional field visits or other data/methods may be required. Similarly, field visits may be needed in order to monitor the absence of subsequent land-use changes or salvage logging on sites where the emissions and removals are excluded from accounting.

Example 2: Area estimation with full coverage and time series comparisons

A Party uses remotely sensed data or a complete land register-based system for land use and land-use change estimation.

Requirements: This approach requires full territorial coverage with remotely sensed data of adequate spatial resolution and appropriate remote sensing techniques for assessing changes in land-cover; or a complete land register containing location and size of parcels of land, and information on land use/land cover (for additional information and guidance, refer to Section 3A.2.4 (Tools for data collection) in Chapter 3, Volume 1 of the *2006 IPCC Guidelines*). The remote sensing or land-register based techniques, including classification algorithms and estimators, have to be validated using ground truth or equivalent data in the case of register based methods.

Estimation method: The total area affected and total emissions are summed over individual areas and their associated emissions related to disturbance types. Time series measurements are then used to support evidence, extent and severity of disturbance. Estimation algorithms, which may be a function of type of disturbance, need also to avoid double counting where more than one disturbance affects a given area.

The potential challenges: All classification and mapping algorithms will have an associated error, which can lead to high absolute errors of area estimates if data from several maps are combined (see Fuller *et al*. (2003) for details). For some disturbance types the error is low (e.g., forest fires), while for others it may be high (e.g., disturbances that cause dispersed single tree mortality over large areas, such as Ash dieback[52]). Another challenge is the validation of the algorithms and ensuring an uncertainty within acceptable levels adopted by the Party.

[52] *Chalara fraxinea (teleomorph: Hymenoscyphus pseudoalbidus)*, a fungus affecting ash trees in Europe

Example 3: Permanent sample plots with repeated measurements combined with remote sensing

A Party conducts a forest inventory based on permanent sample plots in a regular design and uses remotely sensed data for stratification.

Requirements: design-based inference developed from a set of permanent sample plots with regular measurement intervals and full coverage by remotely sensed data with appropriate spatial and temporal resolutions that allow for the identification of disturbance events, combined with classification algorithms consistent with the accuracy and precision sought by the Party.

Estimation method: The total area affected by a disturbance type is determined from remotely sensed data and total emissions are estimated from the permanent sample plots that fall within the disturbed area. The actual affected area is a stratified estimate based on the sample plots that fall within the disturbance strata (plots having been affected by a respective disturbance type) from the remotely sensed data. For example, aerial photography could be used in area and emission estimation, reducing the need for sampling of supplemental data. Estimation algorithms, which may be a function of type of disturbance, need also to avoid double counting where more than one disturbance affects a given area. The strength of this method is that it potentially allows for more accurate estimates of both emission and affected areas than those in either Example 1 or 2 above.

The potential challenges: The potential challenge of this approach is that it requires both extensive remotely sensed data and intensive ground data-based inventory systems. Balancing and matching of the systems and methods, e.g., to avoid double-accounting or the use of outdated data, may be difficult to achieve.

Example 4: Remote sensing and additional field inventory

A Party uses remotely sensed data for land use and land-use change estimation and additional measurements for some disturbances (e.g., identification of defoliator-caused tree death).

Requirements: This approach provides full coverage by remotely sensed data with appropriate spatial and temporal resolutions that allow for identification of disturbance events, combined with appropriate classification algorithms and estimators. Classification algorithms and estimators need to be validated with ground truth observations. Ground data collection need to be suitable to capture the information needed for addressing the specific type of disturbance in question.

Estimation method: The total area affected by a disturbance type is the sum of the areas identified as affected. The total area affected and total emissions are summed over individual areas and their associated emissions related to disturbances. Estimation algorithms, which may be a function of type of disturbance, need also to avoid double counting where more than one disturbance affects a given area.

The potential challenges: All classification and mapping algorithms will have an associated error, which can lead to high absolute errors if data from several maps are combined (see Fuller *et al.* (2003) for details). For some disturbance types the error is low (e.g. forest fires), while for others it may be high (e.g., disturbances that cause dispersed single tree mortality over large areas, such as Ash dieback[53]). Another challenge is the validation of the algorithms and ensuring an uncertainty within acceptable levels adopted by the Party.

2.3.9.3 ESTIMATION OF CO_2 EMISSIONS AND REMOVALS FROM NATURAL DISTURBANCES

For the second commitment period, Parties may apply the provision for natural disturbance emissions for accounting for Forest Management under Article 3.4 and/or Afforestation and Reforestation under Article 3.3 as per the Annex to Decision 2/CMP.7. To apply the provisions for natural disturbance, Parties are required to provide country-specific information on a Forest Management background level and/or an Afforestation and Reforestation background level of emissions from natural disturbances (cf. paragraphs 33 (a) and (b) of the Annex to Decision 2/CMP.7). Parties are also required to calculate the emissions and removals subject to the provisions (cf. paragraphs 33 and 34 of the Annex to Decision 2/CMP.7) for natural disturbances and provide

[53] *Chalara fraxinea (teleomorph: Hymenoscyphus pseudoalbidus)*, a fungus affecting ash trees in Europe

transparent information on how the annual emissions and removals are estimated. The incidence of natural disturbances varies both spatially and temporally. Spatial variability refers to the distribution, intensity and the size of the areas affected by disturbances: the impact of a disturbance (e.g., a strong wind and/or insect attack) could be concentrated in a large and continuous forest area; or spread across small-discontinued areas; with either homogeneous or heterogeneous intensity. Temporal variability refers to the occurrence of natural disturbances over time and the extension of post-disturbance effects over time: Direct releases of carbon to the atmosphere (e.g., during fires) or transfers of carbon out of the ecosystem (e.g., during harvest or landslides) occur during the disturbance event, whereas redistribution of carbon among carbon pools (e.g., during wind-throw) cause emissions in subsequent years.

There are particular considerations in relation to the estimation of the effects of natural disturbances where a Party applies the provision for natural disturbance to Forest Management and/or Afforestation and Reforestation. These include the choice of the estimation method and tier level, the attribution of natural disturbances to individual years and legacy effects, salvage logging, differentiation of natural disturbances from regular management activities or other events, and removals subsequent to the disturbance event.

CHOICE OF ESTIMATION METHOD

The methods to estimate CO_2 emissions associated with carbon stock changes in the relevant pools are given in the *2006 IPCC Guidelines* and are elaborated in Chapter 4, Volume 4 for above and below-ground biomass, dead wood, litter, and soil organic matter.

Land subject to natural disturbance in the context of Decision 2/CMP.7 is land that has already been identified as land under Forest Management or Afforestation and Reforestation. The estimation of carbon stock changes and associated emissions due to natural disturbance should therefore be consistent with or complement the method and tier level applied for each of the pools under the activities of Forest Management and/or Afforestation and Reforestation for reporting under the Kyoto Protocol. The estimation of carbon stock changes due to natural disturbance should also take into account the effect of the disturbance on carbon stock changes in subsequent years so that reporting reflects emissions associated with carbon stock changes in the year they occur. This can be achieved by ensuring that the stratification, activity data, the emissions and removals factors and other parameters used for estimates of carbon stock changes in years beyond the date of occurrence reflect the spatial and time incidence of the natural disturbance. It is also *good practice* to estimate emissions associated with carbon stock changes from natural disturbance in a manner consistent with the method used for the calculation of emissions in the background level, or conduct technical correction if that is not the case.

Where the *Forest Land Remaining Forest Land* category under the UNFCCC is a key category it is *good practice* to apply Tier 2 or 3 to estimate carbon stock changes from natural disturbance for Forest Management; and similarly for Afforestation and Reforestation if the *Land Converted to Forest Land* category under the UNFCCC is a key category (Chapter 4, Volume 1 of the *2006 IPCC Guidelines*). The assumption under Tier 1 is that the net carbon stock change in DOM is zero. Decision 2/CMP.7 specifies that the carbon stock change in all pools must be accounted for unless the pool can be shown to not be a source[54]. Although subject to the requirements of the Decision 2/CMP.7 carbon stock gains caused by natural disturbances may be excluded from accounting in the second commitment period, they need to be reflected in the accounting of subsequent commitment periods. Significant amounts of carbon may be transferred to the DOM pool, which will then decay, and thus it becomes less likely that a Party could subsequently show that these pools are not a source in the subsequent commitment periods. Therefore, countries that experience significant changes in disturbance regimes in their forests (which would be the case if major natural disturbance events occur) are encouraged to quantify the impacts from these changes using Tier 2 or 3 methodologies (Section 2.2.1, Volume 4 of the *2006 IPCC Guidelines*).

It is *good practice* for methodologies to represent the effect of the particular natural disturbance event or circumstance on the carbon stocks on the land affected by the natural disturbance. The effects of natural disturbances which should be considered include: direct reductions in carbon stocks due to the disturbance (e.g., release of CO_2 to the atmosphere during wildfires); transfer of carbon between pools (e.g., transfer of living biomass to the DOM pool due to wind-throw); changes in carbon stocks following the disturbance (e.g., through the decay of DOM post disturbance); changes in post disturbance stand dynamics that affect the growth rate of the forest (e.g., early rapid growth in young trees that regenerate after a stand replacing fire). The effect of post-disturbance emission dynamics in dead wood, litter, and soils may be included in estimating carbon stock changes given that the necessary capacity in terms of data and models is available in a country. The effects considered in estimations may require appropriate stratification of the impacted area to adequately represent the disturbance types, climate zones, ecosystems and affected parts of ecosystems, and land use history based on data available from national forest inventory, remote sensing and/or other sources; and appropriate estimation of

[54] Paragraph 26 of the Annex to Decision 2/CMP.7 (Land use, land-use change and forestry) contained in document FCCC/KP/CMP/2011/10/Add.1, p. 16.

emission factors, decomposition rates and other factors and functions involved that are representative for the disturbance event and for the different strata. Remote sensing or ground-based assessments that focus on the disturbance event can be helpful for addressing spatial variability and attributing carbon stock changes due to natural disturbance to individual years. Other statistics that record, for example, salvage logging on an annual basis may also be relevant.

Annex I Parties that apply the provisions for natural disturbance are required to provide transparent information on how the emissions from natural disturbances have been estimated during the commitment period[55]. This includes documentation of data sources and estimation methodologies in accordance with the tier level used for applying the natural disturbance provision. Disturbance matrices[56] (Section 2.3.1.1, Volume 4 of the *2006 IPCC Guidelines*) can be used to define the impact of the event on the proportion of each carbon pool that is transferred to another pool, released to the atmosphere, or removed from forest in salvage logging and entering the carbon pool of harvested wood products.

ATTRIBUTION TO INDIVIDUAL YEARS

For natural disturbances that occur during the second commitment period, reporting of areas and emissions from lands subject to natural disturbances should commence in the year in which the natural disturbance commences and continue in subsequent years.

It is *good practice* to attribute direct releases of carbon to the atmosphere, e.g. from wildfires, which occur during the disturbance event, to the year of occurrence. Post-disturbance emissions from the DOM pools through the decay process, taking account of redistribution, will extend over a period of time. It is *good practice* to estimate these legacy emissions in the year they occur, while avoiding double counting. For example, if a large amount of live biomass damaged during disturbances is transferred to DOM pool, loss of biomass should be estimated as a loss from the biomass pool and an input to the DOM pool. In case of disturbances lasting more than one year, it is *good practice* to estimate, as emissions associated with natural disturbances, both the direct carbon emissions in the year they occur and legacy emissions in the subsequent years of the commitment period. It is possible to represent an insect infestation as a series of annual disturbance events, for example repeated annual defoliation of forests will lead to cumulative impacts on growth reduction, mortality and subsequent emissions (e.g., Dymond *et al*. 2010). Lands affected by natural disturbances will remain in the disturbance category until the end of the commitment period. Guidance on legacy effects associated with natural disturbances after the end of the second commitment period is given in Section 2.3.9.8 below.

SALVAGE LOGGING

Box 2.3.5 defines salvage logging (SL) in the context of natural disturbances. Where SL occurs on land subject to natural disturbance, the carbon stock change due to salvage logging must be accounted for and not excluded with emissions associated with natural disturbances (cf. paragraphs 33(c) and34 (f) of the Annex to Decision 2/CMP.7). The carbon stock change due to wood removals is treated as a loss of carbon from the land in the year the salvage logging occurs, and is subject to the harvested wood provisions of Decision 2/CMP.7 where wood derived from salvage logging can be shown to enter HWP pools. It is *good practice* to assign carbon stock change from salvage logging to the year when they take place.

Emissions from non-biomass carbon pools (e.g. soil organic matter) due to altered decay rates after salvage logging operations should be included in the accounting if the required information or models are available to a Party and transparent information on the estimation of these emissions can be provided. The current state of knowledge indicates limitations and generally high uncertainties for emission estimation from these pools under natural disturbance conditions (Chapter 4, Volume 4 of the *2006 IPCC Guidelines*), nevertheless countries having the necessary capacities are encouraged to capture those dynamics.

[55] Paragraph 34(b) of the Annex to Decision 2/CMP.7 (Land use, land-use change and forestry) contained in document FCCC/KP/CMP/2011/10/Add.1, p. 18.

[56] A description of disturbance matrices and their use in greenhouse gas accounting can be found in Kurz *et al*. (2009).

BOX 2.3.5

DEFINITION OF SALVAGE LOGGING (SL), IN THE CONTEXT OF THE EXCLUSION OF EMISSIONS FROM NATURAL DISTURBANCES

Salvage logging is the practice of harvesting and removing trees or parts of trees (living or dead) from disturbed areas. This management activity is also known as salvage cutting, salvage harvesting, sanitation cutting, and other designations. If it is conducted on areas not subject to the application of the natural disturbance provisions, it can be part of the regular Forest Management emissions and removals estimation and accounting framework, i.e. salvage logging would then be treated as harvest. In case the Party chooses to exclude emissions due to natural disturbances, it *shall account for emissions associated with salvage logging* (paragraph 33(c) of the Annex to Decision 2/CMP.7).

These emissions result from the following:

1) the removal of living biomass and dead wood (and hence, carbon) from the disturbance area due to harvest and removal of trees or parts of trees;

2) losses of carbon from the dead wood remaining on site, litter, and the soil organic matter pools due to SL activities, if any; and,

3) non-CO_2 emissions due to management activities associated with SL, e.g. burning of harvest residues.

Carbon stock changes due to gains in living biomass (removals) are not associated with SL.

In case salvage logging is done in a selective way not affecting most of the disturbed area, for example as recovery of economically very valuable single stems by helicopter logging, it is *good practice* to use methodology appropriate to estimate the effects of this activity on the various pools and to attribute the respective emissions to salvage logging. For example, the share of carbon from living biomass that is transferred to the dead wood pool may be higher in salvage logging operations than in regular harvesting, which has to be reflected. Emissions from harvest residues left after SL have to be accounted for as "associated with salvage logging", too.

A Party needs to demonstrate that the emissions from salvage logging in the area affected by the disturbance were not included in the total emissions associated with the disturbance event, and to demonstrate how, in subsequent years (of the commitment period), disturbed areas are monitored for the occurrence of SL, and how emissions associated with SL are estimated if SL is conducted in subsequent years, after the disturbance. This is particularly relevant to those Parties that report carbon stock changes using the stock difference method.

DIFFERENTIATION FROM OTHER MANAGEMENT ACTIVITIES

Lands affected by natural disturbances can be similar in appearance to, and thus can be confused with, forest areas where regular management activities have taken place. For example, areas affected by wildfire can be similar to prescribed burning, and wind damaged areas after salvage logging can be difficult to distinguish from clear-cuts. For the application of the natural disturbance provision the emissions from natural disturbances have to be clearly differentiated from management activities. It is *good practice* to show that the emissions accounted for under the natural disturbance provision are unambiguously attributable to natural disturbances and do not contain or double count emissions from regular management activities.

REMOVALS

According to paragraph 33 (a) and (b) of the Annex to the Decision 2/CMP.7, *any subsequent removals during the commitment period on the lands affected shall also be excluded from the accounting*. The removals on lands previously disturbed can be estimated using the methodologies provided for Forest Land in Chapter 4, Volume 4 of the *2006IPCC Guidelines*. It is *good practice* to apply estimation methodologies that take into account the respective conditions found on the affected land following the natural disturbance event and to show that the subsequent removals are completely estimated and that double accounting is avoided. If a disturbance results in the loss of all old, large trees but leaves younger age classes intact, estimation methodology for Forest Management may well be appropriate.

MONITORING LANDS AFFECTED BY NATURAL DISTURBANCE

Parties that apply the natural disturbance provision to Forest Management under Article 3.4 and/or Afforestation and Reforestation under Article 3.3 should monitor the lands that have been designated as affected by natural disturbance over the second commitment period. Monitoring of these lands will be required to:

- estimate changes in carbon stocks due to post-disturbance decay and removals;
- keep track of rehabilitation effects on the affected lands;
- identify cases where land-use change has occurred after a natural disturbance;
- estimate the equivalent amount of removed carbon stock in salvage logging
- identify lands where the natural disturbance is followed by another disturbance event

The monitoring of natural disturbances and compilation of associated data on these lands including the disturbance type, size and location is required to provide consistent time series information about the affected area. The methods used in the post-disturbance monitoring of affected areas should be consistent with those applied to identify the lands because emissions from these areas have to be estimated using comparable methodologies.

If land-use change occurs on areas affected by natural disturbances, it is *good practice* to account for this amount of emissions accordingly in the year when the land-use change is detected.

2.3.9.4 ESTIMATION OF NON-CO_2 GREENHOUSE GAS EMISSIONS FROM NATURAL DISTURBANCES

As Section 2.3, Volume 4 of the *2006 IPCC Guidelines* specifies, losses in carbon stocks or pools may in particular cases imply emissions of non-CO_2 greenhouse gases. Typically, emissions of these gases occur due to fires, for which the estimation methodology is provided in Section 2.4, Volume 4 of the *2006 IPCC Guidelines*, which should be applied (together with land-use specific enhancements in Chapter 4 (Forest Land), Volume 4 of the *2006 IPCC Guidelines*) including the requirement to check for complete coverage of CO_2 and non-CO_2 emissions related to changes in carbon stocks and pools in order to avoid omissions and double-counting. It is also *good practice* to document how non-C greenhouse gas (e.g., N_2O) emissions due to natural disturbances are estimated and reported.

If fire in forests contributes to a key category, it is *good practice* to apply higher tiers and to develop a more complete and country-specific methodology which includes the dynamics of dead organic matter and improves the estimates of direct and post-fire emissions.

2.3.9.5 GUIDANCE ON THE DEVELOPMENT OF THE BACKGROUND LEVEL AND MARGIN

Parties which have previously announced their intention[57] may exclude emissions from natural disturbances in year(s) for which emissions due to natural disturbances exceed the background level plus a margin, provided that they meet all requirements detailed in Decision 2/CMP.7[58]. The margin (see below) is a positive number or zero that is used to select years when emissions from natural disturbance may be excluded. Conceptually the background level is the level of disturbance emissions included in the Forest Management Reference Level (FMRL), or expected in association with Afforestation or Reforestation (AR) in the commitment period, and the margin defines outlier events. The purpose of the background level and the margin is to avoid the expectation of net credits or net debits during the commitment period from applying the disturbance provision.

Decision 2/CMP.7 requires separate background levels and margins to be developed for Forest Management (FM), and AR. For both FM and AR, emissions from natural disturbances may occur due to several types of disturbances. In estimating the background level and margin it is *good practice* to combine emissions from different disturbance types, and then to develop one overall background level and margin for FM, and one for AR.

[57] In their national inventory report in 2015.

[58] Paragraph 34 of the Annex to Decision 2/CMP.7 (Land use, land-use change and forestry) contained in document FCCC/KP/CMP/2011/10/Add.1, p. 18.

Decision 2/CMP.7 requires that the background levels be constructed using consistent and initially complete time series containing, but not limited to, 1990–2009 annual emissions associated with natural disturbances[59]. The period of this time series of emissions is referred to as the calibration period. As separate background levels are required for FM and AR, data are necessary for the development of the respective background levels and margins.

To develop background levels and margins, it is *good practice* to apply the stepwise procedure[60] described below.

Step 1: Define the type of disturbances that the Party wishes to be able to exclude from accounting

It is *good practice* that Parties define, and report in their national inventory report in 2015, the disturbances types (e.g., wildfires, insect attack and disease infestations, extreme weather events, geological events) from which they wish to be able to exclude emissions from accounting during the commitment period. Disturbance types may be subdivided as needed. For example, extreme weather events could be divided into wind storms and floods. These disturbance types can include rare events (such as volcanic eruptions) which have not necessarily occurred during the calibration period.

Step 2: Establish a consistent and initially complete time series for the calibration period for each disturbance type

For each disturbance type considered by the Party, a time series of annual emissions associated with the disturbance type is obtained for the calibration period, and entered into Table 2.3.2, which is used for subsequent calculations and for reporting. If emissions from a disturbance type can be demonstrated to be zero (which will usually be the case for rare events, e.g., volcanic eruptions), then the time series will contain zero for all years in the calibration period. For other disturbance types, the Party needs to estimate and report verifiable emissions for the years in the calibration period. The Party is not eligible to exclude emissions for disturbance types for which it fails to report historical time series of emissions for the calibration period. However, the Party may submit such a historical time series later in the commitment period, in which case the background level and the margin need to be recalculated and a technical correction may be needed for the FMRL, to maintain consistency. Separate copies of Table 2.3.2 need to be completed, one for FM and one for AR.

It is *good practice* to sum by year, separately for FM and AR, the emissions from all included disturbances types in each year of the calibration period in order to obtain combined disturbance time series for the calibration period. It is good *practice* to report transparently the combined time series. If the time series is inconsistent with the treatment of disturbances in the FMRL submitted in 2011, a technical correction of the FMRL may be needed to avoid expectation of net credits or debits (see Section 2.7.6).

TABLE 2.3.2
EMISSIONS FROM DISTURBANCES FOR THE CALIBRATION PERIOD

Disturbance type*	**Inventory year during the calibration period**							
	. . .	1990	1991	1992	. . .	2008	2009	. . .
	Total annual emissions from disturbance type							
Wildfires								
Insect attack and disease infestations								
Extreme weather events								
Geological disturbances								
Other								
Sum								

* Sub-divisions of types can be added as needed

[59] Footnote 7 to paragraph 33(a) of the Annex to Decision 2/CMP.7 (Land use, land-use change and forestry) contained in document FCCC/KP/CMP/2011/10/Add.1, p. 17.

[60] The stepwise procedure applies independently of how the FMRL has been set (see Section 2.7.5)

If data are missing for one or several years of the calibration period for a disturbance type, it is *good practice* to apply one of the methods described below to fill gaps.

- If the historical time series contains data for most but not all years during the period 1990-2009, data from at least an equivalent number of other years before or after the calibration period and closest to it should be used. If the missing data are for a subset of disturbance types it is *good practice* to remove the partially complete year and replace it by the closest year outside the calibration period for which complete data are available and which has not already been used for replacement purposes.
- In case the Party has data for most but not all years within the period 1990 to 2009, and there are no data available from before or after this period, it is *good practice* to use all data available, and to apply proxy data or additional information if possible, including expert judgment, to develop data for the missing years.
- If the Party has data only for a few years of the calibration period or if there are no historical estimates of emissions and removals associated with natural disturbances, the Party may still be able to construct a time series if reliable information using country-specific methods such as modeling may make it possible. How to do this is outlined below.

The data to complete Table 2.3.2 and the application, if necessary, of gap filling methods should be done in consultation with the national forest agency responsible for forest measurement and statistics, or an equivalent body. The way in which the data have been provided and any gaps filled should be reported transparently in the national inventory report.

Emissions from and associated with salvage logging cannot be excluded from accounting during the commitment period[61]. This means that, in order to avoid the expectation of credits or debits during the commitment period, historical emissions from natural disturbances should exclude emissions from salvage logging.

If the required historic time series of emissions associated with natural disturbances cannot directly be estimated for a particular disturbance type, country-specific methods can be applied to indirectly develop the time series For example, if a Party lacks estimates of emissions from natural disturbances on AR land, it may choose to use area-specific emissions from natural disturbances on Forest Management land as a proxy, and combine it with the total area of AR land to estimate emissions from natural disturbances on AR land. The use of the proxy must be demonstrated to be justified. In this above example, it should be demonstrated for each disturbance type that the applied area-specific emission rates on Forest Management land are age-independent, or can be corrected for age, and are otherwise independent from the differences in species, size, density etc. that may occur between the forests on AR land and those on Forest Management land. Correction for age class may be achieved by stratifying FM data accordingly.

In all cases, it is *good practice* to report the methodology of how the Party has estimated the emission data in the time series.

Step 3: Develop the background level

Once the time series for the calibration period has been developed by disturbance type, and summed over the types by year, the Party can apply the default or an alternative method (see description below) in order to obtain the background level and the margin.

The default method

The *default method* involves the application of the following steps:

(1) Calculate the arithmetic mean of the annual emissions summed over disturbance types (in the bottom row of Table 2.3.2) using all years in the calibration period.

(2) Calculate the corresponding standard deviation (SD) of the mean annual emissions. As the historical time series is usually relatively short (the number of data points, N, is less than 30), it is *good practice* to apply the following formula:

[61] Paragraph 33(c) of the Annex to Decision 2/CMP.7 (Land use, land-use change and forestry) contained in document FCCC/KP/CMP/2011/10/Add.1, p. 18

EQUATION 2.3.1
CALCULATION OF THE STANDARD DEVIATION OF THE MEAN FOR THE CALIBRATION PERIOD

$$SD = \sqrt{\sum_{i=1}^{N} (x_i - X)^2 \Big/ (N-1)}$$

where

x_i = the emission or removal estimate for year i, i = 1, 2…, N where N is the number of data points (years in the calibration period for which data is available).

X = the average of all x_i.

(3) Check whether any data points are greater than the mean plus twice the SD, or smaller than the mean minus twice the SD. In case there is one or more such data points ("outliers"), remove them from the dataset and go back to step (1) above using the reduced dataset.

In case there are no (or no more) outliers, the background level is equal to the mean calculated in the last step, and the margin is equal twice the SD calculated in the last step.

An example of the application of the default method is found in Box 2.3.6, Example 1.

Alternative methods

Possible alternative methods are country-specific but should all be based on a consistent time series for the calibration period as outlined in Step 2 above.

Alternative methods include approaches that use other approaches to exclude outliers and/or set a background level that is not equal to the average of the emissions (excluding outliers) during the calibration period. Examples include setting the background level to the lowest historical annual emission, a value between this and the average of the historical dataset (excluding outliers), or a background level of zero. Whatever alternative method the Party has chosen, it is *good practice* to describe transparently the method and assumptions used to establish the background level, and to demonstrate consistency with the FMRL or expectations for AR, as the case may be, and to show that the alternative method avoids expectation of net credits or debits.

An example of the application of an alternative method is found in Box 2.3.6, Example 2

Step 4: Development of the margin

The margin must be set so that the expectation of net credits or debits is avoided. For the default method (Step 3), the margin is twice the standard deviation of the calibration period time series (excluding outliers).

For the alternative methods (Step 3), the margin depends on the background level. Where the background level is set to the lowest emissions from natural disturbances in the calibration period, the margin is to be set to zero if the Party wishes to avoid the expectation of debits. For the same reasons, the margin is set to zero for any background level, including the case when the background level is zero, when the background level is lower than, or equal to, the expected lowest annual emission from natural disturbance during the commitment period, always ensuring consistency with FMRL or AR assumptions.

Step 5: Ensuring that the method applied does not lead to expectation of net credits or net debits

For all approaches used to develop the background level and the margin, Parties have to report information on how the expectation of net credits or net debits[62] is avoided. To this end, it is *good practice* to analyze under what conditions the application of the background level and margin are going to yield net credits or net debits for the Party during the commitment period. If expected conditions in the commitment period lead to the expectation of net credits it is *good practice* to modify the background level and the margin to avoid this expectation.

The default method as well as alternative methods should be analyzed for the expectancy of no net credits or net debits. One particular case where adjustment of the background level and margin is necessary for the default method is when the area of the land in the FM or AR categories change during the commitment period. A possible way to do such an adjustment is demonstrated in Box 2.3.7. In such cases, it is *good practice* to correct

[62] Paragraph 33 (a) and (b) of the Annex to Decision 2/CMP.7 (Land use, land-use change and forestry) contained in document FCCC/KP/CMP/2011/10/Add.1, p. 17-18

the background level and the margin so that they both relate to the same mean area during the calibration period and, as an expectation, during the commitment period. In all cases, it is *good practice* to recalculate and report the combined time series from Table 2.3.2 in terms of emissions per unit area, and use them in Steps 3 and 4 above.

In all cases, it is *good practice* to report how the expectation of net credits or net debits has been avoided.

BOX 2.3.6

EXAMPLES OF APPROACHES FOR THE DEVELOPMENT OF THE BACKGROUND LEVEL

Example 1: Application of the default method

In this example, Party X reports total annual emissions from natural disturbances on FM land for the calibration period, as a summary value of emissions from a number of disturbance types, in Table 2.3.2. These total annual emission values are shown in Figure a) (all bars). Based on the iterative process described in Step 3 above, the outliers in the time series (the filled bars in Figure a)) are identified and removed. The background level is estimated as the mean (the thick black horizontal line in Figure b) of the remaining observations (i.e. the hashed bars). The margin is twice the standard deviation of these observations (shown by a thin above and another below the background level). In a year during the commitment period when the total emissions from natural disturbances (e.g., the filled bar for the year 2016 in Figure b)) exceed the background level plus the margin, emissions above the background level (thick dashed line) may be excluded, provided that all the other requirements of the exclusion are met. The emissions that may be excluded are shown as the dotted part of the last bar of Figure b), whereas the height of the grey part of the same bar equals to the background level.

Figure a)

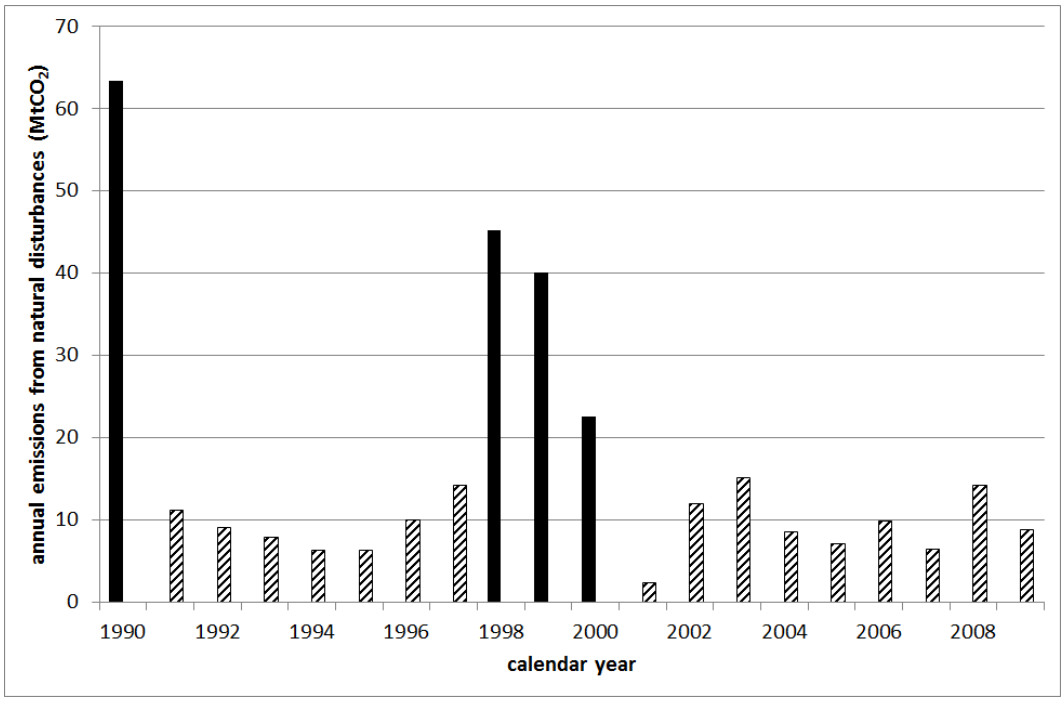
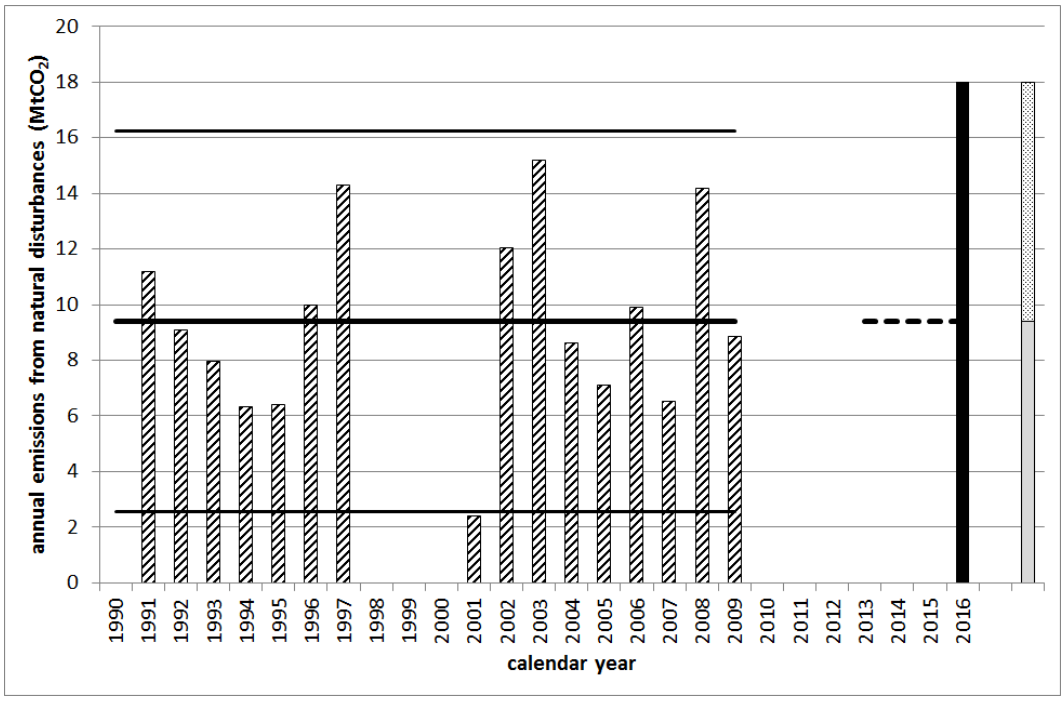


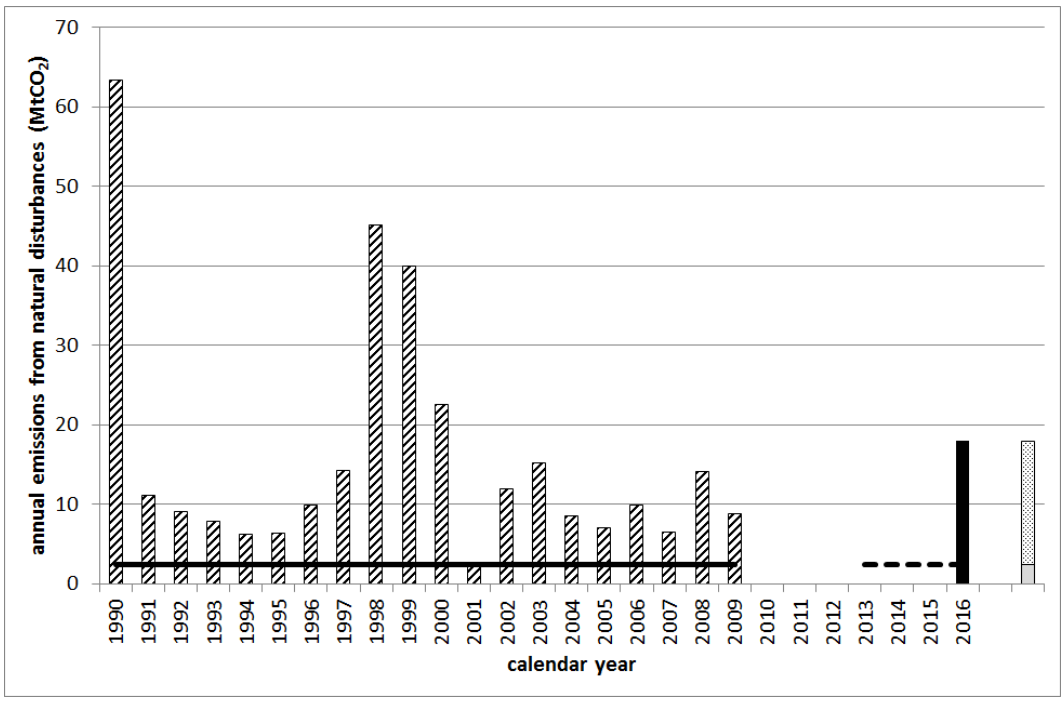
Figure b)



Example 2: An alternative method: the background level is set to the minimum level of historical time series

An alternative method which minimizes the risk of overestimating the emissions from natural disturbances during the commitment period is to set **the background level the minimum level of historical time series.** If emissions are expected to exceed this level in every year during the commitment period, the margin required is equal to zero. In a year during the commitment period when the emissions from natural disturbances (e.g., the filled bar for the year 2016 in Figure c) exceed the background level (the margin is equal to zero), emissions above the background level (thick dashed line) may be excluded, provided that all the other requirements of the exclusion are met. The emissions that may be excluded are shown as the dotted part of the last bar of Figure c), whereas the height of the grey part of the same bar equals to the background level.

Figure c)



BOX 2.3.7
APPROACH FOR ESTIMATING THE BACKGROUND LEVEL IN CASE THE AREA OF THE LAND UNDER A CATEGORY CHANGES BETWEEN THE CALIBRATION PERIOD AND THE COMMITMENT PERIOD

This approach is demonstrated using an example when the area of FM land significantly decreases between the historic time series and the commitment period. Suppose the mean area of FM during the calibration period is $\mathbf{A_{cal}}$, and the FM background level, **BL**, is set based on the total annual emissions from Table 2.3.2 using the default method. This means that the expected level of emissions from natural disturbances for a unit of area in FM land, or area specific background level, is $\mathbf{bl = BL / A_{cal}}$. If the mean area of FM during the commitment period is $\mathbf{A_{comm}}$, then, if we assume that **bl** will not change, the resulting background level will be $\mathbf{BL_{comm} = A_{comm} * bl}$, and if $\mathbf{A_{comm} < A_{cal}}$ then $\mathbf{BL_{comm} = BL_{cal}}$, which may yield net credits. One method to avoid this includes the following steps:

(1) Calculate the mean annual emissions for the calibration period using the totals of all disturbance types (last row of Table 2.3.2)

(2) Use these mean values to apply the default method or an alternative method to develop the area specific background level, **bl**.

(3) Make a projection of the annual area of the category (FM or AR) for the commitment period while demonstrating that this will not lead to net credits or debits.

(4) Calculate the average of the projected annual area values, $\mathbf{A_{comm}}$.

(5) Calculate the background level for the commitment period as $\mathbf{BL_{comm} = A_{comm} * bl}$.

Note that the above approach assumes that the probability of natural disturbances to occur in the various above areas is the same.

The same approach may be needed when not the default method is used, if the area of land under FM increases, and if the area of land under AR is expected to increase (or decrease).

In case this or similar approaches are necessary, it is *good practice* to report the applied methodology, the data applied and how the approach ensures that its application ensures that the expectation of net credits or net debits during the commitment period is avoided.

2.3.9.6 EXCLUSION OF REMOVALS ON LANDS AFFECTED BY THE NATURAL DISTURBANCE PROVISION

In case a Party excludes from accounting emissions from natural disturbances in accordance with the provisions detailed in the Annex to Decision 2/CMP.7, it should also exclude from accounting any subsequent removals during the commitment period on the affected land. Therefore it is *good practice* that the Party assesses and reports the removals (using the guidance given above in Section 2.3.9.3) occurring on lands affected by the disturbance(s) causing the emissions that were excluded from accounting, without regard whether they originate from the re-establishment of young forest vegetation by rehabilitation measures or natural re-growth of vegetation, and to ensure their subsequent exclusion from accounting. Special care has to be taken that the removals are not captured by another assessment system, if for example complementary assessments on the natural disturbance areas are conducted in addition to a national forest inventory; or that the national forest inventory is designed in a way that can provide separate outputs for these areas.

2.3.9.7 INFORMATION ON EFFORTS TAKEN TO REHABILITATE THE LAND SUBJECT TO NATURAL DISTURBANCES

Once a natural disturbance has occurred, the Party may implement actions to rehabilitate the land cover, where practicable, in order to restore or secure forest functions and to prevent degradation of forests. Although rehabilitation is different from restoration and revegetation in terms of greenhouse gas reporting, the techniques used may include the same as used for reforestation and revegetation, e.g., planting, seeding and/or the human-

induced promotion of natural seed sources. The rehabilitation effort will depend on the severity of the impact, the likelihood of regeneration and cost-benefit analysis. Following – for example – wind-throw, usable timber may be removed (salvage logging, see Section 2.3.9.3), the affected areas are cleared by e.g. banking of debris (which affects DOM and soil organic matter pools) or preparation of planting sites in places, and subsequent planting of crop tree species or seed-bed preparation is conducted, if seed trees are still available on the lands. If seed trees or natural regeneration are available (if the disturbance mainly affected higher age-classes and led to a shift in the age-class distribution), rehabilitation can be restricted to activities that ensure the site is accessible for further management activities following e.g. salvage logging. In case of forest fires, species within ecosystems can respond to fire and fire regimes in different ways (Gill, 1975). For example, some forest species are resilient to even the most severe fires and respond through epicormic resprouting post fire. In such instances efforts to rehabilitate may not be required and it is *good practice*, in these cases, to demonstrate that no other direct human intervention is necessary for rehabilitation.

If efforts have been taken and/or are planned to rehabilitate the areas subject to natural disturbances, it is *good practice* to provide transparent information on:

- Area rehabilitated, or planned to be;
- Time frame for the rehabilitation, i.e. duration of the management activity undertaken if this is not completed in the year of reporting, or time until a specified state ('result', see below) is expected to be reached;
- Description of the efforts taken and/or planned, including where no action is to be taken because the forest ecosystem rehabilitates without human intervention;
- Expected results, these may be e.g., recovering of carbon stocks, forest cover, or tree species structure and growth patterns, and ecosystem health conditions, and also any changes in efforts to avoid further disturbances.

If efforts have not been taken and/or are not planned to rehabilitate the areas subject to natural disturbances, it is *good practice* to provide transparent information on the reasons why the rehabilitation is not intended and/or impracticable. For example, natural regeneration in the disturbed area might make human intervention unnecessary or a volcanic eruption may cover an area completely with lava. In case natural or human-induced regeneration is not possible, and there is no other land-use, the area is technically still to be considered as Forest Land (no human-induced deforestation occurred) and included in the reporting and accounting appropriately. If, in the future, other uses are conducted in these areas, e.g. cattle is grazed on grass growing on the disturbed area, this indicates a change in land-use and, depending on the regulations applicable at this point in time, may have to be considered as Deforestation.

2.3.9.8 TREATMENT OF EMISSIONS AND REMOVALS THAT OCCUR ON THE LANDS SUBJECT TO NATURAL DISTURBANCES IN SUBSEQUENT COMMITMENT PERIODS

Emissions and removals from Afforestation and Reforestation under Article 3.3 or Forest Management under Article 3.4 of the Kyoto Protocol over the third and subsequent commitment periods are likely to depend on legacy effects associated with natural disturbances that occurred in the earlier commitment periods. For example an event or circumstances may affect the age structure of forests, the carbon stock increases or decreases of DOM pools and hence emissions and removals associated with them.

It is *good practice* that the annual emissions and removals estimates for years beyond the end of the second commitment period take account of these potential legacy effects.

Therefore, it is *good practice* that these emissions and removals are estimated in a manner consistent with the other forestry estimates in the greenhouse gas inventory, and in a way that legacy effects from natural disturbances can be identified and integrated into estimates for future years, so that accounting in the third and subsequent commitment periods can reflect them. This can be achieved by ensuring that the frequency of data collection, stratification, activity data, the emissions and removals factors and other parameters used for inventory estimates in years beyond the end of the second commitment period reflect the legacy effects of natural disturbance that occurred during the second commitment period.

2.4 OTHER GENERIC METHODOLOGICAL ISSUES

This section presents generic methodology to complement subsequent sections in the report as well as guidance for time series development and recalculations. Issues related to uncertainty assessment, reporting and documentation are also addressed. Draft reporting tables are presented in the Annex to this Report.

2.4.1 Developing a consistent time series

Lands subject to Article 3.3 or 3.4 activities and the management thereon need to be tracked continuously through time, to ensure that all emissions and removals are reported throughout subsequent commitment periods and with no gap between periods. Moreover, the continuity of management greatly influences GHG emissions and removals, and changes in management or land use are often the periods associated with the greatest changes in carbon stocks. For example, it is not sufficient merely to state that 10% of a cropland management area has been under no-till for a specified period. The rate of carbon stock change for the total area depends on whether the same 10% of land has remained under no-till or whether the 10% of no-till occurred on a different portion of the area in different years. It is therefore *good practice* to follow continuously the management of land subject to Article 3.3, FM and elected 3.4 activities. (See also Box 2.4.1)

Assessment of the continuity of management on land could be achieved either by periodically tracking lands subject to an Article 3.3, FM or an elected Article 3.4 activity from 1990 until the end of the commitment period (see Section 2.7.2 Choice of methods for identifying lands subject to Forest Management), or by developing statistical sampling techniques that can determine the transition of different types of management on land subject to Article 3.3, FM or elected 3.4 activities (see *2006 IPCC Guidelines*). An example of how such a scheme could operate is given in Box 2.4.1.

A supplementary condition for developing a consistent time series is to use the same methods for estimating carbon stock change and non-CO_2 greenhouse gas emissions during the whole period and for setting the benchmark value to be used in accounting i.e. either the reference level or the base year value, or to ensure consistency between different methods.

Time series consistency is discussed further in Chapter 5, Volume 1, (Time series consistency and recalculations) of the *2006 IPCC Guidelines*.

BOX 2.4.1
AN EXAMPLE OF CONSISTENCY IN ESTIMATING THE EFFECT OF MANAGEMENT PRACTICES

To estimate changes in soil carbon stocks, whether by Tier 1, 2 or 3 methods, management practices on applicable lands need to be followed continuously over time. Ideally, the management of each land would be tracked explicitly. But such data may not always be available. An alternative approach may be to estimate the *average* history of lands now under a given management. Consider the following example.

Example: Cropland management

Suppose there was a cropland region of 10,000 ha, of which 5,000 are in no-till (NT) in the year 2000, up from 2,000 ha in 1990. The remainder, in each year, is under conventional tillage (CT). In order to simplify this example, suppose also that the land management in the year 1990 was unchanged for a long period before (more than 20 years). The estimated soil carbon stock change is based on a matrix of coefficients; say 0.3 Mg C/ha/yr for land shifting from CT to NT, -0.3 Mg C/ha/yr for a shift from NT to CT. (The carbon stock change is calculated by the amount of soil carbon, the relative carbon stock change[63] factor, over 20 years, for the management activity, and the length of the period, one year. See Chapter 5.2.3, and Tables 2.3 and 5.5, Volume 4 of the *2006 IPCC Guidelines*. Unfortunately, there has been no tracking of management on individual land. However, based on a statistical analysis (e.g., a survey), it is possible to estimate, with reasonable confidence, the following shifts:

CT	→	NT	3,500 ha
CT	→	CT	4,500 ha
NT	→	CT	500 ha
NT	→	NT	1,500 ha

The total carbon gain is therefore:

(3,500 • 0.3 + 4,500 • 0 + 500 • (-0.3) + 1,500 • 0) Mg C/yr = 900 Mg C/yr.

2.4.2 Recalculation of Time Series

This section deals with recalculation of time series, excluding implications for the technical correction of reference levels; which is addressed in section 2.7.6. As inventory capacity and data availability improve, the methods and data used to calculate estimates are updated and refined. Recalculation of historic emissions and removals is *good practice* when new methods are introduced or existing ones refined, when new sources and sinks categories are included, or when data are updated (for example through new measurements during the commitment period or the availability of new information on verification). Recalculations may also be needed if lands are reclassified at a later time (e.g., for lands that have lost forest cover but where a classification as deforested lands was pending and has been resolved, see Section 2.6.1).

The CMP decisions make provisions for recalculation[64], consistent with the UNFCCC reporting guidelines, and mention that previous estimates should be recalculated using the new methods for all years in the time series. Annual greenhouse gas emissions and removals reported for a given year during the commitment period can be recalculated in subsequent reporting years (up to the final year of the commitment period). When recalculating emissions and/or removals, time series consistency must be checked and ensured. It is also *good practice* to report why the new estimates are regarded as more accurate or less uncertain.

One potential problem in recalculating previous estimates is that certain data sets may not be available for the earlier years. There are several ways of overcoming this limitation and they are explained in detail in Chapter 5, Volume 1, of the *2006 IPCC Guidelines*.

[63] "Carbon stock change factor" is in use to refer to carbon emission/removal factors.

[64] See paragraphs 4, 12 (notably 12(d) and12(e)), 13 and 14(e) in the Annex to draft decision -/CMP.1 (Article 5.1), contained in document FCCC/CP/2001/13/Add.3, pp. 5-8, adopted by Decision 19/CMP.1 Article 5, para 1 of KP..

2.4.3 Uncertainty assessment

It is *good practice* that uncertainties are identified, quantified and reduced as far as is practicable and that all information on anthropogenic greenhouse gas emissions by sources and removals by sinks which result from mandatory and elective activities are reported with levels of confidence as elaborated by any IPCC *good practice* guidance adopted by the CMP.[65] Because of the importance for many countries of well-designed sampling programmes to reduce uncertainties when preparing LULUCF inventories, specific information on the design of sampling programmes for land areas and biomass stock, as well as the assessment of associated uncertainties should be provided. Generally, the approaches provided in Chapter 3, Volume 4 of the *2006 IPCC Guidelines* and the estimation of sampling error related to the sampling design used for data collection, can be used for assessing uncertainties associated with estimates reported under the UNFCCC and under the KP LULUCF activities[66]. However, some issues and terms which are specific to the Kyoto Protocol require additional uncertainty assessment, for example the estimation of the areas under LULUCF activities or the need to track activities since 1990. For KP reporting, uncertainty assessment is particularly important in order to support verification requirements. Moreover, while selecting a particular tier to estimate changes in carbon stocks and non-CO_2 greenhouse gas emissions, it is *good practice* to consider the implications of this choice for the management of uncertainties

2.4.3.1 IDENTIFYING UNCERTAINTIES

In the context of the Kyoto Protocol the following sources of uncertainties are likely to be significant:

- Model errors occur whenever models or allometric equations are used to estimate carbon stock changes or non-CO_2 greenhouse gas emissions and removals, which is likely to be the case at higher tiers. It can be very cumbersome to trace the propagation of errors through complex models chained to each other. In general, this may introduce additional uncertainties, except for those cases where simpler models can be used to estimate typical uncertainty ranges that can be combined with central estimates from complex models.
- Definitional errors, such as bias and inconsistencies resulting from the interpretation and implementation of the various definitions in the Kyoto Protocol (including the potential mismatch between data available to Parties and their interpretation of the definitions);
- Classification errors, such as land use and land transition classification errors (e.g., forest vs. non-forest classification with possible errors regarding temporarily unstocked forest lands);
- Activity data errors (e.g., distinction between the harvesting-regeneration cycle vs. deforestation or human-inducement of afforestation and reforestation);
- Estimation errors, such as errors in area estimates (e.g., due to incorrect classification of change events i.e., both omission and commission errors in remote sensing (see below for details), due to differing scales used to identify lands subject to the various activities, e.g., afforestation/reforestation vs. deforestation, or modifications made to the sampling procedures and/or densities during the course of time or due to positional errors);
- Identification errors arising while defining the geographical boundaries of areas encompassing lands subject to LULUCF activities (although this may not have a direct impact on the uncertainty of the carbon stock change estimates for a given activity);
- Sampling errors associated with the number of samples (number and location) within a "geographical boundary". In this case samples do not sufficiently cover the temporal and spatial variability of the estimated parameters. This is particularly critical when reporting land areas that include multiple land units by using legal, administrative, or ecosystem boundaries. This stratification is based on sampling techniques, administrative data, or grids on images produced by remote sensing techniques and the identified geographic boundaries are georeferenced.

Natural Variability

[65] This refers to paragraph 6 (d) including footnote 5, and paragraph 9 including footnote 7 in the Annex to Decision 15/CMP.1 (Article 7). Also refers to Decision 2/CMP.8, Article 2.

[66] See also IPCC 2010, Expert Meeting on Uncertainty and Validation of Emission Inventories eds: Eggleston H.S., Baasansuren J., Tanabe K., Srivastava N., Meeting Report of the Expert Meeting on Uncertainty and Validation of Emission Inventories, Utrecht, the Netherlands, 23-25 March, 2010, Pub. IGES, Japan 2010

Natural variability is a result of variations in natural controlling variables, such as annual climate variability, and variability within units of lands that are assumed to be homogenous, e.g., the spatial variability of e.g., forest soils within a given unit of land. When sufficient experimental data are available, *good practice* should permit determination of the resulting combined plot-level and up-scaling uncertainties using standard statistical methods such as Generalized Linear Models (e.g., Tate *et al.*, 2003). In some cases, especially for inter-annual or periodical variability, considerable impacts may change the sign of the reported net emissions and removals of an entire country or region. In inventory calculations uncertainty due to natural variability can be reduced by using time average coefficients and by averaging direct measurements over a time period sufficiently long to assess the variability, as discussed in Section **Error! Reference source not found.** above.

Lack of activity data

In addition to uncertainties in default carbon emission and removal factors, there are often uncertainties associated with missing activity data. Determining retrospectively the inventory for the base year, in most cases 1990, may pose a particular challenge for cropland management, grazing land management, revegetation and wetland drainage and rewetting. It may be possible to establish base year emissions by extrapolating a consistent time series of emissions and removals established for a period over which activity data are available. Alternatively a country-specific methodology may be used if this can be shown to be more reliable in estimating base year carbon stock change and useful for land cover change detection through time-series analysis notably. It is *good practice* to verify that this methodology does not over- or underestimate emissions/removals in the base year. It is *good* practice to also use in the estimation of base year emissions historical data on management practices prior to 1990, if available.

Spatial resolution of remote sensing and ground truth

The objective of using satellite imagery for land cover and land use assessments is often to obtain, for an inventory region, total area estimates, percentages of land classes, or geographical boundaries. Remote sensing is particularly well suited to completely identify lands. A source of uncertainty is the selection of imagery of inadequate resolution. In order to capture changes in areas as small as one hectare, the resolution of the imagery must be finer than one hectare. In addition, improper or insufficient ground truthing can result in classification errors.

Positional errors occur where (a) the geometric correction is not done, incomplete or false, (b) the pixel location and location of ground truth plot do not coincide, and (c) there is insufficient accuracy in the definition of the borderlines. For example, when detecting land-use changes by a time series of remotely sensed images, the spatial displacement of pixels from one sampled image to the next will introduce errors. In the case of detection of a transition from forest to non-forest or vice versa, the associated uncertainties will be larger when forests are fragmented.

Classification errors arise from an incorrect identification of the real land cover class. They comprise omission errors, i.e., a population element from a given category is omitted and put erroneously into another class, and commission errors, i.e., classifying wrong categories into a given ground truth category.

The use of remote sensing is discussed further in Vol 4, Chapter 3 of the *2006 IPCC Guidelines*, especially section 3A.2.4. An example of quantifying uncertainties in forest carbon estimation using a combination of remote sensing and field measurement is given by Gonzalez et al. (2010).

2.4.3.2 QUANTIFYING UNCERTAINTIES

Uncertainties associated with carbon stock changes and emissions estimation are to be quantified according to standard statistical methods. Uncertainties can originate from several sources and be combined into an overall uncertainty.

It is *good practice* to derive confidence intervals by applying a quantitative method to existing data.

Uncertainties for the activities covered by the KP can be treated in the same way as other uncertainty estimates taking into account that:

- The “since 1990” clause and the use of definitions specific to the KP are likely to cause systematic errors related to the estimation of the required activity data. The potential for differences between the managed forest area and the area subject to Forest Management, and also between grassland area and area subject to Grazing land Management implies that the areas whose uncertainties are being assessed may differ between the KP activities and the corresponding categories of the *2006 IPCC Guidelines.*
- Activity data can also relate to individual practices or ownership structures, e.g., the fraction of cropland farmers use a given amendment on a particular soil. If the fraction is estimated by survey, the survey design

should incorporate an uncertainty estimate depending on the level of inventory data disaggregation, otherwise the uncertainty will have to come from expert judgement.

- For CM, GM, WDR and/or RV (if elected) uncertainty estimates are also needed for the base year. It is *good practice* that the selected methodology neither over- nor underestimate emissions and removals in the base year. But uncertainties are likely to be higher than for estimates in the commitment period, because the estimates for the base year may often be derived only by backward extrapolations or models, rather than by actual inventories in or near the base year. In addition, determination of activities in the base year, where required, may pose difficulties if pre-base year surveys of land use are not available. Where reliable data are not available for 1970 to 1990 (or other applicable time periods), countries can use a country-specific methodology, shown to be reliable, to estimate base year carbon stock change in 1990. In most cases, these methods also require historical data on management practices prior to 1990. The associated uncertainties could, in principle, be assessed by formal statistical methods, but more likely by expert judgement which is based on the feasible ranges of backward extrapolation of time trends. If surrogate data (i.e., alternative datasets that can be used as a proxy for missing data) are available, they can be a useful guide for extrapolating the trend in periodic data and subsequently interpolating the same data following the next data collection cycle. If there are no available surrogates or other information, then the only technique available is to extrapolate, with a recalculated interpolation of the estimates when the new observations are available. Thus, it is *good practice* to attempt to find reliable surrogate data to guide extrapolation and interpolation when the fundamental data used for the inventory estimates are not available annually.

- When remote sensing is used for classification of land use and detection of land-use change, the uncertainties could be quantified by verifying classified lands with adequate actual ground truth data or higher spatial and temporal resolution imagery. In order to estimate the accuracy of land-use/land-cover maps on a category-by-category basis, a number of sample points on the map and their corresponding real world categories are used to create an error matrix as proposed by Lillesand *et al.* (2008). The diagonal of this matrix shows the probability of correct identification and the off-diagonal elements show the probability of misclassification of a land category into one of the other possible categories. The error matrix expresses not only the accuracy of the map but it is also possible to determine which categories are easily confounded with each other. Based on the error matrix, a number of accuracy indices can be derived (Congalton and Green, 2009). It is *good practice* to present an estimate of the accuracy of the land-use/cover map category-by-category and an error matrix may be employed for this purpose where remote sensing is used. Multi-temporal analysis (analysis of images taken at different times to determine the stability of land-use classification) can also be used to improve classification accuracy, particularly in cases where ground truth data are limited. A review of methodologies for monitoring ecosystem is presented by Coppin et al. (2004). Methodology for estimating uncertainties in area estimation is also presented by Olofsson et al. (2013).

Separate annual uncertainty estimates need to be made for each of the mandatory and elective activities, for each reported carbon pool, each greenhouse gas and geographical location. Estimates should be reported using tables generated following the model of Tables 1A-11C in the Annex to this report. Separate tables should be reported for the base year if Cropland Management, Grazing land Management, Revegetation or Wetland Drainage and Rewetting are elected. Estimates should be expressed as percent of the area and of the emissions by sources or removals by sinks (or changes in stocks) reported in Tables 1A-11C.

Uncertainty associated with areas of lands need to be estimated. When using Reporting Method 1, it is *good practice* to report a separate estimate of uncertainty for each of the mandatory activities, and each of the elective activities within a given geographical boundary. Under Reporting Method 2, each geographical boundary is subject to a single activity. Therefore there will only be one uncertainty estimate needed for each geographical boundary. However, because Reporting Method 2 can contain very large numbers of polygons it is *good practice* to also provide uncertainty estimates for the summary statistics.

Where uncertainties are difficult to derive, default values for uncertainties are to be used. Guidance on selecting default carbon emission or removal factors for CM can be found in Annex 4A.1, Tool for Estimation of Changes in Soil Carbon Stocks associated with Management Changes in Croplands and Grazing Lands based on IPCC Default Data. Since these factors are taken from the *IPCC Guidelines*, no true uncertainty ranges can be assigned. However, using expert judgement, default uncertainty ranges corresponding to a sampling error of 50% can be assigned, based on an analysis of no-till long-term experiments in Europe in which the 95% confidence interval of the mean annual emission or removal estimate was found to be around ±50% of that mean (Smith *et al*., 1998). For Revegetation and Wetland Drainage and Rewetting, default uncertainty ranges cannot be specified at present. It is *good practice* for a country electing these activities to provide its own estimates of the uncertainty associated with emissions and removals from all pools for the affected lands. Estimates of uncertainties have to be based on national sources or expert judgment reflecting national circumstances. Inventory compilers may also

apply national methods for estimating the overall uncertainty, e.g., error propagation methods that avoid the simplifying approximations and in this case, it is *good practice* clearly to document such methods.

Problems may arise when activity data are lacking or are not well-documented. Activity data necessary to apply scaling factors (i.e., data on agricultural practices and organic amendments) may not be available in current databases/statistics. Estimates of the fraction of farmers using a particular practice or amendment should then be based on expert judgement, and so should the range in the estimated fraction. As a default value for the uncertainty in the fraction estimate, ±0.2 is proposed (e.g., the fraction of farmers using organic amendment estimated at 0.4, the uncertainty range being 0.2–0.6). As practical consideration it is assumed that uncertainties of the various input data estimates, either as default values, expert judgement or estimates based of sound statistical sampling can be combined for an overall uncertainty estimates

2.4.3.3 REDUCING UNCERTAINTIES

Estimating uncertainties in a quantitative manner helps to identify major sources of uncertainties and to pin-point areas of potential improvements in order to reduce uncertainties in future assessments. In particular, for reporting under the KP it is recommended to make efforts to convey the overall uncertainty estimates to all agencies and/or firms involved in order to encourage improvement, i.e., reduced uncertainties in estimates of future reports. It is also *good practice* to establish institutional means and procedures that are likely to contribute towards reducing uncertainties. For instance, a country may choose on purpose to estimate uncertainties by more than one procedure. This will produce complementary results for the same country and data category, prompting further research on potential sources of inconsistency and ultimately enhancing the robustness of estimates.

Often, uncertainties can be reduced if areas subject to land-use change are estimated directly as a class by themselves within a stratification scheme, rather than as a difference between two overall estimates of land-use areas.

The extra effort required for area identification should help to reduce uncertainties in the assessment of areas subject to KP activities.

Uncertainties are likely to be reduced by implementing means to make the design, procedure and frequency of data collection more systematic, for example by establishing – whenever possible – long-term, statistically sound monitoring programmes.

2.4.4 Reporting and documentation

2.4.4.1 REPORTING

The anthropogenic greenhouse gas emissions by sources and removals by sinks from land use, land-use change and forestry activities, estimated using the methods described before and in the activity-specific Sections 2.5 – 2.12, must be reported as outlined in relevant decisions[67] of the Conference of the Parties serving as Meeting of the Parties (CMP) of the KP. Some information on definitions and elected activities must be reported once by 15th April 2015, as part of the report to facilitate the calculation of the assigned amount.as established in Annex I of 2/CMP.8, whereas supplementary information must be reported annually during the second commitment period. The information to be reported is summarised in Tables 2.4.1, but excludes information associated with removal unit (RMU) accounting. It is *good practice* to report all information requested in these tables.

Annual reports under the KP must include estimates of areas of land subject to activities under Article 3.3, Article 3.4 Forest Management and any other elected Article 3.4 activities, of greenhouse gas emissions by sources and removals by sinks on these areas of land, and the associated uncertainties, using Tables 1A through 11C in the Annex. It is *good practice* to include in these reports additional information on methods and approaches used to identify lands and to estimate the emissions and removals.

[67] CMP decisions relevant for LULUCF accounting for the second commitment period: decision 2/CMP6, decision 2/CMP.7 and decision 2/CMP.8.

TABLE 2.4.1
SUPPLEMENTARY INFORMATION TO BE REPORTED FOR THE ANNUAL GREENHOUSE GAS INVENTORY DURING THE SECOND COMMITMENT PERIOD ACCORDING TO RELEVANT DECISIONS OF THE CONFERENCE OF THE PARTIES SERVING AS MEETING OF THE PARTIES (CMP) OF THE KYOTO PROTOCOL. TEXT IN ITALICS INDICATES A DIRECT QUOTE FROM THE RELEVANT PARAGRAPHS IN THE CMP DECISIONS TEXT

Information to be reported	Detailed information	Reference in CMP decisions
Land related information		
Information on geographical location and identification of lands	*(b) The geographical location of the boundaries of the areas that encompass:* *(i) Units of land subject to activities under Article 3, paragraph 3, of the Kyoto Protocol;* *(ii) Units of land subject to activities under Article 3, paragraph 3, of the Kyoto Protocol which would otherwise be included in land subject to forest management or elected activities under Article 3, paragraph 4, of the Kyoto Protocol under the provisions of decision 2/CMP.7, annex, paragraph 9;* *(iii) Land subject to forest management under Article 3, paragraph 4, in the second commitment period and to any elected activities under Article 3, paragraph 4;* If the Party applies the Natural Disturbance provision: *(i) Showing that all lands subject to the exclusion due to natural disturbances are identified, including their georeferenced location, year and types of disturbances;* *(iii) Showing that no land-use change has occurred on lands for which the provisions contained in decision 2/CMP.7, annex, paragraph 33, are applied and explaining the methods and criteria for identifying any future land-use changes on those land areas during the second commitment period;* If the Party applies the CEFC provision: *(i) The identification of all lands and associated carbon pools subject to decision 2/CMP.7, annex, paragraph 37, including the georeferenced location and year of conversion*;	Annex II of 2/CMP.8 Paragraph 2 Paragraph 2(f) Paragraph 5(f)
Spatial assessment unit	*(c) The spatial assessment unit used for determining the area of accounting for afforestation, reforestation and deforestation;*	Annex II of 2/CMP.8 Paragraph 2

TABLE 2.4.1 (CONTINUED)
SUPPLEMENTARY INFORMATION TO BE REPORTED FOR THE ANNUAL GREENHOUSE GAS INVENTORY DURING THE SECOND COMMITMENT PERIOD ACCORDING TO RELEVANT DECISIONS OF THE CONFERENCE OF THE PARTIES SERVING AS MEETING OF THE PARTIES (CMP) OF THE KYOTO PROTOCOL. TEXT IN ITALICS INDICATES A DIRECT QUOTE FROM THE RELEVANT PARAGRAPHS IN THE CMP DECISIONS TEXT

Information to be reported	Detailed information	Reference in CMP decisions
Information on methods and approaches to estimate emissions and removals		
Description of methodologies used including methods used for calculating the reference level and the associated background level of emissions	*Information on how inventory methodologies have been applied taking into account the 2006 IPCC Guidelines for National Greenhouse Gas Inventories, and any relevant supplementary methodological guidance developed by the IPCC and adopted by the CMP and the COP, and recognizing the principles as laid out in decision 16/CMP.1;*	Annex II of 2/CMP.8 Paragraph 2
Justification when omitting any carbon pool	*Information on which, if any, of the following pools – above-ground biomass, below-ground biomass, litter, deadwood and/or soil organic carbon – were not accounted for, together with verifiable information that demonstrates that these unaccounted pools were not a net source of anthropogenic GHG emissions;*	Annex II of 2/CMP.8 Paragraph 2(e)
Information on indirect factors on greenhouse gas emissions and removals	*3. Information should also be provided which indicates whether anthropogenic GHG emissions by sources and removals by sinks from LULUCF activities under Article 3, paragraph 3, forest management under Article 3, paragraph 4, and any elected activities under Article 3, paragraph 4, factor out removals from:* *(a) Elevated carbon dioxide concentrations above pre-industrial levels;* *(b) Indirect nitrogen deposition;* *(c) The dynamic effects of age structure resulting from activities prior to 1 January 1990.*	Annex II of 2/CMP.8 Paragraph 3
Changes in data and methods and recalculations	*(e) Information that demonstrates methodological consistency between the reference level and reporting for forest management during the second commitment period, including the area accounted for, the treatment of harvested wood products, and the accounting of any emissions from natural disturbances;* *(f) Any technical corrections made pursuant to decision 2/CMP.7, annex, paragraph 14, to ensure consistency between the reference level and reporting for forest management during the second commitment period;*	Annex II of 2/CMP.8 Paragraph 5

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Specific information for activities under Article 3, paragraphs 3 and 4		
Specific information on Article 3.3 activities and Forest Management	If Party applies the Natural Disturbance provision: *(ii) Showing how annual emissions resulting from natural disturbances and the subsequent removals during the commitment period in those areas are estimated and excluded from the accounting;* *(iv) Demonstrating that the events or circumstances were beyond the control of, and not materially influenced by, the Party in the commitment period, by demonstrating practicable efforts to prevent, manage or control the events or circumstances that led to the application of the provisions contained in decision 2/CMP.7, annex, paragraph 33;* *(v) Demonstrating efforts taken to rehabilitate, where practicable, the land for which the provisions contained in decision 2/CMP.7, annex, paragraph 33, are applied;* *(vi) Showing that emissions associated with salvage logging were not excluded from accounting.* and *(i) Country-specific information on the background level of emissions associated with annual natural disturbances that have been included in its forest management reference level;* *(ii) Information on how the background level(s) for afforestation and reforestation under Article 3, paragraph 3, of the Kyoto Protocol and/or forest management under Article 3, paragraph 4, of the Kyoto Protocol have been estimated, and information on how it avoids the expectation of net credits or net debits during the commitment period, including information on how a margin is established, if a margin is needed;* Harvested Wood Products *(i) Information on activity data for the harvested wood products categories used for estimating the harvested wood products pool removed from domestic forests, for domestic consumption and for export, as appropriate;* *(ii) Information on half-lives used in estimating the emissions and removals for these categories in accordance with decision 2/CMP.7, annex, paragraph 29 or 30, or, alternatively, information on methodologies used to account for harvested wood products in accordance with decision 2/CMP.7, annex, paragraph 30, showing that the methodologies used are at least as detailed or accurate as the first-order decay method with default half-lives provided in decision 2/CMP.7, annex, paragraph 29;* *(iii) If the forest management reference level is based on a projection, information on whether emissions from harvested wood products originating from forests prior to the start of the second commitment period have been included in the accounting;* *(iv) Information on how emissions from the harvested wood products pool that have been accounted for during the first commitment period on the basis of instantaneous oxidation have been excluded from the accounting for the second commitment period;* *(v) Information showing that harvested wood products resulting from deforestation have been accounted on the basis of instantaneous oxidation;* *(vi) Information showing that carbon dioxide emissions from harvested wood products in solid waste disposal sites, where these emissions are separately accounted for, and from wood harvested for energy purposes have been accounted on the basis of instantaneous oxidation;* *Information showing that the emissions and removals resulting from changes in the harvested wood products pool accounted for do not include imported harvested wood products, irrespective of their origin.*	Annex II of 2/CMP.8 Paragraph 2(f) Annex I of 2/CMP.8 Paragraph 1(k) Annex II of 2/CMP.8 Paragraph 2(g)

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Article 3.3 activities specific information	*(a) Information that demonstrates that activities under Article 3, paragraph 3, began on or after 1 January 1990 and before 31 December of the last year of the commitment period, and are directly human-induced;* *Information on how harvesting or forest disturbance that is followed by the re-establishment of a forest is distinguished from deforestation*	Annex II of 2/CMP.8 Paragraph 4
Forest Management and any elected activities under Article 3.4 specific information	*(a) A demonstration that activities under Article 3, paragraph 4, have occurred since 1 January 1990 and are human induced;* *(c) Information that demonstrates that emissions by sources and removals by sinks resulting from forest management under Article 3, paragraph 4, and any elected activities under Article 3, paragraph 4, are not accounted for under activities under Article 3, paragraph 3;* *(d) Information on how all emissions arising from the conversion of natural forests to planted forests are accounted for in accordance with any supplementary methodological guidance developed by the IPCC and adopted by the CMP;*	Annex II of 2/CMP.8 Paragraph 5
	(i) The forest management reference level as inscribed in the appendix to the annex to decision 2/CMP.7, any technical corrections as contained in the inventory report for the first year of the second commitment period and references to those sections in the national inventory report where such information is reported consistent with the requirements of decision 2/CMP.7, annex, paragraph 14;1 *(j) Information on how emissions from harvested wood products originating from forests prior to the start of the second commitment period have been calculated in the reference level in accordance with decision 2/CMP.7, annex, paragraph 16;*	Annex I of 2/CMP.8 Paragraph 1
	If the Party applies the CEFC provision *(ii) A demonstration that the forest plantation was first established through direct human-induced planting and/or seeding of non-forest land before 1 January 1990, and, if the forest plantation was re-established, that this last occurred on forest land through direct human-induced planting and/or seeding after 1 January 1960;* *(iii) A demonstration that a new forest of at least equivalent area to the harvested forest plantation is established through direct human-induced planting and/or seeding of non-forested land that did not contain forest on 31 December 1989;* *(iv) A demonstration that this newly established forest will reach at least the equivalent carbon stock that was contained in the harvested forest plantation at the time of harvest, within the normal harvesting cycle of the harvested forest plantation, and, if not, a debit would be generated under Article 3, paragraph 4*	Annex II of 2/CMP.8 Paragraph 5(g)

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Information related to the estimates of emissions by sources and removals by sinks (for reporting data, see Tables 1A-11C)		
Estimates for greenhouse gas emissions by sources and removals by sinks	(b) *For Parties included in Annex I that elect cropland management and/or grazing land management and/or revegetation and/or wetland drainage and rewetting, anthropogenic GHG* emissions by sources and removals by sinks for *each year of the commitment period and for the base year for each of the elected activities on the geographical locations reported under paragraph 2(b) above*.	Annex II of 2/CMP.8 Paragraph 5(b)
	(d) Information on anthropogenic GHG emissions by sources and removals by sinks resulting from activities under Article 3, *paragraph 3,* forest management under Article 3, paragraph 4, and *any elected activities under Article 3, paragraph 4,* for all geographical locations reported in the current and previous years, *under paragraph 3(b) above,* since the beginning of the commitment period or the onset of the activity, whichever comes later. In the latter case the year of the onset of the activity *shall* also be included. *Once land is accounted for under activities under Article 3, paragraph 3, forest management under Article 3, paragraph 4, or any elected activities under Article 3, paragraph 4, reporting shall continue throughout subsequent and contiguous commitment periods*	Paragraph 2(d)
	[…] Estimates for Article 3, paragraphs 3 and 4, shall be clearly distinguished from anthropogenic emissions from the sources listed in Annex A to the Kyoto Protocol.[…]	Paragraph 1

It is *good practice* to use coordinates as set out in Sections 2.5 to 2.7 below for the reporting of the geographical location of the boundaries that encompass the lands subject to activities under Article 3.3, FM and elected activities under Article 3.4. This information can be summarised on a map for visual presentation and data sharing. It is also *good practice* to report the land transition matrix below (Table 2A) to demonstrate that the Party has accounted for all areas where A/R, D and FM and, if elected, any Article 3.4 activities have occurred. The diagonal cells of the table indicate the area of lands remaining in the same category (e.g., FM land remaining FM land), while other cells indicate the areas of lands converted to other categories (e.g., cropland converted to afforested land). It is *good practice* that the total area reported in consecutive inventories is constant and that any change in area is documented and explained.

It is *good practice* to use Tables 4A – 11C, or future versions of these tables as decided by CMP, to submit annual estimates. For Article 3.3 and 3.4 activities (Tables 4A to 7), data must be provided by geographical locations. Geographical location refers to the boundaries of the areas that encompass lands subject to the activity (or subject to the particular provision). Activity data may be further subdivided according to climate zone, management system, soil type, vegetation type, tree species, ecological zone, national land classification or other criteria; in such a case, for each subdivision, one row should be completed in the table. The CMP decisions also require that, in addition to the data for the actual inventory year, a Party also reports this information for the base year for CM, GM, RV and WDR. No reporting is necessary for those Article 3.4 activities that were not elected by the Party.

When filling in these tables, care should be taken to insert carbon stock changes for each pool with proper signs. Carbon stock changes are to be reported in units of carbon as positive when the carbon stock has increased, and as negative when the carbon stock has decreased. All changes are totalled for each geographic location, and the total values are then multiplied by 44/12 to convert carbon stock changes to CO_2 emissions or removals. This conversion also involves sign change to switch from the ecosystem to the atmospheric perspective: stock changes refer to ecosystem carbon stocks (where increases have a positive sign) while fluxes of CO_2 and non-CO_2 greenhouse gasses refer to exchanges with the atmosphere where emissions are additions to the atmosphere and therefore have a positive sign.

Table 1 is a summary table of carbon stock changes resulting from activities under Articles 3.3 and 3.4 for the inventory year. It is *good practice* to use the table also for the base year for each Article 3.4 elected activity. This table summarises data of the compilation tables by activity across all carbon pools and non-CO_2 greenhouse gas emissions and across all strata within a country.

In addition to the data in the Tables, it is *good practice* to report the underlying assumptions and factors used for the calculation of the carbon stock changes and emissions of CH_4 and N_2O, as well as for the calculation of the uncertainties.

Decision 2/CMP.7 contains a clause for afforestation/reforestation and forest management activities that carbon stock changes and non-CO_2 greenhouse gas emissions resulting from natural disturbances may be excluded from accounting (see Tables 4B, 4C, 4D and 6D, 6E, 6F and Table 5B). If this provision is to be used then the areas where such disturbances occurred have to be identified and monitored for subsequent land-use change.[68] If such lands exist for the inventory year, it is *good practice* to distinguish them from other A/R and/or FM lands and to report them (and the associated carbon stock changes and non-CO_2 greenhouse gas emissions, distinguishing emissions from subsequent removals) separately in Tables 4A.to 6A. Although this is an issue related to accounting, it is mentioned here because inventory data are likely to be needed to implement the provision.

Decision 2/CMP.7 contains a clause that Parties can elect to report carbon stock changes and non-CO_2 greenhouse gas emissions resulting from conversion of forest plantation to non-forest land under forest management together with carbon stock changes and non-CO_2 greenhouse gas emissions resulting from conversion of at least an equivalent area of non-forest land converted to forest land (see Table 6C). If this provision is to be used, then all areas subject to this provision have to be identified and their georeferenced locations reported[69], within table 6A. Although this is an issue related to accounting, it is mentioned here because inventory data are likely to be needed to implement the provision.

Separate tables should be reported for the base year when CM, GM, RV and/or WDR are elected.

Finally, separate annual uncertainty estimates should be reported for each activity under Articles 3.3 and 3.4, for each carbon pool, each greenhouse gas and geographical location. Uncertainty estimates are to be made at the 95% confidence limits expressed as percent of the emissions by sources or removals by sinks (or changes in stocks).

2.4.4.2 DOCUMENTATION

Documentation requirements under the KP are outlined in the relevant decisions of UNFCCC as part of the description of the requirements for inventory management[70]. The information required includes all disaggregated emission factors, activity data, and documentation about how these factors and data have been generated and aggregated for the preparation of the inventory.

It is *good practice* to document and archive the underlying data and description of, or reference to, methods, assumptions and parameters used, which are used to produce estimates of emissions by sources and removals by sinks of greenhouse gases that would allow independent reviewers to follow the process of developing the reported estimates. Documented data and explanation of methods, and the rational for their selection should be provided for both steps: the identification of land and the assessment of carbon stock changes and the emissions of non-CO_2 greenhouse gases.

Documentation should also include information about uncertainty assessment (see also Section 2.4.3 Uncertainty Assessment), QA/QC procedures, external and internal reviews, verification activities and key category identification and planned improvements (see *2006 IPCC Guidelines* Volume 1, General Guidance and Reporting).

ACTIVITIES DEFINITION AND IDENTIFICATION

It is *good practice* to explain how the definitions of Forest Management and of the elected Article 3.4 activities have been interpreted according to national circumstances. For instance, if only a part of the managed forests reported in the UNFCCC greenhouse gas inventory is included under FM in the KP reporting, the criteria that are used to distinguish forests under FM from managed forests should be provided. It is also *good practice* to document differences between the definitios for croplands (or grasslands) in the UNFCCC greenhouse gas inventory and lands subject to CM (or GM), as well as the difference between the wetland and other organic land under KP reporting.

DATA DOCUMENTATION

When using Reporting Method 1, the areas encompassed by the geographical boundaries resulting from the stratification of a country, should be identified by unique serial numbers in the tables. These serial numbers are to be cross-referenced to a database or other archive (the LULUCF Archive) specifying the locations in terms of

[68] Paragraphs 33, 34 and 35 in the Annex to decision 2/CMP.7 (Land use, land-use change and forestry)

[69] Paragraphs 33, 34 and 35 in the Annex to decision 2/CMP.7 (Land use, land-use change and forestry)

[70] Paragraph 16 (a) in the Annex to the decision 19/CMP.1 (Article 5.1), contained in FCCC/KP/CMP/2005/8/Add.3, p.15.

established legal or administrative boundaries, or by means of an existing coordinate system, for example an established national grid system, the UTM (Universal Transverse Mercator) grid or latitude and longitude. When using Reporting Method 2, land-area identification should be possible through the databases associated with the use of this reporting method.

It is *good practice* to ensure that the documentation of estimates of greenhouse gas emissions and removals include:

- The sources of all data used in the calculations (i.e., complete citations for the statistical database(s) from which data were collected);
- The information, rationale and assumptions that were used to develop reported data and results, in cases they were not directly available from databases (for instance if interpolation or extrapolation methods have been applied) and a comparison to other published emission factors and explanation of any significant differences
- The frequency of data collection; and
- Estimates of the associated uncertainties together with a description of the major sources of the uncertainties.

DESCRIPTION OF THE METHODS USED IN LAND IDENTIFICATION AND ESTIMATION OF EMISSIONS AND REMOVALS

It is *good* practice to document the methods with the following information:

- Choice of reporting methods for lands subject to Articles 3.3 and 3.4 (Reporting Method 1 or 2) or a description of the reporting method, if a combination of the two is used;
- Description of the approach used for geographical location and identification of the geographical boundaries, lands; references of maps used, if any;
- Choice of tier(s) used for estimating greenhouse gas emissions and removals;
- Methods used for estimating carbon stock changes, non-CO_2 greenhouse gas emissions and magnitudes of the corresponding uncertainties;
- Choice of activity data;
- Identification of key categories
- If Tier 1 is used: all values of default parameters and emission/removal factors used;
- If Tier 2 is used: all values and references of default and national parameters and emission/removal factors used;
- If Tier 3 is used: Parties should, as applicable, report information on: basis and type of model, application and adaptation of the model, main equations/processes, key assumptions, domain of application, how the model parameters were estimated, description of key inputs and outputs, details of calibration and model evaluation, uncertainty and sensitivity analysis, QA/QC procedures adopted and references to peer-reviewed literature, description of the process by which carbon stock changes and emissions or removals are estimated;
- In case of Tier 2 or 3 the documentation should justify the use of specific parameters, factors or models;
- Transparent and verifiable information that demonstrates that the pools not included in the reporting are not sources.

ANALYSIS OF INTERANNUAL VARIABILITY

It is *good practice* to explain significant interannual variability in reported emissions or removals. The reasons for any changes in activity levels and in parameter values from year to year should be documented. If the reason for the changes is an improvement in methods, it is *good practice* to recalculate results for the preceding years by using the new methods, new activity and/or new parameter values (see Chapter 5, Volume 1 of the *2006 IPCC Guidelines* 'Time series consistency')

2.4.5 Quality assurance and quality control

It is *good practice* to implement quality control checks as outlined in Volume 1, Chapter 6 (Quality Assurance and Quality Control) of the *2006 IPCC Guidelines* on category-specific QC Procedures, and expert review of the emission estimates. Additional quality control checks and quality assurance procedures may also be applicable, particularly if higher-tier methods are used to estimate carbon stock changes and non-CO_2 greenhouse gas emissions. A detailed treatment of inventory QA/QC for field measurement is described in Appendix 4A.3 of the *Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories* (*GPG)*.

Some important issues are highlighted and summarised below.

When compiling data, it is *good practice* to cross-check estimates of emissions and removals of greenhouse gases against independent estimates. The inventory compilers should ensure that estimates undergo quality control by:

- Cross-referencing aggregated production data (e.g., crop yield, tree growth) and reported area statistics with national totals or other sources of national data (e.g., agriculture / forestry statistics);
- Back-calculating national emission/removal factors from aggregated emissions and other data;
- Comparing reported national totals with default values and data from other countries.
- Comparing results from two different methods, such as national statistical data versus remote sensing source or two different remote sensing sources (e.g. Dymond et al. 2012), on the total area under one activity of Article 3.3, or Article 3.4 if elected.

It is also *good practice* to verify that the sum of the disaggregated areas used to estimate the various emissions/removals equals the total area under the activity, reported as per guidance in Volume 1, Chapter 6 of *2006 IPCC Guidelines* (using the LU/LUC matrix).

2.4.6 Verification

Generic *good practice* guidance for verification is given in Section 6.10, Volume 1 of the *2006 IPCC Guidelines* (Verification). It is also *good practice* to develop verification activities as part of the overall QA/QC and verification system. The specific guidance and issues are provided in the sections below for the elaboration of verification planning

2.4.6.1 Specific guidance for Verification of LULUCF Inventories

The checklist in the Box 2.4.2 summarises some of the tools that can be used for internal verification of an inventory on the LULUCF sector.

BOX 2.4.2
VERIFICATION OF INVENTORY OF LULUCF SECTOR IN A NATIONAL INVENTORY

A. Checks:

Does the inventory of the LULUCF sector document the data and assumptions used for estimating emissions and removals for all IPCC source/sink categories?

Have all important carbon pools been included in the inventory?

If some LULUCF emission/removal categories have been excluded, does the report explain why?

Are emissions and removals reported as *positive* and *negative* terms, respectively?

For the total area of the inventory of the LULUCF sector, are the overall changes in land use for the inventory year equal to zero within the confidence limit?

Are any discontinuities in trends from base year to end year evaluated and explained?

B. Comparisons of emissions and removals from LULUCF:

Compare the inventory of the LULUCF sector with independently prepared national inventories for the same country or compare regional sub-sets of the national inventory with independently prepared inventories for those regions. (*Approach 1**).

Compare the inventory of the LULUCF sector with national inventories for a different, but similar country (*Approach 1*).

Compare activity data and/or emission factors of the inventory of the LULUCF sector with independent international databases and/or other countries. For example, compare Biomass Expansion Factors of similar species with data from countries with similar forest conditions (*Approach 1*).

Compare the inventory of the LULUCF sector with results calculated using another tier methodology, including defaults (*Approach 2*).

Compare the inventory of the LULUCF sector with available high-intensity studies and experiments (*Approach 1-3*).

Compare land areas and biomass stocks used in the inventory with remote sensing (*Approach 4*).

Compare the inventory of the LULUCF sector with models (Approach 5).

C. Comparisons of uncertainties:

Compare uncertainty estimates with uncertainty reported in the literature.

Compare uncertainty estimates with those from other countries and the IPCC default values.

D. Direct measurements:

Carry out direct measurements (such as local forest inventory, detailed growth measurements and/or ecosystem fluxes of greenhouse gases, *Approach 3*).

* See Section 5.7 of *GPG-LULUCF* for the details on each Approach.

Taking into account resource limitation, the information provided in the national inventory report should be verified as far as possible, particularly for key categories. The verification approaches in Box 2.4.2 can be applied as follows:

The checks listed under A are essential and, ideally, these should have been conducted as part of QA/QC.

It is *good practice* to perform verification with at least one of the approaches listed under B (see Table 5.7.1 and Section 5.7.2 in *GPG-LULUCF* for more information on the applicable approaches).

If independent estimates on emissions and removals of greenhouse gases by LULUCF are not available, then internal or external verification will most probably be limited to scrutiny of the data and methods. Under these circumstances, it is *good practice* for the inventory compiler to carry out these checks and to provide sufficient documentation in its national inventory report and other supporting material to facilitate external verification.

Inventory compilers, taking into account country-specific circumstances and the availability of resources, can assess the proper combination of approaches for verifying their LULUCF inventories. Approaches 1, 2 and 3 are feasible for verifying several components of the inventory. Among those listed, Approaches 1 and 2 can be easily implemented by an inventory compiler with low to moderate resources. Remote sensing is the most suitable method for the verification of land areas. Direct measurements (under D in Box 2.4.2) are relevant, although this approach can be resource-intensive and, on a large scale, costs may be a constraint. Models can be used as an alternative when direct measurements combined with remote sensing is not feasible.

2.4.6.2 SPECIFIC ISSUES LINKED TO THE KYOTO PROTOCOL

An inventory compiler can use the questions in Box 2.4.3 to help guide the development of a verification plan for supplementary information reported under Articles 3.3 and 3.4 of the KP.

BOX 2.4.3
GUIDANCE FOR VERIFYING CARBON POOLS AND ACTIVITIES

Which carbon pools to verify?

It is *good practice* to focus verification on those carbon pools that are expected to be most relevant to the KP but also on non-CO_2 greenhouse gas emissions. The Decision 2/CMP.7 lists the following pools: aboveground and belowground biomass, litter, dead wood, soil organic carbon and harvest wood products. A Party may exclude particular pools from reporting, if verifiable information is provided showing that the pool has not been a source of greenhouse gases for activities under Article 3.3 and elected activities under Article 3.4. As for LULUCF inventories, if a pool is expected to change significantly over the inventory reporting period, particular attention should also be devoted to it.

Which activities to verify?

According to Decision 2/CMP.7, a Party has to report activities under Article 3.3 and FM and may choose any or all elected activities under Article 3.4 of the KP. For all mandatory or elected activities, elements which are specific to the reporting under KP inventories include: the identification of the areas in which such activities have taken place, demonstration that the activities have occurred since 1st January 1990 and are human induced, demonstration of the methodological consistency between the reference level and reporting for FM including in the treatment of HWP, and in the accounting of any emissions from natural disturbances and the establishment of the "1990" base year (reference year for reforestation activities and base year for net-net accounting).

Specific verification related to estimates developed under Articles 3.3 and 3.4 of the KP may include:

For lands subject to reporting under the KP, it is *good practice* to verify such lands using geographical and statistical information, such as remote sensing data. Even if georeferencing was not required, this would facilitate verification.

The reporting of greenhouse gas emissions and removals of most Article 3.3 and 3.4 activities requires reference to 1990 or pre-1990 data (classification of forest/non forest lands for 1990, net-net accounting for CM, GM, RV and WDR, etc.). In some cases, these data may not be available or their reliability may be limited and estimates may be used. In such cases, it is *good practice* to verify the estimation approach and values, as much as possible.

As with inventories of the LULUCF sector, inventory compilers, taking specific circumstances and the resource availability into account, may choose the proper combination of approaches for verifying supplementary information reported under the KP. Among these approaches, remote sensing is the most suitable for the verification of land areas. Direct measurements are relevant, although this approach can be resource intensive. Models can be used as an alternative when direct measurements combined with remote sensing is not feasible. Some verification steps, which are unique to the KP, are presented in Box 2.4.4.

BOX 2.4.4
VERIFICATION OF LULUCF UNDER THE KYOTO PROTOCOL

Checks:

If a Party reports that an activity has occurred on forest land, is the definition of 'forest' provided and consistent with activities and lands reported? Is information on selected crown cover and tree height provided?

Are changes in all carbon pools reported (aboveground and belowground biomass, dead wood, litter, soil organic carbon, harvest wood products)? If not, is the reason and documentation for omitting a pool given?

Are geographical boundaries of land areas specified for the activities eligible under Articles 3.3 and 3.4?

Is the total land area reported under Article 3.3 and 3.4 constant or increasing throughout subsequent or contiguous commitment periods?

Is information provided that demonstrates that the elected activities under Article 3.4 occurred since 1990 and are human induced?

For Article 3.3, is information provided to distinguish deforestation from harvesting (clear-cut) or forest disturbance followed by re-establishment of a forest?

The checks listed in Box 2.4.4 are essential and, ideally, should have been conducted as part of QA/QC. In addition to these specific checks, the comprehensive list presented in Box 2.4.2 under items B to D can be used to identify additional useful verification activities.

For verification, it is *good practice* for inventory compilers to choose a key category by giving a priority, or emissions and removals with high uncertainty or with relevance to mitigation policies, or carbon pool with a significant change, or all of them as criteria to implement their verification plan.

2.5 AFFORESTATION AND REFORESTATION

This section addresses specific methods applicable to Afforestation and Reforestation activities and should be read in conjunction with the general discussion in Sections 2.2 to 2.4.

2.5.1 Definitional issues and reporting requirements

According to the definitions of the Decision 16/CMP.1, both Afforestation and Reforestation refer to direct human- induced conversion of non-forested land to forested land. For the first and second commitment period of the Kyoto Protocol, Afforestation and Reforestation activities are restricted to those which occurred on or after 1 January 1990. The distinction between Afforestation and Reforestation is linked to the period of time the land has been non-forested. Afforestation occurs on land that has not been forested for at least 50 years. Reforestation occurs on land that has been forested more recently, though was non-forested on 31 December 1989[53]. Land that was subject to Deforestation to non-forested land, and is subsequently subject to regrowth of forests continues to be reported under Deforestation as a subcategory.

The country's definition of forest should be consistent with guidance provided in Section 1.2, and consistent with that used by the country in the first commitment period. A direct-human induced gain in tree cover above the country-specific forest thresholds (or the potential to meet these thresholds) is required as a precondition to report a land under Afforestation/Reforestation activity. When a country's definition of forest takes account of predominant land use[54] as well as the thresholds adopted by the country, tree cover gain will not necessarily correspond to a land-use change, because in this case, the gain of tree cover alone is not necessarily enough to result in the classification of land as forested. For example, fruit orchards or urban trees can meet the threshold values of forest, but since the predominant land-use may be cropland or settlements rather than forest, they may not meet the country-specific definition of forest. If the land remains classified as Cropland or Settlements, the growth of these trees beyond the forest threshold would then not constitute Reforestation.

Afforestation and Reforestation definitions do not include regrowth of forests following harvest or natural disturbance of forests. This is because the loss of forest cover in these cases is only temporary and therefore not considered Deforestation unless a land-use change occurs: the land remains as forested land. Harvesting followed by re-establishment of forest is considered Forest Management activity (Section 2.7). Lands that would be subject to Afforestation/Reforestation activity under Article 3.3 but are instead accounted for under Forest Management activity under the Carbon Equivalent Forest Conversion provision should be identified separately (Section 2.7.7).

For identification of lands[55], Afforestation and Reforestation will be discussed together because the two definitions differ only by the time since the area was last forested, and because the same carbon reporting and accounting rules apply to both activities. When calculating changes in carbon stocks following afforestation and reforestation, the assumptions about the initial size and composition of the litter, dead wood, and soil organic carbon pools should reflect the preceding land-use type and history, rather than the distinction between afforested and reforested sites.

A Party's choice of methods for the development of an inventory of Afforestation and Reforestation activities will depend on the national circumstances. For the identification of lands subject to Afforestation and Reforestation since 1st January 1990, it is *good practice* to use Approach 3 for consistent representation of lands (see Volume 4, Chapter 3, Section 3.3, of the *2006 IPCC Guidelines*), or Approach 2, with supplementary

[53] This date is contained in the definition of reforestation in Decision 16/CMP.1, for the first commitment period: "Reforestation" is the direct human-induced conversion of non-forested land to forested land through planting, seeding and/or the human-induced promotion of natural seed sources, on land that was forested but that has been converted to non-forested land. For the first commitment period, reforestation activities will be limited to reforestation occurring on those lands that did not contain forest on 31 December 1989. Decision 2/CMP.6 (paragraph 2) indicates that: ...the definitions of forest, afforestation, reforestation, revegetation, forest management, cropland management and grazing land management shall be the same as in the first commitment period under the Kyoto Protocol. This supplement assumes that the date of 31 December 1989 continues to be applicable in the second commitment period, but notes that a different interpretation may be possible subject to decisions of the CMP

[54] The *KP Supplement* recognizes whilst the definition of forest adopted by 16/CMP1 and taken over by 2/CMP.7 for the second commitment period is based on area, tree height and canopy cover thresholds, in implementing this definition in the first commitment period, many countries did not count as forested land which meets these definitions but was predominantly under agricultural or urban land use, consistent with information reported to FAO or by national inventories. See section 1.1, step 1 for further guidance.

[55] "Lands" in this supplement refers to units of land subject to Art 3.3 activities and lands under Art 3.4.

information provided that allows identification and tracking of lands on a statistical basis[56]. A general discussion of methods for identifying and reporting on lands subject to Afforestation and Reforestation activities are discussed in Section 2.2 of this report. It is *good practice* to provide information on uncertainties in the estimates of the total area of the lands subject to Afforestation and Reforestation as discussed in Section 2.4.3 of this report.

The annual inventory should, at a minimum, identify (for Reporting Method 1 in Section 2.2.2):

- The geographical location of the boundaries of the areas that encompass lands subject to Afforestation/Reforestation activities. The geographical boundaries which are reported should correspond to strata in the estimation of land areas as described in Volume 4, Chapter 3 of the *2006 IPCC Guidelines*;
- For each of these areas, or strata, an estimate of the area of lands subject to Afforestation/Reforestation activities under Article 3.3 of the Kyoto Protocol;
- The area of lands subject to direct human-induced Afforestation/Reforestation in each of the previous land-use categories (e.g., Cropland, Grassland). This is to support the transparent calculation of carbon stock changes and non-CO_2 emissions and the identification of lands.

A more comprehensive system (Reporting Method 2 in Section 2.2.2) identifies each unit of land subject to Afforestation/Reforestation activities since 1st January 1990 using the polygon boundaries, a coordinate system (e.g., the Universal Transverse Mercator (UTM) Grid or Latitude/Longitude), or a legal description (e.g., those used by land-titles offices) of the location of the land subject to Afforestation or Reforestation activities. Volume 4, Chapter 3 of the *2006 IPCC Guidelines* (Basis for Consistent Representation of Lands) discusses in detail the possible approaches for consistent representation of land areas.

In both cases, it is *good practice* to provide information on the area of Afforestation/Reforestation activities by year, and on any other information relevant for the estimation of emissions and removals (e.g., species, growth rate by species and / or site conditions, productivity classes, etc.).

2.5.2 Choice of methods for identifying lands subject to direct human-induced Afforestation/Reforestation

Parties are required to report on the carbon stock changes and non-CO_2 greenhouse emissions during the commitment period on areas that have been subject to Afforestation and Reforestation activities since 1990. The first step in this process is to make national parameter choices for the forest definition within the ranges allowed by Decision 16/CMP.1, namely minimum area of 0.05 – 1 ha, minimum tree crown cover of 10-30% (or equivalent stocking level), minimum height at maturity of 2 to 5 meters and to report on these parameters, in the annual greenhouse gas inventory as set out in Table 2.4.1. As explained in Section 2.2.6.1, it is also *good practice* to choose a parameter for the minimum width of forested areas. Once the parameters have been chosen, they will be used in identifying of lands subject to Afforestation and Reforestation.

The identification of lands subject to Afforestation/Reforestation activities requires the determination of areas that:

1. Meet or exceed the size of the country's minimum area in the applied forest definition (i.e., 0.05 to 1 ha), and
2. Did not meet the country's definition of forest on 31 December 1989, and
3. Do meet (or have the potential to meet) the definition of forest at the time of the assessment as the result of direct human-induced activities, and
4. Do not meet the criteria for Carbon Equivalent Forest Conversion at the time of the assessment if this provision is applied.

Note that the definition of forest can be met by young trees that do not yet meet the minimum height or crown cover criteria, provided that they are expected to reach these parameter thresholds at maturity.

It is *good practice* to distinguish those areas that did not meet the crown cover threshold in the definition of forest, for example, because of recent harvest or natural disturbances, from those areas that were non-forested on 31 December 1989, because only the latter areas are eligible for Afforestation and Reforestation activities under Decision 16/CMP.1. Decision 16/CMP.1 requires that Parties provide information on the criteria used to distinguish harvesting or forest disturbance that is followed by the re-establishment of a forest from

[56] In the case of Afforestation and Reforestation, the minimum information required is the land-use which preceded the Afforestation and Reforestation event. This is particularly important for estimating the carbon stock change in soil, which may depend on the previous land-use and soil type.

deforestation[57]. It is *good practice* to apply the same criteria when evaluating whether a unit of land meets the definition of forest. For example, if a country uses the criterion "time since harvest" to distinguish temporary forest cover loss from Deforestation, and specifies that a harvested area will regenerate within X years, then only those areas that have been harvested more than X years prior to 31 December 1989 and that have not regenerated would be eligible for reforestation, as only they would be considered non-forested on 31 December 1989. Similarly, areas that have been disturbed by wildfire or other natural disturbances (Section 2.3.9) more than X years prior to 31 December 1989, and that have not regenerated to forest are classified as non-forested on 31 December 1989 and would therefore be eligible for Reforestation.

As discussed in Section 2.2.2 (Reporting Methods for lands subject to Article 3.3 and 3.4 activities), Parties have the option either to report a wall-to-wall estimate of all lands subject to Article 3.3 activities, or to stratify the land into areas, i.e., defining the boundaries of these areas, and to then develop for each area statistical estimates of the lands subject to Afforestation, Reforestation and Deforestation activities. Combined approaches are also possible: wall-to-wall can be developed for some strata, while estimates based on sampling approaches are developed for other strata in the country, ensuring consistency in land representation in order to avoid double counting.

It is *necessary* to provide information demonstrating that all afforestation and reforestation activities included in the identified lands are direct human-induced[58]. Relevant information includes documentation which demonstrates that a decision has been taken that aimed at replanting or promoting or allowing forest regeneration, for example, through laws, policies, regulations, management decisions and practices. In the absence of such documentation or information, forest regrowth as a consequence of abandonment does not qualify as direct human-induced Afforestation or Reforestation[59]. Forest regrowth as a consequence of environmental change (including global climate change) is not direct-human induced and therefore does not qualify as Afforestation/Reforestation, for example, vegetation thickening at high elevation or high latitude tree lines.

In some cases it may be unclear whether newly established trees will pass the forest threshold. A difference between Afforestation/Reforestation activities and Revegetation is that Revegetation is not required to meet (in X years) the Party's definition of a forest. Where it is uncertain whether the trees on a unit of land will exceed the thresholds of the definition of forest, it is *good practice* that the carbon stock changes on these lands continue to be reported as under the Article 3.4 activity which was previously reported, or reported under Revegetation, and to await confirmation (at a later time) that all the thresholds have been or will be passed before reporting these areas as Afforestation or Reforestation. This approach is consistent with the treatment of Deforestation, i.e., after loss of forest cover that may be temporary; lands remain as forested lands until confirmed as Deforestation (see Section 2.6.2.1). A decision tree for determining whether an area will qualify for Afforestation/Reforestation or for Revegetation is given in Figure 2.5.1.

[57] Paragraph 5 of the Annex to Decision 16/CMP.1 (Land use, land-use change and forestry) contained in document FCCC/KP/CMP/2005/8/Add.3, p.6; Paragraph 4 of the Annex to Decision 2/CMP.7 (Land use, land-use change and forestry) contained in document FCCC/KP/CMP/2011/10/Add.1, p.11.

[58] Decision 16/CMP.1 defines Afforestation/Reforestation as *the direct human-induced conversion* of *[land that has not been forested for 50 years/non forested land] to forested land through planting, seeding and/or the human-induced promotion of natural seed sources*. Decision 2/CMP.7 maintained the same definitions. According to Decision 2/CMP.8 (Implications of the implementation of decisions 2/CMP.7 to 5/CMP.7 on the previous decisions on methodological issues related to the Kyoto Protocol, including those relating to Articles 5, 7 and 8 of the Kyoto Protocol), Annex II, paragraph 4(a), *specific information to be reported for activities under Article 3, paragraph 3, shall include information that demonstrates that activities under Article 3, paragraph 3, began on or after 1 January 1990 and before 31 December of the last year of the commitment period, and are* ***directly human-induced***. The demonstration of direct-human induced afforestation and reforestation is therefore a specific requirement under the Kyoto Protocol, additional to the reporting requirements under the UNFCCC. It should be noted that the *2006 IPCC Guidelines*, used for reporting under the UNFCCC, use the term "afforestation and reforestation" with a broader meaning: *Land is converted to Forest Land by afforestation and reforestation, either by natural or artificial regeneration (including plantations). The anthropogenic conversion includes promotion of natural re-growth (e.g., by improving the water balance of soil by drainage), establishment of plantations on non-forest lands or previously unmanaged Forest Land, lands of settlements and industrial sites, abandonment of croplands, pastures or other managed lands, which re-grow to forest.* Due to this difference, some areas that have been reported as *Land Converted to Forest Land* since 1990 in the UNFCCC inventory may not have been converted through direct human-induced activity and cannot therefore be accounted under Afforestation/Reforestation activity under the Kyoto Protocol.

[59] When forest regrowth that does not meet the definition for Afforestation/Reforestation is on land already included in KP reporting and accounting, then it must continue to be so, either under an elected (CM, GM, WDR) or mandatory (FM) Article 3.4 activity. If the land was not previously under a mandatory or elected KP activity, it should nevertheless be included in Convention reporting. Thus the total area accounted as forest under KP may be less than that reported under UNFCCC.

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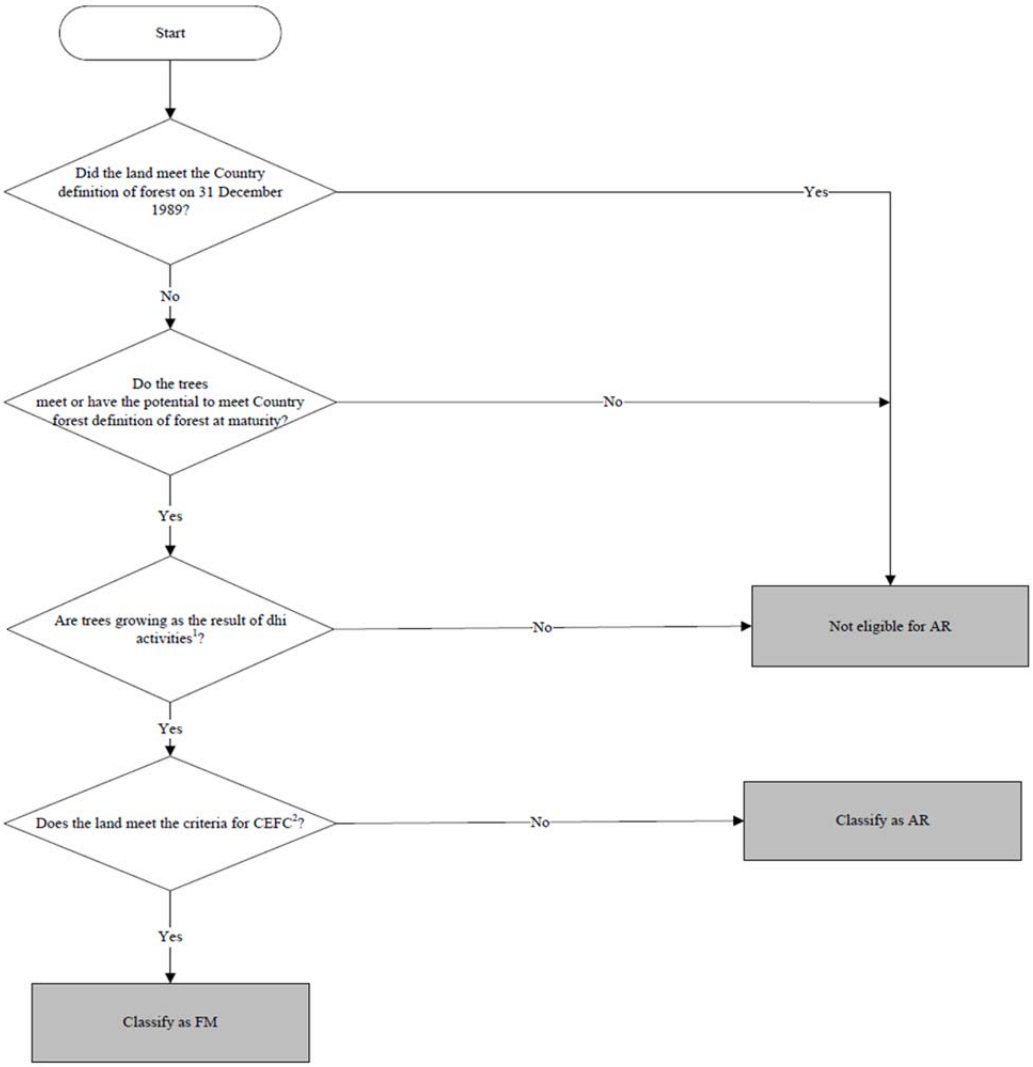
Figure 2.5.1 Decision tree for determining whether a unit of land qualifies for direct human-induced (dhi) Afforestation/Reforestation (AR)



Note:

(1) Direct human induced (dhi) Afforestation/Reforestation activities occur if trees are growing as a result of laws, policies, regulations, management decisions and practices aimed at planting, promoting or allowing forest regeneration.

(2) Carbon Equivalent Forest Conversion (CEFC): refer to Section 2.7.7

Links with methodologies in the *2006 IPCC Guidelines* on reporting of land areas and carbon stock changes and non-CO2 emissions in inventories under the UNFCCC are given in the Box 2.5.1.

BOX 2.5.1
IDENTIFICATION OF AR LANDS: LINKS WITHIN THIS REPORT AND WITH OTHER IPCC REPORTS

LINKS WITH OTHER CHAPTERS OF THIS REPORT

Section 2.2.2: Reporting Methods for Lands subject to Article 3.3 and Article 3.4 activities

LINKS WITH THE *2006 IPCC GUIDELINES*

Chapter 4 (Forest Land), Section 4.3 (Land Converted to Forest Land): methodological guidance on annual estimation of emissions and removals of greenhouse gases, which occur on *Land Converted to Forest Land* from different land-uses, through afforestation and reforestation, either by natural or artificial regeneration (including plantations). Note that some areas that have turned into forest since 1990 in the UNFCCC inventory may not have been converted through direct human-induced activity.

2.5.3 Choice of methods for estimating carbon stock changes and non-CO_2 emissions

Estimation of carbon stock changes from Afforestation and Reforestation activities should be consistent with the methods set out in Volume 4, Chapter 4 (Forest Land), Section 4.3 (Land Converted to Forest Land) of the *2006 IPCC Guidelines* and the equations it contains, and applied at the same or higher tier as used for UNFCCC reporting. Growth characteristics of young trees differ from those of the managed forest as a whole, and special provisions may be needed where the UNFCCC inventory (prepared according to Section 4.3: Land Converted to Forest Land) is not sufficiently detailed to provide information that applies to young stands.

For Afforestation and Reforestation under Article 3.3 activities, gross-net accounting rules are applied and information on carbon stock changes and non-CO_2 greenhouse gas emissions in the base year (i.e., 1990) is therefore not required. Only the carbon stock changes and non-CO_2 greenhouse gas emissions during each year of the commitment period are estimated and reported.

At Tier 1, biomass growth is determined using the data in Volume 4, Chapter 4, Section 4.3 (Land Converted to Forest Land) in the *2006 IPCC Guidelines.*

Under Tier 2, regional or national growth rates are likely to be available as a function of stand age, species or site quality, but data may be missing for stands between ages 0 years and that reached by the end of the commitment period. Where biomass estimates exist for older age stands, biomass at younger ages can be estimated by interpolating between the known value and biomass zero at age zero using a non-linear growth function fitted to the data that are available for older stands; in some cases, depending on the availability of data other interpolation methods may be applied.

At Tier 3, biomass growth rates should be established directly using measured data, validated growth models, or empirical yield tables for the appropriate combinations of species and site conditions. The estimates of changes in carbon stocks in biomass can be carried out on the basis of finer geographical scale and sub-division to forest type. It is *good practice* to include ground-based field measurements as part of any Tier 3 method, either as a component of a national (or project) forest inventory or of a growth and yield forest monitoring system.

Determination of the size and dynamics of litter, dead wood and soil organic carbon pools prior to the Afforestation/Reforestation activity may require the use of methods developed for Cropland or other land uses (Chapter 5 and other relevant chapters *of the 2006 IPCC Guidelines*).

Definition of pools under Afforestation/Reforestation should be consistent with Volume 4, Chapter 1, Section 1.2.2 (Carbon pool definitions and non-CO_2 gases) and Table 1.1 of the *2006 IPCC Guidelines.*

It is *good practice* to estimate emissions and removals of the harvest wood products pool associated with Afforestation and Reforestation activities using the guidance provided in Section 2.8 (Harvested Wood Products) of this report. It is *good practice* to report carbon stock changes and non-CO_2 greenhouse gas emissions from organic soils associated with drainage and rewetting of wetlands under Afforestation and Reforestation activities

using the guidance provided in Section 2.12.3 (Wetland Drainage and Rewetting) of this report and the *Wetlands Supplement*.

Links with methodologies in this report and the *2006 IPCC Guidelines* on reporting of carbon stock changes and non-CO_2 greenhouse gas emissions in inventories under the UNFCCC are given in Box 2.5.2 below.

BOX 2.5.2
METHODOLOGICAL GUIDANCE ON ESTIMATING CARBON STOCK CHANGES AND NON-CO_2 EMISSIONS ON AR LANDS: LINKS WITHIN THIS REPORT AND WITH OTHER IPCC REPORTS

LINKS WITH CHAPTERS OF THIS REPORT

Section2.8: Harvested Wood Products

Section 2.12.4: Wetland Drainage and Rewetting

LINKS WITH THE *2006 IPCC GUIDELINES*

Section 4.3, Chapter 4 (Land Converted to Forest Land)

This section provides methodological guidance on estimation of emissions and removals of greenhouse gases, which occur on lands converted to Forest Land from different land-uses, including Cropland, Grassland, Wetlands, Settlements, and Other Land, through afforestation and reforestation, either by natural or artificial regeneration (including plantations).

LINKS WITH THE *WETLANDS SUPPLEMENT*

Guidance on estimation of carbon stock changes and non-CO_2 emissions from lands with organic and wetland mineral soils in all land-uses with these soil types is provided in Chapters 2-5 of the *Wetlands Supplement.*

2.5.3.1 POOLS AFFECTED BY AFFORESTATION/REFORESTATION ACTIVITIES

Afforestation/Reforestation activities may involve site preparation (slashing and possibly burning coarse biomass residue, and tilling or ploughing on parts of or the whole area), followed by planting or seeding. These activities may affect not only above and below-ground biomass pools, but also soil, as well as dead wood, and litter, if (in the latter instances) land with woody shrub or sparse tree cover was afforested.

Decision 16/CMP.1 requires Parties to estimate carbon stock changes in all five pools (see *2006 IPCC Guidelines* Volume 4, Chapter 1, Table 1.1) during the commitment period unless the Party can demonstrate by transparent and verifiable information that the pool is not a source[60], for which *good practice* guidance is set out in Section 2.3.1. Decision 2/CMP.7 further requires Parties to estimate carbon stock changes in the harvested wood products pool. It is *good practice* to include carbon stock changes and non-CO_2 greenhouse gas emissions that result from pre-planting activities, such as site preparation or shrub removals. Afforestation/Reforestation on mineral soils may either maintain or create conditions that increase belowground carbon stocks, particularly if the land was previously managed for annual crop production (Merino *et al.,* 2004; Post and Kwon, 2000; Schulp *et al.,* 2008; Laganière *et al.*, 2010; Don *et al.,* 2011). However, under certain circumstances, soil carbon may decline with afforestation of grasslands or wetlands for several years following conversion (Davis and Condron, 2002; Guo and Gifford, 2002; Paul *et al.*, 2003; Tate *et al.,* 2003; Vesterdal *et al.,* 2002), and net losses of carbon after planting or` seeding can persist over many years. Therefore, it is *good practice* to ensure that estimates of pre-activity carbon stocks in the area are used to compute stock changes, including for methodologies involving modelling. Since there is no forest on the area prior to the Afforestation/Reforestation activity, the assessment should be done by methods described in Chapter 4, Section 4.3 (Land Converted to Forest Land) of the *2006 IPCC Guidelines*.

[60] Paragraph 26 of Annex to Decision 2/CMP.7 (Land use, land-use change and forestry) contained in document FCCC/KP/CMP/2011/10/Add.1, p.16; Paragraph 2 (e) of Annex II to Decision 2/CMP.8 contained in document FCCC/KP/CMP/2012/13/Add.1, p.19.

For Article 3.3 Afforestation or Reforestation activities that begin during the commitment period, reporting for that unit of land shall begin at the beginning of the year in which the activity commences[61]. Site preparation and seeding/planting activities should be considered part of the activity, and associated emissions during the commitment period should therefore be included.

The methods given in *2006 IPCC Guidelines* (Volume4, Chapter 4, Section 4.3: Land Converted to Forest Land) for estimating non-CO_2 greenhouse gas emissions on *Land Converted to Forest Land* are applicable for the Afforestation and Reforestation activities.

2.5.3.2 METHODS TO ADDRESS NATURAL DISTURBANCE

Calculation of carbon stock changes and non-CO_2 greenhouse gas emissions on areas subject to Afforestation and Reforestation can be influenced by the presence of natural disturbances, i.e. non-anthropogenic events or non-anthropogenic circumstances that cause significant emissions in forests and are beyond the control of, and not materially influenced by a Party. Decision 2/CMP.7 allows that under certain conditions, the effect of natural disturbances that occur in forests may be excluded from accounting under the Kyoto Protocol for the second commitment period. Methods for addressing natural disturbances are provided by Section 2.3.9 Disturbances.

[61] Paragraph 2(d) of Annex II to Decision 2/CMP.8 contained in the document FCCC/KP/CMP/2012/13/Add.1, p.19.

2.6 DEFORESTATION

This section addresses specific methods applicable to deforestation activities and should be read in conjunction with the general discussion in Sections 2.2 to 2.4.

2.6.1 Definitional issues and reporting requirements

According to the definition in Decision 16/CMP.1, Deforestation is the direct, human-induced conversion of forested to non-forested land[62].

The country's definition of forest should be consistent with guidance provided in Section 1.2 and consistent with that used in the first commitment period. A loss in tree cover below the country-specific forest thresholds is required as a precondition to report a land under Deforestation. When a country's definition of forest takes account of predominant land[63] use as well as the thresholds adopted by the country, permanent loss of tree cover alone is not necessarily enough to define direct human induced Deforestation. For example, fruit orchards or urban trees can meet the threshold values of forest, but since the predominant land-use may be cropland or settlements rather than forest, they may not meet the country-specific definition of forest. If the land was classified as Cropland or Settlements, the removal of trees below the forest threshold would then not constitute Deforestation.

The definition of Deforestation does not include loss of forest cover due to harvest or natural disturbance events that are followed by natural or human-induced re-establishment of forest. This is because in these cases, loss of forest cover is only temporary and therefore not considered Deforestation, the land remains as forested land.

Harvest followed by re-establishment of forest is considered Forest Management activity and reported according to Section 2.7. Natural disturbance followed by re-establishment of forest is not counted as Deforestation and disturbance emissions may be excluded from accounting following the methodologies in Section 2.3.9. Human activities (since 1990) such as agricultural practices or the construction of roads or settlements, that prevent forest regeneration by changing land-use on areas where forest cover was removed by a natural disturbance, are considered direct human-induced deforestation. All emissions and removals on lands subject to Deforestation must continue to be reported under Deforestation, even if they are subsequently subject to regrowth of forests; it is *good practice* to report these lands as a separate subcategory (e.g. forest regrowth)[64]. Lands that were subject to elected activities under Article 3.4 of the Kyoto Protocol prior to tree cover loss and remain classified under the same activity, are reported under the relevant Article 3.4 activity (and not under Deforestation).

Following Decision 2/CMP.7,[65] it is mandatory to report and account for conversion of natural forest to planted forest under Forest Management. It is not considered Deforestation, because the land remains under forest land

[62] Paragraphs 3 and 4 in the Annex to Decision 2/CMP.7 (Land use, land-use change and forestry) contained in document FCCC/KP/CMP/2011/10/Add.1, p.13, specifies that:

For the purposes of determining the area of deforestation to come into the accounting system under Article 3, paragraph 3, each Party shall determine the forest area using the same spatial assessment unit as is used for the determination of afforestation and reforestation, but not larger than 1 hectare.

Each Party included in Annex I shall report, in accordance with Article 7, on how harvesting or forest disturbance that is followed by the re-establishment of a forest is distinguished from deforestation. This information will be subject to review in accordance with Article 8.

[63] The *KP Supplement* recognizes whilst the definition of forest adopted by 16/CMP.1 and taken over by 2/CMP.7 for the second commitment period is based on area, tree height and canopy cover thresholds, in implementing this definition in the first commitment period, many countries did not count as forested land which meets these definitions but was predominantly under agricultural or urban land use, consistent with information reported to FAO or by national inventories. See Section 1.2, step 1 for further guidance

[64] This is consistent with the treatment in *GPG-LULUCF*. Treating Deforestation and Deforestation which is subsequently subject to forest regrowth as separate sub-categories is useful for transparency purposes, because different methods may be applied and different emission patterns may be reported for these subcategories.

[65] Paragraph 5 in the Annex to Decision 2/CMP.7 contained in FCCC/KP/CMP/2011/10/Add.1, p.13: *Each Party included in Annex I shall report and account for, in accordance with Article 7, all emissions arising from the conversion of natural forests to planted forests*. Paragraph 5(d) in Annex II to the Decision 2/CMP.8 contained in the document FCCC/KP/CMP/2012/13/Add.1, p.21, specifies this activity as being reported under Forest Management.

use (Section 2.7). Under the Decision 2/CMP.7, planted forest lands subject to conversion to non-forested land may, in special circumstances, be identified and accounted for as a Forest Management activity under the Carbon Equivalent Forest Conversion provisions and are not considered Deforestation (Section 2.7.7).

Parties will need to use the methods outlined in Volume 4, Chapter 3 of the *2006 IPCC Guidelines* (Consistent Representation of Lands), and the guidance in Section 2.2 to ensure that lands subject to Deforestation are adequately identified in land-use change and other inventory databases and can be tracked over time once accounted under the Kyoto Protocol. Land identification and tracking provide means to associate the relevant activity data to the correct emission factor. The Decision 2/CMP.8 requires that areas subject to direct human-induced Deforestation since 1990 (Article 3.3) be identified separately from areas subject to direct human induced Deforestation that are also subject to other activities under Article 3.4 (such as Cropland Management)[66]. Providing information on these areas will improve transparency and ensure that carbon stock changes and non-CO_2 greenhouse gas emissions are not counted twice.

A Party's choice of methods for the development of an inventory of lands subject to Deforestation activities will depend on the national circumstances. For the identification of lands subject to Deforestation since 1st January 1990, it is *good practice* to use Approach 3 for consistent representation of lands (see Volume 4, Chapter 3, Section 3.3.1 of the *2006 IPCC Guidelines*), or Approach 2 with supplementary information provided that allows identification and tracking of lands on a statistical basis[67]. Section 2.2.2 of this report provides a general discussion of methods for reporting on lands subject to Article 3.3 activities. It is *good practice* to provide information on uncertainties in the estimates of the total area of the lands subject to Afforestation and Reforestation as discussed in Section 2.4.3 of this report.

The annual inventory should, at a minimum, identify (for Reporting Method 1 in Section 2.2.2):

- The geographical location of the boundaries of the areas that encompass lands subject to direct human-induced deforestation activities. The geographical boundaries which are reported should correspond to strata in the estimation of land areas as described in Volume 4, Chapter 3 of the *2006 IPCC Guidelines*;
- For each of these areas, or strata, an estimate of the area of the lands subject to direct human-induced Deforestation activities under Article 3.3 of the Kyoto Protocol, and the area of these lands which would otherwise be included in lands subject to elected activities under Article 3.4 of the Kyoto Protocol (Cropland Management, Grazing land Management, Revegetation and Wetland Drainage and Rewetting).
- The area of lands subject to direct human-induced deforestation in each of the new land-use categories (Cropland, Grassland, Settlements) and areas of lands subject to direct human-induced deforestation that are subsequently subject to forest regrowth. This is to support the transparent calculation of carbon stock changes and non-CO_2 greenhouse gas emissions and identification of lands.

A more comprehensive system for compiling annual inventory (Reporting Method 2 in Section 2.2.2) identifies each unit of land subject to deforestation since 1990 using the polygon boundaries, a coordinate system (e.g., the Universal Transverse Mercator (UTM) Grid or Latitude/Longitude) at possible finer resolution, or a legal description (e.g., those used by land-titles offices) of the location of the land subject to deforestation activities. Volume 4, Chapter 3 of the *2006 IPCC Guidelines* (Basis for Consistent Representation of Lands) discusses in detail the possible approaches for consistent representation of lands.

It is *good practice* to provide information on the area deforested by year, and on any other information relevant to the estimation of emissions and removals (e.g. forest type, site conditions, etc.).

2.6.2 Choice of methods for identifying lands subject to direct human-induced deforestation

Parties are required to report carbon stock changes and non-CO_2 emissions during the commitment period on land areas that have been subject to direct human-induced deforestation activities since 1990 (after 31 December 1989) .

It is *good practice* that the identification of areas subject to Deforestation is consistent with the country's definition of forest. The identification of areas subject to Deforestation requires the detection of a permanent reduction in forest cover from above to below the country-specific threshold of forest. Forest is required to be first defined in terms of potential height, tree crown cover and minimum area as already described for

[66] Paragraph 2(b) in Annex II to Decision 2/CMP.8 contained in the document FCCC/KP/CMP/2012/13/Add.1, p.18.

[67] In the case of Deforestation, the minimum information required is the land-use (or land uses) that followed the Deforestation event.

Afforestation and Reforestation activities. When a country's definition of forest takes account of predominant land-use as well as the thresholds adopted by the country, the permanent loss of tree cover should be accompanied by a change in land-use (from forest to non-forest) to define direct human induced Deforestation. The same parameter values for the definition of forest are required to be used for determining the area of land subject to Deforestation. Once a Party has chosen its definition of forest, the forest area can be identified for any point in time. Only areas within these boundaries are potentially subject to deforestation activities.

The identification of lands subject to deforestation activities requires the determination of areas that:

1. Meet or exceed the size of the country's minimum forest area (i.e., 0.05 to 1 ha), and
2. Have met the country's definition of forest on or after 31 December 1989, and
3. Have ceased to meet the definition of forest at some time after 1 January 1990 as the result of direct human-induced conversion from forested to non-forested land, and
4. Do not meet the criteria for Carbon Equivalent Forest Conversion if this provision is applied.

Lands can only be classified as Deforestation if they have been subject to direct human-induced conversion from forested land to non-forested land. Areas in which forest cover was lost as a result of natural disturbances are not considered deforested, even if changed physical conditions delay or prevent regeneration, provided no land-use change has occurred (Section 2.3.9). If, however, the natural disturbance is followed by a non-forest land-use, then this will prevent the regeneration of forest, and the disturbance emissions count as Deforestation and cannot be excluded from accounting. Change in management or policy that could be reasonably expected to directly result in forest cover loss is considered to be direct human-induced Deforestation. For example, loss of forest cover in areas that have been flooded as a result of changed drainage patterns due to hydroelectric dams or road construction. Loss of forest cover due to environmental change (i.e., not direct human induced), which is not subject to land use change, would not be considered Deforestation (e.g. naturally raising or lowering of water tables in areas with permafrost thawing or river/coastal erosion).

Linkages with methodologies in this report and the *2006 IPCC Guidelines* on reporting of land areas related to deforestation (conversion of forest to other land uses) in inventories under the UNFCCC are given in the Box 2.6.1.

BOX 2.6.1
IDENTIFICATION OF D LANDS: LINKS WITHIN THIS REPORT AND WITH OTHER IPCC REPORTS

LINKS WITH OTHER CHAPTERS OF THIS REPORT

Section 2.2.2: Reporting Methods for Lands subject to Article 3.3 and Article 3.4 activities

Provides methods for identifying lands subjected to direct human induced Deforestation, along with conditions for identifying areas of lands subject to Deforestation activities.

LINKS WITH THE *2006 IPCC GUIDELINES*

Volume 4: Agriculture, Forestry and Other Land Use

Chapter 3: Consistent Representation of Lands

Chapter 5 (Cropland), Section 5.3 (Land Converted to Cropland): methodological guidance on annual estimation of emissions and removals of greenhouse gases, which occur on *Land Converted to Cropland* from different land-uses.

Chapter 6 (Grassland), Section 6.3 (Land Converted to Grassland): methodological guidance on annual estimation of emissions and removals of greenhouse gases, which occur on *Land Converted to Grassland* from different land-uses.

Chapter 7 (Wetlands), Section 7.3.2 (Land Converted to Flooded Land): methodological guidance on annual estimation of emissions and removals of CO_2, which occur on *Land Converted to Flooded Land* from different land-uses.

Chapter 8 (Settlements), Section 8.3 (Land Converted to Settlements): methodological guidance on annual estimation of emissions and removals of greenhouse gases, which occur on *Land Converted to Settlements* from different land-uses.

Chapter 9 (Other Land), Section 9.3 (Land Converted to Other Land): methodological guidance on annual estimation of emissions and removals of greenhouse gases, which occur on *Land Converted to Other Land* from different land-uses.

2.6.2.1 DISCRIMINATING BETWEEN DEFORESTATION AND TEMPORARY LOSS OF FOREST COVER

Parties are required to report on how they distinguish between deforestation and areas that remain forests but where tree cover[68] has been removed temporarily[69], notably areas that have been harvested or have been subject to other human disturbance but for which it is expected that a forest will be replanted or regenerated naturally. It is *good practice* to develop and report criteria by which temporary removal or loss of tree cover can be distinguished from deforestation. For example, a Party could define the expected time periods (years) between removal of tree cover and successful natural regeneration or planting. The length of these time periods could vary by region, biome, species and site conditions. In the absence of land-use change, such as conversion to Cropland or construction of settlements, areas without tree cover are considered "forest" provided that the time since forest cover loss is shorter than the number of years within which tree establishment is expected. After that time period, lands that were forest on or after 31 December 1989, that since then have lost forest cover due to direct human-induced actions and that failed to regenerate are identified as deforested and the carbon stock changes and non-CO_2 greenhouse gas emissions for this land are to be recalculated and added to those of other deforested areas. There is an exception under the Carbon Equivalent Forest provision which allows the carbon stock changes and non-CO_2 emissions from some plantation conversion to non-forest to be reported under Forest Management if a Carbon Equivalent Forest is established elsewhere (see Section 2.7.7).

Although the loss of forest cover is often readily identified, e.g., through change detection using remote sensing images or field inventories, the classification of this area as deforested is more challenging. It involves assessing the lands on which the forest cover loss has occurred, as well as the surrounding area, and typically requires data from multiple sources to supplement the change detection information. In some cases a new land-use can be determined from remote sensing images, for example where it is possible to identify agricultural crops or infrastructure such as houses or industrial buildings. Information about actual or planned land-use changes and

[68] Or equivalent stocking level

[69] Paragraph 4 of Annex to Decision 2/CMP.7 (Land use, land-use change and forestry) contained in document FCCC/KP/CMP/2011/10/Add.1, p.13; Paragraph 4 (b) in the Annex 2 to Decision 2/CMP.8 contained in document FCCC/KP/CMP/2012/13/Add.1, p.20.

actual or planned forest regeneration activities can be used to distinguish deforestation from temporary loss of forest cover. Where such information is missing or unavailable, only a lapse of time will reveal whether or not the cover loss is temporary. In the absence of land-use change or infrastructure development, and until the time for regeneration has elapsed, these lands remain classified as forest. It could occur that the information needed to distinguish Deforestation from temporary loss of forest cover (e.g. the expected time for regeneration has elapsed) will be available only in the following commitment period. To avoid a potential underestimation of emissions from Deforestation in the commitment period, it is *good practice* to estimate by the last inventory reporting of the commitment period, the proportion of the lands without forest cover that is expected *not* to regenerate to forest based on country-specific or regional averages or other spatial data consistent with the national inventory methods. This proportion of the area will then be assigned to lands subject to deforestation, while the remaining proportion will remain classified as forest[70].

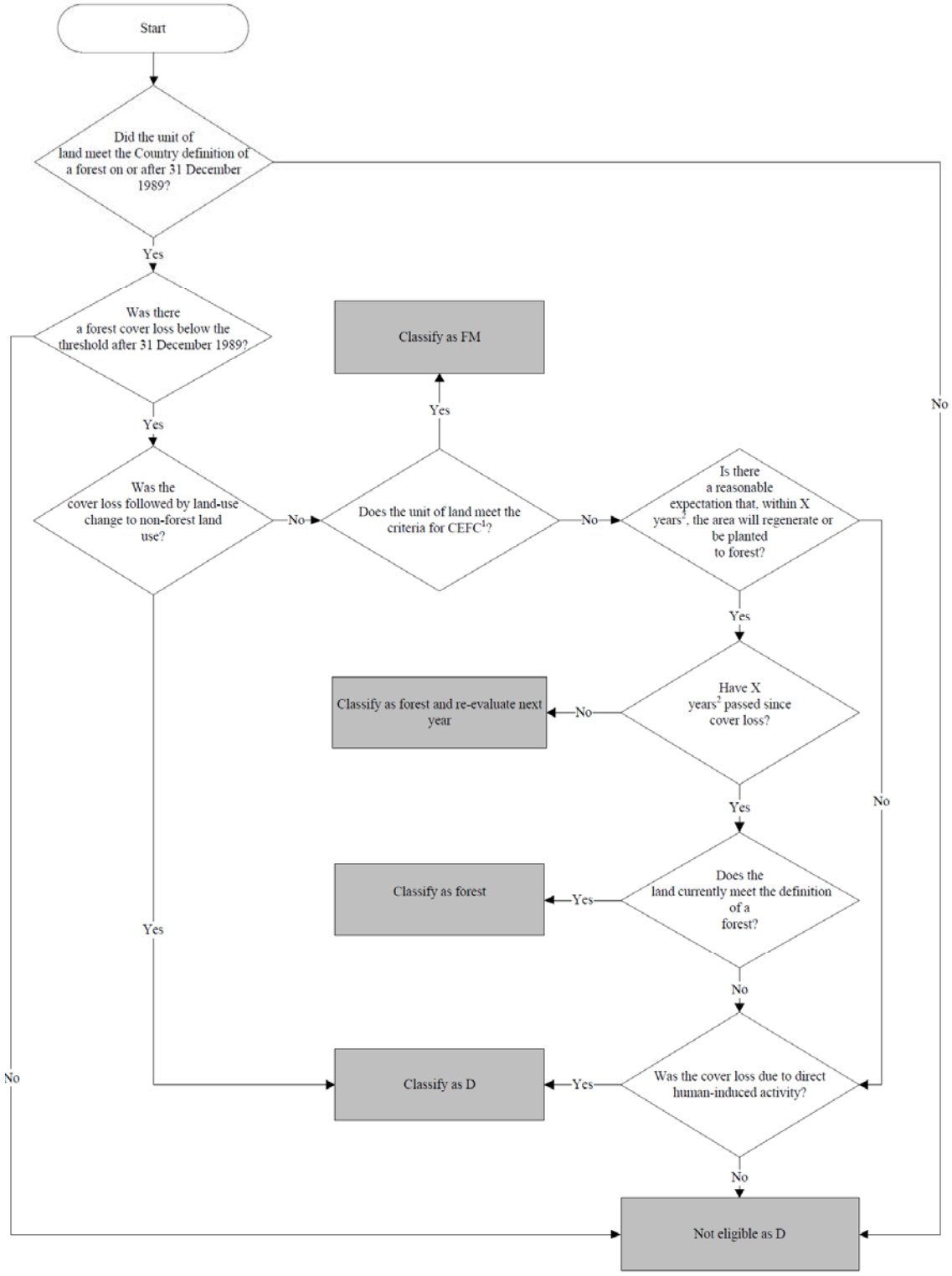
It is *good practice* for Parties to identify and track the lands with loss of forest cover that are not yet classified as deforested, and to report on their area and status in the annual supplementary information (see Table 2.4.1 in Section 2.4.4.1). It is also *good practice* to confirm on these lands, whether or not regeneration occurred within the expected time period. Lands for which, at the end of a commitment period, no direct information was available to distinguish deforestation from other causes of cover loss, could be reassessed annually or at a minimum prior to the end of the next commitment period. If regeneration did not occur or if other land-use activities are observed, then these lands that had remained classified as forest should be reclassified as Deforestation and the carbon stock changes and non-CO_2 greenhouse gas emissions recalculated accordingly (see also Volume1, Chapter 5 of the *2006 IPCC Guidelines*: Time Series Consistency)

The task of distinguishing temporary forest cover loss from Deforestation can be supported by information on harvested areas and areas subject to natural disturbances. In many countries, information on harvest cut blocks and on natural disturbance events is more readily available than information on deforestation events. Such information can be used to distinguish direct human-induced deforestation from temporary cover loss (e.g., harvest) or non-human induced disturbances (e.g., wildfire or insect outbreak). Attribution of the cause of forest cover loss to the remaining areas would be made easier and would support the identification and verification of lands subject to deforestation.

A decision tree for determining of whether a unit of land is subject to direct human-induced deforestation is given in Figure 2.6.1.

[70] For instance, in the last inventory year of the commitment period, an area of 1000 ha was subject to loss of forest cover; 800 ha of this area was classified as Deforestation, while for remaining 200 ha the information needed to classify it definitively was still not available. Of these 200 ha, based on country-specific or regional statistics or other data, the country estimates that 150 ha are expected not to regenerate. This 150 ha are assigned to Deforestation, while the remaining 50 ha remain classified as forest.

Figure 2.6.1 Decision tree for determining whether a unit of land is subject to direct human-induced (dhi) Deforestation (D).



Note:

1. Carbon Equivalent Forest Conversion (CEFC): refer to Section 2.7.7: Carbon Equivalent Forest

2. Refer to country-specific criteria for distinguishing harvesting from deforestation. Reassess annually or at a minimum prior to the end of the next commitment period.

2.6.3 Choice of methods for estimating carbon stock changes and non-CO_2 emissions

All carbon stock changes and non-CO_2 emissions during the commitment period on lands subject to direct human-induced Deforestation since 1990 are required to be reported[71]. Where deforestation occurred between 1 January 1990 and the beginning of the commitment period, changes in the carbon pools after the Deforestation event need to be estimated for each inventory year of the commitment period[72]. After the deforestation event, losses during the commitment period will result primarily from the continuing decay of dead wood, litter, below-ground biomass and soil carbon remaining on the site. These losses can be offset by increase in biomass pools. Definitions of pools under Deforestation should be consistent with provisions introduced by *2006 IPCC Guidelines* (Volume 4, Chapter1, Section 1.2.2: Carbon pool definitions and non-CO_2 gases and Table 1.1).

Harvested wood products derived from Deforestation activity are accounted for as an instantaneous emission at the time of deforestation (see Chapter 2.8).

It is *good practice* to report carbon stock changes and non-CO_2 greenhouse gas emissions from organic soils associated with drainage and rewetting under Deforestation activities using the guidance provided in Section 2.12.4 (Wetland Drainage and Rewetting) of this report, and in the *Wetlands Supplement*.

On areas subject to Article 3.3 activities, gross-net accounting rules are applied[73] and information on carbon stock changes and non-CO_2 greenhouse gas emissions in the base year (i.e., 1990) is therefore not required. Only the carbon stock changes and non-CO_2 greenhouse gas emissions during each year of the commitment period are required to be estimated and reported.

For the estimation of carbon stock changes, it is *good practice* to use the same or a higher tier than is used for estimating emissions from forest conversion in *2006 IPCC Guidelines* Volume 4, Chapters 5,6,7,8,9 (Conversion from Forest Land to any other land-use category).

Carbon stock changes on lands subject to Deforestation activities during the commitment period can be estimated by determining the carbon stocks in all pools prior to and after the deforestation event. Alternatively, the stock changes can be estimated from the carbon transfers out of the forest, e.g., the amount harvested (Volume 4, Chapter 2 of the *2006 IPCC Guidelines*) or the fuel consumed in the case of burning. For deforestation events that occur prior to the commitment period, knowledge of pre-deforestation carbon stocks will also be useful for the estimation of post-disturbance carbon dynamics. For example, estimates of emissions from decay of litter, deadwood, and soil organic carbon pools can be derived from data on pool sizes and decay rates. Information about pre-deforestation carbon stocks can be obtained from forest inventories, aerial photographs, satellite data, by comparison with adjacent remaining forests, or can be reconstructed from stumps where these are remaining on the site. Information on the time since deforestation, on the current vegetation and on management practices on that site is required for the estimation of carbon stock changes and non-CO_2 greenhouse gas emissions.

Harvested wood products derived from Deforestation activity are required to be accounted for as an instantaneous emission at the time of Deforestation

Where lands subject to Deforestation become land under other land-use categories such as Cropland or Grassland, the established methodologies described in relevant sections of the *2006 IPCC Guidelines* should be used to estimate carbon stocks changes. Several of these categories may contain little or no carbon, or the change in carbon stocks may be very small. Box 2.6.2 summarises links with methodologies for estimation of carbon stock changes and non-CO_2 emissions in this report and with the *2006 IPCC Guidelines*.

[71] Paragraph 17, 18 and 19 of the Annex to Decision 16/CMP.1 (Land use, land-use change and forestry) contained in document FCCC/KP/CMP/2005/8/Add.3, p.8; Paragraph 22 and 23 of the Annex to Decision 2/CMP.7 contained in document FCCC/KP/CMP/2011/10/Add.1, p.16.

[72] Pools which are not a source can be excluded from accounting, though this is unlikely in the case of deforestation.

[73] Except for Parties that fall under the provisions of the last sentence of Article 3.7 of the Kyoto Protocol. as adopted in Annex I decision 1/CMP.8 (Amendment to the Kyoto protocol pursuant to its article 3, paragraph 9) contained in document FCCC/KP/CMP/2011/10/Add.1.

BOX 2.6.2

METHODOLOGICAL GUIDANCE ON ESTIMATING CARBON STOCKS CHANGES AND NON-CO_2 EMISSIONS ON D LANDS: LINKS WITHIN THIS REPORT AND WITH OTHER IPCC REPORTS

LINKS WITH OTHER CHAPTERS OF THIS REPORT

Section 2.8: Harvested Wood Products

Section 2.12.3: Wetland Drainage and Rewetting

LINKS WITH THE *2006 IPCC GUIDELINES* (Volume 4: Agriculture, Forestry and Other Land Use)

Chapter 5 (Cropland), Section 5.3 (Land Converted to Cropland): methodological guidance on annual estimation of emissions and removals of greenhouse gases, which occur on *Land Converted to Cropland* from different land-uses.

Chapter 6 (Grassland), Section 6.3 (Land Converted to Grassland): methodological guidance on annual estimation of emissions and removals of greenhouse gases, which occur on *Land Converted to Grassland* from different land-uses.

Chapter 7 (Wetlands), Section 7.3.2 (Land Converted to Flooded Land): methodological guidance on annual estimation of emissions and removals of CO_2, which occur on *Land Converted to Flooded Land* from different land-uses.

Chapter 8 (Settlements), Section 8.3 (Land Converted to Settlements): methodological guidance on annual estimation of emissions and removals of greenhouse gases, which occur on *Land Converted to Settlements* from different land-uses.

Chapter 9 (Other land), Section 9.3 (Land Converted to Other Land): methodological guidance on annual estimation of emissions and removals of greenhouse gases, which occur on *Land Converted to Other Land* from different land-uses.

LINKS WITH THE *WETLANDS SUPPLEMENT*

Guidance on estimation of carbon stock changes and non-CO_2 emissions from lands with organic and wetland mineral soils in all land-uses with these soil types is provided in Chapters 2-5 of the *Wetlands Supplement.*

2.7 FOREST MANAGEMENT

According to Decision 2/CMP.7 (Land use, land-use change and forestry), accounting of emissions and removals from Forest Management under the Kyoto Protocol during the second commitment period is mandatory[74] , and based on a reference level[75] .

This section addresses definitional issues and specific methods for identification of areas subject to Forest Management and calculation of carbon stock changes and non-CO_2 greenhouse gas emissions for those areas (Sections 2.7.1, 2.7.2, 2.7.3).

This section also addresses the new elements introduced by Decision 2/CMP.7, including:

- Reporting of emissions arising from the conversion of natural forests to planted forest (within Section 2.7.1);
- Methodological requirements related to the forest management reference level (Section 2.7.5);
- Performance of Technical Corrections for accounting purposes (see Section 2.7.6);
- Reporting and accounting of lands under the Carbon Equivalent Forest Conversion provision (i.e., lands under Forest Management that would otherwise be accounted as Article 3.3 lands, Section 2.7.7).

The treatment of harvested wood products related to Forest Management, according to Decision 2/CMP.7, is discussed briefly in this section and in more detail in Section 2.8. Disturbances as they relate to Forest Management are dealt with in 2.7.4 below and in greater depth in Section 2.3.9.

This section should be read in conjunction with the general discussion in Sections 2.2 to 2.4.

2.7.1 Definitional issues and reporting requirements

Decision 2/CMP.7 maintains the same definition of "forest" and "Forest Management" as in Decision 16/CMP.1[76].

Decision 16/CMP.1 defines "forest" using area and vegetation threshold criteria[77], including the potential to meet them, and including areas that are temporarily unstocked. Decision 2/CMP.7 specifies that, for the purpose of applying the definition of "forest", each Party shall apply the definition selected in the first commitment period. If a country's definition of forest differs from the definition they use for UNFCCC or FAO or reporting it is *good practice* to explain why. The country's definition of forest should be consistent with guidance provided in Section 1.1, including the information to be provided in case areas which would otherwise meet the area and the vegetation criteria for forest are excluded on the grounds that they are Cropland (e.g., orchards), Grassland (e.g. grazed savannah) or Settlements (e.g., urban trees).

Decision 16/CMP.1 defines "Forest Management" as *a system of practices for stewardship and use of forest land aimed at fulfilling relevant ecological (including biological diversity), economic and social functions of the forest in a sustainable manner*. It includes forests meeting the definition of "forest" in Decision 16/CMP.1 with the parameter values for forests that have been selected and reported by the Party, and that have not been classified by the Party under Afforestation/Reforestation category.

There are two approaches that countries could choose to interpret the definition of Forest Management. In the *narrow approach*, a country would define a system of specific practices that could include stand-level forest management activities, such as site preparation, planting, thinning, fertilization, and harvesting, as well as landscape-level activities such as fire suppression and protection against insects, undertaken since 1990. In this approach, the area subject to Forest Management might increase over time as the specific practices are implemented on new areas. In the *broad approach*, a country would define a system of forest management

[74] See paragraph 7 in the Annex to Decision 2/CMP.7 (Land use, land-use change and forestry), contained in document FCCC/KP/CMP/2011/10/Add.1, p.14.

[75] See paragraph 12 in the Annex to Decision 2/CMP.7 (Land use, land-use change and forestry), contained in document FCCC/KP/CMP/2011/10/Add.1, p.14.

[76] See paragraphs 1, 20 and 21 of the Annex to Decision 2/CMP.7 (Land use, land-use change and forestry), contained in document FCCC/KP/CMP/2011/10/Add.1, p.13 and 16.

[77] See footnote 19 and Section 1.2, step 1 for further guidance.

practices, and identify the area that is subject to this system of practices during the inventory year of the commitment period.

According to Decision 2/CMP.7, Parties are required to report and account for all emissions and removals arising from the conversion of natural forests to planted forests after 31 December 2012. In this context, "conversion" does not involve a land-use change but refers to the replacement of natural forest after harvesting with planted forests. Following Section 1.1, it is *good practice* that Parties, according to their national circumstances, provide their definition of natural forest and planted forest, which should include forest plantations (as defined in the *2006 IPCC Guidelines*), define the circumstances under which a transition from natural forest to planted forest occurs, and apply these definitions consistently throughout the commitment periods. It is *good practice* that emissions and removals on lands subject to conversion from natural forest to planted forest are reported and accounted within Forest Management.

According to Decision 2/CMP.7, Parties applying the Carbon Equivalent Forest Conversion provision described in Section 2.7.7 need to report these lands separately from other Forest Management lands. These lands will include both forest and non-forest lands but are accounted for under Forest Management.

Section 2.2 (Generic Methodologies for Area Identification, Stratification and Reporting) explains that the geographical location of the areas containing land subject to forest management activities need to be defined and reported. Two Reporting Methods are outlined in Section 2.2.2.

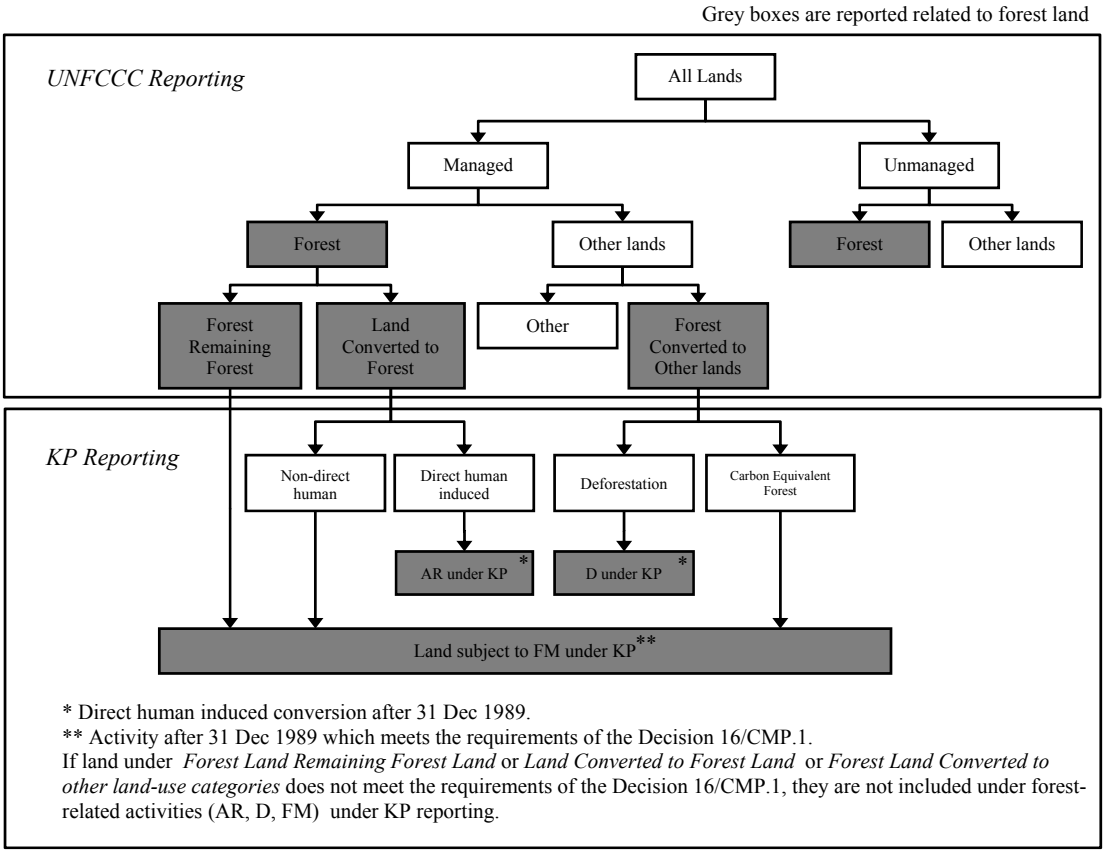
In Reporting Method 1, a boundary may encompass multiple Forest Management lands and other kinds of land-use such as agriculture or unmanaged forests. In Reporting Method 2, a Party identifies the geographic boundaries of all lands subject to Forest Management throughout the country. Reporting Method 1 or 2 are used for reporting the carbon stock changes and non-CO_2 greenhouse gas emissions in the above-ground biomass, below-ground biomass, dead wood, litter, and soil organic carbon. Accounting for the harvested wood products pool is at the national level. For both Reporting Methods, Forest Management lands include also non-forest land accounted for under Forest Management through the Carbon Equivalent Forest Conversion provision.

2.7.2 Choice of methods for identifying lands subject to Forest Management

It is *good practice* for each Party to describe in its National Inventory Report how it applies the definitions of "forest" and "Forest Management" under Decisions 16/CMP.1 in a consistent way across space and time, and how it distinguishes areas subject to Forest Management from other areas. It is *good practice* to base the assignment of land to activities following the guidance in Sections 1.1. and 1.2 of this report and Volume 4, Chapter 3 (Consistent Representation of Lands) of the *2006 IPCC Guidelines* .

Furthermore, land subject to "Forest Management" as defined by Decision 16/CMP.1 is not necessarily the same area as "managed forests" in the context of the *2006 IPCC Guidelines* used for UNFCCC reporting. The latter includes all forests under direct human influence, including forests that may not meet the requirements of the Decision 16/CMP.1.

Figure 2.7.1 Relationship between different categories under UNFCCC reporting and forest activities under Kyoto Protocol reporting. See Sections 2.7 and 2.7.1 for further explanation.



* Some non-forest land can also meet the eligibility criteria of Decision 2/CMP.7 for accounting as Forest Management, under the Carbon Equivalent Forest Conversion provision (see Section 2.7.7).

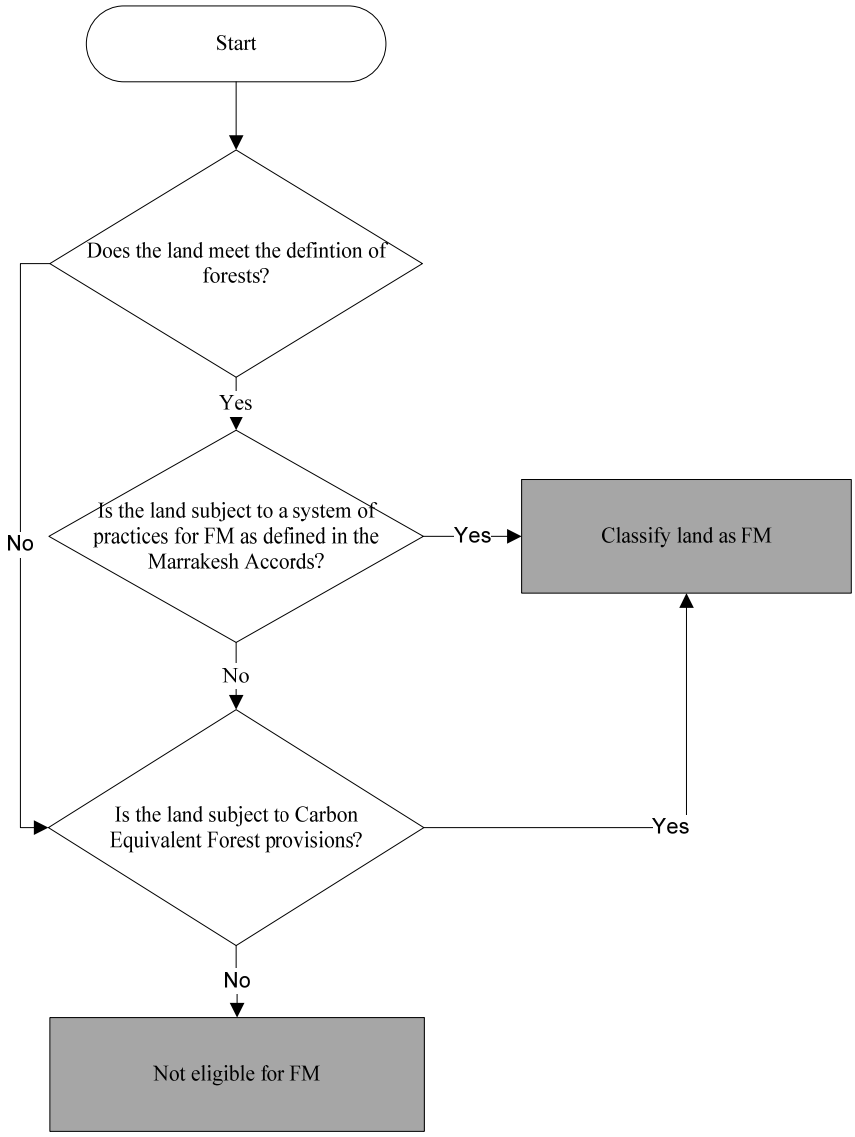
Figure 2.7.1 outlines the relationship between different forest categories. For UNFCCC reporting, countries may have subdivided their forest area into managed forests (those that are included in the reporting) and unmanaged forest (not included).

The managed forests could further be subdivided into those areas that meet the eligibility criteria for Forest Management activities under Decision 2/CMP.7 and those (if any) that do not. However, since most countries have in place policies to manage forests sustainably, and/or use *practices for stewardship and use of forest land aimed at fulfilling relevant ecological (including biological diversity), economic and social functions of the forest in a sustainable manner*[78] , the total area of managed forest in a country will often be the same as the area subject to Forest Management. It is *good practice* to define the national criteria for the identification of land subject to Forest Management such that there is consistency between the area of managed forest (as reported under the UNFCCC) and the area of forest subject to Forest Management. Where differences occur between the two, it is *good practice* to explain and document the extent of the differences. In particular, where areas that are considered managed forest are excluded from the area subject to Forest Management, it is *good practice* to provide the reason for the exclusion (including the use of the *narrow approach*), and to document how any possible unbalanced accounting is avoided (Figure 2.7.1). Unbalanced accounting can occur if areas that are considered a source are preferentially excluded and areas considered a sink are included in the national reporting. The IPCC Report on Definitions and Methodological Options to Inventory Emissions from Direct Human-Induced Degradation of Forests and Devegetation of Other Vegetation Types (IPCC, 2003) discusses the issue of unbalanced accounting. The inclusion of non-forested areas within Forest Management accounting under the Carbon Equivalent Forest Conversion provision can also lead to differences between the reported area of managed forest and the area under Forest Management – all such areas must be clearly identified (see Section 2.7.7).

[78] See paragraph 1(f) in the Annex to Decision 16/CMP.1 (Land use, land-use change and forestry) contained in document FCCC/KP/CMP/2005/8/Add.3, p.5.

Figure 2.7.2 gives the decision tree for determining whether land qualifies for Forest Management. Land that is classified as subject to Forest Management is required to meet the country's criteria for forest or, if non-forest, is required to be subject to CEFC provision.

Figure 2.7.2 Decision tree for determining whether land qualifies for Forest Management. This decision tree applies to lands which are not eligible for direct human-induced AR (see Figure 2.5.1).



It is *good practice* for each Party to describe its application of the definition of Forest Management and to identify the areas of land subject to Forest Management in the inventory year of the commitment period. In most cases, this will be based on information contained in national forest inventories including criteria such as administrative, zoning (e.g., protected areas or parks) or ownership boundaries, since the difference between managed and unmanaged forests or, possibly, between managed forest meeting the definition of Forest Management in Decision 16/CMP.1[79] and managed forest not doing so, may be difficult or impossible to detect by remote sensing or other forms of observation.

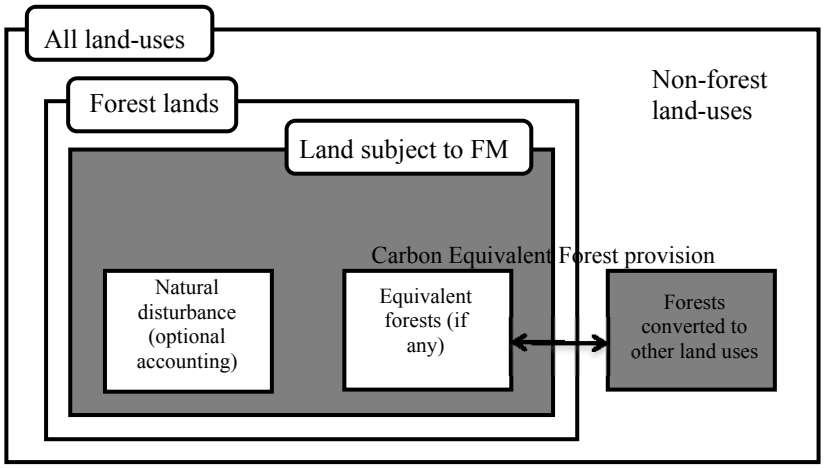
It is *good practice* for each Party to provide information to show when a transition from natural forest to planted forest has occurred based on their national definitions, how reporting and accounting of emissions and removals has been captured within Forest Management.

According to Decision 2/CMP.7, the carbon stock changes and non-CO_2 greenhouse gas emissions on lands subject to Forest Management under Article 3.4 can be excluded from accounting if they are associated with natural disturbance (See Section 2.3.9).

The area of land subject to Forest Management can increase or decrease over time. For example, if a country expands its road infrastructure into previously unmanaged forests and initiates management activities, the area of land subject to Forest Management is increasing and the associated carbon stock changes need to be estimated accordingly. If an area of forest expansion after 1990 does not qualify for direct-human induced Afforestation/Reforestation, and if this area meets the requirements of the Decision 16/CMP.1, it may be included under Forest Management (see Figure 2.7.1). On the other hand, Deforestation decreases the area under Forest Management. Where changes in area occur over time, it is essential that the methods for carbon stock change calculation are applied in the sequence outlined in Section 2.3.3 of this report. Failure to use the correct computational methods may result in an apparent but incorrect increase in carbon stocks that is the result of the area change.

Once an area has been included in the carbon stock change reporting under the Kyoto Protocol it cannot be removed, but the reporting category of the area can change (as outlined in Section 1.3). Lands that are deforested are, however, subject to the rules of Article 3.3 and future carbon stock changes must be reported. Accordingly the area reported under Article 3.4 would decrease, and the area reported under Article 3.3 would increase by the same amount.

Figure 2.7.3 Relationship among forest lands, lands subject to FM, lands subject to natural disturbance and Carbon Equivalent Forests. Grey areas are reported under FM.



Forest land that is converted to non-forest under the Carbon Equivalent Forest provision (see Section 2.7.7) is reported under Article 3.4, as is the compensating non-forest land converted to forest land. This means that the area reported under Forest Management may increase without an increase in forested land. It is *good practice* that lands subject to the Carbon Equivalent Forest provision are transparently identified separately. All lands under the Carbon Equivalent Forest provision are subject to Forest Management, and these lands include newly

[79] See paragraph 1 in Annex to Decision 16/CMP.1 (Land use, land-use change and forestry) contained in document FCCC/KP/CMP/2005/8/Add.3, p. 5

planted Carbon Equivalent Forests and forests converted into other land-uses. Figure 2.7.3 shows relationships of lands subject to Forest Management.

Box 2.7.1 summarises links with methodologies in this report and with the *2006 IPCC Guidelines* for the identification of land areas.

BOX 2.7.1
LINKS WITH CHAPTER 3 OR 4 OF THE *2006 IPCC GUIDELINES*

Volume 4: Agriculture Forestry and Other Land Use

Chapter 3: Consistent Representation of Lands

Chapter 4, Section 4.2: Forest Land Remaining Forest Land

2.7.3 Choice of methods for estimating carbon stock changes and non-CO_2 emissions

The methods to estimate carbon stock changes in the various pools within Forest Management lands follow those in the *2006 IPCC Guidelines*, as elaborated in Volume 4, Chapter 4, for above- and below-ground biomass, dead wood, litter and soil organic carbon. For HWP, estimation methods in line with Decision 2/CMP.7 are provided in Section 2.8 of this report. including guidance to distinguish among HWPs originated from lands subject to each forest-related activity, i.e. AR, FM or D, or from lands not subject to any of those activities. On areas subject to Forest Management activities, the reference level accounting rule is applied for the second commitment period, i.e. for each Party the accounting is based on the comparison between the emissions and removals reported for Forest Management during the commitment period and the Forest Management Reference Level (FMRL) inscribed in the Appendix to the Decision 2/CMP.7 (see Section 2.7.5). In certain cases, it is *good practice* to apply Technical Corrections for accounting purposes (see Section 2.7.6).

It is *good practice* to use the same tier or a higher tier for estimating stock changes and greenhouse gas emissions as the one that was used for the corresponding land-use in the UNFCCC inventory, following the guidance on methodological choice and identification of key categories included in Volume 1, Chapter 4 of the *2006 IPCC Guidelines*. In particular:

- Tier 1 can only be applied if Forest Management is not considered a *key category*, or if the pool is not "significant", according to the guidance in Section 2.3.6 (Choice of method). Tier 1 as elaborated in Volume 4, Chapter 4 assumes that the net change in the carbon stocks for litter (forest floor), dead wood and soil organic carbon (SOC) pools is zero, but Decision 2/CMP.7 specifies that above- and below-ground biomass, litter, dead wood, and SOC shall all be accounted unless the country chooses not to report changes in a pool demonstrating it is not a source. Therefore Tier 1 can only be applied if the litter, dead wood and SOC pools can be shown not to be sources using the methods outlined in the Section 2.3.1 (Pools to be reported). It is important to note that, once a pool has been included in the FMRL, for consistency reasons it is *good practice* to report this pool during the commitment period, irrespective of the pool being a sink or a source (see Section 2.7.5.2 on methodological consistency). For the harvested wood products, specific guidance is provided in Section 2.8.

- It is *good practice* to apply Tier 2 and 3 methods if Forest Management is a *key category* and if the pool is "significant", according to the guidance in Section 2.3.6. With the exception of the pools already included in the FMRL, a country may decide to exclude those pools that can be shown not to be a net-source, using the methods described in Section 2.3.1.

- Where it is possible to obtain estimates from both the *Gain-Loss method* and the *Stock-Difference* methods, it is *good practice* to use the comparison for verification purposes because this may help identify errors and understand better the trends and reasons of interannual variations.

In most cases, the information requirements for Kyoto Protocol reporting exceed the information contained in the national UNFCCC inventory. The conditions that need to be met to ensure that the information contained in the national UNFCCC inventory satisfies the requirements for Kyoto Protocol reporting include:

1. The areas subject to Forest Management are the same as the areas of the managed forest (Figure 2.7.1), or where these are not the same the area and carbon stock changes and non-CO_2 greenhouse gas emissions on the areas subject to Forest Management are known, and

1. The area and carbon stock changes of the managed forest within the geographic boundaries of each of the strata used in a country are known, and
2. The area of the managed forest that was the result of direct human-induced Afforestation or Reforestation since 1990 is known, along with the carbon stock changes and non-CO_2 greenhouse gas emissions on this area.
3. There are no non-forest lands within managed forest lands reported to the UNFCCC, even if non-forest land are accounted for within Forest Management as Carbon Equivalent Forest Conversion.
4. Even if forest lands have been subject to natural disturbance for which emissions and subsequent uptake have been excluded from accounting, lands and associated emissions and removals have not been excluded from UNFCC reporting.
5. Harvested wood products are reported in a manner consistent with the requirements for accounting as defined in Decision 2/CMP.7 (e.g. harvested wood products from Deforestation are reported on the basis of instantaneous oxidation and imports are excluded)[80].

To meet the Kyoto Protocol reporting requirements, national inventory systems need be able to identify and track all forest areas as specified in Section 2.2, whether these are classified as managed forest (UNFCCC) or subject to Articles 3.3 and/or 3.4 of the Kyoto Protocol, and whether they have been subject to natural disturbances or to the Carbon Equivalent Forest accounting provisions. Such systems can then be used to calculate and report the net carbon stock changes and non-CO_2 greenhouse gas emissions in all relevant categories for both UNFCCC and Kyoto Protocol reporting. Properly implemented, such a comprehensive approach ensures consistency among the methods used for calculating and reporting carbon stock changes and non-CO_2 greenhouse gas emissions, because the same forest and land-use change inventories is the basis for the computations used in both UNFCCC and Kyoto Protocol reporting.

Box 2.7.2 summarises links with methodologies in this report and with the *2006 IPCC Guidelines* to estimate carbon stock changes and non-CO_2 emissions.

BOX 2.7.2
METHODOLOGICAL GUIDANCE FOR ESTIMATION OF CARBON STOCK CHANGES AND NON-CO_2 EMISSIONS FROM FM ACTIVITIES; LINKS WITHIN THIS REPORT AND WITH OTHER IPCC REPORTS

LINKS WITH THE *2006 IPCC GUIDELINES*

Chapter 4 Section 4.2: Forest Land Remaining Forest Land

The area subject to Forest Management may not be the same as the area of *Forest Land Remaining Forest Land* and estimates may have to be adjusted accordingly.

LINKS WITH THE *WETLANDS SUPPLEMENT*

Guidance on estimation of carbon stock changes and non-CO_2 greenhouse gas emissions from lands with organic and wetland mineral soils in all land-uses with these soil types is provided in Chapters 2-5 of the *Wetlands Supplement.*

2.7.4 Methods to address natural disturbance

Calculation of carbon stock changes and non-CO_2 greenhouse gas emissions on areas subject to Forest Management can be influenced by the presence of natural disturbances, i.e. non-anthropogenic events or non-anthropogenic circumstances that cause significant emissions in forests and are beyond the control of, and not materially influenced by a Party. Emissions from Forest Management can be influenced by natural disturbances in two ways: 1) through emissions from natural disturbances occurring in the commitment period and; 2) through an inconsistency between the treatment of natural disturbances in the reporting of Forest Management emissions in the commitment period and the FMRL. Methods for addressing natural disturbances in case 1) are provided by Section 2.3.9 Disturbances. Guidance to address inconsistencies in the treatment of natural disturbances in reported data and the FMRL are presented in Sections 2.7.5 and 2.7.6.

[80] See Section 2.8 (Harvested Wood Products)

2.7.5 Forest Management Reference Levels

According to Decision 2/CMP.7[81], for the second commitment period, accountable anthropogenic greenhouse gas emissions by sources and removals by sinks resulting from Forest Management under Article 3.4, shall be equal to anthropogenic greenhouse gas emissions by sources and removals by sinks in the commitment period, less the number of years of the commitment period to be accounted times the FMRL inscribed in the Appendix to the decision. The FMRL is a value of annual net emissions and removals from Forest Management, against which the net emissions and removals reported for Forest Management during the second commitment period, will be compared for accounting purposes.

This section addresses methodological issues related to the FMRL, including: (i) an overview of approaches and methods used and the elements taken into consideration by Parties for the construction of their FMRL; (ii) a description of how to demonstrate methodological consistency between the FMRL and reporting for Forest Management during the commitment period; and (iii) a description of how and when to perform Technical Corrections for accounting purposes, if necessary to ensure consistency, or to exclude from the accounting any impact due to inconsistencies. This section should be read in conjunction with the general guidance on Forest Management in Sections 2.7.1 to 2.7.4.

The guidance on how to construct the FMRL is provided by the Appendix II to the Decision 2/CMP.6 and is not provided in this section. The overview of approaches, methods and elements used in construction of FMRLs is provided to clarify the discussions on methodological consistency and Technical Corrections.

2.7.5.1 Overview of Approaches, methods and elements considered in the construction of FMRL

Decision 2/CMP.6 requested Annex I Parties to submit information on how the country's FMRL was constructed and provided guidelines for the submission of such information. The objectives of the submissions were: (a) to provide information consistent with the general reporting principles set out by the Convention and elaborated by the IPCC on how the elements contained in footnote 1 in paragraph 4 of decision 2/CMP.6[82] were taken into account by Parties in the construction of FMRLs, and to provide any additional relevant information; (b) to document the information that was used by Parties in FMRLs in a comprehensive and transparent way; and (c) to provide transparent, complete, consistent, comparable and accurate methodological information used at the time of the construction of the FMRL.

The information provided by the Parties on how the FMRL was constructed provides the basis for assessing the methodological consistency between the FMRL and the reporting of Forest Management during the second commitment period. This section summarizes the approaches and methods used and the elements considered in the construction of the FMRL, based on the FMRL submissions made by Parties and the Synthesis report of the technical assessments provided by the UNFCCC Secretariat[83].

Approaches and methods used to construct FMRL

The FMRL submissions included a description of the approaches, methods and models used in the construction of the FMRLs, including assumptions used and referring, where relevant, to the latest available National Inventory Report. Based on the submissions on FMRL made by Parties, the following general approaches used to set FMRLs may be recognized (see Box 2.7.3 for more details):

2. FMRLs based on projections under a business-as-usual scenario. This approach includes two methods:

   a) modelled projections under a business as usual scenario.

[81] Decision 2/CMP.7 (Land use, land-use change and forestry) contained in document FCCC/KP/CMP/2011/10/Add.1.

[82] These elements are: (a) removals or emissions from forest management as shown in greenhouse gas inventories and relevant historical data; (b) age-class structure; (c) forest management activities already undertaken; (d) projected forest management activities under a 'businessas usual' scenario; (e) continuity with the treatment of forest management in the first commitment period; (f) the need to exclude removals from accounting in accordance with decision 16/CMP.1, paragraph 1. Points (c), (d) and (e) above were applied where relevant. The FMRLs also took into account the need for consistency with the inclusion of carbon pools and the provisions for addressing natural disturbances.

[83] Synthesis report of the technical assessments of the forest management reference level submissions. Note by the secretariat. FCCC/KP/AWG/2011/INF.2, http://unfccc.int/bodies/awg-kp/items/5896.php.

b) projections based on the average of or the linear extrapolation of historical data from GHG inventories, assumed as proxy for a business-as -usual scenario.

6. FMRLs based on a single year (1990).

7. FMRL set as zero.

BOX 2.7.3
APPROACHES AND METHODS USED FOR CONSTRUCTING FOREST MANAGEMENT REFERENCE LEVELS

Based on the UNFCCC's synthesis report of the technical assessments of the FMRL submissions, it emerges that out of the 38 Parties submitting FMRLs, 17 used country-specific projections, 14 used a common approach for projections, one proposed a historical average, two proposed an extrapolation of historical data, three proposed historical FMRLs based on a single year, and one proposed an FMRL of zero. Below are summarized the different approaches and methods used, aggregated into three groups:

1) FMRLs based on projections under a business as usual scenario. This approach includes the following methods:

a) modelled projections under a business-as-usual scenario

Model-based projections using country-specific methodology. Most of the country-specific approaches used data from national forest inventory (NFI) as a source information for future forest resources, combined with projections of future harvest demand from partial equilibrium models or scenario analysis.

Model-based projections using a common methodological approach. Several EU countries followed a common approach developed by Joint Research Centre (JRC) of the European Commission, in collaboration with modelling groups from the International Institute for Applied Systems Analysis (IIASA) and the European Forest Institute (EFI). Two models projected annual estimates of emissions and removals for Forest Management until 2020 for the living biomass carbon pool. To calculate the FMRL, the average of models' results for the time series 2000–2020 were "calibrated" ex-post using historical GHG data from each country for the period 2000–2008. This was achieved by shifting the projection up or down to achieve the same average as the historical data for the calibration period.

b) projections based on the elaboration of historical data from GHG inventories, assumed as proxy for a 'business-as-usual' scenario

Average of historical data. One Party for its revised FMRL used the average removals under the *Forest land Remaining Forest Land* category, as reported for the period 1990–2009 in the 2011 GHG inventory.

Extrapolation from a historical time series trend. Two Parties used a linear extrapolation of net emissions historical data (1990–2008) to construct the FMRLs.

2) Historical FMRL based on the single year 1990

Three Parties proposed the use of a historical FMRL based on 1990 data.

3) FMRL equal to zero

One Party used the narrow approach for Forest Management, and set its FMRL equal to zero, which is equivalent to a Forest Management scenario in which emissions and removals are assumed to balance to zero.

ELEMENTS CONSIDERED IN THE CONSTRUCTION OF FMRL

Pools and gases

Decision 2/CMP.6 requested Parties to identify pools and gases which have been included in the FMRL, to explain the reasons for omitting a pool from the FMRL construction (i.e. including evidence for the pool not being a source), and to explain consistency between the pools and gases included in the FMRL and those included in the reporting of Forest Management or *Forest Land Remaining Forest Land*.

Decision 2/CMP.7 also specified that for the second commitment period Party shall account for all changes in above-ground biomass, below-ground biomass, litter, dead wood, soil organic carbon and harvested wood products (see Section 2.3.1 for additional information and methodological guidance). Nevertheless, with the

exception of HWP, a Party may choose not to account for a given pool in a commitment period, if transparent and verifiable information is provided that demonstrates that the pool is not a source.

Area under Forest Management

The FMRL submissions contain information on the Forest Management area used in the construction of the FMRL with the aim of showing consistency with the reporting of Forest Management or *Forest Land Remaining Forest Land*. Parties also explained how the area used in the construction of the FMRL relates to the area accounted for as subject to Deforestation and Afforestation or Reforestation activities. In the case of modelled projections, consistency between FMRL area and area under Article 3.4 activities means that the future deforestation is taken into account by projecting a decreasing FM area in the second commitment period[84] , and that the expected future afforestation and reforestation should not affect the evolution of FM area considered for FMRL. In some cases, an increase in the future FM area was included in FMRL due to new forest area (e.g., previously unmanaged) assumed to enter the FM area.

Historical data from greenhouse gas inventory

Parties were requested to include in the FMRL submissions information on the relationship between Forest Management and *Forest Land Remaining Forest Land* as shown in GHG inventories and relevant historical data, including information provided under Article 3.3, and, if applicable, Article 3.4. The purpose of this information is to show the consistency between the proposed FMRLs and historical data as reported in each Party's GHG inventory and NIR. The historical data came from the 2010 GHG inventory, unless otherwise specified. In case of modelled projections, the consistency with historical data can be shown by the fact that the model used for constructing the projected FMRL reproduces historical data for Forest Management or *Forest Land Remaining Forest Land* from the GHG inventory or that ex-post calibrations have been carried out to align the model results with the historical data.

Forest characteristics and related management

The FMRL submissions included information on forest characteristics, including age-class structure, increments, rotation lengths, and other relevant information, including information on forest management activities already undertaken and assumed under business-as-usual. In many cases information included the forest types, the soil types, the growing stock, the tree species composition and the detailed silvicultural practices (including the regeneration modality, the type and frequency of cuttings, etc.). In the case of models used for projected FMRLs, other information included the assumptions on future silvicultural practices, on key drivers (i.e., harvest rates), on the expected evolution of key forest characteristics (age structure, increment), with the aim to describe transparently the forest management activities foreseen under the business-as-usual scenario and to demonstrate their feasibility.

Historical and assumed harvesting rates

Harvest rate is a major driver of emissions and removals from Forest Management. The FMRL submissions included the time series of historical harvesting rates and the predicted future harvest rates. In the case of modelled projections, it is particularly important that the information showing that the historical harvest used by the models is consistent with data used in the GHG inventory or, in case harvest is not used in GHG inventories (i.e., if the *Stock-Difference* method is used), that the historical harvest used by the models is consistent with official country statistics.

For projected FMRLs, Parties provided information on the assumptions about the future harvesting rates, based on business-as-usual scenarios (i.e. considering domestic policies adopted and implemented no later than December 2009). Some Parties used averages of historical harvest rates as a proxy of business-as-usual scenario, while other Parties predicted future harvest based on macroeconomic scenarios or based on the continuation of current forest management activities associated with the actual age-class structure. For transparency purposes, information on the assumptions made on the disaggregation of future harvest, by type of wood use (i.e. industrial wood/wood for energy use) and/or by assortment types (as feedstock for HWP production, cf. Section 2.8.1), was useful to demonstrate consistency between the biomass losses due to assumed future harvest rates and the biomass used for HWP estimates.

Harvested wood products

Many Parties presented in their FMRL submissions values related to the contribution of HWP, assuming either instantaneous oxidation, or a first-order decay function with default half-lives (see Section 2.8.).

[84] Some Parties did not consider the impact of future deforestation rate on the evolution of the FM area, assuming this has a conservative impact on the FMRL value.

Since the final agreement on HWP, included in the Decision 2/CMP.7, was reached after the FMRL submissions, it is essential to consider the need for a Technical Correction for accounting purposes in order to reflect the Decision 2/CMP.7. See Section 2.8 for detailed information and *good practice* guidance on HWP.

Natural disturbances

Decision 2/CMP.6 also requested Parties to consider including in the construction of their FMRLs information on disturbances in the context of *force majeure* (as defined in decision 2/CMP.6). Most Parties did not consider disturbances explicitly in the construction of their FMRLs, often noting the low frequency of such events. In some cases, the average impact of past disturbances is incorporated in the FMRL through the methodologies used. In other cases, the impact of natural disturbances on FMRL was expressed as a range of possible disturbances scenarios or as a constant background level of natural disturbances.

Since the final agreement on natural disturbances, included in the Decision 2/CMP.7, was reached after the FMRL submissions, a Technical Correction for accounting purposes may be needed if a country intends to apply the provision on natural disturbances for the second commitment period. See Section 2.3.9 for detailed information and *good practice* guidance on natural disturbances.

Factoring out

Decision 2/CMP.6 required Parties to consider in their FMRL submissions factoring out in accordance with paragraph 1(h) (i) and 1(h) (ii) of decision 16/CMP.1 (i.e. to factor out the removals from elevated carbon dioxide concentrations above pre-industrial level, indirect nitrogen deposition, and the dynamic effects of age class structure resulting from activities and practices before the reference year 1990). Parties did not explicitly consider factoring out in their FMRLs. In the case of historical FMRLs, it is noted that, given the present state of scientific knowledge, the effects of elevated CO_2 concentrations and indirect nitrogen deposition are considered to be approximately the same in the FMRL and in the commitment period estimates, and therefore they can be assumed to be factored out. The dynamic age-class effects will remain over any given commitment period but may eventually be removed from accounting by being cancelled out over successive commitment periods. For projected FMRLs, it is generally assumed that there is no effect from elevated CO_2. Furthermore, the use of a projected FMRL means that removals resulting from elevated CO_2 concentrations above the pre-industrial level and indirect nitrogen deposition will be factored out when subtracting the FMRL from net emissions or removals that occur during the commitment period (assuming that both include or exclude these effects). Similarly, the dynamic effects of differing age-class structures across the forests resulting from past activities and practices and natural disturbances are included in both the construction of the FMRL and the estimation of net emissions during the reporting period and therefore they cancel out.

Continuity with the treatment of Forest Management in the first commitment period

This is not a relevant element for most approaches used to calculate the FMRL. For one Party, the continuity with the treatment of Forest Management in the first commitment period means that the same narrow approach with gross–net accounting will continue, and therefore FMRL was set as zero. In this case, the narrow approach accounts for emissions and removals only from forest land where these activities, including thinning, are implemented or where any additional activity is to be implemented to enhance sustainable forest management in the future. In doing this, the narrow approach provides continuity with the first commitment period.

Policies included

Following Decision 2/CMP.6, Parties were requested to include in their FMRL submissions a description of the domestic policies adopted and implemented no later than December 2009 and explain how these polices have been considered in the construction of the FMRL. Parties were also requested to confirm that the construction of the FMRL does not include assumptions about changes to domestic policies adopted and implemented after December 2009. The aim of this information is also to document the feasibility of the policies and the assumptions included in the FMRL, in relation to the country-specific circumstances. A few Parties also clarified the effects of policies related to biofuel or the use of biomass as a renewable source in the calculation of their FMRLs.

Parties proposing historical FMRLs based on 1990 do not take into account policies and measures since that year.

2.7.5.2 METHODOLOGICAL CONSISTENCY BETWEEN FMRL AND REPORTING FOR FOREST MANAGEMENT DURING THE COMMITMENT PERIOD

According to Decision 2/CMP.7, when accounting for Forest Management, Parties shall demonstrate methodological consistency between the FMRL[85] and reporting for Forest Management during the second commitment period, and shall apply Technical Correction, if necessary, to ensure consistency. This section discusses general issues and *good practice* guidance related to methodological consistency. Technical Corrections are addressed in the following section.

Consistency is one of the key principles in the estimation of greenhouse gases inventories. In the UNFCCC reporting guidelines consistency means that an inventory should be internally consistent in all its elements with inventories of other years, i.e. it refers to the need of time-series consistency of an inventory. An inventory is consistent if the same methodologies are used for all years and if consistent data sets are used for estimating carbon stock changes and non-CO_2 greenhouse gas emissions during the whole period. Under certain circumstances[86], an inventory using different methodologies for different years can be considered to be consistent if it has been recalculated in a transparent manner, and if potential inconsistencies are minimized in accordance with the guidance provided in the *2006 IPCC Guidelines* (Volume 1, Chapter 5) and with *GPG-LULUCF* (Chapter 5).

The *2006 IPCC Guidelines* describe common situations in which time series consistency may not be achieved, including: (i) recalculations due to *methodological changes and refinements*; and (ii) *adding new categories*. A methodological change is a switch to a different tier (or to a different method, e.g. from *Stock-Difference* to *Gain-Loss*, or from inventory-based to process-based method) from the one previously used for reporting, often driven by the development of new and different data sets. A methodological refinement occurs when an inventory compiler uses the same tier to estimate emissions but applies it using a different data source or a different level of aggregation. Both methodological changes and refinements over time are an essential part of improving inventory quality. The adding of new categories includes also the addition of new carbon pools and gases.

In the context of FMRL, the following distinction needs to be made:

3. *Approach* used to construct FMRL (see Section 2.7.5.1 and Box 2.7.3)

4. *Methodological elements* , including:

   (iii) The method used to establish the FMRL (for projected FMRL only), as reported in the FMRL submission: model or average/extrapolation of historical data;

   (iv) The historical data (i.e. prior to FMRL submission[87]) used to establish the FMRL, as reported in the FMRL submission (e.g. area, harvest, increment, age structure, forest characteristics and management, net emissions and related estimation parameters, etc.);

   (v) Other methodological elements used to establish the FMRL as reported in the FMRL submission, including: pools and gases, the treatment of HWP, the treatment of natural disturbances;

   (vi) Elements newly introduced or modified by Decision 2/CMP.7 (as compared to the text in Decision 2/CMP.6), including: the CEFC provision (see Section 2.7.7); the accounting HWP removed from areas under Forest Management (see Section 2.3.8); the possible exclusion of emissions associated with natural disturbances (see Section 2.3.9).

8. *Policy assumptions under business-as-usual scenarios* (for projected FMRL only, as reported in the FMRL submission), including economic assumptions or responses and assumptions on the evolution (after the FMRL submission) of forest management, of the forest area, of forest characteristics, and harvesting rates or amounts.

During the commitment period, it is essential to ensure consistency between the methodological elements (see 2 above) used in the construction of FMRL and those used in the reporting of Forest Management. To this end it is *good practice* to consider all the specific elements highlighted in paragraphs 14 and 15 of the Annex to Decision 2/CMP.7, and the list of criteria and elements included in Table 2.7.1 to address any inconsistency through a Technical Correction (see following section).

[85] As inscribed in the Appendix of Decision 2/CMP.7 contained in document FCCC/KP/CMP/2011/10/Add.1

[86] Referred to in Annex I paragraph 4(b) of Decision 15/CP.17 contained in document FCCC/CP/2011/9/Add.2, p.27.

[87] Depending on the country, the FMRL may have been constructed using historical data up to 2008 or 2009.

By contrast, a deviation in policy assumptions (see 2 above) from those assumed in constructing the FMRL, including differences in economic assumptions or responses (e.g. harvesting decisions), does not represent methodological inconsistencies, and thus should not be considered for Technical Corrections.

A common situation of methodological inconsistency is the change, after the FMRL has been set, of one or more of the methodological elements used in the construction of FMRL when reporting Forest Management during the commitment period. For instance, a methodological change (e.g. from *Stock-Difference* to *Gain-Loss*) or refinement (e.g. updated data) may lead to the recalculation of historical data (pre-2010) used to establish FMRL, or the treatment of HWP or natural disturbances may change in the commitment period as compared to the FMRL. These changes would introduce methodological inconsistencies. Other possible cases of inconsistency between the FMRL and reporting for Forest Management during the commitment period are possible. For this reason, for the purpose of demonstrating that the accounting of emissions and removals during the commitment period is not affected by methodological or time-series inconsistency, additional information and/or checks may be needed, depending on the approach and method used to set FMRL.

For projected FMRLs, it is *good practice* to provide information on the main factors generating the accounted quantity (i.e., the difference in net emissions and removals between reporting of Forest Management during the second commitment period and the FMRL); for instance, given that harvest rate is generally the main driver of the forest carbon balance in the short term, it is *good practice* to show that, e.g., a higher (or lower) sink during the second commitment period, as compared to what was assumed in the business-as-usual scenario, is quantitatively consistent with the observed lower (or higher) harvest rate, and/or to provide evidence that other major factors are involved. It increases transparency to report on any differences between policies assumed and policies implemented, and how these might have affected actual emissions and removals. The aim of this information is to show that the accounted quantity in the second commitment period can be explained in terms of deviations in policy assumptions or responses to them (e.g. harvest rate) as compared to what was assumed in the FMRL. The aim is not to provide the basis for a Technical Correction. In addition, it is *good practice* to show that a model used for constructing a projected FMRL reproduces the historical data of Forest Management or *Forest Land Remaining Forest Land* as reported in FMRL submission. It is also *good practice* that the documentation of the model follows the criteria listed in the Annex 1 of the Use of Models and Facility-level Data in Greenhouse Gas Inventories: Report of the IPCC Expert Meeting on the Use of Models and Measurements in GHG Inventories (IPCC, 2010), including information on model selection and development, on model calibration and evaluation, on input data used, on uncertainties, on model implementation and on the evaluation of model results.

According to Decision 2/CMP.7, a Party may choose not to account for a given pool in a commitment period (with the exception of harvested wood products) if transparent and verifiable information is provided that demonstrates that the pool is not a source. However, for any of the approaches used to set FMRL, once a pool has been included in the FMRL inscribed in the Appendix to Decision 2/CMP.7, for consistency reasons it is *good practice* to report this pool during the commitment period, irrespective of the pool being a sink or a source.

2.7.6 Technical Corrections for accounting purposes

Estimation of the FMRL typically relies upon data inputs, assumptions, and models brought together in a consistent and transparent way. For accounting of Forest Management, what counts is the difference between the FMRL and Forest Management emissions and removals occurring in the second commitment period. Therefore, it is important to ensure that the FMRL and the reporting of Forest Management during the commitment period are as methodologically consistent as possible (see Section 2.7.5.2).

If the reported data on Forest Management or *Forest Land Remaining Forest Land* used to establish the reference level are subject to recalculations, or if other methodological inconsistency exists between the FMRL and the Forest Management reporting during the commitment period, to ensure consistency, Parties are required[88] to apply a Technical Correction. The Technical Correction ensures methodological consistency between the FMRL and the reporting of Forest Management during the commitment period, or at least it removes the impact of any methodological inconsistency when accounting.

Essentially, the Technical Correction is a net value of emissions and removals, which is added *at the time of accounting* to the original FMRL (contained in Decision 2/CMP.7) to ensure that accounted emissions and removals will not reflect the impact of methodological inconsistencies. The Technical Correction is defined as (in Mt CO_2eq yr^{-1}):

[88] Paragraphs 14 and 15 of Annex to the Decision 2/CMP.7 (Land use, land-use change and forestry) contained in document FCCC/KP/CMP/2011/10/Add.1, p.15.

EQUATION 2.7.1
TECHNICAL CORRECTION

$$Technical\ \_Correction = FMRL_{corr} - FMRL$$

Where:

Technical Correction= net value of emissions and removals, which is added *at the time of accounting* to the original FMRL (contained in Decision 2/CMP.7) to ensure that accounted emissions and removals will not reflect the impact of methodological inconsistencies

FMRL = Forest Management Reference Level inscribed in the Appendix of Decision 2/CMP.7

$FMRL_{corr}$ = Forest Management Reference Level recalculated for the purpose of calculating the Technical Correction.

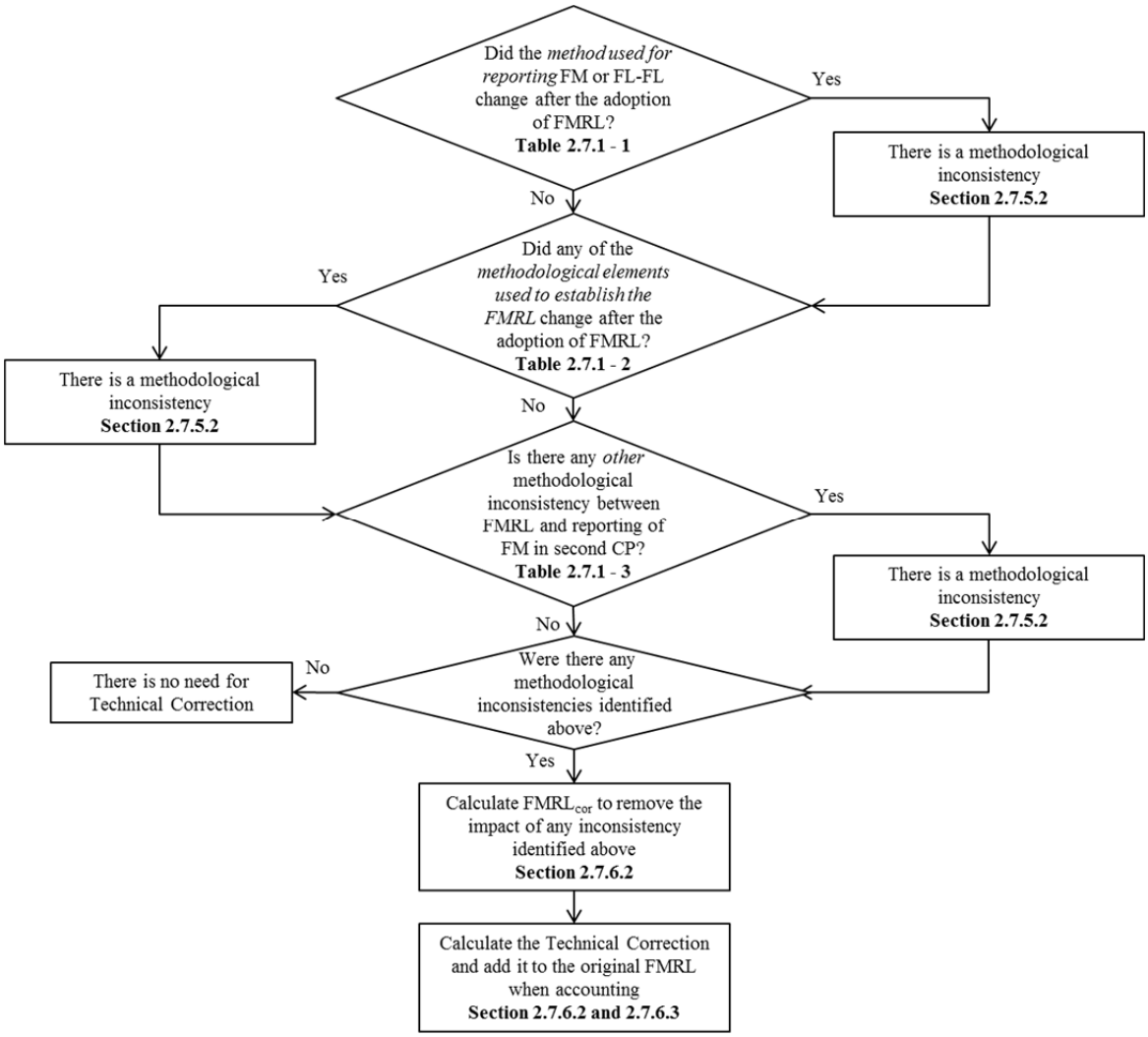
FMRL itself is not changed through a Technical Correction. However, in the case the need for Technical Correction is identified, i.e. if a methodological inconsistency is found at any time during the commitment period, the $FMRL_{corr}$ represents the recalculated reference level which does not contain impacts of any methodological inconsistencies.

This section describes how to detect the need for Technical Correction, how to calculate $FMRL_{corr}$, and when to apply the Technical Correction.

2.7.6.1 HOW TO DETECT THE NEED FOR TECHNICAL CORRECTIONS

Figure 2.7.4 provides a general decision tree on how to identify the need for Technical Correction. Table 2.7.1 provides the specific criteria and the elements to be checked to detect a possible methodological inconsistency and the consequent need for Technical Correction.

Figure 2.7.4 Decision tree for identifying methodological inconsistency and the need for Technical Correction during the second commitment period.



If a methodological inconsistency is identified between FMRL and reporting of Forest Management during the commitment period, Technical Corrections are for the purpose of removing the impact of this methodological inconsistency when accounting. The need for Technical Correction may arise *only* if at least one of the following conditions is met (see Table 2.7.1 for a full list of criteria and elements to be checked):

5. The *method used for GHG reporting* changed after the adoption of FMRL, as part of improving inventory quality. This change will lead to a recalculated time series which, in turn, leads to an inconsistency between FMRL and reporting of Forest Management in second commitment period.

6. Any of the following *methodological elements used to establish the FMRL* (as reported in the FMRL submission) changed after the adoption of FMRL:

   (i) pools and gases and the historical data (i.e. prior to FMRL submission) used to establish the FMRL;

   (ii) treatment of the elements newly introduced or modified by Decision 2/CMP.7 (i.e. accounting of HWP, treatment of natural disturbances).

9. Any *other methodological inconsistency*, e.g., the FMRL model's outputs are inconsistent with historical data (prior to FMRL submission) reported in GHG inventory.

Technical Corrections can neither be triggered by changes in policy assumptions nor responses to them.

Specifically, common cases where it is *good practice* to apply a Technical Correction for accounting purposes may include:

- Methodological changes (i.e. moving to a different method or tier) or refinements (i.e. improvements within a method or tier) are implemented in the reporting of Forest Management, which lead to recalculation of

reported historical data (prior to FMRL submission) of Forest Management or *Forest Land Remaining Forest Land*, e.g.:

(i) In the future, new methods may be developed that take advantage of new datasets, and modelling tools, new technologies or improved scientific understanding. For example, remote-sensing technology and site-specific modelling are making it feasible to estimate historic emissions from land clearing activities more accurately than by using simple aggregate emission factors and activity data. The development of new or refined inventory methods for reporting is part of the broader process of continuous improvement, which countries are encouraged to follow.

(ii) New data become available. For example, forest inventory data may be compiled only once in a five or ten year period. In the case new historic (prior to FMRL submission) forest inventory data (e.g., new area, age structure, carbon stock, net removals, harvest or increment rates) become available that could not be used for the construction of the FMRL, and this new data is used in GHG reporting in the second commitment period, a Technical Correction could allow the inclusion of such new information in the $FMRL_{corr}$.

(iii) Errors have been identified in the previous inventory methods or data that affect the data used to establish the FMRL.

- New pools or GHG sources are included in the reporting for Forest Management in the second commitment period. For instance, if a pool that was not a source and therefore not reported earlier (and also not included in the FMRL) becomes a source in the future, it is *good practice* to include this pool in the reporting of Forest Management and applying a Technical Correction.

- The FMRL and the reporting of Forest Management in the second commitment period are not consistent with respect to:

  (i) The treatment of harvested wood products as agreed in Decision 2/CMP.7. Since the final agreement on HWP was reached after the FMRL submissions, a Technical Correction related to HWP is expected to be a common case.

  (ii) The treatment of natural disturbances as agreed in Decision 2/CMP.7. For instance, if the calculation of the background level of natural disturbances indicates that one or more events need to be excluded, it is *good practice* to remove these events from historical emissions and to calculate $FMRL_{corr}$ (see end of this section).

- Other kinds of methodological inconsistency may exist between the FMRL and the Forest Management reporting during the commitment period. For example, if a model used for constructing a projected FMRL does not reproduce the historical data (prior to FMRL submission) of Forest Management or *Forest Land Remaining Forest Land*, this is a likely sign of inconsistency. In this case, it is *good practice* either to provide additional evidence demonstrating consistency or to apply a Technical Correction.

- In the case of FMRLs based only on the elaboration of historical data from GHG inventories (average of past data, linear extrapolation) or FMRLs based on the single year 1990, any recalculation of the time series used to establish the FMRL will trigger a Technical Correction.

TABLE 2.7.1
CHECK LIST TO DETECT METHODOLOGICAL INCONSISTENCIES AND THE NEED FOR TECHNICAL CORRECTION

Criteria		**Comment /action**
1 The *method used for GHG reporting* (for *Forest Land Remaining Forest Land* or Forest Management) changed after the adoption of FMRL		Calculate $FMRL_{corr}$ ensuring consistency between reported FM and FMRL (see examples in Box 2.7.4)
2. Any of the following *methodological elements used to establish the FMRL* (as reported in the FMRL submission) changed after the adoption of FMRL		
Element	**Change in GHG inventory**	
a) Pools and gases	New pools or gases[89]	Calculate $FMRL_{corr}$ by including the new pools or gases
b) Area under Forest Management	New historical area (prior to FMRL submission)	Calculate $FMRL_{corr}$ using the new area
c) Historical data from GHG inventory	New historical data (prior to FMRL submission) for FL-FL or FM, due to recalculation.	Calculate $FMRL_{corr}$ using the new data
d) Forest characteristics and related management[90]	New historical data (prior to FMRL submission)	Calculate $FMRL_{corr}$ using the new data and information
e) Historical Harvesting rates	New historical data (prior to FMRL submission)	Calculate $FMRL_{corr}$ using the new harvesting rates
f) Harvested wood products	New data and/or methods	Calculate a $FMRL_{corr}$ by applying the new data and/or method
g) Natural disturbances	New data and/or method	Calculate a $FMRL_{corr}$ by applying the new data and/or method
3. *Other possible methodological inconsistencies*, e.g., the FMRL model's outputs are inconsistent with historical data (prior to FMRL submission) reported in GHG inventory (for FM or FL-FL)		If needed, calculate a $FMRL_{corr}$, e.g., by applying IPCC methods to ensuretime-series consistency.

Table 2.7.1 provides a full list of criteria and general guidance on the cases for which methodological consistency is affected and Technical Correction needs to be applied. By contrast, policy assumptions occur without affecting methodological consistency. In particular, the evolution of specific elements after the FMRL submission (i.e. area under Forest Management, harvesting rates, and forest characteristics and related management including, among others: age-class structure, increment, species composition, rotation lengths, management practices) represent a deviation from the policy assumptions described in the FMRL submission. These deviations do not imply a methodological inconsistency, and therefore do not trigger Technical Corrections.

Under Decision 2/CMP.7, Parties may account for emissions by sources and removals by sinks resulting from the harvest and conversion of some forest plantations to non-forest land under Forest Management, provided that a forest of at least the same area and carbon stock potential must be created on non-forest land (Carbon Equivalent Forest Conversion, CEFC, see Section 2.7.7). Whether included in the projected FMRL, this activity of converting plantation forest to non-forest while simultaneously establishing a "Carbon Equivalent Forest" on non-forest land elsewhere is a policy assumption, and the comparison between the FMRL and the carbon stock changes on CEFC land either will create debits for failing to achieve equivalence or may create credits for achieving higher stock increases. These credits and debits are due to a policy change during the commitment period to replant rather than deforest (even if replanting is elsewhere). The same applies to the case if CEFC is not included in the projected FMRL. Therefore, implementation of the CEFC provisions under Decision 2/CMP.7[91] does not trigger a Technical Correction because this activity is regarded as a change in policy. The effects of this will be accounted for against the FMRL (see Section 2.7.7).

[89] Note that, when accounting, it is not possible to exclude a pool or gas already included in the FMRL.
[90] This includes, among others: age-class structure, increment, species composition, rotation lengths, management practices, etc.
[91] Paragraphs 37-39 of Decision 2/CMP.7 (Land use, land-use change and forestry) contained in document FCCC/KP/CMP/2011/10/Add.1, p.19.

BOX 2.7.4
EXAMPLES OF METHODOLOGICAL CHANGES FOR GHG REPORTING (FOR *FOREST LAND REMAINING FOREST LAND* OR FOREST MANAGEMENT) WHICH MAY LEAD TO METHODOLOGICAL INCONSISTENCY BETWEEN FMRL AND REPORTING OF FOREST MANAGEMENT DURING THE SECOND COMMITMENT PERIOD.

Case 1:

At the time of FMRL submission:
-The GHG inventory uses a *Stock-Difference* or *Gain-Loss* method (i.e. not a model)
-The FMRL was constructed using model X
Can this country apply a different method in GHG reporting during the second commitment period?
Yes, but this will create a methodological inconsistency, which needs to be addressed through a Technical Correction process.
Can this country apply the model X (same version used for FMRL) in GHG reporting?
Yes, this will ensure consistency between the methods used for FMRL and FM reporting. However, it is always *good practice* to check the need for Technical Correction during the second commitment period (Figure 2.7.4).

Can this country apply a new model Y (or a new version of model X) in GHG reporting?
Yes, but this will create a methodological inconsistency, which needs to be addressed through a Technical Correction process. In this case, a possible way to address the inconsistency is using the new model Y (or a new version of the model X) also for calculating the $FMRL_{corr}$ as part of the Technical Correction process.

Case 2:

At the time of FMRL submission:
- The GHG inventory using model X
- FMRL constructed using model X
Can this country use a new model Y (or a new version of model X) in GHG reporting?
Yes, this will create a methodological inconsistency, which may be addressed by using the new model Y (or new version of the model X) also for calculating the $FMRL_{corr}$ as part of a Technical Correction process.

When the method for GHG reporting changes, it is always *good practice* checking the ability of the model used for FMRL to reconstruct historical data (as reported in the latest GHG inventory). The inability to reconstruct historical data

Natural disturbances

According to Dec 2/CMP.7, when accounting for Forest Management, Annex I Parties shall demonstrate methodological consistency between the FMRL and reporting for Forest Management during the second commitment period, including in the accounting of any emissions from natural disturbances. The FMRLs contained in the Appendix to the Annex of Decision 2/CMP.7 were submitted and reviewed before the provisions related to natural disturbances in the Annex to Decision 2/CMP.7 were agreed. The FMRLs may therefore be inconsistent with the agreed provisions, including those specifying that the expectation of neither credits not debits are to arise from application of the disturbance provisions. Using the methods set out in Section 2.3.9 (on natural disturbances) Parties should provide information in National Inventory Reports that this is the case, and make Technical Corrections if needed to ensure that it is so.

2.7.6.2 HOW TO PERFORM AND DOCUMENT THE CALCULATION OF $FMRL_{CORR}$

If the need for Technical Correction is determined, it is *good practice* to calculate $FMRL_{corr}$. Several methods may be considered to address methodological inconsistencies and to calculate $FMRL_{corr}$, depending on the approach used to construct FMRL, the cause of the inconsistency and the data that are available to perform the recalculations. Irrespective of the method used, it is *good practice* to provide information that the method used avoids the expectation of net credits linked to any methodological inconsistency between $FMRL_{corr}$ and reporting for Forest Management during the commitment period.

In the case of projected FMRLs, $FMRL_{corr}$ may be calculated by, *inter alia*, a new model projection using new historical data or applying a different treatment of a specific element (e.g., HWP, natural disturbances). When new projections are made, it is essential to keep all the policy assumptions under the business-as-usual scenario unchanged.

If the need for a Technical Correction due to a methodological inconsistency has been identified, but a new model run cannot be performed, the time-series consistency may be ensured by using one of the methods described by *2006 IPCC Guidelines*, including the overlap between models results and data for Forest Management of *Forest Land Remaining Forest Land* reported for the historical period (before the FMRL submission). In this case, consistency would be ensured *ex-post*, i.e. adjusting existing model results to the historical reported data.

It is essential that the criteria to calculate $FMRL_{corr}$ are the same as those used for setting FMRL, i.e., if the FMRL is calculated as a linear extrapolation of any historical period trend, the same period should be used for $FMRL_{corr}$ in case a recalculation of historical time series occurs. This is because, for the FMRL submission, the period selected was assumed as proxy for a business-as-usual scenario, and changing the period would mean changing the policy assumptions. In the case of FMRL based on elaboration of historical data only (average of past data, linear extrapolation) or on the single year 1990, any recalculation of the time series will automatically produce $FMRL_{corr}$.

Irrespective of the method applied to calculate $FMRL_{corr}$, it is *good practice* to accompany any Technical Correction with transparent information on:

- Rationale for calculating $FMRL_{corr}$ (description of which criteria in Table 2.7.1 has been met);
- Methods used to calculate $FMRL_{corr}$. In case a model is used, it is *good practice* to document the implementation of the model according to the criteria listed in the Annex 1 of the IPCC Expert Meeting Report on the Use of Models in GHG Inventories (IPCC, 2010);
- Results, i.e. the $FMRL_{corr}$;
- Discussion of the differences between $FMRL_{corr}$ and FMRL. For this purpose, it is *good practice* to report a comparison of recalculated estimates with previous estimates, e.g., as shown in Table 2.7.2 and whenever possible also as a graphical plot showing the temporal dynamics of the estimates underlying $FMRL_{corr}$ and FMRL.

TABLE 2.7.2
EXAMPLE OF SUMMARY TABLE WHEN PERFORMING A TECHNICAL CORRECTION

	Emissions and Removals
FMRL	-10000 [Gg yr^{-1}]
$FMRL_{corr}$	-10500 [Gg yr^{-1}]
Difference in per cent =100●[($FMRL_{corr}$–FMRL)/FMRL] %	5%
Technical Correction= $FMRL_{corr}$ - FMRL	-500 [Gg yr^{-1}]
FM reported during the commitment period	-12000 [Gg yr^{-1}]
Accounted Quantity[92] = reported FM – (FMRL + Technical Correction)	-1500 [Gg yr^{-1}]

2.7.6.3 WHEN TO APPLY TECHNICAL CORRECTION

It is essential to apply Technical Correction when accounting, i.e., annually or at end of the commitment period, depending on the choice made by the Party.

[92] The accounting quantity is the total quantity of units to be added to or subtracted from a Party's assigned amount for a particular activity in accordance with the provisions of Article 7.4 of the Kyoto Protocol. Negative values means credits, positive values means debits.

For most Parties, it is expected that in most years there will be the need to calculate $FMRL_{corr}$, e.g., due to change in reporting methods or new data which cause a recalculation of historical data used to construct FMRL. Therefore, also for non-accounting years, for transparency purposes whenever it is possible it is *good practice* to assess annually the need for Technical Correction, i.e. to check the criteria set in Table 2.7.1, to calculate $FMRL_{corr}$ and to report such information in the annual National Inventory Report.

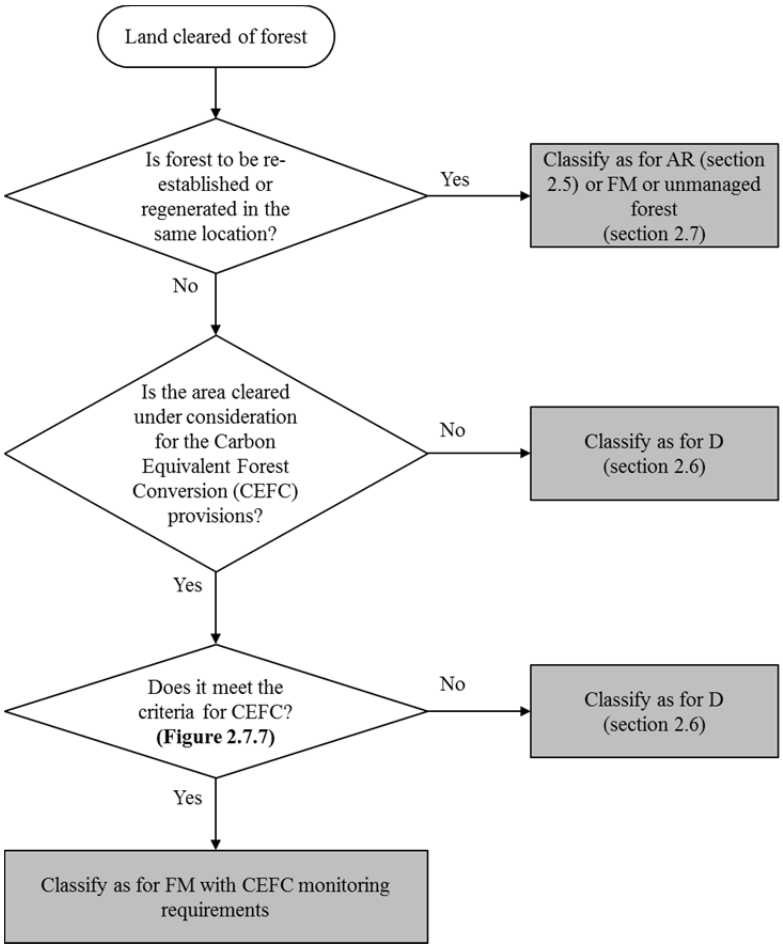
2.7.7 Carbon Equivalent Forests

2.7.7.1 DEFINITIONAL ISSUES AND REPORTING REQUIREMENTS

Under Decision 2/CMP.7, Parties may account for emissions by sources and removals by sinks resulting from the harvest and conversion of some forest plantations to non-forest land under Forest Management, provided that certain conditions are met.. The main condition is a requirement that a forest of at least the same area and carbon stock potential is created on non-forest land. Carbon Equivalent Forest Conversion (CEFC) is the activity of converting plantation forest to non-forest while simultaneously establishing a "Carbon Equivalent Forest" on non-forest land elsewhere.

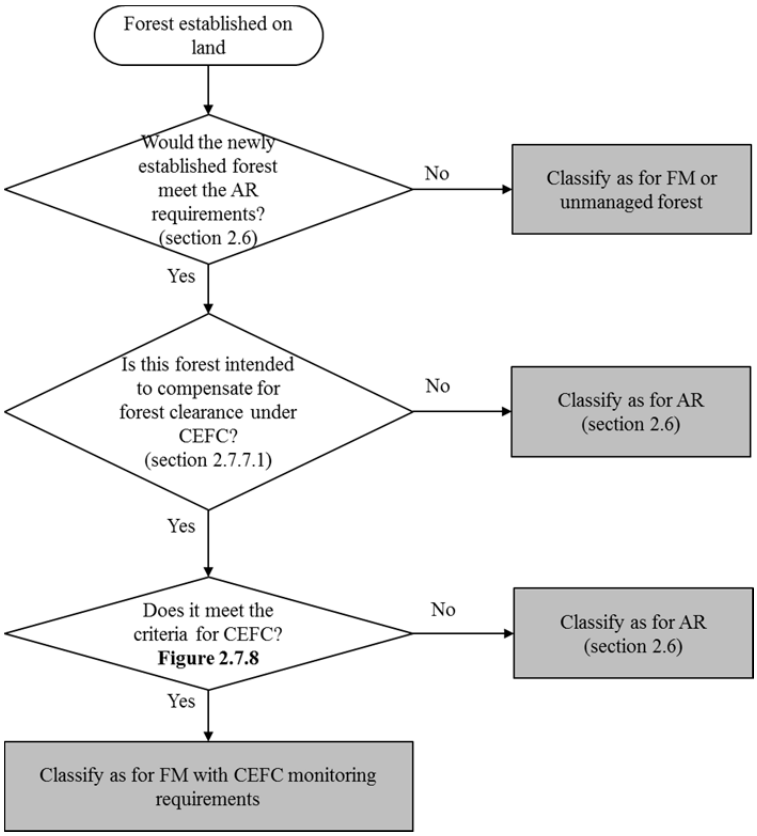
CEFC requires two land components – the existing forest land to be cleared (CEF-d) and the non-forest land on which a Carbon Equivalent Forest is to be established (CEF-ar). Both components shall meet the criteria for CEFC set out in Decision 2/CMP.7[93] in order to be accounted for under Forest Management. Figures 2.7.5 and 2.7.6 provide decision trees for categorising forest clearance and establishment activities.

Figure 2.7.5 CEFC decision tree for land cleared of forest



[93] Paragraphs 37-39 of Decision 2/CMP.7 (Land use, land-use change and forestry) contained in document FCCC/KP/CMP/2011/10/Add.1, p.19.

Figure 2.7.6 CEFC decision tree for forest establishment



In accordance with Decision 2/CMP.7 Parties shall identify, monitor and report all lands and associated carbon pools subject to the CEFC provision, including the geo-referenced location and year of conversion. Accounting for Forest Management lands is with respect to the FMRL, so pools should be consistent with the pools included within the FMRL, including HWPs.

It is *good practice* for the Party to apply Reporting Method 2 (Section 2.2.2) to identify the area and polygon boundaries of lands subject to the CEFC provision. It is *good practice for* the Party to provide:

- The year of conversion, which will be between 1 January 2013 and the end of the last inventory year. The year of forest land conversion to non-forest under the CEFC provision is taken as the year in which CEF-d land is cleared and corresponding CEF-ar land is identified.;
- The area of lands subject to CEFC activity in each productivity class and species combination (where relevant) to support the calculation of carbon stock changes and non-CO_2 emissions;
- Documentation that demonstrates the relationship between forest and cleared and the corresponding land established in forest under the CEFC provision;
- The rotation length, carbon stock at the end of the rotation and long term average carbon stock on CEF-d lands, as assumed under business as usual management in the FMRL.

It is *good practice* for Parties to provide, according to their national circumstances, the definition of forest plantation that is used in the application of the CEFC provision. This definition should be consistent throughout the time series and the inventory.

2.7.7.2 CHOICE OF METHODS FOR IDENTIFYING LANDS SUBJECT TO CARBON EQUIVALENT FOREST CONVERSION

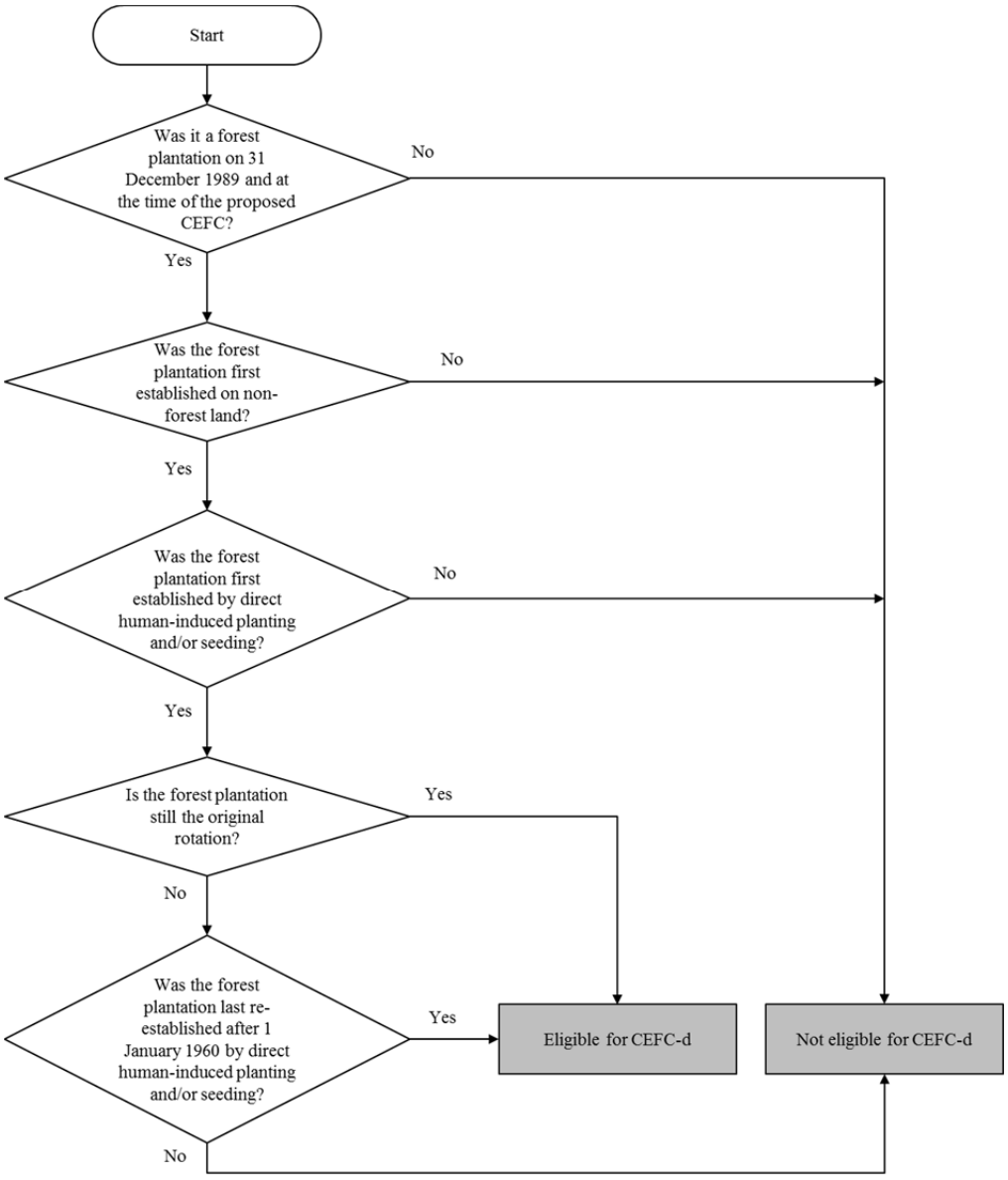
For eligibility under the CEFC provision, conditions apply to both the land converted from plantation forest to non-forest (CEF-d land) and the corresponding land converted from non-forest to forest (CEF-ar land). According to Decision 2/CMP.7 the forest to be cleared shall meet the following criteria:

- Is plantation forest at the time of conversion, meeting or exceeding the thresholds for the country's definition of forest as well as their specific definition of plantation forest;
- Had been plantation forest on 31 December 1989;
- Had been first established by direct-human induced planting and/or seeding;
- Had been first established onto non-forest land. If this non-forest land was previously forested (that is to say it had been converted from forest to another land use), it is *good practice* to apply the same criteria used to distinguish Deforestation from harvesting or forest disturbance that is followed by the re-establishment of a forest. For example, if normal practice in a country is to re-establish forests within three years after harvesting, then a plantation that was first established on land that had remained non-forest for more than three years would normally be eligible under the CEFC provision;
- Is still the original forest established, or, if re-established after harvesting, this had last occurred through direct human induced planting and/or seeding after 1 January 1960.

It is *good practice* to apply the methods described in Section 2.6.2 for identifying units of land subject to direct human-induced Deforestation, to also identify units of land cleared of forest which may be accounted for under the CEFC provision, since only land that qualifies as Article 3.3 D land will qualify as CEF-d land. In addition, the land should be identified as under consideration for accounting under the CEFC provision and the corresponding land at least equal in area to be established in forest should be identified.

The decision tree for determining eligibility for forest land to be converted to non-forest land under the CEFC provision is shown in Figure 2.7.7.

Figure 2.7.7 Decision tree for determining the eligibility of land to be converted to non-forest under CEFC provision (CEF-d land)



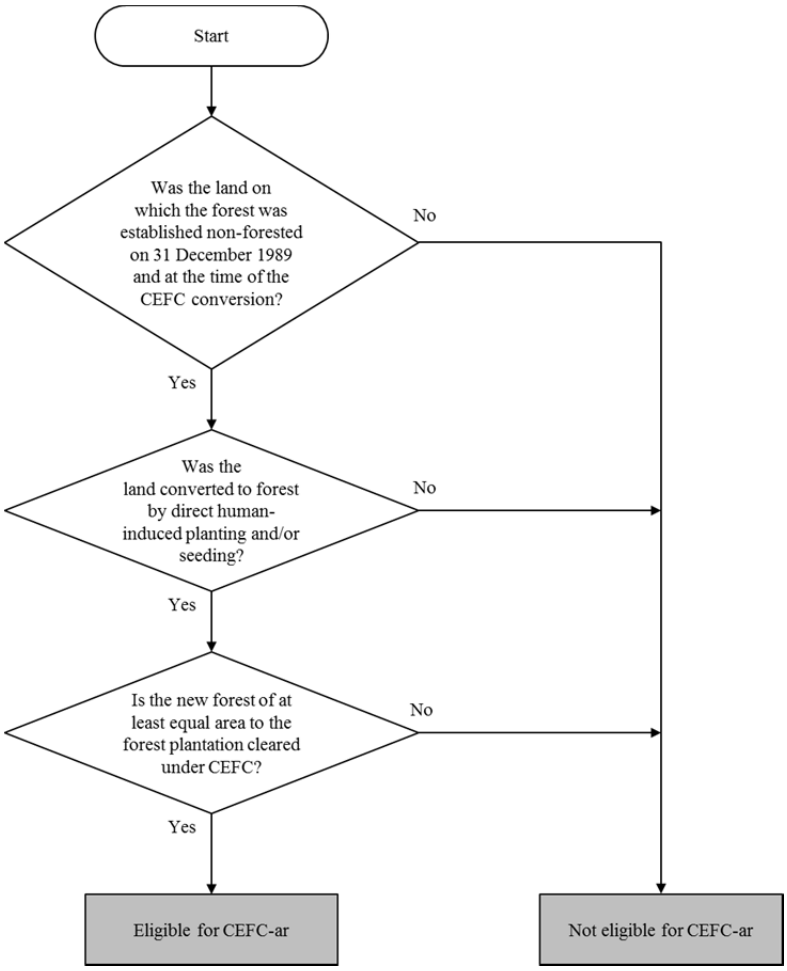
According to Decision 2/CMP.7 the land on which a forest is to be established under the CEFC provision- (CEF-ar land) shall meet the following criteria:

- Did not contain forest at the time of conversion;
- Did not contain forest on 31 December 1989;
- Be converted to forest land through direct human-induced planting and/or seeding;
- The forest established shall be at least equal in area to the forest converted to non-forest.

It is *good practice* to apply the methods described in Section 2.5.2 for identifying units of land subject to direct human-induced Afforestation and Reforestation also for identifying units of land established in forest which may be accounted for under the CEFC provision, since only land that qualifies as Article 3.3 AR land will qualify as CEF-ar land.

The decision tree for determining eligibility for non-forest land to be converted to forest land under the CEFC provision is shown in Figure 2.7.8.

Figure 2.7.8 Decision tree for determining eligibility of land to be established in forest plantation under CEFC provision (CEF-ar land)



All lands and associated carbon pools subject to the CEFC provision should be accounted for as Forest Management under Article 3.4. This includes any harvested wood products resulting from the conversion of forest to non-forest land.

It is *good practice* to provide documentation that CEF-ar lands included in the identified units of land are forests established by direct human-induced planting and/or seeding.

DISCRIMINATING BETWEEN ARD LAND AND CARBON EQUIVALENT FOREST CONVERSION LAND

It is *good practice* that areas subject to the CEFC provision are reported separately from areas subject to direct human induced Deforestation and Afforestation/Reforestation. Both the CEF-d and CEF-ar land should be reported as Article 3.4 Forest Management lands from the time of conversion. Documentation should be provided to demonstrate that all the requirements for the CEFC provision have been met and there is no double-counting of emissions or removals.

If non-forest land established in forest under the CEFC provision is subsequently deforested (before or after achieving carbon stock equivalence) the land should be reclassified as Article 3.3 Deforestation land and reported accordingly.

DISCRIMINATING BETWEEN CM, GM AND RV LAND AND CARBON EQUIVALENT FOREST CONVERSION LAND

It is a requirement under Decision 2/CMP.7 that areas subject to the CEFC provision are reported under Forest Management which has priority over elected activities under Article 3.4. This means that there may be land units that are subject to elective Article 3.4 activities (e.g. Cropland Management) but are reported under Forest Management. These lands should be identified and reported separately from other Forest Management lands and elected Article 3.4 lands. Methodologies appropriate to the actual land-use should be applied, such that

emissions and removals are neither under- nor over-estimated. It is *good practice* to provide documentation to show how double counting of emissions and removals has been avoided.

2.7.7.3 CHOICE OF METHODS FOR ESTIMATING CARBON STOCK CHANGES AND NON-CO_2 EMISSIONS

It is *good practice* to apply the same methods for estimating carbon stock changes and non-CO_2 emissions on CEFC lands as are applied on Forest Management land, described in Section 2.1.3. The same or a higher tier should be used. In addition, forest land converted to non-forest under the CEFC provision may be subject to management that results in carbon stock changes and non-CO_2 greenhouse gas emissions over-and-above what would have been expected if the forest had been re-established. It is *good practice* to capture these emissions and removals by applying the methods for the appropriate land-use (e.g. cropland or grazing land) found in the *2006 IPCC Guidelines*.

Accounting for Forest Management is based on a reference level approach. The FMRL is described in Section 2.7.5. The basis for determining accounting credits or debits is a comparison of emissions and removals in the FMRL with those on CEF-d and CEF-ar lands combined. Accounting against the FMRL should be cumulative, with credits and debits accrued annually or periodically from the time of conversion. If exact equivalence is reached at the end of the normal harvesting cycle, the cumulative credits and debits will sum to zero.

In the case where the average long term stock is lower on CEF-ar land than it would have been on CEF-d land, it is possible that cumulative net credits and debits will not reflect the net increase in atmospheric greenhouse gases relative to business-as-usual. In these cases a one-off adjustment needs to be made at the time of felling of CEF-ar, in addition to the cumulative accounting against the FMRL. The adjustment is equal to the difference between average carbon stocks for CEF-d and those for CEF-ar. In both cases the average stock is calculated as the stock at the end of the normal rotation divided by the normal rotation. It is *good practice* to repeat this comparison each time CEF-ar is harvested, calculating a new long-term average stock on CEF-ar land each time. If the long-term average stock on CEF-ar land is lower than the equivalent stock on CEF-d land under business- as-usual management, the debit incurred is the difference between average stocks minus any adjustment made at the end of the previous CEF-ar rotation. No adjustments are required if a Party can demonstrate that the average increment of CEF-ar is higher than that of CEF-d throughout the normal rotation length of CEF-d, or if the rotation length of CEF-ar is longer than that of CEF-d.

It is *good practice* to provide documentation to show that artefact removals due to the increase in area under Forest Management have been avoided. Guidance is provided in Section 2.3.3. The accounting methodology should take into account whether the CEF-ar land was previously accounted for under the Kyoto Protocol. For example, if the CEF-ar land was previously accounted for under an elective activity (e.g. CM, GM), then the stock increase in FM caused by shifting this land to FM will be balanced by a stock loss in the elective activity.

If forest land established under the CEFC provision is affected by natural disturbance, the emissions and subsequent uptake on that land can be excluded from accounting in accordance with the natural disturbance provisions in Section 2.3.9. The natural disturbance accounting provision applies to emissions from forests, so cannot be used for natural disturbances affecting non-forest CEF-d land that is accounted for under Forest Management using the CEFC provision.

2.8 HARVESTED WOOD PRODUCTS (HWP)

Section 2.8 provides *good practice* guidance for estimating annual changes in carbon stocks and CO_2 emissions and removals from the Harvested Wood Products (HWP) pool (hereinafter referred to as the *HWP contribution*) to be accounted for in accordance with Decision 2/CMP.7.[94] It gives guidance for selecting the adequate data and methods consistent with the system boundaries of the accounting approach defined the Decision.

Various approaches have been proposed to estimate and report the *HWP contribution*. They differ in the reference to the atmosphere and/or the treatment of HWP trade, due to different interpretations of some key terms relevant for the reporting framework (Winjum*, et al.* 1998, Cowie*, et al.* 2006). This situation is reflected in Volume 4, Chapter 12 of the *2006 IPCC Guidelines* which states that the guidance given "does not prefer any of these approaches and does not attempt to prejudge whether these, or any other approach, should be used to account" for the *HWP contribution* (IPCC 2006). Hence, it suggests calculating different variables that are needed to estimate the *HWP contribution* according to the different approaches (see Table 12.1, Chapter 12, Volume 4 of the *2006 IPCC Guidelines*).

One of the implications of Decision 2/CMP.7 is that accounting of HWP is confined to products in use where the wood was derived from domestic harvest, i.e. trees harvested in the reporting country.[95] In principle, this is similar to basing estimates of the *HWP contribution* on changes in the pool (i.e. stock-changes) reflected by variable 2A in Table 12.1, Chapter 12, Volume 4 of the *2006 IPCC Guidelines*, but Decision 2/CMP.7 imposes some additional constraints and limits the extent of HWP which can be included in the estimates.

2.8.1 Initial steps to estimate the HWP contribution

To estimate the HWP contribution and account for the changes in the HWP pool in line with Decision 2/CMP.7, it is good practice to follow the decision tree (Figure 2.8.1) and the steps described below.

STEP 1: Check the construction of FMRL and the availability of transparent and verifiable activity data on HWP

According to Decision 2/CMP.7 Parties are required to account for HWP on the basis of the change in the HWP pool during the second and subsequent commitment periods, provided that transparent and verifiable activity data are available for the three HWP categories, sawn wood, wood panels and paper.[96] In case the country's FMRL is based on a projection, accounting shall be on the basis of the change in the HWP pool (i.e. Tier 2 or 3 methods).[97] To meet the requirements of the Decision 2/CMP.7 countries should:

STEP 1.1: Check whether the FMRL has been based on a projection (See 2.7.5). If this is the case, skip the next step and go to STEP 1.3.

STEP 1.2: Check databases of international organizations, such as the public database of the Food and Agriculture Organization of the United Nations (FAO)[98] for the availability of production and trade statistics on the HWP categories defined in the Decision 2/CMP.7. Detailed guidance is given in Section 2.8.1.1. In case such data are available go to Step 1.3, otherwise apply Tier 1 (Section 2.8.2).

STEP 1.3: Check whether other activity data (i.e. country-specific) are available which fulfil the requirement to be "transparent and verifiable". Further guidance is given in Section 2.8.4.1.

STEP 1.4: If available country-specific activity data do not follow the classification of forest products as outlined in Section 2.8.1.1, determine whether HWP activity data represent information on the material use of wood (products in service) in order to exclude HWP used for energy purposes and HWP in solid waste disposal sites[99] and cross-check the information with guidance given in Sections 2.8.1.1 and 2.8.4.1. If activity data represent information on material use of HWP in service go to STEP 2, otherwise apply Tier 1 (Section 2.8.2).

[94] References to paragraphs in this chapter refer to the Annex of Decision 2/CMP.7 contained in document FCCC/KP/CMP/2011/10/Add.1, unless indicated otherwise

[95] Cf. paragraphs 27 and 32

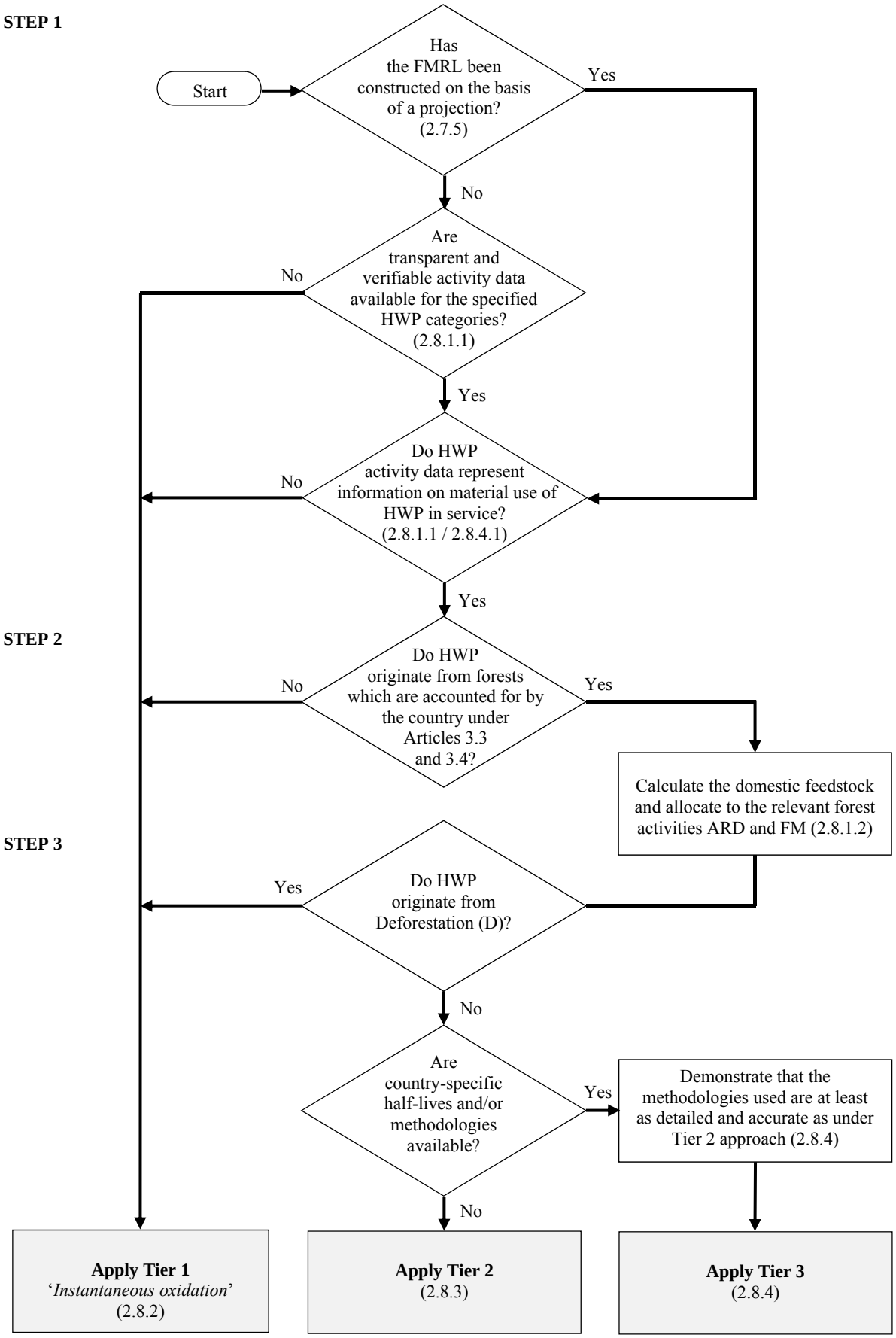
[96] Cf. paragraph 29

[97] Cf. paragraph 16

[98] http://faostat.fao.org/site/630/Default.aspx

[99] Cf. paragraph 32

4735 **Figure 2.8.1 Decision tree for selection of a correct tier method for estimating HWP**
4736 **carbon stock change**



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STEP 2: Check whether HWP categories originate from forests that are accounted for by the country and allocate HWP to the particular forest related activity

Decision 2/CMP.7 limits the mandatory accounting to HWP originating from domestic forests which are accounted for under Article 3, paragraphs 3 and 4. Imported HWP, irrespective of their origin, are excluded[100]. Figure 2.8.1 shows that Decision 2/CMP.7 specifies the methods to be used for the estimation of the *HWP contribution* depending on the origin of HWP.[101]

Detailed guidance on how to implement all the following steps is given in Section 2.8.1.2.

STEP 2.1: Estimate the share of HWP originating from forests within the country. The default assumption is that domestically consumed industrial roundwood represents the production feedstock for the subsequent processing of the semi-finished product categories sawnwood and wood panels. Domestically consumed wood pulp is the feedstock for paper production.

STEP 2.2: Estimate the share of HWP originating from Afforestation, Reforestation and Deforestation (ARD) under Article 3 paragraph 3 and Forest Management (FM) under Article 3 paragraph 4, as the methods for estimating the *HWP contribution* will differ according to the provisions outlined in the decision tree for tier selection (Figure 2.8.1).

STEP 2.3: The share of HWP activity data entering the accounting framework is obtained by allocating HWP which originate from domestic harvest (STEP 2.1) to the relevant forest activity accounted for under Article 3, paragraphs 3 (ARD) and 4 (FM) (STEP 2.2).

STEP 3: Check availability of country-specific information and estimate carbon stock in HWP and its annual change

Depending on the results of STEPS 1 and 2, as well as the availability of country-specific half-lives and/or country-specific methodologies, the estimation of the *HWP contribution* follows different tier methods.

Tier 1 method specifies the assumption of instantaneous oxidation and is to be used under certain circumstances and for specific parts of the HWP pool. The combination of HWP activity data following the international classification system of semi-finished wood products (Figure 2.8.2) with default conversion factors and default half-lives constitutes Tier 2. Under a Tier 3 method, more accurate country-specific information is applied. This includes activity data and/or emission factors (i.e. service life information of HWP), which is intended to improve the accuracy of the estimates. In order to choose the appropriate tier method, please follow all the steps below.

STEP 3.1: In case HWP originate from Deforestation (D) within the country use Tier 1 method (Section 2.8.2).

STEP 3.2: Check whether country-specific HWP activity data following the international classification system outlined in Section 2.8.1.1 together with specific conversion factors are available for the country following guidance given in Section 2.8.4.1. If this is the case, allocate HWP activity data in line with STEP 2 and apply Tier 3 (Section 2.8.4).

STEP 3.3: Check whether country-specific half-life values for the three HWP categories and/or their disaggregates (See Section 2.8.1.1) can be obtained following the guidance given in Section 2.8.4.2. If this is the case, apply Tier 3 (Section 2.8.4).

STEP 3.4: Check whether other country-specific methods are available that meet the requirements as specified in Section 2.8.1.1 and 2.8.4. If this is the case, allocate HWP activity data in line with STEP 2 and apply Tier 3 (Section 2.8.4).

STEP 3.5: In case the country will not make use of a Tier 3 method as outlined for the STEPS 3.2 to 3.4, allocate HWP activity data in line with STEP 2 and apply Tier 2. Guidance on Tier 2 is given in Section 2.8.3.

2.8.1.1 AVAILABILITY OF TRANSPARENT AND VERIFIABLE ACTIVITY DATA

A prerequisite for Parties when accounting for HWP on the basis of the change in the HWP pool is the availability of "transparent and verifiable activity data" for the three specified HWP categories "paper, […]

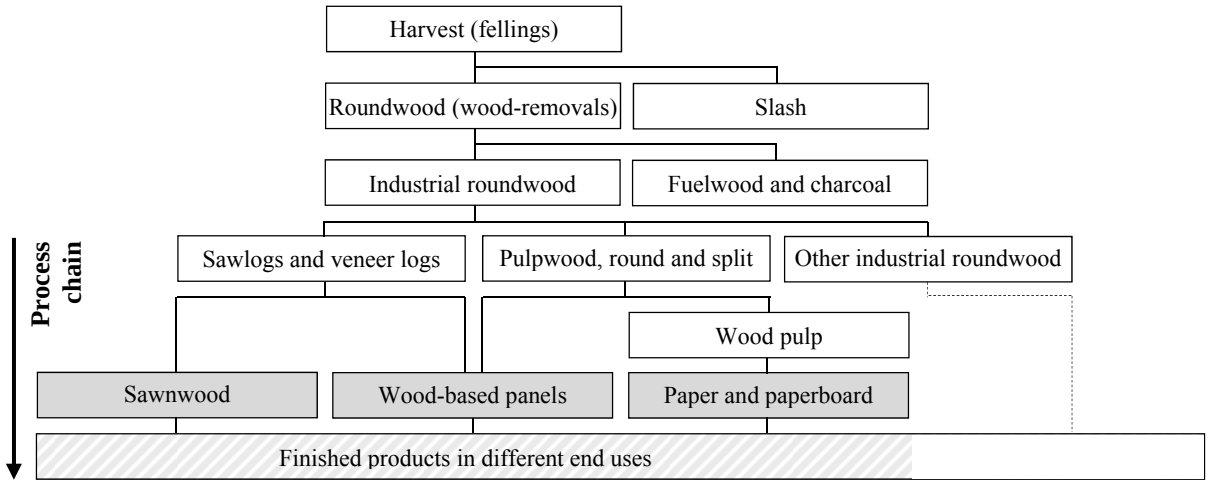
[100] Cf. paragraph 27

[101] Cf. paragraphs 28, 29, 31 and 32

wood panels, and […] sawnwood" (cf. STEP 1).[102] This section gives guidance on when available data is to be considered transparent and verifiable for estimating the *HWP contribution*.

Whereas the term "harvested wood products" is based on a concept containing the two separate elements "forest harvesting" and "wood products" (Brown, et al. 1998, FCCC/TP/2003/7), the named categories refer to the definitions of semi-finished wood products of the international classification system of forestry products (cf. FAO 2010). It is thus *good practice* to assume that the three HWP categories named in Decision 2/CMP.7 accord with these commodities. "Removals" (i.e. roundwood) are a subset of "forest harvesting" of biomass (i.e. fellings) at the beginning of the forest-wood chain (see definitions below). Following the forestry products definitions of the Food and Agriculture Organization (FAO), Figure 2.8.2 furthermore shows the relevance of the aggregate commodity "industrial roundwood". Its subcategories provide the feedstock for the subsequent processing of the three named semi-finished HWP commodities along the value chain (cf. FAO 2012). The international classification system for forestry products can be related to the Harmonized Commodity Description and Coding System (HS) of tariff nomenclature provided by World Customs Organization (WCO).[103]

Figure 2.8.2 Forest-wood chain based on simplified classification of wood products based on FAO forestry products definitions



In the following, definitions of semi-finished product commodities, which are relevant for the application of the guidance on estimating the *HWP contribution* in line with Decision 2/CMP.7, are listed (cf. Figure 2.8.2). They are drawn from the definitions of the Joint Forest Sector Questionnaire as established by the Intersecretariat Working Group on Forest Sector Statistics[104] and form the basis for the forest products statistics e.g. provided by FAO (2010).[105] Datasets for these aggregate product categories are freely and easily accessible, are updated on at least an annual basis with a 6-month or one year reporting lag, and time series are available for most countries worldwide.[106]

SAWNWOOD (Decision 2/CMP.7 refers to this as "sawn wood")**:** "Wood that has been produced from both domestic and imported roundwood, either by sawing lengthways or by a profile-chipping process and that exceeds 6 mm in thickness. It includes planks, beams, joists, boards, rafters, scantlings, laths, boxboards and "lumber", etc., in the following forms: unplaned, planed, end-jointed, etc. It excludes sleepers, wooden flooring, mouldings (sawnwood continuously shaped along any of its edges or faces, like tongued, grooved, rebated, V-jointed, beaded, moulded, rounded or the like) and sawnwood produced by resawing previously sawn pieces. It is reported in cubic metres solid volume."[105]

WOOD-BASED PANELS (Decision 2/CMP.7 refers to this as "wood panels")**:** "This product category is an aggregate comprising veneer sheets, plywood, particle board, and fibreboard. It is reported in cubic metres solid volume."[105]

[102] Paragraph 29

[103] http://www.wcoomd.org/en/topics/nomenclature/instrument-and-tools/hs-online.aspx (2012/11/26)

[104] Comprising the Forestry Department of FAO, the Economic Commission for Europe (ECE), the Statistical Office of the European Communities (EUROSTAT) and the International Tropical Timber Organization (ITTO)

[105] http://www.fao.org/forestry/80570/en/

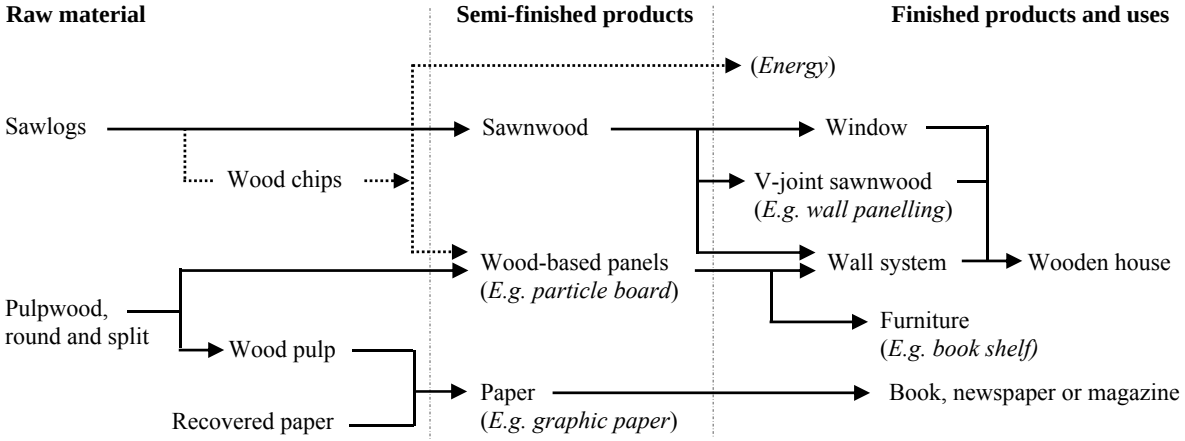
[106] http://faostat.fao.org/site/630/default.aspx

For the definitions of these subcategories please see FAO 2010. [105]

PAPER AND PAPERBOARD (Decision 2/CMP.7 refers to this as "paper")**:** "The paper and paperboard category is an aggregate category. In the production and trade statistics, it represents the sum of graphic papers; sanitary and household papers; packaging materials and other paper and paperboard. It excludes manufactured paper products such as boxes, cartons, books and magazines, etc. It is reported in metric tonnes."[105]

By definition, these three aggregate commodities of semi-finished wood products represent information on the material use of HWP and equal the default categories mentioned in Decision 2/CMP.7. Additionally, all datasets are reported in cubic metres solid volume or metric tonnes, which is information that enables countries to convert the data given into carbon units. Commodities which are excluded from the definitions above (e.g. V-jointed sawnwood) might be the result of subsequent processing and therefore fall under the category of finished wood products as illustrated in Figure 2.8.3. This also applies e.g. to wooden flooring that is produced from sawnwood and/or hardboard which belongs to the category of wood-based panels; wooden flooring is therefore implicitly covered by the semi-finished HWP categories sawnwood and wood-based panels and included in the estimates for the *HWP contribution*. Thus, using statistical data both for sawnwood and for wooden flooring would result in double counting.

Figure 2.8.3 Examples of different processing stages of wood products along the process and value chain



To avoid potential double counting, countries are encouraged to consult e.g. FAO 2010 for further clarification on the mass flows along the forest wood processing chain and definitions of the relevant commodities. The inclusion of the commodity wood pulp under the HWP category "paper" would for example result in double counting, as wood pulp by definition constitutes the feedstock for the production of paper and paperboard (cf. definition below and Figure 2.8.2).

In order to implement STEP 2, further information is needed on commodities representing the processing stages of forest harvesting eventually used as feedstock for the production of the semi-finished HWP categories listed above (cf. Figure 2.8.2). This is provided below. Some possible feedstock commodities are not included due to difficulties in determining sources and multiple uses, e.g. wood chips used in wood-based panel production as some chips come from industry co-products, others could be recycled products and others go to energy use (see Figure 2.8.3).

According to the 2006 *IPCC Guidelines*, "**WOOD-REMOVALS** are generally a subset of fellings".

ROUNDWOOD: "All roundwood felled or otherwise harvested and removed. It comprises all wood obtained from removals, i.e. the quantities removed from forests and from trees outside the forest, including wood recovered from natural, felling and logging losses during the period, calendar year or forest year. It includes all wood removed with or without bark, including wood removed in its round form, or split, roughly squared or in other form (e.g. branches, roots, stumps and burls (where these are harvested) and wood that is roughly shaped or pointed. It is an aggregate comprising wood fuel, including wood for charcoal and industrial roundwood (wood in the rough). It is reported in cubic metres solid volume underbark (i.e. excluding bark)." [105]

INDUSTRIAL ROUNDWOOD (WOOD IN THE ROUGH): "All roundwood except wood fuel. In production, it is an aggregate comprising sawlogs and veneer logs; pulpwood, round and split; and other industrial roundwood. It is reported in cubic metres solid volume underbark (i.e. excluding bark). The customs classification systems used by most countries do not allow the division of Industrial Roundwood trade statistics into the different end-use

categories that have long been recognized in production statistics (i.e. sawlogs and veneer logs, pulpwood and other industrial roundwood). Thus, these components do not appear in trade. It excludes: telephone poles." [105]

WOOD PULP: "Fibrous material prepared from pulpwood, wood chips, particles or residues by mechanical and/or chemical process for further manufacture into paper, paperboard, fibreboard or other cellulose products. It is an aggregate comprising mechanical wood pulp; semi-chemical wood pulp; chemical wood pulp; and dissolving wood pulp." [105]

Production data on finished wood products processed from the three semi-finished product categories (see Figure 2.8.2) are not included in international databases. However, the World Customs Organisation Harmonised System (HS) nomenclature (see Section 2.8.1.1) also includes some commodities for finished HWP (e.g. furniture, builders' joinery and carpentry of wood). Accordingly, information on such commodities could be available in national production and trade statistics (See Section 2.8.4.1). Consequently, *good practice* in providing transparent and verifiable activity data for HWP, which qualifies for the provision of Decision 2/CMP.7 to account for the *HWP contribution* on the basis of changes in the HWP pool, is achieved by the availability of data for the three aggregate HWP commodities sawnwood, wood-based panels and paper and paperboard in publicly available databases of international organizations (e.g. FAO). It is *good practice* to report on uncertainties and, wherever it is applicable, levels of confidence related to these datasets (see Section 2.8.6)

In addition, countries with available data on finished wood products produced from the default HWP categories are encouraged to use these data following the guidance given in Section 2.8.4.

2.8.1.2 ALLOCATION OF HWP TO DOMESTIC FOREST ACTIVITIES UNDER ARTICLE 3, PARAGRAPHS 3 AND 4

According to Decision 2/CMP.7, accounting for the *HWP contribution* is restricted to carbon in HWP from forests which are accounted for by the particular Party under Article 3, paragraphs 3 and 4. Carbon in imported HWP is to be excluded.[107] As the accounting framework differentiates between activities under Article 3 paragraph 3 and activities under Article 3 paragraph 4, it is *good practice* to allocate the carbon in HWP to these particular activities. Also within Article 3 paragraph 3, HWP from Deforestation is treated differently from HWP for Afforestation and Reforestation activities.

This section provides a default method on how to implement STEP 2 (See 2.8.1) for estimating the *HWP contribution* originating from forests that are accounted for under the particular forest activities.

Implementation of STEP 2.1

Firstly, the share of carbon in HWP coming from domestic forests is estimated. For this purpose, the domestic consumption of industrial roundwood (IRW_{CONS}) (see Section 2.8.1.1) is assumed to equal the feedstock being used for the subsequent processing of the semi-finished HWP categories sawnwood and wood-based panels within the country (i.e. domestic production, cf. Figure 2.8.1) (Rüter 2011, Johannsen*, et al.* 2011). Similarly it is assumed that the domestic consumption of wood pulp being produced from pulpwood serves as feedstock for the semi-finished HWP commodity paper and paperboard. Generally, domestic consumption is computed from production data plus imports less exports.

However, commodities other than industrial roundwood and/or wood pulp can also serve as feedstock for the production of HWP and the fraction of domestic feedstock in reality differs within the different product categories (Rüter and Diederichs 2012). For example, substantial amounts of industrial wood residues including wood chips are being used for producing particle board (Wilson 2010) (cf. Figure 2.8.3). If detailed and representative information on the composition of feedstock and the associated wood flows is available for these domestically produced HWP commodities, countries are encouraged to use this country-specific information to estimate the fraction of feedstock from domestic harvest for HWP production and apply Tier 3 (see Section 2.8.4.1).

If no country-specific estimates are available to determine the processing of feedstock coming only from domestic origin (e.g. track and trace systems), it is *good practice* to apply Equation 2.8.1 for estimating the annual fraction of the feedstock coming from domestic harvest $f_{IRW}(i)$ for the HWP categories sawnwood and wood-based panels.

[107] Cf. paragraph 27

EQUATION 2.8.1
ESTIMATION OF ANNUAL FRACTION OF FEEDSTOCK FOR HWP PRODUCTION ORIGINATING FROM DOMESTIC HARVEST

$$f_{IRW}(i) = \left(\frac{IRW_P(i) - IRW_{EX}(i)}{IRW_P(i) + IRW_{IM}(i) - IRW_{EX}(i)}\right)$$

Where:

$f_{IRW}(i)$ = share of industrial roundwood for the domestic production of HWP originating from domestic forests in year *i*.

$IRW_P(i)$ = production of industrial roundwood in year *i*, Gg C yr^{-1}

$IRW_{IM}(i)$ = import of industrial roundwood in year *i*, Gg C yr^{-1}

$IRW_{EX}(i)$ = export of industrial roundwood in year *i*, Gg C yr^{-1}

In consideration of the HWP process chain and countries that produce paper from traded pulp and in order to provide more reliable figures, it is likewise *good practice* to apply Equation 2.8.2 to estimate the annual fraction of domestically produced wood pulp as feedstock originating from domestic harvest for the production of the HWP category paper and paperboard ($f_{PULP}(i)$).

EQUATION 2.8.2
ESTIMATION OF ANNUAL FRACTION OF DOMESTICALLY PRODUCED WOOD PULP AS FEEDSTOCK FOR PAPER AND PAPERBOARD PRODUCTION

$$f_{PULP}(i) = \left(\frac{PULP_P(i) - PULP_{EX}(i)}{PULP_P(i) + PULP_{IM}(i) - PULP_{EX}(i)}\right)$$

Where:

$f_{PULP}(i)$ = share of domestically produced pulp for the domestic production of paper and paperboard in year *i*.

$PULP_P(i)$ = production of wood pulp in year *i*, Gg C yr^{-1}

$PULP_{IM}(i)$ = import of wood pulp in year *i*, Gg C yr^{-1}

$PULP_{EX}(i)$ = export of wood pulp in year *i*, Gg C yr^{-1}

The resulting feedstock factor $f_{IRW}(i)$ is then applied for the aggregate commodities sawnwood and wood-based panels in Equation 2.8.4 below. For estimating the *HWP contribution* of the aggregate commodity paper and paperboard, both feedstock factors $f_{IRW}(i)$ and $f_{PULP}(i)$ apply.

Implementation of STEP 2.2

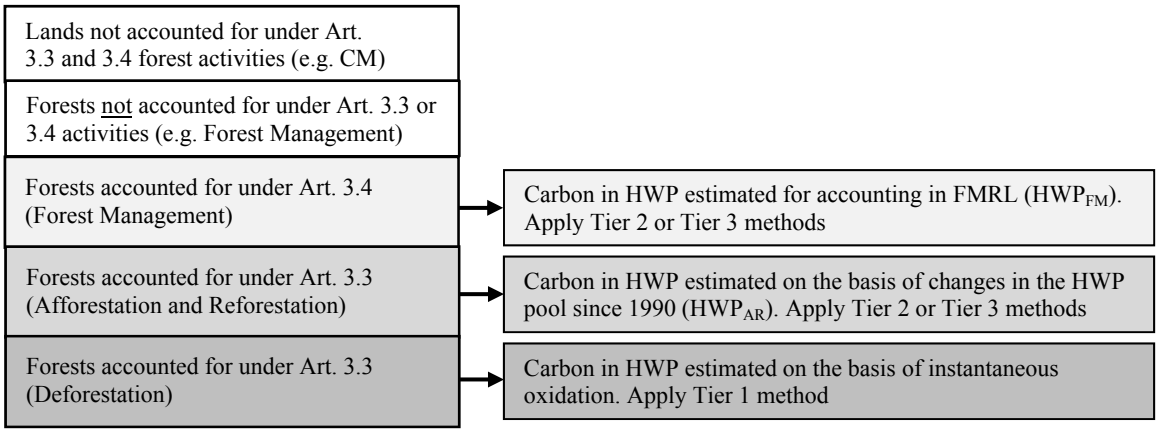
In a next step, the carbon in HWP needs to be allocated to the particular forest activities under Article 3, paragraphs 3 and 4 (see Figure 2.8.1) as the *HWP contribution* is estimated differently depending on the origin of the wood. Under Article 3 paragraph 3, the *HWP contribution* originating from forest activities Afforestation (A), Reforestation (R) and Deforestation (D) is estimated since the base year 1990. The *HWP contribution* from HWP originating from the activity Forest Management (FM) under Article 3 paragraph 4 is accounted for in the second commitment period on the basis of a forest management reference level (FMRL) [108] (See Section 2.7.5).

It is *good practice* to apply Tier 2 or Tier 3 methods for the particular fractions of HWP derived from domestic forests accounted for under FM and AR activities (HWP_{FM} and HWP_{AR}) in line with the provisions set out in Decision 2/CMP.7[109] (See Section 2.8.1.2 and Figure 2.8.4). In both cases, guidance on estimation methods is provided in Sections 2.8.3 and 2.8.4. For HWP originating from D activities the Tier 1 method "shall" be applied (Section 2.8.2).

[108] Paragraphs 12 and 14

[109] Paragraph 16, 29 and 30

Figure 2.8.4 Relationship between sources of feedstock for HWP, forest activities and the application of the relevant tier method for estimating the HWP contribution



If no country-specific approaches are available to allocate domestic harvest and subsequently produced products therefrom to the activities ARD and/or FM (e.g. by track and trace systems), it is *good practice* to apply Equation 2.8.3 for estimating the annual fraction of HWP derived from the specific forest activity ($f_j(i)$) as a default. This also includes harvest that has been subject to salvage logging. The identified share of the total harvest is then be assigned to the HWP associated with the particular forest activity by application of Equation 2.8.4.

EQUATION 2.8.3
ESTIMATION OF ANNUAL FRACTION OF FEEDSTOCK FOR HWP ORIGINATING FROM FOREST ACTIVITIES UNDER ARTICLE 3, PARAGRAPHS 3 AND 4

$$f_j(i) = \left(\frac{harvest_j(i)}{harvest_{Total}(i)}\right)$$

Where:

$f_j(i)$ = share of harvest originating from the particular activity *j* in year *i*.

j = activity *FM* or *AR* or *D* in year *i*.

Where countries already collect data of harvesting discriminating among different activities (i.e. lands subject to FM, lands subject to AR, lands subject to D, and any other treed land) – and among material and energy use of harvested roundwood (i.e. industrial roundwood and fuelwood, cf. Figure 2.8.2), this information can be used. This is usually the case where countries apply the gain-loss (i.e. flux data) method.

Most countries only report industrial roundwood from forests to the statistics and the uncertainties associated with feedstock for HWP production (cf. Figure 2.8.2) originating from lands other than forests (see Figure 2.8.4) are generally expected to be insignificant. However, due to the definition of roundwood (see Section 2.8.1.1), it may be the case that the specified HWP categories are produced from industrial roundwood (or domestic feedstock), which does not originate from forests which are accounted for under Article 3, paragraphs 3 (AR and D) and 4 (FM) (cf. Figure 2.8.2).[110] In the Kyoto Protocol accounting framework, activities on lands which are not considered to be forests (cf. Figure 1.1) and which could provide industrial roundwood to the markets (e.g. short-rotation plantations), could instead be accounted for under the activity Cropland Management on a voluntary basis[111] (e.g. as perennial crops including trees, see Section 2.9.2). Following the guidance given in Sections 2.9.1 and 2.9.2 countries are encouraged to provide information on how lands that could potentially be the source of industrial roundwood have been included in their accounting. This is relevant also for forest lands which are not subject to FM, depending on the countries' interpretation of FM (see Section 2.7.1). It is thus *good*

[110] Cf. Paragraph 27

[111] Paragraph 6

practice to ensure that no significant amounts of biomass not originating from forests-related activities have been used as feedstock for the production of the HWP default commodities.

Countries that apply the stock-difference method may need to collect additional data for estimating harvest fractions associated with the particular activity *j* related to forests under Article 3, paragraphs 3 and 4 to apply Equation 2.8.3. When countries cannot track the harvested wood by the land of origin (FM, AR, D, or from treed lands, cf. Figure 2.8.4) and by different uses of wood (i.e. industrial roundwood, fuelwood), the following *good practice* applies:

For deforested lands, the starting information is the standing volume of tree before the deforestation event, which corresponds to the total harvest (i.e. fellings). The following steps should be applied:

STEP 1: Separate roundwood from slash. To this aim:

- Either multiply the standing volume by the ratio of roundwood to total harvested removals that has been calculated for other activities or at national level;
- Or divide the standing volume by the biomass expansion factors (BEF2) provided in Table 3A.1.10, Chapter 3 of the *GPG-LULUCF*, so deriving the amount of roundwood.

STEP 2: Disaggregate the roundwood into industrial roundwood and fuelwood (cf. Figure 2.8.2). To this aim:

- Either multiply the roundwood by the ratio of industrial roundwood to roundwood that has been calculated for other activities or at national level;
- Or use the proportion calculated by comparing production data from FAOSTAT of the commodities industrial roundwood and fuelwood (i.e. wood fuel) and after having multiplied wood fuel data by a factor[112] of 0.7 in order to exclude all fuelwood originating from slash.

For afforested/reforested lands, the starting information is the standing volume of trees from which fellings is derived according with the age-class structure and/or yield tables and/or information on the timing of harvesting and thinning operations for each management system. Then, same steps, as described for deforested lands, should be applied to separate roundwood from slash and disaggregate roundwood into industrial roundwood and fuelwood.

For treed lands that are not reported under any forest-related activity (See Sections 1.1 and 1.2), and that produce significant amounts of harvest (cf. Figure 2.8.4), then the country should estimate the amount of industrial roundwood annually produced from those lands in order to exclude it from the HWP estimation.

Industrial roundwood from treed lands could be estimated:

- Either by knowing, for each tree species, the total amount of harvest, from which the amount of harvest originating from AR and D lands is subtracted and the remaining amount is apportioned among lands subject to FM and other treed lands on the basis of the proportion of the total area covered by each species under FM and under treed lands. Once the fellings amount has been apportioned to treed lands the industrial roundwood is estimated by applying same steps as described for afforested/reforested lands;
- Or by subtracting from the total harvest the amount of fellings originating from AR and D lands, as quantified by available data or as estimated according to above-listed guidance, and, then, apportioning the remaining quantity on the basis of the proportion of the area under FM and under treed lands.

Finally, the amount of industrial roundwood produced from FM lands is estimated by subtracting from the total harvest the quantity of fellings originating from AR, D and treed lands and by calculating the amount of industrial roundwood associated with FM in line with the above-listed guidance.

For each forest-related activity, for the years of the time series for which a ratio of industrial roundwood originated by the activity to the total produced roundwood cannot be estimated, it is *good practice* to derive missing values from the values of the ratio that have been calculated according to methods of gap-filling as provided in the *2006 IPCC Guidelines*.

Countries that use the stock-difference method, and that apply the above-listed *good practice* for estimating the fellings for D, AR and/or FM, are encouraged to ensure the quality of estimated values of harvesting by checking their consistency with the estimated net changes in aboveground biomass.

In case it is not possible to differentiate between the harvest from AR and FM, it is a conservative approach and *good practice* to assume that all HWP entering the accounting framework originate from FM. The reason is that the potential contribution to the reported carbon stock changes is higher if HWP originate from AR rather than

[112] This factor has been derived from the publication "Le bois-énergie en France" of the Institut d'évaluation des stratégies énergétiques en Europe (INESTENE) published on Les cahiers du CLIP - N°8 (1994)

from FM, as for AR, the estimates start in 1990 and gross-net accounting rules apply (cf. Sections 2.5.3 and 2.8.3).

It is furthermore a conservative approach and *good practice* to assume that all harvested wood prior to the start of the first commitment period is derived from FM as the annual fraction of feedstock for HWP originating from forest activities under Article 3, paragraphs 3 and 4 ($f_j(i)$) can only be estimated from information available from the first and second commitment periods.

Implementation of STEP 2.3

In order to obtain the annual fractions of HWP entering the accounting framework from domestic harvest associated with the particular activity *j* (ARD and FM), the results of STEP 2.1 (i.e. Equations 2.8.1 and 2.8.2) and STEP 2.2 (i.e. Equation 2.8.3) are, as a default, to be combined with the annual production of the HWP commodity categories (HWP_P) as specified in Section 2.8.1.1 (i.e. sawnwood, wood-based panels, paper and paperboard). For this purpose, it is *good practice* to apply Equation 2.8.4, in case no country-specific track and trace systems are available.

EQUATION 2.8.4
ESTIMATION OF ANNUAL HWP AMOUNTS BEING PRODUCED FROM DOMESTIC HARVEST RELATED TO ACTIVITIES UNDER ARTICLE 3, PARAGRAPHS 3 AND 4

$$HWP_j(i) = HWP_P(i) \bullet f_{DP}(i) \bullet f_j(i)$$

with: $f_{DP}(i) = f_{IRW}(i)$ for HWP categories 'sawnwood' and 'wood-based panels'; and
$(f_{IRW}(i) \bullet f_{PULP}(i))$ for HWP category 'paper and paperboard'
with: $f_{IRW}(i) = 0$ if $f_{IRW}(i) < 0$ and $f_{PULP}(i) = 0$ if $f_{PULP}(i) < 0$

Where:

$f_{DP}(i)$ = share of domestic feedstock for the production of particular HWP category originating from domestic forests in year *i*

$HWP_j(i)$ = HWP amounts being produced from domestic harvest associated with activity j in year *i*, in m³ or Mt yr^{-1}

$HWP_P(i)$ = production of the particular HWP commodities (i.e. sawnwood, wood-based panels and paper and paperboard, or their sub-categories, see Section 2.8.1.1) in year *i*, in m³ or Mt yr^{-1}

Note: Equation 2.8.4 must be applied separately to each of the defined HWP commodities (HWP_p) and separately to HWP related to activities under Article 3, paragraphs 3 and 4 (HWP_j).

The estimates associated with the forest related activities ARD and FM also apply in case countries provide estimates for sub-categories of the three HWP default categories (see Section 2.8.3.1), or for country-specific activity data e.g. on assemblies composed of a combination of products, such as in wooden buildings. Further guidance on how to estimate fraction of HWP originating from forests being accounted for under Article 3, paragraphs 3 and 4 using country-specific activity data is provided in Section 2.8.4.1.

2.8.2 Tier 1: "Instantaneous oxidation"

The method presented in this section is to be applied by countries as the default method to estimate the *HWP Contribution*.[113] It is based on the assumption that the annual amount of carbon leaving the HWP pool is the same as the annual carbon inflow to the pool. In consequence, this method corresponds to an estimate of no change in HWP carbon stocks. It equals the assumption that all carbon in biomass harvested is oxidised in the removal year and is equivalent to reporting no net-emissions from HWP, as the annual change in carbon stock in HWP is zero (cf. IPCC 1997, IPCC 2006).

For the first commitment period, the storage of carbon in HWP was not included in the reporting since the mere presence of carbon stocks is excluded from the accounting and HWP were not listed as a pool covered by the Marrakesh Accords.[114] Countries following the *good practice* guidance as described in *GPG-LULUCF* (IPCC

[113] Paragraph 28

[114] Decision 11/CP.7

2003) and applying instantaneous oxidation, did thus not report and/or account for emissions from HWP in the first commitment period.[115]

Decision 2/CMP.7 establishes mandatory accounting of all changes in the HWP pool.[116] A prerequisite for accounting HWP on the basis of delayed emissions is the availability of transparent and verifiable HWP activity data (see Section 2.8.1.1). Consequently, it is *good practice* to apply the Tier 1 method as outlined in this section (i.e. reporting no net-emissions from HWP) only in case no transparent and verifiable activity data for the default HWP categories sawnwood, wood-based panels and paper and paperboard as outlined in Section 2.8.1.1 are available.[117] However, Decision 2/CMP.7 specifies that "the treatment of HWP in the construction of a projected forest management reference level (FMRL, see Section 2.8.5) shall not be on the basis of instantaneous oxidation".[115].

For the following HWP fractions instantaneous oxidation (i.e. Tier 1) "shall be" applied (see Figure 2.8.1):

- HWP resulting from D activities under Article 3 paragraph 3 (see Section 2.8.1.2);[118]
- HWP in solid waste disposal sites;[119]
- Harvested wood being used for energy purposes.[119]

Following the guidance given in Section 2.8.1.2, the fraction of HWP originating from domestic forests being accounted for under the activities AR and FM can be derived. Thereby, the fraction of HWP resulting from D is implicitly excluded from further estimation of the *HWP contribution* and instantaneous oxidation is applied. In line with the requirements of Decision 2/CMP.8[120], it is *good practice* to demonstrate that harvested wood originating from D (i.e. $harvest_D$, see Equation 2.8.3) has not been included in the estimates on the basis of the change of the HWP pool. This could be done by reporting the annual share of the overall harvest originating from D ($harvest_D$ (i)).

By estimating the *HWP contribution* on the basis of methodologies as outlined in Sections 2.8.3 and 2.8.4, only the *HWP contribution* of HWP in use is estimated. HWP in solid waste disposal sites and wood harvested for energy are thus implicitly treated on the basis of instantaneous oxidation (i.e. reporting no net-emissions from HWP). Estimates that are based on the three default commodities are per definition not derived from wood harvested for energy purposes. Where CO_2 emissions from HWP in solid waste disposal sites are separately accounted for, it is *good practice* to include them on the basis of instantaneous oxidation".

2.8.3 Tier 2: First order decay

Provided transparent and verifiable activity data are available for the three default HWP categories sawnwood, wood-based panels and paper and paperboard, as defined in Section 2.8.1.1, and no country-specific information qualifying to apply a Tier 3 method are available (cf. Section 2.8.4), Parties are required to obtain estimates on the *HWP contribution* by application of the Tier 2 method as outlined in this section.[121]

In line with the Decision 2/CMP.7, it is *good practice* to estimate the change in carbon stocks separately for each of the HWP fractions originating from AR (HWP_{AR}) and from FM (HWP_{FM}) as estimated from Equation 2.8.4. For this purpose, the first-order decay (FOD) function as presented in Equation 2.8.5, which is a flux data method that corresponds to Equation 12.1, Chapter 12, Volume 4 of the *2006 IPCC Guidelines*, is to be applied:

[115] Cf. Paragraph 16

[116] Paragraph 26

[117] Cf. Paragraph 29

[118] Paragraph 31

[119] Paragraph 32

[120] Paragraph 2 of the Annex II of Decision 2/CMP.8 contained in document FCCC/KP/CMP/2012/13/Add.1

[121] Paragraph 29

EQUATION 2.8.5
ESTIMATION OF CARBON STOCKS AND ANNUAL CARBON STOCK CHANGES IN HWP POOL OF THE REPORTING COUNTRY

$$C(i+1) = e^{-k} \bullet C(i) + \left[\frac{(1-e^{-k})}{k}\right] \bullet Inflow(i)$$

$$\Delta C(i) = C(i+1) - C(i)$$

Sources: IPCC 2006 ; Pingoud and Wagner 2006

Where:

i = year

C (i) = the carbon stock in the particular HWP category at the beginning of year i, Gg C

k = decay constant of first-order decay for HWP category given in units yr^{-1} (k = ln(2)/HL, where HL is half-life of the HWP pool in years (see Section 2.8.3.2).

Inflow (i) = the inflow to the particular HWP category (HWP_j) during year i, Gg C yr^{-1}

$\Delta C(i)$ = carbon stock change of the HWP category during year i, Gg C yr^{-1}

It is *good practice* to apply Equation 2.8.5 with activity data for the semi-finished wood product categories sawnwood, wood-based panels and paper and paperboard that have been assigned to the particular forest activities (HWP_{AR} *and* HWP_{FM}) (see Section 2.8.1). In combination with semi-finished wood product commodities, this FOD implicitly includes finished HWP in the pool estimates, and it is assumed that "immediate losses of the HWP pool due to final processing along the processing chain (cf. Figure 2.8.2) are described realistically by the exponential decay pattern" (Pingoud and Wagner 2006). Emissions from wood processing residues used for energy purposes along the process chain of HWP are also well described by FOD (cf. Rüter and Diederichs 2012).

Whereas Equation 12.1, Chapter 12, Volume 4 of the *2006 IPCC Guidelines* suggests to start with i = 1900, application of FOD in the context of the Decision 2/CMP.7 necessitates a differentiated approach to enable HWP accounting associated with the different forest activities (see Section 2.8.1.2).

In order to produce an estimate of the existing HWP carbon pool by means of Equation 2.8.5, and based on the subsequent changes of this pool to produce an estimate of the *HWP contribution*, the historical wood use (i.e. the accumulation of the historic *Inflow* to the HWP pool) has to be included. This procedure is needed as this also includes the historic and current discard from the HWP pool, which is also termed "inherited emissions" (IPCC 2006). This is reflected in Decision 2/CMP.7, which states that "emissions that occur during the second commitment period from harvested wood products removed from forests prior to the start of the second commitment period shall also be accounted for."[122] The term "emissions" from HWP (which are defined as a pool[123]) thus refers to the "decay" from that pool, which is the discarding of wood and paper products from end uses described e.g. by FOD (i.e. Equation 2.8.5). Discarding, thus, does not mean that the products' carbon is oxidized, but describes the release of HWP from the HWP pool in use (or in service) from where the products are potentially recycled, burned, composted or transferred to solid waste disposal.[124] The discard from the pool of HWP in use (comprising wood products in service), therefore depends on the historic level of Inflow (see Section 2.8.1) and the particular service life and/or half-life of the HWP commodities (cf. Sections 2.8.3.2 and 2.8.4.2).

In order to account for the *HWP contribution* from A and R activities, estimates are to be based on activity data since the base year 1990. It is thus *good practice* to include inherited emissions from the pool that has been established from HWP_{AR} since 1990. This is implemented by the use of Equation 2.8.5 starting with i = 1990.

For HWP from FM activities, however, the inclusion of inherited emissions in the estimates of the HWP carbon pool depends on the Party's accounting approach for FM. In case the FM reference level (FMRL) is based on a projection which represents a 'business as usual scenario' (See Sections 2.7.5.1 and 2.8.5), Parties may exclude inherited emissions from before the start of the second commitment period in their estimates.[125] In this case, the

[122] Paragraph 16

[123] Cf. Paragraph 26

[124] For more information see IPCC FAQ, Q4-29 (http://www.ipcc-nggip.iges.or.jp/faq/faq.html)

[125] Paragraph 16

estimation by means of Equation 2.8.5 starts with i = 2013. If the Party's FMRL is not based on a projection representing a 'business as usual scenario', it is thus *good practice* to include inherit emissions from the pool.

As reflected by Equation 2.8.4 ($HWP_j(i)$), it is also *good practice* to separately estimate and report by the above procedure the annual *HWP contribution* for:

- HWP from AR activities (HWP_{AR}) and for HWP from FM activities (HWP_{FM})
- HWP for each of the particular commodities (i.e. sawnwood, wood-based panels, paper and paperboard or their subcategories)

The availability of activity data series (i.e. $Inflow(i)$) varies. For most countries e.g. the FAO statistics provide data on the HWP commodity categories since 1961.[126] However, for some countries activity data are available only since their independence or foundation (e.g. in 1991). Further guidance on the activity data to be used for Tier 2 method is provided in Section 2.8.3.1.

As a proxy in the Tier 2 method it is assumed that the HWP pools are in steady state at the initial time t_0 from which the activity data start. This means that as a proxy $\Delta C(t_0)$ is assumed to be equal to 0. This steady state carbon stock $C(t_0)$ for each HWP commodity category is approximated by means of Equation 2.8.6 based on the average of $Inflow(i)$ during the first 5 years of which statistical data are available. By substituting $C(t_0)$ in Equation 2.8.5, the $C(i)$ and $\Delta C(i)$ in the sequential time instants can be calculated. In the Tier 2 method, it is *good practice* to use Equation 2.8.6 for estimating stock at $t = t_0$.

EQUATION 2.8.6
APPROXIMATION OF THE CARBON STOCKS IN HWP POOLS AT INITIAL TIME, I.E. SINCE WHEN ACTIVITY DATA ARE AVAILABLE

$$C(t_0) = \frac{k}{Inflow_{average}}$$

where $Inflow_{average} = \left(\sum_{i=t_0}^{t_4} Inflow(i)\right)/5$

Only in case a projected FMRL is applied (cf. Section 2.8.5), also other methods could be used. Further estimation methods for calculating the carbon inflow to the HWP_{FM} pool (*Inflow(i)*) back to the year 1900 are provided by the *2006 IPCC Guidelines* (i.e. on the basis of estimated annual rates of increase for industrial roundwood production that are based, inter alia, on the annual per cent change of population growth) or in Rüter 2011 (i.e. calculate missing activity data since the year 1900 on HWP_{FM} carbon pool inflow from the average of the first five years for which activity data are given for the country).

In case the FMRL has been based on a projection representing a 'business as usual scenario' (see Section 2.7.5 and 2.8.5), in line with Decision 2/CMP.8, it is *good practice* to provide information whether and how inherit emissions have been included in the HWP estimates. Otherwise, if the inclusion of HWP in the countries' FMRL is not based on a projection, it is *good practice* to explain that the approach chosen to include inherited emissions in the estimates of the HWP carbon pool reflects best the countries' circumstances (e.g. data availability). Further guidance on the consideration of HWP in the FMRL is provided in Section 2.8.5.

The carbon stock change in all the HWP pools of the commodities associated with the particular activities is obtained by summing the stock changes ΔC of each commodity category. The carbon stock change is then converted into Gg CO_2 yr^{-1} by multiplying by –44/12.

Under the Tier 2 method, Equation 2.8.5 is equally applied for domestically consumed as well as for exported HWP together with the same half-life parameters (See Section 2.8.3.2). Therefore, it complies with *good practice* not to differentiate between domestic consumption and exports in the reporting of the *HWP contribution*. In order to increase transparency and facilitate potential changes in the methodology used to estimate the *HWP contribution* (e.g. by application of country-specific half-lives following the guidance provided in Section 2.8.4), however, Parties are encouraged to report separately for domestically consumed and exported HWP.

[126] http://faostat.fao.org/site/630/default.aspx

2.8.3.1 ACTIVITY DATA

Activity data include the carbon stock of the HWP pool at the beginning of each year (C(i)) and the inflow to the HWP pool during each year (*Inflow* (*i*)) for each HWP category. In order to apply Equation 2.8.5, it is *good practice* to determine C(*i*) and *Inflow* (*i*).

TABLE 2.8.1
DEFAULT CONVERSION FACTORS FOR THE DEFAULT HWP CATEGORIES AND THEIR SUBCATEGORIES

HWP categories	Oven dry density [Mg / m^{-3}]	Carbon fraction (per oven dry density)	C conversion factor (per air dry density) [Mg C / m^{-3}]	Source
Sawn wood (*aggregate*)	0.458	0.5	0.229	1
Coniferous sawnwood	0.45	0.5	0.225	2
Non-coniferous sawnwood	0.56	0.5	0.28	2
Wood-based panels (*aggregate*)	0.595	0.454	0.269	3
Hardboard (HDF)	0.788	0.425	0.335	4
Insulating board (Other board, LDF)	0.159	0.474	0.075	5
Fibreboard compressed	0.739	0.426	0.315	6
Medium-density fibreboard (MDF)	0.691	0.427	0.295	4
Particle board	0.596	0.451	0.269	4
Plywood	0.542	0.493	0.267	7
Veneer sheets	0.505	0.5	0.253	8
	[Mg / Mg]		**[Mg C / Mg]**	
Paper and paperboard (*aggregate*)	0.9		0.386	9

[1] Calculated from the weighted average of coniferous and non-coniferous sawnwood production volumes (FAOSTAT average of the years 2006-2010) of the countries as listed in Appendix of the Annex of Decision 2/CMP.7

[2] IPCC 2003, Appendix 3a.1

[3] Calculated from the weighted average of included subcategories of the production volumes (FAOSTAT average of the years 2006-2010) of the countries as listed in Appendix of the Annex of Decision 2/CMP.7

[4] Rüter and Diederichs (2012)

[5] Derived from Environmental product declarations EPD-GTX-2011111-E, EPD-KRO-2009212-E and EPD-GTX-2011211-E provided by IBU e.V. (http://bau-umwelt.de/hp550/Insulating-materials.htm)

[6] Calculated from 50% of HDF and 50% of MDF

[7] Derived from Wilson and Sakimoto (2005) and BD for non-coniferous species listed in the table above

[8] Calculated from 50% sawnwood (C) and 50% of sawnwood (NC)

[9] Calculated from the weighted average of included subcategories of the production volumes (FAOSTAT average of the years 2006-2010) of the countries as listed in Appendix of the Annex of Decision 2/CMP.7, including information derived from Fengel and Wegener (1984), Paulapuro (2000), Gronfors (2010) and industry information.

For this purpose, Tier 2 uses forest products data from FAO or other international organizations (e.g. UNECE) for semi-finished HWP commodities as set out in Section 2.8.1.1. As a default, the annual *Inflow*(i) to the HWP pool comprises of the three default HWP commodity categories, i.e. sawnwood, wood-based panels, paper and paperboard), separated by the particular activity ($HWP_j(i)$, see Section 2.8.1.2).

In order to estimate carbon amounts in HWP, default conversion factors are provided in Table 2.8.1. In fact, the conversion factors for the HWP default commodities (i.e. aggregates) very much depend on composition of countries' production amounts of the particular subcategories (e.g. particle board). If Parties have disaggregated data on subcategories of semi-finished wood products as listed in Table 2.8.1, it is thus *good practice* to apply Equation 2.8.5 to the disaggregated subcategories.

In order to reduce uncertainties associated with assumptions on the conversion factors of activity data (i.e. data on semi-finished wood product commodities derived from statistics) (See Section 2.8.6), Parties are encouraged to use country-specific activity data comprising further items of the HWP subcategories as listed in Table 2.8.1. More information can be obtained in Section 2.8.4.1.

2.8.3.2 EMISSION FACTORS

The rate at which carbon in the default HWP categories is removed from the HWP pool in service in a given year is specified by a constant decay rate (k) is expressed as half-life in years. The *2006 IPCC Guidelines* define the half-life as "the number of years it takes to lose one-half of the material currently in the pool". As the half-life in the context of Decision 2/CMP.7 refers to HWP in use (cf. Section 2.8.1.1), the half-life to be applied is a function of the adjusted estimated service life (ESL) of the particular HWP commodities (with HL = Adjusted ESL * ln(2), cf. Section 2.8.4.2).

When applying the Tier 2 method, Decision 2/CMP.7 requires countries to use the default half-lives of the three HWP categories as specified in Table 2.8.2. The same half-lives apply for the particular subcategories of the aggregate HWP categories as specified in Table 2.8.1.

TABLE 2.8.2
TIER 2 DEFAULT HALF-LIVES[127] OF HWP CATEGORIES

HWP categories[128]	Default half-lives (years)
Paper	2
Wood panels	25
Sawn wood	35

In order to reduce uncertainties associated with the assumptions on the half-lives of the HWP commodities (See Section 2.8.6) Parties are encouraged to use country-specific half-lives, both for the domestic use of HWP categories, as well as country-specific half-lives as being applied by the importing country for the exported HWP categories. Further guidance on how to use and obtain country-specific half-life information for the relevant HWP categories can be obtained in Section 2.8.4.2.

2.8.4 Tier 3: Country-specific methods

This section provides *good practice* guidance on the use of country-specific methods to estimate the HWP carbon pool and its changes in order to estimate the *HWP contribution*. They may include country-specific half-lives and/or methodologies and may be applied by Parties where sufficient data are available in line with requirements as outlined in Section 2.8.1 and the Decision 2/CMP.7[129] covering the three semi-finished HWP categories.[130] It complies with *good practice* to apply country-specific methods "provided that verifiable and transparent activity data are available and that the methodologies used are at least as detailed or accurate"[129] as those described in Section 2.8.3 (Tier 2). *Good practice* thus includes a verification of the Tier 3 methods used, e.g. by comparing the results derived using the Tier 2 method (See Section 2.8.3), and by providing all relevant information in a transparent and verifiable way to demonstrate how the *HWP contribution* has been estimated. More information on how to verify Tier 3 methods can be found in IPCC FAQs on HWP.[131]

Two key Tier 3 methodological pathways allow for estimating changes in the HWP carbon pool in line with the requirements as outlined in Decision 2/CMP.7 comprising (i) flux data methods, and (ii) combinations of stock inventory and flux data methods.

FLUX DATA METHODS

[127] See footnote of paragraph 29 of Decision 2/CMP.7: Half-lives are based on Table 3a.1.3 of the *GPG-LULUCF*.

[128] HWP categories as defined in paragraph 29 of Decision 2/CMP.7 refer to the commodities sawnwood, wood-based panels, paper and paperboard, acc. to the international classification system for forestry products (See guidance in Section 2.8.1.1)

[129] Paragraph 30

[130] Use of Tier 3 methods does not apply to exported wood in circumstances where the importing country uses Tier 3 methods and the exporting country uses Tier 2 methods. This would lead to inconsistencies in the accounting. An example of this situation would be exported sawnwood accounted for under a Tier 2 method, which is then processed into floor boards by the importing country, which applies a Tier 3 method with half-lives for HWP subcategories.

[131] http://www.ipcc-nggip.iges.or.jp/faq/faq.html

In flux data methods HWP carbon pool and its changes are basically calculated from the difference of the production (i.e. carbon inflow to the HWP pool) and decay/discard rate. There are comprehensive international activity databases on production and trade of HWP (See Section 2.8.1.1), whereas information on the discard from the HWP pool is incomplete. Using this discard information (e.g. from waste statistics) to calculate the above difference would lead to overestimation of HWP carbon pool and its changes. Thus practicable flux data methods that comply with *good practice* rest on service life information of HWP. They are based on the use of decay functions and dynamic models assuring the continuity of mass so that all HWP carbon coming into the pool will be discarded in the long run.

Following alternatives under a Tier 3 method could be used:

- The Tier 2 FOD function (See Equation 2.8.5) is a special case of flux data methods and could also be applied under Tier 3 with:
  - (i) Default half-lives in combination with country-specific activity data for disaggregated commodity items of the three HWP commodities that follow the HS nomenclature system as explained in section 2.8.1.1 (see 2.8.4.1)
  - (ii) Country-specific half-lives to be based on national information on service life of the default HWP commodities or their sub-categories (See below and Section 2.8.4.2).
- Other country- or product-specific decay functions could be applied. Examples of different decay functions include logarithmic decay (e.g. Karjalainen, et al. 1994), retention curves (e.g. Skog and Nicholson 1998) and distribution functions (e.g. Marland, et al. 2010). They could be used with in combination with:
  - (i) Default half-lives (See Table 2.8.2), or country specific half-lives as specified in Section 2.8.4.2
  - (ii) Country-specific activity data (See Section 2.8.4.1).

Furthermore, it complies with *good practice* to separately estimate and report the *HWP contribution* of the HWP pool for the domestic market (i.e. reporting Party) and for export markets, in case:

- Country-specific half-lives or decay functions, and/or
- Country-specific activity data (i.e. other than specified in Section 2.8.3.1) are used.

In case HWP pools of both semi-finished and finished products are included in Tier 3 calculation models it is *good practice* to ensure that overlapping of the HWP pools must be eliminated to avoid any double-counting of HWP carbon stock changes.

COMBINED HWP STOCK INVENTORY AND FLUX DATA METHODS

HWP stock inventory methods use data of the HWP carbon pool itself for two or preferably more separate points in time to estimate changes in the pool. Its application is basically relevant for HWP pools in the reporting country alone (See Section 2.8.4.1) and could be used to estimate the annual change in carbon stock of some specific finished HWP pools (cf. Figure 2.8.3) such as buildings. Examples of such inventories are reported in Gjesdal*, et al.* (1996) for Norway, in Pingoud*, et al.* (2001) and Statistics Finland (2011) for Finland.

In case of inventory methods, no procedure for adding up wood use data from historical data is needed to estimate the existing HWP stock or annual change in stock, which is an advantage compared to the flux methods (IPCC 2006). However, a fundamental problem in the application of inventory methods alone for the present accounting purpose is the estimation of that part of the HWP carbon stock originated from domestic forests and being thus accountable for (See Section 2.8.1). Furthermore, in line with Decision 2/CMP.7, imported HWP must be excluded from the estimated HWP pool increasing the uncertainties.[132]

Since in practice inventory data are not available for all finished HWP for domestic and export markets covering the HWP categories sawnwood, wood-based panels, paper and paperboard (e.g. wooden houses, furniture, newspaper), it is *good practice* to apply inventory methods only in combination with flux data methods.

In case a Party applies inventory methods for specific HWP end uses (e.g. the housing sector), it is thus *good practice* to estimate the *HWP contribution* for the remaining fraction of the three HWP default commodities in combination with the flux-data method under Tier 2 or 3. For this purpose, the three HWP categories being used in the housing sector must be factored out from the flux-data calculation to avoid double-counting and to meet the requirements of Decision 2/CMP.7.

[132] Paragraph 27

2.8.4.1 COUNTRY-SPECIFIC ACTIVITY DATA

Section 2.8.1.1 introduces the international classification system of forestry products following HS nomenclature, which is also relevant for activity data used for a Tier 3 method. Whereas data for semi-finished HWP can be obtained from national statistics as well as from international databases, HWP activity data other than outlined in Section 2.8.3.1 (See Table 2.8.1) are available from national sources only. In the case of Parties using country-specific activity data as described in this section, it is *good practice* to disclose the source of data and provide in a transparent and verifiable manner additional information for items that make up subcategories and/or final products being produced from the three default HWP categories as defined in Decision 2/CMP.7[133] (cf. Figure 2.8.2).

Country-specific HWP activity data to be used for Tier 3 could be:

1. Item data following the international HS nomenclature and classification system

These data could be available from country-specific statistics containing further disaggregated items of the subcategories as specified in Table 2.8.2. Examples would be coated particle board, fibreboard with specific density or surface, or coniferous sawnwood made from specific tree species (e.g. larch). Introducing disaggregated item data using appropriate carbon conversion factors e.g. based on information on wood densities can contribute to considerably improve the accuracy of the HWP estimations. Further information could be obtained e.g. in Forest Products Laboratory 2010.

In some cases, the aggregated datasets for the specified HWP categories available from national statistics are different from available databases of international organizations (e.g. FAO or UNECE). In order to reduce uncertainties associated with the use of these datasets (see Section 2.8.6) and in order to provide country-specific activity data in a transparent and verifiable way, Parties are encouraged to explain the differences between data used from national sources from these provided in international databases.

2. Finished HWP not containing components with different service lives

These types of activity data refer to finished HWP that do not contain components with different potential half-lives. They are made up from at least one of the (default) semi-finished HWP categories (See Figures 2.8.2 and 2.8.3). This group of products comprise e.g. doors, flooring systems, books or furniture, which could also be obtained from national production statistics (e.g. furniture production statistics).

3. Data on buildings with different wooden construction components with different renovation intervals

These types of products rather represent a market segment where finished products (see above) are used (See Figure 2.8.3). Wooden houses are composed of different construction components with different renovation intervals, e.g. long lived roof construction made of beams, wall systems, and comparatively short-lived wooden flooring systems. Country-specific activity data for buildings could again be derived from the production statistics (e.g. Building Construction Starts statistics) or from inventories and surveys.

Some of the above mentioned country-specific activity data (1, 2 and 3) might be available from annual statistics being applicable for flux data methods. Other activity data might be available only at the start and the end of the commitment period for the use in combined HWP stock inventory and flux data methods. Whereas data derived from inventories (e.g. for buildings, see 3) could not be used for the share of exported HWP, data from production and export statistics for finished product categories, such as books or furniture, could be used to estimate the contribution of exported HWP.

In order to allocate the carbon in HWP to the particular forest activities under Article 3, paragraphs 3 and 4 (see 2.8.1.2) Parties could still apply the relevant equations as suggested in Section 2.8.1 for the use in Tier 3 methods. Nevertheless, Parties are encouraged to estimate carbon in HWP originating from domestic forests using more country-specific information, including e.g. detailed data on the use of timber assortments for the subsequent processing of HWP categories. Provided country-specific approaches are available for this purpose, it is *good practice* to demonstrate and report how the allocation has been done to meet the requirements as set out in Decision 2/CMP.7.

When using country-specific activity data, information on carbon conversion factors (cf. Table 2.8.1) may not be readily available. Especially HWP activity data representing finished commodities (See Figure 2.8.2) or market segments of wood use (e.g. wooden building components, see Figure 2.8.3 in Section 2.8.1.2 and Table 2.8.3 in Section 2.8.4.2) often include mixes of wood and other materials. In this case, specific conversion factors could be obtained from statistics or from life cycle inventory (LCI) information, which forms the basis for life cycle assessment (LCA) according to ISO 14040:2006 and 14044:2006. Information on the average amount of wood

[133] Paragraph 30

content per unit could be provided e.g. per square meter of floor space (Tsunetsugu and Tonosaki 2010). Examples of representative LCI information are reported e.g. in Rüter and Diederichs (2012) for Germany.

When using such specific conversion factors, it is *good practice* to demonstrate and report how conversion factors have been derived and provide information on the representativeness of associated data as regards time, technology and geographical scale (see e.g. European Union 2010).

2.8.4.2 COUNTRY-SPECIFIC EMISSION FACTORS

This section gives guidance on the concept of service life and half-life information to estimate the *HWP contribution* on the basis of flux data methods.

In general, national values for service- or half-life could be derived for the three default HWP categories and their subcategories (See Section 2.8.1.1). But also other HWP categories could be established and combined with the respective service life information. However, in order to ensure that the methodology used is at least as accurate as the one described in Section 2.8.3, Parties are encouraged to make those HWP categories broad enough to capture significant carbon volumes contributing to the HWP pool. As a guide, the volumes of HWP categories are deemed significant if they represent at least 5% of the total HWP production.

Potential data providers and sources for national service life information are national and industry agencies, technical literature and direct consultations (i.e. surveys of experts, industry and the general public). It is important to note that service- and half-life values representing the material use of wood can differ notably among and within countries depending on factors such as construction practices, culture, fashion, and climate. Thus, in case country-specific information is used, a national quality control system is encouraged in order to provide transparent and verifiable data.

Several approaches can be used to derive country-specific service- and half-life values based on transparent and verifiable data:

- Following ISO 15686 standard series approach, since this is an already established system for service life estimation on a national, not case specific, level in combination with obsolescence on national level (See Box 2.8.1),
- A combination of production and trade statistics data with building stock inventory information in order to estimate more realistic country-specific through this calibration, and/or
- National surveys on the final market use of wood.

In the following, ways on improving service life estimates based on the ISO 15686 series are shown, and an example of HWP half-life calculation for HWP categories is given based on its ESL (cf. Section 2.8.3.2) in combination with an obsolescence factor and information on its market share.

In order to adequately apply flux data methods based on information on country-specific HWP service life (i.e. time carbon is held in HWP pool in use before they are disposed or recycled), apart from the concept of half-life (See Section 2.8.3.2), following terms and concepts are to be differentiated:

- ISO 15686-1:2011 defines the reference service life (RSL) as the service life of a product, component, assembly or system which is known to be expected under a particular set, i.e. a reference set of in-use conditions;.
- The ESL on the other hand is the service life that a wooden or wood based component would be expected to have in a set of specific in-use conditions. It is determined from RSL data after taking into account any differences from the reference in-use conditions (ISO 15686-1:2011);
- The factor method is used to calculate the ESL. It is a modification of RSL by seven factors to take account of the specific in-use conditions (ISO 15686-8:2008); and
- Obsolescence arises (according to ISO 15686-1:2011) when a facility no longer can be adapted to satisfy changing requirements. Obsolescence tends to result from unexpected changes, often unrelated to the construction, and includes:
    - (i) Functional obsolescence: function no longer required.
    - (ii) Technological obsolescence: new alternatives can offer better performance, change the pattern of use.
    - (iii) Economic obsolescence: Fully functional but less efficient, more expensive than alternatives. This includes also replacement due to changing fashion or taste.

ISO 2011 states that estimates of obsolescence should be based on the designer's and clients experience, and, if possible, documented feedback from practice. In order to estimate the carbon storage of HWP in use and its impact on emissions/removals by means of flux data methods using country-specific service life information, it is thus *good practice* to take into account obsolescence and to distinguish replacement of HWP in use due to e.g. a defective performance from obsolescence (cf. ISO 2011).

For example:

In northern Europe a wooden decking can last for 50 years or more given proper construction and choice of material. But the same decking is likely to be replaced already after 20 years (or less) e.g. due to aesthetical reasons. Hence, for calculating country-specific ESL or half-life values an obsolescence factor is needed to use in Tier 3 estimates of the *HWP contribution* the time actually spent in the HWP carbon pool, not the potential full service life of a wooden component given by ESL.

In this guidance document the ESL is applied for estimates on national level and not for a specific case as suggested in the ISO 15686 standard series. To include the effect of obsolescence:

- Either an additional factor (O) is included, with
  - (i) Obsolescence = 1 when there is considered to be no significant effect of obsolescence compared to RSL
  - (ii) Obsolescence is given a value < 1 based on the intensity of obsolescence
  - (iii) Obsolescence can never be larger than 1.
- Or a decay function to be assigned that uses the service life data to estimate the decay profile (based on products leaving the pool, not only biological decay and not a biological decay profile) or the actual time path that products take to go out-of-use.[134]

An example of how to derive national service life estimates by means of the factor method is given in the box 2.8.1 below.

[134] For more information see IPCC FAQ, Q4-29 (http://www.ipcc-nggip.iges.or.jp/faq/faq.html)

BOX 2.8.1
EXAMPLE ON THE CALCULATION OF NATIONAL ESL BY MEANS OF FACTOR METHOD

A theoretical example with wooden claddings in Norway is given based on the ISO 15686-8: 2008, but elevated from the case specific level given in the standard to a national level. Details about RSL and service life estimation are in ISO 15686-8: 2008.

A factor = 1 when the factor does not to deviate from the RSL conditions. A higher value (x>1) is given if the national performance is better than RSL conditions; a lower value (x<1) is given if the national performance is lower than the RSL conditions. Non relevant factors are excluded from the equation.

The RSL is based on accelerated field trials and failure was defined when the mean decay rating reached 2 (on a scale from 0–4 where 0 is no decay and 4 is failure).

National ESL = 55(RSL)*1(A)*1(B)*1(C)*1.2(E)*1(F)*0.9(G) = 59.4 years

Factor D 'indoor environment' is excluded because it is not relevant. It is *good practice* to include factors that do not deviate from the RSL even if they do not contribute in changing the RSL since they are given the value 1. A more detailed explanation for the choice of factors used is to be provided in the countries' annual reporting.

A = *Inherent performance level* 'represents the grade of the component as supplied'.
- Here equals to RSL.

B = Design level 'reflects the component's installation in the building/constructed asset and is typically based on the level of shelter and protection from agents provided by the design of the building/constructed asset'.
- Here equals to RSL.

C = *Work execution level* 'considers the level of skill and control in sitework'.
- Here equals to RSL.

D = *Indoor environment* 'considers the exposure of the object to indoor agents of degradation and their severity'.
– Not relevant in this example.

E = *Outdoor environment* 'considers exposure to outdoor agents of degradation and their severity'.
- In this example the climate on a national level is less harsh than at the test sites included in RSL.

F = *Usage conditions* 'reflects the effect of the use of the building/constructed asset.'
- Here equals to RSL.

G = *Maintenance level* 'reflects the level of maintenance assumed. For certain components that are inaccessible or require special equipment for access, a particularly low maintenance level should be considered'.
- Here slightly lower than RSL intervals.

Another example in Table 2.8.3 shows how to derive country-specific half-life values for the three aggregate HWP categories (see Section 2.8.1.1) as a function of information on market share of the use of wood (see above), ESL and obsolescence. The use of composed HWP categories in different markets, such as in the construction sector, can be divided further into different segments (e.g. wall systems, flooring, and roof construction). These different segments comprise different service lives and obsolescence factors. Hence, Parties are encouraged to allocate the contribution of the different HWP categories or subcategories (e.g. coniferous sawnwood) to markets and their segments in order to receive improved service life estimates for the particular HWP categories. Thereby, it is important to keep in mind that the assumed service life is driven by the products technical properties and, depending on this, its particular application area (e.g. load-bearing beam or wood panelling, both made of sawnwood). Thus, in order to calculate a country-specific emission factor (i.e. service- or half-life), different sources of information, e.g. on the market use of different HWP categories, could be combined as illustrated in Table 2.8.3.

The definition of half-life and also guidance on how to calculate half-life for Tier 2 is provided in Section 2.8.3.2.

TABLE 2.8.3
EXAMPLE ON HOW TO DERIVE COUNTRY-SPECIFIC HALF-LIFE FOR HWP CATEGORIES AS A FUNCTION OF INFORMATION ON MARKET SHARE, ESTIMATED SERVICE LIFE (ESL) AND OBSOLESCENCE

HWP categories (*here: aggregates*)	Markets*	Market share of HWP category	National estimated service life (ESL), years	National obsolescence factor (O)	Adjusted ESL of HWP category (=ESL*O* market share adjustment)	Half-life (=Adjusted ESL* ln(2))
Sawn wood	construction	60%	70	0.9	41.0	28.4
	furniture	10%	45	0.6		
	packaging	30%	6	0.3		
	paper	0%	-	-		
Wood-based panels	construction	50%	60	0.7	30.5	21.2
	furniture	45%	35	0.6		
	packaging	5%	6	0.3		
	paper	0%	-	-		
Paper and paperboard	construction	0%	-	-	1.5	1
	furniture	0%	-	-		
	packaging	50%	3	0.3		
	paper	50%	10	0.2		

HALF-LIFE DATA TO BE USED FOR EXPORTED HWP

"In the case of exported HWP, country-specific data refers to country-specific half-lives and HWP usage in the importing country."[135] Thus, if country specific half-life information should be used also for the exported HWP, the half-life information from the importing country must be used. For this purpose, it is necessary to quantify export activity data within the three HWP categories and/or sub categories. Furthermore, in order to ensure that the half-life information from the exporting country complies with the categories of the activity data for the exported HWP, it is *good practice* to only apply country-specific half-life information in case the same categories of activity data for the exported HWP both in the exporting and importing country are being used. Otherwise the default values (Tier 2) are to be used. When transparent and verifiable activity data are available, the categories should be broad enough to capture significant volumes contributing to the pool. The amount of exported and domestic wood should be separately reported.

2.8.5 Consideration of the HWP pool in FMRLs

In this section, guidance is given on the relation of HWP originating from FM as described in Section 2.8.1 and its consideration in the FMRL as outlined in the Decisions 2/CMP.6[136], 2/CMP.7 and 2/CMP.8. Guidance on the FMRL is provided in Section 2.7.5.

APPROACHES AND METHODS FOR CONSIDERATION OF HWP IN FMRL

Decision 2/CMP.6 requested Parties to *inter alia* submit descriptions of how HWP were considered in the construction of the FMRL.[137] In line with the different approaches and methods used by Parties to construct the FMRL as listed in Section 2.7.5.1, two general approaches on how to treat HWP in FMRL can be differentiated:

1. Instantaneous oxidation

In this case, Parties only presented values for a FMRL which do not contain estimates on the *HWP contribution*.[138] Similar to the treatment of HWP in the first commitment period as described in *GPG-LULUCF*, as result of the assumption of instantaneous oxidation, changes in the HWP carbon pool are not reported (cf.

[135] Paragraph 30, Footnote 6

[136] Paragraphs 2, 4 and 9 of Appendix II contained in document FCCC/KP/CMP/2010/12/Add.1

[137] See submissions by Parties on FMRL as requested by Decision 2/CMP.6 (http://unfccc.int/5896.php) and document FCCC/KP/AWG/2011/Inf.2

[138] See FMRL values in column '*Reference level*' in the table of the Appendix of the Annex of Decision 2/CMP.7

Section 2.8.2). This approach equates the HWP Tier 1 estimation method as described in Section 2.8.2 and was chosen by Parties following the FMRL approach 3) and 4) as described in Box 2.7.3.

2. Inclusion of the HWP pool on the basis of modeled projections under a 'business as usual' scenario

In this case, Parties presented values for the FMRL that include estimates of the *HWP contribution* based on changes in the HWP pool.[139] This approach was chosen by Parties following the FMRL approaches 1) and 2) as described in Box 2.7.5.1. Many countries derived the values for the projected *HWP contribution* by means of FOD as specified in Section 2.8.3 for the Tier 2 HWP estimation method (Equation 2.8.5) applying default half-lives as listed in Table 2.8.2 for the HWP categories sawnwood, wood panels and paper (cf. Section 2.8.1.1).[140] However, different approaches had been used as regards the consideration of HWP originating from forests prior to the start of the second commitment period[141], as indicated in the application of HWP activity data (i) since 1900, or (ii) since 1990.

BOX 2.8.2
EXAMPLE ON THE ESTIMATION OF THE *HWP CONTRIBUTION* AS PRESENTED IN PARTIES' FMRL

The following example is intended to show, how estimates of the projected *HWP contribution* based on changes in the HWP pool could be derived that are consistent with the assumed harvesting rates following a 'business as usual' scenario in case no country-specific information on assumed future production of HWP and/or 'track and trace' models were available (cf. Rüter 2011).

In line with the guidelines for the submission and review of information on FMRL contained in the Appendix II of Decision 2/CMP.6, Parties had been requested to provide information on historic and assumed harvesting rates following a 'business as usual' scenario for Forest Management.

STEP 1: Calculation of the rates of change of the projected harvest as compared to the last five years' average of the historic harvest, for which up-to-date data were available.

Numeric example:

(i) *Average historic harvest for the years 2005-2009: 50 $Mm^3\ yr^{-1}$*

(ii) *Projected harvest (in $Mm^3\ yr^{-1}$): in 2013=52, in 2014=53, in 2015=55 …*

(iii) *Rates of change as compared to historic average: in 2013=4%, in 2014=6%, in 2015=10%*

STEP 2: Application of these annual change rates to the same five year average of historic carbon inflow to the HWP pool, which has been calculated from HWP production (cf. Section 2.8.3), in order to project the future carbon inflow to the HWP pool.

Numeric example:

(i) *Production of sawnwood for the years 2005-2009: 10 $Mm^3\ yr^{-1}$*

(ii) *Projected production of sawnwood (in $Mm^3\ yr^{-1}$): in 2013=10.4, in 2014=10.6, in 2015=11 …*

As a result, it is assumed that the same average proportion of harvested timber being used as feedstock for the subsequent production of HWP in the chosen historic five year period will also apply in the projection period.

A five year average was chosen, in order to reduce the uncertainties associated with because the proportions of harvested timber being used for HWP production can vary considerably from year to year. A similar approach had been proposed by Kangas and Baudin (2003). In case of substantially varying time series, they suggest to use a 'fixed constant' as the projection that is an average over the last five years.

Besides these two basically different methodological approaches in the treatment of HWP in the FMRL, further distinction between Parties' estimates on the *HWP contribution* to the FMRL can be recognized for (i) the applied models that have been used (including activity data, carbon conversion factors, etc.), and (ii) the applied underlying assumptions as regards the projected *HWP contribution* and/or its relation to particular projected

[139] See FMRL values in column '*Applying first-order decay function for HWP*' in the table of the Appendix of the Annex of Decision 2/CMP.7

[140] Paragraph 27 of Chapter II, Annex I in contained in document FCCC/KP/AWG/2010/18/Add.1.

[141] Cf. paragraph 15 sexies, Ibid.

harvest rates of Parties. An example of how estimates of the *HWP contribution* in the FMRL could be derived is listed in Box 2.8.2.

METHODOLOGICAL CONSISTENCY BETWEEN HWP IN THE FMRL AND THE REPORTING DURING THE SECOND COMMITMENT PERIOD

General guidance on methodological consistency in relation to the FMRL is provided in Section 2.7.5.2.

In line with Decision 2/CMP.7, it is *good practice* to demonstrate methodological consistency between the treatment of HWP in the reference level and the reporting for FM during the second commitment period.[142]

Provided that Parties comply with the requirements as outlined in Section 2.8.1.1 to estimate the *HWP contribution* on the basis of changes in the HWP pool following a Tier 2 or Tier 3 method (See Sections 2.8.3 or 2.8.4), methodological consistency between the treatment of HWP in the FMRL and the reporting as explained in Section 2.7.5.2 can be demonstrated by providing following information in the annual greenhouse gas inventory in accordance with Article 5, paragraph 2, of the Kyoto Protocol, which shall be submitted starting with the annual inventory for the first year of the second commitment period[143]:

- Time series of HWP_{FM} separately for the included HWP categories (HWP_P), including historic information as appropriate (See Sections 2.8.3, 2.8.4 and below), in order to also demonstrate that
  - (i) the method(s) to be used for estimating HWP contribution following the different tiers have been applied consistently (See Sections 2.8.2, 2.8.3 and 2.8.4);
  - (ii) the method to determine the fraction of HWP originating from FM has been applied consistently (See Section 2.8.1.2);
  - (iii) the same HWP categories (HWP_P) have been applied (See Sections 2.8.1.1, 2.8.3.1 and 2.8.4.1);
  - (iv) the same carbon conversion factors have been used (See Sections 2.8.3.1 and 2.8.4.1)
- Emission factors (i.e. service- or half-life information) associated with the particular HWP categories (HWP_P)

Since the final agreement on HWP, included in the Decision 2/CMP.7, was reached after the FMRL submissions, a technical correction for accounting purposes as described in Section 2.7.6 might be needed in the estimation of the *HWP contribution* to the FMRL to reflect the changes in the applied methodological elements as described above and in the relevant Sections 2.8.1, 2.8.2, 2.8.3 and 2.8.4.

Further general guidance on the detection for the need for, the procedures of performance and documentation of, and the timing of the application of a technical correction is provided in the relevant Section 2.7.6.

2.8.6 Uncertainty assessment

This section provides information on potential sources of uncertainty associated with the estimates of the *HWP contribution*. The uncertainties can be divided into uncertainties associated with the methods as well as parameter uncertainties.

METHOD UNCERTAINTIES

In the Tier 2 flux data method the basic model uncertainties are related to the assumption of FOD (Equation 2.8.5). A model is always a simplification of real world inducing method based uncertainties. The reason for using decay models instead of just counting the inflow minus outflow from the HWP pools is that there are no extensive and reliable statistics on the real discard flows (unlike on the inflows of semi-finished products), but some knowledge on the service life of wood products. FOD decay is assumed to be a good proxy for the decay of semi-finished products and other type of distributions could be used to describe the true decay process. However, the real world is even more complex. The service life and decay pattern of wood products are not just a technical issue, but are also related to socio-economic factors (See Section 2.8.4.2). For instance, the demand for wood products is likely to grow in economic booms resulting simultaneously in increasing replacement of old HWP with new ones. Thus also discards of HWP correlate with their increasing consumption. This is not reflected in the FOD pattern, where the discard rate is a constant fraction of the HWP pools in use over time. As

[142] Paragraph 14

[143] This information includes methodological elements as used in the estimation of the *HWP contribution* to the FMRL and the reporting during the second commitment period as defined in Annex II of Decision 2/CMP.8

a result of FOD the annual change of carbon stock in HWP is steered too strongly by the instantaneous production rate of HWP of domestic origin.

In the Tier 2 method another uncertainty is associated with initialisation of the FOD model. Due to lack of long historical data series on semi-finished HWP – for some countries series only since early 1990s – the initial stocks of the HWP categories ($C(t_0)$) are approximated by assuming that the stock change was zero at initial time. This proxy slightly overestimates the inherited emissions within the second commitment period from the long-lived HWP categories sawnwood (with half-life of 35 years) and wood based panels in case their stock in reality was growing at initial time, particularly when the calculation in Equation 2.8.5 is started just from the early 1990s. Depending on the accounting of HWP under Article 3 paragraph 4, this could thus potentially increase the uncertainties of the *HWP contribution* provided especially from products with high half-life values. In case the accounting approach for FM is based on a projected FMRL, however, this source of uncertainty is of no relevance and consequence for the accounting of the *HWP contribution*.

Another model uncertainty is related to the number of HWP categories in the model. In the simplest Tier 2 method there are three HWP sub-pools for the main categories: sawnwood, wood-based panels and paper and paperboard, each of which follows the FOD pattern but with different half-lives. The uncertainty could basically be lowered by introducing disintegrated sub-pools (e.g. for sawnwood) with differing half-lives based on their end-use (cf. Table 2.8.3) or based on subcategories (e.g. wood-based panels disintegrated to particle board, fibreboard etc., cf. Table 2.8.1).

In Tier 3, direct inventories of HWP in service (e.g. in the construction sector) could also be used to reduce the uncertainties associated with the flux data based method of Tier 2. The advantage of direct inventories is that no idealised models with uncertain assumptions on decay pattern are needed and whose verification and validation could be questioned. The inventory method could in principle provide more robust and less uncertain estimates for the carbon stock changes of the included HWP pools. Sequential direct inventories could also be applied to calibrating of the flux-data models and their half-life parameters (see Box 2.8.1) and thus reducing their uncertainties. However, the limitation of the method is that the statistics, if available, contains only some major pools such as the housing sector of the reporting country: but there is no information e.g. on the use of wood for furniture or packaging. For the use of HWP in export markets inventory methods are inapplicable either for the reporting country. Thus it must always be combined with flux data methods inducing double-counting risks of semi-finished and final products. Furthermore, it is applicable only in those few countries from which relevant and sequential statistics are available.

UNCERTAINTIES OF ACTIVITY DATA

Uncertainties related to activity data on HWP from international databases (e.g. FAO) and associated uncertainties of the estimates of the level of the *HWP contribution* could arise due to:

- Lack of time series: some Annex I countries were founded in the early 1990s and thus older activity data might not be available (see above).
- Definitional uncertainties (i.e. data provided do not conform to what has been requested). Removals data e.g. tend in fact to be only commercial forestry operations or planned cuts, sawnwood production is being provided in nominal, not solid m^3, and pulp is only market (commercially sold) pulp.
- The scope of data collection, as not all information is collected, particularly in the informal sector and from small operators. This tends to affect especially the sawmilling industries, as limits to collect statistical data might be linked to business volume or number of employees.
- Double counting (e.g. final products counted in semi-finished commodities, such as cut paper being added to paper in rolls).
- Reporting errors in providing correct data that is numbers are put into the wrong category or incorrectly processed by reporter or collecting agency.
- Uncertainties associated with aggregate HWP commodities (e.g. wood-based panels): in general, the sum of the subcategories accords with the value for the aggregate commodities, but some categories may underreport because of missing subcategories (e.g. missing data on veneer sheets result in an underestimate for wood-based panels).

Concerning data on the feedstock of production of semi-finished HWP categories (i.e. industrial roundwood and wood pulp as proposed in section 2.8.1.2), uncertainty could be caused by unreported sources, by-product use or trade data.

Also the semi-finished HWP categories (i.e. sawnwood, wood-based panels and paper and paperboard) are subject to the above mentioned conditions. An overall estimate of these factors results in an estimated deviation of the reported values between -25% to +5%.

All of these sources of uncertainty together tend to result in an under-reporting of HWP commodity data in international databases, that is actual figures are usually higher. As this is particularly the case in roundwood (i.e. wood-removals, see Figure 2.8.2) the allocation of the HWP categories to forest activities as described in Section 2.8.1.2 should be fairly conservative.

Further uncertainties associated with activity data are caused by conversion factors. The provided conversion factors (See Table 2.8.1) are highly generalized and reflect global averages which are not correct for species and specific items.

In order to reduce uncertainties around conversion factors for carbon, Parties are encouraged to use sub-categories under Tier 2 (See Section 2.8.3.2) or use a Tier 3 approach where they can make use of commodity specific conversion factors linked e.g. to various wood species of the particular items (See Section 2.8.4.2).

Aside from reviewing the data to check if it fits with a general understanding of the forest products supply in a country, it is most useful for reducing the uncertainties relating to activity data to cross-check if the amount of domestic production of HWP categories balances with the available supply of wood. Other validation methods could include a review of trade unit values and determination of per capita apparent consumption.

UNCERTAINTIES ASSOCIATED WITH EMISSION FACTORS (SERVICE- AND HALF-LIFE ESTIMATES)

The half-life parameters are in general the most uncertain part of the Tier 2 calculation method. There is not much robust scientific evidence behind the default values given in Table 2.8.2[144]. Nor do they present a conservative estimate that would rather lead to underestimation than overestimation of the carbon stock changes in HWP. For decreasing uncertainty countries are strongly encouraged to adjust the Tier 2 half-life parameters by calibrating the FOD model either a) with direct inventories of HWP in use, or b) with market information as shown in Table 2.8.3. The application of stock inventory information, however, due to the lack of appropriate statistics is hardly practicable in most countries. Furthermore, it does not cover export markets of the reporting country. Two specific calibration studies (Pingoud*, et al.* 2001, Statistics Finland 2011) indicate that the true half-life of sawnwood and wood-based panels in Finland is likely to be much shorter than the default half-lives (Table 2.8.2). Thus, in this particular case the use of default half-lives would substantially overestimate the HWP pool in use. The results of this kind of case studies could possibly be generalised to obtain better estimates for default half-lives.

Even though the uncertainty associated with Tier 2 estimates using default data could be high, working through such estimates can be the first step in identifying ways to improve them. Initial improvements can be made using country-specific data with country-specific half-lives instead of the default half-lives in Tier 3.

To decrease uncertainties in Tier 3 Parties are encouraged to use direct inventories of HWP in use, to develop more realistic decay patterns for HWP and use of more sub-pools in case transparent information is available. However, the model calibration procedure to direct HWP inventories requires in practice a model with very few adjustable parameters.

2.8.7 Quality assurance/Quality control

Detailed steps to improve estimates of HWP activity data are already described in detail for Tiers 2 and 3 methods in Sections 2.8.3 and 2.8.4, and also in Section 2.8.6 (as it relates to uncertainties). These steps include the use of country-specific data and half-lives for Tier 2 methods (Sections 2.8.3.1.and 2.8.3.2) and the application of potential steps to derive improved Tier 3 estimates (Sections 2.8.4.1. and 2.8.4.2). Therefore, this section does not provide a separate, detailed sub-section on Quality assurance and Quality control.

[144] Paragraph 29

2.9 CROPLAND MANAGEMENT

2.9.1 Definitional issues and reporting requirements

Cropland Management (CM) is the system of practices on land on which agricultural crops are grown and on land that is set-aside or temporarily not being used for crop production.[145] CM includes all lands under annual and perennial crops, and all fallow lands set at rest for one or several years before being cultivated again.

It is *good practice* to include, in land subject to CM, all the lands in the Cropland category of Volume 4, Chapter 3, Section 3.2 of the *2006 IPCC Guidelines*, namely cropped land, including rice fields. It is also *good practice* for countries to specify how land subject to CM is distinguished from other activities under the Kyoto Protocol using the guidelines provided in Volume 4, Chapter 3, Section 3.3 of the *2006 IPCC Guidelines*, together with the guidance presented here.

Perennial crops can include orchards, vineyards and plantations such as cocoa, coffee, tea and bananas. If perennial cropped lands meet the threshold criteria for forests (see Footnote 8 in Section 1.2 of this report for the definition of "forest" given in the Marrakesh Accords), it is *good practice* to include them under CM or Forest Management (FM), but not under both. Rice paddies are also included under Cropland, but associated methane emissions are reported under Agriculture in reporting under the UNFCCC and KP and hence not under this activity. Treed areas such as orchards or shelterbelts that were established after 1990 and meet the definition of a forest can qualify as Afforestation/Reforestation (AR), and if they do, are included under those categories (see Section 1.2 of this report). Recognizing that the forest definition is threshold based, in order to achieve consistency with established practice during the first commitment period, Parties can continue to report taking account of predominant land use, as reviewed under the provisions of the Kyoto Protocol (Section 1.2 of this report). Cropland that is temporarily used for grazing can also be included under CM. Set aside lands are included in CM when they return, or are expected to return, to cropping after some period of time. Countries are encouraged to develop consistent criteria for defining set aside lands and their allocation among activities.

The aim of the accounting exercise is to identify and report trends and systematic changes in the carbon stocks resulting from changes in CM over time. The premise is that changes in soil carbon stocks result from changes in CM that influence the rates of either additions to, or losses of, soil carbon. However, CM is not the only driver of changes in carbon stocks. Natural effects, such as weather, wild fire, abnormal flooding or prolonged drought can also influence the rate of carbon gains and losses in cropland, and if their effects are large enough, can mask the carbon trend or signal resulting from CM practices, as elements of CM activities. Countries are encouraged to use higher tier methods (Tier 2 or Tier 3) to develop emissions coefficients or models to represent the effects of management practices rather than those of inter-annual variability and natural disturbances on carbon stocks. More information about higher tier methods is provided in Section 2.9.4 of this report.

The main processes involved in estimating emissions and removals are, first, to subdivide the total cropland area into strata that represent consistent classes of land types, biophysical characteristics and management practices for the base year and each of the years in the commitment period (see Section 2.9.3 of this report and examples in Volume 4, Chapter 5, Table 5.5 of the *2006 IPCC Guidelines*). Broad sets of practices under CM that affect carbon stocks include tillage practices, rotations and cover crops, fertility management, plant residue management, erosion control and irrigation management (IPCC 2000b). The second main process is to estimate how management practices and changes in management practices influence emissions and removals over time, using methods discussed in Section 2.9.4 of this report.

It is a *good practice* that Parties ensure consistency in methods applied for estimating emissions and removals from land-use and land-use change categories. Methods across different practices covered under Articles 3.3 and 3.4 and management practices occurring on land that was deforested should be consistent with methods used for the surrounding CM practices, even though they are accounted under Article 3.3 of the Kyoto Protocol and not under CM.

It is *good practice* to apply the following steps for estimating emissions and removals from CM:

STEP 1: Define CM and apply the definition in a consistent manner over time, including in the base year. Crops such as vineyards and orchards that meet the definition of forest can be included under CM or under Forest Management, but not under both. It is important to apply the definitions consistently over time, even though data and information from the past may be of lower quality.

[145] Paragraph 1(g) in the Annex to Decision 16/CMP.1 (Land use, land-use change and forestry) contained in document FCCC/KP/CMP/2005/8/Add.3, p.5.

STEP 2: Identify the land under CM using the approaches described in Volume 4, Chapter 3, Section 3.3 of the *2006 IPCC Guidelines* and the appropriate sections in this report.

STEP 3: Distinguish between the two subcategories of CM: mineral soils and organic soils.

STEP 4: Select the appropriate tier and methodology for estimating emissions and removals, based on key category analysis including assessment of significant subcategories (Volume 1, Chapter 4, Section 4.2 of the *2006 IPCC Guidelines* and Figure 2.9.1 of this report) and subject to available data. For mineral soils, this includes methodologies for monitoring land management activities and change.

STEP 5: Stratify by climate. For mineral soils also stratify by other relevant biophysical characteristics of the land and CM practices (see Section 2.9.3 of this report).

STEP 6: For each stratum, estimate the CM emissions/removals for the base year and the commitment year using Tier 1, Tier 2 or Tier 3 methods (see Section 2.9.4 of this report). Total emissions are the sum of net emissions or removals from mineral soils plus organic soils.

2.9.2 Base year

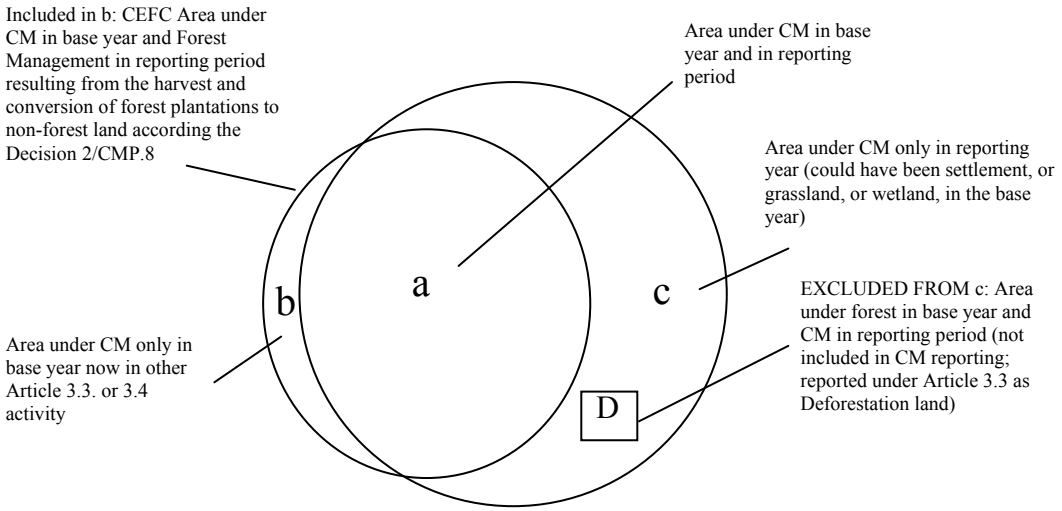
Under Article 3.4 of the Kyoto Protocol, emissions and removals resulting from CM are estimated using a net-net accounting approach (as are all elective activities under Article 3.4). Net-net accounting requires that greenhouse gas emissions and removals are estimated for the base year and each year of the commitment period[146]. This entails determining the total area under CM for the base year and for each year of the commitment period and calculating the carbon stock change for those areas. Guidance for estimating the corresponding non-CO_2 greenhouse gas emissions from cropland for 1990 are covered in Volume 4, Chapters 10 and 11 of the *2006 IPCC Guidelines* (see the text on non-CO_2 gases in this Section 2.9.4 of this report).

If the area under CM changes significantly between the base year and the commitment period, e.g., due to AR or Deforestation (D), or land moving into another mandatory or elected activity under the Kyoto Protocol, this may lead to estimates on moving land basis (that is, subtraction of stock changes on a land base that changes in size over time). In cases where land under CM moves under activities which are not mandatory or elected by the Party, it should continue reporting on these lands under CM (see Box 2.9.1).

[146] Net-net accounting refers to the provisions of paragraph 10 of the Annex to Decision 2/CMP.7 (Land use, land-use change and forestry) contained in document FCCC/KP/CMP/2011/10/Add.1.

BOX 2.9.1
AN EXAMPLE OF CROPLAND MANAGEMENT AREAS IN 1990 AND IN THE COMMITMENT PERIOD (NET-NET ACCOUNTING)

In this example the area under CM in the reporting year during the commitment period is larger than in the base year. Some of the area was under CM in both the base year and during the reporting period. This includes also lands which are no longer managed as cropland nor reported under any other activity under the Kyoto Protocol (a). Some of the area under CM in the base year is no longer under CM in the reporting year but reported under another activity under the Kyoto Protocol (b). There are also areas under CM in the reporting year that were not under CM in the base year (c). Area (D) is under CM, but was subject to Deforestation which takes precedence. Under the Kyoto Protocol, the emissions and removals in areas (a) + (b) in the base year are compared to emissions and removals in areas (a) + (c) – (D) in the reporting year.



For most Parties with commitments under the Kyoto Protocol, the base year is 1990. Under the provisions of Article 4.6 of the UNFCCC, however, Parties with economies in transition (EITs) are granted some flexibility on the level of historical emissions chosen as a reference. As a consequence five EITs have a base year or period between 1985 and 1990 and hence need to assess the CO_2 and other greenhouse gas emissions and removals for those years. Historical data on land-use and management practices in 1990 (or the appropriate year(s)) and in years prior to 1990 are needed to establish the 1990 base year net emissions/removals of soil carbon from CM. The Tier 1 method described in Volume 4, Chapter 5, Section 5.3.3 of the *2006 IPCC Guidelines* for mineral soils assumes that a change in land-use/land management has an impact on carbon emissions and removals for a duration of 20 years; hence, under this tier and if a change in management has taken place since 1970, it is *good practice* to calculate the net carbon stock change in 1990 taking this change into account. If area and activity data are available for 1970 to 1990, the net carbon stock change during the 1990 base year can be established using the default carbon emission and removal factors. For organic soils, the inventory time period is treated the same as long-term cropped organic soils, Tier 1 emission factors provided in Table 5.6 of Volume 4, Chapter 5 of the *2006 IPCC Guidelines* and updated by the *Wetlands Supplement* (see Footnote 19, Section 2.1 of this report).

The duration of impact may be shorter or longer than 20 years. If data on the duration of impact are available, it is *good practice* to use the appropriate time period, based on country-specific data and measurements (see Tier 2 and Tier 3 approaches in Section 2.9.4 of this report).

If area and activity data are not available for 1970 to 1990, countries can establish the 1990 carbon stock using the most appropriate of the following options, in a manner consistent with guidance provided in Volume 1, Chapter 5, Section 5.3.1 of *2006 IPCC Guidelines*. It is *good practice* to use a time period of sufficient duration (e,g. 20 years) as close to 1990 as possible. For example, the carbon stock for 1990 could be estimated:

- if data are available for the time series between 1990 and 2010, based on the trend in carbon stock for the time series between 2010 and 1990;
- if data for the time series between 1970 and 1990 or 1990 and 2010 are incomplete, using the available data to extrapolate a trend through 1990.

The results of accounting on a net-net basis depend not just on changes in land management activities, but also partly on where the base year and commitment period years fall within the temporal dynamics of carbon sequestration processes. As noted above, carbon stock change resulting from land use and land management changes on mineral soil tends to persist for about 20 years, after which the cropland carbon levels approach a new equilibrium carbon stock. The rate of carbon sequestration in cropland following a change in management in which carbon additions increase or carbon losses decline tends to be high in the first decades and then decline over time, as illustrated in Figure 2.9.2. This will be reflected in net sinks and sources in the accounting.

2.9.3 Choice of methods for identifying lands subject to Cropland Management activities

General guidance on consistent representation of lands is provided in Chapter 3 of the *2006 IPCC Guidelines* with additional guidance about identification of lands subject to CM provided in Sections 1.1, 1.2, 2.1, and 2.2 of this report.

According to the Decision 2/CMP.8[147], the geographical location of the boundaries of the area that encompass land subject to CM needs to be reported annually, along with the total land areas subject to this activity. The geographical location of boundaries may include a spatially explicit specification of each land subject to CM, but does not have to. Instead, the boundaries of larger areas encompassing smaller lands subject to CM may be provided, along with estimates of the area subject to CM in each of the larger areas. In either case, the land subject to CM and the management thereon need to be tracked through time because the continuity and duration of management practices and changes affects carbon emissions and removals.

If a Party estimates a change in cropland carbon pools resulting from a change in management practice using default emissions or removal factors that assume continuity of the practice, such as the values provided in Table 5.5 in Volume 4, Chapter 5 of the *2006 IPCC Guidelines*, it is *good practice* to demonstrate that the land has remained continuously under the practice. This could be achieved by tracking each land subject to CM from 1990 until the end of the commitment period (e.g. see Section 2.9.2 of this report). Alternatively, countries could develop statistical sampling techniques, consistent with the advice in Volume 4, Chapter 3, Annex 3A.3 of the *2006 IPCC Guidelines*, which allow the management transitions on CM land to be determined (see also Section 2.4.1 of this report).

If a management practice does not occur continuously on the same land, a Party may use statistical sampling techniques to estimate the duration and proportion of the management practice of interest. In this case, country-specific emission and removal factors (Tier 2) or modelling (Tier 3) approaches can be developed to represent the duration and proportion of the practice over the time series. More information about statistical sampling methods is provided, for example, in Volume 4, Chapter 3, Annex 3A.3.3 in the *2006 IPCC Guidelines*.

At the national level, it is *good practice* to identify criteria that could be relevant to subdivision for the purpose of stratification when setting up a sampling strategy. Stratification criteria may include relatively static biophysical characteristics, such as climate and soil type, rotation cycles, as well as management practices that tend to be more dynamic drivers of change in emissions and removals from the carbon pools. Guidance on stratifying land to match data needs for estimating emissions and removals is provided in Volume 4, Chapter 3, Section 3.3.2 of the *2006 IPCC Guidelines*.

Management factors that may be useful in establishing a national stratification include:

- Degree of soil disturbance (e.g. tillage frequency and intensity)
- Level of input of crop biomass or organic carbon (e.g. plant litter, roots, manure, other amendments)
- Rotation cycle
- Frequency of fallow practices
- Inclusion of woody biomass in the cropping system (e.g. shelterbelts, orchards, other perennial plantations)
- Temporary use for livestock grazing

For all resulting subcategories under CM, the areas derived from the conversion of forests (i.e., D) since 1990 need to be tracked separately as these will be reported as units of lands subject to D under Article 3.3 of the Kyoto Protocol. Area of CM in base year which converted to FM in reporting period due to the harvest and

[147] Paragraph 2(d) in Annex II to Decision 2/CMP.8. (Land use, land-use change and forestry), contained in document FCCC/KP/CMP/2012/13/Add.1., p. 19.

conversion of forest plantations to non-forest land will be reported under carbon equivalent forest conversion according to the Decision 2/CMP.8[148]. At higher tiers further subdivision of the CM area may be necessary.

Methods to identify croplands with adequate disaggregation may include:

- National land-use and management statistics: in most countries, the agricultural land base including croplands is surveyed regularly, providing data on distribution of different land uses, crops, tillage practice and other aspects of management, often at sub-national regional level. These statistics may originate, in part, from remote sensing methods.
- Inventory data from a statistically based, plot-sampling system: land-use and management activities are monitored at specific permanent sample plots that are revisited on a regular basis.

2.9.4 Choice of methods for estimating carbon stock changes and non-CO_2 greenhouse gas emissions

For CM, the *2006 IPCC Guidelines*, updated by the *Wetlands Supplement* for organic soils and wetlands, give methodological guidance for estimates of:

- Annual changes in C stocks of above- and below-ground biomass
- Annual changes of dead organic matter (DOM; dead wood and litter)
- Annual changes in organic carbon stocks of mineral and organic soils
- Annual emissions of non-CO_2 gases from biomass burning

Section 2.3.6 of this report gives guidance about the choice of methods and identification whether CM is a key category. If CM is a key category, the inventory compiler should determine which subcategories, such as mineral soil or organic soil or above-ground biomass, are particularly significant. Volume 1, Chapter 4, Section 4.2 of the *2006 IPCC Guidelines* suggests ranking subcategories according to their contribution to the aggregate key category. It may be appropriate to focus efforts towards methodological improvements of these most significant subcategories.

The Decision 2/CMP.7[149] specifies that a Party may choose not to account for a particular pool in a commitment period, if transparent and verifiable information is provided that demonstrates that the pool is not a source. Requirements for reporting excluded pools and documenting that a pool is not a source can be found in Section 2.3.1 of this report. It is possible that Parties will use different tiers to prepare estimates for individual subcategories (e.g., soil organic C stocks changes in mineral soils and organic soils). Since different methods may yield different estimates with different levels of uncertainty, it is *good practice* to use the same tier and methodology for estimating carbon emissions and removals from each subcategory and pool for the full time series, for example, in 1990 and during the commitment period.

Methods for estimating cropland CO_2 emissions and removals or carbon stock changes for the base year and the commitment period are provided in Volume 4, Chapters 2 and 5 of the *2006 IPCC Guidelines*. The following sections of this report highlight aspects of these methods specific to the Kyoto Protocol.

2.9.4.1 BIOMASS AND DEAD ORGANIC MATTER

Crop biomass carbon from herbaceous and annual crops is assumed to cycle annually (biomass gains are assumed to equal biomass losses in a single year) and is not estimated. Carbon stock changes in other pools (above-ground, below-ground biomass, litter and dead wood) associated with perennial crop biomass (e.g., trees, shelterbelts and orchards) should be estimated unless the Party to the Kyoto Protocol chooses not to report on a certain pool and provides verifiable information that carbon stocks are not decreasing.

For carbon stock changes in biomass resulting from changes in CM, it is *good practice* for Parties to use the decision tree in Figure 2.9.1 to identify the appropriate tier to estimate carbon stock changes in biomass and dead organic matter under the Kyoto Protocol. Relevant methods for estimating carbon stock changes in above- and below-ground biomass, and dead organic matter can be found in Volume 4, Chapter 5, Sections 5.2.1 and 5.2.2 of the *2006 IPCC Guidelines*, respectively. Default coefficients for above-ground woody biomass and harvest

[148] Paragraph 5(g) in Annex II to Decision 2/CMP.8 (Land use, land-use change and forestry), contained in document FCCC/KP/CMP/2012/13/Add.1, p. 21.

[149] Paragraph 26 in the Annex to the Decision 2/CMP.7 (Land use, land-use change and forestry), contained in document FCCC/KP/CMP/2011/10/Add.1, p16.

cycles in cropping systems containing perennial species are provided in Table 5.1; potential C storage for agroforestry systems in different eco-regions of the world are provided in Table 5.2; default above-ground biomass for various types of perennial croplands are given in Table 5.3 in Volume 4, Chapter 5 of the *2006 IPCC Guidelines*.

Box 2.9.2 is an example of how estimating carbon stock changes for biomass for fruit orchards.

BOX 2.9.2
EXAMPLE OF ESTIMATING BIOMASS CARBON CHANGES FOR FRUIT ORCHARDS

Canada chose to consistently include the orchards of fruit trees as a practice within CM. The general Canadian orchard recommendations are to replace about 5% of the orchard each year. Therefore it was assumed that the orchard consisted of an even representation of all age classes from 0 to 20 years. With this constant tree removal and addition to the orchard area, the gain in carbon from growing trees would equal the loss of carbon from removed trees. The loss of C from removed trees was assumed instantaneous. Because of intense pruning, above- and below-ground carbon stocks of fruit trees was considered to increase linearly with age. The average carbon stock of an orchard was therefore the equivalent of 10-year old fruit trees. The loss of orchards was assumed to be from fundamental change to different land use purpose and that decision would not be affected by the age class structure of the eradicated orchard. Consequently, the loss of orchard was the equivalent of losing an average orchard of carbon stocks equivalent to an orchard of entirely 10-year old trees. New orchard areas were assumed to accumulate carbon stock linearly for 10 years to the amount of a 10-year old tree. After new orchard area had existed for 10 years, it was assumed that carbon stock removal equalled carbon stock gain because of regular tree removal and pruning so there is no further gain or loss of carbon.

2.9.4.2 SOIL CARBON

In most croplands, the main soil carbon flux associated with changes in land-use and management for CM activities is from changes in soil organic carbon in soils. Volume 4, Chapter 5 of the *2006 IPCC Guidelines* identifies two sources or sinks of CO_2 from agricultural soils:

- Net changes in organic carbon associated with changes in land use and management on mineral soil;
- Emissions of CO_2 from cultivated organic soils (updated by the *Wetlands Supplement*).

Total annual emissions and removals of CO_2 are calculated by summing emissions and removals from the two subcategories (mineral and organic soils) using methods outlined in Volume 4, Chapter 5 and Equation 2.24 of the *2006 IPCC Guidelines* and updates in the *Wetlands Supplement* (see footnote 19, Section 2.1 of this report).

MINERAL SOILS

Methods for estimating mineral soil carbon stock changes resulting from changes in CM fall into one of three methodological tiers described in Volume 4, Chapter 1, Sections 1.3.2 and 1.3.3 of *2006 IPCC Guidelines*.

Methods for estimating carbon stock changes in mineral soils

It is *good practice* to use the decision tree in Figure 2.9.1 to decide which tier to use for estimating carbon stock changes associated with changes in CM under the Kyoto Protocol. It is *good practice* to use Tier 2 or Tier 3 methods for reporting carbon stock changes from mineral soils if CM is a key category.

Tier 1

The Tier 1 method for estimating carbon stock changes in mineral soils is described in Volume 4, Chapter 2, Section 2.3.3.1 and Chapter 5, Section 5.2.3 of the *2006 IPCC Guidelines*. This guidance assumes continuous practice for a 20-year period applying stock change factors provided in Table 5.5 and default reference soil organic carbon stocks for mineral soils given in Table 2.3 of the *2006 IPCC Guidelines* and applying updates using Chapter 5 of the *Wetlands Supplement*.

Volume 4, Chapter 5, Section 5.2.3.4 of *2006 IPCC Guidelines* outlines the steps for estimating average annual rates of carbon stock change of cropland mineral soils using the default reference carbon stocks (Tables 2.3), carbon stock change factors (Table 5.5) and Equation 2.25 of Chapter 2. The Tier 1 method can be used to estimate carbon flux resulting from changes in land-use, CM or the level of carbon input across a range of temperature and moisture regimes and soil types. It only applies to persistent changes in management, not to rotational changes.

5966 **Figure 2.9.1 Decision tree for selecting the appropriate tier for estimating carbon stock**
5967 **changes in mineral soils under Cropland Management for Kyoto Protocol**
5968 **reporting (see also Volume 4, Chapter 2, Figure 2.4 of the *2006 IPCC***
5969 ***Guidelines*)**

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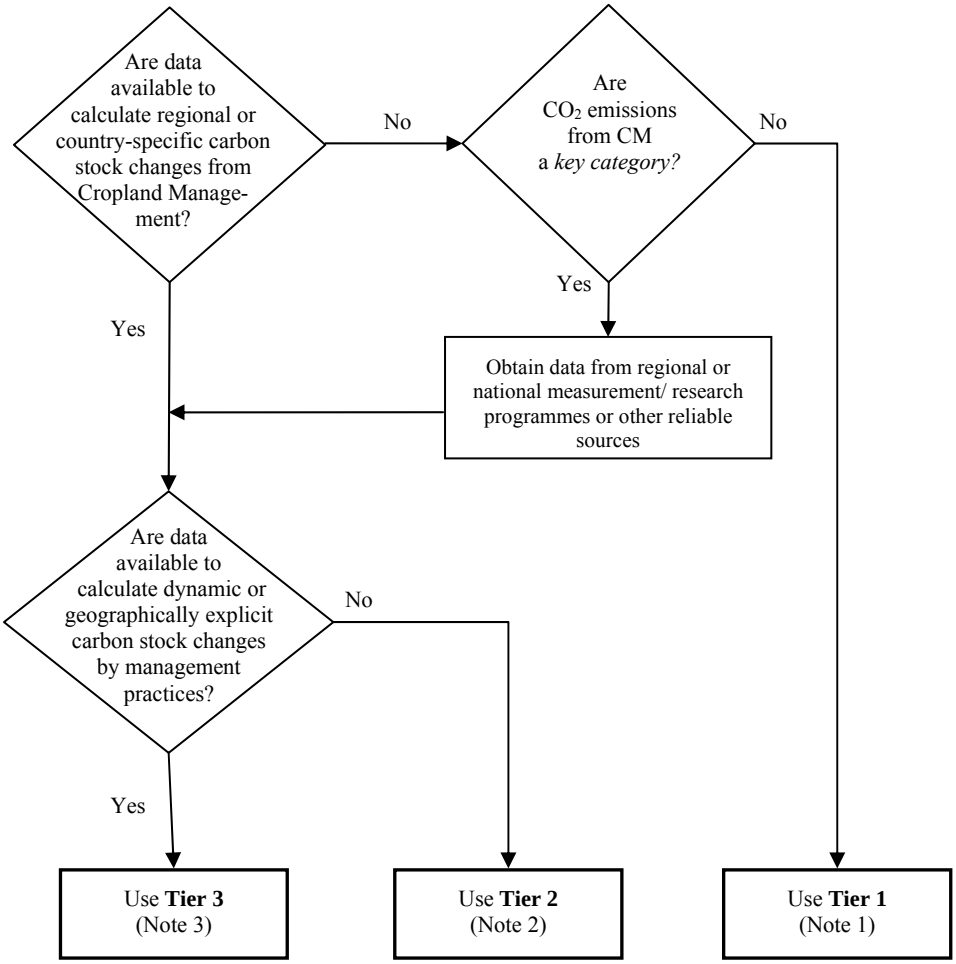

Note 1: Use the matrix/database of default values.

Note 2: Use regionally specific parameters, soil data and duration of impact.

Note 3: Use more sophisticated modelling techniques, often linked to geographical databases.

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Since the Tier 1 default methods assume continuity of practice on the land subject to CM, it is *good practice* to follow continuously the land subject to CM from the base year through the commitment period. Methods for continuously tracking land are described in Section 2.9.3 of this report.

The carbon stock change estimated using Equation 2.25 in Volume 4, Chapter 2 of the *2006 IPCC Guidelines* can be used to calculate a yearly emission/removal of carbon resulting from CM activities (a carbon stock change factor) by multiplying the carbon stock change factor by the cropland area to which the management change has been applied. For net-net accounting, the calculation using Equation 2.25 has to be performed for the base year and each year of the commitment period. For discussion of how to estimate the CM area, see Section 1.3 of this report.

Box 2.9.3 provides illustration of estimating carbon stock changes for CM practices that are not continuous over time.

Tier 2

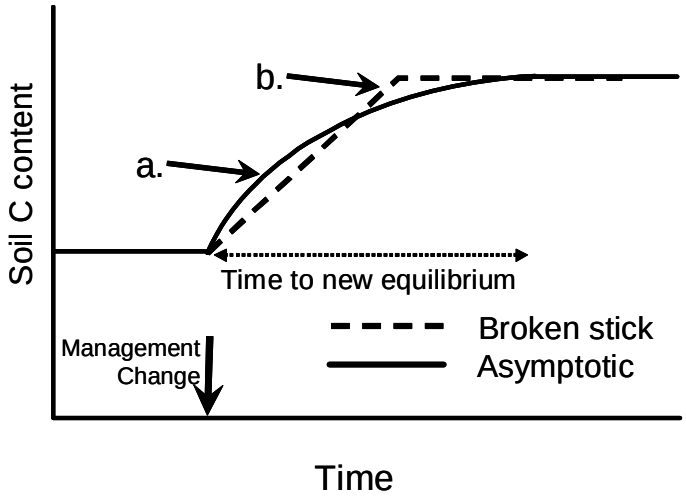
The Tier 2 method also uses the methodology described in Volume 4, Chapter 5 of the *2006 IPCC Guidelines*, but now the default factors are replaced with more reliable country- or region-specific values. It is *good practice* to obtain region- or country-specific emissions factors from literature values, long-term experiments or the local application of well-calibrated, well-documented soil carbon models. Region-specific data for soil carbon content (such as that available from national soil inventories) can also be used.

To ensure that regionally-specific carbon stock change factors are better than default factors at representing actual carbon stock change in a given region, rigorous criteria must be applied to demonstrate that the more specific factors do not lead to under- or overestimation of the soil carbon change. Regional or country-specific factors should be based on verified soil carbon model estimates or measurements that are conducted frequently enough and over a long enough time period and with sufficient spatial density to reflect variability of the underlying biochemical processes, and documented in accessible publications.

For Tier 2 approaches, it is *good practice* to replace the 20-year default with a value that reflects national or regional information about the duration of changes in CM on soil carbon emissions and removals.

An asymptotic model can also be fitted to data of soil carbon stock changes (Figure 2.9.2). Using this method, the higher carbon factors applied immediately after a land-use or management change gradually diminish, so that stock changes are not underestimated soon after a change ("a" on Figure 2.9.2), or overestimated as the soil approaches the new equilibrium ("b" on Figure 2.9.2).

Figure 2.9.2 Schematic representation of a change in soil carbon stocks after a carbon-sequestering management change



At Tier 2, default factors (e.g., input factors) associated with a different land-use or land-management change can be replaced by more detailed relationships between the intensity of a practice (e.g., the amount of an organic amendment applied to the soil) and a change in the yearly soil carbon emissions/removals. For example, in Europe, Smith *et al.* (2000) have developed such relationships (e.g., average yearly soil carbon stock change (tonnes C ha^{-1}) = 0.0145 x amount of animal manure (tonnes dry matter ha^{-1} yr^{-1}) added; recalculated from data in Smith *et al.*, 1997; $R^2 = 0.3658$, n = 17, $p < 0.01$). Similar relationships could be derived from long-term data for different soil types in different climatic regions. Alternatively, well-calibrated and well-evaluated models of soil carbon change (e.g., CENTURY (Parton *et al.*, 1987), RothC (Coleman and Jenkinson, 1996)) could be used

to generate either stock change factors, or the intensity relationships described above, for different soils in different climatic regions.

Rigorous criteria must be applied so that any carbon stock change is not under- or overestimated. It is *good practice* that stock change factors be based on experiments sampled according to the principles set out in Volume 4, Chapter 2, Section 2.3.3 of the *2006 IPCC Guidelines*, and to use the experimental values if they are more appropriate than the default values to the region and management practice. Factors based on models should only be used after the model has been tested against experiments such as those described above and any model should be widely evaluated, well-documented and archived. It is *good practice* to provide confidence limits and/or uncertainty estimates associated with regional, country-specific or local stock change factors.

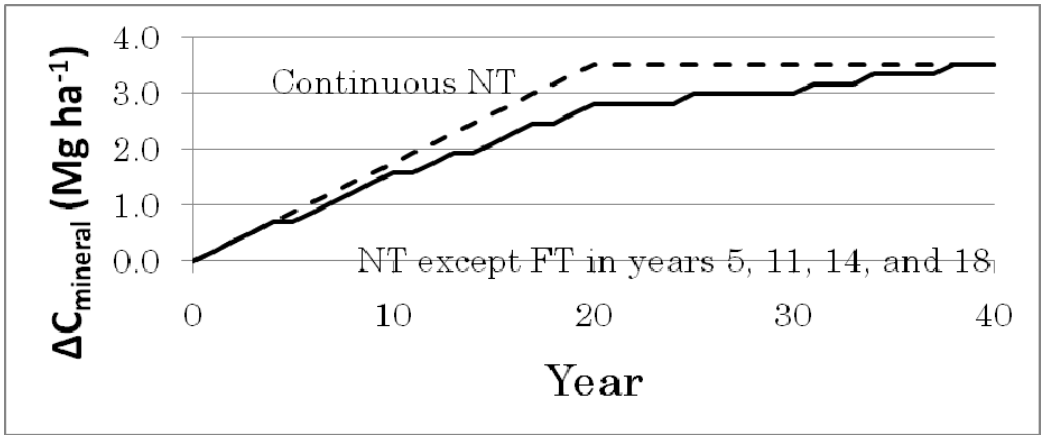
Tier 3

Tier 3 methods generally encompass a range of methodologies that are more elaborate than Tier 2, usually based on sophisticated modeling techniques, and often linked to geographical databases. Compared with the static matrix used at Tiers 1 and 2, Tier 3 can represent the management history of a land that facilitates calculation of soil carbon changes resulting from multiple changes in management practices over time including rotational changes in land use. Tier 3 (like Tier 2) methods can also take into account longer time period to reach equilibrium than 20 years. Current computing power makes it possible to link spatially disaggregated (stratified) land data to management practice data. Using these analytical systems, carbon stock changes can be tracked over time by linking equations describing the rate of change in soil carbon under specific management practices with carbon contents, initialised at some point and cross-checked periodically. Tier 3 methods can also be based on repeated statistical sampling consistent with the principles set out in Volume 4, Chapter 3, Annex 3A.3 of *2006 IPCC Guidelines.* The sampling protocol should be of sufficient density to capture the soil types, climatic regions and management practices.

BOX 2.9.3
ILLUSTRATION OF ESTIMATING CARBON STOCK CHANGES FOR DISCONTINUOUS CROPLAND MANAGEMENT PRACTICES

Many compilers need to use Reporting Method 1 (non-spatially explicit aggregate statistics, see Section 2.2.4 of this report) for representing areas of CM practices because of availability of activity data. From such data it is not possible to discern if practices are continuous over time. The effect of discontinuity of practices is expected to affect soil carbon change. This is a particular concern for no-till (NT) practices because it is not uncommon for there to be occasional tillage within NT cropping systems. The amount of reduction of accumulated additional carbon from single tillage on land under long-term NT ranges from 0-11% (Conant *et al*., 2007; Koch and Stockfisch, 2006; Quincke *et al,*. 2007; VandenBygaart and Kay, 2004). However, in some situations, more than a 30% loss of accumulated soil carbon occurs from single plowing of land that had been in long-term NT (VandenBygaart and Kay, 2004).

The lack of data on continuity of practice does not invalidate the use of Tier 1 estimation methods for discontinuous CM practices. To illustrate, consider a parcel of land under NT with occasional full tillage (FT) and having consistent medium input on sandy soils in warm, moist temperate zone. From Table 2.3 in Volume 4, Chapter 2 of the *2006 IPCC Guidelines,* the reference soil organic C stock is 34 Mg ha^{-1} and F_{LU}=0.69 (This land parcel under long term cultivation and continuing medium input that is put under NT in year 1 but undergoes FT in years 5, 11, 14, and 18. As is necessary using approach 1, each decrease of NT is assumed to occur on land that has been under NT for at least 20 years and each increase on land that has been under FT for at least 20 years. Following guidance in Volume 4, Chapters 2 and 5 of the *2006 IPCC Guidelines*, the effect of carbon change is calculated using Formulation A (Box 2.1) of annual soil organic carbon stock change (applying Equation 2.25 and Table 5.5). As shown in the Figure below, the calculated $\Delta C_{mineral}$ is lower with occasional FT than for continuous NT (e.g. 80% of carbon change of continuous NT at year 20) until that land has been under NT for 20 years continuously (i.e. year 38). This is consistent with understanding of effect of intermittent tillage on soil organic carbon on land otherwise under NT. Using Reporting Method 1 to represent land areas, the discontinuous tillage practice on any individual land parcel would not be discernible from the data of land areas under different tillage practices. Nevertheless, this example illustrates that Tier 1 methods are valid for discontinuous practices embedded within the data of net areas under different CM practices. If there is knowledge about discontinuous CM practices on land parcels and about the effect of practice discontinuity on soil organic carbon change, it is *good practice* to use higher tier methods.



Choice of carbon stock change factors for mineral soils

The carbon emission/removal factors used at each tier are described briefly in the following sections.

Tier 1

At Tier 1, average yearly carbon stock changes in mineral soils are calculated from default values by dividing the 20-year stock change by 20, as formulated in Equation 2.25 in Volume 4, Chapter 2 of *2006 IPCC Guidelines*. Default reference (under native vegetation) soil organic C stocks (SOC_{REF}) for mineral soils, full details of default relative stock change factors for land use (F_{LU}), input (F_I) and management (F_{MG}) factors (over 20 years) can be found in Table 2.3 (for SOC_{REF}), Chapter 2 and Table 5.5 (for F_{LU}, F_I and F_{MG}), Chapter 5 of the *2006 IPCC Guidelines*, respectively. Management practice is assumed to influence stocks to a depth of 30 cm. For a summary of the steps, see Sections 2.3.3 and 5.2.3.4 of Volume 4, Chapters 2 and 5 of the *2006 IPCC Guidelines*.

Tier 2

At Tier 2, some or all of the default values for carbon stock change (Tier 1) are replaced by values shown to be more reliable. These new values may be based on literature values, measured changes in carbon stocks, on simple carbon models, or a combination of these. (See 'Choice of management data for mineral soils' below for examples). It is *good practice* to derive relative stock change factor values for a higher resolution classification of management, climate and soil types if there are significant differences in the stock change factors among more disaggregated categories based on an empirical analysis. Reference soil organic C stocks (SOC_{REF}) can also be derived from country-specific data in a Tier 2 approach. Additional guidance is provided in Volume 4, Chapter 2, Section 2.3.3.1 of the *2006 IPCC Guidelines*.

Tier 3

For mineral soils, Tier 3 carbon stock change factors are country-derived, and may be calculated using complex models. The carbon models used for Tier 3 are generally more complex than those in Tier 2, taking into account soil (e.g., clay content, chemical composition, parent material), climate (e.g., precipitation, temperature, evapotranspiration), and management factors (e.g., tillage, carbon inputs, fertility amendments, cropping system). *Good practice* requires that the models be calibrated using measurements at benchmark sites, and that model and assumptions used are described transparently.

In all cases, rigorous criteria must be applied so that any change in carbon stocks is neither under- nor overestimated; models used to estimate carbon stock changes should be well-documented and should be evaluated using reliable experimental data for conditions and practices to which the models are applied. It is *good practice* to provide estimates of confidence limits or uncertainty according to the description in Volume 4, Chapter 5, Sections 5.2.3.5 and 5.3.3.5 of *2006 IPCC Guidelines*. Default carbon stock change factors may also be replaced by values generated as part of national/regional carbon accounting systems (see Section 2.7.3 of this report).

Choice of management data for mineral soils

Area data on land uses and practices need to be available in accordance with Approach 2 or Approach 3 as described in Volume 4, Chapter 3, Section 3.3.1 of the *2006 IPCC Guidelines* and guidance given in Section 2.2.4 of this report. The data on management required for each of three tiers are outlined briefly below.

Tier 1

Following Volume 4 of the *2006 IPCC Guidelines*, impacts of land-use or land management change are assumed, by default, to have an impact for 20 years. If area and activity data are available for 20 years prior to the base year, a net carbon removal/emission for the base year can be established using the default carbon stock change factors described above. The land-use changes and management practices at Tier 1 are the same as those given in the *2006 IPCC Guidelines*: differing cultivation, differing tillage, and differing input levels. Within these specific land-use or land-management changes, activities are defined semi-quantitatively, e.g., low, medium, high without manure, and high with manure input levels, full, reduced and no-till systems. Areas may be obtained from international data sets (e.g., FAO), though some of these sources lack the spatial explicitness needed for reporting and may only be helpful for cross-checking data. If area and activity data are available for 1970 and 1990, a 1990 baseline net carbon stock change can be established using the default carbon stock change factors described above and the area and activity data for 1970 and 1990.

If area and activity data are not available for 1970 and 1990, countries can derive the area and activity data using the most appropriate of the following options, in a manner consistent with guidance provided in Volume 1, Chapter 5, Section 5.3.1 of the *2006 IPCC Guidelines*. It is *good practice* to use a time period of sufficient duration (e.g., 20 years) as close to 1990 as possible.

- if the area and activity data are available for the time series between 1990 and 2010, by calculating the trend in area and activity data using the time series between 1990 and 2010;

- if the area and activity data for the time series between 1970 and 1990 or 1990 and 2010 are incomplete, using the available data to extrapolate a trend through 1990.

Tier 2

Tier 2 approaches are likely to involve a more detailed stratification of management systems than in Tier 1 if sufficient data are available. This can include further subdivisions of annual cropping input categories (i.e., low, medium, high, and high with amendment), rice cultivation, perennial cropping systems, and set-asides. It is *good practice* to further subdivide default classes based on empirical data that demonstrates significant differences in soil organic C storage among the proposed categories. In addition, Tier 2 approaches can involve a finer stratification of climate regions and soil types.Tier 2 methods may require area descriptions of higher resolution than those in Tier 1. In any case, rigorous criteria must be applied so that emissions in the base year and removals in the inventory year are not overestimated; emissions in inventory year and removals in the base year are not underestimated. This criterion may result in a conservative estimate of net soil carbon stock change.

Tier 3

Management data used in the more complex Tier 3 methodologies need to be consistent with the level of detail required by the model. It is *good practice* to use management data at a spatial resolution appropriate for the model, and to have, or be able to estimate reliably, quantitative measures of the management factors required by the model.

CARBON STOCK CHANGES IN ORGANIC SOILS

It is *good practice* to use the decision tree in Figure 2.9.1 to decide which tier to use for estimating carbon stock changes in organic soils associated with changes in CM under the Kyoto Protocol. It is *good practice* to use Tier 2 or Tier 3 methods for reporting carbon stock changes from organic soils if CM is a key category.

Methods for estimating CO_2 emissions/removals from organic soils

When organic soils are converted to or managed for agriculture, they are typically drained, tilled and fertilized, resulting in on-site CO_2 emissions to the atmosphere as well as to waterborne carbon losses that lead to off-site CO_2 emissions. Countries may use methods of different tier level for on-site and off-site CO_2 emissions from organic soils. The rate of CO_2 release will depend on, inter alia, climate, the degree of drainage, depth of the peat layer, nutrient status and practices such as fertilisation and liming. Oxidation of organic soils results in land subsidence and CO_2 emissions will continue until the organic soil layer is depleted or until further lowering of the drainage base is not feasible. In addition to on-site and off-site CO_2 emissions, drainage will result in CH_4 emissions from ditches (see Section 2.9.4.5 of this report). Drained organic soils under CM can be (partially) rewetted while remaining under CM. Guidance on (partially) rewetted organic soils can be found in Section 2.12 of this report. For all tier levels it is *good practice* to follow the methods for on- and off-site CO_2 emissions set out in Chapter 2 of the *Wetlands Supplement* (see Footnote 19, Section 2.1 of this report).

Tier 1

The Tier 1 approach is based on default emission factors per hectare of land under CM. The methods for on- and off-site CO_2 emissions are set out in Chapter 2 of the *Wetlands Supplement*.

Tier 2

If more reliable country- or region-specific data is available on CO_2 emissions from organic soils it is *good practice* to use these instead of Tier 1 defaults. Any data used should be shown to be more reliable and representative for the national conditions than defaults. It is *good practice* to use a finer classification for climate and management practices, in particular drainage classes, if there are significant differences in measured carbon loss rates among the proposed classes.

Tier 3

A Tier 3 approach may involve estimation of CO_2 and non-CO_2 greenhouse gas emissions in an integrated way. However, the non-CO_2 emissions should be reported under Agriculture, and double counting and omission should be avoided. It is *good practice* to use models that are calibrated using measurements at benchmark sites, and to describe models and assumptions used transparently.

Choice of carbon emission/removal factors for organic soils

For all tier levels it is *good practice* to follow the guidance on emission/removal factors on-site and off-site CO_2 emissions set out in Chapter 2 of the *Wetlands Supplement*.

Tier 1

The tier 1 default emission factors for on- and off-site CO_2 emissions are described in Chapter 2 of the *Wetlands Supplement*.

Tier 2

For organic soils, it is *good practice* to replace the default values identified in Chapter 2 of the *Wetlands Supplement* with country- or region-specific factors. It is *good practice* to use country- or region-specific emission/removal factors derived from measurements or experiments within the region that are well-designed and with adequate sampling and coverage. It is *good practice* to provide confidence limits and/or uncertainty estimates associated with any country- or region-specific emission/removal factors.

Tier 3

For organic soils, CO_2 and non-CO_2 greenhouse gas emissions or emissions/removals may be estimated using a model or measurement based approach. Time-dependent emission/removal factors capture more accurately the effects of land-use and management changes. Dynamic models should capture the influence of (changes in) land use and management practices, particularly the effect of variable drainage levels. Before such models are applied they should be thoroughly tested and evaluated country- or region-specific field data.

Choice of management data for organic soils

The same considerations apply as for management data for CM activities on mineral soils, as described in Section 2.9.4.2 of this report.

Area data on land uses and management practices need to be available in accordance with Approach 2 or Approach 3 following Section 2.2.2 and guidance given in Section 2.2.4 of this report. The data on management required for each of the three tiers are outlined briefly here.

Tier 1

Drainage of organic soils results in immediate and ongoing emissions that are not restricted to a 20 year time period, but are determined by subsidence rates, thickness of the peat and technical possibilities of deepening of the drainage base in subsiding land. Net carbon emission/removal from the soil in the base year can be established based on data from the base year only. The types of land-use changes and management practices that occur at Tier 1 are in principle the same as those for mineral soils.

Tier 2

It is *good practice* to disaggregate data on management practices by drainage depth, nutrient status of the organic soil, land use intensity, and peatland type if appropriate emissions factors for on-site and off-site CO_2 emissions/removals are available. In many instances standard drainage depths are used in management practices and disaggregation may not be useful in improving accuracy of the emission/removal estimates. Where significant variation in drainage depth exists for different management practices, and where appropriate emissions factors exist, it is *good practice* to improve the accuracy of an inventory by separating out drainage classes. Tier 2 methods may require area descriptions of higher resolution than those in Tier 1. It is *good practice* to apply rigorous criteria so that any change in emissions or removals is neither under- nor overestimated.

Tier 3

Management data used in the more complex Tier 3 methodologies need to be consistent with the level of detail required by the model. It is *good practice* to use management data at a spatial resolution appropriate for the model, and to have, or be able to estimate reliably, quantitative measures of the management factors required by the model.

2.9.4.3 NON-CO_2 GREENHOUSE GAS EMISSIONS FROM *IN-SITU* ABOVE-GROUND WOODY BIOMASS BURNING

N_2O and CH_4 emissions from CM related field burning of agricultural residues are reported under Agriculture whereas *in-situ* above-ground woody biomass burning is reported under CM. The decision tree in Figure 2.9.1 provides general guidance on the choice of appropriate Tier to be applied. Equation 2.27 in Chapter 2 and Section 5.2.4 in Chapter 5, Volume 4 of the *2006 IPCC Guidelines* give guidance for estimating N_2O and CH_4 emissions from *in-situ* above-ground woody biomass burning. It is *good practice* that a Party improve inventory and reporting approaches by applying the highest Tier possible. If CM is a key category and *in-situ* above-ground woody biomass burning is significant, Parties should use either Tier 2 or Tier 3 method.

2.9.4.4 REPORTING NON-CO_2 GREENHOUSE GASES EMISSIONS AND CO_2 EMISSIONS FROM LIMING AND UREA APPLICATION

The following N_2O and CH_4 emissions are reported under CM, whilst avoiding double-counting with Agriculture:

- N_2O emissions from N mineralised during soil organic matter losses in mineral soils

- N_2O and CH_4 emissions from *in-situ* burning of woody biomass (but not field burning of agricultural residues which are reported under Agriculture)
- CH_4 emission from drainage and rewetting of organic soils. The *Wetlands Supplement* of the *2006 IPCC Guidelines* provides updated methodologies for drained and wet organic soils. Further guidance on non-CO_2 emissions related to land management on organic soils is given in Chapter 2.12 on WDR.

In contrast, N_2O and CH_4 emissions from the following management practices under cropland are reported under Agriculture and not included under CM[150]:

- Direct N_2O emissions from agricultural soils due to
  - (iii) Use of synthetic fertilisers;
  - (iv) Use of animal excreta as fertiliser;
  - (v) Crop residue and sewage sludge application;
  - (vi) Cultivation of soils with high organic content;
  - (vii) Urine and dung N deposited by grazing animals on pasture, range and paddock.
- Indirect N_2O emissions from nitrogen used in agriculture, including emissions from
  - (viii) Volatilisation and subsequent atmospheric deposition of NH_3 and NO_x (originating from the application of fertilisers and manures);
  - (ix) Nitrogen leaching and runoff
- CH_4 emissions from rice cultivation

Also emissions from the following practices are reported under Agriculture, irrespective of land use:

- CO_2 emissions from liming
- CO_2 emissions from urea application

2.9.4.5 THE TRADE-OFFS OF SYNERGIES OF CROPLAND MANAGEMENT ON SOIL CARBON STOCKS AND NON-CO_2 GASES

Some management practices adopted to increase soil carbon may also influence the emissions of non-CO_2 gases. Many of these effects are included in Volume 4, Chapters 5 and 11 of the *2006 IPCC Guidelines*, but there may be other effects on non-CO_2 gases not considered. The effects on non-CO_2 emissions of these and other management practices may be included in higher tier methods for CM. Examples of how these effects could be estimated include: 1) Direct measurement of the non-CO_2 greenhouse gases at representative sites; 2) Estimation of emission rates based on literature values taking into account management, soil and climate. Box 2.9.4 gives examples of such potential trade-offs and synergies.

[150] According to the Marrakesh Accords estimates of emissions from sources and removals by sinks from for Article 3.3 and 3.4 activities are to be clearly distinguished from anthropogenic emissions from the sources listed in Annex A to the Kyoto Protocol (cf. paragraph 5 in the Annex to Decision 16/CMP.1 (Article 7), contained in document FCCC/CP/2001/13/Add.3, p.22).

BOX 2.9.4
EXAMPLES OF POSSIBLE INFLUENCES OF CARBON STOCK CHANGES ON EMISSIONS OF NON-CO_2 GASES

Example 1: Influence of reduced tillage on N_2O emission.

Adoption of reduced or no-tillage often increases soil carbon in croplands. However, at the same time it may also alter N_2O emissions, through effects on porosity (and the fraction of the porosity occupied by water) (Ball *et al.*, 2008), N and C cycling (Six *et al.*, 2004; Drury *et al.*, 2006; Ahmad *et al.*, 2009; Six *et al.*, 2004), temperature (Singurindy *et al.*, 2009), and other factors (Lee et al., 2009). The observations are inconclusive, with some studies showing higher N_2O emission under no-till than under tilled systems (Six *et al.*, 2004; Liu *et al.*, 2006; Ball *et al.*, 2008; Rochette *et al.*, 2008; Ahmad *et al.*, 2009; Suddick *et al.*, 2011), and others showing little effect or lower N_2O emissions (Venterea *et al.*, 2005; Helgason *et al.*, 2005; Elder and Lal, 2008; Gregorich *et al.*, 2008; Petersen *et al.*, 2008; Chirinda *et al.*, 2010; Bhatia *et al.*, 2010). The available data suggest that this variable response depends on interactive effects of soil and climate, and that wetter environments with poorer aeration, in which N_2O emissions generally tend to be highest, are also associated with higher emissions under no-till than under conventional tillage (Ball *et al.*, 2008).

Example 2: Links between organic matter turnover and N_2O emission.

Organic matter in soil is continually decomposing, resulting in the release of ammonia, and of nitrate. A portion of this 'available' N may be converted to N_2O. Consequently, practices that increase the rate of organic matter decomposition may stimulate N_2O emissions (Millar *et al.*, 2004; Rochette and Janzen 2005; Ruser *et al.*, 2006; Chantigny *et al.*, 2007; Thomsen *et al.*, 2010). In contrast, re-planting grasslands and reducing 'fallow' frequency may reduce N_2O emissions (Millar *et al.*, 2004). The significance and magnitude of these effects, however, are not well-understood and it may not be possible to quantify them reliably at this stage.

2.10 GRAZING LAND MANAGEMENT

2.10.1 Definitional issues and reporting requirements

Grazing Land Management (GM) is the system of practices on land used for livestock production aimed at manipulating the amount and type of vegetation and livestock produced[151]. Lands under GM are predominantly used for production of herbaceous perennial vegetation (introduced or indigenous) for harvest by grazing, cutting, or both. In order to ensure a comprehensive coverage, it is *good practice* to include all lands with the following management activities in GM: grazing, burning, cutting for forage or bedding material as well as fertilizing/manuring, liming, irrigation, drainage, reseeding, and application of organic amendments or agrochemicals to control productivity. Note that not all grasslands are necessarily included under GM.

Given the potential overlap with other activities, it is *good practice* for countries to specify what types of lands are included under other activities under Articles 3.3 and elected under Article 3.4. This will enhance the comparability of reporting across countries and ensure there is no double-counting of greenhouse gas emissions/removals.

Where land having trees meets the definition of a forest land and the trees have been established since 1990, the lands are included under the AR category (see Section 2.2.6 of this report). Lands that meet the definition of forest land can be included under GM, if grazing is the predominant land-use and the land is not included under Forest Management, based on the criteria established and consistently applied by the country (see Section 1.2 of this report). Some lands included under GM may have trees and/or shrubs. Permanent grasslands, pastures, rangelands or savannahs are normally included under GM if growing of forage crops or grazing is the most important activity on the area (see Section 1.2 of this report). Protected lands, such as those subject to permanent cover programmes, are also normally included under GM, if they are also used for livestock production. Treed areas on grassland or being grazed that were established after 1990 and meet the definition of a forest can qualify as AR, and if they do, are included under those categories (see Section 1.3 of this report). Recognizing that the forest definition is threshold based, in order to achieve consistency with established practice during the first commitment period, countries can continue to report taking account of predominant land use, as reviewed under the provisions of the Kyoto Protocol (Section 1.2 of this report).

[151] Paragraph 1(h) in the Annex to Decision 16/CMP.1 (Land use, land-use change and forestry), contained in document FCCC/KP/CMP/2005/8/Add.3, p. 5.

Lands that are only temporarily used for grazing, as part of a cropping rotation, would normally be included under CM (see Section 2.9 of this report). If CM is not elected, such land can be included under GM, subject to national criteria that are consistently applied. If a country reports all cropland and grassland used for livestock production under CM (or GM), then the Party does not need to elect one of CM or GM activities. If GM is elected with CM, it is *good practice* to include all cropland under CM and all grassland (see Chapter 1 of this report) used for livestock production under GM. The criteria used to distinguish between land under CM and GM needs to be explicitly stated and applied consistently based on national definition.

If GM is elected with Revegetation (RV; see Section 2.11 of this report), the criteria used to distinguish between land under RV and razing needs to be explicitly stated and applied consistently based on national definition. It is *good practice* to include revegetated land that is used predominantly for production of livestock under GM.

The aim of reporting is to identify and report trends in the carbon stocks resulting from GM over time. The methodology for estimating CO_2emissions/removals is based on the premise that changes in carbon stocks over time occur following changes in management that influence the rates of either carbon additions to, or carbon losses from soil. If no change in management practices occurs, the carbon stocks are assumed to be at equilibrium, and hence the change in carbon stocks is deemed zero. Parties are encouraged to use methods that show systematic changes in the carbon pools rather than inter-annual variability and short-term temporal dynamics. Another factor that may mask the carbon trend or signal is the occurrence of natural disturbances on grassland. Box 2.10.1 provides an example of practical application of elected GM.

BOX 2.10.1
GRAZING LAND MANAGEMENT – COUNTRY EXAMPLE

Denmark elected GM. The land included in grazing management is equal to the area of permanent grassland. Grassland is defined as all land not meeting definition of forest land, cropland, wetland, or settlement land and is identified using remote sensing. All grass in rotation with annual crops is included within cropland. Grassland includes land identified as under permanent grazing plus any other permanent grassland regardless of grazing. Denmark uses the same carbon stock change estimation methods for Grassland for national inventory reporting as used for GM for reporting for the Kyoto Protocol. Grazing on grassland is extensive and carbon stocks of mineral soils are estimated to not change over time. Some carbon stock losses occur under grazing management from emissions from organic soils on grassland and residual C losses from land converted to grassland in the past. The number of days of grazing within GM is included in estimates of N_2O emissions from nitrogen deposited from grazing animals reported under Agriculture for national inventory reporting and for reporting GM for the Kyoto Protocol.

To use the proposed methodology for determining carbon stock change on those lands, the total GM area needs to be subdivided into areas under various sets of management practices (which may overlap both in time and space) for the base year and each of the years in the commitment period, such as those provided in Table 6.2 of Volume 4, Chapter 6 of the *2006 IPCC Guidelines*. Broad families of practices under GM that affect carbon stocks include animal stocking rate, fertility management, irrigation management, species composition and fire management. The carbon stock change factors depend on both the current and previous management. Some areas may be emitting CO_2, others may be sequestering carbon, others may be in equilibrium and this may change if management changes. Further detail can be found in Volume 4, Chapter 6 of the *2006 IPCC Guidelines.* See also Section 2.10.2 of this report.

Parties should aim for consistency and completeness across activities. For example, all lands that were forest land on 31 December 1989 and that are subject to GM in the reporting year need to be identified, tracked and reported as a separate category under D (see Section 2.6 of this report).

2.10.2 Base year

Under Article 3.4 of the Kyoto Protocol, emissions and removals resulting from GM are estimated using a net-net accounting approach (as are as are all elective activities under Article 3.4). Net-net accounting requires that greenhouse gas emissions and removals are estimated for the base year and each year of the commitment period[152]. This entails determining the total area under GM for the base year and for each year of the commitment period and calculating the carbon stock change for those areas. Guidance for estimating the corresponding non-CO_2 greenhouse gas emissions from GM are covered in Volume 4, Chapters 10 and 11 of the

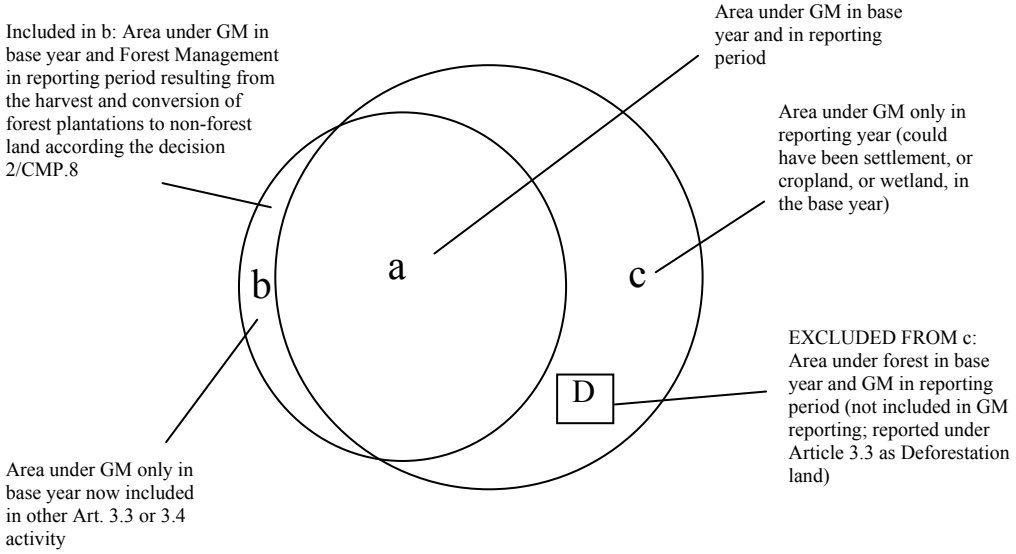
[152]Net-net accounting refers to the provisions of paragraph 10 of the Annex to Decision 2/CMP.7 (Land use, land-use change and forestry) contained in document FCCC/KP/CMP/2011/Add.1, p. 14.

2006 IPCC Guidelines. Guidance on reporting those non-CO_2 greenhouse gas emissions under Agriculture is identical to that provided in Section 2.9.4.4 of this report.

If the area under GM changes significantly between the base year and the commitment period, this may lead to estimates on moving land basis (that is, subtraction of stock changes on a land base that changes in size over time; see Box 2.10.2). Note that land can move from GM only to mandatory or elected activities under Articles 3.3 or 3.4 but cannot drop from the reporting under the Kyoto Protocol.

BOX 2.10.2
AN EXAMPLE OF GRAZING LAND MANAGEMENT AREAS IN 1990 AND IN THE COMMITMENT PERIOD (NET-NET ACCOUNTING)

In this example the area under GM in the reporting year during the commitment period is larger than in the base year. Some of the area was under GM in both the base year and during the reporting period. This also includes lands which are no longer managed as grazing land, which are not reported under any other activity under the Kyoto Protocol (a). Some of the area under GM in the base year is no longer under GM in the reporting year but reported under another activity under the Kyoto Protocol (b). There are also areas under GM in the reporting year that are not under GM in the base year (c). Area (D) is under GM, but was subject to Deforestation which takes precedence. Under the Kyoto Protocol, the emissions and removals in areas (a) + (b) in the base year are compared to emissions and removals in areas (a) + (c) – (D) in the reporting year.



For most Parties with commitments under the Kyoto Protocol, the base year is 1990. Under the provisions of Article 4.6 of the UNFCCC, however, Parties with economies in transition (EITs) are granted some flexibility on the level of historical emissions chosen as a reference. As a consequence five EITs have a base year or period between 1985 and 1990 and hence need to assess the CO_2 and other greenhouse gas emissions and removals for those years. Historical data on land-use and management practices in 1990 (or the appropriate year(s)) and in years prior to 1990 are needed to establish the 1990 base year net emissions/removals of soil carbon from GM. The Tier 1 method described in Volume 4, Chapter 6, Section 6.3.3 of the *2006 IPCC Guidelines*, for mineral soils assumes that a change in land-use/land management has an impact on carbon emissions and removals for a duration of 20 years; hence, in this approach and if a change in management has taken place since 1970, the net carbon stock change in 1990 has to be calculated taking this change into account. If area and activity data are available for 1970 to 1990, the net carbon stock change during the 1990 base year can be established using the default carbon emission and removal factors. For organic soils, the inventory time period is treated the same as long-term drained organic soils, with Tier 1 emission factors provided in Chapter 2 of the *Wetlands Supplement*.

The duration of impact may be shorter or longer than 20 years. If data on the duration of impact are available, it is *good practice* to use the appropriate time period, based on country-specific data and measurements (see Tier 2 and Tier 3 approaches in Section 2.10.4 of this report).

If area and activity data are not available for 1970 to 1990, countries can establish the 1990 carbon stock using the most appropriate of the following options, in a manner consistent with guidance provided in Volume 1, Chapter 5, Section 5.3.1 in the *2006 IPCC Guidelines*. It is *good practice* to use a long time period (e.g., 20 years) as close to 1990 as possible. For example, the carbon stock for 1990 could be estimated:

- if data are available for the time series between 1990 and 2010, based on the trend in carbon stock for the time series between 2010 and 1990;
- if data for the time series between 1970 and 1990 or 1990 and 2010 are incomplete, using the available data to extrapolate a trend through 1990.

The results of accounting on a net-net basis depend not just on changes in land management activities, but also partly on where the base year and commitment period years fall within the temporal dynamics of carbon sequestration processes. As noted above, carbon stock change resulting from land use and land management changes on mineral soil tends to persist for about 20 years, after which the carbon levels of land under GM approaches a new equilibrium carbon stock. The rate of carbon sequestration in land under GM following a change in management in which carbon additions increase or carbon losses decline tends to be high in the first decades and then decline over time, as illustrated in Figure 2.9.2. This will be reflected in net sinks and sources in the accounting.

2.10.3 Choice of methods for identifying lands subjected to Grazing Land Management

General guidance on identification of lands relevant to GM is provided in Sections 1.2, 1.3, 2.1, and 2.2 of this report. The geographical location of the boundaries of the area that encompass land subject to GM need to be reported annually, along with the total land areas subject to this activity[153].

The geographical location of the boundaries may include a spatially explicit specification of all land subject to GM, but that is not necessary. This is analogous to the case for CM as discussed in Section 2.9.1. It is *good practice* to follow continuously the management of land subject to GM. This could be achieved either by continuously tracking each land subject to GM from 1990 until the end of the commitment period (see Section 2.10.1). Alternatively, countries could develop statistical sampling techniques, consistent with the advice in Volume 4, Chapter 3, Annex 3A.3 of the *2006 IPCC Guidelines*, which allow the management transitions on GM land to be determined (see also Section 2.4.1 of this report).

At the national level, it is *good practice* to identify criteria that could be relevant to subdivision for the purpose of stratification when setting up a sampling strategy. Stratification criteria may include relatively static biophysical characteristics, such as climate and soil type, as well as management practices and natural disturbances which tend to be more dynamic drivers of change in emissions and removals from the carbon pools. Management factors and disturbance information which may be useful in establishing a national stratification include:

- Level of input of biomass or grassland productivity, organic amendments (e.g., vegetation growth, manure/compost, other amendments)
- Grazing intensity (stocking rate, frequency, seasonality)
- Prescribed fire
- Re-seeding
- Irrigation management
- Inclusions of woody biomass (shrubland, shelterbelts, other perennial plantations on grazed lands)
- Land use history since 1990 (land-use change)

For all resulting subcategories under GM, the area derived from conversion of forests (i.e., D) since 1990 need to be tracked separately as these will be reported as units of lands subject to D (See Section 2.6 of this report).

At higher tiers further subdivision of the area subject to GM may be necessary. Methods to identify lands subject to GM with necessary disaggregation available in some Annex I countries include the following:

[153] "Implications of the implementation of decisions 2/CMP.7 to 5/CMP.7 on the previous decisions on methodological issues related to the Kyoto Protocol, including those relating to Articles 5, 7 and 8 of the Kyoto Protocol"

- National land use and management statistics: the agricultural land base including land subject to GM is surveyed in most countries on a regular basis. These may be derived, in part, from remote sensing of pasture/rangeland and soil surface condition and changes in stocking rate.
- Inventory data from a plot, statistically based, plot-sampling system: land use and management activities are monitored at specific permanent sample plots that are revisited on a regular basis.

Information on these areas would have to be compiled either for all lands subject to GM or summarised as estimates for all the strata (defined by the boundaries of the areas of GM) that a Party chooses to apply for the reporting of its land use statistics. Further *good practice guidance* on identifying land areas is given in Section 2.2 of this report.

2.10.4 Choice of methods for estimating carbon stock changes and non-CO_2 greenhouse gas emissions

It is *good practice* to report GM following the *2006 IPCC Guidelines* methodologies for grassland estimates of:

- Annual changes in carbon stocks of above- and below-ground biomass;
- Annual changes of dead organic matter (dead wood and litter; DOM);
- Annual changes in organic carbon stocks of mineral and organic soils;
- Annual emissions of non-CO_2 gases from woody biomass burning.

Section 2.3.6 gives guidance about the choice of methods and identifying whether GM is a key category. If GM is a key category, the inventory compiler can determine if certain subcategories, such as mineral soil or above-ground biomass, are significant. Volume 1, Chapter 4, Section 4.2 of the *2006 IPCC Guidelines* suggests ranking subcategories according to their contribution to the aggregate key category. It may be appropriate to focus efforts towards methodological improvements of these most significant subcategories.

The Decision 2/CMP.7[154] specifies that a Party may choose not to account for a particular pool in a commitment period, if transparent and verifiable information is provided that demonstrates that the pool is not a source. Requirements for reporting excluded pools and documenting that a pool is not a source can be found in Section 2.3 of this report. It is possible that Parties will use different tiers to prepare estimates for individual subcategories (e.g., soil organic C stocks changes in mineral soils and organic soils). Since different methods may yield different estimates with different levels of uncertainty, it is *good practice* to use the same tier and methodology for estimating carbon emissions and removals from each subcategory and pool for the full time series, for example, in 1990 and during the commitment period.

Methods for estimating GM carbon emissions and removals for the base year and the commitment period are provided in Chapter 2 and Chapter 6, Volume 4 of the *2006 IPCC Guidelines*. The following sections of this report highlight aspects of these methods specific to the Kyoto Protocol.

2.10.4.1 BIOMASS AND DEAD ORGANIC MATTER

Herbaceous grassland vegetation is assumed to cycle annually (biomass gains are assumed to equal biomass losses in a single year) and is not estimated. It is *good practice* to estimate carbon stock changes in other pools (above-ground, below-ground biomass, and DOM) associated with perennial woody biomass (e.g., trees, shelterbelts and shrubs) unless the Party chooses not to report on a certain pool and provides verifiable information that carbon stocks are not decreasing.

For carbon stock changes in biomass resulting from changes in GM, it is *good practice* for Parties to use the decision tree in Figure 2.10.1 to identify the appropriate tier to estimate carbon stock changes in biomass and DOM under the Kyoto Protocol. Relevant methods for estimating carbon stock changes in above- and below-ground biomass, and DOM can be found in Volume 4, Chapter 6, Section 6.2.1 and 6.2.2 of the *2006 IPCC Guidelines*, respectively. Default coefficients for above-ground woody biomass and harvest cycles in agroforestry or silvopastoral systems containing perennial species are provided in Table 6.1 of Volume 4, Chapter 6 of the *2006 IPCC Guidelines*.

[154]Paragraph 26 in the Annex to the Decision 2/CMP.7 (Land use, land-use change and forestry), contained in document FCCC/KP/CMP/2011/10/Add.1, p16.

2.10.4.2 SOIL CARBON

In most grasslands, the main soil carbon flux associated with changes in land-use and management for GM activities is from changes in soil organic carbon in soils. The *2006 IPCC Guidelines* identify two sources or sinks of CO_2 from agricultural soils:

- Net changes in organic carbon associated with changes in land use and management on mineral soil (Chapter 6);
- Emissions of CO_2 from drained organic soils (updated by Chapter 2 of the *Wetlands Supplement;* see footnote 19, Section 2.1 of this report).

Total annual emissions and removals of CO_2 are calculated by summing emissions and removals from the two subcategories (mineral and organic soils) using methods outlined in Chapter 6 and Equation 2.24 of Chapter 2, Volume 4 of the *2006 IPCC Guidelines*.

MINERAL SOILS

Methods for estimating mineral soil carbon stock changes resulting from changes in GM fall into one of three methodological tiers described in Volume 4, Chapter 1, Sections 1.3.2 and 1.3.3 of the *2006 IPCC Guidelines*.

Methods for estimating carbon stock changes in mineral soils

The decision tree in Figure 2.10.1 should be used to decide which tier to use for estimating carbon stock changes associated with changes in GM under the Kyoto Protocol. It is *good practice* to use Tier 2 or Tier 3 methods for reporting carbon stock changes from mineral soils if GM is a key category.

Tier 1

The Tier 1 method for estimating carbon stock changes in mineral soils is described in Volume 4, Chapters 2 and 6, Sections 2.3.3.1 and 6.2.3.2 of the *2006 IPCC Guidelines*. Default soil carbon factors, which assume continuous practice for a 20-year period are provided in Table 6.2. Default reference soil organic carbon stocks for mineral soils are given in Table 2.3.

Volume 4, Chapter 6, Section 6.2.3 of the *2006 IPCC Guidelines* outlines the steps for estimating average annual rates of carbon stock change of mineral soils using the default reference carbon stocks (Table 2.3 in Chapter 2), carbon stock change factors (Table 6.2 in Chapter 6) and Equation 2.25 of Chapter 2. The Tier 1 method can be used to estimate carbon flux resulting from changes in land-use, management or the level of carbon input across a range of temperature and moisture regimes and soil types.

6546 **Figure 2.10.1 Decision tree for selecting the appropriate tier for estimating carbon stock**
6547 **changes in mineral soils under GM for Kyoto Protocol reporting (see also**
6548 **Figure 2.4 in Volume 4, Chapter 2 of the *2006 IPCC Guidelines*)**

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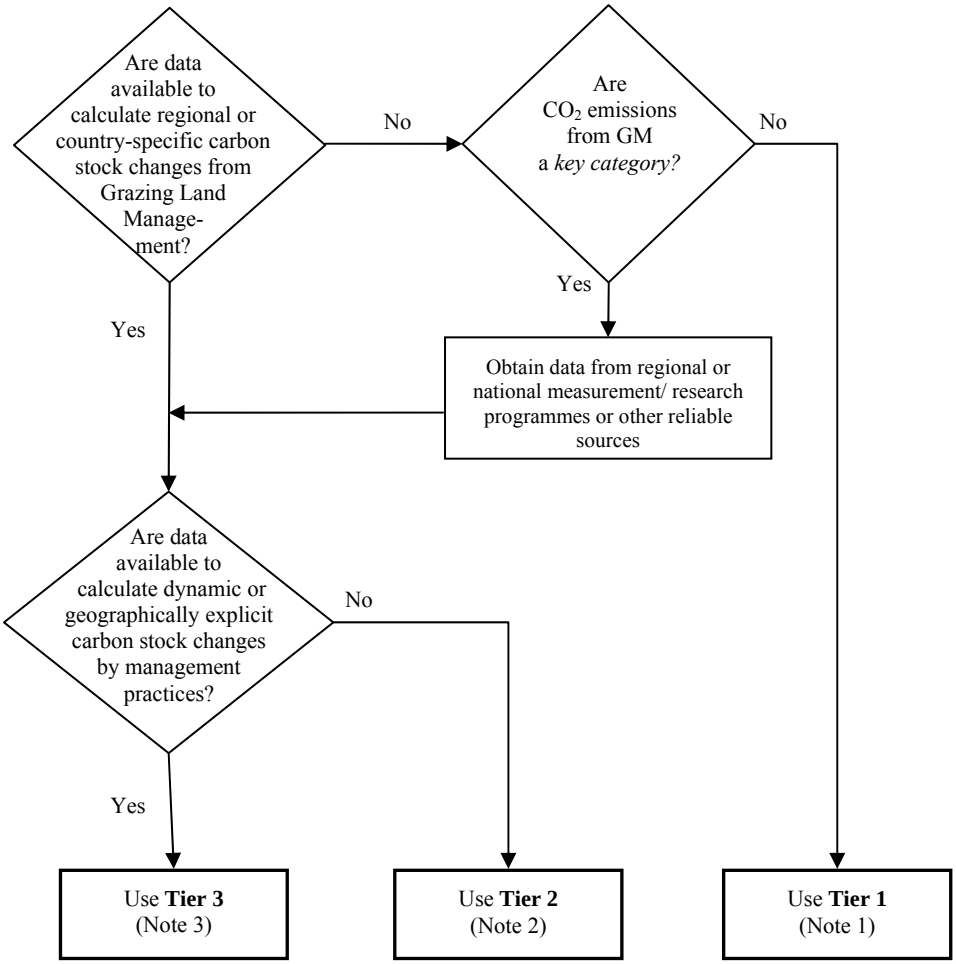

Note 1: Use the matrix/database of default values.

Note 2: Use regionally specific parameters, soil data and duration of impact.

Note 3: Use more sophisticated modelling techniques, often linked to geographical databases.

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Since the Tier 1 default methods assume continuity of practice on the land subject to the GM, it is good practice to follow continuously the land subject to GM from the base year through the commitment period. Methods for continuously tracking land are described in Section 2.10.2 of this report.

Box 2.9.3 in Section 2.9.4.2 of this report provides an illustration of estimating carbon stock changes for GM practices that are not continuous over time, which is analogous to those for CM. Reporting discontinuous practices under Reporting Method 1 implies that each change in net area of a practice assumes the change is from an equilibrium carbon state.

The carbon stock change estimated using Equation 2.25 from Volume 4, Chapter 2 of the *2006 IPCC Guidelines* can be used to calculate a yearly emission/removal of carbon resulting from GM activities (a carbon stock change factor) by multiplying the carbon stock change factor by the GM area to which the management change has been applied. For net-net accounting, the calculation shown in Equation 2.25 has to be performed for the base year and each year of the commitment period. For discussion of how to estimate the GM area, see Section 1.3 of this report.

Tier 2

The Tier 2 method also uses the methodology described in Volume 4, Chapter 6 of the *2006 IPCC Guidelines*, but now the default factors are replaced with more reliable country- or region-specific values. It is *good practice* to obtain region- or country-specific emissions factors from literature values, long-term experiments or the local application of well-calibrated, well-documented soil carbon models. Region-specific data for soil carbon content (such as that available from national soil inventories) can also be used.

To ensure that regionally-specific carbon stock change factors are better than default factors at representing actual carbon stock change in a given region, rigorous criteria must be applied to demonstrate that the more specific factors do not lead to under- or overestimation of the soil carbon change. Regional or country-specific factors should be based on verified soil carbon model estimates or measurements that are conducted of sufficient frequency, time period and spatial density to reflect variability of the underlying biochemical processes, and documented in accessible publications.

For Tier 2 approaches, it is *good practice* to replace the 20-year default with a value that reflects national or regional information about the duration of changes in GM on soil carbon emissions and removals.

Rigorous criteria must be applied so that any carbon stock change is not under- or overestimated. It is *good practice* that stock change factors be based on experiments sampled according to the principles set out in Volume 4, Chapter 2, Section 2.3.3 of *2006 IPCC Guidelines*, and to use experimental values if they are more appropriate than the default values to the region and management practice. Factors based on models should only be used after the model has been tested against experiments such as those described above and any model should be widely evaluated, well-documented and archived. It is *good practice* to provide confidence limits and/or uncertainty estimates associated with regional, country-specific or local stock change factors.

Tier 3

Tier 3 methods generally encompass a range of methodologies more elaborate than Tier 2, are usually based on sophisticated modeling techniques, and often linked to geographical databases. Compared with the static matrix used at Tiers 1 and 2, Tier 3 can represent the management history of a land that facilitates calculation of soil carbon changes resulting from multiple changes in management practices over time including rotational changes in land use. Tier 3 (like Tier 2) methods can also take into account a longer time period sufficient to reach equilibrium (i.e. longer than 20 years). Current computing power makes it possible to link spatially disaggregated (stratified) land data to management practice data. The analytical system can track carbon stock changes over time by linking equations describing the rate of change in soil carbon under specific management practices with carbon contents, initialised at some point and cross-checked periodically. Tier 3 methods can also be based on repeated statistical sampling consistent with the principles set out in Volume 4, Chapter 3, Annex 3A.3 of the *2006 IPCC Guidelines.* The sampling protocol should be of sufficient density to capture the soil types, climatic regions and management practices.

Choice of carbon stock change factors for mineral soils

Tier 1

At Tier 1, average yearly carbon stock changes in mineral soils are calculated from default values by dividing the 20-year stock change by 20, as set out in Volume 4, Chapter 2, Equation 2.25 of the *2006 IPCC Guidelines*. Default reference (under native vegetation) soil organic C stocks (SOC_{REF}) for mineral soils, full details of default relative stock change factors for land use (F_{LU}), input (F_I) and management (F_{MG}) factors (over 20 years) can be found in Table 2.3 (for SOC_{REF}) and Table 6.2 (for F_{LU}, F_I and F_{MG}) in Chapters 2 and 6, respectively, of Volume 4 of the *2006 IPCC Guidelines*. Management practice is assumed to influence stocks to a depth of 30 cm. For a summary of the steps, see Volume 4, Chapter 2, Section 2.3.3 of the *2006 IPCC Guidelines*.

Tier 2

At Tier 2, some or all of the default values for carbon stock change (Tier 1) are replaced by values shown to be more reliable. These new values may be based on literature values, measured changes in carbon stocks, on simple carbon models, or a combination of these. (See 'Choice of management data for mineral soils' below for examples). It is *good practice* to derive relative stock change factor values for a higher resolution classification of management, climate and soil types if there are significant differences in the stock change factors among more disaggregated categories based on an empirical analysis. Reference soil organic C stocks (SOC_{REF}) can also be derived from country-specific data in a Tier 2 approach. Additional guidance is provided in Volume 4, Chapter 2, Section 2.3.3.1 of the *2006 IPCC Guidelines*.

Tier 3

For mineral soils, Tier 3 carbon stock change factors are country-derived, and may be calculated using complex models. The carbon models used for Tier 3 are generally more complex than those in Tier 2, taking into account soil (e.g., clay content, chemical composition, parent material), climate (e.g., precipitation, temperature, evapotranspiration), and management factors (e.g., species introduction or removal, carbon inputs, fertility amendments, vegetation utilization by grazing livestock). *Good practice* requires that the models be calibrated using measurements at benchmark sites, and that model and assumptions used are described transparently.

In all cases, rigorous criteria must be applied so that any change in carbon stocks is neither under- nor overestimated; models used to estimate carbon stock changes should be well-documented and should be evaluated using reliable experimental data for conditions and practices to which the models are applied. It is *good practice* to provide estimates of confidence limits or uncertainty according to the description in Volume 4, Chapter 6, Sections 6.2.3.5 and 6.3.3.5 of the *2006 IPCC Guidelines*. Default carbon stock change factors may also be replaced by values generated as part of national/regional carbon accounting systems (see Section 2.7.3 of this report).

Choice of management data for mineral soils

Area data on land uses and practices need to be available in accordance with Approach 2 or Approach 3 as described in Chapter 3, Section 3.3.1 and guidance given in Chapter 2, Volume 4 of the *2006 IPCC Guidelines*. The data on management required for each of three tiers are outlined briefly below.

Tier 1

Following Volume 4 of the *2006 IPCC Guidelines*, impacts of land-use or land management change are assumed, by default, to have an impact for 20 years. If area and activity data are available for 20 years prior to the base year, a net carbon removal/emission for the base year can be established using the default carbon stock change factors described above. The land-use changes and management practices at Tier 1 are the same as those given in the *2006 IPCC Guidelines*: differing degradation states, improved vs. unimproved grassland, and differing input levels for improved grassland. Within these specific land-use or land-management changes, activities are defined semi-quantitatively, e.g., non-, moderately, and severely degraded. Areas may be obtained from international data sets (e.g., FAO), though some of these sources lack the spatial explicitness needed for reporting and may only be helpful for cross-checking data. If area and activity data are available for 1970 and 1990, a 1990 baseline net carbon stock change can be established using the default carbon stock change factors described above and the area and activity data for 1970 and 1990.

If area and activity data are not available for 1970 and 1990, countries can derive the area and activity data using the most appropriate of the following options, in a manner consistent with Volume 1, Chapter 5, Section 5.3.1 of the *2006 IPCC Guidelines*. It is *good practice* to use a long time period (e.g., 20 years) as close to 1990 as possible.

- if the area and activity data are available for the time series between 1990 and 2010, by calculating the trend in area and activity data using the time series between 1990 and2010;
- if the area and activity data for the time series between 1970 and 1990 or 1990 and 2010 are incomplete, using the available data to extrapolate a trend through 1990.

Tier 2

Tier 2 approaches are likely to involve a more detailed stratification of management systems than in Tier 1 if sufficient data are available. This can include further subdivisions of GM categories (e.g., nature of degradation, improved grassland subdivided by vegetation community). It is *good practice* to further subdivide default classes based on empirical data that demonstrates significant differences in soil organic C storage among the proposed categories. In addition, Tier 2 approaches can involve a finer stratification of climate regions and soil types. Tier 2 methods may require area descriptions of higher resolution than those in Tier 1. An alternative to the use of more detailed descriptor categories is the use of relationships relating the intensity of a practice (e.g., grazing level) with a change in the carbon emission/removal factor. Alternatively, well-calibrated and well-evaluated models of soil carbon change, e.g. RothC (Coleman and Jenkinson, 1996; Shirato et al. 2004, or others) can be

used to generate either default carbon stock change factors, or to generate the intensity relationships for each activity, for different soils in different climatic regions. These examples show how, at Tier 2, activities can be made more country-specific, but other refinements are also possible. In any case, rigorous criteria must be applied so that emissions in the base year and removals in the inventory year are not overestimated, emissions in inventory year and removals in the base year are not underestimated. This criterion may result in a conservative estimate of net soil carbon stock change.

Tier 3

Management data used in the more complex Tier 3 approaches are likely to be subdivided as described for Tier 2 above. For application of dynamic models (e.g., CENTURY (Parton et al., 1987), RothC (Coleman and Jenkinson, 1996; Shirato et al. 2004), measured/estimated activity data based on national statistics (e.g., herbage yield, input level of organic amendment), detailed data of the combination of climate, soil and management are needed.

CARBON STOCK CHANGES IN ORGANIC SOILS

It is *good practice* to use the decision tree in Figure 2.10.1 to decide which tier to use for reporting carbon stock changes in organic soils under the Kyoto Protocol.

Methods for estimating CO_2 emissions/removals from organic soils

When organic soils are converted to or managed for agriculture, they are typically drained, tilled and fertilized, resulting in on-site CO_2 emissions to the atmosphere as well as to waterborne carbon losses that lead to off-site CO_2 emissions. Countries may use methods of different tier level for on-site and off-site CO_2 emissions from organic soils. The rate of CO_2 release will depend on, inter alia, climate, the degree of drainage, depth of the peat layer, nutrient status and practices such as fertilisation and liming. Oxidation of organic soils results in land subsidence and CO_2 emissions will continue until the organic soil layer is depleted or until further lowering of the drainage base is not feasible. In addition to on-site and off-site CO_2 emissions, drainage will result in CH_4 emissions from ditches (see Section 2.9.3.3). Drained organic soils under GM can be (partially) rewetted while remaining under GM. Guidance on (partially) rewetted organic soils can be found in Section 2.12 of this report. For all tier levels it is *good practice* to follow the methods for on- and off-site CO_2 emissions set out in Chapter 2 of the *Wetlands Supplement* (see Footnote 8, Section 2.3 of this report).

Tier 1

The tier 1 default methods for on- and off-site CO_2 emissions are described in Chapter 2 of the *Wetlands Supplement*.

Tier 2

If more reliable country- or region-specific data is available on CO_2 emissions from organic soils it is *good practice* to use these instead of Tier 1 defaults. Any data used should be shown to be more reliable and representative for the national conditions than defaults. It is *good practice* to use a finer classification for climate and management practices, in particular drainage classes, if there are significant differences in measured carbon loss rates among the proposed classes.

Tier 3

A Tier 3 approach may involve estimation of CO_2 and non-CO_2 greenhouse gas emissions in an integrated way. However, double counting and omission in relation to reporting under Agriculture (see analogous section 2.9.4.4 of this report) needs to be avoided. It is *good practice* to use models that are calibrated using measurements at benchmark sites, and to describe models and assumptions used transparently.

Choice of carbon emission/removal factors for organic soils

For all tier levels it is *good practice* to follow the guidance on emission/removal factors on-site and off-site CO_2 emissions set out in Chapter 2 of the *Wetlands Supplement*.

Tier 1

The tier 1 default emission factors for on- and off-site CO_2 emissions are described in Chapter 2 of the *Wetlands Supplement*.

Tier 2

For organic soils, it is *good practice* to replace the default values identified in Chapter 2 of the *Wetlands Supplement* with country- or region-specific factors. It is *good practice* to use country- or region-specific emission/removal factors derived from measurements or experiments within the region that are well-designed and with adequate sampling and coverage. It is *good practice* to provide confidence limits and/or uncertainty estimates associated with any country- or region-specific emission/removal factors.

Tier 3

For organic soils, CO_2 and non-CO_2 greenhouse gas emissions or emissions/removals may be estimated using a model or measurement based approach. Time-dependent emission/removal factors capture more accurately the effects of land-use and management changes. Dynamic models should capture the influence of (changes in) land use and management practices, particularly the effect of variable drainage levels. Before such models are applied they should be thoroughly tested and evaluated country- or region-specific field data.

Choice of management data for organic soils

The same considerations apply as for management data for GM activities on mineral soils, as described earlier in Section 2.10.3.

Area data on land uses and management practices need to be available in accordance with Approach 2 or Approach 3 in Section 2.2.2 and guidance given in Section 2.2.4 of this report. The data on management required for each of the three tiers are outlined briefly below.

Tier 1

Drainage of organic soils results in immediate and ongoing emissions that are not restricted to a 20 year time period, but are determined by subsidence rates, thickness of the peat and technical possibilities of deepening of the drainage base in subsiding land. Net carbon emission/removal from the soil in the base year can be established based on data from the base year only. The land-use changes and management practices at Tier 1 are the same as those for mineral soils.

If rewetting of organic soils for GM occurs additional guidance for those lands is found in Chapter 3 of the *Wetlands Supplement*.

Tier 2

It is *good practice* to disaggregate data on management practices by drainage depth, nutrient status of the organic soil, land use intensity, and peatland type if appropriate emissions factors for on-site and off-site CO_2 emissions/removals are available. In many instances standard drainage depths are used in management practices and disaggregation is not useful in improving accuracy of the emission/removal estimates. Where significant variation in drainage depth exists for different management practices, and where appropriate emissions factors exist, it is *good practice* to improve the accuracy of an inventory by separating out drainage/rewetting classes. Tier 2 methods may require area descriptions of higher resolution than those in Tier 1. It is *good practice* to apply rigorous criteria so that any change in emissions or removals is neither under- nor overestimated.

Tier 3

Management data used in the more complex Tier 3 methodologies need to be consistent with the level of detail required by the model. It is *good practice* to use management data at a spatial resolution appropriate for the model, and to have, or be able to estimate reliably, quantitative measures of the management factors required by the model.

2.10.4.3 NON-CO_2 GREENHOUSE GAS EMISSIONS FROM *IN-SITU* ABOVE-GROUND WOODY BIOMASS BURNING

N_2O and CH_4 emissions related *in-situ* above-ground woody biomass burning is reported under GM. The decision tree in Figure 2.10.1 provides general guidance on the choice of appropriate Tier to be applied. Equation 2.27 in Volume 4, Chapter 2, of the *2006 IPCC Guidelines* is applied to estimate N_2O and CH_4 emissions from -situ aboveground woody biomass burning. It is *good practice* that a Party improve inventory and reporting approaches by applying the highest Tier possible. If burning in GM is significant, Parties need to use either Tier 2 or Tier 3 method.

2.10.4.4 REPORTING NON-CO_2 GREENHOUSE GAS EMISSIONS AND CO_2 EMISSIONS FROM LIMING AND UREA APPLICATION

The following N_2O and CH_4 emissions are reported under GM, whilst avoiding double-counting with Agriculture:

- N_2O emissions from N mineralised during soil organic matter losses in mineral soils
- N_2O and CH_4 emissions from *in-situ* burning of woody biomass (but not field burning of agricultural residues which are reported under Agriculture)
- CH_4 emission from drainage and rewetting of organic soils. The *Wetlands Supplement* provides updated methodologies for drained and wet organic soils. Further guidance on non-CO_2 emissions related to land management on organic soils is given in Section 2.12 on Wetland Drainage and Rewetting (WDR).

In contrast, the following N_2O and CH_4 emissions are reported under Agriculture and not included under GM[155]:

- Direct N_2O emissions from agricultural soils due to
  - (i) Use of synthetic fertilisers;
  - (ii) Use of animal excreta as fertiliser;
  - (iii) Cultivation of soils with high organic content;
  - (iv) Urine and dung N deposited by grazing animals on pasture, range and paddock.
- Indirect N_2O emissions from nitrogen used in agriculture, including emissions from
  - (i) Volatilisation and subsequent atmospheric deposition of NH3 and NOx (originating from the application of fertilisers and manures),
  - (ii) Nitrogen leaching and runoff
- CH_4 and N_2O emissions from enteric fermentation of livestock and manure management.

Also emissions from the following practices are reported under Agriculture, irrespective of land-use:

- CO_2 emissions from liming
- CO_2 emissions from urea application

2.11 REVEGETATION

2.11.1 Definitional issues and reporting requirements

Revegetation (RV) is a direct human-induced activity to increase carbon stocks on sites through the establishment of vegetation that covers a minimum area of 0.05 hectares and does not meet the definitions of A and R[156] (see also Footnote 1, Chapter 1 of this report).

Land should be classified as RV if it meets the RV definition and takes place after 1 January 1990. RV typically affects the aboveground carbon pool significantly and may also have a significant impact on belowground carbon pools through increases in soil carbon stocks.

RV implies that vegetation is established to replace the previous (sometimes minimal) ground cover that had followed a land disturbance. For example, activities such as reclaiming/restoring herbaceous ecosystems on degraded or carbon-depleted soils, establishment of vegetation cover on disturbed construction sites or mined lands, planting of trees, shrubs, grass or other non-woody vegetation various types of lands including urban areas, might qualify as RV (see Box 2.11.1). Any tree planting could be elected as a RV activity, if besides meeting the area requirement for this activity it does not meet the requirements for a forest[157], or satisfies the criteria a Party uses to specify the shape of forests and areas subject to A/R, D, or conversion of a natural forest to a planted forest (see Section 2.2.6.1 of this report). RV does not necessarily entail a change in land-use, in contrast to A or R, for example. RV activities must be clearly differentiated from natural, non-human driven RV processes.

Set-aside lands such as cultivated lands subjected to RV should be included under CM, if they are only temporarily set-aside (typically this is for 5 years or less, but any set-aside likely to return to cropland under the national conditions for set-aside should be counted as cropland).

It is *good practice* for Parties electing RV to provide documentation (a) describing how the included areas meet the definition of RV and (b) how they can be distinguished from other activities under Articles 3.3 and 3.4.

The following general guidance is provided in order to ensure a reasonably transparent, consistent, complete and accurate reporting of RV activities:

[155] According to the Marrakesh Accords estimates of emissions from sources and removals by sinks from for Article 3.3 and 3.4 activities are to be clearly distinguished from anthropogenic emissions from the sources listed in Annex A to the Kyoto Protocol (cf. paragraph 5 in the Annex to Decision 16/CMP.1 (Article 7), contained in document FCCC/CP/2001/13/Add.3, p.22).

[156] Paragraph 1(e) in the Annex to Decision 16/CMP.1 (Land use, land-use change and forestry), contained in the document FCCC/KP/CMP/2005/8/Add.3, p. 5.

[157] Paragraph 1(a) in the Annex of Decision 16/CMP.1 (Land use, land-use change and forestry), contained in the document FCCC/KP/CMP/2005/8/Add.3, p.5.

- It is *good practice* to stratify lands subject to RV by either land-use category or land-use change type, by type of RV activity, and final land-use if different from the initial one.
- It is *good practice* to further disaggregate each land-use category to be revegetated into subcategories characterised by available information on most relevant climate, soil etc., whatever is most relevant for stratifying land according to the activity effects on carbon stocks and carbon stock changes. This characterisation would aid selecting suitable RV options and activity tracking; i.e. species, planting design, and soil preparation.
- Lands subjected to RV and each of its subcategories (if any) must be clearly identified as to their individual locations and areas (see Section 2.11.2 in this report).

BOX 2.11.1

[4]RV Activities[A]

Iceland: The conversion of eroded or desertified land from Other Land or less vegetated subcategories of grassland to Grasslands (as defined by a vascular vegetation cover of 20% or larger) or grasslands with more vegetation cover.

Japan: Plantation of trees in parks and green spaces in both public and private urban areas.

Romania: Plantation of trees on degraded croplands: outside forest lands under administrative stewardship; roadsides; shelterbelts; around cities; and erosion-prone lands. All revegetated lands are classified as Croplands remaining Croplands.

[A]As described in each Party's NIR for 2011. See http://unfccc.int/national_reports/annex_i_GHG_inventories/national_inventories_submissions/items/6598.php

2.11.2 Base year

See Section 2.9.2 of this report and apply it in analogous manner.

2.11.3 Choice of methods for identifying lands

Land areas subject to RV can be represented with data obtained with either Approach 2—provided there is additional spatial information—or Approach 3 (see Volume 4, Chapter 3, Section 3.3.1 of the *2006 IPCC Guidelines*). It is *good practice* that the particular Approach chosen be consistent with the one used for identifying and tracking the lands of other Kyoto Protocol activities, be they mandatory (Article 3.3) or elected (Article 3.4).

Generally, all lands subject to RV since 1 January 1990 should be tracked in agreement with the national criteria that establish a hierarchy among Article 3.4 activities (if applicable) as explained in Section 1 of this report.

The geographical location of boundaries may include a spatially explicit specification of each land subject to RV, but does not have to. Instead, the boundaries of larger areas encompassing smaller lands subject to RV may be provided, along with estimates of the area subject to RV in each of the larger areas. In either case, the lands subject to RV and the management thereon need to be tracked continuously through time. Continuity in monitoring/reporting of management of revegetated land could be achieved either by continuously tracking each land subject to RV from 1990 until the end of the commitment period (see Section 2.9.2 for CM and Section 2.10.2 for GM or Volume 4, Chapter 3, Section 3.3 of the *2006 IPCC Guidelines* for land-use categories in general) or by developing statistical sampling techniques (see Volume 4, Chapter 3, Annex 3A.3 of the *2006 IPCC Guidelines*) that allow the transition of different types of management on RV land to be determined.

Methods for monitoring RV lands depend on the kind of land-use at the start and end of a RV activity. A common criterion, the minimum area of 0.05 hectares has to be detected and all carbon pools have to be considered unless they are demonstrated not to be a source. If RV were done with herbs or grasses, monitoring should use methods appropriate for monitoring GM (see Section 2.10 of this report). If RV were done with tree species, monitoring methods should be the same as those used for monitoring A/R activities (see Section 2.5 of this report) or FM activities (see Section 2.7 of this report). For designing RV activities on settlement lands, it is *good practice* to use tree inventories (if available), land surveys on parks and green spaces, brownfields and any other spatial information on areas amenable to RV. A clear definitional distinction with respect to A or R is required.

2.11.4 Choice of methods for estimating carbon stock changes and non-CO_2 greenhouse gas emissions

Methods for estimating changes in above-ground biomass, below-ground biomass, and DOM carbon pools in a RV activity described in Volume 4, Chapters 4 - 9 of the *2006 IPCC Guidelines*. The biomass carbon pool is likely to be the carbon pool most affected by RV. Parties are encouraged to use higher tier methods for reporting C stock changes in biomass. It is *good practice* to use Tier 2 or Tier 3 for estimating carbon stock changes from biomass if RV is a key category.

For estimating carbon stocks in mineral soils and organic soils, and for estimating CO_2 emissions from liming RV lands, relevant methods and approaches can be found in Volume 4, Chapters 4 - 9 and 11 of the *2006 IPCC Guidelines*. For urban soils, methods are described in Volume 4, Chapter 8 on Settlements in the *2006 IPCC Guidelines*. Also see Pavao-Zuckerman (2008).

In the case of a RV activity involving cropland or grassland, guidance on choice of methods (Tier 1) for stock changes in mineral soils can be found in Sections 2.9.3.1 of this report. It is *good practice* to use Tier 2 or Tier 3 for estimating carbon stock changes from mineral soils if RV is a key category. A decision tree for selecting the tier for estimating carbon stock changes in mineral soils under RV is analogous to that for CM (see Figure 2.9.1 of this report). At higher tiers, carbon stock change factors can be obtained from relevant literature (e.g., Akala and Lal, 2000), long-term experiments and models. Further guidance on the use of higher tier models can be found in Volume 4, Chapter 2, Section 2.3.3, of the *2006 IPCC Guidelines.*

The decision tree for methods to estimate emissions from organic soils under RV is similar to the one drawn for CM (see Figure 2.9.3 of this report) if the RV activity did involve either CM or GM. The methods described under Tiers 1, 2 and 3 for either FM, CM or GM also apply to RV activities involving either treed lands, croplands or grasslands (see Sections 2.7, 2.9 and 2.10, respectively, of this report) and Chapters 7 - 9 in Volume 4 of *2006 IPCC Guidelines.*

For the estimation of CO_2 emissions from liming revegetated lands, the *good practice* methods developed for either FM, CM or GM can be used based on the annual amount of lime application. For general *good practice* guidance on the estimation of CO_2 emissions from liming, see Volume 4, Chapter 11, Section 11.3 of the *2006 IPCC Guidelines*.

2.11.4.1 Choice of carbon stock change factors

Tier 1

Estimation of RV is more dependent on national definitions than is the case for other Article 3.4 activities. When using Tier 1 methodologies, it is *good practice* to provide national information substantiating that they adequately represent a Party's national circumstances (Sections 2.2 and 2.3 of this report and Volume 4, Chapters 4 - 9 of the *2006 IPCC Guidelines* contain methodologies that may be relevant). It is *good practice* for a Party electing RV to provide values for stock change in each carbon pool. In the case of pools not reported, it is *good practice* to provide verifiable information to demonstrate that these pools are not a source of carbon emissions. If RV is deemed a key category, then it is *good practice* to use Tier 2 or 3 methods.

Tier 2

At Tier 2, it is *good practice* to provide verifiable methods and documentation to show how the carbon stock change has been estimated for each pool elected under a RV activity. For any carbon pool not reported, it is *good practice* to provide verifiable information to demonstrate that it is not a source of greenhouse gas anthropogenic emissions.

Tier 3

At Tier 3 ecosystem carbon cycle models, parameterised for the relevant plant functional types and soils included in the selected RV area, could be used to estimate annual carbon emissions and removals. These models need to be calibrated and validated against field observations that represent the national circumstances, be fully documented and archived.

2.11.4.2 Choice of management data

Activities such as reclaiming or restoring herbaceous ecosystems on carbon-depleted soils, environmental plantings, planting of trees, shrubs, grass or other non-woody vegetation on various types of lands including urban areas, which qualifying as RV can be considered. Area data on land uses and practices need to be available

in accordance with Approach 2 or Approach 3 (Section 2.2 of this report), following guidance given in Section 2.2.3 of this report. The data on RV management required for each of three tiers are outlined briefly here.

TIER 1

Following guidance in Volume 4 of the *2006 IPCC Guidelines,* impacts of land-use change or land management change under a RV activity are assumed, by default, to fully develop at the end of 20 years. The choice of default emission factors influenced by management factors depends on the particular land uses involved in a particular RV activity. As minimum the six broad land-use categories and changes between these categories need to be specified and different types of RV activities separated.

TIER 2

For Tier 2 some management practices for RV may be either subdivided or new ones may be added to make them country-specific, depending of the land-uses involved in a RV activity. It is *good practice* that those subdivisions reflect close relationships between management practices and changes in carbon pools.

TIER 3

Management data used in the more complex Tier 3 methodologies need to be consistent with the level of detail required by the model or models used to describe a particular RV activity. It is *good practice* to use management data at a spatial resolution appropriate for the model, and to have, or be able to estimate reliably, quantitative measures of the management factors required by the model.

It is *good practice* to provide detailed documentation specifying the practices included under RV and the carbon emission/removal factors associated with each practice for each pool elected.

2.11.4.3 NON-CO_2 GREENHOUSE GASES

The choice of methods for estimating N_2O and CH_4 emissions from a RV activity depend on the land-use categories involved (e.g. Cropland, Grassland, etc.) and the particular management practices (e.g. biomass burning, nitrogen fertilisation, liming, etc.) on those lands.

Methodologies for estimating N_2O and CH_4 emissions from RV activities involving the management of trees (outside forests but not in settlements), croplands or grasslands can be found in Sections 2.7.3 (FM), 2.9.4 (CM) or 2.10.4 (GM), respectively. For RV activities leading to the establishment of wetlands, appropriate methodologies can be found in the *Wetlands Supplement*. N_2O and CH_4 emissions from the RV of settlement lands can be estimated with methods described in Volume 4, Chapter 8 of the *2006 IPCC Guidelines.* For guidance on reporting non-CO_2 emissions that may otherwise fall under Agriculture, follow analogous guidance as for CM (Section 2.9.4 of this report).

2.12 WETLAND DRAINAGE AND REWETTING

2.12.1 Definitional issues and reporting requirements

According to the Decision 2/CMP.7 *"Wetland Drainage and Rewetting" is a system of practices for draining and rewetting on land with organic soil that covers a minimum area of 1 hectare. The activity applies to all lands that have been drained since 1990 and to all lands that have been rewetted since 1990 and that are not accounted for under any other activity, where drainage is the direct human-induced lowering of the soil water table and rewetting is the direct human-induced partial or total reversal of drainage*[158]

Wetland Drainage and Rewetting (WDR) can only be implemented on organic soils, but under any Land-use category. Organic soils are defined in Volume 4, Chapter 3, Annex 3A.5 of the *2006 IPCC Guidelines*. This definition of organic soils simplifies the FAO (1998/2006) definition of 'Histosol' and links (and even largely equates) organic soils to peat soils or peaty soils (Chapter 1 of the *Wetlands Supplement*; see footnote 19, Section 2.1 of this report). All other soils are classified as mineral soils following the *2006 IPCC Guidelines* (Volume 4, Chapter 3, Annex 3A.5).

The definition of organic soils in the *2006 IPCC Guidelines* excludes the thickness criterion of the FAO definition and allows for country-specific definitions with respect to thickness of the organic layer (Chapter 1 of the *Wetlands Supplement*). It is *good practice* that Parties, within their report on the choice of definitions, define

[158] Paragraph 1(b) in the Annex to Decision 2/CMP.7 (Land use, land-use change and forestry), contained in the document FCCC/KP/AWG/2011/10/Add.1, p.13.

the minimum depth and the minimum organic content of the organic layer in their definition of organic soil and use this definition consistently over time.

Drainage and rewetting refer to all practices in and outside the area with organic soil that directly affects the hydrological system, leading to a change in the water table and its seasonal pattern in the area with organic soil. Drainage includes both new drainage of formerly undrained land and a change in an existing drainage regime. Whereas rewetting includes partial rewetting and complete rewetting to near-natural water table level or even beyond (see Chapters 2 and 3 of the *Wetlands Supplement*), as far as these practices have taken place since 1990.

Human-induced drainage includes e.g. the installation of (additional) ditches, drainage pipes and groundwater extraction. Direct human-induced rewetting includes blocking drainage ditches and pipes or disabling pumping facilities. Also abandoning the maintenance of ditches resulting in water table rise is considered to be direct human-induced rewetting, whereas naturally rising water tables, e.g. in areas with permafrost thawing is not considered to be direct human-induced rewetting.

The WDR activity includes only lands that are not accounted for under any other activity. Therefore, emissions and removals due to drainage and rewetting practices on organic soils will also be reported under other Kyoto Protocol activities (see Box 2.12.1):

- Emissions/removals from drainage and rewetting associated with a conversion from non-forested land to forest or from FM to any other Articles 3.3 or 3.4, the activity will be reported under A, R or D.
- Emissions/removals from drainage and rewetting of land remaining under FM will be reported under FM.
- Lands drained and rewetted since 1990 that meet the criteria for classification under CM, GM or RV, will be reported under WDR only when the above-mentioned activities are not elected but WDR is elected.

Flooded land (as defined in Volume 4, Chapter 7, Section 7.3 of the *2006 IPCC Guidelines*) is not included under this activity. CO_2 emissions from rice cultivation are by priority reported under the CM activity, but may be included under WDR when organic soils are rewetted for rice cultivation, and CM is not elected.

The guidance for estimating and reporting of emissions from drainage and rewetting is given in the *2006 IPCC Guidelines* and the *Wetlands Supplement*. The *Wetlands Supplement* introduces updated emission/removal factors and new sources of off-site CO_2 emissions and CH_4 emissions from ditches for drained organic soils.

The base year for WDR is the same as for CM, GM and RV. Practical guidance for identification of land areas for WDR in the base year and during the commitment period is given in Section 2.12.3 of this report.

Drainage and rewetting result in immediate changes of greenhouse gas emissions and removals so that there may be less need to establish a land-use history prior to 1990 for tier 1 methods. However, when higher tier methods that consider dynamic transitions since the drainage or rewetting took place require the land-use history prior to 1990.

BOX 2.12.1

EXAMPLES FOR REPORTING OF EMISSIONS/REMOVALS FROM ORGANIC SOILS DRAINED/REWETTED SINCE 1990 UNDER THE VARIOUS KYOTO PROTOCOL LULUCF ACTIVITIES

Whereas the activity WDR – if elected - only applies to lands on organic soils that have been drained and rewetted since 1990 and that are not subject to any other mandatory or elected activity, the *practices* of drainage and rewetting of organic soils may occur under any other activity under Articles 3.3. or 3.4 and would be reported under these mandatory or elected activities accordingly. The resulting emissions/removals from drained and rewetted lands would be reported under:

Deforestation when

- a forest with organic soil is drained and converted to e.g. cropland
- forest harvesting affects hydrologic conditions to the extent that regeneration to forest is not anymore possible (e.g. when reduced evapotranspiration and consequent higher water tables after clear felling prevent re-establishment of forest)
- rewetting practices change the hydrologic conditions to the extent that forest cannot persist or is not allowed to regenerate (e.g. when forest with organic soils is rewetted and felled to enhance specific biodiversity)

Afforestation/Reforestation when

- other land than forest land is drained for forestry (e.g. when a naturally treeless or sparsely treed organic soil is drained to stimulate forest growth)
- other land than forest land is rewetted for forestry (e.g. when drained organic soil used for grassland is rewetted and planted with wetland trees, e.g. alder/*Alnus*)

Forest Management when

- forest land is drained and remains forest land (e.g. when unproductive forested organic soil is drained to increase productivity)
- forest land is rewetted and remains forest land (e.g. when an ash/*Fraxinus* forest on organic soil is rewetted for alder/*Alnus* forestry)

Cropland Management (if elected[1]) when

- other land than forest land is drained for agriculture (e.g. when a treeless peatland is converted to cropland)
- cropland is rewetted but remains cropland (e.g. when a potato field on organic soil is rewetted for paludiculture)

Grazing Land Management (if elected[1]) when

- other land on organic soil than forest land is drained to improve grazing
- grassland on organic soil is rewetted but remains grassland (e.g. when a drained grassland for dairy cow husbandry is converted to to a wet grassland for water buffalo husbandry)

Revegetation (if elected[1]) when

- other land than forest land is revegetated and rewetted (e.g. when an abandoned bare peat extraction site is actively converted to a vegetated wetland)

Wetland Drainage and Rewetting (land-based net-net accounting) when

- other land than forest land is rewetted and CM, GM and RV has not been elected by the Party (but WDR has) in the cases presented above.

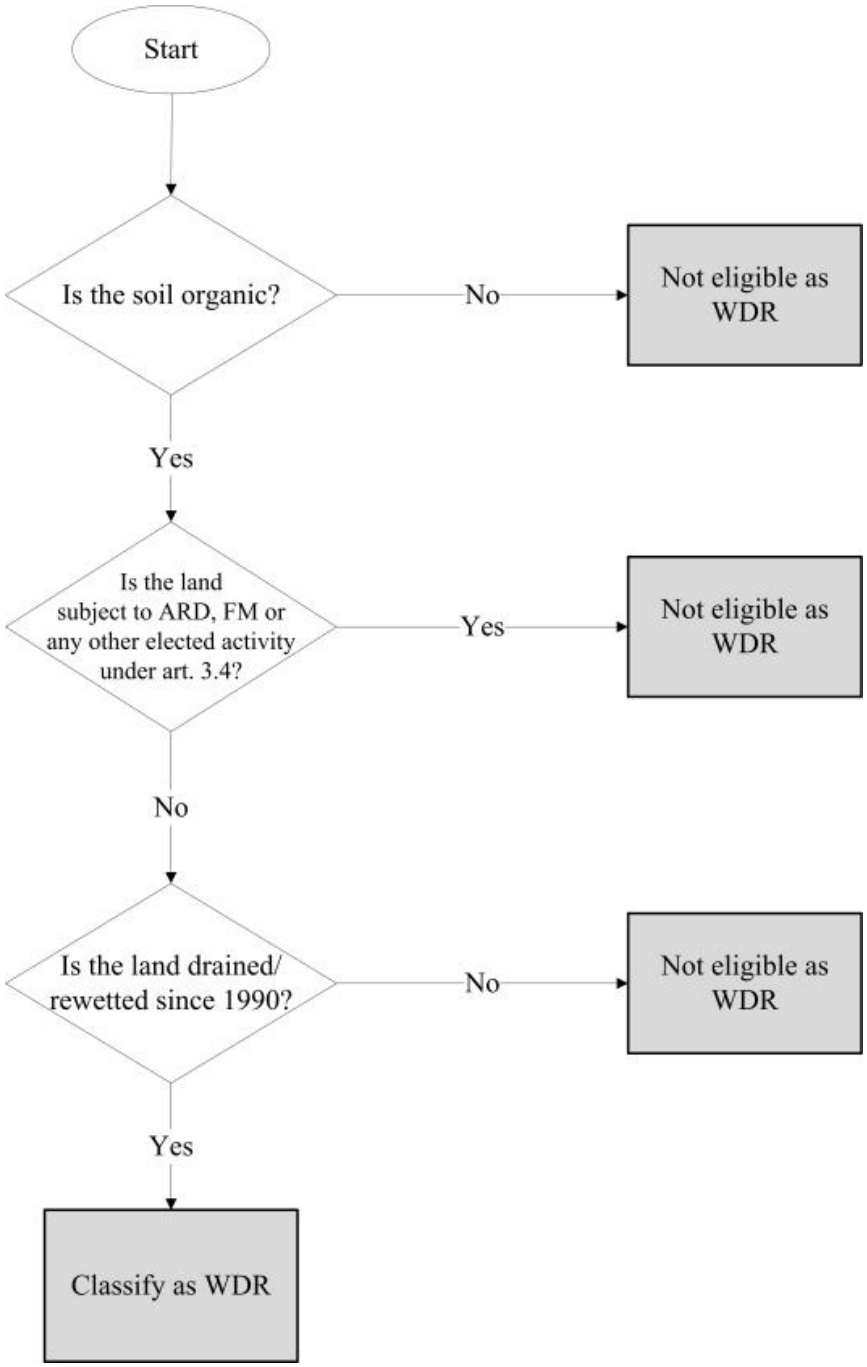
[1] if a Party has elected an activity (CM, GM or RV) under Article 3.4, in the first commitment period the reporting under this activity will be mandatory during the second commitment period

2.12.2 Choice of methods for identifying lands

2.12.2.1 GENERAL GUIDANCE FOR IDENTIFYING LANDS

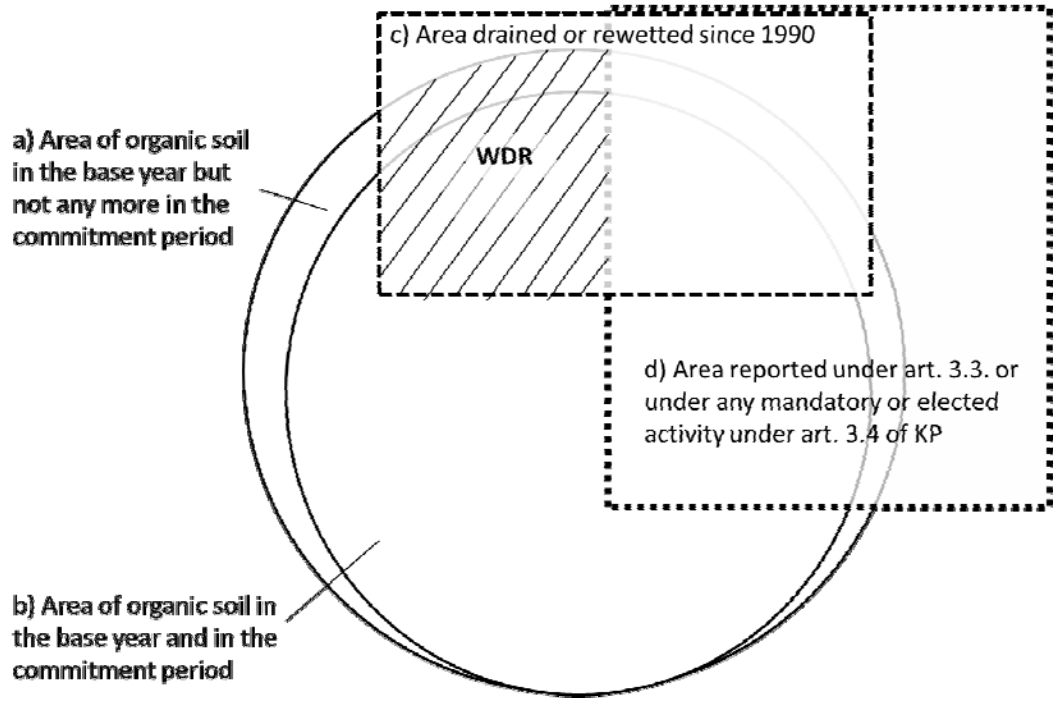
The activity WDR can only be applied to organic soils that are drained or rewetted since 1990 and that are not included under any other accounted activity (see Chapter 1 and Figure 2.12.1 of this report for further guidance).

Figure 2.12.1 Decision tree for identifying land under the Article 3.4 activity WDR if this activity is elected.



As rewetting and drainage of organic soils may also occur under other accounted land-use activities, the WDR activity will always concern only a subset of the total area of organic soil in the country. When drained organic soil oxidizes, the organic material layer becomes shallower. Over time the organic soil layer may become so shallow that an area no longer complies with the criteria of an organic soil. It is good practice to apply the activity to all land with an organic soil that has been drained or rewetted since 1990 even if the soil on these lands has converted to mineral soil before or in the commitment period. These issues are illustrated in Box 2.12.1.

BOX 2.12.2
WETLAND DRAINAGE AND REWETTING AREAS IN 1990 AND THE COMMITMENT PERIOD (NET-NET ACCOUNTING)



Lands to be reported under WDR if WDR is elected. The area of organic soils in the base year (a) can be larger than the area in the commitment period (b) if part of the organic soils have changed into mineral soils due to e.g. oxidation, peat extraction or deep-ploughing. The activity applies only to lands that have been drained and rewetted since 1990 (c) and the lands may *not* be accounted for under any other activity (d). The land that will be reported under WDR (if elected) is thus the hatched area with the conditions: a– (c∩d). Emissions and removals from the same land are to be reported both for the base year and for the commitment period year.

Drainage and rewetting of organic soils can lead to large changes in greenhouse gas emissions per hectare. Consequently, particular care must be taken to make accurate estimates of greenhouse gas emissions and removals both in the 1990 base year and in the commitment period. Countries are encouraged to use stratification by land-use category or similar or further subcategories in a way that the guidance in the *Wetlands Supplement* on methodologies and emission factors best matches the national conditions. .

It is *good practice* for countries to include, within their report on the choice of definitions, a description of the criteria used to identify areas where WDR applies and to apply these criteria consistently (see Section 2.2 of this report).

With respect to the minimum area of 1 ha to which WDR applies criteria can be defined as to the minimum width. Then the minimum length of the area follows from the combination of width and the prescribed minimum area of 1 ha. For example, with a minimum width of 20 m, a rectangle of minimum width has to be at least 500 m long to meet the 1 ha size requirement.

2.12.2.2 SPECIFIC GUIDANCE FOR IDENTIFYING LANDS

The identification of lands to be included under the WDR should follow a similar approach as described in Section 2.9.1 of this report (see also decision tree in Figure 2.2.2). It is *good practice* to identify the lands drained since 1990 and the lands rewetted since 1990 separately.

There are two ways of identifying lands subject to WDR: the 'Difference-method' and the 'Change-method'.

DIFFERENCE METHOD

The 'Difference method' compares all lands with organic soils in 1990 with all lands with organic soils in the commitment period, using the following steps:

STEP 1: Identify the geographical boundaries and areas of organic soils. The area of organic soils and mineral soils, respectively, need to be constant over time unless it is demonstrated that organic and mineral soils are converted over time. The sum of the areas of organic and mineral soils also needs to be constant over time and equal the total national land area (unless the national land area is changing), taking account of any areas that do not have soil. It is *good practice* to ensure complete coverage of organic soils accordingly, including by providing information on reasons for any changes in the reported areas (see also Box 2.12.1).

STEP 2: Define relevant water table classes (e.g. undrained, shallowly drained, deeply drained, fully rewetted) and their proxies/indicators (e.g. water table, land-use category, drainage structure, management) to be identified, and apply these consistently over time, including in the base year. Data and information from the past can be of lower quality than recent data, whereas data sets may also be incomplete for past years. Volume 1, Section 5.4 of the *2006 IPCC Guidelines* provides guidance how to provide consistent time series in these cases.

STEP 3: Quantify the areas of the defined classes for the base year and for the reporting year, while complying with the minimum area and land tracking requirements for activities under the Kyoto Protocol (see Section 2.2) and identify the lands where a direct human-induced change in class has taken place since 1990. Identify lands where drainage and lands where rewetting has taken place separately. Approach 2 will result in a non-spatially explicit land-use matrix, while Approach 3 is spatially explicit. Approach 3 can only be used if additional spatial information is available. It is *good practice* to describe the additional spatial information transparently to ensure complete reporting (see also Section 12.2.2.3).

STEP 4: Identify the relevant lands accounted under any other activity that takes precedence over WDR using the decision tree (Figure 2.12.1) and report the changes on these lands under the respective activities (see Box 2.12.1). Exclude these lands from the areal information for WDR to avoid double-counting.

CHANGE METHOD

The 'Change method 'directly identifies the lands with organic soil where direct human-induced drainage or rewetting has taken place since 1990, using the following steps:

STEP 1: Define relevant water table classes (e.g. undrained, shallowly drained, deeply drained, fully rewetted) and their proxies/indicators (e.g. water table, land-use category, drainage structure, management) to be identified, and apply these definitions in a consistent manner over time, including in the base year. Data and information from the past can be of lower quality than recent data, whereas data sets may also be incomplete for past years. Section 5.4 in Volume 1 of the *2006 IPCC Guidelines* provides guidance how to provide consistent time series in these cases.

STEP 2: Identify the land areas where a direct human-induced drainage and rewetting has occurred since the base year, while complying with the minimum area and land tracking requirements for activities under the Kyoto Protocol (see Section 2.2 of this report). Identify lands where drainage and lands where rewetting has taken place separately. Approach 2 will result in a non-spatially explicit land use matrix, while Approach 3 is spatially explicit.

STEP 3: Identify the lands with organic soils within the lands where direct human-induced drainage or rewetting has occurred since the base year. It is *good practice* to ensure complete coverage of organic soils over time by providing information on reasons for any changes in the reported areas since the base (see STEP 1 under the "Difference method").

STEP 4: Identify within the lands on organic soil where direct human-induced drainage or rewetting practices have occurred since the base year the lands that are accounted under any other activity that takes precedence over WDR using the decision tree (Figure 2.12.1) and report the changes on these lands under the respective activities (see Box 2.12.1). Exclude these lands from the spatial information for WDR to avoid double-counting.

All the lands thus identified fall under WDR both in the base year (i.e. when the practice of rewetting or drainage had not yet taken place) and in the reporting year of the commitment period. The land under WDR in the base

year must fully match the land under WDR in each reporting year of the commitment period. As the area of land under WDR may grow during the commitment period when newly drained or newly rewetted lands are added, the area of land under WDR in the base year has to grow accordingly.

2.12.2.3 GEOGRAPHICAL BOUNDARIES

A country that elects WDR must identify the geographical boundaries of all drainage and rewetting events that are one hectare or larger, are directly human-induced, and do not fall under any other activity that takes precedence.

Approach 2 with supplementary information, or Approach 3 described in Volume 4, Chapter 3, Section 3.3.1 of the *2006 IPCC Guidelines* can be chosen for land area identification. For Approach 2, existing administrative records, land-use databases and soil maps may have relevant information. Additional spatially explicit data through sampling or otherwise geographically referenced methods are likely to be necessary to delineate the relevant combinations of land-use categories, land-use changes, management practices and drainage or rewetting systems and their changes over time. This supplementary information allows creating a detailed non-spatially explicit land-use matrix for the WDR activity that tracks changes in land-use and drainage status over time. The area under the activity WDR is cumulative and includes *all* land that has been drained or rewetted since 1990, independent of what the former or later drainage situation was.

Information sources about drainage and rewetting practices since 1990 with adequate disaggregation may include:

- National land-use registries and statistics, land-use maps and soil maps, maps of water and nature conservation zones with restrictions for water management and maps of wetlands.
- National water management statistics: in most countries, the agricultural land base including croplands is surveyed regularly, providing data on distribution of different land uses, crops, tillage practice and other aspects of management, often at sub-national regional level. These statistics may originate, in part, from remote sensing methods, from which additional information about wetness or periods with flooding could be extracted.
- Inventory data from a statistically based, plot-sampling system of water table wells, ditches and surface waters on organic soils that allow interpretation of data in terms of human-induced drainage and rewetting rather than interannual variability.
- Water management plans and documentation from water management installations.
- Drainage maps.
- Maps of rewetting projects including remote sensing.

The geographical boundaries identified by the 'Difference method' include the whole area of organic soils identified after step 3 described above in this Section. Approach 2 with supplementary information or Approach 3 can be used for the difference method.

The geographical boundaries identified by the 'change method' identify the areas on which drainage or rewetting activities have occurred since 1990, equivalent to the area after STEP 4 described above in this Section. Only spatially explicit data (Approach 3) that allow land tracking on one hectare minimum area, for example, from drainage and rewetting projects, is suitable for the change method.

2.12.2.4 STRATIFICATION

Stratification needs to be consistently applied in the base year and the commitment period. The following factors may be useful in establishing a national stratification for drained and rewetted land, which result in different levels of greenhouse gas emissions or removals:

- Land-use and management practices, as relevant
- Drainage regime (water level, seasonality), following the water table classes defined in the first steps of the Difference- and the Change-method (Section 2.12.3), respectively, e.g.
  - (iii) undrained / near natural water regime (Chapter 3 of the *Wetlands Supplement*),
  - (iv) drained comparable to the typical water table range of the *Wetlands Supplement* for drained organic soils (Chapter 2 of the *Wetlands Supplement*),

(v) drained deeper than water level range of *Wetlands Supplement* for part or all of the year if applicable,

(vi) drained more shallow than the water table range of *Wetlands Supplement* for partially drained or rewetted for part or all of the year if applicable,

(vii) flooded (maybe further stratified by seasonally flooded or flooded throughout the year) land if applicable, which does not fall under the definition of "flooded land" or "reservoir" (Volume 4, Chapter 7, Section 7.1 of the *2006 IPCC Guidelines*).

For all resulting subcategories where drainage and rewetting have taken place, the areas afforested, reforested or deforested since 1990 need to be tracked separately as these areas will be reported as units of lands subject to the activities AR and D. Similarly areas under FM or any elected activity need to be tracked and reported separately.

At higher tiers further subdivision of the area under WDR may be useful, e.g. by seasonality of drainage management.

2.12.3 Choice of methods for estimating greenhouse gas emissions and removals

Guidance on methodologies for estimating carbon stock changes, CO_2 emissions and removals and non-CO_2 gas emissions on lands subject to WDR is given in the *2006 IPCC Guidelines* and the *Wetlands Supplement*. The *2006 IPCC Guidelines* provide methodologies for the estimation of carbon stocks and carbon stock changes in above- and below-ground biomass, dead wood and litter for inland organic soils, whereas Chapter 4 of the *Wetlands Supplement* provides additional guidance for these pools for coastal organic soils. The *Wetlands Supplement* provides methodologies and updated emission factors for estimating soil emissions from wetlands and organic soils. Chapter 2 of the *Wetlands Supplement* provides guidance for drained inland organic soils, Chapter 3 of the *Wetlands Supplement* for rewetted and wet inland organic soils and Chapter 4 of the *Wetlands Supplement* for coastal organic soils.

It is *good practice* to estimate and report greenhouse gas emissions from drained lands (Chapter 2 of the *Wetlands Supplement)* and from rewetted lands (Chapter 3 of the *Wetlands Supplement)* under WDR separately.

Generic guidance about the choice of methods is given in Section 2.3.6 of this report. For key category analysis, the absolute values of emissions and removals from all land under WDR are summed up. WDR is a key category if (1) this sum is greater than the emissions from the key category with the smallest emissions as identified in the UNFCCC inventory (including LULUCF) (= level analysis) or (2) the trend (change over time) of WDR is larger than that from the key category with the smallest changes (= trend analysis).

If WDR is a key category, it is *good practice* to determine whether one of the two subcategories rewetting or drainage is particularly important. Following decision trees in Figures 1.2 and 1.3 in Volume 4, Chapter 1 of the *2006 IPCC Guidelines*, a subcategory is considered *significant* if it accounts for 25-30 percent of the overall emissions or removals of the category (which applies to at least one of the two subcategories drainage or rewetting). Alternatively, finer subcategories, e.g. by land-use category, drainage level or change in drainage level or by carbon pool, are ranked according to their contribution to the aggregate key category WDR. Those subcategories that contribute together more than 60 percent to the key category are considered *significant*. It is *good practice* to report the *significant* subcategories with higher tier methods and to focus efforts towards methodological improvements on these subcategories.

Detailed guidance for the five carbon pools (excluding HWP) and non-CO_2 greenhouse gas emissions is found, inter alia:

- For above-ground and below-ground biomass, dead wood and litter, if relevant, in Volume 4 of the *2006 IPCC Guidelines* in Chapter 2 (generic), Chapter 5 (Cropland), Chapter 6 (Grassland), Chapter 7 (Wetlands) and Chapter 8 (Settlements). It is *good practice* to use consistent methodologies and emission factors across ARD, FM and elected Article 3.4 activities. Guidance includes non-CO_2 greenhouse gas emissions from biomass burning by controlled burning and wildfires.
- For organic soils:
  - (i) for drained and partially rewetted inland organic soils: Chapter 2 of the *Wetlands Supplement*, Tier 1 and higher tier methods,
  - (ii) for fully rewetted and wet inland organic soils: Chapter 3 of the *Wetlands Supplement*, Tier 1 and higher tier methods,
  - (iii) for coastal organic soils: Chapter 4 of the *Wetlands Supplement*, Tier 1 and higher tier methods.

- For dissolved organic carbon (DOC) from inland organic soils: Chapter 2 (from drained land) and Chapter 3 (from rewetted land) of the *Wetlands Supplement*, Tier 1 and higher tier methods.
- For greenhouse gas emissions from peat fires: Chapter 2 of the *Wetlands Supplement.*
- For off-site CO_2 emissions from peat extraction for horticulture and soil amendment: Chapter 7 of *2006 IPCC Guidelines* for Tier 1. Countries using higher tier methods that deviate from the Tier 1 assumption that the peat is fully oxidized during the extraction year need to document that no double-counting takes place and that CO_2 emissions from peat in horticultural use are taken into account.
- For N_2O emissions from drained organic soils: Chapter 2 of the *Wetlands Supplement* for inland organic soils; Chapter 4 of *Wetlands Supplement* for coastal organic soils, Tier 1 and higher tier methods.
- For CH_4 emissions from drainage ditches on organic soils: Chapter 2 of the *Wetlands Supplement*, Tier 1 and higher tier methods.
- For CH_4 emissions from rewetted organic soils: Chapter 3 of the *Wetlands Supplement,* Tier 1 and higher tier methods.

Decision 16/CMP.1 specifies that *a Party may choose not to account for a given pool in a commitment period, if transparent and verifiable information is provided that the pool is not a source*[159]. Guidance for documentation that excluded carbon pools are not a source is given in Section 2.3.1 of this report. This choice only applies to CO_2 emissions and removals, not to N_2O or CH_4 emissions, which can be sources regardless of whether the carbon pool is a sink or source.

It is *good practice* to use the same methodologies for estimating emissions and removals in the base year and in all years of the commitment period.

It is *good practice* to include all carbon pools and associated emissions and removals reported under the UNFCCC sectors, and land-use categories and land conversion categories, in estimating greenhouse gas emissions and removals of the lands included in WDR. Non-CO_2 emissions on lands under WDR are often reported under Agriculture and double-counting of the emissions should be avoided. Table 2.12.1 provides general guidance how to avoid double-counting across activities and sectors.

TABLE 2.12.1 CHECKS TO AVOID DOUBLE COUNTING AND TO ENSURE COMPLETENESS

Sector, land-use category or Activity	
Agriculture	Under Agriculture are reported: • Direct and indirect N_2O emissions on agricultural land (cropland, grassland). If the application of fertilizers to other land categories cannot be separately identified, this application should be included under Agriculture. • CH_4 emissions from rice cultivation. • CO_2 emissions from urea application and liming are reported under the sector Agriculture irrespective of the land-use category.
Afforestation, Reforestation, Deforestation (ARD)	All emissions and removals from lands under ARD are reported under ARD, except those already reported under Agriculture (see above). ARD takes precedence over all other activities.
Forest Land, FM	All emissions and removals from lands included under FM are reported under FM, except those already reported under Agriculture. All emissions and removals from Forest Land on organic soils drained or rewetted since 1990 are reported under WDR if that activity is elected, except those already reported under Agriculture or any other relevant activity.
Cropland, CM	All emissions and removals from lands under CM are reported under CM in case CM is mandatory or elected, except those already reported under Agriculture. All emissions and removals from Cropland on organic soils drained or rewetted since 1990 are, in case CM is not mandatory or elected, but WDR is elected, reported under WDR, except those already reported under Agriculture or any other relevant activity.
Grassland, GM	All emissions and removals from Grassland under GM are reported under GM in case GM is

[159] See paragraph 21 in the Annex to the Decision 16/CMP.1 (Land use, land-use change and forestry), contained in document FCCC/KP/CMP/2005/8/Add.3, p.3.

	mandatory or elected, except those already reported under Agriculture. All emissions and removals from Grassland on organic soils drained or rewetted since 1990 are, in case GM is not mandatory or elected, but WDR is elected, reported under WDR, except those already reported under Agriculture or any other relevant activity.
Wetlands[160]	All emissions and removals from Wetlands on organic soils drained or rewetted since 1990, including emissions from peat extracted for horticultural peat use (but not peat extracted for energy, as these emissions are reported under the Energy sector), are reported under WDR, if that activity is elected, except those already included under Agriculture or any other relevant activity.
Settlements	All emissions and removals from Settlements on organic soils drained or rewetted since 1990 are reported under WDR, if that activity is elected, except those already included under Agriculture or any other relevant activity.
Other Land	All emissions and removals from Other Land on organic soils drained or rewetted since 1990 are reported under WDR, if that activity is elected, except those already included under Agriculture or any other relevant activity.
RV	All emissions and removals resulting from drainage and rewetting practices on lands under RV are reported under RV, if that activity is elected or mandatory, except those reported under Agriculture (see above).

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[160] Mind that the *Wetlands Supplement* interprets the concept of the Wetlands land-use category wider than the *2006 IPCC Guidelines* and also includes wetlands where the water table has not been altered or that have not been created.

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ANNEX 2A.1

REPORTING TABLES FOR KP LULUCF ACTIVITIES UNDER THE KYOTO PROTOCOL

TABLE 2A.1
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ST		
Table 1A	Summary table of emissions and removals from activities under Article 3.3, Forest Management and elected activities under Article 3.4	
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LTM		
Table 2A	Land Transition Matrix with areas and changes in areas between the previous and the current inventory year	The value of the reported area subject to the various activities under Article 3.3 and 3.4 for the inventory year should be that on 31 December of that year.
		Total area reported in this table should match the total area of the country and be constant over time.
Table 2B	Area of natural forests converted to forest plantations (additional information)	This table should be used to report land areas of natural forests converted to forest plantations since the start of the commitment period, if any. Associated emissions and removals are implicitly reported under Forest Management.
KC		
Table 3	Summary of key categories for Land Use, Land-Use Change and Forestry activities under the Kyoto Protocol	
AR		
Table 4A	All lands reported under Afforestation and Reforestation would otherwise be subject to Forest Management	All lands reported under Afforestation and Reforestation would otherwise be subject to Forest Management.
		The value reported for net change in SOC of organic soils could be an emission and not a carbon stock change.
Table 4B	Background level of emissions associated with natural disturbances in AR lands and its margin, where a margin is needed (additional information)	Report information in this table only if the Party elected to exclude emissions in forest associated with natural disturbances that are beyond the control of, and not materially influenced by, a Party.
Table 4C	Emissions associated with natural disturbances (additional information)	Report information in this table only if the Party elected to exclude emissions in forest associated with natural disturbances that are beyond the control of, and not materially influenced by, a Party.
		Information reported in this table is additional to that reported in table 4A and 10, and therefore does not replace the need to report in those tables all carbon stock changes and all non-CO_2 emissions associated with natural disturbances.
		Report in this table information on changes in carbon stocks and non-CO_2 emissions for the inventory year for all geographical locations that encompass lands subject to Afforestation and Reforestation under Article 3.3 where natural disturbances have occurred, only if the total emissions associated with natural disturbances have exceeded the background level plus the margin, where the margin is needed.
Table 4D	Removals subsequent to natural disturbances (additional information)	Report information in this table only if the Party elected to exclude emissions in forest associated with natural disturbances that are beyond the control of, and not materially influenced by, a Party.

		Information reported in this table is additional to that reported in table 4A, and therefore does not replace the need to report in that table all carbon stock changes in AR lands.
		Report here all incremental removals in the inventory year, for all geographical locations that encompass lands subject to Afforestation and Reforestation where natural disturbances have occurred in any previous year of the commitment period and for which associated emissions have exceeded the background level plus the margin, where the margin is needed.
D		
Table 5A	Article 3.3 activities: Carbon stock changes under Deforestation	Lands that have been deforested and subsequently reforested need to be reported as a subcategory of deforested land in order to transparently report emissions and removals on these lands which, despite are reported under D, match the forest definition.
		The value reported for net change in SOC of organic soils could be an emission and not a carbon stock change.
Table 5B	Deforested land previously subject to natural disturbances (additional information)	Report information in this table only if the Party elected to exclude emissions in forest associated with natural disturbances that are beyond the control of, and not materially influenced by, a Party.
		Information reported in this table is additional to that reported in tables 4A and 10, and therefore does not replace the need to report in those tables all carbon stock changes and non-CO_2 emissions associated with natural disturbances.
		Report in this table information on forested land that have been converted to non-forested land use after having been subject to natural disturbances in a year of the commitment period where emissions associated with natural disturbances have exceeded the background level plus the margin, where a margin is needed.
FM		
Table 6A	Article 3.4 activities: Carbon stock changes under Forest Management	The value reported for net change in SOC of organic soils could be an emission and not a carbon stock change.
Table 6B	Forest Management reference level (additional information)	
Table 6C	Carbon Equivalent Forests (additional information)	Information reported in this table is additional to that reported in table 6A, and therefore does not replace the need to report in that table all carbon stock changes associated with clearing and foresting of lands reported as Carbon Equivalent Forests under Forest Management. This table is aimed at checking whether the equivalent forest that has been planted is achieving the expected carbon stock.
		Report in this table information on carbon stock that was in the cleared forest plantation, at time of harvesting, and of current carbon stock in the equivalent forested area, for all lands subject to the "Carbon Equivalent Forest" provisions, within Forest Management under Article 3.4 (see paragraphs 37-39 of the annex to decision 2/CMP.7) for which the "carbon equivalence" has not been achieved yet. This means that lands should be reported here until the year, and including the year, in which the carbon equivalence is achieved.

Table 6D	Background level of emissions associated with natural disturbances in FM lands and its margin, where a margin is needed (additional information)	Report information in this table only if the Party elected to exclude emissions in forest associated with natural disturbances that are beyond the control of, and not materially influenced by, a Party.
Table 6E	Emissions associated with natural disturbances (additional information)	Report information in this table only if the Party elected to exclude emissions in forest associated with natural disturbances that are beyond the control of, and not materially influenced by, a Party.
		Information reported in this table is additional to that reported in tables 4A and 10, and therefore does not replace the need to report in those tables all carbon stock changes and non-CO_2 emissions associated with natural disturbances.
		Report in this table information on changes in carbon stocks and non-CO_2 emissions for the inventory year for all geographical locations that encompass lands subject to Forest Management under Article 3.4 where natural disturbances have occurred, only if the total emissions associated with natural disturbances have exceeded the background level plus the margin, where the margin is needed.
Table 6F	Removals subsequent to natural disturbances (additional information)	Report information in this table only if the Party elected to exclude emissions in forest associated with natural disturbances that are beyond the control of, and not materially influenced by, a Party.
		Information reported in this table is additional to that reported in table 6A, and therefore does not replace the need to report in that table all carbon stock changes in FM lands.
		Report in this table all incremental removals in the inventory year, for all geographical locations that encompass lands subject to Forest Management where natural disturbances have occurred in any previous year of the commitment period and for which associated emissions have exceeded the background level plus the margin, where the margin is needed.
3.4		
Table 7	Carbon stock changes under elected Article 3.4 activities	For each elected activity, this table and all relevant tables should also be reported for the base year.
		The value reported for net change in SOC of organic soils could be an emission and not a carbon stock change.
N_2O		
Table 8A	Direct N_2O emissions from N fertilization of Forest land	N_2O emissions from fertilization for Cropland Management, Grazing Land Management, Revegetation and Wetland Drainage and Rewetting should be reported in the Agriculture sector. If a Party is not able to separate fertilizer applied to Forest Land from Agriculture, it may report all N_2O emissions from fertilization in the Agriculture sector and this table should not be filled.
		The indirect N_2O emissions from lands subject to any Article 3.3. or 3.4 activity are estimated as part of the total indirect emissions in the Agriculture sector based on the total amount of fertilizer used in the country.
Table 8B	N_2O emissions from disturbance associated with land-use conversion to cropland	N_2O emissions from disturbance of soils are only relevant for land conversions of mineral soils to Cropland. N_2O emissions from conversion, including drainage, of organic soils to agricultural uses are reported in the Agriculture sector under Cultivation of

		histosols.
DR-RW		
Table 9A	CH_4 and N_2O emissions from Drainage of organic soils	N_2O emissions from drainage of organic soils which occur on all lands subject to Cropland Management or Grazing Land management and on those lands subject to Revegetation, Wetland Drainage and Rewetting, Deforestation or Forest Management, within the CEFC provision, which are subject to agricultural practices, including grazing, should be reported in the Agriculture sector under Cultivation of Histosols.
Table 9B	CH_4 and N_2O emissions from Rewetting of organic soils	N_2O emissions from rewetting of organic soils which occur on all lands subject to Cropland Management or Grazing Land management and on those lands subject to Revegetation, Wetland Drainage and Rewetting, Deforestation or Forest Management, within the CEFC provision, which are subject to agricultural practices, including grazing, should be reported in the Agriculture sector under Cultivation of Histosols.
Fires		
Table 10	GHG emissions from burning of organic matter	Non-CO_2 emissions associated with burning of living biomass and DOM of Savanna and of agricultural residues should be reported in the Agriculture sector.
HWP		
Table 11A	Carbon stock changes in the Harvested Wood Products pool	
Table 11B	Harvested Wood Products activity data	
Table 11C	Harvested Wood Products in the FMRL	

GENERAL NOTES:

1. Geographical location refers to the boundaries of the areas that encompass lands subject to the activity (or subject to the particular provision)
2. Activity data may be further subdivided according to climate zone, management system, soil type, vegetation type, tree species, ecological zone, national land classification or other criteria. One row should be completed for each subdivision.

TABLE 1A
SUMMARY TABLE

Emissions and removals from activities under Article 3.3, forest management and elected activities under Article 3.4

Inventory year:

Activity		Changes in carbon pool and sources of greenhouse gases reported												
							Soil organic matter							
							Mineral soils		Organic soils					
									Drainage			Rewetting		
		Above-ground biomass	Below-ground biomass	Litter	Dead wood	HWP	SOC	N_2O emissions associated with land-use conversion to cropland	SOC	non-CO_2 emissions associated with		SOC	non-CO_2 emissions associated with	
		(Gg C)					(Gg C)	(Gg N_2O)	(Gg C)	(Gg CH_4)	(Gg N_2O)	(Gg C)	(Gg CH_4)	(Gg N_2O)
Article 3.3 activities	AR													
	D													
Article 3.4 activities	FM													
	CM (if elected)													
	GM (if elected)													
	RV (if elected)													
	WDR (if elected)													

Activity		Changes in carbon pool and sources of greenhouse gases reported				Total emissions/removals reported			
		Fertilization in forest land	Burning of organic mattert			Net CO_2	CH_4	N_2O	Net CO_2-equivalent
		(Gg N_2O)	(Gg C)	(Gg CH_4)	(Gg N_2O)	(Gg)			
Article 3.3 activities	AR								
	D								
Article 3.4 activities	FM								
	CM (if elected)								
	GM (if elected)								
	RV (if elected)								
	WDR (if elected)								

Table 1B Additional information: Selected parameters for defining "Forest" under the Kyoto Protocol	
Inventory Year	
Parameter	**Selected value**
Minimum land area	
Minimum crown cover	
Minimum height	
Minimum width	

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TABLE 2A.
LAND TRANSITION MATRIX

Areas and changes in areas of activities between the previous and the current inventory year

Inventory Year

			To current inventory year								
			Article 3.3 activities		Article 3.4 activities					Other (i.e. All remaining area in the country)	Total area at the beginning of the current inventory year
			Afforestation and Reforestation	Deforestation	Forest Management	Cropland Management (if elected)	Grazing Land Management (if elected)	Revegetation (if elected)	Wetland Drainage and Rewetting (if elected)		
			(kha)								
From previous inventory year	Article 3.3 activities	Afforestation and Reforestation									
		Deforestation			(1)						
	Article 3.4 activities	Forest Management									
		Cropland Management (if elected)			(1)						
		Grazing Land Management (if elected)			(1)						
		Revegetation (if elected)			(1)						
		Wetland Drainage and Rewetting (if elected)			(1)						
	Other (i.e. All remaining area in the country)										
Total area at the end of the current inventory year											

(1) Only in case of Carbon Equivalent Forests

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TABLE 2B ADDITIONAL INFORMATION: AREA OF NATURAL FORESTS CONVERTED TO FOREST PLANTATIONS				
Inventory year				
GEOGRAPHICAL LOCATION	**Area of natural forests converted to forest plantations**			
Identification code	**Subdivision**	**Year of conversion**	**Area subject to conversion**	**Area of organic soils**
			(kha)	
Total				

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TABLE 3 SUMMARY OF KEY CATEGORIES FOR LAND USE, LAND-USE CHANGE AND FORESTRY ACTIVITIES UNDER THE KYOTO PROTOCOL					
Inventory year					
KEY CATEGORIES	**GAS**	**CRITERIA USED FOR KEY CATEGORY IDENTIFICATION**			
Specify key categories according to the national level of disagregation used		**Associated category in UNFCCC inventory is key (indicate which category)**	**Is the category contribution greater than the smallest category considered key in the UNFCCC inventory (including LULUCF)? (Y/N)**	**Other (1)**	**COMMENTS (2)**
(1) Describe the criteria identifying the category as key. (2) Describe if category has been identified for trend/level assessment with Tier1/Tier2 approach.					

TABLE 4A
ARTICLE 3.3 ACTIVITIES: CARBON STOCK CHANGES UNDER AFFORESTATION AND REFORESTATION

Inventory Year

GEOGRAPHICAL LOCATION	ACTIVITY DATA					CHANGE IN CARBON STOCK					
Identification code	Subdivision	Year of conversion	Area subject to the activity	Area of organic soils		Carbon stock change in above-ground biomass			Carbon stock change in below-ground biomass		
				Drained	Rewetted	Gains	Losses	Net change	Gains	Losses	Net change
			(kha)			(Gg C)					
TOTAL FOR ACTIVITY AR											
Lands subject to natural disturbances which associated emissions have been excluded from accounting											
TOTAL											

GEOGRAPHICAL LOCATION	CHANGE IN CARBON STOCK						Net CO_2
Identification code	Net carbon stock change in litter	Net carbon stock change in dead wood	Net carbon stock change in HWP (1)	Net carbon stock change in soils			
				Mineral soils	Organic soils		
					Drained	Rewetted	
	(Gg C)						(Gg CO_2)
TOTAL FOR ACTIVITY AR							
Lands subject to natural disturbances which associated emissions have been excluded from accounting							
TOTAL							

(1) Data to be reported in this table come from the "Net Change" column of table 11A. A single value for the total net change in the HWP at national level could be reported here. Further, if HWP reporting is based on instantaneous oxidation, then report IO.

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TABLE 4B ADDITIONAL INFORMATION: BACKGROUND LEVEL OF EMISSIONS ASSOCIATED WITH NATURAL DISTURBANCES IN AR LANDS AND ITS MARGIN, WHERE A MARGIN IS NEEDED		
Inventory year		
Methodology applied (default/country-specific)	**Background level**	**Margin (where needed)**
	(Gg CO_2-equivalent)	

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TABLE 4C ADDITIONAL INFORMATION: EMISSIONS ASSOCIATED WITH NATURAL DISTURBANCES								
Inventory year								
GEOGRAPHICAL LOCATION	**ACTIVITY DATA**				**EMISSIONS**			
Identification code	**Subdivision**	**Type of natural disturbances (1)**	**Year of occurrence of natural disturbances**	**Area**	**CO_2 (2)**	**CH_4**	**N_2O**	**total CO_2-equivalent**
				(kha)	**(Gg)**			
Total AR land subject to natural disturbances								

(1) More than a single natural disturbance may have occurred in the same year in the same unit of land

(2) Whether a stock-difference method is used for estimating carbon stock losses in the area subject to natural disturbances, it should be demonstrated that CO_2-C emissions associated with harvesting (including salvage logging), in the inventory year, have not been reported here

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TABLE 4D ADDITIONAL INFORMATION: REMOVALS SUBSEQUENT TO NATURAL DISTURBANCES				
Inventory year				
GEOGRAPHICAL LOCATION	**ACTIVITY DATA**			**INCREMENTAL REMOVALS**
Identification code	**Subdivision**	**Year of occurrence of natural disturbances**	**Area (kha)**	**(Gg CO_2)**
Total AR land subject to natural disturbances				

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Table 5A
Article 3.3 activities: Carbon stock changes under Deforestation

Inventory Year

GEOGRAPHICAL LOCATION	ACTIVITY DATA						CHANGE IN CARBON STOCK					
Identification code	Subdivision	Year of conversion	Article 3.4 activity to which the land would otherwise be subject [(1)]	Area subject to the activity	Area of organic soils		Carbon stock change in above-ground biomass			Carbon stock change in below-ground biomass		
					Drained	Rewetted	Gains	Losses	Net change	Gains	Losses	Net change
				(kha)			(Gg C)					
Total for activity D												
Total for areas subsequently reforested												

GEOGRAPHICAL LOCATION	CHANGE IN CARBON STOCK					Net CO_2
Identification code	Net carbon stock change in litter	Net carbon stock change in dead wood	Net carbon stock change in soils			
			Mineral soils	Organic soils		
				Drained	Rrewetted	
	(Gg C)					(Gg CO_2)
Total for activity D						
Total for areas subsequently reforested						

(1) Whether the land would be otherwise subject to FM or to any elected activity, the identification acronym of FM or of the elected activity -i.e. CM, GM, RV, WDR- should be reported here (see paragraph 2 (b) (ii) of the annex II to decision 2/CMP.8)

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TABLE 5B
ADDITIONAL INFORMATION: DEFORESTED LAND PREVIOUSLY SUBJECT TO NATURAL DISTURBANCES

Inventory year

GEOGRAPHICAL LOCATION	ACTIVITY DATA				EMISSIONS ASSOCIATED WITH NATURAL DISTURBANCES			
Identification code	**Subdivision**	**Year of occurrence of natural disturbances**	**Type of natural disturbances (1)**	**Area**	**CO_2**	**CH_4**	**N_2O**	**total CO_2-equivalent**
				(kha)	**(Gg)**			
Total land where deforestation followed natural disturbances								

(1) More than a single natural disturbance may have occurred in the same year in the same land

Table 6A
Article 3.4 activities: Carbon stock changes under Forest Management

Inventory Year

GEOGRAPHICAL LOCATION	ACTIVITY DATA					CHANGE IN CARBON STOCK					
Identification code	Subdivision	Year (1)	Area subject to the activity	Area of organic soils		Carbon stock change in above-ground biomass			Carbon stock change in below-ground biomass		
				Drained	Rewetted	Gains	Losses	Net change	Gains	Losses	Net change
			(kha)			(Gg C)					
TOTAL FOR ACTIVITY FM	[redacted]	[redacted]									
		[redacted]									
		[redacted]									
		[redacted]									
forested land for Carbon Equivalent Forest											
TOTAL	[redacted]	[redacted]									
cleared land within Carbon Equivalent Forest											
TOTAL	[redacted]	[redacted]									
lands subject to natural disturbances which associated emissions have been excluded from accounting											
TOTAL	[redacted]	[redacted]									

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Table 6A (continued)
Article 3.4 activities: Carbon stock changes under Forest Management

Inventory Year

GEOGRAPHICAL LOCATION	CHANGE IN CARBON STOCK						Net CO_2
Identification code	Net carbon stock change in litter	Net carbon stock change in dead wood	Net carbon stock change in HWP (2)	Net carbon stock change in soils			
				Mineral soils	Organic soils		
					Drained	Rewetted	
	(Gg C)						(Gg CO_2)
TOTAL FOR ACTIVITY FM							
forested land for Carbon Equivalent Forest							
TOTAL							
cleared land within Carbon Equivalent Forest							
TOTAL							
lands subject to natural disturbances which associated emissions have been excluded from accounting							
TOTAL							

(1) For lands reported as Carbon Equivalent Forest, report here the year in which the land has been either forested or cleared. While for lands subject to natural disturbances for which associated emissions have been excluded from accounting, report here the year in which the natural disturbances occurred.

(2) Data to be reported in this table come from the "Net Change" column of table 11A. A single value for the total net change in the HWP at national level could be reported here. Further, if HWP reporting is based on instantaneous oxidation, report here IO

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TABLE 6B
ADDITIONAL INFORMATION: FOREST MANAGEMENT REFERENCE LEVEL

Inventory Year

Approach applied (1)	Value inscribed in decision 2/CMP.7	Technical correction as calculated in the reporting year: (2)	
		2015	---

(1) Business-as-usual, Base year

(2) Add a column for each reporting year in which a technical correction has been calculated

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TABLE 6C
ADDITIONAL INFORMATION: CARBON EQUIVALENT FORESTS

Inventory Year

CLEARED AREA				EQUIVALENT FORESTED AREA				
GEOGRAPHICAL LOCATION	Area	Carbon stock	Normal Harvesting cycle	GEOGRAPHICAL LOCATION	CURRENT DATA			
					Subdivision	Area	Age of plantation	Carbon stock
Identification code	(kha)	(Gg C)	Years	Identification code		(kha)	Years	(Gg C)
Total				Total				

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TABLE 6D
ADDITIONAL INFORMATION: BACKGROUND LEVEL OF EMISSIONS ASSOCIATED WITH NATURAL DISTURBANCES IN FM LANDS AND ITS MARGIN, WHERE A MARGIN IS NEEDED

Inventory Year

Methodology applied (default/country-specific)	Background level	Margin (where needed)
	(Gg CO_2-equivalent)	

TABLE 6E
ADDITIONAL INFORMATION: EMISSIONS ASSOCIATED WITH NATURAL DISTURBANCES

Inventory Year

GEOGRAPHICAL LOCATION	ACTIVITY DATA				EMISSIONS			
Identification code	Subdivision	Type of natural disturbances (1)	Year of occurrence of natural disturbance	Area	CO_2	CH_4	N_2O	total CO_2-equivalent
				(kha)	(Gg)			
Total for activity FM								

(1) More than a single natural disturbance may have occurred in the same year in the same land.

TABLE 6F ADDITIONAL INFORMATION: REMOVALS SUBSEQUENT TO NATURAL DISTURBANCES				
Inventory Year				
GEOGRAPHICAL LOCATION	**ACTIVITY DATA**			**INCREMENTAL REMOVALS**
Identification code	**Subdivision**	**Year of occurrence of natural disturbances**	**Area**	
			(kha)	**(Gg CO_2)**
Total FM land subject to natural disturbances				

Table 7
Carbon stock changes under elected Article 3.4 activities

Inventory Year

GEOGRAPHICAL LOCATION	ACTIVITY DATA					CHANGE IN CARBON STOCK					
Identification code	Activity [1]	Subdivision	Area subject to the activity	Area of organic soils		Carbon stock change in above-ground biomass			Carbon stock change in below-ground biomass		
				Drained	Rewetted	Gains	Losses	Net change	Gains	Losses	Net change
			(kha)			(Gg C)					
Total for elected activity [2]											

GEOGRAPHICAL LOCATION	CHANGE IN CARBON STOCK					Net CO_2
Identification code	Net carbon stock change in litter	Net carbon stock change in dead wood	Net carbon stock change in soils			
			Mineral soils	Organic soils		
				Drained	Rewetted	
	(Gg C)					(Gg CO_2)
Total for elected activity [2]						

(1) Report the identification acronym of the elected activity i.e. CM, GM, RV, WDR

(2) For each elected activity, complete a set of rows with lands subject to the elected activity and add one row with the total for the elected activity

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TABLE 8A
DIRECT N_2O EMISSIONS FROM N FERTILIZATION OF FOREST LAND

Inventory Year

GEOGRAPHICAL LOCATION	ACTIVITY DATA		EMISSIONS
Identification code	**Subdivision**	**Total amount of fertilizer applied (kt N/year)**	**N_2O (Gg)**
Total			
Total activity AR			
Total activity FM (1)			
Total activity D (2)			

(1) Excluding areas reported under the CEFC provision which have lost the forest cover and are subject to land uses other than forest

(2) Only for areas that have been subsequently reforested

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TABLE 8B
N_2O EMISSIONS FROM DISTURBANCE ASSOCIATED WITH LAND-USE CONVERSION TO CROPLAND

Inventory Year

GEOGRAPHICAL LOCATION	ACTIVITY DATA			EMISSIONS
Identification code	Activity (1)	Subdivision	Land area converted (kha)	N_2O (Gg)
Total				
Total activity D				
Total elected activity (2)				

(1) Report the identification acronym of the elected activity, Cropland Management, Grazing Land Management, Revegetation, and FM under the CEFC provision - i.e. CM, GM, RV, FM

(2) For each elected activity, complete a set of rows with lands subject to the elected activity and add one row with the total for the elected activity

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TABLE 9A CH_4 AND N_2O EMISSIONS FROM DRAINAGE OF ORGANIC SOILS					
Inventory Year					
GEOGRAPHICAL LOCATION	**ACTIVITY DATA**			**EMISSINOS**	
Identification code	**Activity [1]**	**Subdivision**	**Area**	**N_2O**	**CH_4**
			(kha)	**(Gg)**	
Total					
Total activity AR					
Total activity D					
Total activity FM					
Total elected activity [2]					

(1) Report the identification acronym of the elected activity i.e. CM, GM, RV, WDR.

(2) For each elected activity, complete a set of rows with lands subject to the activity and add one row with the total for the elected activity

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TABLE 9B
CH_4 AND N_2O EMISSIONS FROM REWETTING OF ORGANIC SOILS

Inventory Year

GEOGRAPHICAL LOCATION	ACTIVITY DATA			EMISSIONS	
Identification code	Activity (1)	Subdivision	Area	N_2O (2)	CH_4
			(kha)	(Gg)	
Total					
Total activity AR					
Total activity D					
Total activity FM					
Total elected activity (3)					

(1) Report the identification acronym of the elected activity i.e. CM, GM, RV, WDR.

(2) Under Tier 1 this is assumed to be negligible

(3) For each elected activity, complete a set of rows with lands subject to the activity and add one row with the total for the elected activity

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TABLE 10
GHG EMISSIONS FROM BURNING OF ORGANIC MATTER

Inventory Year

GEOGRAPHICAL LOCATION	ACTIVITY DATA								EMISSIONS		
Identification code	Activity [1]	Subdivision	CARBON POOLS								
			Living biomass (LB)		Dead Organic Matter (DOM)		Soil Organic Matter (SOM) [3]		CO_2 [4]	CH_4	N_2O
			Description [2]	Values	Description [2]	Values	Description [2]	Values			
			Area burned (kha) LB burned (kt dm)		Area burned (kha) DOM burned (kt dm)		Area burned (kha) SOM burned (kt dm)		(Gg)		
Total											
Total activity AR											
Total for controlled burning											
Total for wildfires											
Total activity D											
Total for controlled burning											
Total for wildfires											

TABLE 10 (CONTINUED)
GHG EMISSIONS FROM BURNING OF ORGANIC MATTER

Inventory Year

GEOGRAPHICAL LOCATION	ACTIVITY DATA								EMISSIONS		
Identification code	Activity (1)	Subdivision	CARBON POOLS								
			Living biomass (LB)		Dead Organic Matter (DOM)		Soil Organic Matter (SOM) (3)		CO_2 (4)	CH_4	N_2O
			Description (2)	Values	Description (2)	Values	Description (2)	Values			
			Area burned (kha) LB burned (kt dm)		Area burned (kha) DOM burned (kt dm)		Area burned (kha) SOM burned (kt dm)		(Gg)		
Total activity FM											
Total for controlled burning											
Total for wildfires											
Total elected activity (5)											
Total for controlled burning											
Total for wildfires											

(1) Report the identification acronym of the elected activity i.e. CM, GM, RV, WDR.
(2) For each activity, activity data should be selected between area burned (kha) or organic matter burned (kt dm).
(3) Report this pool only in case of peatland burning.
(4) If CO_2 emissions from biomass burning are not already included in the carbon-stock change table of the relevant activity, they should be reported here. This also includes the carbon component of CH_4.
(5) For each elected activity, complete a set of rows with lands subject to the activity and add rows with the totals (total wildfire, total prescribed burning, total for the activity) of the elected activity

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TABLE 11A
CARBON STOCK CHANGES IN THE HARVESTED WOOD PRODUCTS POOL

Inventory Year

ORIGIN OF WOOD			PRODUCT TYPE			PARAMETERS		CHANGE IN CARBON STOCK			Net CO_2-C
		Harvest	HWP categories[1]	Subcategories		Half-life[2]	Initial stock[3]	Gains[4]	Losses[4]	Net change	
		(Kt C)				(yrs)	(Kt C)				(Kt)
Total			Total								
			Total for HWP_{AR}								
			Total for category								
Article 3.3 activity	From Afforestation and Reforestation				Domestically consumed						
					Exported						
					Domestically consumed						
					Exported						
			Total for category								
					Domestically consumed						
					Exported						
					Domestically consumed						
					Exported						
			Total for category								
					Domestically consumed						
					Exported						
					Domestically consumed						
					Exported						
	From Deforestation										

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TABLE 11A (CONTINUED)
CARBON STOCK CHANGES IN THE HARVESTED WOOD PRODUCTS POOL

Inventory Year

ORIGIN OF WOOD			PRODUCT TYPE			PARAMETERS		CHANGE IN CARBON STOCK			Net CO_2-C
		Harvest	HWP categories(1)	Subcategories		Half-life(2)	Initial stock(3)	Gains(4)	Losses(4)	Net change	
		(Kt C)				(yrs)	(Kt C)				(Kt)
Article 3.4 activity	From Forest Management		Total for HWP_{FM}								
			Total for category								
					Domestically consumed						
					Exported						
					Domestically consumed						
					Exported						
			Total for category								
					Domestically consumed						
					Exported						
					Domestically consumed						
					Exported						
			Total for category								
					Domestically consumed						
					Exported						
					Domestically consumed						
					Exported						
From all remaining lands											

(1) Includes sawnwood, wood-based panels, paper and paperboard.
(2) Half-lives are needed when applying flux data method (i.e. Tier 2 method)
(3) Initial stock is the HWP stock of the specific product type at 1 January of the inventory year.
(4) Gains refers to annual carbon inflow to HWP pool, losses refers to annual carbon outflow from HWP pool.

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TABLE 11B
HARVESTED WOOD PRODUCTS ACTIVITY DATA

Inventory Year								
HWP category[1]								
Reported unit[2]								
Production	Import	Export	Production	Import	Export	Production	Import	Export
C conversion factor[3]								

(1) Includes sawnwood, wood-based panels, paper and paperboard.

(2) Reported e.g. in m^3 or t

(3) Applied to convert from HWP category units to carbon

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TABLE 11C
HARVESTED WOOD PRODUCTS IN THE FMRL

Inventory Year				
Approach applied[1]	Inclusion of the historic pool[2]	HWP value contained in Decision 2/CMP.7[3]	Technical correction as calculated in the reporting year: [4]	
	(Yes/No)	(Kt CO_2-equivalent)	2015	---

(1) Business-as-usual, Base year, Instantaneous oxidation

(2) This is reflected in cell "Initial stock" in Table 11A

(3) Value derived from value in Appendix of the Annex of Decision 2/CMP.7 in column "Applying first-order decay function for HWP" less the value in column "Reference level" (the latter includes HWP on the basis of instantaneous oxidation) (in Mt CO_2 eq/yr)

(4) Add a column for each reporting year in which a technical correction has been calculated

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GLOSSARY

Accounting

The rules for comparing emissions and removals as reported with commitments.

Approach

The way in which areas are represented and reported for land-use categories, and conversions between land-use categories, so that they are applied as appropriately and consistently as possible in inventory calculations. The IPCC identifies Approaches 1, 2 and 3 of increasing geographic specificity.

Background Level

Under default assumptions, this is in forests the mean annual level of emissions from natural disturbances, excluding statistical outliers, during a period before the second commitment period, called the calibration period. The intention of using such a Background Level is to exclude, under specific conditions set by Decision 2/CMP.7[1], extreme emissions from natural disturbances in forests from accounting during the commitment period. Providing the expectation of net credits or debits is avoided, countries may develop other types of Background Levels using their country-specific methods for excluding natural disturbance emissions from accounting.

Carbon Equivalent Forest Conversion (CEFC)

The conversion of forest plantation to non-forest while simultaneously establishing a "Carbon Equivalent Forest" on non-forest land elsewhere, under the terms of Decision 2/CMP.7[2]. The "Carbon Equivalent Forest" must be of at least equal area and at least equal stock at the end of the normal rotation of the plantation forest cleared, or a debit will be incurred.

CEF-ar land: Land on which a Carbon Equivalent Forest is established as part of a Carbon Equivalent Forest Conversion under the terms of Decision 2/CMP.7.

CEF-d land: Land on which a forest plantation is converted to non-forest as part of a Carbon Equivalent Forest Conversion under the terms of Decision 2/CMP.7.

Cropland

Arable and tillage land, and agro-forestry systems where vegetation falls below the threshold used for the forest land category, consistent with the selection and application of national definitions.

Cropland Management[3]

The system of practices on land on which agricultural crops are grown and on land that is set aside or temporarily not being used for crop production.

Elective activities

Article 3.4 activities that are not mandatory, but can be elected by a country for a commitment period. For the second commitment period these are Cropland Management, Grazing Land Management, Revegetation, and Wetland Drainage and Rewetting.

Estimation

Inventory definition: The process of calculating emissions.

Statistical definition: Estimation is the assessment of the value of a quantity or its uncertainty through the assignment of numerical observation values in an estimation formula, or estimator. The results of estimation can be expressed as follows:

- a point estimation which provide a number which can be used as an approximation to a parameter (such as the sample standard deviation which estimates the population standard deviation), or
- an interval estimate specifying a confidence level.

Example: A statement like 'The total emission is estimated to be 100 kt and its coefficient of variation is 5%' is based upon point estimates of the sample mean and standard deviation, whereas a statement such as 'The total

[1] Paragraphs 33-36 of the Annex to Decision 2/CMP.7 (Land use, land-use change and forestry) contained in document FCCC/KP/CMP/2011/10/Add.1, p. 17-18.

[2] Paragraphs 37-39 of the Annex to Decision 2/CMP.7 (Land use, land-use Change and forestry) contained in document FCCC/KP/CMP/2011/10/Add.1, p. 19.

[3] In the context of the Kyoto Protocol, as stipulated by Decision 16/CMP.1, cf. paragraph 1 of the Annex to Decision 16/CMP.1 (Land use, land-use change and forestry) contained in document FCCC/KP/CMP/2005/8/Add.3, p.5.

emission lies between 90 and 110 kt with probability 95%' expresses the results of estimation as a confidence interval.

Forest cover

Tree cover which exceeds the country-specific thresholds for defining forest, consistent with Decision 16/CMP.1[4].

Forested land

Land containing forest according to the country-specific definition of forest, consistent with Decision 16/CMP.1[5].

Forest Management Reference Level

Value of annual net emissions and removals from Forest Management against which the net emissions and removals reported for Forest Management will be compared for accounting purposes during the second commitment period.

Georeferencing

Georeferencing is the process of identifying the physical location of a particular area of land (e.g., that subject to Article 3.3 or 3.4 activities) in terms of map projections or coordinate systems. It is the establishment of relationship between raster or vector images and coordinates, and the determination of the spatial location of geographical features in terms of size and configuration.

Good practice

Good Practice is a set of procedures intended to ensure that greenhouse gas inventories are accurate in the sense that they are systematically neither over- nor underestimates so far as can be judged, and that uncertainties are reduced so far as practicable.

Good Practice covers choice of estimation methods appropriate to national circumstances, quality assurance and quality control at the national level, quantification of uncertainties and data archiving and reporting to promote transparency.

Grassland

This category includes rangelands and pasture land that is not considered as cropland. It also includes systems with vegetation that fall below the threshold used in the forest land category and is not expected to exceed, without human intervention, the thresholds used in the forest land category. This category also includes all grassland from wild lands to recreational areas as well as agricultural and silvo-pastural systems, subdivided into managed and unmanaged, consistent with national definitions.

Grazing Land Management[6]

The system of practices on land used for livestock production aimed at manipulating the amount and type of vegetation and livestock produced.

Half-life

The number of years it takes to lose one-half of the material currently in the carbon pool.

Indirect effects

The effects on emissions by sources and removals by sinks caused by climate change, raised CO_2 concentrations, age legacy and atmospheric nitrogen deposition. According to Decision 16/CMP.1 removal resulting from indirect effects are to be excluded from accounting of LULUCF activities under Articles 3.3 and 3.4 of the Kyoto Protocol[7].

Interannual Variability

[4] Paragraph 1 (a) of the Annex to Decision 16/CMP.1 (Land use, land-use change and forestry) contained in document FCCC/KP/CMP/2005/8/Add.3, p.5.

[5] Paragraph 1 (a) of the Annex to Decision 16/CMP.1 (Land use, land-use change and forestry) contained in document FCCC/KP/CMP/2005/8/Add.3, p.5.

[6] In the context of the Kyoto Protocol, as stipulated by Decision 16/CMP.1, cf. paragraph 1 of the Annex to Decision 16/CMP.1 (Land use, land-use change and forestry) contained in document FCCC/KP/CMP/2005/8/Add.3, p.5.

[7] Paragraph 1(h) of Decision 16/CMP.1 (Land use, land-use change and forestry) contained in document FCCC/KP/CMP/2005/8/Add.3, p.3.

Variation of GHG emissions by sources and removals by sinks, or a shift from being a net sink to a net source from year to year, caused by significant fluctuations or abrupt changes in environmental conditions due to natural disturbances and climatic abnormality, such as wild fire, pest and pathogen attacks, drought, flooding, extreme temperatures.

Land[8]

Areas subject to the activities defined under Article 3.4, namely Forest Management, Cropland Management, Grazing Land Management, Revegetation, and Wetland Drainage and Rewetting. Thus *KP Supplement* treats in the same way land as units of land (see below).

Management practice

An action or set of actions that affect the land, the stocks of pools associated with it or otherwise affect the exchange of greenhouse gases with the atmosphere.

Mandatory activities

Activities defined under Article 3.3, namely Afforestation, Reforestation and Deforestation, as wells as (for the second commitment period) Forest Management, and those Article 3.4 activities that were elected by a country in the previous commitment period.

Margin (for Background Level under Decision 2/CMP.7)

This is a specific value that is to be used in combination with the Background Level as a combined threshold to identify years during the commitment period in which emissions from natural disturbances in forests are larger than the Background Level plus the margin, and in which the country may exclude emissions from natural disturbances in forests from accounting, under specific conditions set by the Decision 2/CMP.7.

Natural disturbances[9]

Non-anthropogenic events or non-anthropogenic circumstances that cause significant emissions in forests and are beyond the control of, and not materially influenced by, a Party. These may include wildfires, insect and disease infestations, extreme weather events and/or geological disturbances, beyond the control of, and not materially influenced by, a Party.

Other Land

This category includes bare soil, rock, ice, and all unmanaged land areas that do not fall into any of the other five categories. It allows the total of identified land areas to match the national area, where data are available.

Pasture

Grassland planted and/or managed for grazing.

Planted forest

Forest meeting the country definition of planted forest, which include forest plantations as defined in the *2006 IPCC Guidelines*.

Remote sensing

Practice of acquiring and using data from satellites and aerial photography to infer or measure land cover or infer land use. May be used in combination with ground surveys for estimation, or to check the accuracy of interpretation.

Reporting

The process of providing estimates to the UNFCCC.

Reporting hierarchy

A assignment of all activities under Article 3.3 and 3.4 and land subject to those activities, in which the activities or lands for accounting and reporting of GHG emission and removal are represented as being "above," "below," or "at the same level as" one another. According to Decision 2/CMP.6[10] and Decision 2/CMP.7 for reporting

[8] In the context of the Kyoto Protocol, as stipulated by Decision 15/CMP.1, cf. paragraph 6 of the Annex to Decision 15/CMP.1 contained in document FCCC/KP/CMP/2005/8/Add.2, p.57.

[9] In the context of the Kyoto Protocol, as stipulated by Decision 2/CMP.7, cf. paragraph 1 of the Annex to Decision 2/CMP.7 (Land use, land-use change and forestry) contained in document FCCC/KP/CMP/2011/10/Add.1, p 13.

[10] FCCC/KP/CMP/2010/12/Add.1

consistency and transparency, mandatory activities take precedence over elective activities, Afforestation, Reforestation and/or Deforestation activities over forest management activity.

Reporting Method 1

Method of reporting information on geographical boundaries of areas encompassing lands subject to Article 3.3 and 3.4 activities that entails delineating areas that include multiple land units subject to Article 3.3 and 3.4 activities by using legal, administrative, or ecosystem boundaries. This stratification is based on sampling techniques, administrative data, or grids on images produced by remote sensing techniques. The identified geographic boundaries must be georeferenced.

Reporting Method 2

Method of reporting information on geographical boundaries of areas encompassing lands subject to Article 3.3 and 3.4 activities that is based on the spatially explicit and complete geographical identification of all units of land subject to Article 3.3 activities and all lands subject to Article 3.4 activities.

Salvage logging

Is the practice of harvesting and removing trees or parts of trees (living or dead) from disturbed areas. This management activity is also known as salvage cutting, salvage harvesting, sanitation cutting, and other designations. If it is conducted on areas not subject to the application of the natural disturbance provisions, it can be part of the regular forest management emissions and removals estimation and accounting framework, i.e. salvage logging would then be treated as harvest. In case the Party chooses to exclude emissions due to natural disturbances, it "shall account for emissions associated with salvage logging"[11]

Technical Correction

Value of net emissions and removals, which is added at the time of accounting to the original Forest Management Reference Level to ensure that accounted emissions and removals will not reflect the impact of methodological inconsistencies.

Units of lands[12]

Areas subject to the activities defined under Article 3.3, namely Afforestation, Reforestation and Deforestation. Thus *KP Supplement* treats in the same way land as land (see above).

Wall-to-wall mapping

Complete spatial coverage of a land area, e.g., by satellite data.

Wetlands

This category includes 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 does not fall into the Forest Land, Cropland, Grassland or Settlements categories. It includes reservoirs as a managed sub-division and natural rivers and lakes as unmanaged sub-divisions.

Wetland Drainage and Rewetting[13]

System of practices for draining and rewetting on land with organic soil that covers a minimum area of 1 hectare. The activity applies to all lands that have been drained since 1990 and to all lands that have been rewetted since 1990 and that are not accounted for under any other activity as defined in the Annex to Decision 2/CMP.7, where drainage is the direct human-induced lowering of the soil water table and rewetting is the direct human-induced partial or total reversal of drainage.

[11] Paragraph 33 (c) of the Annex to Decision 2/CMP.7 (Land use, land-use change and forestry) contained in document FCCC/KP/CMP/2011/10/Add.1, p.17.

[12] In the context of the Kyoto Protocol, as stipulated by Decision 15/CMP.1, cf. paragraph 6 of the Annex to Decision 15/CMP.1 contained in document FCCC/KP/CMP/2005/8/Add.2, p.57.

[13] In the context of the Kyoto Protocol, as stipulated by Decision 2/CMP.7 (Land Use, Land-use Change and Forestry), cf. paragraph 1 of the Annex to Decision 2/CMP.7 (Land use, land-use change and forestry) contained in document FCCC/KP/CMP/2011/10/Add.1, p 13.