

## 4.1 INTRODUCTION

This chapter describes the supplementary methods and *good practice* guidance specifically linked to the land use, land-use change and forestry (LULUCF) activities in the Kyoto Protocol and gives full consideration to the requirements and methodologies for measuring, estimating and reporting of activities under Article 3.3, and under Article 3.4 (if elected by a Party). The supplementary methods and *good practice* guidance of this chapter apply generally to those Parties listed in Annex B of the Kyoto Protocol that have ratified the Protocol. This chapter also provides *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 Kyoto Protocol (Article 12, Clean Development Mechanism or CDM projects), see Section 4.3.<sup>1</sup>

Under the Kyoto Protocol, Parties are to report emissions by sources and removals by sinks of CO<sub>2</sub> and other greenhouse gases resulting from LULUCF activities under Article 3.3, namely afforestation (A), reforestation (R) and deforestation (D) that occurred since 1990. They are also to report any elected human-induced activities under Article 3.4, which can be: forest management, revegetation, cropland management and grazing land management.<sup>2</sup> In the commitment period Parties have to report annually, along with their annual reports of greenhouse gas emissions by sources and removals by sinks, supplementary information related to LULUCF under the provisions of the Kyoto Protocol and the Marrakesh Accords to ensure compliance with their emission-limitation and reduction commitments.<sup>3</sup> The annual reporting requirement does not imply a need for annual measurements; however, Parties are expected to develop systems that combine measurements, models and other tools that enable them to report on an annual basis.

<sup>1</sup> It is assumed that the reader is familiar with Articles 3.3, 3.4, 3.7, 6 and 12 of the Kyoto Protocol (<http://unfccc.int/resource/docs/convkp/kpeng.pdf>).

<sup>2</sup> LULUCF related requirements are outlined in paragraph 1 of the Annex to draft decision -/CMP.1 (Land use, land-use change and forestry) contained in document FCCC/CP/2001/13/Add.1, p.58:

“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.

“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.

“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.

<sup>3</sup> Paragraph 5 of the Annex to draft decision -/CMP.1 (Article 7) contained in document FCCC/CP/2001/13/Add.3, p.22: *Each Party included in Annex I shall include in its annual greenhouse gas inventory information on anthropogenic greenhouse gas emissions by sources and removals by sinks from land use, land-use change and forestry activities under Article 3, paragraph 3 and, if any, elected activities under Article 3, paragraph 4, in accordance with Article 5, paragraph 2, as elaborated by any good practice guidance in accordance with relevant decisions of the COP/MOP on land use, land-use change and forestry. 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. In reporting the information requested above, each Party included in Annex I shall include the reporting requirements specified in the paragraphs 6 to 9 below, taking into consideration the selected values in accordance with paragraph 16 of the annex to decision -/CMP.1 (Land use, land-use change and forestry). The footnote to the word “annual” in the first sentence says: It is recognised in the IPCC 1996 Revised Guidelines that the current practice on land use, land-use change and forestry does not in every situation request annual data collection for the purpose of preparing annual inventories based on sound scientific basis.*

Article 7, paragraph 3 of the Kyoto Protocol: *Each Party included in Annex I shall submit the information required under paragraph 1 above annually, beginning with the first inventory due under the Convention for the first year of the commitment period after this Protocol has entered into force for that Party[...].*

**Relationship between UNFCCC and Kyoto reporting:**

The information to be reported under the Kyoto Protocol is supplementary to the information reported under the Convention. Countries do not have to submit two separate inventories but should provide information under the Kyoto Protocol as supplementary, within the inventory report.<sup>4</sup>

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

Example: when a Party that has elected cropland management under Article 3.4 prepares its UNFCCC inventory for croplands according to Section 3.3 of this report, it is efficient to use the stratification into geographical boundaries (Section 4.2.2) in doing so. Then, in preparing the supplementary information to be reported under the Kyoto Protocol, the Party would delineate those UNFCCC cropland areas that were forests before (Section 3.3.2, Land converted to cropland), report these under deforestation according to Article 3.3, and report the remaining croplands under Article 3.4.

This chapter covers supplementary estimation and inventory reporting requirements needed for accounting under the Kyoto Protocol. However, it does not address the implementation of accounting rules as agreed in the Kyoto Protocol and Marrakesh Accords (such as caps, net-net accounting<sup>5</sup> and other specific provisions related to accounting). This is because accounting is a policy matter and is not covered in the request to the IPCC. Estimation refers to the way in which inventory estimates are calculated, reporting in the tables or other standard formats used to transmit inventory information. Accounting refers to the way the information is used to assess compliance with commitments under the Protocol.

The Marrakesh Accords refer to land in two ways, and these terms are adopted here:

- *Units of land* refers to those areas subject to the activities defined under Article 3.3, namely afforestation, reforestation and deforestation, and
- *Land* refers to those areas subject to the activities defined under Article 3.4, namely forest management, cropland management, grazing land management, and revegetation.

## 4.1.1 Overview of steps to estimating and reporting supplementary information for activities under Articles 3.3, 3.4, 6 and 12

This section gives an overview of the steps required to estimate, measure, monitor and report changes in carbon stocks and emissions and removals of non-CO<sub>2</sub> greenhouse gases for Articles 3.3, 3.4, 6 and 12 under the Kyoto Protocol. Detailed methods and *good practice* guidance for each individual activity are provided in Sections 4.2 and 4.3.

### **STEP 1: Define “forest”, apply definitions to national circumstances, establishing precedence conditions and/or a hierarchy among selected Article 3.4 activities.**

STEP 1.1: Select the numerical values in the definition of “forest”.<sup>6</sup>

<sup>4</sup> 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.*

<sup>5</sup> Net-net accounting refers to the provisions of paragraph 9 of the Annex to draft decision -/CMP.1 (Land use, land-use change and forestry) contained in document FCCC/CP/2001/13/Add.1, p.59-60.

<sup>6</sup> According to the Marrakesh Accords, “forest” is a minimum area of land of 0.05 – 1.0 hectares with tree crown cover (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

Parties must, by the end of 2006, decide on their choice of parameters to define forest, i.e., they must choose a minimum area (0.05 – 1 ha), the minimum crown closure 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. The numerical values of those parameters cannot be changed for the commitment period. Each Party has to justify in its reporting that such values are consistent with the information that has historically been reported to the Food and Agriculture Organization of the United Nations or other international bodies, and if they differ, explain why and how 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 units of land subject to ARD activities, as explained in Section 4.2.2.5.1.

STEP 1.2: Apply definitions to national circumstances.

Parties must, by the end of 2006, decide and report which, if any, activities under Article 3.4 they elect (forest management, cropland management, grazing land management and/or revegetation). It is *good practice* that Parties document, for each elected activity, how the definitions will be applied to national circumstances and that they list the criteria that determine under which activity a land would be assigned. These criteria should be chosen in such a way as to minimize or avoid overlap and should be consistent with the guidance provided in the decision tree in Figure 4.1.1 in Section 4.1.2.

STEP 1.3: Establish precedence conditions and/or a hierarchy among selected Article 3.4 activities.

For cases where overlaps may occur, it is *good practice* that the country specifies its precedence conditions and/or a hierarchy among Article 3.4 activities prior to the commitment period, rather than on a case-by-case basis. For example, if land could fall into both cropland management and forest management (such as in agroforestry systems), then it is *good practice* to consistently apply the specified scheme of precedence conditions and/or hierarchy<sup>7</sup> in determining under which activity the land is to be reported.

## **STEP 2: Identify lands subject to activities under Article 3.3 and any 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 must be calculated). This step builds on the approaches described in Chapter 2.

STEP 2.1: Compile land-use and land-cover information in 1990 for the relevant activities.

Using the selected definition of forest, develop means for determining forest and non-forest areas in 1990. This can be accomplished with a map that identifies all areas considered forest on 1 January 1990. All forest-related land-use change activities since 1990 can then be determined with reference to this base map (see Section 4.2.2.2 Reporting methods for lands subject to Article 3.3 and Article 3.4 activities).

STEP 2.2: Stratify the country into areas of land for which the geographic boundaries will be reported, as well as the area of the units of land subject to Article 3.3 and/or the areas of lands subject to Article 3.4 within these geographic boundaries (see Section 4.2.2.4). This step can be omitted if Reporting Method 2 (see Section 4.2.2.2) is used.

STEP 2.3: Identify units of land that, since 1990, are subject to activities defined in Article 3.3, and estimate the total area of these units of land within each geographic boundary. Under Reporting Method 2 (Section 4.2.2.2) the estimation of the area of the units of land will be carried out individually for each unit of land.

Article 3.3 of the Kyoto Protocol requires that net carbon stock changes and non-CO<sub>2</sub> greenhouse gas emissions during the commitment period on land areas subject to afforestation (see Footnote 1 above), reforestation (R) and deforestation (D) since 1990 are used to meet the commitments under Article 3. The Marrakesh Accords require Parties to estimate the area of the units of lands that have been subject to afforestation, reforestation and/or deforestation within the boundaries mentioned in STEP 2.2 above (for details see Sections 4.2.2.2, 4.2.5 and 4.2.6).

STEP 2.4: Identify land areas subject to elected activities under Article 3.4, and estimate the total size of these land areas within each geographic boundary. Under Reporting Method 2 (Section 4.2.2.2) the estimation of land will be carried out individually for each land area subject to elected Article 3.4 activities.

For forest management (FM), if elected, each Party must identify the land area subject to forest management in each inventory year of the commitment period. A Party could interpret the definition of forest management in terms of specified forest management practices, such as fire suppression, harvesting or thinning, undertaken since 1990. Alternatively, a country could interpret the definition of forest management in terms of a broad

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natural causes but which are expected to revert to forest. See paragraph 1(a) in the Annex to draft decision -/CMP.1 (Land use, land-use change and forestry), contained in document FCCC/CP/2001/13/Add.1, p.58.

<sup>7</sup> Such as, e.g., “precedence is given to the dominant activity”, or “precedence is given to cropland management”.

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. (For details see Sections 4.2.2.2 and 4.2.7).<sup>8</sup>

For cropland management (CM), grazing land management (GM), or revegetation (RV), the area subject to each of these activities in any inventory year during the commitment period needs to be determined. As is discussed in more depth in Sections 4.2.8 – 4.2.10, the area under the same activity in 1990 (or the applicable base year) will also have to be determined, because carbon stock changes and non-CO<sub>2</sub> greenhouse gas emissions on this area in 1990 have to be known in order to implement net-net accounting rules of the Marrakesh Accords (see Section 4.2.8.1.1).

STEP 2.5: Identify the areas subject to projects under Article 6.

Some units of land subject to Article 3.3 or lands subject to Article 3.4 can also be projects under Article 6 of the Kyoto Protocol. These have to be reported under Article 3.3 or Article 3.4 (if the relevant activity was elected). In addition, these units of land or lands need to be delineated and the carbon stock changes and non-CO<sub>2</sub> greenhouse gas emissions reported separately as part of the project reporting (see Section 4.3). The relationship between estimation and reporting of activities under Articles 3.3 and 3.4, and projects under Article 6, is discussed in Section 4.1.3.

**STEP 3: Estimate carbon stock changes and non-CO<sub>2</sub> greenhouse gas emissions on the lands identified under Step 2 above.**

This step builds on the methodologies provided by Chapter 3 of this report (LUCF sector *good practice* guidance) and shows supplementary methodologies relevant to reporting of carbon stock changes and non-CO<sub>2</sub> greenhouse gas emissions under the Kyoto Protocol.

STEP 3.1: Estimate carbon stock changes and non-CO<sub>2</sub> greenhouse gas emissions for each year of the commitment period, on all areas subject to afforestation, reforestation or deforestation (as identified in STEP 2.3) and all areas subject to elected activities covered under Article 3.4 (as identified in STEP 2.4), while ensuring that there are no gaps and no double counting.

The estimation of carbon stock changes and non-CO<sub>2</sub> greenhouse gas emissions for an activity begins with the onset of the activity or the beginning of the commitment period, whichever comes later. For further details regarding the beginning of an activity see Section 4.2.3.2 (Years for which to estimate stock changes and non-CO<sub>2</sub> greenhouse gas emissions).

STEP 3.2: Estimate carbon stock changes and non-CO<sub>2</sub> greenhouse gas emissions in projects under Article 6 (see Section 4.3.3 Measuring, monitoring, and estimating changes in carbon stocks and non-CO<sub>2</sub> greenhouse gas emissions).

**For Article 12 Projects:**

**STEP 1: Identify areas.** (Details can be found in Section 4.3.2 Project boundaries)

**STEP 2: Estimate carbon stock changes and non-CO<sub>2</sub> greenhouse gas emissions.** (Details can be found in Section 4.3.3 Measuring, monitoring, and estimating changes in carbon stocks and non-CO<sub>2</sub> greenhouse gas emissions).

Table 4.1.1 provides an overview of the LULUCF activities in the Kyoto Protocol, and the accounting rules that are prescribed by the Marrakesh Accords. This information is summarized here because it has implications for the supplementary estimation and inventory reporting requirements under the Kyoto Protocol.

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<sup>8</sup> 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*.

<b>Activities</b>	<b>Net-net accounting<sup>9</sup></b>	<b>Baseline scenario</b>	<b>Cap on Credits<sup>10</sup></b>
Article 3.3 (Afforestation, Reforestation, Deforestation)	No	No	No
Article 3.4 (Forest Management)	No	No	Yes
Article 3.4 (all other)	Yes	No	No
Article 6	No	Yes	Yes for Forest Management
Article 12 (Clean Development Mechanism)	No	Yes	Yes

## 4.1.2 General rules for categorisation of land areas under Articles 3.3 and 3.4

Chapter 2 (Basis for consistent representation of land areas) describes approaches to classifying and representing land areas associated with LULUCF activities. This is the basis for the *good practice* guidance in Chapter 4 for identifying all relevant lands, for Kyoto reporting and for avoiding double counting of lands. It is *good practice* to follow the decision tree in Figure 4.1.1 for each year of the commitment period in order to

- Distinguish between afforestation and reforestation, deforestation, forest management, cropland management, grazing land management and revegetation activities under Articles 3.3 and 3.4, as well as to remove potential overlaps and gaps between them; and to
- Assign lands to a single activity at any given point in time (i.e., for each year of the commitment period 2008-2012). This is required because of the possible land-use changes which can lead to double counting of units of lands / lands subject to Articles 3.3 and/or 3.4. Additional guidance on how to deal with shifts in land use over time is given in the examples of Box 4.1.1 at the end of this section.

The decision tree in Figure 4.1.1 is based on Marrakesh Accords (MA) definitions and 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.

There are two main branches in the decision tree in Figure 4.1.1. If a unit of land was subject to an afforestation, reforestation or deforestation activity since 1990, then in addition, if a Party has elected one or more Article 3.4 activities, then the questions in the right branch should be answered to determine whether the land was also subject to an elected Article 3.4 activity (secondary classification). This is needed to fulfil the reporting needs of the Marrakesh Accords<sup>11</sup> and to demonstrate that there is no double counting (which could occur if full enumeration was not applied). More detailed decision trees to determine whether or not land or a unit of land is subject to specific activities are presented in Sections 4.2.5 through 4.2.10.

<sup>9</sup> Net-net accounting refers to the provisions of paragraph 9 of the Annex to draft decision -/CMP.1 (Land use, land-use change and forestry) contained in document FCCC/CP/2001/13/Add.1, p.59-60.

<sup>10</sup> See paragraphs 10 to 12 and 14 of the Annex to draft decision -/CMP.1 (Land use, land-use change and forestry) contained in document FCCC/CP/2001/13/Add.1, p.60-61.

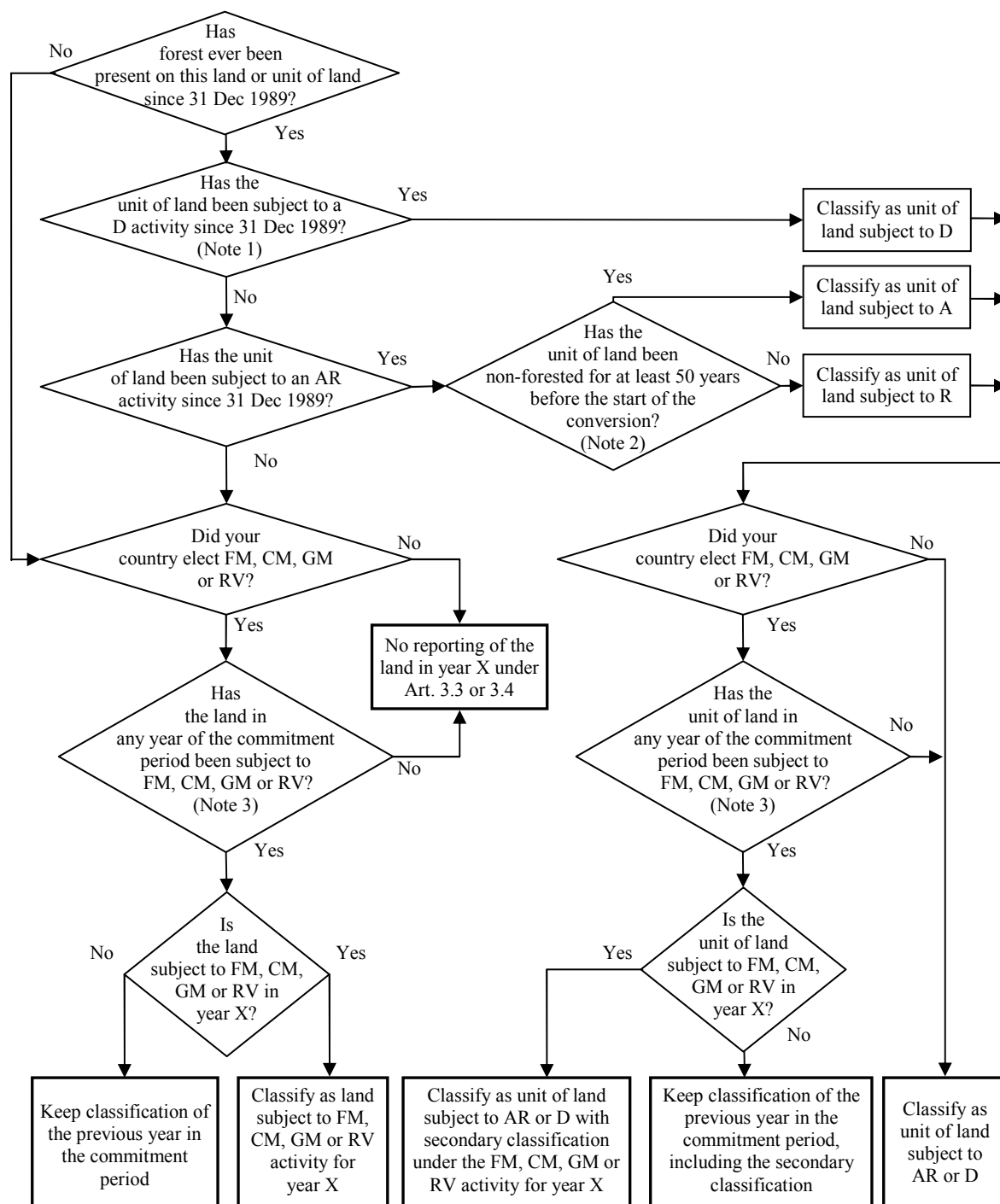
<sup>11</sup> Paragraph 6 (b), bullet (ii) in the Annex to draft decision -/CMP.1 (Article 7), contained in document FCCC/CP/2001/13/Add.3, p.22:

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

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

- (i) Units of land subject to activities under Article 3, paragraph 3;
- (ii) Units of land subject to activities under Article 3, paragraph 3, which would otherwise be included in land subject to elected activities under Article 3, paragraph 4, under the provisions of paragraph 8 of the annex to decision -/CMP.1 (Land use, land-use change and forestry); and
- (iii) Land subject to elected activities under Article 3, paragraph 4.

**Figure 4.1.1** Decision tree for classifying a unit of land under Article 3.3 (ARD) or land under Article 3.4 (FM, CM, GM and RV) as of year X of the commitment period (2008, 2009, ..., 2012)



**Note 1:** No matter whether it had been subject to an AR activity before.

**Note 2:** The distinction between A and R is often irrelevant, in particular if the same methodologies apply. But sometimes they might differ in the rate and direction of soil and litter C stock change.

**Note 3:** Apply this test only to those activities that your country has elected.

#### Abbreviations used in the Figure:

AR	Afforestation / Reforestation	D	Deforestation	FM	Forest Management
CM	Cropland Management	GM	Grazing Land Management	RV	Revegetation

The left branch is for lands that are reported under Article 3.4, and needs to be checked by Parties that have elected one or more Article 3.4 activities. This is necessary to know whether a land was subject to an Article 3.4 activity, and also to determine which Article 3.4 activity (if elected) applied on the land most recently. If a land is subject to more than one Article 3.4 activity over the course of time, it is *good practice* to classify that land under only one Article 3.4 category. Therefore, it is *good practice* for countries to set up a hierarchy among the activities forest management, cropland management, grazing land management and revegetation, and – within the scope of the definitions in the Marrakesh Accords – to set up criteria by which lands will be assigned to a single category (see Section 4.1.1, Overview, STEP 1.3). For example, where agriculture and forestry are practiced on the same land, the land may qualify under forest management and under cropland management or grazing land management. It is *good practice* to assign land according to specific, pre-determined rules, rather than on a case-by-case basis. The definitions in the Marrakesh Accords imply that

- Forest management can only take place on lands that meet the definition of a forest;
- Revegetation can only take place when the land is forest neither before nor after the transition (otherwise it would be afforestation, reforestation or forest management); and
- Grazing land and cropland management can take place on either forest or non-forest lands, but will be predominantly on non-forest lands in practice. Any forest land under grazing land or cropland management can be subject to a deforestation activity.

Regarding the relationship between forest management on the one hand, and cropland/grazing land management on the other hand, countries have two options: 1) It is *good practice* to interpret the definition of forest management such that all managed forests are included, including those where also cropland and grazing land management takes place. With this, all lands subject to grazing or cropland management would necessarily have to be non-forest. 2) Alternatively, it is also *good practice* to use pre-defined criteria other than "forest / non-forest" to determine whether a land area is subject to forest management or grazing land management / cropland management. In that case it is possible that some forest lands are included under cropland or grazing land management.

Special attention should be given to avoid overlap or gaps between lands subject to revegetation (if elected) that could qualify under cropland management, grazing land management or potentially forest management (if elected).

In addition note that:

- The decision tree in Fig. 4.1.1 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 "Identification of lands" in the generic Section 4.2.2, and in the activity-specific sections on land identification (Sections 4.2.5.1 / 4.2.6.1 / 4.2.7.1 / 4.2.8.1 / 4.2.9.1 and 4.2.10.1).
- For the first commitment period, 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 2012.
- For reporting during the commitment period Article 3.4 applies to land that is subject to an elected forest management, cropland management, and grazing land management activity during the commitment period<sup>12,13</sup>. Article 3.4 also applies to land subject to revegetation resulting from direct human-induced activities since 1 January 1990.<sup>14</sup>
- Once a land is reported under Article 3.3 or Article 3.4, all anthropogenic greenhouse gas emissions by sources and removals by sinks on this land must be reported during the first and throughout subsequent and

<sup>12</sup> Conversely, for base year reporting, Article 3.4 applies to land that was subject to an elected cropland management, grazing land management or revegetation activity in the base year.

<sup>13</sup> The reason is that if a land was subject to an Article 3.4 activity between 1 January 1990 and 31 December 2007, but is no longer in the years 2008-2012, it could not be accounted for under the Kyoto Protocol. Carbon reporting of this land during the commitment period would be highly complicated because the land would be under a different land use. Land that left the FM category as a result of deforestation would, of course, be reported under Article 3.3.

<sup>14</sup> As stated in STEP 1.2 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 revegetation, also possibly to forest management, and requires to report 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 cropland and grazing land management – also because there the practices are most likely to occur on an annual basis anyway. Here it is sufficient to report the lands subject to the activity in the reporting year of the commitment period.

contiguous commitment periods<sup>15</sup>, except the Party chooses not to report a pool that has been shown not to be a source as explained in Section 4.2.3.1. That is, 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 that a unit of land or land can be reported under different activities in Article 3.3 and/or Article 3.4 over time during the commitment period. However, for each year it can only be reported under a single activity.
- In order to avoid the reporting of lands or units of land in more than one activity in any year during the commitment period, the following should be applied:
  - (i) Units of land subject to activities under Article 3.3 which would otherwise be included in land subject to an Article 3.4 activity (see item (ii) in footnote 11) must be reported separately as lands that are both subject to Article 3.3 and 3.4 activities (referred to as AR or D land with a secondary classification in the decision tree). The decision tree implies that afforestation, reforestation and deforestation have precedence over the other activities for land classification and reporting purposes not only in a given year, but for the entire period between 1990 and 2012.<sup>16</sup>
  - (ii) For lands that are subject to several activities under Article 3.4 it is *good practice* to apply the national criteria that establish the hierarchy among Article 3.4 activities (in the Marrakesh Accords no precedence is implied among Article 3.4 activities, see STEP 1.3 above).
- A land subject to land-use changes (LUCs) can move between categories in the following cases:
  - Afforestation/reforestation land that is subsequently deforested is reclassified as deforestation land (Section 4.2.4.3.2 describes specific provisions for units of land subject to afforestation and reforestation activities since 1990).
  - Land under one elected Article 3.4 activity is converted into land under another elected Article 3.4 activity and must be reclassified accordingly.
  - Land under an elected Article 3.4 activity becomes subject to an Article 3.3 activity and must subsequently be reported under the latter.
- On the other hand, the following transitions are not possible. Note that these restrictions apply to reporting under the Kyoto Protocol (but do of course not affect the actual management that a country applies to its lands):
  - Land cannot shift from an elected Article 3.4 activity to another Article 3.4 activity that was not elected.
  - Land cannot leave the Article 3.3 reporting.
  - Deforestation land cannot become afforestation/reforestation land in the first commitment period. That is, if a forest is established on land deforested since 1990, the carbon removals cannot be reported as a reforestation activity during the first commitment period because of the time limits in the definition for reforestation agreed in the Marrakesh Accords, designed not to credit reforestation on lands that were forest land in 1990.<sup>17</sup> However, because there is the need for continuous full reporting of lands subject to Article 3.3 and 3.4 activities, any carbon stock increases later in the commitment period on deforestation lands will be reported under the deforestation category.
- Boundaries between forest management and cropland or grazing land systems can be difficult to define where these activities are practiced on the same land area. The decision tree in Figure 4.1.1 suggests that planting of shelterbelt trees or orchards after 1990 that meet the criteria for a forest would be reported under the afforestation and reforestation category, even if they occur on lands whose use is mainly agricultural. For shelterbelts and orchards which already existed in 1990, however, the decision tree implies that the country can prioritise the Article 3.4 reporting category as either cropland management or grazing land management, or as forest management – provided that the land meets the definition of the category chosen, and the prioritisation is consistent with the hierarchy of Article 3.4 activities set up at the beginning. For example, if shelterbelts or farm woodlots do not appear to be part of forest management as such, and are

<sup>15</sup> Paragraph 19 of the Annex to draft decision -/CMP.1 (Land use, land-use change and forestry), contained in document FCCC/CP/2001/13/Add.1, p.61.

<sup>16</sup> This is implied in the text of the Marrakesh Accords cited in footnote 11 above, item b (ii).

<sup>17</sup> Paragraph 1(c) of the Annex to draft decision -/CMP.1 (Land use, land-use change and forestry), contained in document FCCC/CP/2001/13/Add.1, p.58.



clearly associated with cropping or grazing land systems, the hierarchical system set up by a country might determine this to be reported under cropland management or grazing land management.

In summary, this means that the area under Article 3.3 (afforestation, reforestation and deforestation lands) will grow from 0 hectares on 1 January 1990 up to a certain value in 2012. At any given point in time, the afforestation, reforestation and deforestation categories should contain all areas of land that have been afforested, reforested or deforested since 1990. The area under Article 3.3 (deforestation) will stay constant or increase in size during the commitment period. The land area in the afforestation and reforestation category will typically increase, but can also decrease if afforestation and reforestation lands are subject to deforestation activities.

The amount of lands in the forest management, cropland management, grazing land management, and revegetation 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, for example:

- Afforestation and reforestation, and deforestation land areas are allowed to grow;
- Grazing lands can become croplands and vice versa;
- Revegetated lands can become croplands or grazing lands or vice versa; and
- Forest management land areas can increase, for example, as countries expand the road infrastructure to areas previously unmanaged.

Box 4.1.1 provides several examples that summarise the Marrakesh Accords and the considerations that apply for lands subject to activities under Articles 3.3 and 3.4 of the Kyoto Protocol. The preceding sections of Chapter 4 have provided merely an overview of the Marrakesh Accords. For more detailed explanations of the rationale behind the examples in Box 4.1.1, the reader is referred to the detailed explanations in the remaining sections of Chapter 4.

#### Box 4.1.1

##### 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, how different land-use transitions would be categorised in different inventory years under the Kyoto Protocol. This does not necessarily imply that the land-use transition can be directly measured on an annual basis. Note that for croplands and grazing lands only carbon stock changes are discussed in the examples below. Non-CO<sub>2</sub> greenhouse gas emissions for such lands are reported under the Agriculture Sector of the *IPCC Guidelines* (Section 4.5.2 in the Reference Manual), independently of which Article 3.4 activities were elected by the Party.

#### **Example 1: A land under forest management is deforested in 1995 and turned into a cropland.**

2008-2012: Carbon stock changes and non-CO<sub>2</sub> greenhouse gas emissions on this land are reported under deforestation. The methodology for croplands that were previously forest (Section 3.3.2) is to be used.

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 4.1.1 therefore assigns this land to deforestation, with cropland management as a secondary classification.

Should trees be re-established on this land again, for example in 2011, the land remains in the deforestation category, because reforestation is not admissible on lands that were forest in 1990. The methodology to be used to estimate for carbon stock changes, however, is the one for reforestation.

#### **Example 2: A land under forest management is deforested on 1 January 2010 and turned into a cropland.**

2008-2009: Carbon stock changes and non-CO<sub>2</sub> greenhouse gas emissions on this land for the years 2008 and 2009 are reported under forest management (if forest management is elected, otherwise they are not reported at all under the Kyoto Protocol, only as part of the regular annual LUCF inventory under the UNFCCC).

2010-2012: Carbon stock changes and non-CO<sub>2</sub> greenhouse gas emissions on this land in the years 2010-2012 are reported under deforestation. The methodology for croplands that were previously forest (Section 3.3.2) should be used. Non-CO<sub>2</sub> greenhouse gas emissions directly resulting from the deforestation should be reported under the Deforestation category. Non-CO<sub>2</sub> greenhouse gas emissions resulting from the agricultural practices should be reported in the Agriculture sector of the national inventory as per the *IPCC Guidelines*. Double counting should be avoided.

**BOX 4.1.1 EXAMPLES (CONTINUED)**

Carbon stock changes 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 4.1.1 therefore assigns this land to deforestation with cropland as a secondary classification.

**Example 3: A cropland is turned into a grazing land in 2010.**

2008-2009: Carbon stock changes and non-CO<sub>2</sub> GHG emissions on this land are reported under cropland management (if elected, otherwise not reported at all under the Kyoto Protocol, only as part of the annual LUCF inventory).

2010-2012: If grazing land management is elected, carbon stock changes and non-CO<sub>2</sub> greenhouse gas emissions from this land are reported under grazing land management (Sections 3.4.2 and 4.2.9). If grazing land management is not elected, carbon stock changes and non-CO<sub>2</sub> greenhouse gas emissions on this land will still have to be reported under cropland management for those years (if cropland management is elected), because of the requirement to continue to report on future stock changes once land has entered the Kyoto reporting system.

**Example 4: A grazing land is turned into a settlement in 2005.**

2008-2012: Carbon stock changes and non-CO<sub>2</sub> greenhouse gas emissions from this land are not reported under the Kyoto Protocol, since it was not subject to an elected activity during the commitment period.

**Example 5: A grazing land is turned into a settlement land in 2010.**

The land needs to be reported as being subject to grazing land management (if elected) in all five years of the commitment period (because it was under grazing land management at least in one year during the commitment period). Pre-2010, the grazing land methods need to be used whereas, starting in 2010, the methodologies for conversion to settlements need to be used.

**Example 6: Forest management land is turned into a settlement in 2010.**

2008-2009: Carbon stock changes and non-CO<sub>2</sub> greenhouse gas emissions from this land are reported under forest management (if elected, otherwise not reported at all under the Kyoto Protocol, only under the managed forest of the regular LUCF inventory).

2010-2012: Land reported as “deforested”, using the methodologies of Chapter 3, Section 3.6, for lands converted to settlements.

Example 6 shows that land which is converted from an elected land use during the commitment period should continue to be reported. This does not apply to Example 4 because no removal units will have been generated.

**Example 7: Forest management land is turned into a settlement<sup>18</sup> in 1995.**

2008-2012 carbon stock changes are reported under Article 3.3, deforestation.

**Example 8: Other land is turned into grazing land (and reported as revegetation) in 2005.**

In each year of the commitment period the carbon stock changes and non-CO<sub>2</sub> greenhouse gas emissions from this land are reported under revegetation (if elected).

<sup>18</sup> which, by definition, is non-forest, see Chapter 2.

### 4.1.3 Relationship between Annex I Parties' national inventories and Article 6 LULUCF projects

Emissions or removals resulting from Article 6 projects will be part of the host country's annual inventory under the UNFCCC and Kyoto Protocol reporting. The methods for estimating, measuring, monitoring and reporting greenhouse gas emissions and removals resulting from LULUCF project activities are addressed in Section 4.3 (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 according to Section 4.3). This assumes that a properly designed national system will also automatically include the effects of Article 6 projects. This approach is also 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<sub>2</sub> greenhouse gas emissions due to the project are accounted), while afforestation, reforestation, deforestation, forest management, cropland management, grazing land management and revegetation do not have a baseline scenario. Therefore, when using project-level information for reporting under Articles 3.3 and 3.4, one must take account of the overall carbon stock changes and non-CO<sub>2</sub> greenhouse gas emissions associated with the projects, and not just the change relative to the baseline scenario.

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

Section 4.2 provides a discussion of generic methodological issues that concern all possible land use, land-use change and forestry (LULUCF) activities under Kyoto Protocol Articles 3.3 and 3.4 (Section 4.2.1 on the relationship between land-use categories in reporting under the UNFCCC and the Kyoto Protocol, 4.2.2 on land areas, Section 4.2.3 on estimating carbon stock changes and non-CO<sub>2</sub> greenhouse gas emissions, and Section 4.2.4 on other generic methodological issues). This is followed by specific methodologies for monitoring afforestation and reforestation (treated together), deforestation, forest management, cropland management, grazing land management and revegetation (Sections 4.2.5 – 4.2.10), and projects (Section 4.3). Readers should refer to both the generic and the specific issues for any one of the activities.

### 4.2.1 Relationship between UNFCCC land-use categories and Kyoto Protocol (Articles 3.3 and 3.4) land-use categories

This subsection provides an overview of how the activities under Articles 3.3 and 3.4 relate to the land-use categories introduced in Chapter 2 and elaborated/utilized for the purposes of reporting on national greenhouse gas emissions and removals under the UNFCCC in Chapter 3 (LUCF sector good practice guidance).

Land-use systems are classified in Chapters 2 and 3 into:

- (i) Forest land (managed and unmanaged) (Section 3.2)
- (ii) Cropland (Section 3.3)
- (iii) Grassland (managed and unmanaged) (Section 3.4)
- (iv) Wetlands (Section 3.5 and Appendix 3a.3)
- (v) Settlements (Section 3.6 and Appendix 3a.4)
- (vi) Other land (Section 3.7)

Relationships exist between the basic land-use categories (i) to (vi) described in Section 2.2 and the activities of the Kyoto Protocol and Marrakesh Accords (Table 4.2.1). Land subject to Kyoto Protocol activities should be identified as a subcategory of one of these six main types.

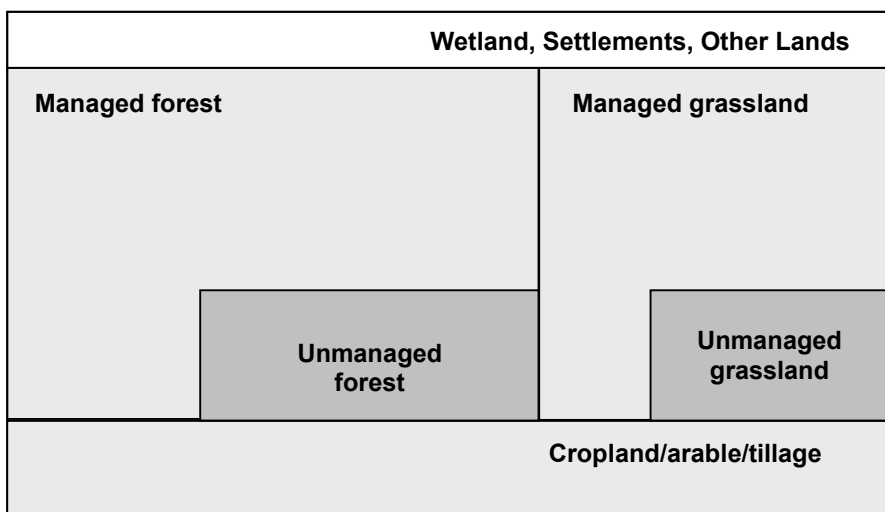
Using categories (i) to (vi) as a basis for estimating the effects of Articles 3.3 and 3.4 activities helps meet *good practice* requirements and will be consistent with the national land categorization used for preparing LUCF greenhouse gas inventories under the Convention. For example: Forest Land could be partitioned into: a) Forest Land under Article 3.3; b) Forest Land under Article 3.4, c) Other managed Forest Land (this would be the case 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 4.2.7, Figure 4.2.7.

Many of the methods described in subsequent sections of Chapter 4 build on methodologies that appear in Chapters 2 and 3 of this report or in the *IPCC Guidelines*. For continuity and clarity, cross-references back to these preceding descriptions appear periodically in Boxes, as they become pertinent. Direct references to the results in Chapter 3 reporting tables is not possible because for Kyoto Protocol reporting additional spatial stratification is required that cannot be inferred from Chapter 3 Reporting Tables.

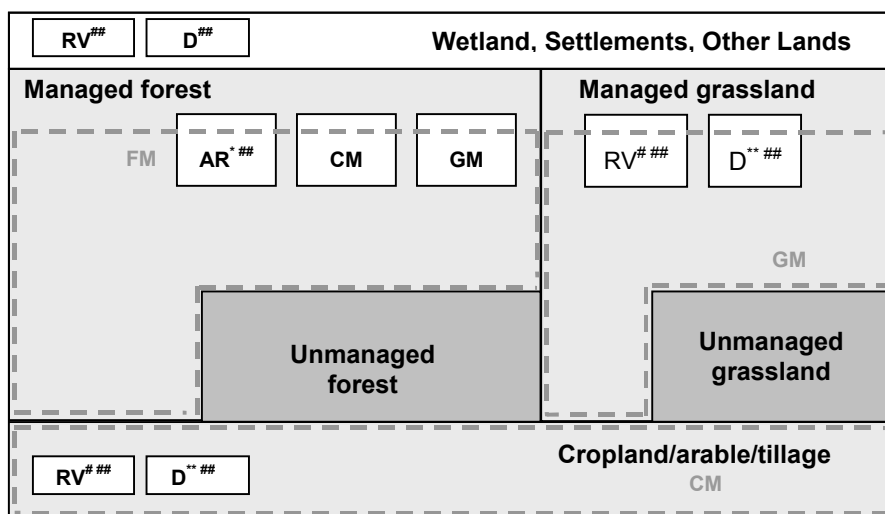
<b>TABLE 4.2.1</b> <b>RELATIONSHIP BETWEEN ACTIVITIES UNDER ARTICLES 3.3 AND 3.4 OF THE KYOTO PROTOCOL</b> <b>AND THE BASIC LAND-USE CATEGORIES OF SECTION 2.2</b>								
Read this table as follows: For example, if a land is initially cropland and then managed forest, then this event <b>must</b> constitute either afforestation or reforestation. Such mandatory Article 3.3-related classifications are highlighted in <b>bold</b> . On the other hand, if a land is first cropland and then managed grassland, then this may constitute GM or RV. The latter choice depends on the election of Article 3.4 activities by a country and on how national circumstances are applied to the definitions related to Article 3.4. Such Article 3.4-related, election-dependent classifications are printed in normal font.								
<b>Final</b> <b>Initial</b>	<b>Managed Forest land</b>	<b>Unmanaged Forest land</b>	<b>Cropland</b>	<b>Managed Grassland</b>	<b>Unmanaged Grassland</b>	<b>Wetland</b>	<b>Settlements</b>	<b>Other land</b>
<b>Managed Forest land</b>	FM or GM or CM		<b>D*</b>	<b>D*</b>		<b>D*</b>	<b>D*</b>	<b>D*</b>
<b>Unmanaged Forest land</b>	FM		<b>D*</b>	<b>D*</b>		<b>D*</b>	<b>D*</b>	<b>D*</b>
<b>Cropland</b>	A/R*		CM, RV	GM or RV		RV	RV	
<b>Managed Grassland</b>	A/R*		CM	GM or RV		RV	RV	
<b>Unmanaged Grassland</b>	A/R*		CM	GM			RV	
<b>Wetland</b>	A/R*		CM	GM		RV	RV	
<b>Settlements</b>	A/R*		CM	GM or RV		RV	RV	
<b>Other land</b>	A/R*		CM, RV	GM or RV		RV	RV	
* Transitions involving Article 3.3 activities have to be the result of direct human-induced activities.								
<b>Notes</b>								
1. "Initial" and "Final" refer to the categories before and after a land-use change. A – Afforestation (land has not been forested for at least 50 years), R – Reforestation (land has not been forested at the end of the year 1989), D – Deforestation, FM – Forest management, CM – Cropland management, GM – Grazing land management, RV – Revegetation (activities other than A or R that increase carbon stocks by establishment of vegetation).								
2. If the "initial" categorization was done for a year of the commitment period, then the land must be classified under the same activity for all subsequent years, even if the land use changes once more.								
3. All units of land subject to direct human-induced A/R activities are considered to be managed forests, and therefore unmanaged forest land cannot result from an A/R event in the table. Similarly, it is assumed that all units of land subject to direct human-induced D activities are managed lands. This includes natural D followed by a change to a <i>managed</i> land use.								

Figures 4.2.1 and 4.2.2 graphically show 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 Kyoto Protocol in any single reporting year. The outer rectangle represents the boundaries of a hypothetical country. The top diagram shows the reporting categories for the UNFCCC national inventory according to Chapter 3, and the bottom diagram includes an additional layer with the Article 3.3 and Article 3.4 categories under the Kyoto Protocol.

**Figure 4.2.1 Land classification in the national inventories under the UNFCCC of a hypothetical country in year X of the commitment period<sup>19</sup>**



**Figure 4.2.2 Land classification for Kyoto Protocol reporting for a hypothetical country in year X of the commitment period. This classification corresponds to the “final” status in Table 4.2.1.**



**Note**

- \* 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.
- # Land can only count either in RV or in cropland/grassland management (choice according to hierarchy by country)
- ## For A/R, D and RV the units of land are shown after the land-use transition has occurred. Therefore, A/R is in forest land, and RV and D are in non-forest lands in the Figure.

A/R : Afforestation / Reforestation, D : Deforestation, FM : Forest Management, CM : Cropland Management  
 GM : Grazing Land Management, RV : Revegetation

Some further observations relating to Figure 4.2.2:

- The areas surrounded by dashed lines are areas subject to the additional activities under Article 3.4, i.e., forest management, cropland management and grazing land management activities.

<sup>19</sup> Unmanaged forests and unmanaged grasslands are not reported in UNFCCC inventories.

- Forest, as defined by the Marrakesh Accords, relates to the physical characteristics of forests. An area subject to forest management is subsequently determined as an area upon which particular management practices are undertaken, consistent with Article 3.4 and the Marrakesh Accords. Forest management lands can include all managed forests according to the *IPCC Guidelines*. However, this situation may not always apply, because (i) countries could use different thresholds for defining forests for Kyoto Protocol as opposed to UNFCCC reporting, (ii) Article 3.4 as well as the Marrakesh Accords require that the activity took place since 1990, and (iii) the Marrakesh Accords' definition of forest management<sup>20</sup> contains additional criteria on stewardship. For further discussion of this possible definitional difference see Figure 4.2.8 and accompanying text in Section 4.2.7.2 (Choice of Methods for identifying lands subject to forest management). Unmanaged forests that remain unmanaged are included neither in the UNFCCC nor in the Kyoto Protocol reporting.
- For Kyoto reporting lands subject to cropland management as described in the Marrakesh Accords are identical to Cropland/arable/tillage lands in UNFCCC reporting.
- 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. Unmanaged grasslands will be excluded from both the UNFCCC and the Kyoto Protocol reporting.
- Afforested and reforested (A/R) lands are always managed forests. Yet, carbon stock changes and non-CO<sub>2</sub> greenhouse gas emissions are to be reported under Article 3.3 only.
- Deforested lands are usually managed (thus, there is no "D" box in the unmanaged grasslands). An exception is a wetland created from alterations of a hydrological regime, e.g., through the construction of a road.

## 4.2.2 Generic methodologies for area identification, stratification and reporting

### 4.2.2.1 REPORTING REQUIREMENTS

The Marrakesh Accords state that areas of land subject to Article 3.3 and Article 3.4 activities must be identifiable<sup>21</sup>, adequately reported<sup>22</sup> and tracked in the future.<sup>23</sup> Section 4.2.2.2 discusses two land reporting

<sup>20</sup> Paragraph 1 (f) of the Annex to the draft decision -/CMP.1 (Land use, land-use change and forestry), contained in document FCCC/CP/2001/13/Add.1, p. 58: "*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.

<sup>21</sup> Paragraph 20 of the Annex to the draft decision -/CMP.1 (Land use, land-use change and forestry), contained in document FCCC/CP/2001/13/Add.1, p.61: *National inventory systems under Article 5.1 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 about these areas should be provided by each Party included in Annex 1 in their national inventories in accordance with Article 7. Such information will be reviewed in accordance with Article 8.*

<sup>22</sup> Paragraph 6 of the Annex of the draft decision -/CMP.1 (Article 7), contained in document FCCC/CP/2001/13/Add.3, p.22: *General information to be reported for activities under Article 3, paragraph 3, 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;*

(ii) *Units of land subject to activities under Article 3, paragraph 3, which would otherwise be included in land subject to elected activities under Article 3, paragraph 4, under the provisions of paragraph 8 of the annex to decision -/CMP.1 (Land use, land-use change and forestry); and*

(iii) *Land subject to elected activities under Article 3, paragraph 4. [...]*

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

<sup>23</sup> Paragraph 19 of the Annex to the draft decision -/CMP.1 (Land use, land-use change and forestry), contained in document FCCC/CP/2001/13/Add.1, p.61: *Once land is accounted for under Article 3, paragraphs 3 and 4, all anthropogenic greenhouse gas emissions by sources from and removals by sinks on this land must be accounted for throughout subsequent and contiguous commitment periods.*

methods that can be applied to all Article 3.3 and Article 3.4 activities. Section 4.2.2.3 discusses how these reporting methods can draw on the three approaches presented in Chapter 2. Section 4.2.2.4 provides a decision tree for selecting one of the two reporting methods, and Section 4.2.2.5 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.

#### 4.2.2.2 REPORTING METHODS FOR LANDS SUBJECT TO ARTICLE 3.3 AND ARTICLE 3.4 ACTIVITIES

To meet the reporting requirements of the Marrakesh Accords, general information to be reported on activities under Articles 3.3 and 3.4 must include the geographical boundaries of areas encompassing units of land subject to afforestation and reforestation, deforestation, and lands subject to elected activities among forest management, cropland management, grazing land management and revegetation activities. To achieve this, a Party may choose one of two methods (Figure 4.2.3):

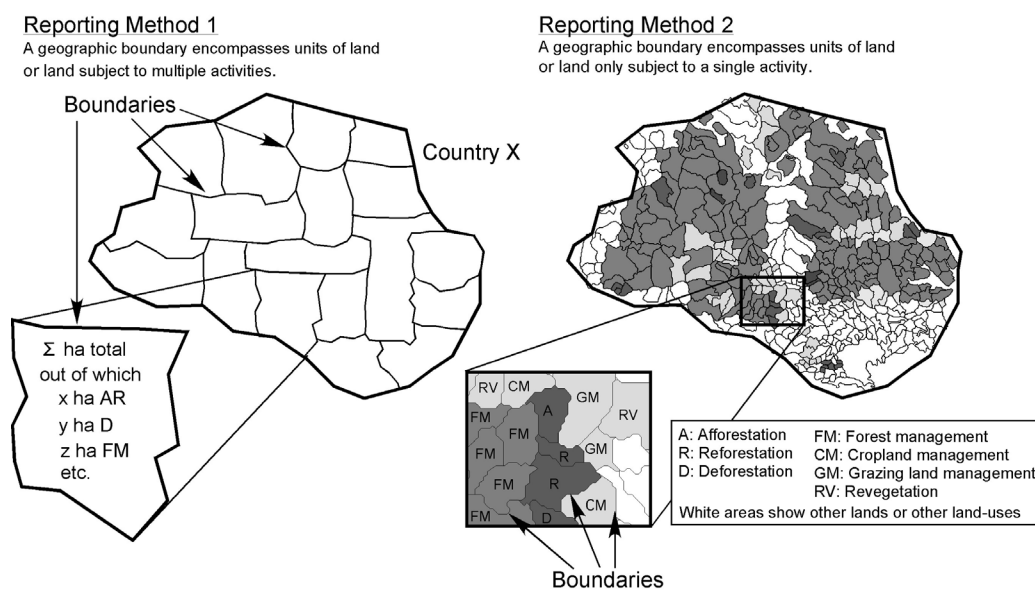
**Reporting Method 1** entails delineating areas that include multiple land units subject to Article 3.3 and 3.4 activities by using legal, administrative, or ecosystem boundaries. This stratification is based on sampling techniques, administrative data, or grids on images produced by remote sensing techniques. The identified geographic boundaries must be georeferenced.

**Reporting Method 2** 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.

To implement Reporting Method 1, it is *good practice* to stratify the entire country and to define and report the geographic boundaries of these areas of land. Criteria for stratification of 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) and elected activities (Articles 3.4), as well as ecological or administrative considerations. Within each resulting geographic boundary the units of land subject to Article 3.3 activities and the lands subject to any Article 3.4 activities (if elected) must then be quantified using the approaches described in Chapter 2 (Section 2.3 Representing land areas), in accordance with the guidance in Section 4.2.2.3, as well as the methods in Sections 4.2.2.5 (generic methods) and 4.2.5 to 4.2.10 (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 boundaries. This is described in Chapter 2 as the wall-to-wall mapping version of Approach 3 (Section 2.3.2.3). This reporting method uniquely identifies lands and units of land 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 summary statistics to ensure that reporting is transparent yet concise.

**Figure 4.2.3 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 Marrakesh Accords, 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 units of land or 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.

The geographic boundaries resulting from the stratification of the country should be reported using printed maps or digital maps, as described in Section 4.2.4.3.1 (Reporting).

### **4.2.2.3 RELATIONSHIP BETWEEN APPROACHES IN CHAPTER 2 AND REPORTING METHODS IN CHAPTER 4**

Chapter 2 (Basis for consistent representation of land areas) describes three approaches to representing land area. The detailed reporting requirements of Articles 3.3 and 3.4 of the Kyoto Protocol as elaborated in the Marrakesh Accords are met by the two reporting methods given in this chapter, and underpinned by the approaches described in Chapter 2. This section, summarised in Table 4.2.2, discusses which of the three Chapter 2 approaches are suitable for identifying units of land 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 2 can only meet the requirements of the Marrakesh Accords 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 grids of 20 to 100 m (see STEP 1.1 in Section 4.1.1). Land cover and land-use mapping using, for example, 1 km<sup>2</sup> (100 ha) pixel resolution does not meet the Protocol's requirements and supplemental information will be required.

#### **4.2.2.3.1 APPROACH 1**

Approach 1 in Chapter 2 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 the Marrakesh Accords. 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-compile the detailed inventory information for the geographical boundaries, which have resulted from the stratification of the country, to meet the reporting requirements of the Marrakesh Accords. 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-compiling the inventory information, and if the gross land-use transitions (rather than the net changes in land-use categories) are quantified.

#### **4.2.2.3.2 APPROACH 2**

Approach 2 focuses on land-use transitions. Although it provides useful information on land-use changes, especially regarding afforestation, reforestation and deforestation under Article 3.3, it is not spatially explicit. Hence, additional spatial information at the required spatial resolution is necessary to meet the reporting requirements of the Marrakesh Accords. This approach can therefore only be used to identify units of land or land subject to activities under Articles 3.3 and 3.4 if additional spatial data are available. 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.

#### **4.2.2.3.3 APPROACH 3**

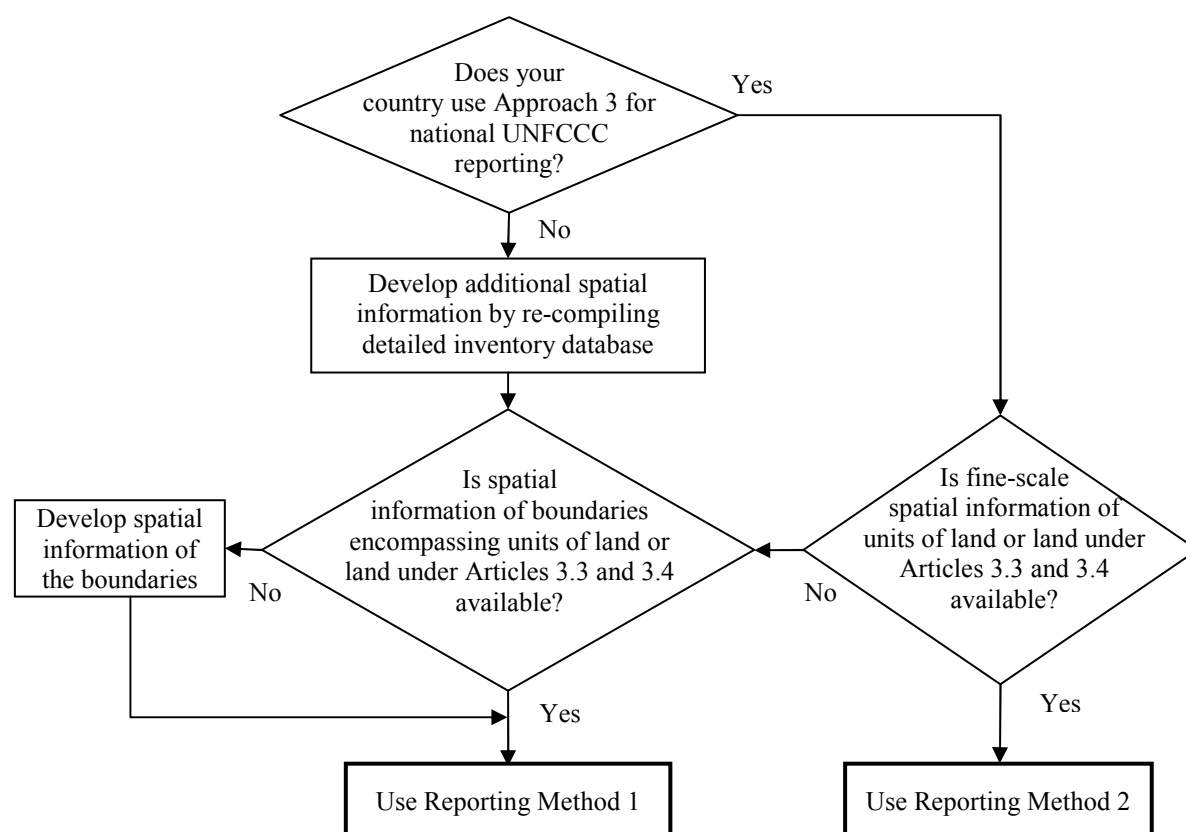
Approach 3 explicitly tracks land based on sample approaches, a grid system, or a polygon system within the geographic boundaries, which have resulted from the stratification of the country. This approach is applicable to Reporting Methods 1 and 2 above, as long as the spatial resolution is fine enough to represent the minimum forest area as defined by the Party under the Marrakesh Accords.

Chapter 2 Approaches	Reporting Method 1 (Broad area identification)	Reporting Method 2 (Complete identification)
<b>Approach 1</b>	Can only be used if additional spatial information is available by re-compiling inventories.	Not applicable
<b>Approach 2</b>	Can only be used if additional spatial information is available by re-compiling inventories.	Not applicable
<b>Approach 3</b>	<i>Good practice</i> if resolution is fine enough to represent minimum forest area. Involves aggregating data within the reported geographic boundaries.	<i>Good practice</i> if resolution is fine enough to represent minimum forest area.

#### 4.2.2.4 CHOICE OF REPORTING METHOD

It is *good practice* to choose an appropriate reporting method using the decision tree given in Figure 4.2.4. National circumstances may allow a Party 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 units of land and land using Reporting Method 1. Within those geographical boundaries where complete spatial identification of lands and units of land is possible, Reporting Method 2 can then be applied.

**Figure 4.2.4** 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 so as 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 or units of land 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.

#### 4.2.2.5 HOW TO IDENTIFY LANDS (UNITS OF LAND) IN GENERAL

##### 4.2.2.5.1 SPATIAL CONFIGURATION OF FORESTS AND AFFORESTATION, REFORESTATION OR DEFORESTATION EVENTS

The Marrakesh Accords specify that each Annex I Party to the Kyoto Protocol must choose country-specific parameters within the definition of forest as an integral part of their Kyoto Protocol reporting. The latest possible date to do that is 31 December 2006, or one year after the entry into force of the Kyoto Protocol for that Party, whichever is later<sup>24</sup>. This requires 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 (10 – 30%) and tree height at maturity (2 – 5 m). The parameter for the minimum area of land that constitutes a forest does also specify the minimum area on which afforestation/reforestation or deforestation events occur. Thus a country that selects, say 0.5 ha as the minimum area of forest land, must also identify all deforestation events that occur on lands that are 0.5 ha or larger. The identification of units of land on which land-use changes occur, such as deforestation, requires the detection of a reduction in forest cover from above to below the country-specific threshold of forest, accompanied by a change in land-use.

The Marrakesh Accords do not specify the shape of areas, neither for forest, nor for those areas on which afforestation, reforestation or deforestation events occur. Square areas that meet the size range of the Marrakesh Accords would be 22.36 m (0.05 ha) to 100 m (1 ha) 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 afforestation, reforestation or deforestation events, and further specifies that these areas are square, then a 20 m wide corridor cut through a forest with 100% canopy closure, will reduce canopy closure to 80%. This is higher than the range of canopy closures (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 kilometers, 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 and of the areas subject to afforestation, reforestation or deforestation events can have a large impact on the amount of land reported under Article 3.3.

It is therefore *good practice* for countries to include, with their report on the choice of forest definitions, a description of the definitional criteria which are used to identify forests and areas on which afforestation, reforestation or deforestation events occur. It is also *good practice* to apply these criteria consistently to the identification of both deforestation and afforestation or reforestation events that have occurred since 1990. For instance, these criteria can simply be defined as the minimum width that will be accepted for a forest and an area subject to an afforestation, reforestation or deforestation 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.

“Linear deforestation events” narrower than the selected minimum width criteria can contribute to reported carbon stock changes if they occur within lands subject to FM activities, given the Party has elected FM as Article 3.4 activity. Similarly, shelterbelts that are narrower than the selected minimum width criteria can also contribute to reported carbon stock changes, if these shelterbelts are within lands subject to cropland management, grazing land management, or revegetation activities, given the Party has elected the respective Article 3.4 activity.

<sup>24</sup> See paragraph 16 of the Annex of Draft decision -/CMP.1 (Land use, land-use change and forestry), contained in document FCCC/CP/2001/13/Add.1, p. 61, and paragraph 8 (b) of the Annex to Draft decision -/CMP.1 (Modalities for the accounting of assigned amounts), contained in document FCCC/CP/2001/13/Add.2, p. 59, and also Table 4.2.4a.

#### 4.2.2.5.2 SOURCES OF DATA FOR IDENTIFYING LANDS

The needs for the reporting of lands subject to activities under Articles 3.3 and 3.4 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. These include the land and forest inventory systems already in place and the additional measures a country chooses to implement in order to meet the reporting requirements.

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

- To use information from existing land-use and forest inventory systems.
- To implement a monitoring and measurement system.
- To implement an activity reporting system that includes verification and auditing procedures.

It is likely that in most countries the existing land use and inventory systems are inadequate to meet all the land reporting requirements of the Kyoto Protocol, and that, with varying degrees of incremental efforts, additional information must be obtained through monitoring or in-country reporting systems. A country's choices of the appropriate systems will depend on national circumstances. For example, a country could determine that it would be most efficient to combine an activity reporting system to identify units of land subject to afforestation/reforestation, and a monitoring system to identify units of land subject to deforestation.

##### 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 1990 and 2008, and between 2008 and 2012, 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. If the latter is not possible, e.g., because monitoring procedures were changed, it is *good practice* to develop computational procedures, which allow to convert the data between the used sampling schemes or which, at least to have a method, allow to map the data from a previous to a successor sampling scheme (see also Sections 4.2.4.1. Developing a consistent time series and 4.2.4.1.1 Recalculation).

Forest inventories in large countries often do not record polygons less than, for example, 3 ha in size. The requirement to identify afforestation, reforestation or deforestation activities 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 or deforestation 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  $1,000 \cdot 100/95 = 1,052.6$  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.

Countries that choose an inventory-based approach for the identification of units of land subject to afforestation/reforestation activities can face the challenge that non-forest areas are not normally 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

In order 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.

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 (see Sections 2.4.2 Sampling methods; 4.2.4.3 Uncertainty assessment; 5.2 Identifying and quantifying uncertainties; and 5.3 Sampling). Appropriate pre-stratification of the country (see Section 4.1.1, STEP 1.3) for which sample estimates will be developed may reduce the uncertainty.

## 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. Instead of trying to detect afforestation events from inventory or monitoring systems, countries can request that those individuals or agencies that afforest or reforest areas report on their 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.

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.

It is *good practice* for Parties that rely on activity reporting systems, which 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 land, 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.

Further details on the identification of lands are provided in the activity-specific sections of this chapter (Sections 4.2.5 to 4.2.10).

## 4.2.3 Generic Methodological Issues for Estimating Carbon Stock Changes and Non-CO<sub>2</sub> Greenhouse Gas Emissions

Once the areas subject to activities under Articles 3.3 and 3.4 have been determined, the Marrakesh Accords specify that the carbon stock changes and non-CO<sub>2</sub> greenhouse gas emissions on these areas must be estimated. The generic methods of estimating the carbon stock changes, for all pools to be reported (see below), are described in Chapter 3 (LUCF sector good practice guidance). 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 4.2.5 to 4.2.10.

Coverage of activities under Articles 3.3 and 3.4 requires an estimation of all carbon stock changes, and emissions and removals of non-CO<sub>2</sub> greenhouse gases (regardless of cause, such as growth, harvest, natural disturbance, decomposition etc.) from all lands subject to the included activities and for all pools with discretionary omission of those that are not a source of carbon, with higher-tier methods used for key categories.

The methodology used to estimate greenhouse gas emissions and removals for a particular year (1990, 2008, 2009, ..., or 2012) depends on the land use in the current and in prior years, because shifts in categories or land

uses can occur over time (see Section 4.1.2). Therefore the methodologies may vary between units of land or land within one Article 3.3 or Article 3.4 category.<sup>25</sup> The methodology used to calculate greenhouse gas emissions or removals associated with a unit of land or land 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 use in the current year does not correspond to an Article 3.3 activity or an elected Article 3.4 activity, and if a reporting requirement was not established through land use or land-use change in prior years, then the land is not reported at all under the Kyoto Protocol.

### 4.2.3.1 POOLS TO BE REPORTED

The *IPCC Guidelines* provide methodologies for the estimation of the carbon stock changes in two major carbon pools: biomass and soil organic carbon; they mention dead organic matter as an area that should be considered in future work on inventory methods. The Marrakesh Accords specify that carbon stock changes in five pools must be reported: aboveground biomass, belowground biomass, dead wood, litter, and soil organic carbon (Table 3.1.2). 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 is calculated. Any net decrease in carbon stocks is converted to the equivalent CO<sub>2</sub> emission in the reporting tables (see Section 4.2.4.3) and any net increase is reported as the equivalent CO<sub>2</sub> removal. Carbon stock changes are converted to CO<sub>2</sub> emissions and removals by multiplying the net carbon stock change by 44/12 (the stoichiometric ratio of CO<sub>2</sub> and C) and by converting the sign: a decrease in carbon stocks (negative sign) leads to an emission to the atmosphere (positive sign) and vice versa. The storage of carbon in harvested wood products is not included in the reporting since it is not listed as a pool covered by the Marrakesh Accords. Chapter 3 provides clear definitions of carbon pools (Table 3.1.2). 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* to provide such information on both the individual pools included in the reporting, and on the total carbon stock change of the five pools.

The Marrakesh Accords specify 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.<sup>26</sup> *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 cropland is converted to forest land by afforestation or reforestation, the dead wood pool cannot decrease, because there is typically no deadwood in a cropland (if it does not contain trees, e.g., if it does not contain any shelterbelts, was no orchard, and was no other agroforestry system);
- Surveys of peer-reviewed literature 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 4.2.4.2 Uncertainty Assessment).

<sup>25</sup> 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.

<sup>26</sup> See paragraph 21 in the Annex to the draft decision -/CMP.1 (Land use, land-use change and forestry), contained in document FCCC/CP/2001/13/Add.1, p.62.

### 4.2.3.2 YEARS FOR WHICH TO ESTIMATE CARBON STOCK CHANGES AND NON-CO<sub>2</sub> GREENHOUSE GAS EMISSIONS

The Marrakesh Accords specify that the carbon stock changes for each unit of land subject to an Article 3.3 activity, and for lands subject to elected activities under Article 3.4 be reported for each year of the commitment period<sup>27</sup>, beginning with the start of the commitment period, or with the start of the activity, whichever is later.

To ensure that actual carbon stock changes are reported, and not artefacts resulting from changes in area over time, the calculations of carbon stock changes should be implemented in the following sequence: For each unit of land or land, the carbon stock change should first be calculated for the year of interest, and these stock changes should then be summed for all areas. The inverse sequence, i.e., first summing up the carbon stocks across all areas at times  $t_1$  and  $t_2$  and then calculating the difference in carbon stocks, can result in errors if the area at times  $t_1$  and  $t_2$  is not the same, and is therefore not recommended.<sup>28</sup>

It is therefore *good practice* to conduct all calculations of carbon stock changes and greenhouse gas emissions for the area at the end of the inventory year, and to use this approach consistently through time.

This means that if the activity started on 1 July 2009, then the carbon stock changes and greenhouse gas emissions should be reported for each of the last four years of the commitment period, 2009-2012. If the activity started after 1990 but before 1 January 2008, then reporting of the carbon stock changes and greenhouse gas emissions for the commitment period should cover each of the five years of the commitment period, 1 January 2008 to 31 December 2012. These reporting requirements as a function of time are summarized in Table 4.2.3. Where differences occur between the sum of the five annual reports and the report for the entire commitment period, these should be addressed and reconciled at the end of the commitment period (see Sections 4.2.3.3, 4.2.4.1.1 and Chapter 5).

Activity started	Calendar year for which reporting is necessary				
	2008	2009	2010	2011	2012
Before 2008	R	R	R	R	R
In 2008	R	R	R	R	R
In 2009		R	R	R	R
In 2010			R	R	R
In 2011				R	R
In 2012					R

Each activity (afforestation, reforestation, deforestation, forest management, cropland management, grazing land management and revegetation) may consist of a suite of practices and may begin with one or several of these. For instance, an afforestation programme may begin with planning, land purchase, producing propagation material etc. Operations like site preparation can also precede the planting or seeding (as a result of which the land actually becomes a "forest"). Some of these operations are carbon-neutral, 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<sub>2</sub> emissions due to any of the suite of the operations. 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

<sup>27</sup> See paragraph 5 in the Annex to the draft decision -/CMP.1 (Article 7), contained in document FCCC/CP/2001/13/Add.3, p. 22.

<sup>28</sup> For example, if the area of an Article 3.4 activity is 100 ha at the beginning of an inventory year and 200 ha at the end of the same inventory year, then the difference in carbon stocks on the 200 ha over the inventory year must be calculated – otherwise the carbon stock at the beginning of the year (X tonnes of C / ha • 100 ha) is almost always smaller than the carbon stock at the end of the year (Y tonnes of C / ha • 200 ha), and an apparent increase would merely result from the presence of carbon stocks as the area increases.

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 operations.

### 4.2.3.3 REPORTING AND MEASUREMENT INTERVALS

The Marrakesh Accords specify that all emissions from sources and removal by sinks caused by Article 3.3 and elected Article 3.4 activities be reported annually.<sup>29</sup> A number of methods are available to obtain annual estimates and the annual reporting requirement does not imply that annual field 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 4.2.3.7 (Interannual variability). Carbon stock changes for pools with high uncertainties, 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, they should seek a balance which is affordable, make best use of data that are already available, allow stock changes to be verified consistently with the approaches set out in Chapter 5 (Section 5.7 Verification), and not make inventories susceptible to the impacts of annual fluctuations in weather. Although Section 4.2.3.7 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. 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.

### 4.2.3.4 CHOICE OF METHOD

Estimation of carbon stock changes and non-CO<sub>2</sub> greenhouse gas emissions from Articles 3.3 and elected Article 3.4 activities should be consistent with the methods set out in Chapter 3. For each unit of land under Article 3.3 or land under Article 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 same land in the UNFCCC inventory, following Chapter 3 of this report. The only exception to this rule is revegetation: if the lands on which revegetation occurs are not a key category, then revegetation is also not a key category. If the lands on which the revegetation occurs are a key category in the UNFCCC inventory<sup>30</sup>, then revegetation can either be treated as a key category, or a separate test to identify the “key category” can be applied (see Chapter 5, Section 5.4.4 Identifying key categories under Kyoto Protocol Articles 3.3 and 3.4).

Tier 1 as elaborated in Chapter 3 assumes that the net change in the carbon stock for litter (forest floor), dead wood and soil organic carbon (SOC) pools is zero, but the Marrakesh Accords specify that above- and belowground biomass, litter, dead wood and SOC should all be counted unless the country chooses not to count a pool that can be shown not to be a source. Therefore Tier 1 can only be applied if the litter, dead wood and SOC pools can be shown not to be a source using the methods outlined in the Section 4.2.3.1. Tier 1 can also only be applied if forest management is not considered a key category, which can only be the case if “forests remaining forests” in Chapter 3 are not a key category.

### 4.2.3.5 FACTORING OUT INDIRECT, NATURAL AND PRE-1990 EFFECTS

The Marrakesh Accords specify that information be provided 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 elevated carbon dioxide concentrations above pre-industrial levels, indirect nitrogen deposition, and the dynamic

<sup>29</sup>Note that although annual reporting is required, countries have the option to account either annually or over the entire commitment period (cf. paragraph 8(d) in the Annex to draft decision -/CMP.1 (Modalities for the accounting of assigned amounts), contained in document FCCC/CP/2001/13/Add.2, p.59).

<sup>30</sup>This is possible where the croplands or grasslands on which the revegetation takes place are key categories with respect to the UNFCCC inventory, whereas the area on which the revegetation takes place may be very small compared to those under cropland or grassland management.



effects of age structure resulting from activities prior to 1 January 1990.<sup>31</sup> In addition to the requirement to report whether or not these effects are factored out, those Parties that choose factoring out should also report the methods they used. For the purpose of accounting under the Kyoto Protocol for the first commitment period, “factoring out” has been addressed through the cap for carbon credits for forest management under Articles 3.4 and 6. The “factoring out” issue is currently under consideration by the IPCC and will therefore not be addressed further here.

#### 4.2.3.6 DISTURBANCES

Disturbances include processes that reduce or redistribute carbon pools in terrestrial ecosystems. Examples include fire, windthrow, insects, droughts, flooding, ice storms, etc. Although disturbances can be either natural or human-induced, or of unknown causes, they affect the carbon cycle of managed forests and other managed lands, and therefore, they are to be included in the carbon stock change and greenhouse gas assessments for those lands that are subject to activities under Articles 3.3, 3.4 or 6. These disturbances are also considered in the inventories under the UNFCCC (see Chapter 3, e.g., the Introduction to Section 3.2 Forest land).

Since unmanaged forests and other unmanaged lands are included neither in the UNFCCC nor in the Kyoto Protocol reporting requirements disturbances in areas which remain unmanaged are not to be considered.

Four major impacts of disturbances on managed ecosystems can be identified. First, disturbances can cause direct releases of carbon and non-CO<sub>2</sub> greenhouse gases to the atmosphere (e.g., during fires) or transfers of carbon out of the ecosystem (e.g., during harvest). Second, they redistribute carbon between ecosystem carbon pools, e.g., live biomass is transferred to dead wood and litter. Third, they result in post-disturbance emissions, e.g., through the decay of residual biomass after a disturbance. Fourth, they re-set stand dynamics to an earlier age class of the same or a new growth trajectory. Tier 3 models that estimate carbon stock changes in forested landscapes simulate each of these processes and integrate the impacts of disturbances on stand and landscape-level carbon stocks (e.g., Kurz *et al.*, 1992; Kurz and Apps 1999).

Taking this into account, the following can be said:

- Carbon stock changes and non-CO<sub>2</sub> greenhouse gas emissions resulting from disturbances on land subject to an Article 3.3 activity (afforestation, reforestation, and deforestation) or an elected Article 3.4 activity (e.g., forest management) have to be included in the reported numbers. See for example, Section 3.2.1.1 for guidance on how to estimate and report carbon stock changes and Section 3.2.1.4 for greenhouse gas emissions from fires. If the carbon stock changes resulting from disturbances were not included in the UNFCCC reporting, they have to be added for the Kyoto reporting.
- Carbon stock changes and non-CO<sub>2</sub> greenhouse gas emissions resulting from disturbances during the commitment period on land subject to projects (Article 6) have to be included in the reported numbers.
- If project-related management activities (e.g., Article 6) result in a reduction or avoidance of disturbances (e.g., fire or insect control), a change in carbon stocks relative to a baseline (with disturbances) can occur. It is *good practice* to estimate and include in the reporting the actual carbon stock changes occurring in the project area.

#### 4.2.3.7 INTERANNUAL VARIABILITY

The annual rate of net carbon emissions or removals in an ecosystem is strongly influenced by local weather patterns, climate variability, management actions, natural disturbance variations and other factors that alter growth and decomposition rates (e.g., in Griffis *et al.*, 2000; Tian *et al.*, 1998; Flanagan *et al.*, 2002). Consequently, the rate of net carbon 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.

There are two aspects to interannual variability, and they need to be addressed independently. First, the national statistics on the between-years variation in harvest rates, land-use change, or natural disturbances such as the area burned, are usually available, and it is *good practice* to include these in the calculation of carbon stock changes. Second, the variations in growth and decomposition rates due to seasonal and annual variations in environmental conditions, such as moisture regimes, temperature, or growing season length are much more difficult to quantify.

<sup>31</sup> See paragraph 7 in the Annex to draft decision -/CMP.1 (Article 7), contained in document FCCC/CP/2001/13/Add.3, p. 23.

The impacts of interannual variability in environmental conditions on the estimates of annual rates of net emissions and removals of carbon may result in incorrect conclusions about long-term trends where estimates from a single year are extrapolated. Conversely, interpolation of long-term trends in, for example, forest growth rates may result in under- or overestimation of the actual growth in a single year. The forest growth functions and yield tables used in countries with forest management planning systems are based on measurements of periodic growth (e.g., over 5 or 10-year re-measurement intervals) and thus are incorporating and averaging the impacts of past interannual variability of environmental conditions. One approach that would meet *good practice* is to use such growth functions to estimate biomass growth rates, because they represent the average growth rates and are therefore influenced little by short-term fluctuations in environmental conditions.

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, the growth estimates should be adjusted accordingly. 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 where necessary.

In addition to the carbon stock changes and non-CO<sub>2</sub> greenhouse gas emissions during the commitment period, the Kyoto Protocol also requires an estimate of carbon stock changes during the base year (1990 in most cases) for those elected activities for which net-net accounting applies (Table 4.1.1). The impact of this estimate for a single year could be large because it will be compared against the estimates for each year in the commitment period in which this activity occurred. The effects of interannual variability in the base year could therefore be large. The direction of the impact depends on how the year 1990 deviated from the long-term climatic averages. Moreover, it may be difficult to confirm the estimate for the base year using direct measurements, unless these were already taken in 1990. Where environmental conditions in the base year (e.g., 1990) caused major deviations in the carbon stock changes and non-CO<sub>2</sub> greenhouse gas emissions from their longer-term (e.g., 5-year) averages, it is *good practice* to consistently report emissions using longer-term averages of environmental conditions or actual annual estimates of emissions when estimating stock changes and non-CO<sub>2</sub> greenhouse gas emissions.

The effect of interannual variability may decrease as the geographical area considered increases. For example, the effects of local weather patterns may partially offset each other across a large country, but may be very pronounced in a small country or within a small region of a country. There are, however, climatic processes that can synchronize variations in weather over large regions, such as El Niño Southern Oscillation (ENSO) events which typically occur on time scales of 3 to 7 years, or global climate change. Within limits, the longer the measurement or estimation interval the more likely it is that the results will capture the true long-term average value. Where non-linear processes are involved, e.g., the sigmoidal accumulation of forest biomass over age, simple linear interpolation for intermediate years will become increasingly unreliable with longer time periods. In general, an averaging period of about five years is likely to reduce the impacts of interannual variation.

It is *good practice* to document whether the methods selected for the estimation of carbon stock changes and non-CO<sub>2</sub> greenhouse gas emissions are sensitive to interannual variability of environmental conditions during the commitment period, and to report how interannual variation was addressed in the inventory calculations.

## 4.2.4 Other generic methodological issues

### 4.2.4.1 DEVELOPING A CONSISTENT TIME SERIES

The lands subject to Article 3.3 or elected Article 3.4 activities and the management thereon need to be tracked continuously through time, to ensure that all emissions and removals are reported. Moreover, the continuity of management greatly influences carbon 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 and elected 3.4 activities. (See also Box 4.2.1)

Assessment of the continuity of management on land could be achieved either by continuously tracking lands subject to an Article 3.3 or elected Article 3.4 activity from 1990 until the end of the commitment period (cf. Section 4.2.7.2 Choice of methods for identification of forest management lands), or by developing statistical sampling techniques that allow the transition of different types of management on land subject to Article 3.3 or

elected 3.4 activities to be determined (see Section 5.3 Sampling). An example of how such a scheme could operate is given in Box 4.2.1.

A supplementary condition for developing a consistent time series is to use the same methods for estimating carbon stock change and non-CO<sub>2</sub> greenhouse gas emissions during the whole period.

Time series consistency is discussed further in Section 5.6 (Time series consistency and recalculations) of this report.

#### Box 4.2.1

##### AN EXAMPLE OF CONSISTENCY FOR 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 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<sup>32</sup> factor, over 20 years, for the management activity, and the length of the period, one year. See Chapter 3.3.1.2, and Tables 3.3.3 and 3.3.4.) 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:

$$(3,500 \cdot 0.3 + 4,500 \cdot 0 + 500 \cdot (-0.3) + 1,500 \cdot 0) \text{ Mg C/yr} = 900 \text{ Mg C/yr.}$$

#### 4.2.4.1.1 RECALCULATION

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 4.2.6.2.1).

The Marrakesh Accords make provisions for recalculation<sup>33</sup>, 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 reporting for 2012). Special attention must be given to those activities under Article 3.4 to which the net-net accounting rule applies, i.e., all activities except Forest Management. For these activities, the use of refined or updated data or changed methods should be peer-reviewed or validated in another way before being implemented, especially if data in the base year will change as a result (see Chapter 7, Section 7.3 Recalculations, in *GPG2000* and Chapter 5, Section 5.6.3 Recalculation and

<sup>32</sup> While Chapter 3 uses the language of emission/removal factors, in Chapter 4 also the term “carbon stock change factor” is in use to refer to carbon emission/removal factors.

<sup>33</sup> See paragraphs 4, 12 (notably 12(d) and 12(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.

periodic data, in this report for additional guidance). 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 (Cross-cutting issues) of this report and Section 7.3 (Recalculations) of the *GPG2000*.

#### 4.2.4.2 UNCERTAINTY ASSESSMENT

According to the Marrakesh Accords, uncertainties should be quantified and all information on anthropogenic greenhouse gas emissions by sources and removals by sinks which result from activities under Articles 3.3 and 3.4 have to be within levels of confidence as elaborated by any IPCC good practice guidance adopted by the COP/MOP.<sup>34</sup> Generally, the approaches provided in Chapters 2 and 3 and Sections 5.2 Identifying and quantifying uncertainties, and 5.3 Sampling, can be used for assessing uncertainties associated with estimates reported under the UNFCCC and under the Kyoto Protocol LULUCF activities. However, some issues and terms which are specific to the Kyoto Protocol require additional uncertainty assessment, for example the identification of the areas subject to Article 3.3 and 3.4 activities or the need to track activities since 1990. For Kyoto Protocol reporting, uncertainty assessment is particularly important in order to support verification in accordance with the Quality Assurance and Quality Control requirements as specified in Chapter 5.<sup>35</sup> In addition, to be consistent with *good practice*, the uncertainties in inventory estimates should be reduced as far as practicable. Moreover, while selecting a particular tier to estimate changes in carbon stocks and non-CO<sub>2</sub> greenhouse gas emissions, it is *good practice* to consider the implications of this choice for the management of uncertainties.

##### 4.2.4.2.1 IDENTIFYING UNCERTAINTIES

For a complete enumeration and explanation of each possible source of uncertainty relevant in the inventory under the UNFCCC, the reader is referred to Chapters 2 and 3. In the context of the Kyoto Protocol the following sources of uncertainties are likely to be significant:

- Definitional errors, such as bias and inconsistencies resulting from the interpretation and implementation of the various definitions in the Kyoto Protocol and the Marrakesh Accords (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 (Article 3.4) vs. deforestation (Article 3.3) 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), or 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);
- Identification errors arising while defining the geographical boundaries of areas encompassing lands and units of lands subject to the activities in Articles 3.3 and 3.4 (although this may not have a direct impact on the uncertainty of the carbon stock change estimates for a given activity);
- Model errors occur whenever models or allometric equations are used to estimate carbon stock changes or non-CO<sub>2</sub> greenhouse gas emissions and removals, which is likely to be the case at higher tiers. It can be very

<sup>34</sup> This refers to paragraph 6 (d) including footnote 5, and paragraph 9 including footnote 7 in the Annex to draft decision -/CMP.1 (Article 7) contained in FCCC/CP/2001/13/Add.3, p.23 and p.24, respectively.

<sup>35</sup> For instance activities under Article 3.3 shall be "...measured as verifiable changes in carbon stocks in each commitment period..." and "...The greenhouse gas emissions by sources and removals by sinks associated with those activities shall be reported in a transparent and verifiable manner...". Article 3.4 explicitly mentions uncertainties, i.e., "...human-induced activities related to changes in greenhouse gas emissions by sources and removals by sinks in the agricultural soils and the land-use change and forestry categories shall be added to, or subtracted from, the assigned amounts for Parties included in Annex I, taking into account uncertainties, transparency in reporting, [and] verifiability...". (Kyoto Protocol Articles 3.3 and 3.4). See also paragraphs 3(a), 3(b) and 3(c) in the Annex to draft decision -/CMP.1 (Article 5.1), contained in FCCC/CP/2001/13/Add.3, pp.4-5.

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.

- 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 using Reporting Method 1 (as described in Section 4.2.2.2). Sampling issues are described in detail in Section 5.3 (Sampling).

## Some notes on factors affecting uncertainty

### *Natural Variability*

Natural variability is a result of variations in natural controlling variables, such as annual climate variability, and variability within units of land 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 upscaling uncertainties using standard statistical methods (e.g., Tate *et al.*, 2003). In some cases, especially for inter-annual or inter-decadal variability, considerable effects may result that can 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 4.2.3.7 above.

### *Lack of activity data and documentation in time-series consistency*

In addition to uncertainties in default carbon emission and removal factors, there are known inaccuracies in the case of missing activity data (cf. Section 4.2.8.1.1). Determining retrospectively the inventory for the base year, i.e., for most Parties the year 1990, may pose a particular challenge for cropland management, grazing land management and revegetation. Where the 1990 base year net carbon emission and removals cannot be established using the default carbon emission and removal factors, they may be estimated by extrapolating a consistent time series. This requires data on the land management history for the past 20 years, because the default method for estimation of the greenhouse gas emissions/removals assumes that it takes 20 years for the soil carbon pool to reach a new equilibrium after a land-use change to agriculture. Options to address the lack of reliable data for the period 1970 to 1990 can be found in Section 4.2.8.1.1 (Base year, Cropland Management).

### *Resolution of remote sensing and ground truth*

The objective of using satellite imagery for land cover assessments is to obtain, for an inventory region, total area estimates, percentages of land-cover classes, or geographical boundaries. Remote sensing is particularly well suited to produce a complete identification of lands and units of land when using Reporting Method 2 (see Section 4.2.2.2). A primary 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.

## 4.2.4.2.2 QUANTIFYING UNCERTAINTIES

Uncertainties are to be quantified according to methods as described in this report: Chapters 2 and 3 provide the necessary data and methodological advice on estimating uncertainties associated with carbon stock changes and emissions estimation. Chapter 5 (see equations in Section 5.2) shows how to combine these estimates into overall uncertainties.

It is *good practice* to derive confidence intervals by applying a quantitative method to existing data. Confidence intervals at given confidence levels provide a minimum basis for a simple quantitative estimate of uncertainty. To remain consistent with *GPG2000*, uncertainties should be estimated at the 95% confidence limits, using component uncertainties assessed by expert judgement aiming at 95% confidence where quantification is not otherwise possible (see Section 5.2 for guidance on expert judgement).

Uncertainties for the Kyoto activities 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 Kyoto Protocol and the Marrakesh Accords 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 Kyoto Protocol activities and the corresponding categories of the *IPCC Guidelines*.
- Activity data can also relate to individual practices or ownership structures, e.g., the fraction of cropland farmers using 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 cropland management, grazing land management and/or revegetation (if elected) uncertainty estimates are needed also for the base year. These are likely to be higher than for estimates in the commitment period, because this information 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. Section 4.2.8 (Cropland Management) discusses a default approach to this problem. 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. Further advice on providing missing data in this way is given in Section 5.6.
- When remote sensing is employed for classification of land use and detection of land-use change including units of land subject to Article 3.3, the uncertainties could be quantified by verifying classified lands with adequate actual ground truth data or higher resolution imagery (see Sections 5.7.2 and 2.4.4). A confusion matrix as described in Section 2.4.4 can be used to assess accuracy.

Separate annual uncertainty estimates need to be made for each activity under Articles 3.3 and 3.4, for each reported carbon pool, each greenhouse gas and geographical location. Estimates should be reported using tables generated following the model of Tables 4.2.6a, 4.2.6b and 4.2.6c as found in Section 4.2.4.3 (Reporting and Documentation). Separate tables should be reported for the base year in case CM, GM and/or RV 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 4.2.6 a, b and c.

Uncertainty associated with areas of lands and units of land need to be estimated. When using Reporting Method 1, it is *good practice* to report a separate estimate of uncertainty for each of the Article 3.3 activities, and each of the elected Article 3.4 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.

Where uncertainties are difficult to derive, default values for uncertainties are to be used. Guidance on selecting default carbon emission or removal factors for cropland management 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 coefficient of variation (the ratio of the standard deviation and the mean) 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  $\pm 50\%$  of that mean (Smith *et al.*, 1998). For revegetation, default uncertainty ranges cannot be specified. It is *good practice* for a Party electing revegetation to provide its own estimates of the uncertainty associated with emissions and removals from all pools for the affected lands. These could be derived from using Tier 2 and 3 methods to assess emissions and removals of carbon due to revegetation (see Section 5.2 Identifying and quantifying uncertainties).

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,  $\pm 0.2$  is proposed (e.g., the fraction of farmers using organic amendment estimated at 0.4, the uncertainty range being 0.2–0.6). Chapter 6 in *GPG2000* (Quantifying Uncertainties in Practice) and Chapter 5 of this report (Cross-cutting issues) provide advice on quantifying uncertainties in practice, including combining expert judgements and empirical data into overall uncertainty estimates.

#### 4.2.4.2.3 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 Kyoto Protocol 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 in 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 Kyoto Protocol 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.

#### 4.2.4.3 REPORTING AND DOCUMENTATION

##### 4.2.4.3.1 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 4.2.5 – 4.2.10, must be reported as outlined in the Marrakesh Accords.<sup>36</sup> Some information on definitions and elected activities must be reported prior to the first commitment period (by the end of 2006), whereas much supplementary information must be reported annually during the first commitment period. The information to be reported is summarised in Tables 4.2.4a and 4.2.4b, respectively, 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 Kyoto Protocol must include estimates of areas of land subject to activities under Article 3.3 and 3.4 (where elected), of emissions by sources and removals by sinks on these areas of land, and the associated uncertainties, using Tables 4.2.5 through 4.2.7. 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.

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<sup>36</sup> See paragraphs 4 to 9 of the Annex to draft decision -/CMP.1 (Article 7), contained in document FCCC/CP/2001/13/Add.3, pp.22-24.

<b>TABLE 4.2.4a</b>		
<b>SUPPLEMENTARY INVENTORY INFORMATION TO BE REPORTED PRIOR TO 1 JANUARY 2007 OR ONE YEAR AFTER THE ENTRY INTO FORCE OF THE KYOTO PROTOCOL FOR THE PARTY, WHICHEVER IS LATER<sup>37</sup></b>		
<b>Information to be reported</b>	<b>Detailed information</b>	<b>Reference in Marrakesh Accords<sup>38</sup></b>
Definition of forest by the Party	<ul style="list-style-type: none"> <li>• A single minimum land area value between 0.05 and 1 hectare;</li> <li>• The minimum width that defines the spatial configuration of that area (see Section 4.2.2.5.1);</li> <li>• A single minimum tree crown cover value between 10 and 30%;</li> <li>• A single minimum tree height value between 2 and 5 metres;</li> <li>• Justification that such values are consistent with the information that has historically been reported to the Food and Agriculture Organization of the United Nations or other international bodies, and if they differ, explanation why and how such values were chosen.</li> </ul>	8 (b) and paragraph 16 of the Annex to draft decision -/CMP.1 (LULUCF), FCCC/CP/2001/13/Add.1 p.61
Elected activities under Article 3, paragraph 4	<ul style="list-style-type: none"> <li>• A list of activities elected by the Party</li> <li>• Information on how the Party's national system under Article 5, paragraph 1 will identify land areas associated with the elected activities</li> <li>• Information on how the Party interprets the definition of Art 3.4 activities (e.g., what activities are included under forest management)</li> </ul>	8 (b) 8 (c)
The Party's own precedence or hierarchy among Article 3.4 activities	<ul style="list-style-type: none"> <li>• As outlined in Section 4.1.1 it is <i>good practice</i> to establish precedence conditions and/or a hierarchy among 3.4 activities to facilitate the estimation and reporting procedures, and so that lands are allocated only to one of the Article 3.4 activities.</li> </ul>	

<sup>37</sup> Paragraph 2 in draft decision -/CMP.1 (Modalities for accounting of assigned amounts), contained in document FCCC/CP/2001/13/Add.2, p.56.

<sup>38</sup> Entries in this column refer to relevant paragraphs in the Annex to draft decision -/CMP.1 (Modalities for the accounting of assigned amounts), contained in document FCCC/CP/2001/13/Add.2, pp.57-72. In the table not necessarily *all* relevant legal texts are referred to.



<b>TABLE 4.2.4b</b>		
<b>SUPPLEMENTARY INFORMATION TO BE REPORTED FOR THE ANNUAL GREENHOUSE GAS INVENTORY DURING THE FIRST COMMITMENT PERIOD ACCORDING TO THE MARRAKESH ACCORDS. TEXT IN ITALICS INDICATES A DIRECT QUOTE FROM THE RELEVANT PARAGRAPHS IN THE MARRAKESH ACCORDS</b>		
<b>Information to be reported</b>	<b>Detailed information</b>	<b>Reference in Marakesh Accords<sup>39</sup></b>
<b>Land related information</b>		
Approach for geographical location and identification of units of land	<i>The geographical location of the boundaries of the areas that encompass:</i> <i>(i) Units of land subject to activities under Article 3, paragraph 3;</i> <i>(ii) Units of land subject to activities under Article 3, paragraph 3, which would otherwise be included in land subject to elected activities under Article 3, paragraph 4, [...];</i> <i>(iii) Land subject to elected activities under Article 3, paragraph 4.</i>	6 (b)
Spatial assessment unit	<i>The spatial assessment unit used for determining the area of accounting for afforestation, reforestation and deforestation</i>	6 (c)
<b>Information on methods and approaches to estimate emissions and removals</b>		
Description of methodologies used	The emissions and removals should be estimated using methodologies given in the <i>IPCC Guidelines</i> as elaborated by this report, and using the principles as laid out in the draft decision -/CMP.1 (Land use, land-use change and forestry). The methodologies used should be reported with information on the reporting method for lands subject to Articles 3.3 and 3.4 (Reporting Method 1, 2 or a combination thereof), the approach(es) used for land identification, and the tier level(s) for estimating the emissions and removals. National approaches, models, parameters and other related information should be described transparently indicating how they improve the accuracy of the reporting. The assumptions and methodologies used for an inventory should be clearly explained to facilitate replication and assessment of the inventory by users of the report and taking into account the principles in paragraph 1, items (a), (b), (d), (g), (h) in the Marrakesh Accords, draft decision -/CMP.1 (Land use, land-use change and forestry), cf. document FCCC/CP/2001/13/Add.1, p.56.	see 6 (a)
Justification when omitting any carbon pool	<i>Information on which, if any, of the following pools: above-ground biomass, below-ground biomass, litter, dead wood 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 greenhouse gas emissions</i>	6 (e)
Information on indirect factors on greenhouse gas emissions and removals	<i>Information should also be provided which indicates whether or not anthropogenic greenhouse gas emissions by sources and removals by sinks from land use, land-use change and forestry activities under Article 3 paragraph 3 and elected activities under Article 3 paragraph 4 factor out removals from:</i> <i>(a) Elevated carbon dioxide concentrations above pre-industrial levels;</i> <i>(b) Indirect nitrogen deposition; and</i> <i>(c) The dynamic effects of age structure resulting from activities prior to 1 January 1990</i> (See Section 4.2.3.5.)	7
Changes in data and methods	Any changes in data or methodology since the report of the previous year, e.g., in the choice of methods, activity data collection method, activity data, difficulties of detection (e.g., distinction between harvesting and deforestation when estimating the D area), parameters used in the calculations should be reported in a transparent manner. The reporting should include information on whether these changes have been applied also to reporting on previous inventory years to ensure consistency of the time series.	10

<sup>39</sup> Entries in this column refer to relevant paragraphs in the Annex to draft decision -/CMP.1 (Article 7), contained in document FCCC/CP/2001/13/Add.3, pp.21-29. In the table not necessarily *all* relevant legal texts are referred to.

<b>TABLE 4.2.4b (CONTINUED)</b>		
<b>SUPPLEMENTARY INFORMATION TO BE REPORTED FOR THE ANNUAL GREENHOUSE GAS INVENTORY DURING THE FIRST COMMITMENT PERIOD ACCORDING TO THE MARRAKESH ACCORDS. TEXT IN ITALICS INDICATES A DIRECT QUOTE FROM THE RELEVANT PARAGRAPHS IN THE MARRAKESH ACCORDS</b>		
<b>Information to be reported</b>	<b>Detailed information</b>	<b>Reference in Marrakesh Accords<sup>40</sup></b>
Other generic methodological issues	Any additional relevant information on methodological issues, such as measurement intervals, disturbances, interannual variability (see Section 4.2.3)	
<b>Specific information for activities under Article 3, paragraphs 3 and 4</b>		
Article 3.3 specific information	<ul style="list-style-type: none"> <li>• <i>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;</i></li> <li>• <i>Information on how harvesting or forest disturbance that is followed by the re-establishment of a forest is distinguished from deforestation;</i></li> <li>• It is good practice to provide information on the size and geographical location of forest areas that have lost forest cover but which cannot be classified as deforested (and will therefore remain classified as forest with a re-assessment in the next inventory).</li> </ul>	8 (a)  8 (b)
Article 3.4 specific information	<i>A demonstration that activities under Article 3, paragraph 4, have occurred since 1 January 1990 and are human induced</i>	9 (a)
<b>Information related to the estimates of emissions by sources and removals by sinks (for reporting data, see Tables 4.2.5-4.2.6)</b>		
Estimates for greenhouse gas emissions by sources and removals by sinks	Estimates of greenhouse gas emissions by sources and removals by sinks for human-induced activities under Article 3, paragraphs 3, and, if any, elected activities under Article 3, paragraph 4, and for all geographical locations reported in the current and previous years, 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 must also be included.	see 6 (d)
	<i>[...] 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.[...]</i>	5
Afforestation and Reforestation	<i>Information on emissions and removals of greenhouse gases from lands harvested during the first commitment period following afforestation and reforestation on these units of land since 1990 consistent with the requirements under paragraph 4 of the annex to draft decision -/CMP.1 (Land use, land-use change and forestry).</i>	8 (c)
Cropland management, grazing land management and revegetation	Anthropogenic greenhouse gas emissions by sources and removals by sinks for <b>each year of the commitment period</b> and for the <b>base year</b> for each of the elected activities on the geographical locations identified, excluding emissions reported under the Agriculture sector of the <i>IPCC Guidelines</i> .	9 (b), and paragraph 9 of the annex to draft decision -/CMP.1 (LULUCF), FCCC/CP/2001/13/Add.1, p.59
Absence of overlap between 3.3 and 3.4 activities	<i>Information that demonstrates that emissions by sources and removals by sinks resulting from elected Article 3, paragraph 4, activities are not accounted for under activities under Article 3, paragraph 3.</i>	9 (c)
Uncertainty of emission and removal estimates	Estimates of emissions and removals <i>shall be within levels of confidence as elaborated by any IPCC good practice guidance adopted by the COP/MOP and in accordance with relevant decisions of the COP/MOP on land use, land-use change and forestry.</i>	6(d), footnote 5

<sup>40</sup> Entries in this column refer to relevant paragraphs in the Annex to draft decision -/CMP.1 (Article 7), contained in document FCCC/CP/2001/13/Add.3, pp.21-29. In the table not necessarily *all* relevant legal texts are referred to.

It is *good practice* to use coordinates as set out in Section 4.2.4.3.2 below for the reporting of the geographical location of the boundaries that encompass the units of land subject to activities under Article 3.3 and the lands subject to 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 4.2.5) to demonstrate that the Party has accounted for all areas where afforestation, reforestation and deforestation and, if elected, 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* to explain any changes in the total area over consecutive inventories.

It is *good practice* to use Tables 4.2.6a-c and Table 4.2.7 to submit annual estimates. For Article 3.3 and 3.4 activities (Tables 4.2.6a and 4.2.6b), data must be provided by geographical locations, whereas for projects (Table 4.2.6c) data must be filled in by project. The Marrakesh Accords also require that, in addition to the data for the actual inventory year, a Party also reports this information for the base year for cropland management, grazing land management, and revegetation. 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<sub>2</sub> emissions or removals. This conversion also involves sign change from the equations used to make the estimates. Non-CO<sub>2</sub> greenhouse gas emissions are to be reported as positive, as these represent increases in abundances in the atmosphere.

Table 4.2.7 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 if cropland management, grazing land management, and/or revegetation have been elected. This table summarises data of the compilation tables by activity across all carbon pools and across all strata within a country.

In addition to the data in the Tables 4.2.6a-c and 4.2.7, respectively, it is *good practice* to report the underlying assumptions and factors used for the calculation of the carbon stock changes and emissions of CH<sub>4</sub> and N<sub>2</sub>O, as well as for the calculation of the uncertainties. Such information can be obtained using the worksheets in Chapter 3 or from equivalent information supporting the estimates obtained using higher tiers or other methods.

The Marrakesh Accords contain a clause that carbon stock changes resulting from harvesting of afforestation/reforestation land during the first commitment period will not result in a debit greater than the credit previously accounted for that unit of land (see Table 4.2.4).<sup>41</sup> If such units of land exist for the inventory year, it is *good practice* to distinguish them from other afforestation/reforestation lands and to report them (and the associated carbon stock changes and non-CO<sub>2</sub> greenhouse gas emissions) separately in Tables 4.2.6 to 4.2.7. Although this is an issue related to accounting, it is mentioned here because inventory data are likely to be needed to implement the provision.

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. Estimates should be reported using tables generated following the model of Tables 4.2.6a, b and c. Separate tables should be reported for the base year when CM, GM and/or RV are elected. 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) reported in Tables 4.2.6a, b and c.

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<sup>41</sup> Paragraph 4 in the Annex to draft decision -/CMP.1 (Land use, land-use change and forestry), contained in document FCCC/CP/2001/13/Add.1, p.59.

<b>TABLE 4.2.5</b> <b>LAND TRANSITION MATRIX: LAND AREA (IN HA) SUBJECT TO THE VARIOUS ACTIVITIES IN THE INVENTORY YEAR AND THE PREVIOUS YEAR</b>										
Note that some of the transitions in the matrix may not be possible (e.g., once land has become subject to A, R, or D, it cannot become subject to FM, CM, GM, or RV in the next year)										
<b>INVENTORY YEAR:</b>										
	<b>Land in inventory year by activity</b>									
		A	R	D	FM if elected	CM if elected	GM if elected	RV if elected	Other	Total
<b>Land in year prior to inventory by activity</b>	A									
	R									
	D									
	FM if elected									
	CM if elected									
	GM if elected									
	RV if elected									
	Other									
	Total									

**TABLE 4.2.6a**

**TABLE FOR REPORTING, FOR THE INVENTORY YEAR, CARBON STOCK CHANGES AND NON-CO<sub>2</sub> EMISSIONS BY SOURCES AND REMOVALS BY SINKS FOR EACH OF THE FOLLOWING ACTIVITIES / LANDS: (I) A AND R<sup>1</sup> NOT HARVESTED DURING THE FIRST COMMITMENT PERIOD; (II) A AND R<sup>1,2</sup> HARVESTED DURING THE FIRST COMMITMENT PERIOD; (III) A AND R<sup>1</sup> THAT ARE ALSO SUBJECT TO ELECTED ARTICLE 3.4 ACTIVITIES<sup>3</sup>; (IV) D; (V) D THAT IS ALSO TO SUBJECT TO ELECTED ARTICLE 3.4 ACTIVITIES<sup>3</sup>; AND (VI) FM IF ELECTED. (I) PLUS (II) EQUALS ALL A AND R LANDS. (IV) EQUALS ALL D LANDS. (I) PLUS (II) PLUS (IV) EQUALS ALL A, R, AND D LANDS (ARTICLE 3.3). (VI) MUST NOT INCLUDE ANY A, R, OR D (ARTICLE 3.3) LANDS. (III) AND (V) ARE PROVIDED ONLY FOR INFORMATION PURPOSES<sup>4</sup>.**

**Activity:**

**Inventory year:**

Geographical Location <sup>5</sup>		Area of Activity	Increases (+) and Decreases (-) in Carbon Stock <sup>6</sup>					Total Carbon Stock Changes <sup>7</sup>	Emissions (+) or Removals (-) from Carbon Stock Changes <sup>8</sup>	CH <sub>4</sub> Emissions	N <sub>2</sub> O Emissions
			Above ground biomass	Below ground biomass	Litter	Dead wood	Soil				
Serial No.	ID <sup>9</sup>	(ha)	(Gg C/yr)	(Gg C/yr)	(Gg C/yr)	(Gg C/yr)	(Gg C/yr)	(Gg CO <sub>2</sub> e/yr)	(Gg/yr)	(Gg/yr)	
1											
2											
3											
...											
N											
<b>Total for the activity</b>											

Note that those countries that use Tier 1 or Tier 2 methods that allow separate reporting of increases (such as growth) and decreases (such as harvesting) of a pool should also do so by appropriately expanding the table. In these cases, the net stock changes should also be reported, and these are subsequently used for the calculation of the total stock changes.

<sup>1</sup> As afforestation (A) and reforestation (R) activities are treated in the same way, they can be reported together. The separation of afforestation and reforestation lands that are harvested from those that are not harvested during the first commitment period is necessary because of the requirement set in paragraph 4 in the Annex to draft decision -/CMP.1 (Land use, land-use change and forestry), cf. FCCC/CP/2001/13/Add.1, p.59.

<sup>2</sup> If A and R lands have been harvested in the inventory year, then special carbon accounting rules apply that allow countries to limit debits from harvesting. This requires the tracking of “credits” earned on these lands in previous inventory years or commitment periods.

<sup>3</sup> Units of land subject to activities under Article 3.3 which would otherwise be included in land subject to elected activities under Article 3.4 must be reported (cf. paragraph 6 item (b) (ii) in the Annex to draft decision -/CMP.1 (Article 7), contained in FCCC/CP/2001/13/Add 3, p.22).

<sup>4</sup> See paragraph 6, in particular 6 (b), of the Annex to draft decision -/CMP.1 (Article 7), contained in FCCC/CP/2001/13/Add 3, p.22.

<sup>5</sup> Geographical location refers to the areas that encompass units of land subject to Article 3.3 and lands subject to Article 3.4 activities.

<sup>6</sup> If a pool is not reported, the text “NR” (for “not reported”) must be entered, and it must be demonstrated that the pool is not a source.

<sup>7</sup> “Total carbon stock changes” is the sum of carbon stock changes of all five pools.

<sup>8</sup> Emissions/Removals are calculated by multiplying total carbon stock changes by 44/12 to convert to CO<sub>2</sub> followed by reversing the sign to follow conventions of emissions/removals reporting.

<sup>9</sup> ID: unique identifier of the geographic location.

TABLE 4.2.6b

TABLE FOR REPORTING, FOR THE INVENTORY YEAR, CARBON STOCK CHANGES AND NON-CO<sub>2</sub> EMISSIONS BY SOURCES AND REMOVALS BY SINKS FOR EACH OF THE FOLLOWING ARTICLE 3.4 ACTIVITIES/LANDS: (I) CM; (II) GM; (III) RV. SEPARATE TABLES (OR SEPARATE ROWS IN ONE TABLE) SHOULD BE USED TO REPORT THOSE ACTIVITIES THAT OCCUR ON MINERAL SOILS AND ON ORGANIC SOILS. THE COLUMN "LIMING CO<sub>2</sub> EMISSIONS" IS TO BE FILLED FOR GEOGRAPHICAL LOCATIONS WHERE THESE EMISSIONS APPLY. (SEE SECTIONS 4.2.8 AND 4.2.9 FOR DETAILS.)

THESE TABLES SHOULD ALSO BE PROVIDED FOR THE BASE YEAR

Activity:

Inventory year:

Geographical Location <sup>1</sup>		Area of Activity	Increases (+) and Decreases (-) in Carbon Stock <sup>2</sup>					Total Carbon Stock Changes <sup>3</sup>	Emissions (+) or Removals (-) from Carbon Stock Changes <sup>4</sup>	Liming CO <sub>2</sub> emissions	CH <sub>4</sub> Emissions <sup>5</sup>	N <sub>2</sub> O Emissions <sup>5</sup>
			Above ground biomass	Below ground biomass	Litter	Dead wood	Soil					
Serial No.	ID <sup>6</sup>	(ha)	(Gg C/yr)	(Gg C/yr)	(Gg C/yr)	(Gg C/yr)	(Gg C/yr)	(Gg C/yr)	(Gg CO <sub>2</sub> e/yr)	(Gg CO <sub>2</sub> e/yr)	(Gg/yr)	(Gg/yr)
1												
2												
3												
...												
N												
<b>Total for the activity</b>												

<sup>1</sup> Geographical location refers to the areas that encompass lands subject to Article 3.4 activities.

<sup>2</sup> If a pool is not reported, the text "NR" (for "not reported") should be entered, and it must be demonstrated that the pool is not a source.

<sup>3</sup> "Total carbon stock changes" are the sum of carbon stock changes of all five pools.

<sup>4</sup> Emissions/Removals are calculated by multiplying total carbon stock changes by 44/12 to convert to CO<sub>2</sub> followed by reversing the sign to follow conventions of emissions/removals reporting.

<sup>5</sup> For CM, GM and RV, if elected, methane and nitrous oxide emissions are reported here for transparency purposes only. They are reported and accounted along with the Kyoto Protocol Annex A sources in the Agriculture sector.

<sup>6</sup> ID: unique identifier of the geographic location.

**TABLE 4.2.6c**

**TABLE FOR REPORTING, FOR THE INVENTORY YEAR, CARBON STOCK CHANGES AND NON-CO<sub>2</sub> EMISSIONS BY SOURCES AND REMOVALS BY SINKS FOR PROJECTS UNDER ARTICLE 6.  
A COPY OF THIS TABLE MUST BE PROVIDED FOR EACH TYPE OF ACTIVITY.**

**Project activity:**

**Inventory year:**

Serial number	Project ID <sup>1</sup>	Area of Project	Increases (+) and Decreases (-) in Carbon Stock <sup>2</sup>					Total Carbon Stock Changes <sup>3</sup>	Emissions (+) or Removals (-) from Carbon Stock Changes <sup>4</sup>	CH <sub>4</sub> Emissions	N <sub>2</sub> O Emissions
			Above ground biomass	Below ground biomass	Litter	Dead wood	Soil				
		(ha)	(Gg C/yr)	(Gg C/yr)	(Gg C/yr)	(Gg C/yr)	(Gg C/yr)	(Gg C/yr)	(Gg CO <sub>2</sub> e/yr)	(Gg/yr)	(Gg/yr)
1											
2											
3											
...											
N											
<b>Total for the activity</b>											

<sup>1</sup> Project ID is a unique identifier of the project.

<sup>2</sup> If a pool is not reported, the text “NR” (for “not reported”) must be entered, and it must be demonstrated that the pool is not a source.

<sup>3</sup> “Total carbon stock changes” is the sum of carbon stock changes of all five pools if temporary plots are used, but if permanent plots are used, the change in stock in each component should be summed by plot and the mean and confidence intervals be computed across all plots. See Section 4.3 for details.

<sup>4</sup> Emissions/Removals are calculated by multiplying total carbon stock changes by 44/12 to convert to CO<sub>2</sub> followed by reversing the sign to follow conventions of emissions/removals reporting.

<b>TABLE 4.2.7</b>				
<b>SUMMARY TABLE OF GREENHOUSE GAS EMISSIONS BY SOURCES AND REMOVALS BY SINKS BY ARTICLES 3.3, 3.4 AND 6 ACTIVITIES FOR THE INVENTORY YEAR. NOTE THAT EMISSIONS ARE TO BE REPORTED BY PROPERLY APPLYING ONE OF TWO REPORTING METHODS DETAILED IN SECTION 4.2.2.2.</b>				
<b>Inventory year:</b>				
Activity	Areas	CO <sub>2</sub> Emissions (+) or Removals (-)	CH <sub>4</sub> <sup>4</sup>	N <sub>2</sub> O <sup>4</sup>
	(ha)	(Gg CO <sub>2</sub> e/yr)	(Gg/yr)	(Gg/yr)
<b>A and R not harvested during the first commitment period<sup>1</sup></b>				
<b>A and R harvested during the first commitment period<sup>1</sup></b>				
<b>A and R that is also to subject to elected Article 3.4 activities<sup>1,6</sup></b>				
<b>D</b>				
<b>D that is also to subject to elected Article 3.4 activities<sup>6</sup></b>				
<b>Article 3.4 FM if elected</b>				
<b>Article 3.4 CM if elected<sup>2</sup></b>	<b>Mineral Soils<sup>5</sup></b>			
	<b>Organic Soils<sup>5</sup></b>			
	<b>Liming</b>			
<b>Article 3.4 GM if elected<sup>2</sup></b>	<b>Mineral Soils<sup>5</sup></b>			
	<b>Organic Soils<sup>5</sup></b>			
	<b>Liming</b>			
<b>Article 3.4 RV if elected<sup>2</sup></b>	<b>Mineral Soils<sup>5</sup></b>			
	<b>Organic Soils<sup>5</sup></b>			
	<b>Liming</b>			
<b>Article 6 A and R activities<sup>3</sup></b>				
<b>Article 6 FM activities<sup>3</sup></b>				
<b>Article 6 CM activities<sup>3</sup></b>				
<b>Article 6 GM activities<sup>3</sup></b>				
<b>Article 6 RV activities<sup>3</sup></b>				

<sup>1</sup> As afforestation (A) and reforestation (R) activities are treated the same way, they can be reported together. The separation of afforestation and reforestation lands that are harvested from those that are not harvested during the first commitment period is necessary because of the requirement set in paragraph 4 in the Annex to draft decision -/CMP.1 (Land use, land-use change and forestry), cf. FCCC/CP/2001/13/Add.1, p.59.

<sup>2</sup> If CM, GM and/or RV is elected, a copy of this table should be completed and reported for the base year.

<sup>3</sup> Emissions and removals related to Article 6 projects hosted by the reporting Party, if any, should be reported in the final five rows, recognizing that they are already implicitly included in the national estimates of activities under Articles 3.3 and 3.4 reported in this table. Double counting will be avoided at the accounting stage when converting Removal Units into Emission Reduction Units.

<sup>4</sup> For Article 3.4 CM, GM and RV, if elected, methane and nitrous oxide emissions are reported here for transparency purposes only. They are reported and accounted along with the Kyoto Protocol Annex A sources in the Agriculture sector.

<sup>5</sup> The headings “Mineral soils” and “Organic Soils” follow the breakdown by sources and sinks in the CM, GM and RV sections of Chapter 4. It should include all C pools, if applicable (i.e., shelterbelts...), occurring on croplands, grazing lands or revegetation lands with mineral and organic soils, respectively and should be equal, for each activity, to the total of the column “Total changes in carbon stocks” of Table 4.2.6b.

<sup>6</sup> Afforestation (A), reforestation (R) and deforestation (D) lands, which are also subject to elected Article 3.4 activities, are already included in the A/R and D totals.



#### 4.2.4.3.2 DOCUMENTATION

Documentation requirements under the Kyoto Protocol are outlined in the Marrakesh Accords as part of the description of the requirements for inventory management.<sup>42</sup>

It is *good practice* to document and archive all information, i.e., 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 should be provided for both steps: the identification of land and the assessment of carbon stock changes and the emissions of non-CO<sub>2</sub> greenhouse gases.

Documentation should also include information about uncertainty assessment (see also Section 4.2.4.2 Uncertainty Assessment), QA/QC procedures, external and internal reviews, verification activities and key category identification (see Chapter 5, Cross-cutting Issues).

#### Activities definition and identification

It is *good practice* to explain how the Marrakesh Accords definitions 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 forest management in the Kyoto reporting, the criteria that are used to distinguish forests under “forest management” from “managed forests” should be provided. Differences between croplands (or grasslands) in the UNFCCC greenhouse gas inventory and lands undergoing cropland management (or grazing land management) under the Kyoto reporting should also be documented.

#### Data documentation

In particular 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 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.

The documentation of estimates of greenhouse gas emissions and removals must 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);
- 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

The methods should be documented with the following information:

- Choice of reporting methods for lands subject to Articles 3.3 and 3.4 (Reporting Method 1, 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, and units of land; 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<sub>2</sub> greenhouse gas emissions and magnitudes of the corresponding uncertainties;

<sup>42</sup> Paragraph 16 (a) in the Annex to the draft decision -/CMP.1 (Article 5.1), contained in FCCC/CP/2001/13/Add.3, p.9.

- Choice of activity data;
- 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: description of, or references to, the scientific basis for the models used, 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 fluctuations**

It is *good practice* to explain significant fluctuations in reported emissions or removals between years. 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, Section 5.6 Time series consistency and recalculations).

#### **4.2.4.4 QUALITY ASSURANCE AND QUALITY CONTROL**

It is *good practice* to implement quality control checks as outlined in Chapter 5, Section 5.5 (Quality Assurance and Quality Control) on category-specific QC Procedures, and expert review of the emission estimates. Additional quality control checks as outlined in Tier 2 procedures in Section 5.5 and quality assurance procedures may also be applicable, particularly if higher-tier methods are used to estimate carbon stock changes and non-CO<sub>2</sub> greenhouse gas emissions. A detailed treatment of inventory QA/QC for field measurement is described in Appendix 4A.3 of the *GPG2000*.

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 agency 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.

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 Chapters 2 and 3 (using the LU/LUC matrix).

#### **4.2.4.5 VERIFICATION**

*Good practice guidance* for verification is given in Chapter 5, Section 5.7 (Verification).