5.4 METHODOLOGICAL CHOICE - IDENTIFICATION OF KEY CATEGORIES

5.4.1 Introduction

This chapter addresses how to identify *key categories* [5] in a national inventory including LULUCF. Methodological choice for individual source and sink categories is important in managing overall inventory uncertainty. In the decision trees in Chapters 3 and 4 of this report, specific guidance is given for each category and each activity under Articles 3.3 and 3.4 of the Kyoto Protocol using the concept of key categories. Generally, inventory uncertainty is lower when emissions and removals are estimated using a higher tier. However, these generally require extensive resources for data collection, so it may not be feasible to use higher tier methods for every category of emissions and removals. It is therefore *good practice* to make the most efficient use of available resources by identifying those categories that have the greatest contribution to overall inventory uncertainty. By identifying these *key categories* in the national inventory, inventory agencies can prioritise their efforts and improve their overall estimates. It is *good practice* for each inventory agency to identify its national *key categories* in a systematic and objective manner. Such a process will lead to improved inventory quality, as well as greater confidence in the emission estimates that are developed.

Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories (*GPG2000,* IPCC, 2000) identifies a *key source category* as "one that is prioritised within the national inventory system because its estimate has a significant influence on a country's total inventory of direct greenhouse gases in terms of the absolute level of emissions, the trend in emissions, or both". The concept of key sources was originally derived for emissions excluding the LULUCF sector and as implemented in *GPG2000* has enabled countries to identify those source categories that should be estimated using higher tiers if sufficient resources are available. In this report, the definition is expanded to also cover LULUCF emissions by sources and removals by sinks. In this document *whenever the term key category is used, it includes both sources and sinks*. The inclusion of the LULUCF categories in the key category analysis facilitates the determination of priorities across all sectors of the national inventory and, where relevant, for Kyoto Protocol supplementary information as well.

Any inventory agency that has prepared a national greenhouse gas inventory will be able to identify *key categories* in terms of their contribution to the absolute level of national emissions. For those inventory agencies that have prepared a time series, the quantitative determination of *key categories* should include evaluation of both the absolute level and the trend of emissions and removals. Some *key categories* may only be identified when their influence on the trend of the national inventory is taken into account.

The quantitative approaches to determine *key categories* are described in Section 5.4.2 (Quantitative Approaches to Determining Key Categories). Both a basic Tier 1 approach and a Tier 2 approach, which takes uncertainties into account, are described. In addition to making a quantitative determination of *key categories,* it is *good practice* to consider qualitative criteria, particularly when a Tier 1 assessment is performed or lower tier estimation methods are used. These qualitative criteria are described in Section 5.4.3 (Qualitative Considerations). The *good practice guidance* provided in Sections 5.4.2 and 5.4.3 is applicable to the full inventory of emissions and removals. For estimates prepared under Articles 3.3 and 3.4 of the Kyoto Protocol, there are additional considerations as described in Section 5.4.4. The guidance on the application of results is given in 5.4.5. The derivation of thresholds for the Tier 1 level and trend assessments taking the LULUCF sector into account is described in Section 5.4.7. Finally, Section 5.4.8 gives an example of the application of the Tier 1 key category analysis.

5.4.2 Quantitative Approaches to Determining Key Categories

[5] In *GPG2000* the concept was named "key source categories" and dealt with the inventory excluding the LULUCF sector. However, because an inventory including the LULUCF sector can consist of both emissions and removals, the term "key category" is used here to better reflect that both sources and sinks are included. In the context of the UNFCCC inventory, categories are land-use categories as described Table 3.1.1 in Chapter 3. In the context of the Kyoto Protocol, each activity under Articles 3.3 and 3.4 (if elected) is a category.

In each country's national inventory, certain categories are particularly significant in terms of their contribution to the overall uncertainty in the inventory. It is important to identify these *key categories* so that resources available for inventory preparation may be prioritised and the best possible estimates prepared.

Two tiers for performing the key category analysis are described, consistent with the two-tiered quantitative approach to identify key source categories described in Chapter 7 (Methodological Choice and Recalculations) of *GPG2000*. In the sections below, this approach is adapted to allow the incorporation of LULUCF categories. The approach adapted for integrating the LULUCF categories is designed to address three objectives: (i) to enable continued assessment of key source categories without LULUCF (as is described in *GPG2000*); (ii) to assess the relative importance of LULUCF categories by integrating them into the overall key category analysis; and (iii) to be consistent with guidance and decisions of the Conference of the Parties to the UNFCCC and the Kyoto Protocol regarding the identification of key categories.

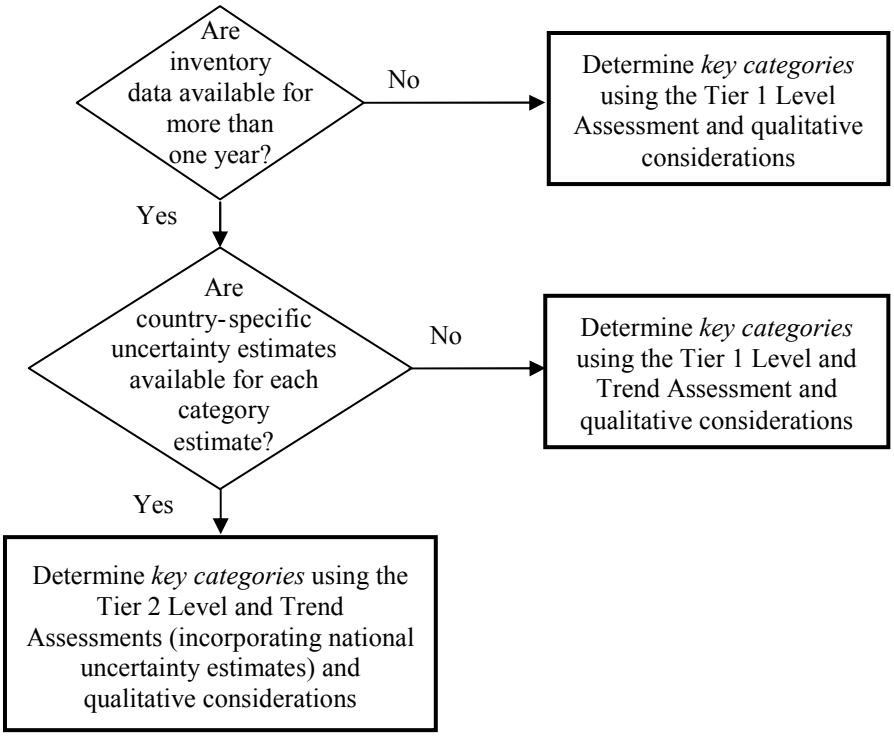
With these objectives in mind, the key quantitative category analysis should be performed as follows:

(i) The key (source) categories should first be identified for the inventory excluding LULUCF (i.e., key categories should be identified for the energy, industrial processes, solvent and other product use, agriculture, and waste sectors) following the guidance in *GPG2000*, Chapter 7 (Methodological Choice and Recalculation).

(ii) The key category analysis then should be repeated for the full inventory including the LULUCF categories. It is possible that some non-LULUCF categories identified as key in the first analysis will not appear as key when the LULUCF categories are included. In this case, these categories should still be considered as key. In a few cases, in countries with small net LULUCF emissions or removals, the integrated analysis may identify additional non-LULUCF categories as key. In this situation, the analysis performed for the non-LULUCF sectors should be used to identify the key categories in those sectors, and the additional non-LULUCF categories identified in the combined analysis should not be considered as key.

Any agency that has developed an essentially complete greenhouse gas inventory can perform a Tier 1 Level Assessment to identify key source or sink categories for the overall emission level. Those inventory agencies that have developed emission inventories for more than one year will also be able to perform a Tier 1 Trend Assessment to identify key categories that influence the trend in emissions. If national category uncertainties or parameter uncertainties are available, inventory agencies can use Tier 2 to identify *key categories.* The Tier 2 approach is more detailed than the Tier 1 and is likely to reduce the number of *key categories* identified. The Tier 2 approach may also take into account a higher complexity, for example assessing key activity data and estimation parameters separately. If both Tier 1 and Tier 2 analysis have been performed it is *good practice* to use the results of the Tier 2 analysis.

Figure 5.4.1 Decision tree to identify key categories of sources and sinks



The decision tree in Figure 5.4.1 shown above illustrates how inventory agencies can determine which approach to use for the identification of *key categories*. This figure was modified from the Figure 7.1 in Chapter 7 of *GPG2000* to make it applicable to the LULUCF sector.

AGGREGATION LEVEL

The results of the analysis of key categories will be most useful if the analysis is done at the appropriate level of detail. For the LULUCF sector, the recommended level of analysis is the level of category nomenclature used in Chapter 3, which is listed in Table 5.4.1 along with "special considerations" which provide additional information on the key category analysis for various categories. Table 5.4.1 is adapted from Table 7.1 from Chapter 7 of *GPG2000* to include the categories of the LULUCF sector. It is reprinted with all source categories and sectors included so as to facilitate the development of an integrated key category analysis. Each suggested category for LULUCF activities in Table 5.4.1 comprises several subcategories and it is *good practice* to further evaluate the significance of these subcategories for purposes of choosing appropriate methods and prioritising resources. Following guidance provided in *GPG2000*, it is *good practice* to identify subcategories as key if they account for 25-30 percent of the overall emissions or removals of the category. Table 3.1.3 in Chapter 3 lists the subcategories associated with each category given in Table 3.1.1 in Chapter 3 for purposes of this analysis. For example, carbon stock changes in soil and biomass can be distinguished within the "forest land remaining forest land" category. If a country prepares its estimates following the LUCF categories from the *IPCC Guidelines*, they can map their estimates onto the categories listed in Table 5.4.1 by following the guidance given by Table 3.1.1 in Section 3.1.2 and details in the respective sections of Chapter 3.

Countries may choose to perform the quantitative analysis at a more detailed level. In this case possible correlations should be taken into account (see the Tier 2 approach for uncertainty assessments described in Section 5.2, Identifying and Quantifying Uncertainties). The assumptions about such correlations should be the same when assessing uncertainties and identifying *key categories*. Table 5.4.1 indicates subcategories that can be distinguished without the need to take correlations into account.

If data are available, the analysis can be performed for emissions and removals separately within a given category. If this is not feasible it is important to apply the qualitative criteria to identify key categories in situations where emissions and removals cancel or almost cancel. See Section 5.4.3 for qualitative considerations.

TABLE 5.4.1
SUGGESTED IPCC SOURCE/SINK CATEGORIES FOR LULUCF AND NON-LULUCF [a]

Source/Sink Categories to be Assessed in Key Category Analysis	Special Considerations
LULUCF	
Forest land remaining forest land	Assess key categories separately for CO_2, CH_4 and N_2O. If the category is key, assess the significance of subcategories by identifying those that contribute 25-30% to the total level of emissions or removals from the category. For information on the subcategories associated with each category, see Table 3.1.1 and 3.1.3 in Chapter 3.
Croplands remaining croplands	
Grassland remaining grassland	
Wetland remaining wetland	
Settlements remaining settlements	
Conversion to forest land	
Conversion to cropland	In addition to the guidance above, assess the impact of all deforestation occurring within the country according to the qualitative guidance provided in the sixth bullet Section 5.4.3.
Conversion to grassland	
Conversion to wetland [b]	
Conversion to settlements	
Conversion to other land	
ENERGY	
CO_2 Emissions from Stationary Combustion	Disaggregate to the level where emission factors are distinguished. In most inventories, this will be the main fuel types. If emission factors are determined independently for some subsource categories, these should be distinguished in the analysis.
Non-CO_2 Emissions from Stationary Combustion	Assess CH_4 and N_2O separately.
Mobile Combustion: Road Vehicles	Assess CO_2, CH_4 and N_2O separately.

TABLE 5.4.1 (Continued)
SUGGESTED IPCC SOURCE/SINK CATEGORIES FOR LULUCF AND NON-LULUCF [a]

Mobile Combustion: Water-borne Navigation	Assess CO_2, CH_4 and N_2O separately.
Mobile Combustion: Aircraft	Assess CO_2, CH_4 and N_2O separately.
Fugitive Emissions from Coal Mining and Handling	If this source is key, it is likely that underground mining will be the most significant subsource category.
Fugitive Emissions from Oil and Gas Operations	This source category comprises several subsource categories which may be significant. Inventory agencies should assess this source category, if it is key, to determine which subsource categories are most important.
INDUSTRIAL PROCESSES	
CO_2 Emissions from Cement Production	
CO_2 Emissions from Lime Production	
CO_2 Emissions from the Iron and Steel Industry	
N_2O Emissions from Adipic Acid and Nitric Acid Production	Assess adipic acid and nitric acid separately.
PFC Emissions from Aluminium Production	
Sulfur hexafluoride (SF_6) from Magnesium Production	
SF_6 Emissions from Electrical Equipment	
SF_6 Emissions from Other Sources of SF_6	
SF_6 Emissions from Production of SF_6	
PFC, HFC, SF_6 Emissions from Semiconductor Manufacturing	Assess emissions from all compounds jointly on a GWP-weighted basis, since they are all used in similar fashions in the process.
Emissions from Substitutes for Ozone Depleting Substances (ODS Substitutes)	Assess emissions from all HFCs and PFCs used as substitutes for ODS jointly on a GWP-weighted basis, given the importance of having a consistent method for all ODS sources.
HFC-23 Emissions from HCFC-22 Manufacture	
AGRICULTURE	
CH_4 Emissions from Enteric Fermentation in Domestic Livestock	If this source category is key, it is likely that cattle, buffalo and sheep will be the most significant subsource categories.
CH_4 Emissions from Manure Management	If this source category is key, it is likely that cattle and swine will be the most significant subsource categories.
N_2O Emissions from Manure Management	
CH_4 and N_2O Emissions from Savanna Burning	Assess CH_4 and N_2O separately.
CH_4 and N_2O Emissions from Agricultural Residue Burning	Assess CH_4 and N_2O separately.
Direct N_2O Emissions from Agricultural Soils	
Indirect N_2O Emissions from Nitrogen Used in Agriculture	
CH_4 Emissions from Rice Production	
WASTE	
CH_4 Emissions from Solid Waste Disposal Sites	
Emissions from Wastewater Handling	Assess CH4 and N_2O separately.
Emissions from Waste Incineration	Assess CO_2 and N_2O separately.
OTHER	Other sources of direct greenhouse gas emissions not listed above should also be included, if possible.

[a] In some cases, inventory agencies modify this list of IPCC source categories to reflect particular national circumstances.
[b] Reservoirs can be distinguished in the analysis.

The analysis can be performed using CO_2-equivalent emissions calculated using global warming potentials (GWP) specified in *the Guidelines for the preparation of national communications by Parties included in Annex I to the Convention, Part I: UNFCCC reporting guidelines on annual inventories* (*UNFCCC Guidelines*) and the Annex to the Kyoto Protocol[6]. Each greenhouse gas from each source and sink category should be considered separately, unless there are specific methodological reasons for treating gases collectively. In the LULUCF sector, for example, estimates will be prepared for emissions or removals of CO_2, N_2O and CH_4. The key category evaluation should be performed for each of these gases separately because the methods, emission factors and related parameters differ for each gas.

5.4.2.1 TIER 1 METHOD TO IDENTIFY KEY CATEGORIES OF SOURCES AND SINKS

The Tier 1 method to identify key categories assesses the influence of various categories of sources and sinks on the *level*, and possibly the *trend*, of the national greenhouse gas inventory. When the national inventory estimates are available for several years, it is *good practice* to assess the contribution of each category to both the level and trend of the national inventory. If only a single year's inventory is available, a Level Assessment should be performed.

The Tier 1 method can be readily completed using a spreadsheet analysis. Tables 5.4.2 and 5.4.3 illustrate the format of the analysis. Separate spreadsheets are suggested for the Level and Trend Assessments because it is necessary to sort the results of the analysis according to two different columns, and the output of the sorting process is more difficult to track if the analyses are combined in the same table. Both tables use a format similar to that described in Chapter 6 of *GPG2000* (IPCC, 2000), Quantifying Uncertainties in Practice. Section 5.4.8 illustrates the application of the Tier 1 approach.

LEVEL ASSESSMENT

The contribution of each source or sink category to the total national inventory level is calculated according to Equation 5.4.1:

EQUATION 5.4.1
LEVEL ASSESSMENT (TIER 1)

$$\text{Key Category Level Assessment} = |\text{Source or Sink Category Estimate}| / \text{Total Contribution}$$

$$L_{x,t}^{*} = E_{x,t}^{*} / E_{t}^{*}$$

Where:

$L_{x,t}^{*}$ = level assessment for source or sink *x* in year *t*. The asterisk (*) indicates that contributions from all categories (including LULUCF categories) are entered as absolute values.

$E_{x,t}^{*} = |E_{x,t}|$: absolute value of emission or removal estimate of source or sink category *x* in year *t*

$E_{t}^{*} = \sum_{x} |E_{x,t}|$: total contribution, which is the sum of the absolute values of emissions and removals in year *t*. The asterisk (*) indicates that contributions from all categories (including LULUCF categories) enter as absolute values.

Because both emissions and removals are entered with positive sign[7], the Total Contribution may be larger than a country's total emissions less removals.[8]

Table 5.4.2 outlines a spreadsheet that can be used for the Level Assessment. This spreadsheet is to be applied *in addition* to the assessment for non-LULUCF sources, as described in *GPG2000,* Table 7.2 in Chapter 7

[6] The methodology is also generally applicable using other weighting schemes, but the threshold for the Tier 1 analysis was derived based on the GWP concept and may be different under other weighting schemes.

[7] Removals are entered with absolute values to avoid an oscillating cumulative value $L_{x,t}$ as could be the case if removals were entered with negative signs, and thus to facilitate straightforward interpretation of the quantitative analysis.

[8] This equation can be used in any situation, regardless of whether the national greenhouse gas inventory is a net source (as is most common) or a net sink.

(Methodological Choice and Recalculation). Section 5.4.8 provides an example of the application of the Tier 1 method.

TABLE 5.4.2
SPREADSHEET FOR THE TIER 1 ANALYSIS – LEVEL ASSESSMENT INCLUDING LULUCF CATEGORIES

A	B	C	D	E
IPCC Source/Sink Categories	**Direct Greenhouse Gas**	**Base or Current Year Estimate of Emissions or Removals (absolute value)**	**Level Assessment with LULUCF, from column C**	**Cumulative Total of Column D**
Total				

Where:

Column A : list of IPCC categories of sources and sinks (see Table 5.4.1)

Column B : direct greenhouse gas

Column C : base year or current year emissions or removals of each greenhouse gas, in CO_2-equivalent units. Removal estimates entered with absolute values (positive signs)

Column D : level assessment with LULUCF from column C, following Equation 5.4.1

Column E : cumulative total of Column D

In the table, the calculations necessary for the Level Assessment are computed in Column D, following Equation 5.4.1. Thus, the value of the Level Assessment including LULUCF should be entered in column D for each category. All entries in Column D should be positive because absolute values of sinks are entered for removal estimates in Column C. The sum of all entries in Column D is entered in the total line of this table (note that this total will not be the total net emission (or net removal)). Once the entries in Column D are computed, the categories should be sorted in descending order of magnitude and the cumulative total summed in Column E. Key categories including LULUCF are those that, when summed together in descending order of magnitude, add up to 95 % of the total in Column D. The rationale for the choice of threshold for the Tier 1 method is explained in the Section 5.4.7. The method builds on *GPG2000* and Rypdal and Flugsrud (2001). It is also *good practice* to examine categories identified between the 95 and 97 % threshold carefully with respect to the qualitative criteria (see Section 5.4.3).

The Level Assessment should be performed for all years for which inventory estimates are available. If previous inventory estimates have not changed, there is no need to recalculate the previous years' analysis. If any estimates have changed or been recalculated, however, the analysis for that year should be updated. Any category that meets the threshold in any year should be identified as a key category.

TREND ASSESSMENT

The contribution of each source or sink category to the trend in the total inventory can be assessed if more than one year of inventory data are available, according to Equation 5.4.2.

EQUATION 5.4.2[9]
TREND ASSESSMENT (TIER 1)

Source or Sink Category Trend Assessment =
(Source or Sink Category Level Assessment) • | (Source or Sink Category Trend – Total Trend) |

$$T_{x,t}^{*} = E_{x,t}^{*} / E_t \bullet \left| [(E_{x,t} - E_{x,0}) / E_{x,t}] - [(E_t - E_0) / E_t] \right|$$

Where:

$T_{x,t}^{*}$ = trend assessment, which is the contribution of the source or sink category trend to the overall inventory trend. The Trend Assessment is always recorded as an absolute value, i.e., a negative

[9] Norwegian Pollution Control Authority with Rypdal and Flugsrud (2001).

value is always recorded as the equivalent positive value. The asterisk (*) indicates that, in contrast to Equation 7.2, in Chapter 7 of the *GPG2000*, LULUCF sources and sinks can be evaluated using this equation.

$E_{x,t}^{*} = |E_{x,t}|$ absolute value of emission or removal estimate of source or sink category *x* in year *t*

$E_{x,t}$ and $E_{x,0}$ = real values of estimates of source or sink category *x* in years *t* and 0, respectively

E_t and E_0 = $\sum_x E_{x,t}$ and $\sum_x E_{x,0}$ total inventory estimates in years *t* and 0, respectively. E_t and E_0 differ from E_t^{*} and E_0^{*} in Equation 5.4.1 in that removals are *not* entered as absolute values.

The Source or Sink Category Trend is the change in the source or sink category emissions or removals over time, computed by subtracting the base year (year 0) estimate for source or sink category *x* from the current year (year *t*) estimate and dividing by the current year estimate.[10]

The Total Trend is the change in the total inventory emissions (or removals) over time, computed by subtracting the base year (year 0) estimate for the total inventory from the current year (year *t*) estimate and dividing by the current year estimate.

In circumstances where the current year emissions for a given category are zero, the expression may be reformulated to avoid zero in the denominator (Equation 5.4.3).[11]

EQUATION 5.4.3
TREND ASSESSMENT WITH ZERO CURRENT YEAR EMISSIONS [12]

$$T_{x,t}^{*} = | E_{x,0} / E_t |$$

The Trend Assessment will identify categories that have a different trend as compared to the trend of the overall inventory. As differences in trend are more significant for the overall inventory level for larger categories of emissions and removals (in absolute terms), the results of the trend difference (i.e., the category trend minus total trend) is multiplied by $| E_{x,t}^{*}| / E_t$ to provide appropriate weighting. Thus, key categories will be those where the category trend diverges from the total trend, weighted by the level of emissions or removals of the category.

Table 5.4.3 outlines a spreadsheet that can be used for the Trend Assessment. This spreadsheet is to be applied *in addition* to the assessment for non-LULUCF sources, as described in *GPG2000,* Chapter 7, Methodological Choice and Recalculation, Table 7.3. Section 5.4.8 provides and example of the application of the Tier 1 method.

TABLE 5.4.3
SPREADSHEET FOR THE TIER 1 ANALYSIS – TREND ASSESSMENT INCLUDING LULUCF CATEGORIES

A	B	C	D	E	F	G
IPCC Source/Sink Categories	**Direct Greenhouse Gas**	**Base Year Estimate**	**Current Year Estimate**	**Trend Assessment**	**% Contribution to Trend**	**Cumulative Total of Column F**
Total						

[10] Although it is common to look at growth rates in the form of $(E_t - E_0) / E_0$, where the growth rate is measured from an initial value in year 0, the functional form of Equation 7.2 in Chapter 7 of *GPG2000* has been designed to minimise occurrences of division by zero and to enable analysis of the importance of source categories with very low emissions in the base year (e.g., substitutes for ozone depleting substances).

[11] Although this equation was not shown in *GPG2000*, it is also generally applicable to non-LULUCF categories as it has been derived from Equation 5.4.2.

[12] This results applies when $E_{x,t}$=0 is inserted into Equation 5.4.2.

Where:

Column A : list of IPCC categories (see Table 5.4.1)

Column B : direct greenhouse gas

Column C : base year estimate of emissions or removals from the national inventory data, in CO_2-equivalent units. Sinks are entered with signed values (positive or negative values).

Column D : current year emissions estimate from the most recent national inventory data, in CO_2-equivalent units. Sinks are entered with signed values

Column E : trend assessment from Equation 5.4.2, recorded as an absolute value

Column F : percentage contribution to the total of assessments in column E

Column G : cumulative total of Column F, calculated after sorting the entries in Column F in descending order of magnitude

The LULUCF categories identified in this analysis should be considered key *in addition* to those identified in the analysis that does not include LULUCF emissions and removals. If additional non-LULUCF categories are identified as key when LULUCF is included in the analysis, these should not be initially considered key, but should be carefully examined using the qualitative considerations.

The entries in Columns A, B and either C or D should be identical to those used in the Table 5.4.2, Spreadsheet for the Tier 1 Analysis - Level Assessment. The base year estimate in Column C is always entered in the spreadsheet, while the current year estimate in Column D will depend on the year of analysis. The absolute value of $T_{x,t}$ should be entered in Column E for each category of sources and sinks, following Equation 5.4.2, and the sum of all the entries entered in the total line of the table.[13] The percentage contribution of each category to the total of Column E should be computed and entered in Column F. The categories (i.e., the rows of the table) should be sorted in descending order of magnitude, based on Column F. The cumulative total of Column F should then be computed in Column G. Key categories are those that, when summed together in descending order of magnitude, add up to more than 95 % of the total of Column E. An example of a Tier 1 analysis for the level and trend is given in Section 5.4.8.

5.4.2.2 TIER 2 METHOD TO IDENTIFY KEY CATEGORIES OF SOURCES AND SINKS

The more sophisticated Tier 2 approach to identify key categories of sources and sinks is based on the results of the uncertainty analysis described in Section 5.2 (Identifying and Quantifying Uncertainties) in this report, and in *GPG2000*, Chapter 6 (Quantifying Uncertainties in Practice). The Tier 2 approach is consistent with, but not required for, *good practice*. Inventory agencies are encouraged to use Tier 2 if possible, because it will provide additional insight into the reasons that particular categories are key and can assist in prioritising activities to improve inventory quality and reduce overall uncertainty. It should be recognized that because the Tier 1 is a simplified approach, the Tier 1 and Tier 2 approaches could result in a few differences in key categories. In such situations, the results of the Tier 2 approach should be utilized.

In particular, it is important to bear in mind that a LULUCF category can comprise large fluxes, and emissions and removals may cancel out. In a Tier 2 analysis it may be possible to make the assessment at the level of even more detailed sub-estimates. In this case correlations need to be evaluated and modeled when appropriate. When the analysis is based on Tier 1, these cases should be evaluated using the qualitative criteria as described in Section 5.4.3.

APPLICATION OF UNCERTAINTY ESTIMATES TO IDENTIFY KEY SOURCES AND SINKS CATEGORIES

The *key category* analysis may be enhanced by incorporating the national category uncertainty estimates developed in Section 5.2. Uncertainty estimates based on the Tier 1 approach described in Section 5.2 are sufficient for the purpose, but estimates based on the Tier 2 uncertainty assessment approach should be used if

[13] Unlike the Level Assessment, where all entries will be positive, in the Trend Assessment negative values will occur if emissions of the source category decline by more in percentage terms than emissions in the overall inventory, or grow by a smaller amount. In this analysis the negative and positive values are considered equivalent, and the absolute values of these are recorded in the table.

available. The category uncertainties are incorporated by weighting the Tier 1 Level and Trend Assessment results by the category's relative uncertainty. The key category equations are shown below.

LEVEL ASSESSMENT

Equation 5.4.4 describes the Tier 2 Level Assessment including uncertainty. The results of this assessment ($LU_{x,t}$) is identical to the results of quantifying uncertainties in practice, as shown in Column H of Table 6.1 of Chapter 6 of *GPG2000*. So if that table has been completed, it is not necessary to recalculate Equation 5.4.4.

EQUATION 5.4.4
LEVEL ASSESSMENT (TIER 2)

Level Assessment with Uncertainty = Tier 1 Level Assessment ● Relative Category Uncertainty

$$LU_{x,t} = L_{x,t} \bullet U_{x,t}$$

Where:

$LU_{x,t}$ = Level assessment with uncertainty

$L_{x,t}$ = computed as in Equation 5.4.1

$U_{x,t}$ = relative category uncertainty in year *t* calculated as described in Section 5.2. The relative uncertainty will always have a positive sign.

The key categories are identified by accounting for those that add up to 90 % of the total value of the total $LU_{x,t}$. This 90 % was the bases for the derivation of the threshold used in the Tier 1 analysis (see Section 5.4.7 and Rypdal and Flugsrud (2001)).

TREND ASSESSMENT

Equation 5.4.5 shows how the Tier 2 Trend Assessment can be expanded to include uncertainty.

EQUATION 5.4.5
TREND ASSESSMENT (TIER 2)

Trend Assessment with Uncertainty = Tier 1 Trend Assessment ● Relative Category Uncertainty

$$TU_{x,t} = T_{x,t} \bullet U_{x,t}$$

Where:

$TU_{x,t}$ = trend assessment with uncertainty

$T_{x,t}$ = trend assessment computed in Equation 5.4.2

$U_{x,t}$ = relative category uncertainty in year *t* calculated as described in Section 5.2. The relative uncertainty will always have a positive sign.

The key categories are identified by accounting for those that add up to 90 % of the total value of the total $TU_{x,t}$. This 90 % was the basis for the derivation of the threshold used in the Tier 1 analysis (see Section 5.4.7 and Rypdal and Flugsrud (2001)).

INCORPORATING MONTE CARLO ANALYSIS

In Section 5.2 (Identifying and Quantifying Uncertainties), Monte Carlo analysis is presented as the Tier 2 approach for quantitative uncertainty assessment. Whereas the Tier 1 uncertainty analysis is based on simplified assumptions to develop uncertainties for each category, Monte Carlo types of analyses can handle large uncertainties, complex probability density functions, correlations and complex emission estimation equations among other things. The output of the Tier 2 uncertainty analysis can be used directly in Equations 5.4.4 and 5.4.5. If uncertainties are asymmetrical, the larger difference between the mean and the confidence limit should be used.

Monte Carlo analysis or other statistical tools can also be used to perform a sensitivity analysis to directly identify the principal factors contributing to the overall uncertainty. Thus, a Monte Carlo or similar analysis can be a valuable tool for a key category analysis. The method can, for example, be used to analyze more disaggregated sources categories (by modelling correlations) and emission factors and activity data separately (to identify key parameters rather than key categories). The analysis of key parameters can be based on Equations

5.4.4 and 5.4.5 above, by compiling correlations coefficients between input and output (Morgan and Henrion, 1990) or on other appropriate techniques.

5.4.3 Qualitative Considerations

In some cases, the results of the Tier 1 or Tier 2 analysis of key categories may not identify all categories that should be prioritised in the inventory system. In *GPG2000*, a list of qualitative criteria was provided to address specific circumstances that could not be readily reflected in the quantitative assessment. These criteria should be applied to categories not identified in the quantitative analysis, and if additional categories are identified they can be added to the list of key categories.

The qualitative considerations identified in Chapter 7 of *GPG2000* have been refined slightly to reflect the LULUCF sector:

- Mitigation techniques and technologies: If emissions from a category are being reduced or removals increased through the use of climate change mitigation techniques, it is *good practice* to identify these categories as key.
- High expected growth of emissions or removals: If the inventory agency expects emissions or removals from a category to grow significantly in the future, they are encouraged to identify that category as key. Some of these categories will be identified by the Trend Assessment or will be identified in the future. Because it is important to implement a higher tier *good practice* method as soon as possible, however, early identification using qualitative criteria is important.
- High uncertainty: If the inventory agency is not taking uncertainty explicitly into account by using the Tier 2 method to identify key categories, they may want to identify the most uncertain categories as key. This is because the largest reductions in overall inventory uncertainty can be achieved by improving estimates of highly uncertain categories.
- Unexpectedly high or low emissions or removals: When emissions or removals are far higher or lower than would be expected using the methods in the *IPCC Guidelines* or those described in Chapters 3 and 4 of this report (for example, due to the use of a national emission factor), these categories should be designated as key. Particular attention should also be paid to QA/QC (Section 5.5) and documentation for these categories.
- Large stocks: When a small net flux results from the subtraction of large emissions and removals, the uncertainty can be very high. Thus, when moving from the Tier 1 to higher tier estimation methods the order of IPCC Source Categories may change and previously insignificant categories may become significant.
- Deforestation: In the quantitative key category analysis, deforestation is spread out under the different land-use change categories (e.g., Lands converted to grassland are considered separately from Lands converted to cropland). To ensure consistency with the *IPCC Guidelines*, countries should identify and sum up the emission estimates associated with forest conversion to any other land category. “Deforestation” should be considered key if the sum is larger than the smallest category considered key in the quantitative analysis. In this case, countries can further examine which land conversions are significant (i.e., account for more than 30 percent) of the estimate and classify them as key.
- Completeness: Neither the Tier 1 nor the Tier 2 approach gives correct results if the inventory is not complete. The analysis can still be performed, but there may be key categories among those not estimated. In these cases it is *good practice* to qualitatively examine potential key categories applying the qualitative considerations above. *IPCC Guidelines* (IPCC, 1997), *GPG2000* (IPCC, 2000) and this report list potential categories of sources and sinks. The inventory of a country with similar national circumstances can also often give good indications on potential key categories.

For each key category identified, the inventory agency should determine if certain subcategories are particularly significant (i.e., represents a significant share of the emissions or removals). It is *good practice* to identify what subcategories are particularly important and focus efforts towards methodological improvements on these subcategories.

5.4.4 Identifying Key Categories under Kyoto Protocol Articles 3.3 and 3.4

The concept of key categories can also be used for choosing the *good practice* estimation methods for emissions and removals due to activities under Articles 3.3 and 3.4 of the Kyoto Protocol to the UNFCCC. The key

categories for Kyoto Protocol reporting can be identified following the guidance in this section. Detailed guidance is provided in Chapter 4 on how to take the key category determination into account in methodological choice for estimates prepared under the Kyoto Protocol.

Taking into consideration that there is not any experience with the preparation of these estimates under the Kyoto Protocol, it is suggested that the basis for assessment of key categories under Articles 3.3 and 3.4 of the Kyoto Protocol is the same as the assessment made for the UNFCCC inventory. Whenever a category is identified as key in the UNFCCC inventory, the associated activity under the Kyoto Protocol should be considered as key in reporting under the Kyoto Protocol.[14] The identification of key categories under the Kyoto Protocol will also have to include some qualitative assessments as there is not always an unambiguous correspondence between the UNFCCC categories and Kyoto Protocol activities. A country may also undertake a quantitative Tier 2 approach to identify the key categories of their inventory including the Kyoto Protocol activities. The results of this assessment will in most circumstances result in fewer LULUCF key categories.

Table 5.4.4 can be used to establish the relationship between categories in Chapter 3 and Chapter 4 for purposes of identifying key categories under Articles 3.3 and 3.4 of the Kyoto Protocol.

TABLE 5.4.4
RELATIONSHIP BETWEEN ACTIVITIES IDENTIFIED IN CHAPTER 3 AND CHAPTER 4 AND IPCC SOURCE/SINK CATEGORIES FOR LULUCF

1	2	3
Chapter 3 Categories	**Chapter 4 Categories**	**Key category if item in Column 1 was identified as key in the analysis of the UNFCCC inventory[a]**
FOREST LAND		
Forest land remaining forest land (managed)	FM, GM, CM	
Land converted to forest land (managed)	AR	
CROPLAND		
Cropland remaining cropland	CM, RV	
Land converted into cropland	D, RV, CM	
GRASSLAND		
Rangeland and grassland remaining rangeland and grassland (managed)	GM, RV	
Land converted to rangeland and grassland (managed)	D, RV , GM	
WETLANDS		
Wetlands remaining wetlands (managed)	RV	
Land converted to wetlands	D, RV	
SETTLEMENTS		
Settlements remaining settlements	RV	
Land converted to settlements	D, RV	
OTHER LAND[a b]		
Other land remaining other land		
Land converted to other land	D	

[a] Article 3.4 activities only when elected
[b] Theoretically revegetation can occur in both subcategories.
FM: forest management, AR: afforestation and reforestation, CM: cropland management, D: deforestation, RV: revegetation, GM: grazing land management.

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

The left column lists the categories of Chapter 3 that may have been used in the key category analysis of the UNFCCC inventory[15]. If any of these are identified as key, the Kyoto Protocol activities in the corresponding right column should initially be considered key. However, as in some cases several Kyoto Protocol activities potentially can be key, it is *good practice* to qualitatively examine which of the possible activities actually are key. For example, if land converted to rangeland and grassland was identified as key, this can involve deforestation, revegetation, grassland management or land-use changes not covered by the Kyoto Protocol. The land area affected by revegetation may be much smaller than the land area of the Chapter 3 category in which it occurs. If this is the case, and if revegetation is identified as potentially key according to Table 5.4.4, then countries may separately assess the importance of greenhouse gas emissions and removals in revegetation compared to the other category (or categories). It is *good practice* to explain and document which of the potential key categories are finally identified as key for Kyoto Protocol reporting.

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

- As shown in Table 5.4.4., several activities under the Kyoto Protocol can occur in more than one category of the UNFCCC inventory. In such cases, it is *good practice* to consider the total emissions and removals from the activity for purposes of the key category analysis. When this approach is needed, an activity should be considered key if the emissions or removals from the sum are greater than the emissions from the smallest category that is identified as key in the UNFCCC inventory (including LULUCF).
- If, when using the quantitative methods, a category is not identified as key for the present year but it is anticipated to strongly increase in the future, it should be designated as key. This could, for example, occur with a large-scale afforestation programme producing only small sinks in initial years, but with the expectation of larger yields later.
- In some cases, it is possible that the emissions or removals from an activity under the Kyoto Protocol could exceed the emissions or removals of the associated category in the UNFCCC inventory. In such a case the Kyoto Protocol activity should be identified as key if its emissions/removals exceed the emissions of the smallest category that is identified as key in the UNFCCC inventory (including LULUCF).

For each key category, the inventory agency should determine if certain subcategories are particularly significant (i.e., represent a significant share of the emissions or removals). For example, if cropland management has been elected and is identified as key, it is *good practice* to identify what subcategories are particularly important and focus efforts towards methodological improvements on these subcategories. As described in Section 5.4.2.2, the quantitative key category assessment can only be made at a more disaggregated level if correlations between input data can be taken into account.

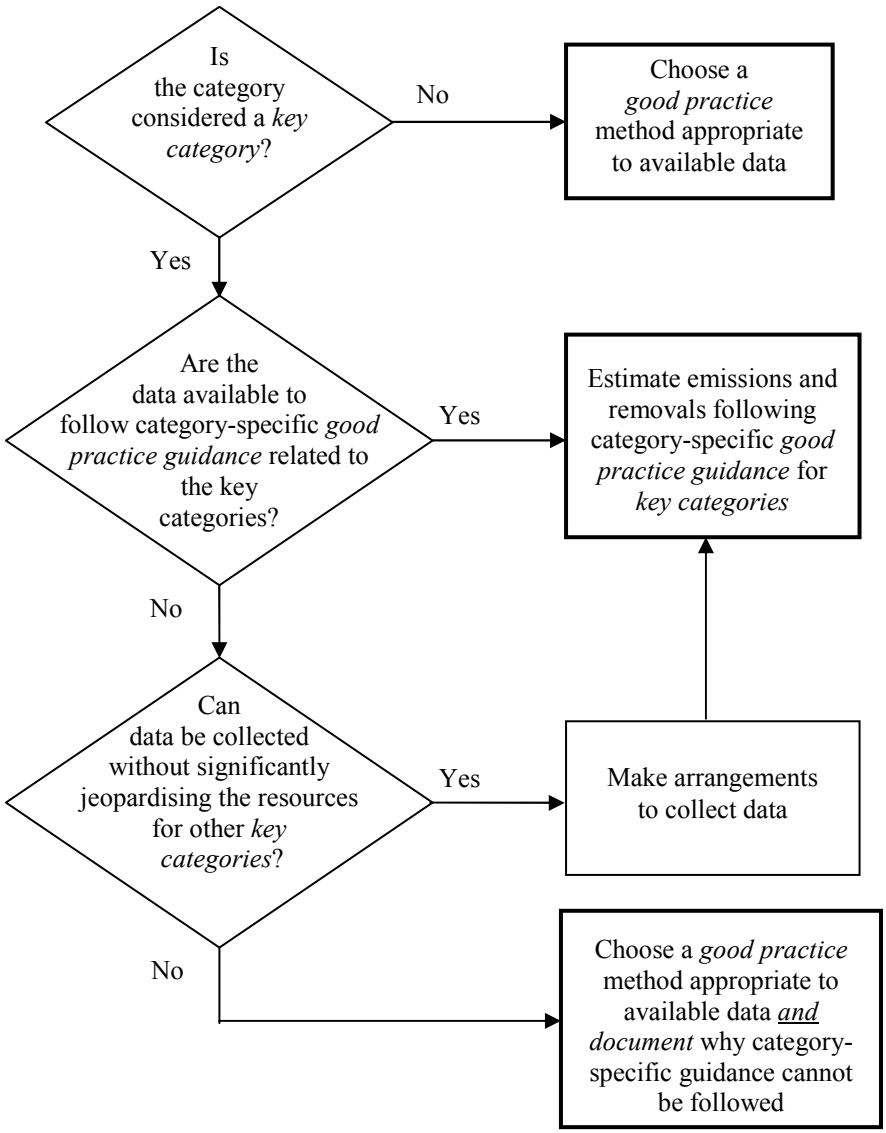
Because there will be special requirements related to methodologies and verification for estimates for LULUCF projects under Articles 6 and 12 of the Kyoto Protocol, projects have not been integrated into the key category concept. Section 4.3 in Chapter 4 gives *good practice guidance* on how these estimates should be prepared for the LULUCF inventories for reporting under the Kyoto Protocol.

5.4.5 Application of the Results

Identification of key categories in national inventories is important because the resources available for preparing inventories are finite and their use should be prioritised. It is essential that estimates be prepared for all categories, in order to ensure completeness. As far as possible, key categories should receive special consideration in terms of two important inventory aspects. Figure 5.4.2 illustrates a decision tree to choose a *good practice* method, which is modified from Figure 7.4 of Chapter 7 of *GPG2000* to make it applicable to the LULUCF sector.

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

Figure 5.4.2 Decision tree to choose a *good practice* method



First, additional attention ought to be focused on key categories with respect to methodological choice. As shown in the decision tree in Figure 5.4.2, inventory agencies are encouraged to use category-specific *good practice* methods for key categories, unless resources are unavailable. For most categories, higher tier (i.e., Tiers 2 and 3) methods are suggested for key categories, although this is not always the case. For guidance on the specific application of this principle to key categories, inventory agencies should refer to the decision trees in Chapter 3. There may be special requirements for methodological choice when reporting under Articles 3.3 and 3.4 of the Kyoto Protocol. These requirements are explained in Chapter 4 of this report.

Second, it is *good practice* for key categories to receive additional attention with respect to quality assurance and quality control (QA/QC). In Section 5.5, detailed guidance is provided on QA/QC for the LULUCF categories in the inventory.

5.4.6 Reporting and Documentation

It is *good practice* to clearly document the key categories in the inventory. This information is essential for explaining the choice of method for each category. In addition, inventory agencies should list the criteria by which each category was identified as key (e.g., level, trend, or qualitative), and the method used to conduct the quantitative key category analysis (e.g., Tier 1 or Tier 2). Table 5.4.5 can be used to document the results of the key category analysis.

TABLE 5.4.5 KEY CATEGORY ANALYSIS SUMMARY				
Quantitative Method Used for Key Category Analysis: Tier 1 ❒ Tier 2 ❒				
A	**B**	**C**	**D**	**E**
IPCC Source/Sink Category	**Direct Greenhouse Gas**	**Key Category Flag (Yes or No)**	**If C is Yes, Criteria for Identification**	**Comments**

Where:

Column A : list of IPCC categories – entry should be the same as column A in Tables 5.4.2 and 5.4.3

Column B : direct greenhouse gas – entry should be the same as column B in Tables 5.4.2 and 5.4.3

Column C : key category flag – enter 'Yes' if the category is key

Column D : criteria by which key category was identified – for each key category identified in Column C, enter one or more of the following: 'Level' for Level Assessment, 'Trend' for Trend Assessment, or 'Qualitative' for qualitative criteria

Column E : comments - enter any explanatory material

5.4.7 Derivation of Threshold for the Tier 1 Key Category Analysis

The thresholds for the level and trend were derived using the same methodology as used in *GPG2000*, but with a more complete data set, longer time series and with LULUCF included. The *GPG2000* method of determining the threshold was documented in more detail in Flugsrud *et al.* (1999). For the level threshold, the relationship between the percentage of the emissions and the sum of uncertainties of each source or sink category was compiled for the reported greenhouse gas inventories of 30 Parties included in Annex I to the United Nations Framework Convention on Climate Change (UNFCCC). As in *GPG2000* the threshold was determined to cover 90 % of the sum of uncertainties of each category as this typically gives 10 to 15 key source categories (Rypdal and Flugsrud 2001). The analysis is based on data received from the UNFCCC Secretariat for 1990 and 1999 (by May 2002). The dataset used to determine the trend threshold is more limited, including only 16 countries, as fewer countries have reported sufficiently detailed data for both years.

5.4.7.1 ASSUMPTIONS ABOUT UNCERTAINTIES

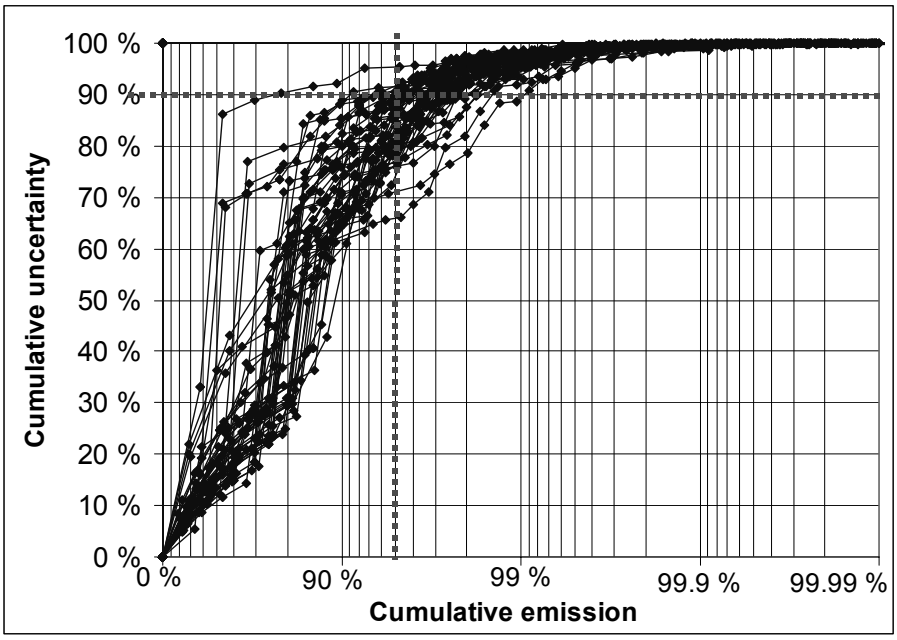
The analysis is based on the assessment of uncertainties in Table 5.4.6 . Sensitivity analysis shows the results to be rather robust with respect to the assumptions made about uncertainties. For the sources under non-LULUCF sectors the assumed uncertainties are: CO_2 5%, CH_4 25 %, N_2O 100%. Non-CO_2 greenhouse gases (N_2O and CH_4) were included for the LULUCF sector to the extent that they have been reported, assuming uncertainties as for the non-LULUCF sector.

TABLE 5.4.6 ASSUMED UNCERTAINTIES TO DETERMINE A KEY CATEGORY THRESHOLD INCLUDING LULUCF	
	Net CO_2 emissions or removal uncertainties
Changes in forest and woody biomass	±50 %
Forest and grassland conversion	-50 to +100 %
Abandonment of managed land	-50 to +100 %
Emissions and removals from soil	-50 to +100 %
Other LULUCF	-50 to +100 %

5.4.7.2 EMISSION LEVEL

In *GPG2000* the threshold value was determined to be 95% of total emissions. The pattern of emission estimates needed to account for 90% of the sum of category uncertainties in the dataset including LULUCF is similar to the one seen previously (as shown in Figure 5.4.3 below).

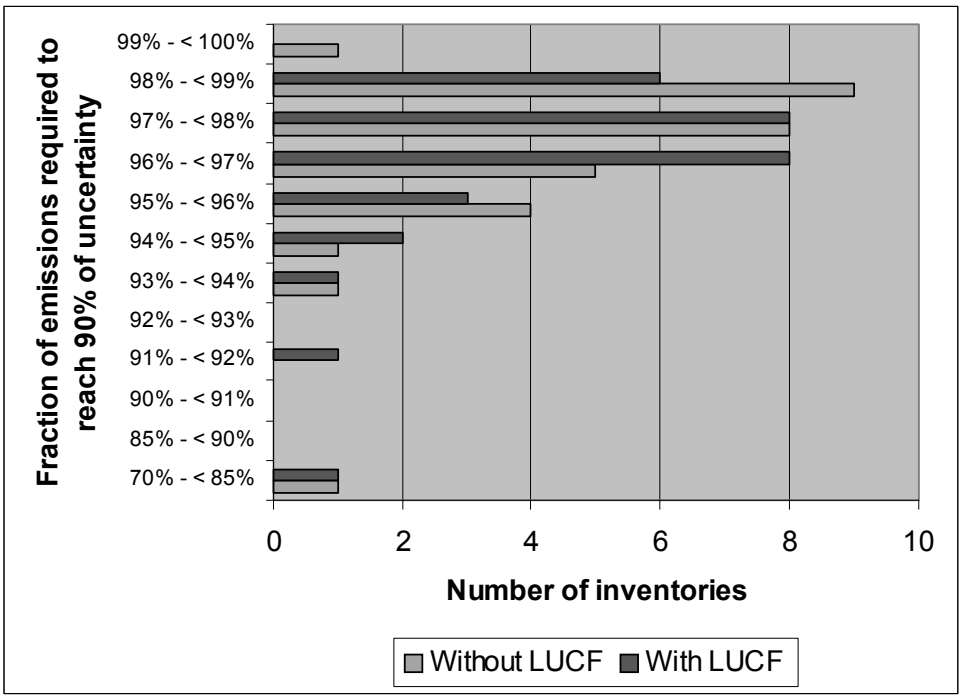
Figure 5.4.3 Cumulative uncertainty plotted against cumulative emissions



Note: The dotted lines show the division of the 95% threshold at 90% of sum of contribution from uncertainties.

Source: Data reported by Parties to the UNFCCC and assumed uncertainties.

Figure 5.4.4 Fraction of emissions required to reach 90% of sum of contribution from uncertainties in different inventories. With and without LULUCF (with LULUCF using absolute values of emissions).



Source: Data reported by Parties to the UNFCCC and assumed uncertainties

Figure 5.4.4 shows that when emissions and removals from LULUCF are included, a slightly smaller fraction of total emissions (by absolute value) is required to account for 90% of sum of source and sink category uncertainties. For the 30 inventories analysed, the median fraction was 97.1% without LULUCF and 96.8% with LULUCFs. The reason is that some of emissions or removals from LULUCF are large and with high uncertainty.

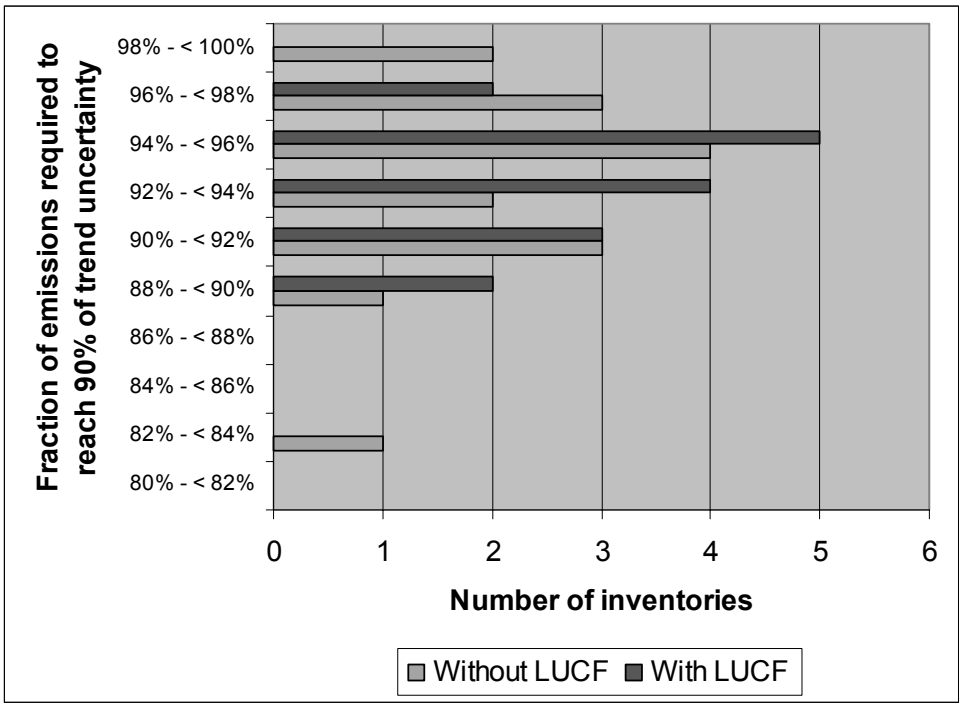
The threshold would need to be very high to be able to identify all Tier 2 key categories in all inventories. It is important to bear in mind that the Tier 2 approach is the most rigorous approach to determine key categories as the uncertainty is taken into account. A high threshold would mean that many non-key categories according to Tier 2 are defined in the Tier 1 approach. For this reason, it was determined to be most effective to set the threshold to 95% and to advise countries to apply qualitative criteria to the categories between 95 and 97%.

The conclusion is that the previously determined threshold of 95% is also recommended for the integrated analysis including LULUCF categories.

5.4.7.3 TREND

The threshold was set to identify 90% of the sum of $T_{x,t}^{*}$ (Equation 5.4.2) in the inventories. Figure 5.4.5 shows the same pattern for trend as Figure 5.4.4 for the level. When emissions and removals from LULUCF are included, a smaller fraction of total assessment (by absolute value) is required to account for 90% of the sum of $T_{x,t}^{*}$[16]. The reason is again that some of the emissions and removals from LULUCF have large contribution to trend and high uncertainty.

Figure 5.4.5 Fraction of emissions required to reach 90% of sum of contribution from trend uncertainty in different inventories. With and without LULUCF (with LULUCF using absolute values of emissions).



Source: Data reported by Parties to the UNFCCC and assumed uncertainties

[16] The available data did not make it feasible to include HFCs, PFCs and SF_6 in the analysis. However, these gases should be included, if possible, when the method is applied.

5.4.8 Example of Tier 1 Key Category Analysis

The example illustrates the application of the Tier 1 approach based on the submitted inventory for an Annex I country. Both the level and trend assessment is shown.

TABLE 5.4.7
EXAMPLE OF A LEVEL ASSESSMENT[a]

A	B			C	D'	E'	D	E
IPCC Source categories (IPCC 1996)	**Direct Green-house Gases**	**Base or Current Year Estimate non-LULUCF**	**Base or Current Year Estimate LULUCF**	**Base or Current Year Estimate Absolute Value**	**Level Assessment without LULUCF, from column C**	**Cumulative Total of Column D'**	**Level Assessment with LULUCF, from column C**	**Cumulative Total of Column D (additional LULUCF sources)**
Sum		535375	**-61309**	643884[b]	1		1	
1.AA.3	CO_2	138822	..	138822	0.259	0.259	0.216	0.216
1.AA.4	CO_2	102167	..	102167	0.191	0.450	0.159	0.374
5.A	CO_2	..	**-84861**	84861	..	0.450	0.132	0.506
1.AA.2	CO_2	77213	..	77213	0.144	0.594	0.120	0.626
1.AA.1	CO_2	61389	..	61389	0.115	0.709	0.095	0.721
4.D	N_2O	51152	..	51152	0.096	0.805	0.079	0.801
4.A	CH_4	27942	..	27942	0.052	0.857	0.043	0.844
6.A	CH_4	16440	..	16440	0.031	0.887	0.026	0.870
5.B	CO_2	..	12540	12540	..	0.887	0.019	0.889
2.B	N_2O	11093	..	11093	0.021	0.908	0.017	0.906
2.A	CO_2	10371	..	10371	0.019	0.928	0.016	0.923
5.E	N_2O	..	5550	5550	..	0.928	0.009	0.931
1.B.2	CO_2	4006	..	4006	0.007	0.935	0.006	0.937
4.B	CH_4	3644	..	3644	0.007	0.942	0.006	0.943
2.C	CO_2	3443	..	3443	0.006	0.948	0.005	0.948
5.D	CO_2	..	3370	3370	..	0.948	0.005	0.954
1.AA.3	N_2O	3174	..	3174	0.006	0.954	0.005	0.959
4.B	N_2O	3109	..	3109	0.006	0.960	0.005	0.963
1.AA.4	CH_4	2817	..	2817	0.005	0.965	0.004	0.968
2.B	CO_2	2723	..	2723	0.005	0.970	0.004	0.972
1.B.1	CH_4	2658	..	2658	0.005	0.975	0.004	0.976
6.C	CO_2	2287	..	2287	0.004	0.980	0.004	0.980
1.B.2	CH_4	1906	..	1906	0.004	0.983	0.003	0.983
5.E	CH_4	..	1880	1880	..	0.983	0.003	0.986
1.AA.4	N_2O	1456	..	1456	0.003	0.986	0.002	0.988
3.A	CO_2	823	..	823	0.002	0.987	0.001	0.989
1.AA.2	N_2O	796	..	796	0.001	0.989	0.001	0.990
1.AA.1	N_2O	683	..	683	0.001	0.990	0.001	0.991
6.B	N_2O	665	..	665	0.001	0.991	0.001	0.992
3.D	CO_2	658	..	658	0.001	0.993	0.001	0.993

TABLE 5.4.7 (CONTINUED)
EXAMPLE OF A LEVEL ASSESSMENT FOR AN ANNEX I COUNTRY[a]

A	B			C	D'	E'	D	E
IPCC Source categories (IPCC 1996)	**Direct Green-house Gases**	**Base or Current Year Estimate non-LULUCF**	**Base or Current Year Estimate LULUCF**	**Base or Current Year Estimate Absolute Value**	**Level Assessment without LULUCF, from column C**	**Cumulative Total of Column D**	**Level Assessment with LULUCF, from column C**	**Cumulative Total of Column F (additional LULUCF sources)**
2.D	CO_2	656	..	656	0.001	0.994	0.001	0.994
3.D	N_2O	613	..	613	0.001	0.995	0.001	0.995
4.D	CH_4	482	..	482	0.001	0.996	0.001	0.996
6.C	N_2O	402	..	402	0.001	0.997	0.001	0.997
6.C	CH_4	368	..	368	0.001	0.997	0.001	0.997
6.D	CH_4	359	..	359	0.001	0.998	0.001	0.998
1.AA.3	CH_4	312	..	312	0.001	0.999	0.000	0.998
6.B	CH_4	282	..	282	0.001	0.999	0.000	0.999
5.B	CH_4	..	236	236	..	0.999	0.000	0.999
4.C	CH_4	163	..	163	0.000	0.999	0.000	0.999
3.B	CO_2	136	..	136	0.000	1.000	0.000	1.000
1.AA.2	CH_4	81	..	81	0.000	1.000	0.000	1.000
2.B	CH_4	55	..	55	0.000	1.000	0.000	1.000
5.C	CO_2	..	**-48**	48	..	1.000	0.000	1.000
1.AA.1	CH_4	28	..	28	0.000	1.000	0.000	1.000
5.B	N_2O	..	24	24	..	1.000	0.000	1.000
1.B.2	N_2O	0	..	0	0.000	1.000	0.000	1.000

[a] Shaded cells of the table show values for cumulative assessment that identifies key categories for the level.

[b] This sum differs from the sum of the two columns to the left because removals are summed up as absolute values.

TABLE 5.4.8
TREND ANALYSIS WITH LULUCFS[a]

A	B	C	D	E	F	G
IPCC Source Categories (IPCC 1996)	**Direct Greenhouse Gas**	**Base Year Estimate**	**Current Year Estimate**	**Trend Assessment**	**% Contribution to Assessment**	**Cumulative Total of Column F**
Sum		486002	474066	0.162226	1	
1.AA.3	CO_2	119156	138822	0.046486	0.28655	0.28655
2.B	N_2O	27775	11093	0.03292	0.202928	0.489477
5.A	CO_2	**-75330**	**-84861**	0.023418	0.144352	0.63383
1.AA.4	CO_2	94375	102167	0.020804	0.128239	0.762069
1.AA.1	CO_2	65495	61389	0.005139	0.031676	0.793745
2.A	CO_2	13016	10371	0.004784	0.029492	0.823237
1.AA.2	CO2	76919	77213	0.004491	0.027681	0.850918
1.AA.3	N_2O	1208	3174	0.004106	0.02531	0.876228
1.B.1	CH_4	4331	2658	0.003225	0.019882	0.896109
4.A	CH_4	30058	27942	0.002834	0.017467	0.913576
5.B	CO_2	11710	12540	0.0023	0.014175	0.927751
6.A	CH_4	17917	16440	0.002134	0.013152	0.940903
2.C	CO_2	4550	3443	0.002046	0.012613	0.953516
5.D	CO_2	4051	3370	0.001197	0.007376	0.960892
4.D	N_2O	52898	51152	0.000918	0.005659	0.966551
1.B.2	CH_4	2199	1906	0.000493	0.003041	0.969592
2.B	CO_2	3007	2723	0.000433	0.002667	0.972259
6.C	CO_2	2133	2287	0.000425	0.00262	0.974879
1.B.2	CO_2	4306	4006	0.000398	0.002456	0.977336
4.B	CH_4	3537	3644	0.000398	0.002453	0.979789
5.E	N_2O	5494	5550	0.000394	0.002428	0.982217
1.AA.4	CH_4	3043	2817	0.000313	0.001927	0.984143
1.AA.4	N_2O	1338	1456	0.00031	0.001913	0.986056
1.AA.1	N_2O	561	683	0.000278	0.001714	0.98777
1.AA.3	CH_4	453	312	0.000267	0.001648	0.989418
6.D	CH_4	246	359	0.000245	0.001513	0.990931
3.B	CO_2	252	136	0.000226	0.001394	0.992325
1.AA.2	N_2O	731	796	0.00017	0.001049	0.993374
3.A	CO_2	920	823	0.000153	0.000943	0.994317
6.B	N_2O	612	665	0.00014	0.000861	0.995178
5.E	CH_4	1861	1880	0.000134	0.000824	0.996002
4.B	N_2O	3249	3109	0.000124	0.000766	0.996768
6.C	CH_4	320	368	0.000115	0.000708	0.997477
6.C	N_2O	357	402	0.000112	0.000689	0.998166
3.D	N_2O	596	613	6.56E-05	0.000404	0.99857

TABLE 5.4.8 (CONTINUED)
TREND ANALYSIS WITH LULUCFS[a]

A	B	C	D	E	F	G
IPCC Source Categories (IPCC 1996)	**Direct Greenhouse Gas**	**Base Year Estimate**	**Current Year Estimate**	**Trend Assessment**	**% Contribution to Assessment**	**Cumulative Total of Column F**
6.B	CH_4	259	282	5.91E-05	0.000365	0.998935
5.B	CH_4	221	236	4.27E-05	0.000263	0.999198
1.AA.1	CH_4	46	28	3.52E-05	0.000217	0.999415
4.D	CH_4	482	482	2.6E-05	0.00016	0.999575
4.C	CH_4	180	163	2.57E-05	0.000159	0.999733
2.D	CO_2	681	656	1.65E-05	0.000101	0.999835
3.D	CO_2	681	658	1.12E-05	6.92E-05	0.999904
2.B	CH_4	53	55	6.85E-06	4.22E-05	0.999946
5.B	N_2O	22	24	4.42E-06	2.72E-05	0.999974
5.C	CO_2	**-48**	**-48**	2.43E-06	1.5E-05	0.999989
1.AA.2	CH_4	82	81	7.13E-07	4.39E-06	0.999993
1.B.2	N_2O	..	0	5.74E-07	3.54E-06	0.999996
1.B.2	N_2O	..	0	5.74E-07	3.54E-06	1

[a] Additional LULUCFs identified are shaded.