7

METHODOLOGICAL CHOICE AND RECALCULATION

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7 METHODOLOGICAL CHOICE AND RECALCULATION

7.1 INTRODUCTION

This chapter addresses two cross-cutting issues in inventory preparation: (i) how to identify *key source categories* in the national inventory, and (ii) how to systematically manage methodological change over time and ensure that trends in national emissions are consistently estimated.

Methodological choice for individual source categories is important in managing overall inventory uncertainty. Generally, inventory uncertainty is lower when emissions are estimated using the most rigorous methods, but due to finite resources, this may not be feasible for every source category. It is *good practice* to identify those source categories that have the greatest contribution to overall inventory uncertainty in order to make the most efficient use of available resources. By identifying these *key source categories* in the national inventory, inventory agencies can prioritise their efforts and improve their overall estimates. Such a process will lead to improved inventory quality, as well as greater confidence in the emissions estimates that are developed. It is *good practice* for each inventory agency to identify its national *key source categories* in a systematic and objective manner.

A *key source category* is 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.

Any inventory agency that has prepared an emissions inventory will be able to identify *key source 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 source categories* should include evaluation of both the absolute level and the trend in emissions. Evaluating only the influence of a source category on the overall level of emissions provides limited information about why the source category is key. Some *key source categories* may not be identified if the influence of their trend is not taken into account.

The quantitative approaches to determine *key source categories* are described in Section 7.2.1, Quantitative Approaches to Identify Key Source Categories. Both a basic Tier 1 approach and a Tier 2 approach, which accounts for uncertainty, are described. In addition to making a quantitative determination of *key source categories*, it is *good practice* to consider qualitative criteria. These qualitative criteria include high uncertainty, mitigation, significant anticipated changes in future emission levels, and significant differences between the estimate and what would be expected using an IPCC default method or factor. The application of these criteria is described in more detail in Section 7.2.2, Qualitative Approaches to Identify Key Source Categories. The ways in which *key source categories* are to be managed within the inventory are also described along with references to other relevant sections of this report.

Inventory agencies will, from time to time, have good reason to change or refine the methods used to estimate emissions from particular source categories. Such changes may be made, for example, in order to improve the estimates of *key source categories*. These changes must be accompanied by a recalculation of previously prepared estimates in order to ensure that the reported emission trend is reliable. As far as possible, the time series should be recalculated using the same method in all years. In some cases, however, the same data sources for all years will not be available. Guidance on how to recalculate emissions to ensure consistency in the trend in situations where the same method cannot be used in every year is described in Section 7.3, Recalculations.

7.2 DETERMINING NATIONAL KEY SOURCE CATEGORIES

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

The results of the *key source category* determination will be most useful if the analysis is done at the appropriate level of detail.

Table 7.1, Suggested IPCC Source Categories, lists the source categories that should be analysed, and identifies special considerations related to the analysis, where relevant. For example, the combustion of fossil fuels is a large emission source category that can be broken down into sub-source categories, and even to the level of individual plants or boilers. The following guidance describes *good practice* in determining the appropriate level of analysis to identify *key source categories*:

- The analysis should be performed at the level of IPCC source categories (i.e. at the level at which the IPCC methods are described). The analysis should be performed using CO_2-equivalent emissions calculated using the global warming potentials (GWPs) 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*).
- Each greenhouse gas emitted from a single source category should be considered separately, unless there are specific methodological reasons for treating gases collectively. For example, carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O) are emitted from mobile sources. The *key source category* evaluation should be performed for each of these gases separately because the methods, emission factors and related uncertainties differ for each gas. In contrast, a collective evaluation of hydrofluorocarbons (HFCs) and perfluorocarbons (PFCs) may be appropriate for some source categories, such as emissions from substitutes for Ozone Depleting Substances (ODS substitutes).
- Source categories that use the same emission factors based on common assumptions should be aggregated before analysis. This approach can also help deal with cross-correlations between source categories in the uncertainty analysis, as explained in Chapter 6, Quantifying Uncertainties in Practice, Section 6.3.3, Tier1 Aggregation and Reporting. The same pattern of aggregation should be used both to quantify uncertainties and to identify *key source categories* unless the associated activity data uncertainties are very different.

Finally, for each *key source category*, the inventory agency should determine if certain sub-source categories are particularly significant (i.e. represent a significant share of the emissions). In the case of CH_4 emissions from enteric fermentation in domestic livestock, for example, emissions from particular species (e.g. cattle, buffalo or sheep) are likely to represent the major share of emissions. This also applies to industrial sources where a few larger plants account for most of the emissions of that source category. It may be appropriate to focus efforts towards methodological improvements on these most significant sub-source categories.

7.2.1 Quantitative approaches to identify key source categories

It is *good practice* for each inventory agency to identify its national *key source categories* in a systematic and objective manner, by performing a quantitative analysis of the relationships between the level and the trend of each source category's emissions and total national emissions.

The decision tree in Figure 7.1, Decision Tree to Identify Key Source Categories, illustrates how inventory agencies can determine which approach to use for the identification of *key source categories*. Any inventory agency that has developed an emissions inventory will be able to perform the Tier 1 Level Assessment and identify the source categories whose level has a significant effect on total national emissions. Those inventory agencies that have developed emissions inventories for more than one year will also be able to perform the Tier 1 Trend Assessment and identify sources that are key because of their contribution to the total trend of national emissions. Both assessments are described in Section 7.2.1.1, Tier 1 Method to Identify Key Source Categories.

TABLE 7.1
SUGGESTED IPCC SOURCE CATEGORIES [a,b]

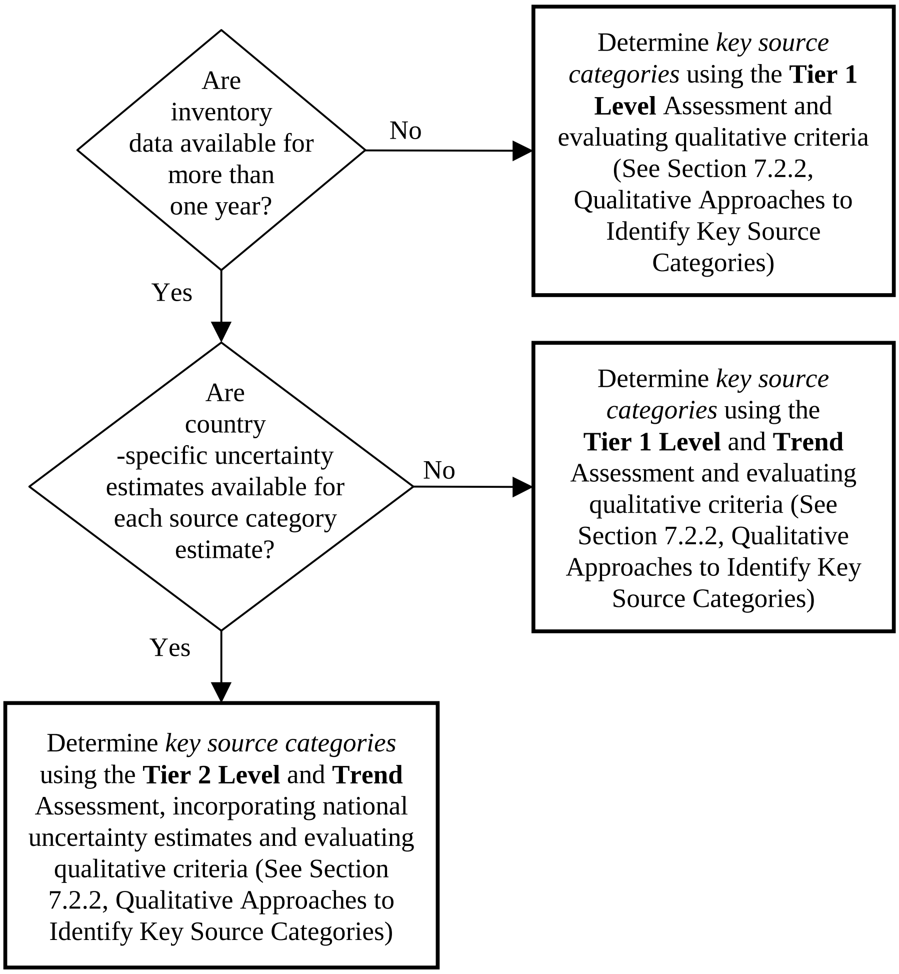
Source Categories to be Assessed in Key Source Category Analysis	Special Considerations
ENERGY	
CO_2 Emissions from Stationary Combustion	Disaggregate to the level where emission factors are distinguished. In most inventories, this will be the main fuel types. If emission factors are determined independently for some sub-source 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.
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 sub-source category.
Fugitive Emissions from Oil and Gas Operations	This source category comprises several sub-source categories which may be significant. Inventory agencies should assess this source category, if it is key, to determine which sub-source 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 sub-source 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 sub-source 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 CH_4 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] The LUCF Sector is not included in this table. In principle, the methods described in this chapter to identify *key source categories* could be applied to LUCF, but further work on this topic is necessary.
[b] In some cases, inventory agencies may make some modification to this list of IPCC source categories to reflect particular national circumstances.

When using the Tier 1 approach, *key source categories* are identified using a pre-determined cumulative emissions threshold. The pre-determined threshold has been determined based on an evaluation of several inventories, and is aimed at establishing a general level where 90% of inventory uncertainty will be covered by *key source categories*. This evaluation is described in more detail in Section 7.2.1.1, Tier 1 Method to Identify Key Source Categories.

If nationally derived source-level uncertainties are available, inventory agencies can use Tier 2 to identify *key source categories*. The Tier 2 approach is a more detailed analysis that builds on the Tier 1 approach, and it is likely to reduce the number of *key source categories* that need to be considered. Under Tier 2, the results of the Tier 1 analysis are multiplied by the relative uncertainty of each source category. *Key source categories* are those that represent 90% of the uncertainty contribution, instead of applying the pre-determined cumulative emissions threshold. This approach is described in more detail in Section 7.2.1.2, Tier 2 Method to Identify Key Source Categories, Considering Uncertainties. If both the Tier 1 and the Tier 2 assessment have been performed, it is *good practice* to use the results of the Tier 2 analysis.

Figure 7.1 Decision Tree to Identify Key Source Categories



7.2.1.1 TIER 1 METHOD TO IDENTIFY KEY SOURCE CATEGORIES

The Tier 1 method to identify *key source categories* assesses the impacts of various source categories on the level and, if possible, the trend, of the national emissions inventory. When the national inventory estimates are available for several years, it is *good practice* to assess the contribution of each source category to both the level and trend of the national inventory. If only a single year's inventory is available, only a Level Assessment can be performed.

The Tier 1 method to identify *key source categories* can be readily completed using a spreadsheet analysis. Tables 7.2 and 7.3 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, Quantifying Uncertainties in Practice. In both tables, columns A through D are inputs of the national inventory data. Appendix 7A.1 illustrates the application of the Tier 1 approach to the US inventory.

LEVEL ASSESSMENT (TABLE 7.2)

The contribution of each source category to the total national inventory level is calculated according to Equation 7.1:

EQUATION 7.1

Source Category Level Assessment = Source Category Estimate / Total Estimate

$$L_{x,t} = E_{x,t} \ / \ E_t$$

Where:

$L_{x,t}$ is the Level Assessment for source x in year t

Source Category Estimate ($E_{x,t}$) is the emission estimate of source category x in year t

Total Estimate (E_t) is the total inventory estimate in year t

Table 7.2 presents a spreadsheet that can be used for the Level Assessment.

TABLE 7.2
SPREADSHEET FOR THE TIER 1 ANALYSIS – LEVEL ASSESSMENT

A IPCC Source Categories	B Direct Greenhouse Gas	C Base Year Estimate	D Current Year Estimate	E Level Assessment	F Cumulative Total of Column E
Total					

Where:

Column A: List of IPCC source categories (see Table 7.1, Suggested IPCC Source Categories)

Column B: Direct greenhouse gas

Column C: Base year emissions estimates from the national inventory data, in CO_2-equivalent units

Column D: Current year emissions estimates from the most recent national inventory, in CO_2-equivalent units

Column E: Level Assessment from Equation 7.1

Column F: Cumulative total of Column E

In the table, the calculations necessary for the Level Assessment are computed in Column E, following Equation 7.1. Thus, the value of the source category Level Assessment should be entered in Column E for each source category, and the sum of all the entries in this column entered in the total line of the table. All entries in Column E should be positive as the analysis deals with emission source categories only. *Key source categories* are those that, when summed together in descending order of magnitude, add up to over 95% of the total of Column E.[1] In order to make this determination, the source categories (i.e. the rows of the table) should be sorted in descending order of magnitude of the Level Assessment. The cumulative total of Column E should then be computed in Column F.

[1] This threshold was determined to be the level at which 90% of the uncertainty in a ‘typical’ inventory would be covered by *key source categories* (Flugsrud *et al*., 1999, and Norwegian Pollution Control Authority, 1999). Note that if the LUCF Sector is considered in the analysis, the pre-determined threshold may need to be re-evaluated, because it was established based on an evaluation of source categories only.

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 been changed or recalculated, however, the analysis for that year should be updated. Any source category that meets the 95% threshold in any year should be identified as a *key source category*.

TREND ASSESSMENT (TABLE 7.3)

The contribution of each source category's trend to the trend in the total inventory can be assessed if more than one year of inventory data are available, according to Equation 7.2:

EQUATION 7.2[2]

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

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

Where:

$T_{x,t}$ is the contribution of the source category trend to the overall inventory trend, called the Trend Assessment. The Trend Assessment is always recorded as an absolute value, i.e. a negative value is always recorded as the equivalent positive value.

$L_{x,t}$ is the Level Assessment for source x in year t (derived in Equation 7.1)

$E_{x,t}$ and $E_{x,0}$ are the emissions estimates of source category x in years t and 0, respectively

E_t and E_0 are the total inventory estimates in years t and 0, respectively

The Source Category Trend is the change in the source category emissions over time, computed by subtracting the base year (year 0) estimate for source category x from the current year (year t) estimate and dividing by the current year estimate.[3]

The Total Trend is the change in the total inventory emissions 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.

The Trend Assessment will identify source categories that have a different trend to the trend of the overall inventory.[4] As differences in trend are more significant to the overall inventory level for larger source categories, the result of the trend difference (i.e. the source category trend minus total trend) is multiplied by the result of the level assessment ($L_{x,t}$ from Equation 7.1) to provide appropriate weighting. Thus, *key source categories* will be those where the source category trend diverges significantly from the total trend, weighted by the emission level of the source category.

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[2] From Flugsrud *et al*. (1999) and Norwegian Pollution Control Authority (1999).

[3] 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 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). In rare circumstances, inventory agencies may find that the denominator term for a particular source category (i.e. the current year estimate) is zero, or close to zero. In this case, the results of the Level Assessment and application of the qualitative criteria should be used to determine if the source category is key.

[4] See Flugsrud *et al*. (1999) for more discussion of this approach to trend analysis.

Table 7.3 presents a spreadsheet that can be used for the Trend Assessment.

TABLE 7.3
SPREADSHEET FOR THE TIER 1 ANALYSIS – TREND ASSESSMENT

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

Where:

Column A: List of IPCC source categories (see Table 7.1, Suggested IPCC Source Categories)

Column B: Direct greenhouse gas

Column C: Base year emissions estimates from the national inventory data, in CO2-equivalent units

Column D: Current year emissions estimates from the most recent national inventory, in CO2-equivalent units

Column E: Trend Assessment from Equation 7.2 recorded as an absolute number

Column F: Percentage contribution to the total trend of the national inventory

Column G: Cumulative total of Column F, calculated by summing Column F from the first row to the current row

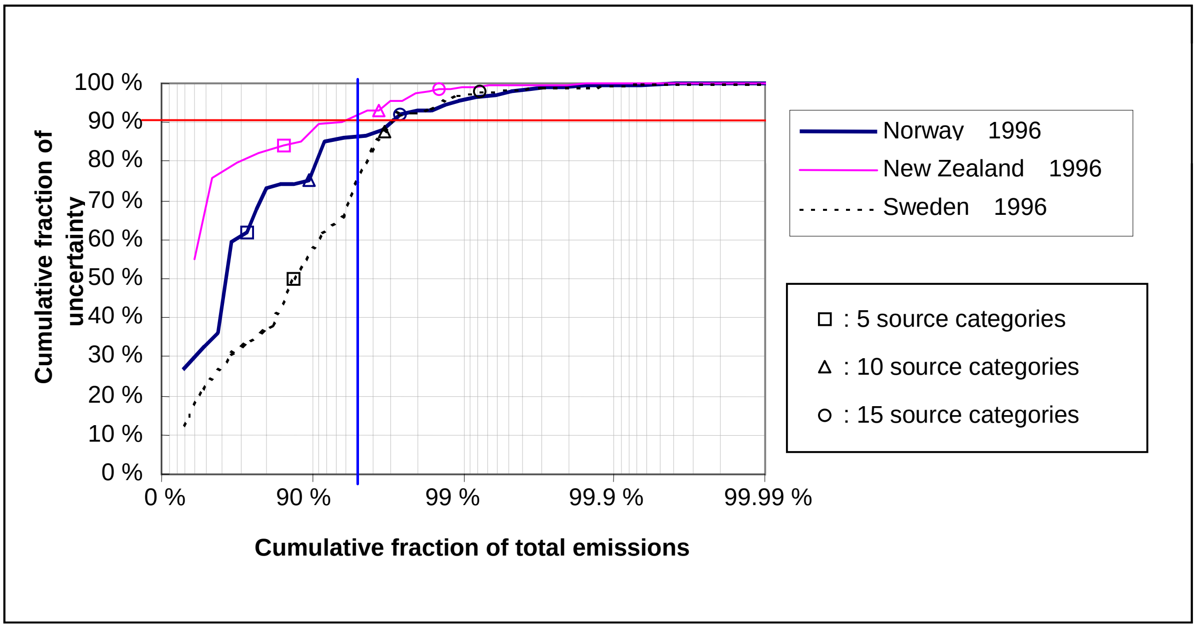
The entries in columns A through D should be identical to those used in Table 7.2, Spreadsheet for the Tier 1 Analysis – Level Assessment. The calculations necessary for the Trend Assessment are computed in column E, following Equation 7.2. The absolute value of $T_{x,t}$ should be entered in Column E for each source category, and the sum of all the entries entered in the total line of the table.[5] Each source category's percentage contribution to the total of Column E should be computed and entered in Column F, and this column should be used to identify those source categories that contribute 95% to the trend of the inventory in absolute terms. Once the entries for Column F are computed, the source 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 source categories* are those that, when summed together in descending order of magnitude, add up to more than 95% of Column G.

DETERMINING THE THRESHOLD

The proposed threshold of 95% for both the Level Assessment ($L_{x,t}$) and the Trend Assessment ($T_{x,t}$) was developed from a review of emissions estimates and uncertainty for several inventories. As described in Flugsrud *et al.* (1999), two analyses were performed. In the first, the relationship between the percentage of emissions and the percentage of total inventory uncertainty was compared for national GHG inventories of 35 Parties included in Annex I to the United Nations Framework Convention on Climate Change (UNFCCC). The results for three inventories are shown in Figure 7.2, Cumulative Fraction of Uncertainty by Cumulative Fraction of Total Emissions, which indicates that a threshold of 90% of emissions would account for 55-85% of uncertainty, a threshold of 95% of emissions would account for 75-92% of uncertainty, and a threshold of 97% of emissions would account for 85-95% of uncertainty. Figure 7.2 also shows the number of source categories associated with the various thresholds in inventories. As it indicates, 90% of the uncertainty is generally covered by 10-15 *key source categories*.

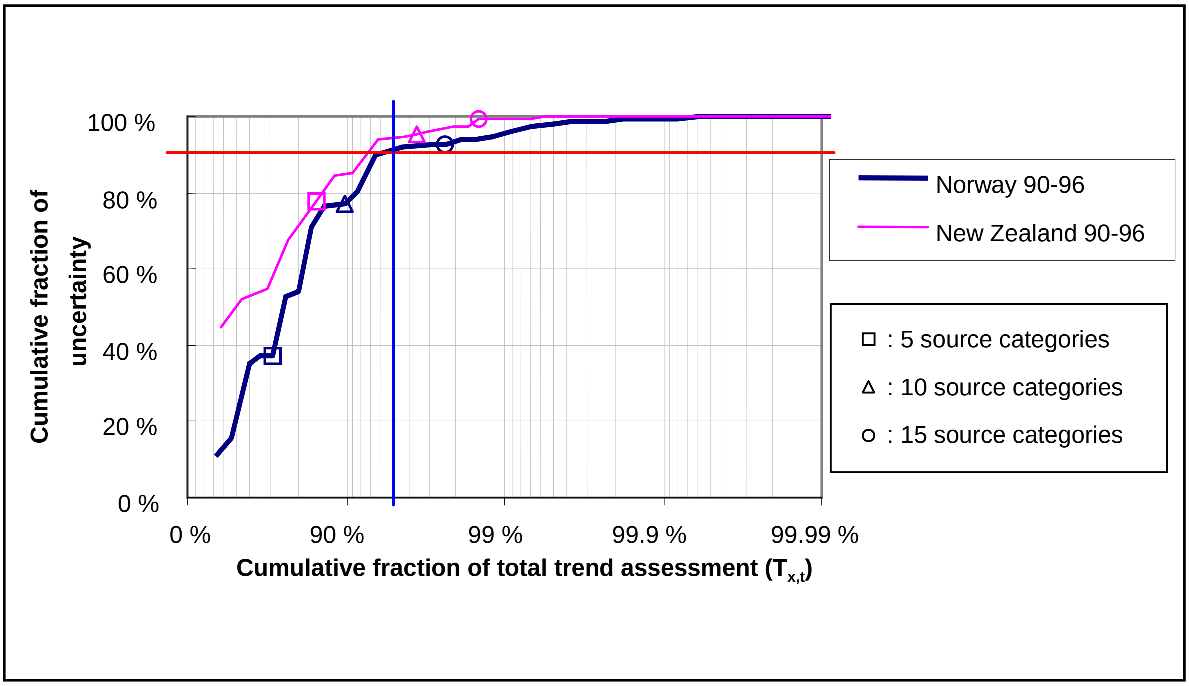
[5] Unlike the Level Assessment, where all entries will be positive if only source categories are considered, in the Trend Assessment negative values will occur if emissions of the source category decline by more in percentage terms than emissions of the overall inventory, or grow by a smaller amount.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

Figure 7.2 Cumulative Fraction of Uncertainty by Cumulative Fraction of Total Emissions



The second aspect of the analysis compared the results of the trend assessment with the cumulative uncertainty in the inventory. As Figure 7.3 shows, in this case a threshold of 90% of the total trend assessment ($T_{x,t}$) would account for 75-85% of uncertainty, a threshold of 95% of the total trend assessment would account for 90-95% of uncertainty, and a threshold of 97% would account for 92-98% of the uncertainty. As in Figure 7.2, using the 95% threshold will generally cover 10-15 source categories in the inventory.

Figure 7.3 Cumulative Fraction of Trend Uncertainty by Cumulative Fraction of Total Trend Assessment



Based on a review of these analyses, a general threshold of 95% for both the Level Assessment ($L_{x,t}$) and the Trend Assessment ($T_{x,t}$) is suggested as a reasonable approximation of 90% of the uncertainty for the Tier 1 method, where a pre-determined threshold is needed. Obviously, other thresholds could be established if it were determined that a different level of uncertainty should be covered by *key source categories*. Inventory agencies can also determine the specific national thresholds for *key source categories* needed to cover 90% of their uncertainty, based on their national uncertainty analyses. The approach for doing this is described in Section 7.2.1.2 below.

7.2.1.2 TIER 2 METHOD TO IDENTIFY KEY SOURCE CATEGORIES, CONSIDERING UNCERTAINTIES

A more sophisticated Tier 2 approach can be used to identify *key source categories* using the results of the uncertainty analysis described in Chapter 6, Quantifying Uncertainties in Practice. The Tier 2 approach is consistent with, but not necessarily required for, *good practice*. Inventory agencies are encouraged to use Tier 2 if possible, because it can provide additional insight into the reasons that particular source categories are key and can assist in prioritising activities to improve inventory quality and reduce overall uncertainty. It should be recognised that, because of the different approaches, there may be a few differences in the *key source categories* that are identified. In such situations, the results of the Tier 2 approach should be utilised. In addition, the Tier 2 approach is likely to reduce the number of *key source categories* that need to be considered. If source category uncertainties are not available, inventory agencies need not develop them solely for the purpose of conducting the Tier 2 analysis of *key source categories*. Instead, they can use the Tier 1 approach, as described in Section 7.2.1.1, Tier 1 Method to Identify Key Source Categories.

Methods for incorporating the two types of uncertainty analyses described in Chapter 6, Quantifying Uncertainties in Practice, into the determination of *key source categories* are presented below.

INCORPORATING CHAPTER 6 TIER 1 SOURCE CATEGORY UNCERTAINTIES

The *key source category* analysis may be enhanced by incorporating national source category uncertainty estimates developed under a Tier 1 uncertainty analysis (described in Chapter 6, Quantifying Uncertainties in Practice, Section 6.3.2, Tier 1 – Estimating Uncertainties by Source Category with Simplifying Assumptions). These uncertainty estimates are developed using the error propagation equation to combine emission factor and activity data uncertainties by source category and gas. The simplified approach is implemented at the source category level, using uncertainty ranges for emission factors and activity data consistent with the guidance in Chapters 2-5. The source category uncertainties are incorporated by weighting the Tier 1 Level and Trend Assessment results by the source category’s relative uncertainty. Thus, the equations used for the quantitative analysis are modified as shown below.

LEVEL ASSESSMENT

Equation 7.3 describes the Tier 2 Level Assessment including uncertainty. The result of this assessment ($LU_{x,t}$) is identical to the result of quantifying uncertainties in practice, as shown in column H of Table 6.1, Tier 1 Uncertainty Calculation and Reporting, in Chapter 6, Quantifying Uncertainties in Practice. So, if Table 6.1 has been completed, it is not necessary to recalculate Equation 7.3.

EQUATION 7.3

Level Assessment, with Uncertainty = Tier 1 Level Assessment • Relative Source Uncertainty

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

TREND ASSESSMENT

Equation 7.4 shows how the Tier 2 Trend Assessment can be expanded to include uncertainty.

EQUATION 7.4

Trend Assessment, with Uncertainty = Tier 1 Trend Assessment • Relative Source Uncertainty

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

Where:

$L_{x,t}$ and $T_{x,t}$ are calculated using Equations 7.1 and 7.2

$U_{x,t}$ is the relative source category uncertainty in year t (if relevant) as calculated for the Tier 1 uncertainty analysis described in Chapter 6, Quantifying Uncertainties in Practice. Specifically, the source category uncertainties should be the same as those reported in Table 6.1, Column G.

INCORPORATING MONTE CARLO ANALYSIS

In Chapter 6, Quantifying Uncertainties in Practice, Monte Carlo analysis is presented as the Tier 2 approach for quantitative uncertainty assessment. Whereas the Tier 1 analysis requires simplified assumptions to develop source category uncertainty, Monte Carlo analysis can handle large uncertainties, complexities in the probability density functions, correlation and both simple and complex emission estimate equations, among other things. Monte Carlo analysis is also useful for performing sensitivity analyses on the inventory to identify the principal factors driving inventory uncertainty. These types of insights can be valuable in the identification of *key source categories* and prioritising resources for inventory improvement. If available, the relative source category uncertainties generated by Monte Carlo analysis can be used in Equations 7.3 and 7.4 using the larger difference between the mean and the confidence limit where the confidence limits are asymmetrical.

ESTABLISHING A NATIONAL THRESHOLD

Use of national inventory uncertainty also makes it possible to adjust the *key source category* threshold, if necessary, to explicitly reflect 90% of the uncertainty in the national inventory. Thus, rather than apply the pre-determined threshold of 95% of the Level and Trend Assessments used in Section 7.2.1.1, Tier 1 Method to Identify Key Source Categories, inventory agencies can use their own uncertainty analyses to develop the threshold.

7.2.2 Qualitative approaches to identify key source categories

There are other criteria to consider when determining *key source categories* that are not as easily assessed through a quantitative analysis. These criteria include:

- *Mitigation techniques and technologies*: If emissions from a source category are being reduced significantly through the use of mitigation techniques or technologies, it is *good practice* to identify these source categories as key. This will ensure that they are prioritised within the inventory and that high quality emissions estimates are prepared. It will also ensure that the methods used are transparent with respect to mitigation which is important for assessing inventory quality.

- *High expected emission growth*: If inventory agencies expect emissions from a source category to grow significantly in the future, they are encouraged to identify that source category as key. Some of these categories will have been identified by the current Trend Assessment (i.e. use of Equations 7.2 or 7.4), and others will be identified by Trend Assessment in the future. Designating a source category as key in anticipation of future emission growth is desirable, because it can result in earlier use of high tier *good practice* methods and earlier collection of more detailed data. This can, in turn, reduce the likelihood of future methodological changes and simplify the recalculation of the emissions estimates over the time series if methodological changes are made.

- *High uncertainty*: If inventory agencies are not taking uncertainty explicitly into account by using the Tier 2 method to identify *key source categories*, they may want to identify the most uncertain source categories as key. This is because the most can be gained in reducing overall inventory uncertainty by improving these estimates of highly uncertain source categories. Designating such source categories as key can therefore lead to improvements in inventory quality.

- *Unexpectedly low or high emissions*: Order of magnitude checks, as described in Chapter 8, Quality Assurance and Quality Control, Section 8.7.1.4, Emission Comparisons, can help identify calculation errors and discrepancies. Inventory agencies may want to identify those source categories that show unexpectedly low or high emissions estimates as key. It is *good practice* to focus attention on those source categories where unexpected results are observed, to ensure that the results are reliable. The source category QA/QC procedures as described in Chapter 8, Quality Assurance and Quality Control, Section 8.7, Source Category-specific QC Procedures (Tier 2), may be implemented if unexpectedly low or high source categories are designated as key.

In most cases, the application of these qualitative criteria will identify source categories already defined as key through the quantitative analysis. Some additional source categories may be identified and these may be added to the list of *key source categories*.

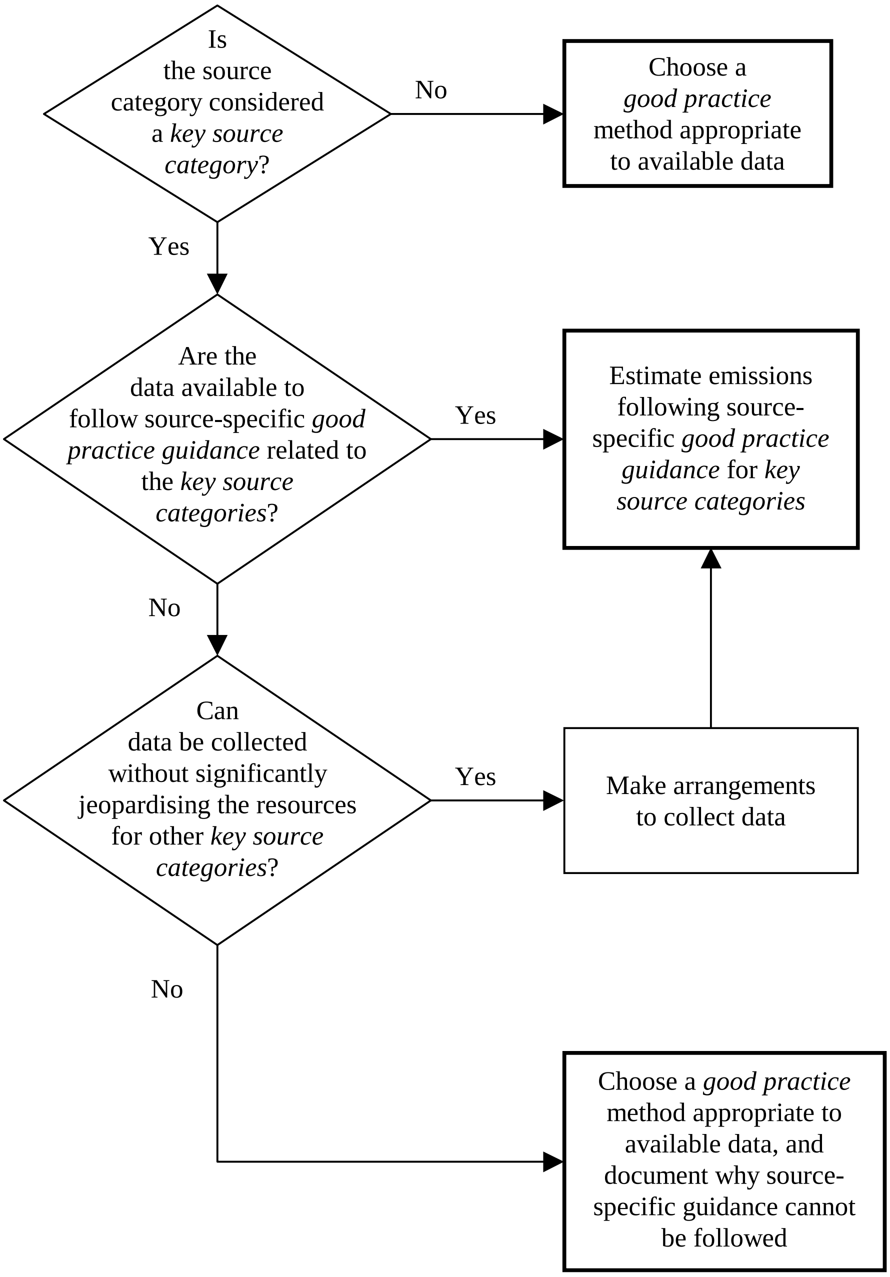
7.2.3 Application of results

Identification of national *key source categories* 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 source categories, in order to ensure completeness. As far as possible, *key source categories* should receive special consideration in terms of two important inventory aspects.

First, additional attention ought to be focused on *key source categories* with respect to methodological choice. As shown in the decision tree in Figure 7.4, Decision Tree to Choose a Good Practice Method, inventory agencies are encouraged to use source category-specific *good practice* methods for their *key source categories*, unless resources are unavailable. For many source categories, higher tier (i.e. Tier 2) methods are suggested for *key source categories*, although this is not always the case. For guidance on the specific application of this principle to particular *key source categories*, inventory agencies should follow the guidance and decision trees in Chapters 2-5.

Second, it is *good practice* that *key source categories* receive additional attention with respect to quality assurance and quality control (QA/QC). In Chapter 8, Quality Assurance and Quality Control, detailed guidance is provided on QA/QC for source categories in the inventory. As described in that chapter, it is *good practice* to carry out detailed source-level quality control and quality assurance on *key source categories*.

Figure 7.4 Decision Tree to Choose a Good Practice Method



7.2.4 Reporting and documentation

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

Table 7.4 should be used to record the results of the *key source category* analysis. This table provides columns for reporting the results of the analysis and the criteria by which each source category was identified.

TABLE 7.4
SOURCE CATEGORY ANALYSIS SUMMARY

Quantitative Method Used : ☐ Tier 1 ☐ Tier 2

A IPCC Source Categories	B Direct Greenhouse Gas	C Key Source Category Flag (Yes or No)	D If C is Yes, Criteria for Identification	E Comments

Where:

Column A: List of IPCC source categories – entry should be the same as column A in Tables 7.2 and 7.3

Column B: Direct greenhouse gas – entry should be the same as column B in Tables 7.2 and 7.3

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

Column D: Criteria by which key source category was identified – for each key source 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

7.3 RECALCULATIONS

As inventory capacity and data availability improve, the methods used to prepare emissions estimates will be updated and refined. Such changes or refinements are desirable when they result in more accurate and complete estimates. In order to assess emission trends it is important that the entire time series of emissions, not just the most recent years, be calculated using the changed or refined methods. It is *good practice* to recalculate historic emissions when methods are changed or refined, when new source categories are included in the national inventory, or when errors in the estimates are identified and corrected.

A *methodological change* occurs when an inventory agency uses a different tier to estimate emissions from a source category or when it moves from a tier described in the *Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories* (*IPCC Guidelines*) to a national method. Methodological changes are often driven by the development of new and different data sets. An example of a methodological change is if an inventory agency begins to use a higher tier method instead of a Tier 1 default method for an industrial source category because it has obtained site-specific emissions measurement data that can be used directly or for development of national emission factors.

A *methodological refinement* occurs when an inventory agency uses the same tier to estimate emissions but applies it using a different data source or a different level of aggregation. An example of a refinement would be if new data permit further disaggregation of a livestock enteric fermentation model, so that resulting animal categories are more homogenous. In this case, the estimate is still being developed using a Tier 2 method, but it is applied at a more detailed level of aggregation. Another possibility is that data of a similar level of aggregation but higher quality could be introduced, due to improved data collection methods.

This section discusses how to determine when methods should be changed or refined, and it describes *good practice* for recalculating emissions. Recalculations of the whole time series should be documented as described below, and consistent with source-specific *good practice guidance*. As far as possible, use of refined emissions 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.

7.3.1 Reasons for recalculations

7.3.1.1 CHANGES OR REFINEMENTS IN METHODS

It is *good practice* to change or refine methods when:

- *Available data have changed*: The availability of data is a critical determinant of the appropriate method, and thus changes in available data may lead to changes or refinements in methods. As inventory agencies gain experience and devote additional resources to preparing greenhouse gas emissions inventories, it is expected that data availability will improve.[6]

- *The previously used method is not consistent with good practice guidance for that source category*: Inventory agencies should review the guidance for each source category in Chapters 2-5.

- *A source category has become key*: A source category might not be considered key in the base year, depending on the criteria used, but could become key in a future year. For example, many countries are only beginning to substitute HFCs and PFCs for ozone depleting substances being phased out under the Montreal Protocol. Although current emissions from this source category are low, they could become key in the future based on trend or level. Inventory agencies anticipating significant growth in a source category may want to consider this possibility before it becomes key.

- *The previously used method is insufficient to reflect mitigation activities in a transparent manner*: As techniques and technologies for reducing emissions are introduced, inventory agencies should use methods that can account for the resulting decrease in emissions in a transparent manner. Where the previously used methods are insufficiently transparent, it is *good practice* to change or refine them.

- *The capacity for inventory preparation has increased*: Over time, the human or financial capacity or both to prepare inventories may increase. If inventory agencies increase inventory capacity, it is *good practice* to

[6] In some circumstances data collections may be reduced which can also lead to a change or refinement in method.

change or refine methods so as to produce more accurate, complete or transparent estimates, particularly for *key source categories.*

- *New methods become available*: In the future, new methods may be developed that take advantage of new technologies or improved scientific understanding. For example, remote-sensing technology may make it possible to estimate emissions from natural gas pipelines more accurately than by using simple production-based emission factors, or improvements in emission monitoring technology may make it possible to directly monitor more emissions. Inventory agencies should ensure that their methods are consistent with the *IPCC Guidelines* and with this report on *Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories* (*Good Practice Report*).

7.3.1.2 INCLUSION OF NEW SOURCES

In some circumstances, inventory agencies may identify new source categories or new gases that should be included in their emissions inventories. In this case, an inventory agency will need to develop or implement a new methodology. This situation is not formally considered a methodological change or refinement, but is mentioned here because guidance provided in Section 7.3.2, Approaches to Recalculations, regarding how to develop a consistent time series is relevant when considering new source categories.

7.3.1.3 CORRECTION OF ERRORS

It is possible that the implementation of the QA/QC procedures described in Chapter 8, Quality Assurance and Quality Control, will lead to the identification of errors or mistakes in the emissions inventory. As noted in that chapter, it is *good practice* to correct errors in previously submitted estimates. In a strict sense, the correction of errors should not be considered a methodological change or refinement. This situation is noted here, however, because the guidance described in Section 7.3.2 below should be taken into consideration when making necessary corrections.

7.3.2 Approaches to recalculations

All emissions estimates in a time series should be estimated consistently, which means that previously submitted estimates should be evaluated for consistency and recalculated if necessary whenever methods are changed or refined. As described below, previous estimates should be recalculated using the new methods for all years in the time series. For many source categories, it should be possible to do this. In some cases, however, it may not be possible to use the same method for all inventory years. This situation may arise more frequently in the future, as the base year of the inventory becomes more distant in time. If it is not possible to use the same method in all years, the alternative approaches described in Section 7.3.2.2, Alternative Recalculation Techniques, should be evaluated.

It is important to note that some changes or refinements to methods will be applicable across the entire time series, while others may only be applicable in particular years. For example, if mitigation technologies have been introduced, it may be necessary to consider the appropriate approach to phase in gradual changes in emission factors or technology deployment. Thus, the specific characteristics of the source category and the methodological change or refinement should be carefully evaluated when undertaking a recalculation.

7.3.2.1 RECALCULATIONS USING A NEW METHOD FOR ALL YEARS

It is *good practice* to recalculate previous estimates using the same method and a consistent set of data in every inventory year. This approach is the most reliable means of ensuring an accurate and consistent trend over the time period.

In some cases, it may not be possible to recalculate previous estimates using the same method and a consistent data set over the entire time series. The most probable difficulty with using a new method for recalculation is the lack of a complete data set for past years. Before concluding that necessary data are not available, particularly in the case of *key source categories*, it is *good practice* to consider a variety of means of obtaining them. For example, it may be possible to initiate new data collection activities, or to obtain additional data from statistical offices, sector experts, or industry contacts, making arrangements for the protection of confidential business information if necessary.

7.3.2.2 ALTERNATIVE RECALCULATION TECHNIQUES

Several alternative recalculation techniques are available if full recalculation using the same method is not possible. Each technique is appropriate in certain situations, as determined by considerations such as data availability and the nature of the methodological modification. Selecting an alternative technique requires evaluating the specific circumstances, and determining the best option for the particular case.

The principal approaches for inventory recalculations are summarised in Table 7.5 below and described in more detail below. These approaches can be applied at the level of the method (in the case of a methodological change) or at the level of the underlying data (in the case of a methodological refinement).

TABLE 7.5
SUMMARY OF APPROACHES TO RECALCULATIONS

Approach	**Applicability**	**Comments**
Overlap	Data necessary to apply both the previously used and the new method must be available for at least one year.	• Most reliable when the overlap between two or more sets of annual emissions estimates can be assessed. • If the relationship observed using the two methods is inconsistent, the recalculation should be based on two or more annual emissions estimates. • If the emission trends observed using the previously used and new methods are inconsistent and random, this approach is not *good practice*.
Surrogate Method	Emission factors or activity data used in the new method are strongly correlated with other well-known and more readily available indicative data.	• Multiple indicative data sets (singly or in combination) should be tested in order to determine the most strongly correlated. • Should not be done for long periods.
Interpolation	Data needed for recalculation using the new method are available for intermittent years during the time series.	• Emissions estimates can be linearly interpolated for the periods when the new method cannot be applied.
Trend Extrapolation	Data for the new method are not collected annually and are not available at the beginning or the end of the time series.	• Most reliable if the trend over time is constant. • Should not be used if the trend is changing (in this case, the surrogate method may be more appropriate). • Should not be done for long periods.

OVERLAP

When a method is changed or modified, the estimates prepared using both the previously used and the new method should be compared in terms of the level and the trend. If the new method cannot be used for all years, it may be possible to develop a time series based on the relationship (or overlap) observed between the two methods during the years when both can be used. Essentially, the time series is constructed by assuming that there is a consistent relationship between the results of the previously used and new method. The emissions estimates for those years when the new method cannot be used directly are developed by proportionally adjusting the previously developed emissions estimates, based on the relationship observed during the period of overlap.

The overlap method is most commonly used when there is a proportional relationship between the two methods. In this case, the emissions associated with the new method are estimated according to Equation 7.5:

EQUATION 7.5

$$y_0 = x_0 \bullet \left(\sum_{i=m}^{n} y_i \Big/ \sum_{i=m}^{n} x_i \right)$$

Where:

y_0 is the recalculated emission estimate computed using the overlap method

x_0 is the estimate developed using the previously used method

sum of y_i and x_i are the estimates prepared using the new and previously used methods during the period of overlap, as denoted by years m through n

A relationship between the previously used and new methods can be evaluated by comparing the overlap between only one set of annual emissions estimates, but it is preferable to compare multiple years. This is because comparing only one year may lead to bias and it is not possible to evaluate trends. Other relationships between the old and new estimates may also be observed through an assessment of overlap. For example, a constant difference may be observed. In this case, the emissions associated with the new method are estimated by adjusting the previous estimate by the constant amount. For more information on the overlap method of recalculating (which can also be called 'splicing methodologies'), refer to Annex 1, Conceptual Basis for Uncertainty Analysis.

SURROGATE METHOD

The surrogate method relates emissions estimates to underlying activity or other indicative data. Changes in these data are used to simulate the trend in emissions. The estimate should be related to the statistical data source that best explains the time variations of the emission source category. For example, mobile source emissions may be related to trends in vehicle distances travelled, emissions from domestic wastewater may be related to population, and industrial emissions may be related to production levels in the relevant industry.

In its simplest form, the emissions estimate will be related to a single type of data as shown in Equation 7.6:

EQUATION 7.6

$$y_0 = y_t \bullet (s_0 / s_t)$$

Where:

y is the emission estimate in years 0 and t

s is the surrogate statistical parameter in years 0 and t

In some cases, more accurate relationships may be developed by relating emissions to more than one statistical parameter. Regression analysis may be useful in selecting the appropriate surrogate data parameters.

Using surrogate methods to estimate otherwise unavailable data can improve the accuracy of estimates developed by the interpolation and trend extrapolation approaches discussed below.

INTERPOLATION

In some cases it may be possible to apply a method intermittently throughout the time series. For example, necessary detailed statistics may only be collected every few years, or it may be impractical to conduct detailed surveys on an annual basis. In this case, estimates for the intermediate years in the time series can be developed by interpolating between the detailed estimates. If information on the general trends or underlying parameters is available, then the surrogate method is preferable.

TREND EXTRAPOLATION

When detailed estimates have not been prepared for the base year or the most recent year in the inventory, it may be necessary to extrapolate from the closest detailed estimate. Extrapolation can be conducted either forward (to estimate more recent emissions) or backward (to estimate a base year). Trend extrapolation simply assumes that the observed trend in emissions during the period when detailed estimates are available remains constant over the period of extrapolation. Given this assumption, it is clear that trend extrapolation should not be used if the emission growth trend is not constant over time. Extrapolation should also not be used over long periods of time without detailed checks at intervals to confirm the continued validity of the trend.

SPECIFIC SITUATIONS

In some cases, it may be necessary to develop a customised approach in order to best estimate the emissions over time. For example, the standard alternatives may not be valid when technical conditions are changing throughout the time series (e.g. due to the introduction of mitigation technology). In this case, revised emission factors may be needed and it will also be necessary to carefully consider the trend in the factors over the period. Where customised approaches are used, it is *good practice* to document them thoroughly, and in particular to give special consideration to how the resultant emissions estimates compare to those that would be developed using the more standard alternatives.

7.3.3 Documentation

Clear documentation of recalculations is essential for transparent emissions estimates, and to demonstrate that the recalculation is an improvement in accuracy and completeness. In general, the following information should be provided whenever recalculations are undertaken:

- The effect of the recalculations on the level and trend of the estimate (by providing the estimates prepared using both the previously used and new methods);
- The reason for the recalculation (see Section 7.3.1, Reason for Recalculations);
- A description of the changed or refined method;
- Justification for the methodological change or refinement in terms of an improvement in accuracy, transparency, or completeness;
- The approach used to recalculate previously submitted estimates;
- The rationale for selecting the approach which should include a comparison of the results obtained using the selected approach and other possible alternatives, ideally including a simple graphical plot of emissions vs. time or relevant activity data or both.

APPENDIX 7A.1
EXAMPLE OF TIER 1 KEY SOURCE CATEGORY IDENTIFICATION

The application of the Tier 1 quantitative analysis to the US emissions inventory for 1990-1997 is shown in Tables 7.A1 to 7.A3. Both the Level and the Trend Assessment were conducted using emissions estimates from USEPA (1999). A qualitative assessment was not conducted in this example, but it was not anticipated that additional source categories would have been identified. The Tier 2 approach was not used because source category uncertainty estimates following the guidance provided in Chapter 6, Quantifying Uncertainties in Practice, were not available at the time of publication of *Good Practice Report.*

The results of the Level Assessment are shown in Table 7.A1, with *key source categories* shaded. The entries for columns A-D were taken directly from USEPA (1999). Entries in Column E were calculated using Equation 7.1. The source categories (i.e. rows of the table) were sorted on column E in descending order of magnitude, and then the cumulative total was included in Column F. *Key source categories* are those which added up to 95% of the entries in Column E after this sorting process.

The results of the Trend Assessment are shown in Table 7.A2, with *key source categories* shaded. As in Table 7.A1, the entries for columns A-D were taken directly from USEPA (1999). Entries in Column E were calculated using Equation 7.2 and entering the absolute value of the result. Column F was calculated as the percentage of the source category entry in Column E over the total for all source categories in Column E. *Key source categories* according to the Trend Assessment were identified by sorting the source category entries in Column F from largest to smallest. Column G was used to determine the cumulative total of Column F, and *key source categories* are those which added up to 95% of the entries in Column F after the sorting process.

Table 7.A3 summarises the results of the analysis, following the reporting and documentation suggestions in Section 7.2.4, Reporting and Documentation. As the table indicates, 17 *key source categories* are identified for the US inventory based on the results of this analysis. All major fuels (i.e. coal, oil and gas) used in the source category 'CO_2 Emissions from Stationary Combustion' were identified as key, for both level and trend. Eight other source categories are key in terms of both the Level and the Trend Assessments. Two source categories – CH_4 Emissions from Manure Management and Indirect N_2O Emissions from Nitrogen Used in Agriculture – are key only in terms of the Level Assessment. The remaining six source categories, all but one of which are Industrial Processes Sector emissions, are key only in terms of the Trend Assessment. For most of the *key source categories* identified due to trend, emissions are falling significantly. A few source categories, such as Emissions from Substitutes for Ozone Depleting Substances source category, are key because of rapid emissions growth.

TABLE 7.A1
TIER 1 ANALYSIS – LEVEL ASSESSMENT (US INVENTORY)

A IPCC Source Categories[a]	B Direct Greenhouse Gas	C Base Year Estimate (Mt Carbon Equivalent [b])	D Current Year Estimate (Mt Carbon Equivalent [b])	E Level Assessment	F Cumulative Total of Column E
CO_2 Emissions from Stationary Combustion – Coal	CO_2	481.6	533.3	0.29	0.29
Mobile Combustion – Road & Other	CO_2	338.1	381.0	0.21	0.50
CO_2 Emissions from Stationary Combustion – Gas	CO_2	266.0	313.1	0.17	0.68
CO_2 Emissions from Stationary Combustion – Oil	CO_2	176.8	177.5	0.10	0.77
CH_4 Emissions from Solid Waste Disposal Sites	CH_4	56.2	66.7	0.04	0.81
Direct N_2O Emissions from Agricultural Soils	N_2O	46.6	53.7	0.03	0.84
Mobile Combustion: Aircraft	CO_2	50.5	50.1	0.03	0.87
Fugitive Emissions from Oil and Gas Operations	CH_4	34.5	35.1	0.02	0.89
CH_4 Emissions from Enteric Fermentation in Domestic Livestock	CH_4	32.7	34.1	0.02	0.91
Indirect N_2O Emissions from Nitrogen Used in Agriculture	N_2O	18.8	20.4	0.01	0.92
Fugitive Emissions from Coal Mining and Handling	CH_4	24.0	18.8	0.01	0.93
CH_4 Emissions from Manure Management	CH_4	14.9	17.0	0.01	0.94
Mobile Combustion: Road and Other	N_2O	13.0	16.9	0.01	0.95
Mobile Combustion: Marine	CO_2	16.4	15.4	0.01	0.96
Emissions from Substitutes for Ozone Depleting Substances	Several	0.3	14.7	0.01	0.96
CO_2 Emissions from Cement Production	CO_2	8.9	10.2	0.01	0.97
HFC-23 Emissions from HCFC-22 Manufacture	HFC	9.5	8.2	0.01	0.97
SF_6 Emissions from Electrical Equipment	SF_6	5.6	7.0	<0.01	0.98
Non-CO_2 Emissions from Stationary Combustion	N_2O	3.8	4.1	<0.01	0.98
N_2O Emissions from Adipic Acid Production	N_2O	4.7	3.9	<0.01	0.98
CO_2 Emissions from Lime Production	CO_2	3.3	3.9	<0.01	0.98
N_2O Emissions from Nitric Acid Production	N_2O	3.3	3.8	<0.01	0.99
CO_2 Emissions from Other Industrial Processes	CO_2	2.7	3.6	<0.01	0.99
SF_6 from Magnesium Production	SF_6	1.7	3.0	<0.01	0.99
N_2O Emissions from Manure Management	N_2O	2.6	3.0	<0.01	0.99
PFC Emissions from Aluminium Production	PFC	4.9	2.9	<0.01	0.99
CH_4 Emissions from Rice Production	CH_4	2.5	2.7	<0.01	0.99
Emissions from Wastewater Handling	N_2O	2.1	2.3	<0.01	1.00
Non-CO_2 Emissions from Stationary Combustion	CH_4	2.3	2.2	<0.01	1.00
Mobile Combustion: Road & Other	CH_4	1.4	1.4	<0.01	1.00
PFC, HFC and SF_6 Emissions from Semiconductor Manufacturing	Several	0.2	1.3	<0.01	1.00
Emissions from Wastewater Handling	CH_4	0.9	0.9	<0.01	1.00
Mobile Combustion: Aviation	N_2O	0.5	0.5	<0.01	1.00
CH_4 Emissions from Other Industrial Sources	CH_4	0.3	0.4	<0.01	1.00
CH_4 Emissions from Agricultural Residue Burning	CH_4	0.2	0.2	<0.01	1.00
Mobile Combustion: Marine	N_2O	0.1	0.1	<0.01	1.00
Emissions from Waste Incineration	N_2O	0.1	0.1	<0.01	1.00
N_2O Emissions from Agricultural Residue Burning	N_2O	0.1	0.1	<0.01	1.00
TOTAL		1632.1	1813.6	1.00	

[a] LUCF is not included in this analysis.

[b] Estimates should be presented in CO_2-equivalent units as indicated in the notes to Tables 7.2 and 7.3.

Source: USEPA (1999).

TABLE 7.A2
TIER 1 ANALYSIS – TREND ASSESSMENT (US INVENTORY)

A IPCC Source Categories[a]	B Direct Greenhouse Gas	C Base Year Estimate (Mt Carbon Equivalent[b])	D Current Year Estimate (Mt Carbon Equivalent[b])	E Trend Assessment	F % Contri-bution to Trend	G Cumulative total of Column F
CO_2 Emissions from Stationary Combustion – Oil	CO_2	176.8	177.5	0.01	19	0.19
CO_2 Emissions from Stationary Combustion – Gas	CO_2	266.0	313.1	0.01	17	0.36
Emissions from Substitutes for Ozone Depleting Substances	Several	0.3	14.7	0.01	14	0.50
Fugitive Emissions from Coal Mining and Handling	CH_4	24.0	18.8	<0.01	8	0.58
Mobile Combustion: Aviation	CO_2	50.5	50.1	<0.01	6	0.64
Mobile Combustion: Road & Other	CO_2	338.1	381.0	<0.01	5	0.69
CH_4 Emissions from Solid Waste Disposal Sites	CH_4	56.2	66.7	<0.01	4	0.73
Fugitive Emissions from Oil & Gas Operations	CH_4	34.5	35.1	<0.01	3	0.76
Mobile Combustion: Marine	CO_2	16.4	15.4	<0.01	3	0.79
PFC Emissions from Aluminium Production	PFC	4.9	2.9	<0.01	3	0.82
Mobile Combustion: Road & Other	N_2O	13.0	16.9	<0.01	2	0.84
HFC-23 Emissions from HCFC-22 Manufacture	HFC	9.5	8.2	<0.01	2	0.87
CH_4 Emissions from Enteric Fermentation in Domestic Livestock	CH_4	32.7	34.1	<0.01	2	0.89
Direct N_2O Emissions from Agricultural Soils	N_2O	46.6	53.7	<0.01	2	0.91
CO_2 Emissions from Stationary Combustion – Coal	CO_2	481.6	533.3	<0.01	2	0.92
N_2O Emissions from Adipic Acid Production	N_2O	4.7	3.9	<0.01	1	0.94
SF_6 from Magnesium Production	SF_6	1.7	3.0	<0.01	1	0.95
PFC, HFC and SF_6 Emissions from Semiconductor Manufacturing	Several	0.2	1.3	<0.01	1	0.96
SF_6 Emissions from Electrical Equipment	SF_6	5.6	7.0	<0.01	1	0.97
CO_2 Emissions from Other Industrial Processes	CO_2	2.7	3.6	<0.01	1	0.97
Indirect N_2O Emissions from Nitrogen Used in Agriculture	N_2O	18.8	20.4	<0.01	<1	0.98
CH_4 Emissions from Manure Management	CH_4	14.9	17.0	<0.01	<1	0.98
Non-CO_2 Emissions from Stationary Combustion	CH_4	2.3	2.2	<0.01	<1	0.99
CO_2 Emissions from Cement Production	CO_2	8.9	10.2	<0.01	<1	0.99
CO_2 Emissions from Lime Production	CO_2	3.3	3.9	<0.01	<1	0.99
Mobile Combustion: Road & Other	CH_4	1.4	1.4	<0.01	<1	0.99
N_2O Emissions from Nitric Acid Production	N_2O	3.3	3.8	<0.01	<1	0.99
Non-CO_2 Emissions from Stationary Combustion	N_2O	3.8	4.1	<0.01	<1	1.0
N_2O Emissions from Manure Management	N_2O	2.6	3.0	<0.01	<1	1.0
Emissions from Wastewater Handling	CH_4	0.9	0.9	<0.01	<1	1.0
CH_4 Emissions from Rice Production	CH_4	2.5	2.7	<0.01	<1	1.0
CH_4 Emissions from Other Industrial Processes	CH_4	0.3	0.4	<0.01	<1	1.0
Mobile Combustion: Aviation	N_2O	0.5	0.5	<0.01	<1	1.0
Emissions from Wastewater Handling	N_2O	2.1	2.3	<0.01	<1	1.0
CH_4 Emissions from Agricultural Residue Burning	CH_4	0.2	0.2	<0.01	<1	1.0
Mobile Combustion: Marine	N_2O	0.1	0.1	<0.01	<1	1.0
Emissions from Waste Incineration	N_2O	0.1	0.1	<0.01	<1	1.0
N_2O Emissions from Agricultural Residue Burning	N_2O	0.1	0.1	<0.01	<1	1.0
Total		1632.1	1813.6	0.05	1.00	

[a] LUCF is not included in this analysis.

[b] Estimates should be presented in CO_2-equivalent units as indicated in the notes to Tables 7.2 and 7.3.

Source: USEPA (1999).

TABLE 7.A3
SOURCE CATEGORY ANALYSIS SUMMARY (US INVENTORY)

Quantitative Method Used : ☑ Tier 1 ☐ Tier 2

A IPCC Source Categories	B Direct Greenhouse Gas	C Key Source Category Flag	D If Column C is Yes, Criteria for Identification	E Comments
ENERGY SECTOR				
CO_2 Emissions from Stationary Combustion – Coal	CO_2	Yes	Level, Trend	
CO_2 Emissions from Stationary Combustion – Oil	CO_2	Yes	Level, Trend	
CO_2 Emissions from Stationary Combustion – Gas	CO_2	Yes	Level, Trend	
Non-CO_2 Emissions from Stationary Combustion	CH_4	No		
Non-CO_2 Emissions from Stationary Combustion	N_2O	No		
Mobile Combustion: Road & Other	CO_2	Yes	Level, Trend	
Mobile Combustion: Road and Other	CH_4	No		
Mobile Combustion: Road and Other	N_2O	Yes	Level, Trend	
Mobile Combustion: Aviation	CO_2	Yes	Level, Trend	
Mobile Combustion: Aviation	N_2O	No		
Mobile Combustion: Marine	CO_2	Yes	Trend	
Mobile Combustion: Marine	N_2O	No		
Fugitive Emissions from Coal Mining and Handling	CH_4	Yes	Level, Trend	
Fugitive Emissions from Oil & Gas Operations	CH_4	Yes	Level, Trend	
INDUSTRIAL SECTOR				
CO_2 Emissions from Cement Production	CO_2	No		
CO_2 Emissions from Lime Production	CO_2	No		
CO_2 Emissions from Other Industrial Processes	CO_2	No		
CH_4 Emissions from Other Industrial Processes	CH_4	No		
N_2O Emissions from Adipic Acid Production	N_2O	Yes	Trend	
N_2O Emissions from Nitric Acid Production	N_2O	No		
PFC Emissions from Aluminium Production	PFC	Yes	Trend	
SF_6 from Magnesium Production	SF_6	Yes	Trend	
SF_6 Emissions from Electrical Equipment	SF_6	No		
PFC, HFC and SF_6 Emissions from Semiconductor Manufacturing	SF_6	No		
Emissions from Substitutes for Ozone Depleting Substances	Several	Yes	Trend	
HFC-23 Emissions from HCFC-22 Manufacture	HFC	Yes	Trend	
AGRICULTURE SECTOR				
CH_4 Emissions from Enteric Fermentation in Domestic Livestock	CH_4	Yes	Level, Trend	
CH_4 Emissions from Manure Management	CH_4	Yes	Level	
N_2O Emissions from Manure Management	N_2O	No		
Direct N_2O Emissions from Agricultural Soils	N_2O	Yes	Level, Trend	
Indirect N_2O Emissions from Nitrogen Used in Agriculture	N_2O	Yes	Level	
CH_4 Emissions from Rice Production	CH_4	No		
CH_4 Emissions from Agricultural Residue Burning	CH_4	No		
N_2O Emissions from Agricultural Residue Burning	N_2O	No		
WASTE SECTOR				
CH_4 Emissions from Solid Waste Disposal Sites	CH_4	Yes	Level, Trend	
Emissions from Wastewater Handling	CH_4	No		
Emissions from Wastewater Handling	N_2O	No		
Emissions from Waste Incineration	N_2O	No		

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