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INTRODUCTION

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1.1 DEVELOPMENT OF THE PROGRAMME

At its 8th session in June 1998, the Subsidiary Body for Scientific and Technological Advice (SBSTA-8) of the United Nations Framework Convention on Climate Change (UNFCCC), *encouraged the IPCC-OECD-IEA Inventories Programme to give high priority to completing its work on uncertainty, as well as to prepare a report on good practices in inventory management and to submit a report on these issues for consideration by the SBSTA, if possible by COP5*. This report is the IPCC's (Intergovernmental Panel on Climate Change) response to the SBSTA.

To prepare for the work required, the IPCC held an Expert Meeting in Paris in October 1998. The Paris meeting treated *good practice* as a way to manage uncertainties, as these would remain associated with greenhouse gas emissions inventories for the foreseeable future. *Good practice guidance* assists countries in producing inventories that are accurate in the sense of being neither over nor underestimates so far as can be judged, and in which uncertainties are reduced as far as practicable. *Good practice guidance* further supports the development of inventories that are transparent, documented, consistent over time, complete, comparable, assessed for uncertainties, subject to quality control and assurance, efficient in the use of the resources available to inventory agencies, and in which uncertainties are gradually reduced as better information becomes available.

The Paris meeting planned a series of four sectoral Expert Meetings to define *good practice* by sector and source category. These meetings covered, respectively, (i) industrial process emissions [1] and emissions of new greenhouse gases i.e., hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulphur hexafluoride (SF_6), (ii) emissions associated with energy production and consumption, (iii) agricultural emissions and (iv) emissions from waste.

The four sectoral meetings were followed by a meeting on quantifying uncertainties and cross-cutting issues in inventory management, and a concluding meeting to finalise the work. Emissions and removals associated with carbon stocks in land use, land-use change and forestry were not addressed in this phase of work because of the parallel IPCC activity to produce a Special Report on this Sector. The Paris meeting anticipated the need to define *good practice* in this area also, once the Special Report is complete and the Parties have had time to consider it. Currently, *good practice guidance* covers emissions of the direct greenhouse gases: carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), HFCs, PFCs, and SF_6. Emissions of the precursor gases carbon monoxide (CO), nitrogen oxides (NO_x), and non-methane volatile organic compounds (NMVOCs) were not covered in this phase of *good practice* but could form part of the future work programme. Emissions associated with Solvents and Other Product Use are not covered in this report as the main gases emitted in this sector fall into the class of NMVOCs.

It soon became clear that the programme initiated in Paris could not be completed by the fifth Conference of the Parties to the UNFCCC (COP5), especially given the need for the report to go through the process of government and expert review. Also, with regard to the UNFCCC, the timetable for methodological work agreed at COP4 required substantive outputs by COP6. Therefore, the timetable was extended, so that the IPCC's report on *Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories* could be available to the Parties at COP6 rather than COP5.

1.2 QUANTIFYING UNCERTAINTIES IN ANNUAL INVENTORIES AND TRENDS

The *IPCC Guidelines* contain some quantitative advice on uncertainties,[2] although so far relatively few countries have reported on uncertainties in a systematic way.

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[1] *Good practice guidance* complementary to the *IPCC Guidelines* has not been developed for some categories of industrial emissions that are identified at the beginning of Chapter 3, Industrial Processes.

[2] *Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories*, Vol. 1, Annex 1, *Managing Uncertainties* (IPCC, 1996).

Nevertheless, evidence considered by the Paris meeting indicated that for a developed country the overall uncertainty in emissions weighted by global warming potentials (GWPs) in a single year could be of the order of 20%, mainly due to uncertainties in non-CO_2 gases.[3]

Analysis also indicated that the uncertainty in the trend in emissions may be less than the uncertainty in the absolute value of emissions in any year. This is because a method that over or underestimates emissions from a source category in one year may similarly over or underestimate emissions in subsequent years. The preliminary evidence available to the Paris meeting suggested that, when this compensation is taken into account, the uncertainty on the trend in emissions between years could fall to a few percent for industrialised countries.[4]

Chapter 6, Quantifying Uncertainties in Practice, of this report describes methods to determine the uncertainty in each source category. These methods use a combination of empirical data and expert judgement according to availability. They estimate the relative contribution that the source category makes to the overall uncertainty of national inventory estimates, in terms of the trend as well as absolute level. These methods are consistent with the conceptual guidance on uncertainties in Annex 1, Conceptual Basis for Uncertainty Analysis. They will enable countries to report on uncertainties in a consistent manner, and provide valuable input to national inventory research and development activities. The methods are capable of allowing for relationships in uncertainties between different inventory components, and are supplemented by an extensive set of default uncertainties developed through the sector workshops.

1.3 ROLE OF GOOD PRACTICE IN MANAGING UNCERTAINTIES

To be consistent with *good practice* as defined in this report, inventories should contain *neither over nor underestimates so far as can be judged*, and the uncertainties in these estimates should be *reduced as far as practicable*.

These requirements are to ensure that emissions estimates, even if uncertain, are bona fide estimates, in the sense of not containing any biases that could have been identified and eliminated, and that uncertainties have been minimised as far as practicable given national circumstances. Estimates of this type would presumably be the best attainable, given current scientific knowledge and available resources.

Good practice aims to deliver these requirements by providing guidance on:

- Choice of estimation method within the context of the *IPCC Guidelines*;
- Quality assurance and quality control procedures to provide cross-checks during inventory compilation;
- Data and information to be documented, archived and reported to facilitate review and assessment of emission estimates;
- Quantification of uncertainties at the source category level and for the inventory as a whole, so that the resources available for research can be directed toward reducing uncertainties over time, and the improvement can be tracked.

Chapters 2 to 5 set out *good practice guidance* on the choice of estimation method at the source category level by means of decision trees of the type illustrated in Figure 1.1, Example-Decision Tree for CH_4 Emissions from Solid Waste Disposal Sites. The decision trees formalise the choice of the estimation method most suited to national circumstances. The source category guidance linked to the decision trees also provides information on the choice of emission factors and activity data, and on the associated uncertainty ranges needed to support the uncertainty estimation procedures described in Chapter 6, Quantifying Uncertainties in Practice. The most appropriate choice of estimation method (or tier) will depend on national circumstances, including the availability of resources and can be determined according to the methods set out in Chapter 7, Methodological Choice and Recalculation.

Inventory development is a resource intensive enterprise which means firstly that inventory agencies may need to prioritise among source categories and estimation methods, and secondly that data quality may improve over time. Guidance applicable to all source categories is given in Chapter 7, regarding how to identify the *key source*

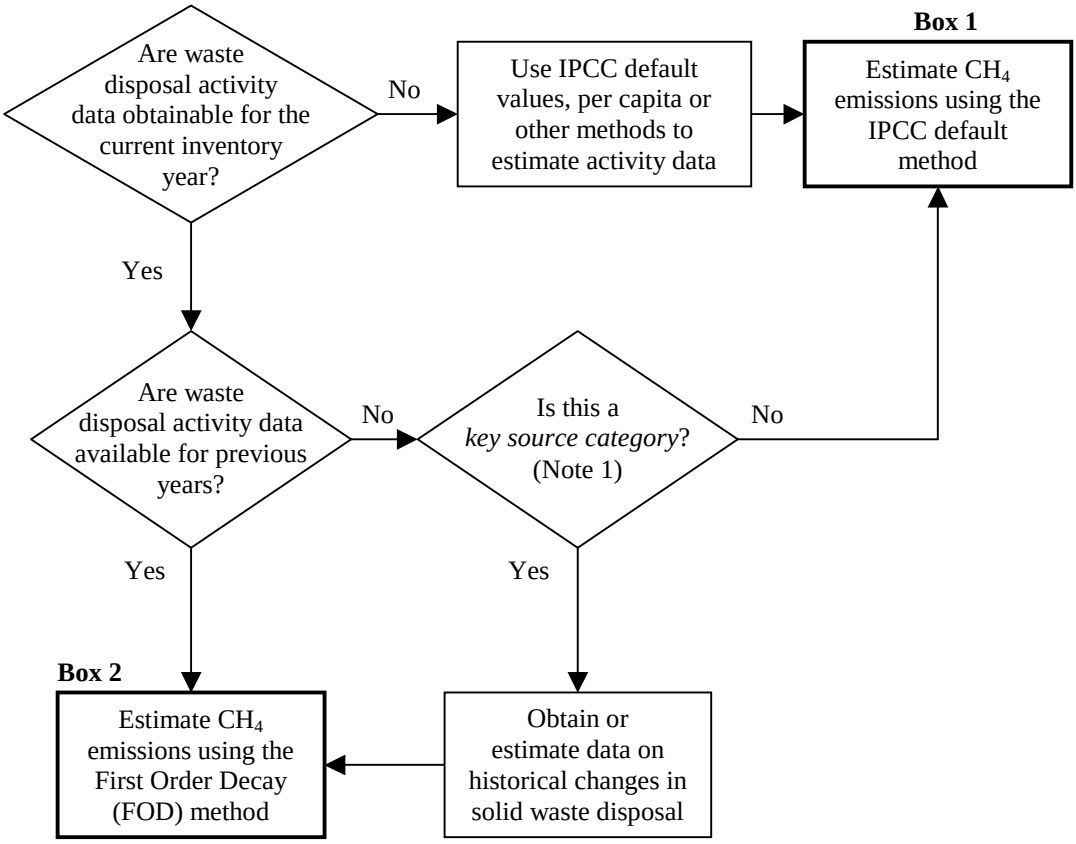
[3] Based on an analysis of the UK inventory presented to the Paris meeting (Eggleston *et al.*, 1998) and which is described in more detail in Chapter 6, Quantifying Uncertainties in Practice, Section 6.3.1, Comparison between Tiers and Choice of Method.

[4] See footnote 3

categories that should be prioritised in the inventory development process, as well as when and how to recalculate previously prepared emissions estimates to ensure consistent emission trends. A *key source category* is defined in Chapter 7, as one that has a significant influence on a country's total inventory of direct greenhouse gases in terms of the absolute level of emissions or the trend, or both. The outcome of the determination of the *key source category* analysis is taken into account during inventory preparation as indicated in the decision trees. Chapter 7, also addresses means to manage methodological changes and recalculations. For example, a change in a method may be due to the introduction of emissions' abatement technology, the availability of more detailed data, or the greater significance of a source category whose rapid variation over time substantially affects the trend in total emissions. Guidance is provided for splicing time series in those cases where changes in methods are consistent with *good practice*.

Good practice in quality assurance and quality control (QA/QC) procedures described in Chapter 8, Quality Assurance and Quality Control, covers measurement standards, routine computational and completeness checks, and documentation and data archiving procedures to be applied to the inventory at the compilation stage. Chapter 8, also describes a system of independent review and auditing that could be implemented by inventory agencies. QA/QC as defined here covers only actions that inventory agencies could take in respect of their own inventories. It does not include an international system of review, except insofar as the requirements for transparency would be common between an international review process and internal reviews conducted routinely by inventory agencies.

Figure 1.1 Example-Decision Tree for CH_4 Emissions from Solid Waste Disposal Sites



Note 1: 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. (See Chapter 7, Methodological Choice and Recalculation, Section 7.2, Determining National Key Source Categories.)

Throughout this report, *good practice* refers to actions that could be undertaken by inventory agencies in producing their greenhouse gas inventories. However, the request from the SBSTA is not restricted to national actions, and in the Annexes the report reflects the broader picture, both scientifically and internationally.

Annex 1, Conceptual Basis for Uncertainty Analysis, deals with the concepts that underlie the practical advice on uncertainties provided in Chapters 2 to 8 of the main report. Annex 2, Verification, discusses international and scientific aspects of inventory verification. Annex 3, the Glossary, defines the terms of particular interest in the context of greenhouse gas inventories, and also summarises mathematical definitions of selected statistical terms for convenient reference.

1.4 POLICY RELEVANCE

The report on *Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories (Good Practice Report)* does not revise or replace the *IPCC Guidelines*, but provides a reference that complements and is consistent with these Guidelines. This is because the Conference of the Parties decided[5] that these *IPCC Guidelines* would be used for reporting by Parties included in Annex I to the UNFCCC. For the purposes of developing *good practice guidance*, consistency with the *IPCC Guidelines* is defined by three criteria:

(i) Specific source categories addressed by *good practice guidance* have the same definitions as the corresponding categories in the *IPCC Guidelines.*

(ii) *Good practice guidance* uses the same functional forms for the equations used to estimate emissions that are used in the *IPCC Guidelines.*

(iii) *Good practice guidance* allows correction of any errors or deficiencies[6] that have been identified in the *IPCC Guidelines.*

Criterion (i) does not exclude identification of additional source categories that may be included in the *Other* category in the *IPCC Guidelines*. Default emission factors or model parameter values have been updated where they can be linked to particular national circumstances and documented.

The main development in the negotiations since the SBSTA-8's request has been agreement on the revised reporting guidelines for Annex I Parties' greenhouse gas inventories.[7] These UNFCCC guidelines contain cross references to the IPCC's work on *good practice* concerning choice of methodology, emission factors, activity data, uncertainties, quality assessment and quality control procedures, time series consistency, accuracy and verification.

It is through *good practice guidance and uncertainty management* that a sound basis can be provided to produce more reliable estimates of the magnitude of absolute and trend uncertainties in greenhouse gas inventories than has been achieved previously. Whatever the level of complexity of the inventory, *good practice* provides improved understanding of how uncertainties may be managed to produce emissions estimates that are acceptable for the purposes of the UNFCCC, and for the scientific work associated with greenhouse gas inventories.

[5] Decision 2/CP.3 and the document FCCC/CP/1999/7 referred to in decision 3/CP.5.

[6] For example, some of the equations in the *IPCC Guidelines* do not formally allow for emissions mitigation technologies or techniques.

[7] See Decision 3/CP.5.