Overview of national GHG inventories: How to prepare national GHG inventory

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Outline

- Background
- Process of inventory preparation
- National system
- QA/QC
- Key Category Assessment
- Uncertainty Analysis

The processes for inventory preparation

<Processes>

(1) Decide calculation methodology using decision tree

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(2) Calculate emissions using UNFCCC software

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(3)Make National Greenhouse Gas Inventory Report

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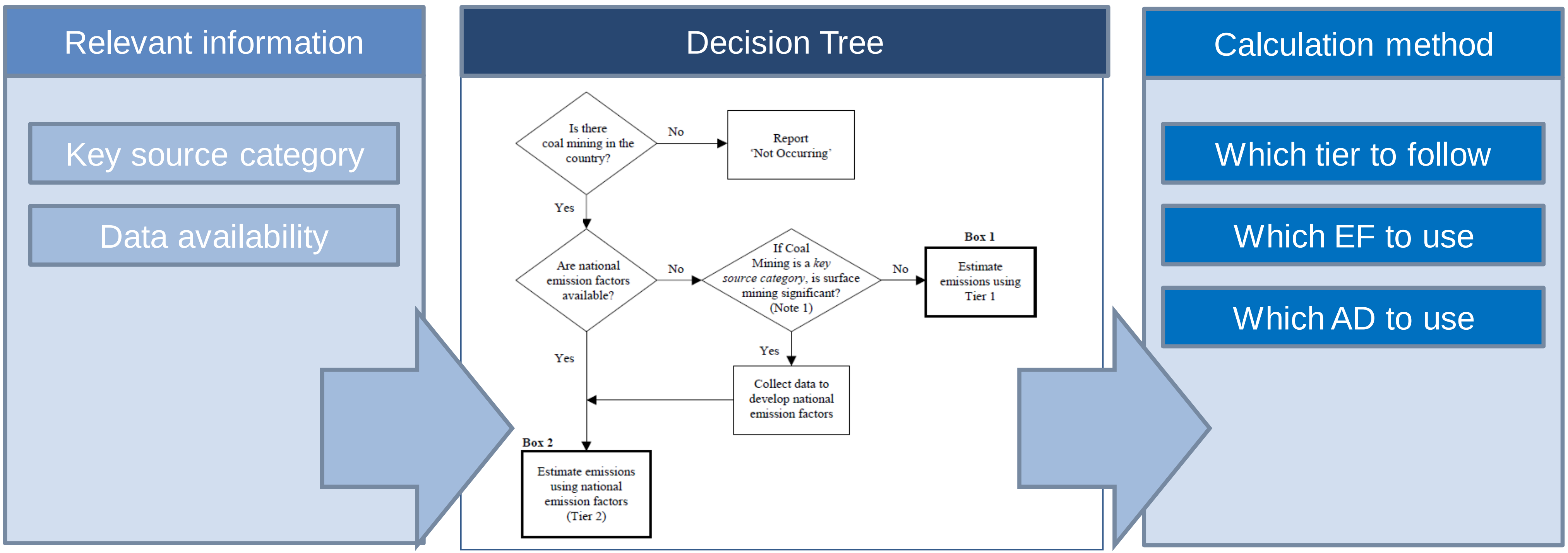
Inventories and reports

Decide calculation methodology using decision tree

■We can know calculation methodology using decision tree.

■To choose Yes/No in decision tree , it is necessary to know Key source category and data availability.



NATIONAL SYSTEM FOR GHG INVENTORY

- National System includes institutional, legal and procedural arrangements within a nation for estimating anthropogenic emissions/removals of GHG for reporting and archiving inventory information.
- The purpose of national system is to enhance the quality as well as ensure the transparency, consistency, comparability, completeness and accuracy of GHG inventory preparation.

General QC

- **General QC procedures** include **generic quality checks** related to calculations, data processing, completeness, and documentation that are applicable to all inventory source and sink categories.
- The lists of general QC checks that the inventory compiler should use routinely throughout the preparation of the inventory are the follows.
  - Check that assumptions and criteria for the selection of activity data, emission factors, and other estimation parameters are documented.
  - Check for transcription errors in data input and references.
  - Check that emissions and removals are calculated correctly.
  - Check that parameters and units are correctly recorded and that appropriate conversion factors are used.
  - Check for consistency in data between categories.
  - Check that the movement of inventory data among processing steps is correct.
  - Check time series consistency.
  - Check completeness. …etc.

Category-Specific QC

- **Category-specific QC** complements general inventory QC procedures and is directed at **specific types of data used in the methods for individual source or sink categories**.
- Category-specific procedures are applied on a case-by-case basis focusing on key categories and on categories where significant methodological and data revisions have taken place.
- Category-Specific QC includes
  - **Emission Factor QC** -check the accuracy and validity of IPCC default EFs, country-specific EFs and direct emission measurements.
  - **Activity Data QC** -check the accuracy and validity of national level AD and site-specific AD.
  - **Calculation-related QC** -check the calculation procedures used to prepare GHG inventory.

Definition of QA

- **Quality Assurance (QA)** is a planned system of **review procedures conducted by personnel not directly involved in the inventory compilation/development process**.

- Reviews, preferably by independent third parties, are performed upon a completed inventory following the implementation of QC procedures. **Reviews ensure that the inventory represents the best possible estimates of emissions and removals given the current state of scientific knowledge and data availability.**

QA -Expert Peer Review

- QA procedures is to assess the quality of the inventory, to determine the conformity of the procedures taken and to identify areas where improvements could be made.
- It is good practice for inventory compilers to **conduct a basic expert peer review of all categories** (or only key categories if there are timing and resource constraints) before completing the inventory in order to identify potential problems and make corrections where possible.
- The objective of the expert peer review is **to ensure that the inventory's results, assumptions, and methods are reasonable as judged by those knowledgeable in the specific field.** Also, where a country has formal stakeholder and public review mechanisms in place, these reviews can supplement expert peer reviews although they should not replace them.

QA/QC plan

- QA/QC plan should, in general, **outline the QA/QC activities** that will be implemented and the institutional arrangements and responsibilities for implementing those activities.
- QA/QC plan should include **a scheduled time frame** for the QA/QC activities that follows inventory preparation from its initial development through to final reporting in any year.
- QA/QC plan is an **internal document** to organize and implement QA/QC activities that ensure the inventory is fit for purpose and allow for improvement. Once developed, it can be referenced and used in subsequent inventory preparation, or modified as appropriate.

Definition and purpose of KCA

- **Key category** is one that is prioritized within the national inventory system because its estimate has a significant influence on a country's total inventory of greenhouse gases in terms of the absolute level, the trend, or the uncertainty in emissions and removals.

- Purpose of the KCA is…
  - to identify categories on which inventory compiler **should focus limited resources available for the improvement.**
  - to identify categories to which **more detailed higher tier methods should be applied.**

Level & Trend Assessment

- There are two kinds of KCA.

  1. **Level Assessment**: identify key categories in terms of their contribution to the absolute level of national emissions and removals.
  2. **Trend Assessment**: identify key categories in terms of their contribution to the trend of national emissions and removals.

- There are two approaches for KCA.

  - Approach 1 : identify key categories by using a pre-determined cumulative emissions threshold. Key categories are those that, when summed together in descending order of magnitude, add up to 95 percent of the total level.
  - Approach 2 : identify key categories based on the results of uncertainty.

Approach 1 of Level Assessment

EQUATION 4.1
LEVEL ASSESSMENT (APPROACH 1)

Key category level assessment = | source or sink category estimate | / total contribution

$$L_{x,t} = \left|E_{x,t}\right| \ / \ \sum_{y}\left|E_{y,t}\right|$$

Where: $L_{x,t}$ *= level assessment for source or sink x in year t*

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

$\Sigma_y |E_{y,t}|$ = *total contribution, which is the sum of the absolute values of emissions and removals in year t. Because both emissions and removals are entered with positive sign (Removals are entered as absolute values), the total contribution can be larger than national total emissions less removals.*

Approach 1 of Trend Assessment

EQUATION 4.2
TREND ASSESSMENT (APPROACH 1)

$$T_{x,t} = \frac{\left|E_{x,0}\right|}{\sum_y \left|E_{y,0}\right|} \bullet \left| \left[\frac{\left(E_{x,t} - E_{x,0}\right)}{\left|E_{x,0}\right|} \right] - \frac{\left(\sum_y E_{y,t} - \sum_y E_{y,0} \right)}{\left| \sum_y E_{y,0} \right|} \right|$$

Where: $T_{x,t}$ *= trend assessment of source or sink category x in year t as compared to the base year (year 0)*

$|E_{x,0}|$ *= absolute value of emission or removal estimate of source or sink category x in year 0*

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

$\Sigma_y E_{y,t}$ *and* $\Sigma_y E_{y,0}$ *= total inventory estimates in years t and 0, respectively*

Example of KCA (Level Assessment)

TABLE 4.5
EXAMPLE OF APPROACH 1 LEVEL ASSESSMENT FOR THE FINNISH GHG INVENTORY FOR 2003 (with key categories in bold)

A	B	C	D	E	F	G
IPCC Category Code	IPCC Category	Greenhouse Gas	$E_{x,t}$ (Gg CO_2 eq)	$\lvert E_{x,t} \rvert$ (Gg CO_2 eq)	$L_{x,t}$	Cumulative Total of Column F
3B1a	**Forest land remaining Forest land**	**CO_2**	**-21 354**	**21 354**	**0.193**	**0.193**
1A1	**Energy Industries: Solid**	**CO_2**	**17 311**	**17 311**	**0.157**	**0.350**
1A3b	**Road Transportation**	**CO_2**	**11 447**	**11 447**	**0.104**	**0.454**
1A1	**Energy Industries: Peat**	**CO_2**	**9 047**	**9 047**	**0.082**	**0.536**
1A1	**Energy Industries: Gas**	**CO_2**	**6 580**	**6 580**	**0.060**	**0.595**
1A4	**Other Sectors: Liquid**	**CO_2**	**5 651**	**5 651**	**0.051**	**0.646**
1A2	**Manufacturing Industries and Construction: Solid**	**CO_2**	**5 416**	**5 416**	**0.049**	**0.695**
1A2	**Manufacturing Industries and Construction: Liquid**	**CO_2**	**4 736**	**4 736**	**0.043**	**0.738**
1A1	**Energy Industries: Liquid**	**CO_2**	**3 110**	**3 110**	**0.028**	**0.767**
3B3a	**Grassland Remaining Grassland**	**CO_2**	**2 974**	**2 974**	**0.027**	**0.793**
3C4	**Direct N_2O Emissions from managed soils**	**N_2O**	**2 619**	**2 619**	**0.024**	**0.817**
4A	**Solid Waste Disposal**	**CH_4**	**2 497**	**2 497**	**0.023**	**0.840**
1A2	**Manufacturing Industries and Construction: Gas**	**CO_2**	**2 174**	**2 174**	**0.020**	**0.859**
3A1	**Enteric Fermentation**	**CH_4**	**1 537**	**1 537**	**0.014**	**0.873**
1A2	**Manufacturing Industries and Construction: Peat**	**CO_2**	**1 498**	**1 498**	**0.014**	**0.887**
2B2	**Nitric Acid Production**	**N_2O**	**1 396**	**1 396**	**0.013**	**0.900**
1A5	**Non-Specified: Liquid**	**CO_2**	**1 083**	**1 083**	**0.010**	**0.909**
2D	**Non-Energy Products from Fuels and Solvent Use**	**CO_2**	**830**	**830**	**0.008**	**0.917**
1A3e	**Other Transportation**	**CO_2**	**651**	**651**	**0.006**	**0.923**
3C5	**Indirect N_2O Emissions from managed soils**	**N_2O**	**592**	**592**	**0.005**	**0.928**
2F1	**Refrigeration and Air Conditioning**	**HFCs, PFCs**	**578**	**578**	**0.005**	**0.933**
3B4ai	**Peatlands remaining Peatlands**	**CO_2**	**547**	**547**	**0.005**	**0.938**
1A3d	**Water-borne Navigation**	**CO_2**	**519**	**519**	**0.005**	**0.943**
1A3b	**Road Transportation**	**N_2O**	**516**	**516**	**0.005**	**0.948**
2A2	**Lime Production**	**CO_2**	**513**	**513**	**0.005**	**0.952**
2A1	Cement Production	CO_2	500	500	0.005	0.957
3A2	Manure Management	N_2O	461	461	0.004	0.961
1A5	Non-Specified: Gas	CO_2	363	363	0.003	0.964
1A3a	Civil Aviation	CO_2	316	316	0.003	0.967
1A4	Other Sectors: Biomass	CH_4	307	307	0.003	0.970

Key Category

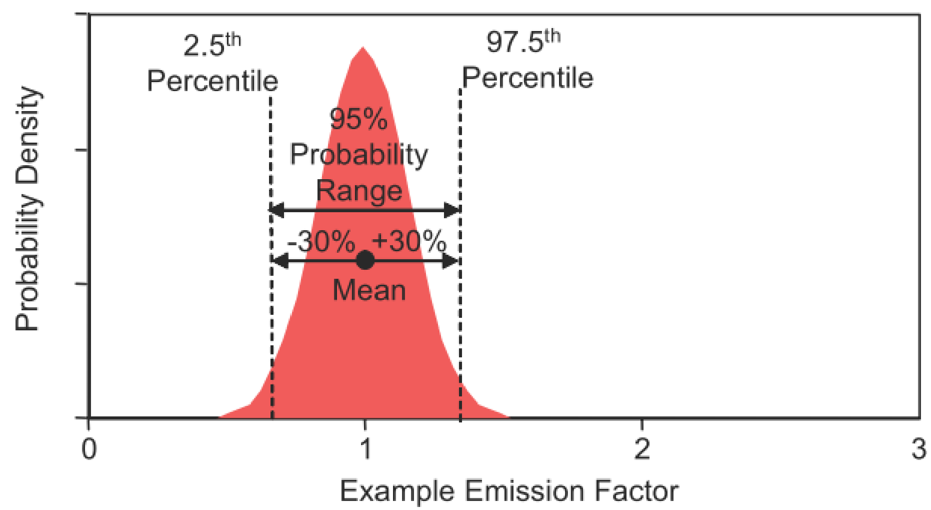
95%

Overview of Uncertainty analysis

- **Uncertain analysis** is to characterize the range and likelihood of values such as EFs, AD and emission estimate.
- Purpose of an uncertainty analysis is not to dispute the validity of the inventory estimates but **to help prioritize efforts to improve the accuracy of inventories** in the future and guide decisions on methodological choice.
- Causes of uncertainty is the follows.
  - Lack of completeness
  - Model
  - Lack of data
  - Lack of representativeness data
  - Statistical random sampling error
  - Measurement error
  - Misreporting or misclassification
  - Missing data

Quantifying Uncertainty

- Quantitative uncertainty analysis is performed by estimating the **95 percent confidence interval** of the emissions and removals estimates for individual categories and for the total inventory.
- The inventory compiler should collect the appropriate information to develop national, and category-specific estimates of uncertainty at the 95 percent confidence interval by statistical analysis of empirical data, expert judgment, using data from research and default values, etc.



Method to combine uncertainties

- Once the uncertainties in AD,EF or emissions for a category have been determined, it is necessary to combine to provide uncertainty estimates for the entire inventory.
- Where uncertain quantities are to be combined by multiplication,

EQUATION 3.1
COMBINING UNCERTAINTIES – APPROACH 1 – MULTIPLICATION

$$U_{total} = \sqrt{U_1^2 + U_2^2 + \ldots + U_n^2}$$

Where: U_{total} = the percentage uncertainty in the product of the quantities (half the 95 percent confidence interval divided by the total and expressed as a percentage);
U_i = the percentage uncertainties associated with each of the quantities.

- Where uncertain quantities are to be combined by addition or subtraction,

EQUATION 3.2
COMBINING UNCERTAINTIES – APPROACH 1 – ADDITION AND SUBTRACTION

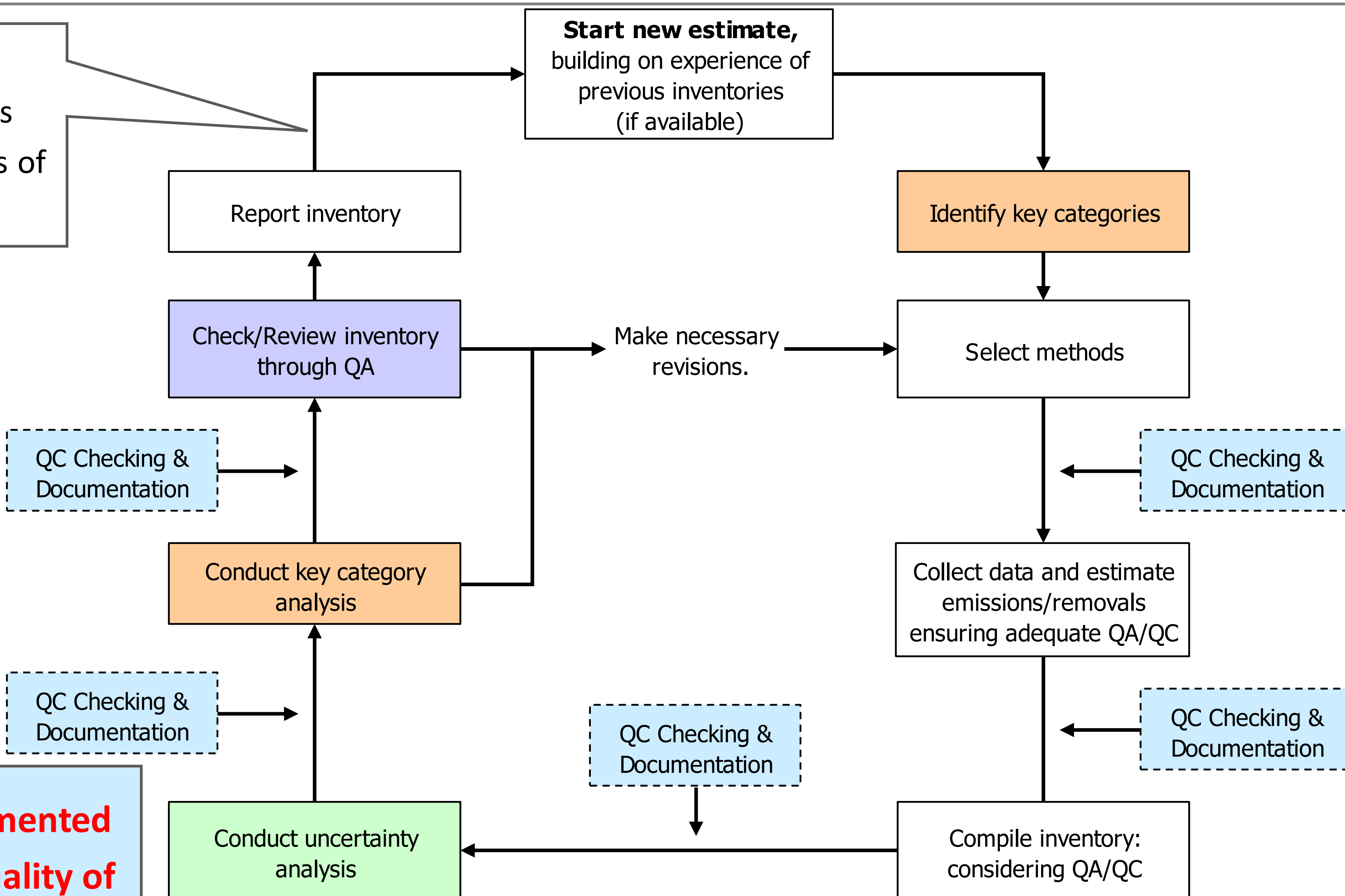
$$U_{total} = \frac{\sqrt{(U_1 \bullet x_1)^2 + (U_2 \bullet x_2)^2 + \ldots + (U_n \bullet x_n)^2}}{|x_1 + x_2 + \ldots + x_n|}$$

Where: U_{total} = the percentage uncertainty in the sum of the quantities (half the 95 percent confidence interval divided by the total (i.e., mean) and expressed as a percentage).

x_i and U_i = the uncertain quantities and the percentage uncertainties associated with them, respectively.

Role of QA/QC, KCA and UA in the inventory development process

The inventory improvement plan is based on the results of the KCA and UA



QA/QC is implemented to ensure the quality of the GHG inventory