Managing Quality in the Finnish Greenhouse Gas Inventory
Leena Raittinen

1. Greenhouse gas inventories in brief

Finland is a Party to the United Nations Framework Convention on Climate Change (UNFCCC) and the Kyoto Protocol. Under these international agreements, Finland is committed to providing annual inventories that cover emissions and removals of direct anthropogenic greenhouse gases (GHGs)\(^2\) from six sectors (Energy; Industrial processes; Solvent and other product use; Agriculture; Land use, Land-use change and Forestry; and Waste) and for all years from the base year to the most recent year \((x-2)\)^3. As a member of the European Union, Finland also has reporting obligations under the mechanism for monitoring European Community greenhouse gas emissions and for implementing the Kyoto Protocol.

1.1 Importance of inventories

The GHG inventory is a kind of link between science and policy-making in global climate change mitigation. The inventory produces the information used in assessing the effectiveness of the measures taken to reduce greenhouse gas emissions and the advancement of each party in fulfilling the obligations to the Convention. Accurate, consistent and internationally comparable data on GHG emissions are essential for the international community to take the most appropriate action to mitigate climate change, and ultimately to achieve the objective of the Convention, that is “…stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system.”

1.2 Requirements for reporting

To promote the provision of credible and consistent GHG information, the Conference of the Parties to the UNFCCC has developed standardised requirements for reporting national inventories: a strict reporting format, timelines and requirements on methodologies.

The annual GHG inventory consists of Common reporting format (CRF) tables and a National Inventory Report (NIR). CRF tables are submitted electronically and consist of a series of standardised data tables containing mainly numerical information. The National Inventory Report is a comprehensive description of the methodologies used

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\(^1\) Address for correspondence: Leena Raittinen, Statistics Finland / Greenhouse Gas Inventory Unit, PB 6 A, FIN-00022 Statistics Finland (leena.raittinen[at]stat.fi)

\(^2\) i.e. carbon dioxide (CO\(_2\)), methane (CH\(_4\)), nitrous oxide (N\(_2\)O), perfluorocarbons (PFCs), hydrofluorocarbons (HFCs) and sulphur hexafluoride (SF\(_6\)). The National inventory report also includes estimates of so-called indirect greenhouse gases (CO, NOx and NMVOCs) and SO\(_2\).

\(^3\) The reported data consistently indicate the emissions during the year before the last \((x-2)\).
in compiling the inventory, the data sources, the institutional structures and quality assurance and quality control procedures.

In the EU greenhouse gas monitoring mechanism, the national inventory from the year (x-2) is submitted to the Commission by 15 January. Member States may complement and update their submission until 15 March. The joint EU inventory is compiled from the Member States’ submissions and it is supplied to the UNFCCC Secretariat by 15 April. Finland's final GHG inventory for the year (x-2), identical with the data submitted to the Commission by 15 March, is submitted to the UNFCCC Secretariat by 15 April. The timelines for the reporting are strict: six weeks delay may cause loss of eligibility to use the Kyoto mechanisms (e.g. emissions trading).

The preparation and reporting of the inventories are based on the IPCC methodologies (IPCC 1997, 2000 and 2003) and guided by the UNFCCC guidelines (UNFCCC 2002 and 2006) and the EU decision on a mechanism for monitoring community GHG emissions (Commission of the European Communities 2004 and 2006). In addition to the calculation methods, the guidelines include requirements on quality assurance, quality control, and uncertainty estimation, etc.

2. Finland’s national system for GHG preparation and reporting

In accordance with the Government resolution of 30 January 2003 on the organisation of climate policy activities of Government authorities in Finland, Statistics Finland assumed the responsibilities of the National Entity for Finland’s greenhouse gas inventory from the beginning of 2005.

Statistics Finland as the general authority of the official statistics of Finland is independently responsible for GHG inventory submissions under the UNFCCC, the Kyoto Protocol and the EU GHG monitoring mechanism.

Besides Statistics Finland, the Finnish Environmental Institute, MTT Agrifood Research Finland and the Finnish Forest Research Institute take part in the inventory preparation. Statistics Finland also acquires parts of the inventory calculations as purchased services from VTT (the Technical Research Centre of Finland) and Finavia (formerly the Civil Aviation Administration).

The legal basis of Finland’s National Greenhouse Gas Inventory System is defined by the above mentioned resolution, an agreement between the Ministry of the Environment and Statistics Finland on operating the national system for estimating GHG emissions under the Kyoto Protocol and on reporting requirements under the climate convention, as well as on regulations concerning Statistics Finland (Statistics Finland Act and Statistics Act). The roles and responsibilities of expert organisations participating in the preparation of the inventory are defined in agreements between Statistics Finland and the expert organisations.

The national system for the GHG inventory in Finland is presented in Figure 1 below.
3. Quality management is implemented in a structured way

Statistics Finland has the overall responsibility for the GHG inventory in Finland including the responsibility for co-ordinating the quality management measures at the national level. The expert organisations contributing to the production of emission or removal estimates are responsible for the quality of their own inventory calculations. Statistics Finland compiles and approves the inventory and submits it to the UNFCCC Secretariat and to the European Commission.

The quality co-ordinator steers and facilitates the quality assurance and quality control (QA/QC) process, and experts of all calculation sectors implement and document the QA/QC procedures. The inventory working group, that consists of participants from all institutes participating in the inventory preparation, has been established to advance communication between the inventory unit and the expert organisations in charge of the different sectors. Issues related to QA/QC are discussed in the meetings of the inventory working group (4-7 meetings per year) and in the bilateral quality meetings between the inventory unit and the expert organisations (once a year).

An electronic quality manual including e.g. guidelines, plans, templates and checklists is in place and available to all parties of the national inventory system via the Internet.

Figure 1. The national system for the GHG inventory in Finland
4. Defining quality

Statistics Finland and its Greenhouse gas inventory unit are committed to quality. The objective of Finland’s GHG inventory system is to produce high-quality GHG inventories.

However, quality is not an easy concept; it is an ambiguous word that allows many different interpretations. For this reason we have emphasised the importance of a common understanding of the concepts related to quality. As we see it, a shared conceptual framework forms the basis for effective and efficient quality management.

According to the established quality management standards and frameworks (e.g. ISO 9001 and EFQM), quality is defined as a relation between expectations and outcomes (ISO 9001: “…degree to which a set of characteristics fulfils requirements”). Quality describes the ability of an organisation to fulfil the needs and expectations of all its stakeholders, especially its customers, that are the receivers or users of the output. It is essential to find out what characteristics of the product or the service are important or critical from the customer’s point of view. Thus, instead of being absolute or universal by nature, the quality of a product or a service is always relative and ultimately dependent on and defined by the particular context of its intended use.

In the context of GHG inventories, high quality provides that both the structures of the national system (i.e. all institutional, legal and procedural arrangements) for estimating GHG emissions and removals and the inventory submissions (i.e. outputs, products) comply with the requirements, principles and elements rising from the UNFCCC, Kyoto Protocol, IPCC guidelines and EU GHG monitoring mechanism.

5. Inventory process

Another element supporting the attainment of the high quality of the inventory is the adoption of a shared mental model for the annual inventory process.

The annual inventory process describes at a general level how the inventory is produced by the national system. The quality of the output is ensured by the inventory experts in the course of compilation and reporting, which consist of four main stages: planning, preparation, evaluation and improvement (Fig. 2). The quality control and quality assurance elements are integrated into the production system of the inventory; each stage of the inventory includes the relevant procedures for quality management.
Inventory Principles:
Continuous Improvement - Transparency - Consistency
- Comparability - Completeness - Accuracy - Timeliness

Figure 2. The inventory process

6. QA/QC process

In addition to the above-mentioned inventory process, the quality assurance and quality control process (QA/QC process) has been identified and described to clarify the logic of quality management (‘how to succeed technically in meeting the customer’s expectations and requirements and thus producing high quality’). The QA/QC process is a sub-process for the inventory process and the two proceed simultaneously (Fig. 3).
6.1 Inventory principles - the framework for quality
The starting point for accomplishing a high-quality GHG inventory is consideration of the expectations and requirements directed at the inventory. The inventory principles defined in the UNFCCC and IPCC guidelines, that is, transparency, consistency, comparability, completeness, accuracy and timeliness, are dimensions of quality for the inventory and form the set of criteria for assessing the output produced by the national inventory system. In addition, the principle of continuous improvement is included.

6.2 Quality planning includes setting of quality objectives and planning the QC and QA procedures
The inventory planning stage includes the setting of quality objectives and elaboration of the QA/QC plan for the coming inventory preparation, compilation and reporting work.

6.2.1 Quality objectives
The setting of quality objectives is based on the inventory principles. Quality objectives are concrete expressions about the standard that is aimed at in the inventory preparation with regard to the inventory principles. The objectives’ aim is to be appropriate and realistic while taking account of the available resources and other conditions in the operating environment. Where possible, quality objectives should be measurable.

The quality objectives regarding all calculation sectors for Finland’s latest (2006) inventory were the following:
1. Continuous improvement
   1.1. Review feedback is considered in a systematic way.
   1.2. The improvements promised in the National Inventory Report (NIR) are carried out.
   1.3. The inventory is improved in a systematic way.
   1.4. The quality control (QC) procedures meet the requirements.
   1.5. Appropriate and sufficient quality assurance procedures of the inventory are in place.

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4 Timeliness is stipulated by the EU greenhouse gas monitoring mechanism.
2. Transparency
2.1. Archiving of the inventory is systematic and complete.
2.2. Internal documentation for the calculation supports the emission and removal estimates.
2.3. The CRF tables and National Inventory Report (NIR) include transparent and appropriate descriptions of the emission and removal estimates and their production.

3. Consistency
3.1. The time series are consistent.
3.2. The data have been used in a consistent manner in the inventory.

4. Comparability
4.1. The methodologies and formats of the inventory meet the requirements for comparability.

5. Completeness
5.1. The inventory covers all the emission sources, sinks, gases and geographic areas.

6. Accuracy
6.1. Estimates are systematically neither over nor under true emissions or removals.
6.2. Calculation is correct.
6.3. Inventory uncertainties are estimated.

7. Timeliness
7.1. The inventory reporting is of high quality and reaches its receiver (EU / UNFCCC) within the set time.

The quality objectives and the planned QC and QA procedures are recorded as the QA/QC plan. The QA/QC plan is a checklist that specifies the QC and QA actions, the schedules for the actions and the responsibilities.

Quality objectives and QA/QC plans are updated yearly in the spirit of continuous improvement.

6.3 Quality control procedures aim at attainment of the quality objectives

The quality control (QC) procedures are performed by the experts during inventory calculation and compilation according to the QA/QC plan. QC measures aim at the attainment of the quality objectives.

The QC procedures in use in the Finland’s GHG inventory comply with the IPCC good practice guidance. General inventory QC checks include routine checks of the integrity, correctness and completeness of data, identification of errors and deficiencies and documentation and archiving of inventory data and quality control actions. In addition to general QC checks, category-specific QC checks including technical reviews of the source categories, activity data, emission factors and methods are applied on a case-by-case basis focusing on key categories and on categories where significant methodological and data revisions have taken place.
6.4 Quality assurance comprises a planned system of review procedures

The quality assurance (QA) activities recorded in the QA/QC plan are performed at the inventory evaluation stage. QA reviews are performed after the implementation of QC procedures to the finalised inventory. The inventory QA system comprises reviews and audits to assess the quality of the inventory and the inventory preparation and reporting process, to determine the conformity of the procedures taken and to identify areas where improvements could be made.

QA actions differ from one another in their viewpoints and timings. The actions include basic reviews of the draft report, internal self-evaluations, peer reviews, UNFCCC reviews of inventories and data verifications.

A basic review of the draft GHG estimates and the draft report takes place before the submission to the EU (in November to December) by the inventory working group, the inventory unit and the advisory board.

In internal self-evaluations experts in their specific calculation sectors and the inventory unit at the level of the whole inventory examine the actual activity and the results attained, and compare them with the quality objectives set and the QA/QC plans made. The findings of internal self-evaluations are discussed in the bilateral quality meetings that are held between the inventory unit and the expert organisations annually from January to February.

Peer reviews are sector or category specific projects that are performed by external experts or expert groups. Preferably the reviewers would be external experts who are independent of the inventory preparation. The reviewers may also be experts in other calculation sectors of the GHG inventory system. The objective of the peer review is to ensure that the inventory's results, assumptions and methods are reasonable, as judged by those knowledgeable in the specific field.

Peer reviews may also be bilateral collaboration. For example, the Finnish and Swedish GHG inventory teams have met twice annually to exchange information, experiences and views relating to the preparation on the national GHG inventories. This collaboration also provides opportunities for bilateral peer reviews. The first step in this collaboration relating to quality assurance was an independent comparison and review of the emission factors in the energy sector in Swedish and Finnish inventories. The objectives of the review were to check whether the reporting and choice of emission factors are in accordance with the UNFCCC and IPCC guidelines and in addition, to compare the emission factors used in Finland and Sweden, and to assess whether the differences (if any) are explainable and reasonable taking the national circumstances into account.

The UNFCCC inventory review teams co-ordinated by the UNFCCC Secretariat carry out international reviews of the inventory according to the annual schedule after the submission of the annual inventory report. The expert review teams produce yearly an independent review report on Finland's GHG inventory.
Emission and activity data are verified by comparing them with other available data compiled independently of the GHG inventory system. These include measurement and research projects and programmes initiated to support the inventory system, or for other purposes, but producing information relevant to the inventory preparation.

The procedures for audits are under development. In the audits the representative of the inventory unit evaluates how effectively the experts in their specific calculation sectors comply with the QC specifications outlined in the QC plans. The audit may be directed at topical or otherwise important factors. Audits would provide an in-depth analysis of the respective procedures taken to develop an inventory, and on the documentation available.

6.5 QA/QC process contributes to the improvement of the inventory
The ultimate aim of the QA/QC process is to ensure the quality of the inventory and to contribute to the improvement of the inventory. In the improvement stage of the QA/QC process, conclusions are made on the basis of the realised QA/QC measures and their results.

The bilateral quality meetings between the inventory unit and the expert organisations are held before the final submission to the UNFCCC in April. The findings of internal self-evaluations, UNFCCC review feedback and other accumulated information on the quality of the inventory are discussed in the meetings. Inventory development needs and projects that need additional resources are identified and included in the inventory improvement plan to be considered by the advisory board of the inventory. In addition, the conditions (resources, schedules, procedures, support needs) for the inventory work are discussed. The main findings and conclusions of the quality meetings are communicated to the parties to Finland’s GHG inventory system for decision-making concerning the next inventory round.

7. Experiences and conclusions
The quality management system of Finland’s GHG inventory has been built up since 2004 and the efforts have produced good results. According to the feedback of the latest UNFCCC review (UNFCCC 2007), the quality of Finland’s GHG inventory is high; both the national system and the inventory submission are consistent with the guidelines and requirements.

The pillars of Finland’s GHG inventory quality management system are the common conceptual framework and the process approach. With this holistic quality management approach we have aimed at promoting the inventory experts’ learning in the field of quality issues and thus at facilitating the implementation and use of the specific quality tools and procedures. Understanding the rationale behind quality management practices is a prerequisite for acceptance of new practices and new ways of thinking. We have also encouraged the inventory experts to adopt the principle of systematic, continuous and fact-based improvement of the inventory. In addition, our aim has been to achieve an integrated quality management system including well-organised and co-ordinated quality management activities instead of a separate quality world.
Quality management needs resources, time and knowledge. A competent and full-time quality co-ordinator is a resource that facilitates the design and implementation of the appropriate quality management procedures. In addition to that, it should be ensured that the inventory experts have enough time to do the planned procedures, for example the QC checks. There should also be forums for quality-related steering and discussions. The quality meetings have proven to be very useful in the inventory quality management. The meetings have created opportunities to concentrate on discussions on the quality of a specific inventory category or sector at a very concrete level.

In conclusion, our experiences are positive. However, much still remains to be done. Let us keep in mind that the basic task of Finland’s national system for GHG inventory is to produce high-quality inventories, not the quality management itself. Quality management should be as easy, automatic, efficient and effective as possible. We are still developing the procedures and practices further in this direction on the grounds of the experience gathered so far. In addition, we have to keep in touch with the ongoing climate negotiations concerning the post-Kyoto period in order to be prepared to meet new requirements after the first commitment period of the Kyoto Protocol (2008-2012). And finally, attainment of high quality is very much dependent on the inventory experts’ attitude and willingness to follow the rules and procedures of the quality management system. In future, constant attention needs to be paid also to the management of this ‘soft side’.

References


UNFCCC 2006. Updated UNFCCC reporting guidelines on annual inventories following incorporation of the provisions of decision 14/CP.11. FCCC/SBSTA/2006/9.