Technical review of national greenhouse gas inventories

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ABSTRACT

The Conference of the Parties to the United Nations Framework Convention on Climate Change (UNFCCC) decided to initiate a technical review process of the national greenhouse gas inventories that are reported on an annual basis. These inventories have to adhere to the Revised 1996 Intergovernmental Panel on Climate Change (IPCC) Guidelines for National Greenhouse Gas Inventories, as elaborated by the IPCC good practice guidance, and to the UNFCCC reporting guidelines on annual inventories that require the provision of information in a standardized format.

The paper describes the methods used for the preparation and review of national greenhouse gas inventories at the international level under the Climate Change Convention and analyses the experience gained with the technical review of 30 national greenhouse gas inventories. It also assesses how the results of the inventory review process have helped to overcome a range of inventory problems, to encourage a better use of the methodologies for preparing greenhouse gas inventories and to facilitate that greenhouse gas estimates are neither over nor underestimated so far as can be judged.

The technical review process of greenhouse gas inventories comprises three complementary stages, namely: initial checks, synthesis and assessment and individual reviews. Three operational approaches were used to conduct individual reviews: sending inventory information to experts (desk reviews), expert meetings in a single location (centralized reviews) and in-country visit reviews.

The information presented in the paper might be useful in the consideration of emission data by industry, environmental regulators, regional and international agencies.

INTRODUCTION

The United Nations Framework Convention on Climate Change[1] (UNFCCC) was signed at the Rio Janeiro Earth Summit, in 1992. Currently 186 countries are Parties to the Convention. In accordance with the provisions of the Convention, Parties shall prepare national inventories of emissions by sources and removals by sinks of greenhouse gases (GHG) not controlled by the Montreal Protocol (hereinafter referred to as inventories) for the consideration by the Conference of the Parties (COP). The reporting requirements under the UNFCCC for Parties included in Annex I to the Convention (developed countries) are different compared to the requirements for Parties that are not included in Annex I to the Convention (developing countries). This paper focuses only on issues relating to the reporting and review of greenhouse gas data from developed countries.

Developed countries should prepare annual national inventories using the Revised 1996 Intergovernmental Panel on Climate Change (IPCC) Guidelines for National Greenhouse Inventories[2] (IPCC Guidelines). In addition, the IPCC Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories[3] (IPCC good practice guidance) should also be applied in preparing inventories starting with the inventory submission due in 2001.

Developed countries have prepared and submitted to the COP inventories since 1994, and on an annual basis since 1996. The level of completeness, transparency and quality of these inventories has largely differed across the reporting countries. In order to improve the adequacy and reliability of the reported inventory information, the COP, in 1999, adopted revised reporting guidelines on annual inventories[4] (reporting guidelines) and guidelines for the technical review of inventories[5] (review guidelines) from developed countries.

Many inventory problems are being improved as the IPCC good practice guidance is applied, national experts gain experience with the preparation of inventories, the input from the review process is considered and expert review teams gain experience with the technical review of inventories.

This paper describes to what extent the technical review of inventories from 30 developed countries has assisted to identify a range of problems that affect the reliability of the inventories and discusses the contribution to the review process of comparisons of inventory data across countries, the assessment of the time series consistency and of the need for a standard reporting format that allows these comparisons and assessments to be performed as part of the review process. It also discusses how the expertise and skills of the review experts as well as the interaction between review experts from different countries (with different experiences and perspectives) and the national experts who prepare the inventories contribute to an effective review process.

The limitations of the technical review process of inventories that have been identified so far are also described.

The development and maintenance of a database management system for storing inventory information and the development of dedicated software tools for extracting inventory information for the purpose of the review process are also discussed.

The paper does not analyze to what extent the experiences gained with the technical review of inventories at the international level could be applied for the preparation of inventories at a local, regional or national level.

METHODS

The provisions and guidelines that countries should use to prepare, report and review inventories under the Convention, as well as the software tools to support these actions, are considered as the methods used for achieving the results described in this paper.

UNFCCC Convention

The ultimate objective of the climate change Convention and any related legal instruments that the Conference of the Parties may adopt, such as the Kyoto Protocol, is to achieve stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system. [1]

The objective of the Convention is only achievable through the reduction or limitation of GHG emissions from sources and the enhancement of GHG removals by sinks, which can only be “tracked” either through measurement or estimation. At the national level, the only way to estimate such reductions and limitations of GHG emissions and enhancement of removals is through the preparation of a reliable and comprehensive inventory. At that level the direct measurement of GHG emissions and removals are not possible due to economic and physical constraints.

The Convention states that all countries, shall develop, periodically update, publish and make available national inventories using comparable methodologies. The COP decided that the IPCC Guidelines constitute the comparable methodology for the preparation of national inventories and agreed that all developed countries should use these guidelines in preparing their submissions that were due in 1998.

IPCC Guidelines

The IPCC Guidelines represented a first and substantial step towards the assembly and wide understanding of the methodologies needed for inventory preparation. Their preparation constituted an enormous task involving many hundreds of experts and users as well as financial and other support from many countries and international organizations. The IPCC guidelines include specific guidance to prepare inventories of GHG emissions and removals from six sectors, namely *Energy, Industrial Processes, Solvent and other Product Use, Agriculture, Land-Use Change and Forestry* and *Waste,* disaggregated at the level of source-categories in which these emissions and removals occur. They were completed in 1994 and subsequently were updated and revised in 1996.

The IPCC Guidelines have demonstrated their usefulness, enabling the provision of inventory data in most source/sink categories and the reporting of the results in a comparable manner. As they were developed for a wide range of users, the guidelines allow a large degree of flexibility in the estimation of inventory data through the use of different methods, tiers and types of emission factors. For some categories, this flexibility could lead to differences in emission estimates from a given sector, while for other categories the methods included in the guidelines do not facilitate a comprehensive estimation and reporting of GHG emissions and removals.

IPCC good practice guidance

Having recognized the limitations of the IPCC Guidelines, the Subsidiary Body for Scientific and Technological Advice (SBSTA) to the Convention invited the IPCC to complete its work on uncertainties and to prepare good practice guidance in inventory management. The IPCC completed its report on good practice guidance in the year 2000.

The aim of this guidance is to assist countries in producing inventories that are neither over nor underestimated so far as can be judged, and in which uncertainties are reduced as far as practicable. To this end, it supports the development of inventories that are transparent, sufficiently documented, consistent, comparable, assessed for uncertainties, subject to quality control and quality assurance, and efficient in the use of resources. For each IPCC sector, guidance is provided, *inter alia*, on the choice of the most suitable methods, emission factors and other data necessary, in view of national circumstances.

The SBSTA decided that the IPCC good practice guidance should be used for inventories starting with the submissions that were due in 2001. The experience and information available to date on the application of the IPCC good practice guidance is limited to some countries that have used it for the first time.

UNFCCC reporting guidelines

Before 2000, inventories were prepared and reported following the guidelines for the preparation of national communications, which were first prepared in 1994 and were subsequently updated in 1996. These guidelines were not sufficiently specific to facilitate a complete, transparent and comparable reporting of greenhouse gas data and some important inventory aspects, such as recalculations, were not considered. In addition, the reporting of inventories was not aimed to support their subsequent review.

To overcome these shortcomings, the COP, in 1999, adopted more precise and complete guidelines, namely the UNFCCC guidelines for reporting annual inventories.[4] The purposes of these guidelines were to assist developed countries in meeting their reporting commitments under the Convention, to facilitate the process of considering annual inventories, including the preparation of technical analysis of GHG inventory data, and to facilitate the expert review of the inventory information. In accordance with these guidelines, GHG data should be submitted through the national inventory report (NIR) and the common reporting format (CRF).

The NIR should contain detailed and complete information on the national inventory for all years from the base year (1990) to the last but one year prior to the year of submission (for example the submission for the year 2000 should include inventory data for the years 1990 to 1998). It may only be published electronically and should be updated annually to reflect changes. The CRF, which is a part of the NIR, is a standardized set of tables for reporting estimates of GHG emissions and removals at an aggregate level and is to be submitted in both electronic form (using an MS Excel application) and in hardcopy. Provision of the inventory information in a standard electronic format allows for the improved handling and processing of the data for the purposes of the review process.

The CRF enables the reporting of implied emission factors and activity data at a level of source-category disaggregation that facilitates comparisons across countries, comparison of national data with relevant international statistics, transparent reporting of recalculations, reporting of time-series and provision of explanations for non-reporting emissions or removals from certain GHG sources or sinks.

UNFCCC review guidelines

Until 2000, national inventories were reviewed as part of the in-depth reviews of the national communications prepared by developed countries (first national communication were reviewed during 1995-1997 and second national communications were reviewed during 1997-1999). In general, the review teams that participated in these in-depth reviews had only one inventory expert and no more than one day was available for examining the inventory. This kind of review was not sufficient to assess the quality and reliability of the reported GHG data and in order to overcome this, the COP, in 1999, adopted guidelines for the technical review of inventories.

The purposes of the technical review of inventories are, *inter alia*, to ensure that the COP has adequate information on inventories and GHG emission trends, and to assist countries in improving the quality of their inventories. The technical review process comprises three stages, namely: initial checks, synthesis and assessment and individual reviews. The stages of the technical review complement each other so that, in general, for each developed country one stage is concluded before the next one is undertaken. At all stages of the review process, the countries under review have the opportunity to clarify issues or provide additional information. The reports from each stage of the review process are finalized and published with the agreement of the country concerned.

Initial checks are performed to determine promptly whether the national inventory submission, and in particular the data electronically submitted in the CRF, is complete and in the correct format to enable subsequent review stages to occur. The results are published on the UNFCCC web site as a status report for each developed country, mainly in tabular format.

Synthesis and assessment of annual inventories facilitates the consideration of GHG data and other information (submitted using the CRF) across countries and identifies issues for further consideration during the individual reviews. The results of this stage are published on the UNFCCC web site as a synthesis and assessment report, which contains a set of tables comparing inventory data

across countries, a preliminary country-by-country analysis and tables and graphs based on the submitted data.

Individual reviews provide for a periodic examination of the inventory estimates and the procedures and methodologies used in the preparation of inventories. These reviews are carried out by teams of experts nominated to the UNFCCC roster (2 of the experts serve as lead reviewers) that are coordinated by the secretariat. They cover the national inventory submission, any supplementary material submitted by the country under review and, as appropriate, previously submitted information. During an individual review, the expert review team considers the "paper trail" of an inventory from the collection of data to the reported emission estimate and assesses the quality and reliability of the inventories. The results of this stage are published as individual review reports, which are prepared under the collective responsibility of the members of the expert review team.

Three operational approaches for the individual review were used: sending inventory information to experts (desk review), experts meetings in a single location (centralized review) and in-country visits of experts.

A preliminary guidance for individual reviews[6] was developed to facilitate the review of inventories and the consistency of the review across different expert review teams. This guidance provides a set of instructions which experts are encouraged to follow and includes a general guidance, an outline of the written report to be prepared by the teams, a review checklist and additional instructions for the lead reviewers. The guidance is being further developed to include sectoral specific guidance in each main sector of the IPCC Guidelines.

Database and software tools

In 1995, the secretariat developed a database for maintaining inventory data following the first submissions of GHG data from developed countries. This initial database served as a basic depository of GHG data and included some limited reporting and output generation functions. Although the database was subsequently appended with additional functionalities, the adoption of the revised reporting guidelines and the review guidelines, in 1999, necessitated the development of a more sophisticated system for the management of the inventory information.

In 2000, on the basis of the CRF structure, a MS SQL based database system was developed. The new database was designed to satisfy the data maintenance requirements of the reporting and of the review process, to enable the processing of submitted information and to ensure adequate data accessibility and quality. In the course of 2001, a number of modifications were made to adjust certain data definitions and include additional administrative and data processing functions. In addition, software tools were developed to support the analytical needs of the review process and to provide the user with access to basic CRF data as well as information on reporting completeness, recalculations, emission contributions and emissions trends.

The inventory data in the system are updated in the second quarter of each year following the receipt of submissions which are due by 15 April of each year. As the data processing is closely linked to the initial checks stage, some data quality assurance is undertaken, thus allowing the possibility for resubmission or submission of additional data to address any issues raised.

During 2002, further changes are to be considered to take into account the needs of the review process and possible changes to the reporting requirements.

RESULTS

Preliminary results on the use of the reporting guidelines

The reporting guidelines, including the CRF, have contributed to the increase in the number of reported inventories by developed countries as well as the timeliness of reporting. The number of submissions was 21 and 28 in 1998 and 1999, respectively. After the introduction of the reporting guidelines in 2000 this number rose to 32. Countries have adhered more closely to the official due date (15 April) since the adoption of the reporting guidelines, as compared to inventories submitted prior to 2000. In 1998 and 1999 only 11 and 13 per cent of the inventories were received by 15 April, while in 2000 and 2001 this figure increased to almost 25 and 50 per cent, respectively.

The quality and completeness of the reporting has also improved as national inventory experts gained more experience with the use of the guidelines. The number of developed countries providing the CRF for the entire time-series increased from 5 in 2000 (time-series required: 1990 to 1998) to 14 in 2001 (time-series required: 1990 to 1999). In addition, the number of national inventory reports has also increased between 2000 and 2001 (from 8 to 15). However, there are still many reporting gaps and problems. Many developed countries do not report complete inventories in accordance with the reporting guidelines and a number of developed countries with economies in transition have not, to date, submitted their annual inventories.

The submission of information in accordance with the reporting guidelines has demonstrated its usefulness in supporting the review process. It has provided new possibilities to the review experts in assessing the quality and reliability of inventories, such as:

- Easier detection of anomalies/mistakes through data search processes;
- Comparison of implied emission factors across countries;
- Comparison of activity data with international statistics, if possible;
- Assessment of time series consistency.

<u>Identified limitations and ways to address them</u>

After two years of experience in using the guidelines the following issues, which need to be further addressed, were identified:

- Unsatisfactory reporting requirements concerning the use of the IPCC good practice guidance, in particular on the identification of major sources of emissions and on the selection of methods and emission factors for these sources;
- Insufficient information on the application of QA/QC procedures in the preparation of the inventories and the estimation of uncertainties;
- No precise guidance on the outline and content of the NIR which should provide more complete and transparent inventory information;
- The need to eliminate reporting of redundant or duplicate information in the CRF and to modify CRF tables to make them more consistent with the IPCC good practice guidance and actual data availability.

Revisions to the guidelines, prepared to overcome the above mentioned issues, are currently under consideration. It is anticipated that revised reporting guidelines will be adopted by the next session of the COP that is scheduled for the second semester of this year.

Review activities performed

The secretariat completed the initial checks of inventories submitted in 2000 and 2001. In addition, it completed the synthesis and assessment of these inventories with the assistance of several experts from the UNFCCC roster. The secretariat also coordinated individual reviews of 30 inventories through 4 desk reviews (each desk review covering 3 to 7 inventories), 2 centralized reviews (each centralized review covering 6 inventories) and 8 in-country reviews. In-country reviews were conducted only for those developed countries which volunteered for such an individual review. The inventory submissions of some countries were reviewed using more than one of the three approaches to facilitate the identification of relative advantages and disadvantages of these approaches. Review reports resulting from each stage of the review process (status reports, synthesis and assessment reports and individual country review reports) are published on the web site of the climate change secretariat.[7]

The completion of the tasks mentioned above would not have been possible without the active involvement of national experts and the support of all countries for the technical review process. The main criteria used for selecting review experts (nominated by different countries to the UNFCCC roster of experts) were their experience and expertise in preparing inventories, ensuring that the expert review teams have collective skills to address all the IPCC sectors. Without affecting the previous criteria, a wide geographical representation was ensured to the extent possible.

In 2001, a total of 123 national experts participated in 14 expert review teams. Out of this total, 69 experts were from developed countries and developed countries undergoing the process of transition to a market economy, 52 from developing countries and 2 experts from international organizations. The participation of 8 inventory experts from the United States of America was an important contribution to the review activities of the year 2001. In general, for each desk or centralized review team, 12 experts were selected (two experts per sector plus two generalists), while for each in-country review team 6 experts were selected (one expert per sector plus one generalist).

Two members of each review team (one from a developing country and one from a developed country) served as “lead reviewers”, who, in addition to the review of a specific part of the assigned inventory(ies), had to coordinate the work of the review team, with the assistance of the secretariat, including the drafting of the review report integrating the input from other team members. The ultimate responsibility for the content and the ownership of the final report remained with the whole review team.

Preliminary results on the use of the review guidelines

Identification of potential inventory problems in the synthesis and assessment

The identification of potential inventory problems for further consideration during individual reviews is carried out and published on an annual basis. The early identification of potential problems provides an opportunity for developed countries to overcome any identified problem in a systematic manner. It also provides useful information to the expert review teams allowing them to conduct a deeper analysis of the potential problem(s) and to investigate possible cause(s) thus contributing to an increase in the efficiency of the third and most costly stage of the review process.

The major problem that has been identified in many national inventories is the lack of reporting information from source-categories or activities that according to international statistics exist in the countries. These reporting gaps hamper the analysis of methodological aspects and affect the reliability of the GHG estimates. Other examples of common general gaps, which were identified in the 2000 inventory submissions and could lead to over or underestimation of the GHG emissions, are listed below:

- Differences between data reported in the CRF and data published in international statistics;
- Transcription errors or other typographical mistakes that lead to including or summarizing incorrect data;
- Misallocation of categories/sources that may lead to erroneous analysis;
- Insufficient disaggregation of sources that may lead to uncertain/incorrect estimates;
- Inconsistency in time series;
- Relatively high/low implied emission factors not justifiable by national circumstances;
- Apparent overestimation or underestimation of activity data or emissions;
- Use of inappropriate methods for estimation of emissions from major sources.

Developed countries recognized that these gaps/problems need to be rectified and most of these countries informed of their plans to do so while preparing their next inventory submission.

For the inventories submitted in 2001, the problems identified during the synthesis and assessment stage were similar to those listed above. This was due to the fact that the time between the publication of the synthesis and assessment report for the 2000 submissions and the preparation of the 2001 inventory submissions was too short and, therefore, national inventory compilers were unable to take into account the identified problems. It is anticipated that the benefits of this stage of the review process will become more obvious when the inventory submissions due in 2002 are considered.

Identification of problems in individual reviews

The third stage of the review process, which comprises an individual review of the inventory (either as a desk, centralized or in-country review), allows for a comprehensive assessment of all aspects of the inventory and results in the identification of more complex problems in the inventory preparation. Although, during individual reviews, the findings resulting from the previous stages were investigated further and, in a number of occasions, the existence of problems was confirmed, the expert review teams were able to provide a more in-depth analysis of the inventory problems that could have not been identified during the previous stage.

The strength of the individual reviews lies in the assessments of methodologies and all related aspects that influence the accuracy of the estimates. While missing source categories are already systematically identified trough the synthesis and assessment report, only an individual review allows to determine full completeness of estimates, for instance in cases where emissions from an activity of an IPCC source category were omitted. The same applies for the assessment of the transparency of the supporting documentation (such as description of methods, derivation of emission factors, underlying assumptions etc), which was deemed to be insufficient for many source categories in almost all inventories that were reviewed. This was particularly the case for methods that were country-specific and very unique, such as CO_2 sequestration from aluminium and soda ash production, use of models in the land use change and forestry sector, etc.

In addition, this stage of the review process (in particular the in-country visits) revealed weaknesses in the verification of the data as well as in the data collection process and archiving systems, and highlighted cases where estimates could be considered as unreliable. Particularly the review of the archives and sources of information referenced by a country gives useful indication as to how well any assumptions used in the emissions calculations are supported and whether they reflect current practices (e.g. numerous references to private or expert opinion could indicate a lack of factual supporting data). Other problems, such as use of different methods for data collection for different years sometimes resulted in unreliable base year estimates and trends.

The methodological problems listed below were identified during the individual reviews for 6 countries whose individual review reports have already been published on the secretariat's website. This list is not exhaustive as it is limited to those examples that could have a significant impact on the accuracy of the estimates:

- Use of outdated emission factors that do not take into account recent research or technological developments (e.g. in transportation) or changes in certain parameters (e.g. feed intake, milk fat content) or emission factors that are based on outdated measurements (e.g. fugitive emissions). Not taking into account such information could lead to unreliable emissions trends for certain source categories;
- Insufficiently robust assumptions in the methodologies could significantly influence the trend in emissions (e.g. models driven by assumptions on government policies, but without any factual assessment of the real effects of such policies);
- Use of assumptions, emission factors or parameters that do not reflect real conditions (e.g. emission factors that do not take into account the amount of cars with 3-way-catalysts, the landing and take-off and altitude components, captured gas amounts or efficiency of such processes, cement kiln dust losses or leakage from anaerobic treatment plants, etc.);
- Use of gross calorific value instead of net calorific value as requested;
- Errors in the calculation of emission factors;
- Combination of parameters such as carbon emission factor and oxidation factor, thus making the inventory less transparent and verifiable;
- Identification of methods that are not fully consistent with IPCC methodology, or parameters and emission factors that are considerably different from IPCC defaults, resulting in potential over- or underestimation of emissions;
- Difficulties in the allocation of domestic and international marine and aviation emissions that appear to lead to an over- or underestimation in the emissions trends.

The process of individual country reviews has also highlighted a number of good examples in inventory preparation and on-going research that could be of value for other countries with similar national circumstances. This process may also be a useful tool to facilitate the dissemination of such examples or research results within the international community.

Expert considerations relating to the technical review process

All experts involved in desk, centralized and in-country reviews provided very positive feedback about the usefulness of the technical review process. The experts agreed that one of the most important elements for the success of the technical review process is the involvement of competent review experts either with extensive expertise at a particular IPCC sector or with broad knowledge of all areas of the inventory process.

Experts have identified strengths and weaknesses of the different review approaches, as summarized in Table 1 below . Despite the identified shortcomings of the various reviews activities, the national inventory authorities of the countries whose inventories were reviewed have also generally reported positive experiences on the results of the review of their national inventories.

Table 1. Major advantages and disadvantages of different review approaches.

Desk reviews	Centralized reviews	In-country reviews
Advantages		
• Opportunity to study the NIR and CRF without the time constraint of in-country visits or centralized reviews • No travel and per-diem costs • Easier to engage experts	• Quick and easy exchange of views/information between the members of the review team and between the review team and the secretariat • Dedicated period of time for reviews	• Active interaction with national experts and opportunity to immediately clarify issues • Availability of additional information (not included in NIR) assists in dealing better with national circumstances • Confidence building between countries
Disadvantages		
• Limited interaction with national experts from the countries under review • Tendency to focus on differences from IPCC defaults • Non-availability of additional information that is not incorporated in the NIR • Delay due to higher priority of office work • Limited communication between members of the review team • More difficult to produce review reports which are comparable in style	• Limited interaction with national experts from the countries under review • Tendency to focus on differences from IPCC defaults • Non-availability of additional information that is not incorporated in the NIR	• More resource intensive • More difficult to organize due to non-availability of experts • Need for additional resources within the country under review

In addition to the issues outlined above, the experts indicated that the following aspects deserve careful attention to achieve a more efficient review process:

- Cooperative, helpful and positive approach by review teams and national experts;
- Strong commitment by all to implement the process as planned;
- Availability of documentation (NIR and CRF) and supporting material (status reports, synthesis and assessment report) well in advance of the review activity;
- Good communication within the review team;
- Good guidance by lead reviewers, planning and preparation;
- Availability of supporting documentation at location of review (applicable to in-country reviews and centralized reviews);
- Good working facilities for experts (to be provided by countries for in-country reviews and the secretariat for centralized reviews).
- Increased time requirements for the members of the review teams who need to allow for time after visits for considering host country comments, and particularly for the lead reviewers who in addition should integrate the comments of the other members of the team;
- Requirement for sufficient time whilst performing in country or centralized reviews to prepare draft review reports;

- Differences in expertise between experts, including the need of training for experts who did not participate in a review activity before and who have limited or no experience with the reporting guidelines.

Preliminary results in using the database and software tools

Over the last year and a half as the database system has been used for the production of UNFCCC publications and in support of the inventory review process, the secretariat has found the system to be essential to the provision of timely and accurate information to countries, review experts and the public. The review experts have indicated that the availability of the data in a user-friendly searchable format has greatly facilitated the process, as has the standard analysis and comparisons produced. Given the time frame in which reviews must be undertaken the review experts have noted that the inventory database system should continue to be a core element of the process and be used to a greater extent to optimize both information assessment and experts/countries' time.

Identified limitations and ways to address them

As the main focus of development and support has been the maintenance and provision of data required for the review process, the present database system and software tools are limited in their ability to meet all the needs evolving in terms of the inventory reporting and review process, not to mention the increasing public interest in accessing inventory data and related information.

The immediate priorities are to continue to ensure the provision of data accessibility and quality requirements, integration of related information and data for the review process, the production of standard data analysis and publications and implementation of modifications to the database in line with any revised guidelines agreed in 2002. However, the experience gained so far has shown that there is a need to develop much more robust data analysis tools that would provide multi-functional access to the inventory data, including graphical representations, information on major sources of emissions and trend assessments, basic statistical functions and incorporate relevant external datasets for comparability.

In addition, to further increase the efficiency of experts' involvement in the inventory assessments, it is necessary to provide an information technology-based mechanism to meet the data and information exchange needs of the review process (e.g. data portal, extra-net, clearinghouse). Such a mechanism would facilitate the dissemination and exchange of data and inventory related information and would contribute to the training/capacity building needs of the review process. Such developments would also contribute to increased public awareness, facilitating a more timely and wider dissemination of information on inventories to the public.

CONCLUSIONS

The development of well defined, complete and coherent guidelines for reporting and review of GHG and other inventory information and the development of database and dedicated software tools that facilitate the implementation of both sets of guidelines have proved to contribute to the preparation of reliable and high quality inventories.

The increasing familiarity of national inventory compilers with the reporting requirements has resulted in an increase in the number of annual submissions, in an improved adherence to agreed timelines for providing the required information and in significant enhancement of the quality and completeness of the inventories.

The development of a standardized reporting format for providing annual information on emissions and trends, and its availability as a software application, has facilitated the processing of the reported information and has contributed to the effectiveness of the review process. In addition, the submission of a national inventory report facilitates the assessment of the transparency, accuracy and completeness of an inventory. From the experience gained so far, it is clear that national inventory reports should have a common and comprehensive structure that would assist the reporting of the necessary information in a systematic and comparable manner and would facilitate the review of the reported information in an efficient way.

The technical review process has demonstrated its ability to identify gaps and methodological and other problems in national inventories through a systematic data screening process followed by a thorough examination of the reported GHG information and to provide opportunities for inventory compilers to rectify deficiencies in the inventory preparation process. The three stage approach that was followed has proved to be an invaluable tool allowing for a detailed assessment of the quality and reliability of inventories as well as for the early detection of potential problems.

The review process has also highlighted that competence and extensive inventory expertise of review experts are of paramount importance. The interaction between review experts and national inventory compilers constitutes an important element that enhances the experience and skills of all involved experts, while it contributes to improvements in the quality and reliability of the GHG inventories of both the country under review and the countries of the review experts. Training of experts to increase their familiarity with the review process is essential for ensuring the success of future review activities, which will require the active participation of more than 100 inventory experts annually.

The existence of database and software tools is vital in ensuring that the large number of annual inventories can be processed and reviewed in a cost-effective, timely and accurate manner. The review process was to a large extent facilitated by the ease of data access and the availability of standardized data comparisons, allowing for rapid identification of inconsistencies and omissions and easy data manipulation for analysis purposes. However, the database system and related software tools will need to be further developed, not only to take into account the expected revisions to the guidelines, but to overcome the existing limitations and make it available to a larger group of users (review experts, countries, general public).

Although this paper analyzes the experiences gained with the technical review of inventories at the international level, the authors believe that due to the similarities in preparing inventories at different levels (local, regional or national) some of the experiences described could also be relevant for developing and reviewing such inventories.

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The views and opinions of the authors expressed in this paper do not state or reflect those of the secretariat of the United Nations Framework Convention on Climate Change or those of the Parties to the United Nations Framework Convention on Climate Change.

KEY WORDS

Climate change
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