DEVELOPING THE GHG INVENTORY FOR SOUTH AFRICA

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Abstract

South Africa is a signatory to the UNFCCC and therefore required to share information on, among other things, the sources and sinks of greenhouse gases (GHGs). DEAT is the national focal point for climate change activities, and is responsible for co-ordinating South Africa's obligations under the UNFCCC, including the GHG inventory. The IPCC Methodologies have been the most commonly used in reporting to the UNFCCC. In 2006, a new set of guidelines was published, IPCC (2006). The new guidelines provide more comprehensive and holistic methodologies for quantifying GHG emissions. ERC and CSIR are currently engaged in the development of the new GHG emissions inventory, using year 2000 as the baseline and using the IPCC (2006) where appropriate. The inventory will be used for the Second National Communication to the UNFCCC. Furthermore, the GHG inventory will be a critical source of information for air quality management and climate change mitigation in South Africa.

Keywords: Greenhouse gases national inventory, climate change, South Africa, IPCC guidelines, UNFCCC, air quality information system

1. Introduction

1.1. GHG inventories in SA

South Africa is among the top 25 largest emitters of Greenhouse-Gases (GHG) globally (Yawitch 2008) and the largest emitter in Africa. The greatest proportion of South Africa's GHG emissions comes from the energy sector, which is crucial to the economic development of the country. Accounting for emissions from the energy and other sectors is an essential part of quantifying emissions and producing GHG emission inventories. GHG Inventories can be prepared at many levels; from that of a company/business project through to a National Inventory. An example of a small scale inventory could be one that would be required for an organisation to quantify its carbon footprint or contribute to mitigation. Certain inventories, such as that required for an application for the Clean Development Mechanism (CDM) funding, must adhere to stringent international guidelines (http://cdm.unfccc.int/index.html). A larger scale inventory would be the GHG inventory that could be an integral part of the municipal and provincial Air Quality Management Plans. A GHG inventory is often included in energy strategies.

To enhance the quality, accuracy and acceptability of GHG inventories, the "South African National Standard for Greenhouse gases" was developed. It was published by Standards South Africa (2006). It has the following three components;

Part 1 SANS14064-1:2006: Specification with guidance at the organization level for quantification and reporting of greenhouse gas emission and removals

Part 2 - SANS 14064-2:2006: Specification with guidance at the project level for quantification, monitoring and reporting of greenhouse gas emission reduction or removal enhancement

Part 3 - SANS 14064-3:2006: Specification with guidance for the validation and verification of greenhouse gas assertions

In the past, most of the GHGs were not defined as air quality pollutants that require reporting. However, the National Environmental Management: Air Quality Act (No.39 of 2004) recognised the importance of GHG emissions and included monitoring and reporting on GHG emissions as a part of the license conditions in section 43.1 (l). Some large polluters, such as Eskom, reported GHG emissions in their annual reports even prior to this requirement. This paper will focus on the development of the national GHG inventory for the year 2000.

1.2. The need for the national GHG inventory in SA

South Africa is a signatory to the United Nations Framework Convention on Climate Change (UNFCCC). As part of its commitment to the convention, South Africa is required to share information on, among other things, the sources and sinks of greenhouse gases (GHGs). The use of internationally accepted methodologies allows for consistency amongst national inventories and uniform global GHG accounting. This is crucial for the fair international negotiations and for the monitoring of global effort on climate change mitigation. Therefore the national inventory should be prepared using the Intergovernmental Panel on Climate Change (IPCC) methodologies. It is compulsory to use the IPCC guidelines in emission level reporting to the UNFCCC.

The Department of Environmental Affairs and Tourism (DEAT) is the national focal point for climate change activities, and is responsible for co-ordinating South Africa's obligations under the UNFCCC. Part of this responsibility requires South Africa, as a Party to the Convention, to "Develop, periodically update, publish and make available to the Conference of Parties, in accordance with Article 12, national inventories of anthropogenic emissions by sources and removals by sinks of all greenhouse gases". South Africa is prepared to go beyond UNFCCC requirements for the non-Annex I countries (developing countries) and in this way it assumes a leading role, among developing countries, as stated by the DEAT's Minister (Van Schalkwyk 2008): *"The world faces a global climate emergency. It is now clear that only action by both developed and developing countries can prevent the climate crisis from deepening. While developed countries bear most of the responsibility for causing the problem to date, developing countries – including South Africa – must face up to our responsibility for the future…. South Africa takes a leading position in the developing world and demonstrates it is ready to shoulder its fair share of responsibility as part of an effective global response to climate change."*

SA developed its first national GHG inventory as part of the Initial National Communication to the UNFCCC (DEAT, 2004). In 2006 a UNFCCC program for the submission of the Second National Communication by non-Annex 1 countries was initiated, to include the preparation of national GHG inventories for 2000.

It is recognized that the rapid economic development of SA may render a 2000 base year national GHG inventory outdated even before it is published. Regular updates of the national GHG inventory are planned by the DEAT (as explained in the following sections) regardless of the UNFCCC base year requirements for non-Annex 1 countries. This is because a national inventory is fundamental to the understanding of major sources and sinks of GHGs and for the development of regional, national and provincial/local climate change mitigation measures and strategies.

In particular, an up-to-date national GHG inventory would be a vital foundation for the vision, strategic direction and framework for climate policy announced in July 2008 (Van Schalkwyk 2008). To implement this policy a plan is required for measurable, reportable and verifiable domestic emission reductions, which must be based on the accurate national GHG inventory.

2. Review of previous GHG inventories

The preparation of the 1990 GHG inventory was coordinated by the CSIR in collaboration with a team of experts from different sectors, including government, non government and the private sector (van der Merwe and Scholes 1998). The 1994 GHG inventory was an update of the 1990 inventory, using 1994 activity data, but the methodologies were essentially the same as in the 1990 inventory. Preparation of the national GHG inventory was part of the Country Study Programme which led to the submission of South Africa's Initial National Communication to the UNFCCC Secretariat. The GHG inventory became an input into the Initial National Communication (DEAT 2004).

In preparation for the inventory for the year 2000, the previous inventory was reviewed. From this review it was concluded that the previous inventory was conducted in accordance with the UNFCCC requirements and was generally complete and adequate.

The inventory was developed using the IPCC 1996 Revised Guidelines for National GHG Inventories. The following major direct GHGs were estimated, in accordance with the UNFCCC requirements and the IPCC guidelines - Carbon dioxide (CO_2); Methane (CH_4) and Nitrous oxide (N_2O). Other emission estimates in the national inventory included Carbon monoxide (CO); Nitrogen oxides (NOx); Non-methane volatile organic compounds (NMVOC) and Sulphur dioxide (SO_2), which is not a greenhouse gas.

The national emissions as quantified in the previous inventory were as follows: CO_2 contributed to 83.2% of the total GHG emissions in 1994. The energy sector contributed 78.3% of the total emissions (excluding land use and forestry). The agricultural sector contributed 9.3%, the industrial processes sector 8% and the waste sector 4.3 to the total emissions. The review assessed the key categories of emissions in SA, which contribute to 95% of the total (see Appendix A). For these categories it is necessary to apply Tier 2 approach, which requires local activity data and emission factors. The potential improvements for the current inventory have been summarised. The limitations of

the previous inventory were noted, such as the problem of transparency. The UNFCCC transparency requirement is for a detailed description of the methodologies and of the assumptions to be used. This transparency requirement applies only to the Annex 1 (developed) countries. IPCC guidelines require a transparent review process. The review could not find any details of such a process and it was suggested that this should be improved for the GHG inventory for the year 2000.

3. New IPCC guidelines

Recently a new set of guidelines was published by the IPCC (IPCC 2006). It provides comprehensive and holistic methodologies for quantifying GHG emissions, especially in the non-energy sectors. In line with South Africa being keen and willing to take a leading position on climate change, it was decided to adopt these new guidelines, where possible, in contrast to the other non-Annex 1 countries which have yet to start implementing them.

The main differences between the guidelines are briefly explained below.

The IPCC, 2006 guidelines, restructured sectors to improve transparency and completeness and to reduce double accounting. In particular, to ensure transparency the methodology applied and the justification for the selection of local emission factors must be described in GHG inventory. Furthermore, both should be based on published information as the use of expert opinion is no longer acceptable. The new guidelines have improved the methods and the default data, including the uncertainty range for the default factors. (Default emission factors are used for Tier 1 calculations Tier 2 calculations require local emission factors, while Tier 3 calculations are based on the methodologies or models developed to represent specific local conditions). The new guidelines cover additional GHGs and give methods for additional sectors and sources of emissions. The previous IPCC publications on good practice guidance were integrated into the IPCC, 2006 guidelines for clarity and ease of use. The GHG inventory should now include trend analysis, uncertainty analysis and data quality plan.

Although energy sector guidelines have not changed much, better guidance is provided on demarcation between the Energy and Industrial Processes and Product Use (IPPU) sectors. Emissions from non-energy uses of fossil fuels are now reported under IPPU rather than under the energy sector and a method has been introduced for checking the completeness of emission estimates from the non-energy uses.

The emissions from the Agriculture and Land Use sectors have been integrated into a new framework (Agriculture, Forestry and Other Land Uses – AFOLU) in order to resolve inconsistencies and avoid double accounting. This removed the somewhat arbitrary distinction between these categories in the previous guidance, and promoted the consistent use of data between them, especially for the more detailed methods. It also allows for a more consistent treatment of land conversions. Spatial data for all managed land is now required and detailed guidelines are provided on three possible approaches to spatial data use. (Approach 1 for activity data identifies the total area for each individual land-use category within a country, but does not provide detailed information on the nature of conversions between land uses. Approach 2 introduces tracking of conversions between land-use categories. Approach 3 extends the information available in Approach 2 by allowing land-use conversions to be tracked on a spatially explicit basis.)

A summary of the differences between the guidelines for the AFOLU sector is presented in Table 1 below.

According to the new guidelines, the waste sector emission calculations should be done using a 1st order decay model. Therefore more comprehensive data is needed for the Tier 1 approach than was needed for this approach in the previous inventory. In particular this model requires long time series data (at least 42 years for the South African climate).

Table 1: Differences between IPCC guidelines (AFOLU)

IPCC category	IPCC 1996	IPCC 2006
Fire	Emissions from prescribed burning only Only non-CO_2 gases Emissions from crop residue and savanna burning reported under Agriculture	Emissions from fires on all managed lands CO_2 included except when emissions = uptake in a year All fire emissions reported separately
Wetlands	Compulsory reporting only for land converted to peatlands	Some methodologies not fully developed, except land converted into peatlands and flooded lands
Settlements	Not Included	Included as separate chapter
Direct and Indirect emissions of CO_2	Assumed all carbon emitted as CO_2. (implication for fire calculation)	Only direct emissions of carbon CO_2 Excludes carbon emitted in other forms (CH_4, CO…) and converted over time into CO_2 in the atmosphere
Direct and Indirect emissions of N_2O	Report indirect N_2O emissions only for some agricultural sources	Report indirect N_2O from manure management and all other non-agricultural sources

4. Project progress

In 2007 the ERC and CSIR were commissioned by DEAT to undertake the preparation of a national

GHG inventory, as part of the GHG information Management project.

The objective of the GHG project is two-fold:

1. To prepare a South African GHG emission inventory system that uses broadly agreed data collection and generation methodologies to provide current, accurate, relevant and complete greenhouse gas emission information of a quality that complies with both UNFCCC and local requirements.
2. To ensure that this GHG inventory (and subsequent inventories) is fully anchored within the DEAT's Atmospheric Information Management directorate and that the directorate is fully capacitated to efficiently and effectively implement and maintain the system.

At a project planning workshop in March 2008 it was agreed that where possible the methodologies recommended in the latest IPCC guidelines (2006) would be applied and the structure of the National Inventory Report (NIR) would be similar to reports from Annex I counties. The opportunities for sectoral GHG inventories by other government departments (such as the Department of Agriculture and Transport) were discussed as it became clear that DEAT will need to rely on other departments for preparing future GHG inventories.

Presently the drafts for the Energy and Waste sectors have been submitted to the Project Steering Committee (PSC). The activity data for the energy sector were based on the national energy balances compiled by the Department of Minerals and Energy (DME, 2006). The energy sector emission results showed a similar trend to previous inventories by way of sector contribution, though a number of issues on data quality required to be resolved. The local coal emission factors vary, because coal is sourced from mines producing coals with a very wide range of carbon contents and calorific values. However a single emission factor was applied. The emissions for all sub-sectors of the energy sector were calculated using Tier 1 methodology. In some sub-sectors (for example in iron and steel production, where large amounts of the fuels are used in blast furnaces for the reduction processes), no separation between energy and process emissions could be made, and both emissions were included in the energy sector. A detailed assessment of fugitive emissions from coal mining was conducted, including emissions from coal waste dumps. It was concluded that this source could be significant. Fugitive emissions from abandoned mines have not been included in the current inventory due to lack of sufficient data but every effort should be made to include them in the next inventory.

The results for the waste sector were based on 2nd tier methodology and are more accurate than in the previous inventory. It shows that emissions from this sector were previously overestimated.

An intensive attempt was made to define land use changes based on available spatial data. However the rigorous analysis demonstrated that existing data is not sufficient to provide results suitable for emissions calculations. It was therefore decided to use Approach 1 of the IPCC, 2006 (which identifies the total area for each individual land-use category). The evaluation of international experience showed that even developed countries such as the US and Australia are still busy developing the full spatial capabilities required for applying Approach 2. The US has applied the IPCC, 2006 guidelines, but had to use the Approach 1 for representing spatial data.

As explained in Table 1 above, a more comprehensive calculation of fire emissions is required by the IPCC (2006). More accurate activity data than that used in the previous inventory and new methodology (3rd tier) were prepared for the calculation of emissions from fire. The activity data is based on MODIS satellite images and the preliminary results show that in this sector the previous inventory also overestimated emissions. The first attempt to estimate emissions from flooded lands was made using IPCC, 2006 new methodology and defaults. It was shown that this source is not a significant contributor of GHG emissions in SA.

The draft reports on the above issues were submitted for review to the Department of Water Affairs and Forestry; to the South African National Botanical Institute (SANBI) and to the PSC, which includes representatives from government departments, the energy, industry and agriculture sectors.

5. Way forward

At present consultants from the ERC and the CSIR are busy with the development of a national GHG inventory and are carrying out activities that can create a platform for institutionalising the GHG inventory process in South Africa within DEAT. The inventory will be used for the Second National Communication to the UNFCCC and will be included as a module in the South African Air Quality Information System (SAAQIS) currently being developed for the DEAT. Furthermore, the GHG inventory will be a critical source of information for air quality management in South Africa.

Acknowledgments

This project is being carried out by the ERC and CSIR teams. From the CSIR the contributions by Bongani Majeke, Heidi van Deventer and Sally Archibald to the land use sector and of Ndeke Muse to the Waste sector are acknowledged. The support

and review by Marna van der Merwe and Bob Scholes are appreciated. From the ERC the contribution from Ajay Trikam is acknowledged.

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Appendix A: GHG Emission Sources, 1994 (Key Categories highlighted)

Source	CO_2	CH_4	N_2O	CO_2 eq	Contribution level	Level assessment
	Gg					
1A1a Public electricity and heat production	152505		1.94	153109	0.4031	40.31%
1A3b Road transport	29816	9.68	1.07	30352	0.0799	48.30%
1A2a Iron and steel energy	19194	2.18	0.25	19320	0.0509	53.39%
2C1 Iron and steel production	18034			18035	0.0475	58.13%
4A Enteric fermentation		844.01		17724	0.0467	62.80%
1A4c Others Agriculture/forestry/fishing	15953	30.70	0.53	16762	0.0441	67.21%
1A2c Chemicals	16240	2.39	0.27	16376	0.0431	71.52%
4D Agricultural soils			50.05	15516	0.0408	75.61%
6A Solid waste disposal		721.74	0	15157	0.0399	79.60%
1A1c Manufacture of solid fuels and other energy industries	10551	0.28	0.64	10756	0.0283	82.43%
1A2f Others	10554	1.23	0.15	10628	0.0280	85.23%
1A3d Navigation	8627	0.79	0.23	8714	0.0229	87.52%
1A4b Others Residential	7397	0.60	0.08	7436	0.0196	89.48%
1B1a Coal mining fugitive		316.90		6655	0.0175	91.23%
1A1b Petroleum refining	4760	0.18	0.02	4770	0.0126	92.49%
2A1 Cement production	3952			3952	0.0104	93.53%
1A3a Civil aviation	2961	0.02	0.08	2987	0.0079	94.32%
2C2 Ferroalloys production	2539			2540	0.0067	94.98%
1A5 Others Mining and Quarrying	2273	0.15	0.03	2285	0.0060	95.59%
2B2 Nitric acid production			7.27	2254	0.0059	96.18%
1A2e Food processing, beverage and tobacco	1888	0.14	0.03	1900	0.0050	96.68%
2B1 Ammonia production	1867			1867	0.0049	97.17%
4B Manure management		78.47	0.07	1670	0.0044	97.61%
1A2d Pulp, paper and print	1583	0.02	0.03	1592	0.0042	98.03%
1A2b Non ferrous metals energy	1450	0.012	0.02	1458	0.0038	98.41%
1A3c Railways	1281	0.073	0.50	1437	0.0038	98.79%
2A2 Lime production	1305			1306	0.0034	99.14%
6B Waste water handling		21.33	2.66	1273	0.0034	99.47%
1A4a Others Commercial/institutional	780	0.07	0.01	785	0.0021	99.68%
4E Prescribed savannah burning		12.63	0.61	454	0.0012	99.80%
2C3 Aluminium production	248			249	0.0007	99.86%
1B2b Natural gas fugitive		9.59		201	0.0005	99.92%
4F Agric residue burning		2.31	0.14	92	0.0002	99.94%
2B4 Carbide production	85	0		85	0.0002	99.96%
2A4 Soda ash production and use	72			73	0.0002	99.98%
1A3eOther: LPG, Kerosene	29	0.001	0.0001	30	0.0001	99.99%
2B5 Other		1.25		26	0.0001	100.00%
1B2a Oil fugitive		0.63		13	0.0000	100.00%
1B1c Coal liquefication; fugitive				0	0.0000	100.00%
2A3 Limestone and dolomite use	0			0	0.0000	100.00%
4C Rice cultivation		0		0	0.0000	100.00%
				379837		