UNITED
NATIONS

UNFCCC Framework Convention on Climate Change

Distr.
GENERAL

FCCC/ARR/2006/FIN
15 January 2008

ENGLISH ONLY

Report of the individual review of the greenhouse gas inventory of Finland submitted in 2006*

* In the symbol for this document, 2006 refers to the year in which the inventory was submitted, and not to the year of publication.

CONTENTS

I. Overview

A. Introduction

1. This report covers the in-country review of the 2006 greenhouse gas (GHG) inventory submission of Finland, coordinated by the United Nations Framework Convention on Climate Change (UNFCCC) secretariat, in accordance with decision 19/CP.8. The review took place from 28 May to 2 June 2007 in Helsinki, Finland, and was conducted by the following team of nominated experts from the roster of experts: generalist – Mr. Manfred Ritter (Austria); energy – Mr. Tomas Gustafsson (Sweden); industrial processes – Mr. William Kojo Agyemang-Bonsu (Ghana); agriculture – Mr. Donald Kamdonyo (Malawi); land use, land-use change and forestry (LULUCF) – Mr. Mikhail Gytarsky (Russia); waste – Mr. Ayite-Lo Ajavon (Togo). Mr. Agyemang-Bonsu and Mr. Gytarsky were the lead reviewers. The review was coordinated by Ms. Astrid Olsson (UNFCCC secretariat). Ms Maria Socorro Manguiat (UNFCCC secretariat) participated in the review as an observer.

2. In accordance with the "Guidelines for the technical review of greenhouse gas inventories from Parties included in Annex I to the Convention" (hereinafter referred to as the UNFCCC review guidelines), a draft version of this report was communicated to the Government of Finland, which provided comments that were considered and incorporated, as appropriate, in this final version of the report.

B. Inventory submission and other sources of information

3. In its 2006 submission, Finland submitted a complete set of common reporting format (CRF) tables for the years 1990–2004 and a national inventory report (NIR). Where needed the expert review team (ERT) also used the previous year's submission, additional information provided during the review and other information. The full list of materials used during the review is provided in the annex to this report.

C. Emission profiles and trends

4. In 2004, the most important GHG in Finland was carbon dioxide (CO_2), contributing 84.8 per cent to total[1] national GHG emissions expressed in CO_2 eq., followed by nitrous oxide (N_2O), 8.5 per cent, and methane (CH_4), 5.8 per cent. Hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulphur hexafluoride (SF_6) taken together contributed 0.9 per cent of the overall GHG emissions in the country. The energy sector accounted for 82.1 per cent of the total GHG emissions followed by industrial processes (7.6 per cent), agriculture (6.9 per cent), waste (3.3 per cent) and solvent and other product use (0.1 per cent). Total GHG emissions amounted to 80,895.56 Gg CO_2 eq. and increased by 13.9 per cent from 1990 to 2004. The ERT acknowledges that these trends are reasonable.

5. Tables 1 and 2 show the greenhouse gas emissions by gas and by sector, respectively.

[1] In this report, the term total emissions refers to the aggregated national GHG emissions expressed in terms of CO_2 eq. excluding LULUCF, unless otherwise specified.

Table 1. Greenhouse gas emissions by gas, 1990–2004

GHG emissions	Gg CO_2 equivalent								Change
	Base year Convention	1990	1995	2000	2001	2002	2003	2004	BY–2004 (%)
CO_2 (with LULUCF)	35 327.79	35 327.79	42 802.20	40 884.48	43 234.86	45 931.53	54 859.94	50 091.65	41.8
CO_2 (without LULUCF)	56 767.66	56 767.66	58 210.01	57 209.15	62 327.03	64 833.90	72 739.58	68 605.07	20.9
CH_4	6 301.34	6 301.34	6 085.46	5 391.18	5 271.15	5 074.77	4 879.16	4 706.66	–25.3
N_2O	7 886.88	7 886.88	7 170.20	6 871.10	6 779.54	6 834.52	6 941.02	6 880.95	–12.8
HFCs	0.02	0.02	29.33	501.73	656.87	463.44	652.07	695.07	3 926 841.8
PFCs	0.07	0.07	0.14	22.46	20.06	13.37	14.85	12.23	17 370.0
SF_6	94.38	94.38	68.53	51.49	55.03	51.31	41.71	23.18	–75.4

Note: BY = Base year; LULUCF = Land use, land-use change and forestry.

[a] Finland submitted revised estimates for the base year and 2004 in the course of the initial review on 3 July 2007. These estimates differ from Finland's GHG inventory submitted in 2006.

Table 2. Greenhouse gas emissions by sector, 1990–2004

Sectors	Gg CO_2 equivalent								Change
	Base year Convention	1990	1995	2000	2001	2002	2003	2004	BY–2004 (%)
Energy	54 655.61	54 655.61	56 564.78	55 101.48	60 350.42	63 002.57	70 667.93	66 382.45	21.5
Industrial processes	5 074.07	5 074.07	4 601.59	5 553.91	5 595.94	5 358.47	5 957.08	6 154.94	21.3
Solvent and other product use	178.37	178.37	142.77	124.71	122.00	111.08	104.46	105.10	–41.1
Agriculture	7 113.82	7 113.82	6 317.66	5 960.84	5 846.34	5 818.38	5 736.31	5 614.53	–21.1
LULUCF	–21 389.50	–21 389.50	–15 381.02	–16 293.19	–19 059.76	–18 867.91	–17 848.08	–18 485.82	–13.6
Waste	3 978.11	3 978.11	3 910.07	3 274.69	3 162.58	2 946.36	2 771.05	2 638.54	–33.7
Other	NA	NA	NA	NA	NA	NA	NA	NA	NA
Total (with LULUCF)	49 610.48	49 610.48	56 155.86	53 722.44	56 017.51	58 368.94	67 388.75	62 409.74	25.8
Total (without LULUCF)	70 999.98	70 999.98	71 536.88	70 015.62	75 077.28	77 236.86	85 236.83	80 895.56	13.9

Note: BY = Base year; LULUCF = Land use, land-use change and forestry; NA = not applicable.

[a] Finland submitted revised estimates for the base year and 2004 in the course of the initial review on 3 July 2007. These estimates differ from Finland's GHG inventory submitted in 2006.

D. Key categories

6. Finland has reported a tier 2 key category analysis, both level and trend assessment, and also applied a qualitative approach in determining its key categories as part of its 2006 submission. The key category analysis performed by the Party and the secretariat[2] produced different results, mainly because Finland uses a tier 2 approach to identify its key categories. Finland provided a transparent description of its key category analysis in the NIR.

E. Main findings

7. Finland has submitted a complete set of CRF tables for the years 1990–2004 and an NIR which is complete in terms of geographical coverage, years and sectors, and also in terms of categories and gases.

8. The inventory is generally in line with the *Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories* (hereinafter referred to as the Revised 1996 IPCC Guidelines), the IPCC *Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories* (hereinafter referred to as the IPCC good practice guidance) and the IPCC *Good Practice Guidance for Land Use, Land-use Change and Forestry* (hereinafter referred to as the IPCC good practice guidance for LULUCF). During the in-country review, the ERT identified a few categories where the methods or emission factors (EFs) used were not fully in accordance with the IPCC good practice guidance and might lead to overestimation of emissions in the base year or underestimation of emissions in the most recent year (e.g. feedstocks and non-energy use of fuels and iron and steel production). The ERT recommended Finland to revise its estimates for these categories. After the in-country review, Finland provided revised estimates for these categories for the base year and 2004 in accordance with the recommendations of the ERT.

9. The NIR provides information on the methodologies used, activity data (AD) and EFs. However, the ERT noted the need to provide more information and explanation in the NIR, including in annexes if needed, to facilitate future reviews. Such information should include, for example, better documentation of choices of methodologies and of EFs. The ERT also encourages Finland to better explain the trend in emissions.

10. Quality assurance/quality control (QA/QC) procedures are in place and QC reports are prepared by all six core institutions (Statistics Finland, the Finish Environment Institute (SYKE), the Finnish Forest Research Institute (Metla), Agrifood Research Finland, the Technical Research Centre of Finland (VTT), and Finavia). However, a strengthening of these procedures and a further elaboration of the QC reports is still needed.

F. Cross-cutting topics

1. Completeness

11. The inventory submitted is complete in terms of geographical coverage, years and sectors, and fairly complete in terms of categories and gases. Actual and potential emissions are given for the fluorinated gases (F-gases). Categories where no methodology is available are reported as not estimated ("NE").

[2] The secretariat identified, for each Party, those source categories that are key categories in terms of their absolute level of emissions, applying the tier 1 level assessment as described in the IPCC *Good Practice Guidance for Land Use, Land-use Change and Forestry* (hereinafter referred to as the IPCC good practice guidance for LULUCF) for the base year as well as the latest inventory year. Key categories according to the tier 1 trend assessment were also identified. Where the Party performed a key category analysis, the key categories presented in this report follow the Party's analysis. However, they are presented at the level of aggregation corresponding to a tier 1 key category assessment conducted by the secretariat.

2. Transparency

12. The transparency of the CRF and the NIR has been improved compared with previous submissions. However, the detail in the documentation and the level of transparency still differ between the sectors. The ERT encourages Finland to further improve the transparency of all sectors by ensuring a minimum level of documentation detail in all sectors, for example, by developing internal reporting guidelines. These guidelines could include recommendations on the extent to which trend explanations need to be provided in the sectors.

3. Recalculations and time-series consistency

13. The ERT noted that a number of recalculations had been made since the last inventory submission to take account of methodological improvements as well as better AD and EFs. In the energy sector, point-source data have been revised after thorough checking for inconsistencies in AD. Non-CO_2 EFs had been updated and indirect N_2O emissions from atmospheric deposition of nitrogen (N) from nitrogen oxides (NO_X) have been included. Emissions from peat production previously reported as fugitive emissions in the energy sector have been reallocated to wetlands in the LULUCF sector. Indirect CO_2 emissions from fugitive emissions from fuels have been calculated from emissions from non-methane volatile organic compounds (NMVOC) for the first time. A number of further recalculations were performed in order to take into account the recommendations from previous reviews and the findings of internal checks.

4. Uncertainties

14. The Party has provided an uncertainty analysis for each category and for the inventory in total, following the IPCC good practice guidance. Finland performed a tier 1 and a tier 2 uncertainty assessment and included the LULUCF sector in the uncertainty estimation. The uncertainty results, level of aggregation used, correlations considered and methodological approaches used are transparently reported in the NIR. The NIR discusses planned improvements and uncertainty analysis within each category and is considered in prioritizing improvements to the inventory.

5. Verification and quality assurance/quality control approaches

15. Finland has elaborated and implemented a QA/QC plan in accordance with the IPCC good practice guidance. This includes general QC procedures (tier 1) as well as category-specific procedures (tier 2) for key categories and for those individual categories in which significant methodological and/or data revisions have occurred.

16. QA/QC procedures are in place and QC reports are prepared by all six core institutions. However, strengthening of these procedures and a further elaboration of the QC reports is still needed. The ERT recommends a further strengthening of the QA/QC procedures at the relevant institutions and a further elaboration of the QC reports, for example by including summary results of the checks performed in the NIR and by including links to the underlying checklists.

17. There is a description of general and category-specific QA/QC procedures in the NIR. The NIR describes the overall quality objectives. During the in-country review, Finland presented an updated and extended overall improvement plan that includes a timetable and responsibilities. The ERT recommends the Party to include this improvement plan in the next NIR.

18. During the in-country visit, Finland explained that systems audits have not yet been performed but that it has explored the possibility of certifying the inventory system, although a decision on this has not yet been taken.

6. Follow-up to previous reviews

19. The ERT noted that a number of recalculations had been made since the last inventory submission to take account of methodological improvements as well as better AD and better EFs. In the energy sector, point-source data had been revised after thorough checking for inconsistencies in AD. Non-CO_2 EFs had been updated and indirect N_2O emissions from atmospheric deposition of N from NO_X have been included for the first time. Emissions from peat production previously reported as fugitive emissions in the energy sector have been reallocated to wetlands in the LULUCF sector. Indirect CO_2 emissions from fugitive emissions from fuels have been calculated from NMVOC emissions for the first time. A number of further recalculations were performed in order to take account of the recommendations from previous reviews and the findings of internal checks.

G. Areas for further improvement

1. Identified by the Party

20. The inventory improvement plan in the NIR identifies the following areas for improvement: (a) direct use of emissions trading data for inventory verification, (b) verification of the F-gas emission trends, (c) methodological developments for calculating CH_4 emissions from enteric fermentation from cattle, (d) improved data collection for agricultural soils, (e) inclusion of N_2O emissions from disturbance associated with land-use conversion to cropland, (f) implementation of a new method to estimate carbon stock change in living biomass, (g) separate estimates for 'land remaining' and 'land converted' to the specific land-use categories and (h) review of the waste composition data for municipal solid waste (MSW). During the in-country visit, Finland explained further its future plans for improving the overall QA/QC system.

2. Identified by the ERT

21. The ERT identifies the following cross-cutting issues for improvement:

(a) QA/QC system: improve the performance of the overall system by further considering the resource implications of QA/QC for the different institutions involved in preparing the inventory; the use of internal audits for the sector; and further improve the systematic approach to quality checks;

(b) CRF and NIR: further improve the completeness and consistency of the documentation given in the NIR and consider updating version management for the CRF and the NIR. Provide more precise descriptions of any methodologies that differ from those of the IPCC;

(c) The enhancement of consistent land representation;

(d) A re-evaluation of the applicability of the tier 1 methods in the IPCC good practice guidance for LULUCF to intensively managed land in the country.

22. Recommended improvements relating to specific source categories are presented in the relevant sector sections of this report

II. Energy

A. Sector overview

23. The energy sector is the largest contributor to GHG emissions in Finland. It accounted for 82.1 per cent of the total national GHG emissions (excluding LULUCF) in 2004. In 2004, fuel combustion contributed 66,382.45 Gg CO_2 eq. and fugitive emissions contributed 172.17 Gg CO_2 eq. to

the total national GHG emissions. The largest category within the energy sector in 2004 was public electricity and heat production, which accounted for 36.7 per cent of the total national GHG emissions. The GHG emissions from public electricity and heat production increased by 79.1 per cent in 1990–2004. Over the period 1990–2004 GHG emissions in the energy sector as a whole increased by 21.5 per cent.

24. All categories as well as all years and gases are covered in the energy sector. In addition, the proper notation keys have been applied where needed. Finland derives most of the underlying AD for the energy sector from the compliance monitoring data system (VAHTI system) and the national energy statistics. The energy balances are used to ensure that all fuels are accounted for, especially liquid fuels. Data collection is comprehensive and of good quality. EFs are mostly country-specific.

25. The energy sector in the Finnish NIR is generally transparent. However, there is insufficient information provided on several categories to fully explain emission trends and inter-annual variations, particularly for emissions from mobile combustion, where models are mostly used and the underlying drivers for the emission trends are not included in the NIR but described on external web pages. For the next inventory submission, the ERT recommends Finland to include more qualitative and quantitative analyses of changes in the underlying AD and the shares of different technology types in stationary and mobile combustion. In order to keep the NIR from expanding too much, it is recommended that extensive category-specific information is placed in annexes properly linked to the relevant category section in the energy sector.

26. Finland has performed many recalculations in its 2006 submission compared to its 2005 submission. The recalculations in the energy sector have been properly addressed in the NIR, in particular the inclusion of national EFs for stationary combustion. However, the NIR does not contain all the information necessary to fully understand the emission trends, so the complete impact of the recalculations cannot be assessed based on the information provided. During the in-country visit, the ERT was provided with additional information that justified the recalculations, for example, the reasons for reporting on corrections of heavy fuel oil under other (1.A.5.a). The ERT recommends that Finland include this information in the next NIR.

27. The NIR gives general descriptions of category-specific QC procedures and verifications. The ERT recommends that Finland formalize the documentation of QC procedures, for example, in manuals for applying AD from the largest emitting plants and by checking the data for large industries, especially the iron and steel industry.

B. Reference and sectoral approaches

1. Comparison of the reference approach with the sectoral approach and international statistics

28. Finland has calculated CO_2 emissions from fossil fuel combustion using the reference and the sectoral approaches for all years in the time series. For the year 2004, there is a difference of 1.21 per cent in the CO_2 emission estimates between the two approaches. Because the difference is below 2 per cent, explanations were not required in the CRF tables.

29. In addition to the IPCC reference approach, Finland estimates CO_2 emissions for 2004 from the energy sector based on a national reference tier 1 method (NIR, annex 4) and compares these to the sectoral approach. The results show good coherence for 2004. The ERT commends Finland for its effort to estimate CO_2 emissions for 2004 using the national reference approach and encourages Finland to further include additional qualitative and quantitative analyses on underlying data in its national reference approach and for more years, given the importance of a solid reference method to avoiding omissions and double counting of emissions.

2. International bunker fuels

30. Finland uses AD on fuel sales to estimate emissions from international bunkers. EFs for CO_2 emissions are national and for non-CO_2 emissions are based on average EFs calculated using the national calculation system for air traffic emissions (ILMI model). Emissions from international bunkers are separated from domestic navigation and aviation in accordance with the IPCC good practice guidance.

31. The ERT noticed several differences in international bunker data between the CRF and those reported to the IEA, for example, a systematic difference of about 3 per cent for jet kerosene, with lower figures in the CRF. Finland responded that the AD come from the same source. The ERT encourages Finland to double-check the estimates included in the CRF, especially the NCVs applied.

32. The ERT noticed discrepancies between CRF table 1.C and CRF table 1.A(b) for jet kerosene (international aviation), gas/diesel oil and residual fuel oil (international marine bunkers) for all years. The Party is encouraged to use the same, most up-to-date data in both CRF tables 1.C and 1.A(b) in its future reporting.

3. Feedstocks and non-energy use of fuels

33. In previous submissions, emissions from feedstocks and non-energy use of fuels were calculated assuming that all non-stored carbon is combusted. In its 2006 submission Finland estimated emissions from feedstocks and non-energy use of fuels based on plant-specific information and reported the emissions under corresponding categories in the CRF. In addition, smaller amounts of feedstocks and lubricants are judged, by national experts, to be released as CO_2, CH_4 and N_2O and reported under other – non-specified emissions of fuels from non-energy use (1.A.5.a). Remaining amounts are reported as stored carbon. The ERT commends Finland for its effort to establish national emission estimates for feedstocks and non-energy use of fuels instead of using the IPCC default values.

34. During the in-country review, Finland indicated that approximately 254 Gg CO_2 in 2004 (and small amounts of CH_4 and N_2O emissions) from burned feedstock, based on the judgment of national experts, may also be totally or partly accounted for as fugitive emissions from oil and natural gas flaring. The ERT noted that it could be a potential double counting of emissions and requested Finland to provide underlying information supporting the expert judgement or exclude the emissions from feedstock burning from the estimates for this category. In response to the ERT request, Finland provided revised estimates of other – non-specified emissions of fuels from non-energy use for 2004, which changed from 308.71 Gg CO_2 eq. to 95.04 Gg CO_2 eq. This also affected the estimates of other – indirect N_2O from NO_X emissions in 2004, which changed from 302.40 Gg CO_2 eq. to 301.79 Gg CO_2 eq. The ERT agreed with the revised estimates and recommended Finland to include them in the next inventory submission.

C. Key categories

1. Stationary combustion: solid – CO_2

35. All the values of the CO_2 implied emission factors (IEFs) for solid fuels for iron and steel (145.34–162.86 t/TJ) are higher than the IPCC default range (94.60–106.70 t/TJ) and are among the highest of reporting Parties (4.51–247.98 t/TJ). The Party had responded in earlier 2006 review stages that a major part of the AD relate to blast furnace gas with plant-specific EFs (155–265 t/TJ). Judging from the production data on crude steel presented in the Finnish NIR (page 92) the ERT believes that the CO_2 emissions in iron and steel show a similar overall trend but differences in inter-annual changes, for example, in 1999–2000 CO_2 emissions increased by 8.0 per cent, whereas production data only increased by 3.5 per cent. Finland is recommended to explain the drivers behind the large variance in CO_2 IEFs and if possible relate them to the production data.

36. During the in-country review, Finland indicated that the derived emissions from iron and steel are mainly based on detailed data on burned gases (blast furnace gas, coke oven gas, etc.) instead of, for

example, carbon mass balances. Finland reports emissions in both the energy sector and the industrial processes sector in accordance with the Revised 1996 IPCC Guidelines. Finland is encouraged to include more information on the underlying calculations and the methods used to ensure that no omission or double counting of emissions occurs, for example, by including comparisons with mass-balances, and so on. In addition, during the in-country review, it was discovered that there is a possible underestimation of CO_2 emissions in the CRF data on the second largest plant for the entire time series, and between underlying CRF data and plant-specific data, of about 4 Gg CO_2 in 1990. Finland responded by providing revised estimates that only affect iron and steel production (2.C) (see paragraph 45).

2. Road transportation: liquid – N_2O

37. Road traffic mileage in Finland increased by about 20 per cent in 1990–2004, but the corresponding CO_2 emissions only increased by 9 per cent. Emissions of CO_2 are based on the allocation of fuel sales and are considered to be accurate. The reasons behind the divergence in the trend for fuel consumption and vehicle mileage for road traffic at the end of the time series 1990–2004 are not included in the NIR. During the in-country review, the Party could not fully explain the reasons for this divergence. This indicates that there may be a possible overestimation of vehicle mileage in the road traffic sector at the end of the time series, which may lead to a possible overestimation of emissions of N_2O. The ERT recommends Finland to provide more information in the next NIR on its underlying assumptions and AD (e.g. annual average vehicle fuel efficiency) and to explain the reasons for the divergence in the trends.

D. Non-key categories

1. Fuel combustion: gas – CO_2

38. Finland applies a national EF for CO_2 from natural gas (55.04 t/TJ) that is lower than the IPCC default value (56.10 t/TJ). During the in-country visit, Finland provided the ERT with the underlying calculations on its national CO_2 EF for natural gas. The ERT judged that it provides a good understanding of the derivation of the EF estimate, but encourages Finland in its next NIR to further document the proportion of the EF underlying components using relevant references.

2. Fugitive emissions: oil and natural gas – CO_2

39. From 1990 to 2004, the CO_2 emissions from venting and flaring decreased by 49.6 per cent. The trend shows some large inter-annual changes. The trend for the CO_2 IEFs is a strongly decreasing (12,444 kg/kt in 1990 to 4,794 kg/kt in 2004). According to the NIR, the estimates of CO_2 emissions from flaring were derived directly from data received from the industry, and inter-annual changes resulted from production difficulties and output changes. During the in-country visit, Finland double-checked the data from the plants and no obvious mistake was detected. The ERT recommends Finland to provide data on production and outputs that confirm the trend and the inter-annual changes in CO_2 emissions. The ERT further recommends Finland to provide the rationale behind the decline in the CO_2 trend in the next NIR.

III. Industrial processes and solvent and other product use

A. Sector overview

40. In 2004, total national GHG emissions from the industrial processes sector amounted to 6,154.94Gg CO_2 eq., accounting for 7.6 per cent of total national GHG emissions. Metal production amounted to 41.4 per cent of the emissions from the industrial processes sector followed by chemical industry (26.6 per cent), mineral products (19.9 per cent), consumption of halocarbons and SF_6

(11.9 per cent) and other production (0.2 per cent). CO_2 accounted for 64.2 per cent of the total sectoral emissions, N_2O (23.7 per cent), F-gases (11.9 per cent) and CH_4 (0.2 per cent).

41. In 2004, the total national GHG emissions from solvent and other product use amounted to 105.10 Gg CO_2 eq., accounting for 0.1 per cent of total national GHG emissions. CO_2 accounted for 61.7 per cent of the total solvent and other product use emissions, and N_2O (38.3 per cent).

42. The inventory of the industrial processes and solvent and other product use sectors is complete. Finland performed recalculations, compared to its 2005 submission, for CO_2 emissions from industrial processes (the chemical industry, metal production and other production) and solvent and other product use as a result of the inclusion of indirect CO_2 emissions from NMVOC. The ERT found that the overall total of national GHG emissions was not affected by the recalculations in these categories. Finland performed uncertainty estimates and used them in the key category analysis. The Party has implemented QA/QC procedures for the categories under this sector.

43. The Party's inventory for the industrial processes and solvent and other product use sectors is largely transparent. However, better documentation of the choice of methods and EFs, for instance, for nitric acid and hydrogen production, would further improve the transparency. Finland estimated both actual and potential emissions for the F-gases.

B. Key categories

1. Nitric acid production – N_2O

44. Finland uses plant-specific AD and EFs to estimate the N_2O emissions. The EFs used (7.6 kg/t, 9.5 kg/t and 9.2 kg/t) are based on plant-specific measurements. All nitric acid plants in Finland are medium pressure plants and the EFs used are high compared to IPCC default range (6.0–7.5 kg/t). In order to enhance transparency, the ERT recommends that Finland explore the reasons for the high EFs and document its findings in the next submission.

2. Iron and steel production – CO_2

45. Production of iron and steel increased between 1997 and 2002, but Finland's reported CO_2 emissions decreased over the same time period. However, during the in-country visit Finland presented the total emissions of CO_2 from iron and steel, which it has correctly allocated to the energy sector (combustion-related emissions, paragraph 36) and the industrial processes sector (process-related emissions). The trend for total iron and steel production was consistent with the trend for total CO_2 emissions (energy and industrial processes sectors). The ERT therefore recommends that Finland either cross-check the allocation of CO_2 emissions between the energy and industrial processes sectors or revise the CO_2 estimates, if applicable, to ensure consistency of CO_2 emissions reported under industrial processes. In response to questions raised on the energy sector during the review (see paragraph 36), Finland revised the estimates for 2004 for CO_2 emissions from iron and steel production (from 2,551.45 Gg to 2,540.55 Gg CO_2). The ERT considers the revision to be accurate and recommends that Finland include it in the next inventory submission.

3. Electrical equipment – SF_6

46. The trend for SF_6 emissions from 1990 to 1995 displays considerable year-to-year variation. In addition, the ERT observed significant inter-annual changes in SF_6 emissions from 1995 to 2004, with a decrease of about 83.4 per cent from 1995 to 2004. Finland provided no information on the drivers behind the trend in emissions of SF_6 in the NIR. However, during the in-country visit, Finland provided documentation to the ERT that explains the trend in SF_6 emissions from 1990 to 1998 and also for some earlier years. Finland explained that its uses tier 3c methodology for SF_6 emissions from electrical equipment. This is determined by the annual sales of SF_6 to manufacturers, users, service companies and contractors; the net increase in total nameplate capacity or charge and the amount of SF_6 destroyed. The

nameplate capacity depends predominantly on the capacity growth rate, which is determined by the quantities of installed electrical equipment which showed considerable annual variations in the period 1978 to 1998. The peak in emissions in 1995 is a reflection of increased capacity installations with associated higher levels of emissions. The ERT recommends that Finland provide this detailed information in the next NIR, explaining the decreasing trend in SF_6 emissions from 1990 to 1994 and the sudden increase in 1995. Moreover, the ERT encourages Finland to explain the trend in SF_6 emissions from 1995 to 2004 and beyond, in order to avoid future review teams questioning the decreasing trend.

C. Non-key categories

1. Limestone and dolomite use – CO_2

47. The Party indicates in the NIR that some plants may exist and that emissions from some of these plants are not included in the national total. For the sake of completeness of reporting, the ERT recommends that Finland gather AD and estimate the associated emissions.

2. Other (chemical industry) – CO_2

48. Finland reports CO_2 emissions from hydrogen production in the category other (chemical industry). During the review, Finland indicated that it had discovered an error in the equation it had used for estimating the amount of hydrogen produced given in the current NIR. This error did not influence the calculation of the emissions, as they are calculated based on the feedstocks used. The ERT recognizes that the Revised 1996 IPCC guidelines and the IPCC good practice guidance do not provide any default EF(s) for this activity. However, as Finland has chosen to report the emissions from this category, the ERT encourages Finland to do it in a transparent manner by providing information on the underlying chemical reactions, choice of methods, AD and EFs.

IV. Agriculture

A. Sector overview

49. The agriculture sector contributed 6.9 per cent of the total emissions in 2004. There has been a decrease in these emissions by about 21.1 per cent over the period 1990–2004, due to Finland's membership of the European Community which resulted in changes in the economic structure followed by an increase in the average farm size, a decrease in the number of farms, and a decrease in livestock numbers except for horses. In addition, the resulting decrease in the use of N fertilizers and improved manure management have also reduced emissions.

50. Finland's NIR and CRF tables are transparent. The sub-chapter on time-series consistency was only provided in the NIR for enteric fermentation. There is a lack of detailed explanation of the development of national EFs. Recalculations were made in all key categories, mainly to update AD (animal numbers), EFs and N excretion rates.

51. QA/QC was undertaken for the sector and the Party has developed an elaborate and well documented QA/QC plan for which it should be commended.

52. Uncertainties have been estimated using Monte Carlo simulation for all the key categories with the lowest uncertainties for CH_4 from enteric fermentation in domestic livestock (–20 to +30 per cent) and the highest for N_2O emissions from agriculture soils (–60 to +170 per cent). The agriculture sector has some of the highest uncertainties in the inventory — especially for EFs. This is to be expected and is in line with other reporting Parties.

53. The Party has planned several improvements in the sector, such as the examination of specific N excretion rates for reindeer, swine and poultry, a revision of animal waste management systems (AWMS) and further enhancement of AD collection, particularly in the areas of cultivated organic soils

and agricultural land properties. The Party has undertaken a single livestock characterization and used these data across all categories, which is in line with the IPCC good practice guidance. Finland has improved its use of notation keys, which had been a concern in previous reviews.

B. Key categories

1. Enteric fermentation – CH_4

54. An enhanced characterization was carried out for cattle, which is a significant key emitter in the category, and tier 1 methods were used for all other animals. Similarly, national EFs were used for cattle, and IPCC default factors were used for swine, horses and goats. This is in line with the IPCC good practice guidance. EFs for cattle are updated annually, which is commendable, but those for other animal groups are not. The Party indicates that these EFs will be updated if more national data become available. The Party is encouraged to endeavour to update these EFs.

2. Direct soil emissions – N_2O

55. To estimate direct and indirect N_2O emissions from agricultural soils, Finland used the IPCC tier 1b method, as well as country-specific and default EFs. Fractions of N volatilized as NH_3 and NO_x from synthetic fertilisers ($Frac_{GASF}$) equal to 0.6 per cent and from manure ($Frac_{GASM}$) equal to 33 per cent have been used, based on national knowledge. Country-specific EFs were applied to cultivated organic soils, while default EFs were used for other soil types. The use of country-specific EFs was documented in the NIR and supported by relevant scientific research and publications. The ERT evaluated these values and found them appropriate for the inventory. Based on soil analysis data, Finland assumed that 50 per cent of cultivated organic soil was under cereal crops and the other 50 per cent was grassland. However, such a subdivision may inadequately represent the distribution of land uses over the area of cultivated organic soils. The ERT encourages Finland to elaborate its methodology and estimate areas of cultivated organic soils under cropland and grassland, and to report these in its next inventory submission.

3. Indirect emissions – N_2O

56. IPCC methodologies were used in this category. National EFs were used to calculate N_2O emissions from atmospheric deposition and nitrogen leaching and run-off, while default EFs were used to calculate N_2O emissions from N excretion on pasture range and sewage sludge spreading.

C. Non-key categories

1. Manure management – CH_4

57. Tier 2 method and national EFs were used for cattle, and a tier 1 method and default EFs were used for the other animals. This is in line with the IPCC good practice guidance. The ERT further noted that Finland used a methane conversion factor (MCF) of 10 per cent for slurry in a cool climate from the Revised 1996 IPCC Guidelines instead the revised value of 39 per cent from the IPCC good practice guidance, referring to the use of this value in Sweden. In response to the ERT's question, Finland clarified that the selected MCF value is considered more accurate for the conditions of the country and that a relevant reference for it has been provided in the NIR.

2. Manure management – N_2O

58. The Party used an IPCC tier 2 method for cattle and a tier 1 method for all other livestock categories. National values for N excretion rates and distribution of manure management systems have been used. Recalculations have been made in the category because AD (such as animal numbers) and calculation parameters (N excretion rates) were updated. The previously used N excretion rates did not give a full image of N excretion as they were by kg per animal per place instead of kg per animal per place multiplied by estimated production cycle per year. The N excretion rates were updated on the

recommendation of a nutrition expert and are considered to better reflect national circumstances. The Party is encouraged to continuously update these values.

3. Field burning of agricultural residues – CH_4 and N_2O

59. CH_4 and N_2O emissions from field burning of agricultural residues are reported as not occurring ("NO") in the CRF tables. However, the NIR states that field burning of agricultural residues does occur occasionally but that no data are available. Although the emissions may be negligible, the Party is encouraged to try to collect such data or to report the estimates as not estimated ("NE").

V. Land use, land-use change and forestry

A. Sector overview

60. In 2004, the LULUCF sector was a net sink of 18,485.82 Gg CO_2 eq., off-setting 22.9 per cent of total national GHG emissions. Overall removals, having increased by 68.9 per cent in 1991, decreased by 57.4 per cent from 1991 to 1995, increased by 48.9 per cent in 1996 and again decreased by 19.3 per cent from 1996 to 2004. Finland explained that these fluctuations were due to a reduction in harvests that was linked to changes in wood prices on international markets. The ERT noted that the NIR does not include consistent representation of land as outlined in the IPCC good practice guidance for LULUCF. The information on the areas of land included in the GHG inventory was provided to the ERT during the review. In order to improve the completeness of the reporting, the ERT encourages Finland to include information on consistent land representation in national borders in its next inventory submission.

61. In its 2006 submission, Finland reports CO_2 removals for forest land remaining forest land and grassland remaining grassland. CO_2 and non-CO_2 emissions are reported for biomass burning and nitrogen fertilization for forest land, cultivation and liming for cropland and peat extraction and drainage of wetlands. Settlements are reported as included elsewhere and not estimated ("IE", "NA"), and other land is reported as not applicable and not estimated ("NA", "NE"). These categories are optional for the LULUCF sector. The areas of lands were estimated on the basis of data from the National Land Survey (NLS), the National Forest Inventory (NFI) and the Ministry of Agriculture and Forestry, the VAHTI database and a survey by Statistics Finland.

62. Finland has established enhanced inter-agency cooperation for AD collection and GHG estimation that allows for consistent improvement of the inventory for the LULUCF sector. The tier 2 level and trend key category analyses performed by the Party identified the categories forest land remaining forest land, cropland remaining cropland, grassland remaining grassland and land converted to wetlands as key categories. In order to estimate emissions and removals from key categories, Finland used a combination of tier 1, tier 2 and tier 3 methods as outlined in the IPCC good practice guidance for LULUCF. QA/QC procedures and a tier 2 uncertainty assessment have been implemented and documented in the NIR. The ERT noted that GHG emissions and removals are reported only for lands remaining in the same category. In order to improve the completeness of the reporting, the ERT encourages Finland to separate reporting on emissions and removals from lands remaining in the same category from lands converted to other land uses in its future inventory submissions.

B. Key categories

1. Forest land remaining forest land – CO_2

63. In 2004, CO_2 removals by forest land remaining forest land were 5.8 per cent lower than in 1990 and about 32.3 per cent of total national GHG emissions. Finland used a tier 2 method to estimate carbon stock change in biomass and the tier 3 YASSO model to calculate carbon stock change in dead organic matter and soils. The ERT noted that areas for forest lands were not provided in the NIR but

that, according to information provided by the Party during the review, they have already been included in the 2007 submission. The ERT further noted that different parameters were used to estimate removals in and emissions from the same forest biomass pool. In order to improve transparency in the reporting, the ERT encourages Finland to further document in the next submission areas of forest lands and supporting AD as well as the parameters used in the calculations.

2. Cropland remaining cropland – CO_2

64. Cropland remaining cropland has the largest CO_2 emissions in the sector, providing for almost 4.8 per cent of total national GHG emissions in 2004. Since 1990, the emissions have decreased by 47.9 per cent. For this category, Finland used a tier 1 methodology to calculate emissions from mineral soils and liming. Emissions from organic soils were estimated using a tier 2 method based on the national AD and parameters documented in the NIR. The ERT noted that the IPCC good practice guidance for LULUCF tier 1 method contained in the IPCC good practice guidance for LULUCF may not be fully applicable to the intensively managed mineral soils in the country and encourages Finland to re-evaluate its applicability for croplands. The ERT further encourages Finland to change its estimation method if it appears to be not applicable.

3. Grassland remaining grassland – CO_2

65. In 2004, CO_2 emissions from grassland remaining grassland were 3.9 per cent of total national GHG emissions, 293.6 per cent higher than in 1990, when this category was a net removal of 1,647.96 Gg. Finland estimated carbon stock change in soil under this category. The national data from the NFI, a tier 1 method and default parameters were used in the calculations. The ERT noted that the IPCC good practice guidance for LULUCF tier 1 method may not be fully applicable for the estimation of removals in grasslands and encourages Finland to re-evaluate its applicability for this category. The ERT further encourages Finland to change the estimation method if it appears to be not applicable.

4. Land converted to wetlands – CO_2

66. Land converted to wetlands had minor CO_2 emissions of 0.8 per cent of the total national GHG emissions in 2004, which was 4.0 per cent higher than the 1990 level. Finland reports emissions from peat extraction under this category. National data on peat production areas and country-specific EFs were used for the estimates. The method used corresponds to IPCC good practice guidance for LULUCF tier 2. The ERT noted the efforts by Finland to enhance reporting on peat extraction under this category in the NIR and the CRF.

C. Non-key categories

1. Direct N_2O emissions from N fertilization – N_2O

67. In 2004, direct N_2O emissions from nitrogen fertilization were 0.01 per cent of total national emissions, which was 55.6 per cent lower than in 1990. Finland reported only on N fertilization of forest land remaining forest land under this category, as it was unable to divide the AD by N inputs to land remaining forest land and land converted to forest land. The estimates were made using the use of IPCC default method and parameters.

2. Non-CO_2 emissions from drainage of soils and wetlands – CH_4

68. The drainage of soils and wetlands caused CH_4 emissions of 0.008 per cent of total national GHG emissions in 2004, which was 0.68 per cent higher than in the base year. Finland reported only drainage of wetlands for peat extraction under this category. The estimates were made using a tier 2 method. The ERT noted that wetland drainage was not documented in the NIR and encourages Finland to document calculations from this category in the next inventory submission.

3. Non-CO_2 emissions from drainage of soils and wetlands – N_2O

69. In 2004, N_2O emissions from drainage of soils and wetlands were 0.01 per cent of the national total. Finland estimated N_2O emissions from this category using the default method, national AD and country-specific EFs. The N_2O emissions are linked to peat extraction and have remained stable since 1990.

4. Biomass burning –CH_4

70. Biomass burning emitted CH_4, and accounted for 0.002 per cent of the total national emissions in 2004, 82.3 per cent lower than in the base year. The emission estimations were performed using a tier 2 method, country-specific data and default parameters.

5. Biomass burning – N_2O

71. N_2O emissions from biomass burning were 0.0002 per cent of the total national GHG emissions in 2004. Emissions have decreased by 82.3 per cent since 1990. The N_2O emission estimates were performed using a tier 2 method, country-specific data and default parameters.

VI. Waste

A. Sector overview

72. In 2004, GHG emissions from the waste sector accounted for 2,638.54 CO_2 eq., corresponding to 3.3 per cent of total national GHG emissions. Solid waste disposal on land accounted for 86.7 per cent of sectoral emissions. In addition, the waste sector includes CH_4 emissions from municipal and industrial wastewater handling, N_2O emissions generated from nitrogen input from fish as well as domestic and industrial discharge into waterways, NMVOC emissions from solid waste disposal sites and wastewater handling, and, for the first time, CH_4 and N_2O from composting.

73. The inventory includes information on key categories and methods, data sources, the EFs used, uncertainty estimates and QA/QC procedures; and contains most of the relevant information needed for replication of the inventory. The methodologies for estimating GHG emissions are consistent with the Revised 1996 IPCC Guidelines and the IPCC good practice guidance. The transparency of the reporting has improved compared with previous inventory submissions, for example, by including some of the references recommended in the 2005 review report. Both the NIR and the CRF are consistent with the UNFCCC reporting guidelines. Recalculations have been made for all the reported categories for the entire time series due to revisions of AD.

74. Emissions from the waste sector have decreased by 33.7 per cent between 1990 and 2004. Finland explains in the NIR that this is due to the implementation of a new waste law in 1994. The implementation of the law led to minimization of waste generation, increased recycling and reuse of waste material and an increase in alternative treatment methods to landfills (e.g. composting). This is valid for industrial waste and municipal waste a well as industrial sludge.

B. Key categories

Solid waste disposal – CH_4

75. Finland has used a first-order decay (FOD) method with a slightly modified equation 5.1 which complies with the IPCC good practice guidance. Recalculations using more accurate AD, changes in waste classification of industrial wastes and reallocation of waste between waste categories has led to a decrease in CH_4 emissions from solid waste disposal on land by 1.1 per cent compared with the 2005 GHG submission. In response to the 2005 review report, Finland has included in the NIR references to documents supporting the AD used for the base year. The ERT appreciates this effort, but recommends

Finland to include a short description of how the data have been derived, which was raised in the 2005 review report, especially as the referenced documents are in Finnish.

76. The 2005 review report recommended Finland to update its waste composition data for recent years and to collect data on waste composition periodically. Finland indicates in its NIR that it will review the municipal solid waste composition data for the 2008 submission. The ERT welcomes this work and recommends that it be undertaken.

C. Non-key categories

1. Waste incineration – CO_2, CH_4 and N_2O

77. The NIR states that CO_2, CH_4 and N_2O emissions from waste incineration are reported in the energy sector. However, no explanation is provided for why these emissions are reported in the energy sector. The ERT recommends that this be included in the next NIR.

2. Composting – CH_4 and N_2O

78. In response to the 2005 review report, Finland has reported emissions of CH_4 and N_2O from composting for the first time. The category includes emissions from composting of biowastes (municipal solid waste, municipal and industrial sludge and industrial solid waste including construction and demolition waste).

79. Finland uses a method analogous to that included in recently published recognized international scientific literature. The ERT welcomes this effort by Finland and recommends that Finland continue reporting these emissions in its future inventory submissions.

VII. Conclusions and recommendations

80. Finland has submitted a complete set of CRF tables for the years 1990–2004 and an NIR which is complete in terms of geographical coverage, years and sectors, and also complete in terms of categories and gases. Some minor categories are reported as "not occurring" ("NO"), or "not estimated" ("NE") because emissions are assumed to be negligible (e.g. field burning of agricultural residues). Finland's GHG inventory is in general accurate, as defined in the UNFCCC reporting guidelines, and is consistent with the Revised 1996 IPCC Guidelines and the IPCC good practice guidance.

81. During the in-country review, the ERT identified a small number of categories where the methods or EFs used were not fully in accordance with the IPCC good practice guidance and might lead to overestimations of emissions in the base year or underestimations of emissions in the most recent years. The ERT recommended that Finland check and if needed revise its estimates for these categories. After the in-country review, Finland provided revised estimates for these categories for the base year and 2004 in accordance with the recommendations of the ERT and in line with the IPCC good practice guidance.

82. In the course of the review, the ERT formulated a number of recommendations relating to the completeness and transparency of Finland's reported information. The key recommendations[3] are that Finland:

- Present more detailed documentation of inventory estimates as well as cross-checks and corrections of AD and emissions as a part of its entire QA/QC system in the NIR;

[3] For a complete list of recommendations, the relevant sections of this report should be consulted.

- Enhance the overall QA/QC system through strengthening cooperation between institutions involved in preparing the inventory, inter alia, by the use of internal audits and quality checks for particular sectors and improving the systematic approach of the QA/QC system as a whole;

- Improve archiving of the inventory calculations and other working files prepared at the category level to facilitate information flow and exchange;

- Further elaborate on the completeness and consistency of the documentation in the NIR and the CRF, for example, by developing internal reporting guidelines on the levels of detail to be provided for recording AD, emission trends and parameters used at the sectoral level.

Annex

Documents and information used during the review

A. Reference documents

IPCC. Good practice guidance and uncertainty management in national greenhouse gas inventories, 2000. Available at: <http://www.ipcc-nggip.iges.or.jp/public/gp/english/>.

IPCC. Good practice guidance for land use, land-use change and forestry, 2003. Available at: <http://www.ipcc-nggip.iges.or.jp/public/gpglulucf/gpglulucf.htm>.

IPCC/OECD/IEA. Revised 1996 IPCC Guidelines for national greenhouse gas inventories, volumes 1–3, 1997. Available at: <http://www.ipcc-nggip.iges.or.jp/public/gl/invs1.htm>.

UNFCCC. Guidelines for the preparation of national communications by Parties included in Annex I to the Convention, Part I: UNFCCC reporting guidelines on annual inventories. FCCC/SBSTA/2004/8. Available at: <http://unfccc.int/resource/docs/2004/sbsta/08.pdf>.

UNFCCC. Guidelines for the technical review of greenhouse gas inventories from Parties included in Annex I to the Convention. FCCC/CP/2002/8. Available at: <http://unfccc.int/resource/docs/cop8/08.pdf>.

UNFCCC secretariat. Status report for Finland. 2006. Available at: <http://unfccc.int/resource/docs/2006/asr/fin.pdf>.

UNFCCC secretariat. Synthesis and assessment report on the greenhouse gas inventories submitted in 2006. FCCC/WEB/SAI/2006. Available at: <http://unfccc.int/resource/docs/webdocs/sai/sa_2006.pdf>.

UNFCCC secretariat. Finland: Report of the individual review of the greenhouse gas inventory submitted in the year 2005. FCCC/WEB/IRI/2005/FIN. Available at: <http://unfccc.int/resource/docs/2006/arr/fin.pdf>.

B. Additional information provided by the Party

Responses to questions during the review were received from Ms. Riitta Pipatti (Statistical Finland) including additional material on the methodology and assumptions used.

Alm J., Shurpali N.J., Mikkkinen K., Aro L., Hytonen J., Laurila T., Lohila A., Maljanen M., Martikainen P.J., Makiranta P., Penttila T., Saarnio S., Silvan N., Tuittila E.-S., Laine J. 2007. Emission Factors and their Uncertainty for the Echange of CO2, CH4 and N2O in Finnish Managed Peatlands. Boreal Environment Research, 12, pp. 191–209.

Finnish Statistical Yearbook of Forestry. 2005. Finnish Forest Research Institute.Vammala 2005. ISBN 951-40-1985-7.

Ilomaki S., Nikinmaa E., Makela A. 2003. Crown Rise due to Competition Drives Biomass Allocation in Silver Birch. Can. J. For. Res., 33, pp. 2395–2404.

Karjalainen T., Kellomaki S. 1996. Greenhouse Gas Inventory for Land Use Change and Forestry in Finland Based on International Guidelines. Mitigation and Adaptation Strategies for Global Change. 1, pp. 51–71.

Kujala M. 1980. A Calculation Method for Measuring the Volume Growth over Bark of Stemwood. Folia Forestalia, 441, pp. 1–8.

Laiho R., Vasander Y. 2003. Dynamics of Plant-Mediated Organic Matter and Nutrient Cycling Following Water-Level Drawdown in Boreal Peatlands. Global Biogeochemical Cycles, 17(2), 1053.

Lapvetelainen T., Regina K., Perala P. 2007. Peat-Based Emissions in Finland's National Greenhouse Gas Inventory. Boreal Environment Research, 12, pp. 225–236.

Lehtonen A., Makipaa R., Heikkinen J., Sievanen R., Liski J. 2004. Biomass Expansion Factors (BEFs) for Scots Pine, Norway Spruce and Birch According to Stand Age for Boreal Forests. Forest Ecology and Management, 188, pp. 211–224.

Lehtonen A., Sievanen R., Makela A., Makipaa R., Korhonen K.N., Hokkanen T. 2004. Potential Litter fall of Scots Pine Branches in Southern Finland. Ecological Modelling, 180, pp. 305–315.

Liski J., Lehtonen A., Palosuo T., Peltoniemi M., Eggers T., Muukkonen P., Makipaa R. 2006. Carbon Accumulation in Finland's Forests 1922–2004 – an Estimate Obtained by Combination of Forest Inventory Data with Modelling of Biomass, Litter and Soil. Ann. For. Sci. 63, pp. 687–697.

Liski J., Nissinen A., Erhard M., Taskinen O. 2003. Climatic Effects on Litter Decomposition from Artcic Tundra to Tropical Rainforest. Global Change Biology, 9, pp. 575–584.

Liski J., Pelosuo T., Peltoniemi M., Sievanen R. 2005. Carbon and Decomposition Model Yasso for Forest Soils. Ecological Modelling, 189, pp. 168–182.

Marklund L.G. 1988. Biomass Functions for Pine, Spruce and Birch in Sweden. Swedish University for Agricultural Sciences. Department for Forest Survey. Report 45.

Mikkola P. 1972. Proportion of Waste Wood in the Total Cut in Finland. Folia Forestalia, 148.

Minkkinen K., Laine J., Shurpali N.J., Makiranta P., Alm J., Penttila T. 2007. Heterotrophic Soil Respiration in Forestry-Drained Peatlands. Boreal Environment Research, 12, pp. 115–126.

Monni S., Peltoniemi M., Palosuo T., Lehtonen A., Makipaa R., Savolainen I. 2007. Uncertainty of Forest Carbon Stock Changes – Implications to the Total Uncertainty of GHG Inventory of Finland Climatic Change, 81, pp. 391–413.

Muukkonen P., Lehtonen A. 2004. Needle and Branch Biomass Turnover Rates of Norway Spruce (Picea abies). Can. J. For. Res., 34, pp. 2517–2527.

Muukkonen P., Makipaa R., Laiho R., Minkkinen K., Vasander H., Finer L. 2006. Relationship Between Biomass and Percentage Cover in Understorey Vegetation of Boreal Coniferous Forests. Silva Fennica, 40(2), pp. 231–245.

Palosuo T., Liski J., Trofymow J.A., Titus B.D. 2005. Litter decomposition affected by climate and litter quality—Testing the Yasso model with litterbag data from the Canadian intersite decomposition experiment. Ecological Modelling, 189, pp. 183–198.

Peltoniemi M., Makipaa R., Liski J., Tamminen P. 2004. Changes in Soils Carbon with Stand Age – an Evaluation of Modelling Method with Empirical Data. Global Change Biology, 10, pp. 2078–2091.

Peltoniemi M., Palosuo T., Monni S., Makipaa R. 2006. Factors Affecting the Uncertainty of Sinks and Stocks of Carbon in Finnish Forest Soils and Vegetation. Forest Ecology Management, 232, pp. 75–85.

Salminen S. 1993. Forest Resources of the Southernmost Finland, 1986–1988. Folia Forestalia, 825, –111 p.

Salminen S., Salminen O. 1998. Forest Resources in Middle Finland, 1988–92, and the Whole South Finland, 1986–92. Metsantutkimuslaitkosen tiedonantoja 710. –137 p.

Starr M., Saarsalmi A., Hokkanen T., Merila P., Helmisaari H.-S. 2005. Models of Litterfall Production for Scots Pine (Pinus sylvestris L.) in Finland Using Stand, Site and Climate Factors. Forest Ecology and Management, 205, pp. 215–225.

Teemu Oinonen, Finnish 2001 Inventory of HFC, PFC and SF6 emission, ISBN 952-11-1398-7.

Teemu Oinonen, Finnish 2002 Inventory of HFC, PFC and SF6 Emissions, HELSINKI 2004, ISBN 952-11-1654-4 (PDF), ISSN 1238-7312.

Tomppo E., Henttonen H., Tuomainen T. 2001 Valtakunnan metsien 8. inventoinnin menetelma ja tulokset matsakeskuksittain Pohjois-Suomessa 1992–94 seka tulokset Etela-Suomessa 1986–92 ja koko maassa 1986–94. METLA.

- - - - -