National Greenhouse Gas Inventory Report of JAPAN

Revised sections of the Inventory relating to LULUCF

August, 2005

Ministry of the Environment, Japan

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Preface

Background to submitting the revised LULUCF inventory

Japan has submitted a revised LULUCF sector for its national inventory of greenhouse gas emissions and removals (hereafter, inventory), previously submitted on May 27, 2005 on the basis of Article 4 and 12 of the United Nations Framework Convention on Climate Change (UNFCCC).

The revisions of the LULUCF have been made in accordance with using the Common Reporting Format (CRF) pursuant to the *Good Practice Guidance for Land Use, Land-Use Change and Forestry* (hereafter, *LULUCF-GPG*), decided during the Ninth Session of the Conference of Parties (COP9) held in December 2003, for the trial use in the 2005 inventory submission.

The overall procedures to prepare and report the inventories are based on *IPCC Guidelines for National Greenhouse Gas Inventories*, the *IPCC Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories*, and the *LULUCF-GPG*, welcomed in 2003.

The revisions made to the inventory submitted on May 27, 2005 (hereafter, previous inventory) regarding data and calculations method in the LULUCF sector is as indicated in the figure below.

Chapter	Summary of NIR revision
Executive Summary	Replacement of the trend of emissions/removals data and its description due to the changes made regarding LULUCF data.
Chapter 1	In “1.1 About the Inventories (1990-2003)”, the paragraph describing on the trial use of *LULUCF-GPG* has been added. In “1.3.5 Land-Use Change and Forestry (Category5)”, the description on further inventory development for the LULUCF sector has been revised.
Chapter 2	Replacement the trend of emissions/removals data and its description due to the changes made regarding LULUCF data.
Chapter 7	Replacement of the entire chapter.
Chapter 10	In 10.1.5, a description on recalculations made in accordance with *LULUCF-GPG* has been added. （Due to this revision, the subsections after 10.1.5 has shifted down.） Replacement of Table 10-4.
Annex 5	Replacement of the description associated with the LULUCF sector categories not estimated in Japan’s inventory.
Annex 9	The description of contents and structure of the LULUCF sector Inventory File System has been added.
Annex 10	*LULUCF-CRF* Summary 2 is used as the CRF overview.

Please read previous inventory with revisions in mind.

Executive Summary of National GHGs Inventory Report of Japan 2005

E.S. 1. Background Information on Greenhouse Gas Inventories and Climate Change

This National Inventory Report comprises the inventory of the emissions and removals of greenhouse gases, indirect greenhouse gases and SO_2 in Japan for fiscal 1990 through to 2003[1], on the basis of Article 4 and 12 of the United Nations Framework Convention on Climate Change (UNFCCC).

Estimation methodologies of greenhouse gas inventories should be in line with the *Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories* (hereafter, *Revised 1996 IPCC Guidelines*) which was developed by the Intergovernmental Panel on Climate Change (IPCC). In 2000, the *Good Practice and Uncertainty Management in National Greenhouse Gas Inventories (2000)* (hereafter, *the Good Practice Guidance (2000)*) was published. The Guidance presents the methods for choosing methodologies appropriate to the circumstances of each country and quantitative methods for evaluating uncertainty. Parties are required to seek to apply the *Good Practice Guidance (2000)* to their inventory reporting from 2001 and after ward.

For the submission of Japan's inventories, the trial use of the *UNFCCC Reporting Guidelines on Annual Inventories* (FCCC/SBSTA/2004/8) has been determined by the Conference of the Parties, and the inventory will be reported in accordance with this guideline. For the preparation of the LULUCF inventory, the *IPCC Good Practice Guidance for Land Use, Land-Use Change and Forestry* (hereafter, *LULUCF-GPG*) was published in 2003, and parties are required to seek to apply the *LULUCF-GPG* to their inventory reporting from 2005 and after ward.

E.S. 2. Summary of National Emission and Removal Related Trends

Total greenhouse gas emission in fiscal 2003 (the sum of emissions of CO_2, CH_4, N_2O, HFCs, PFCs, and SF_6 converted to CO_2 equivalents by multiplying its global warming potential [GWP][2] respectively; excluding carbon dioxide removals) was 1,339 million tons (in CO_2 equivalents), an increase by 12.8% compared to emissions (CO_2, CH_4, N_2O, excluding carbon dioxide removals) in FY1990 (Removals of carbon dioxide in FY1995 were 83.7 million tons[3], an increase by 24.7% from FY1990). Compared to emissions in the base year under the Kyoto Protocol (FY1990

[1] "Fiscal" is used because CO_2 is the primary GHGs emissions and estimated on the fiscal year basis; from April of the year to March of the next year.

[2] Global Warming Potential (GWP): It is the coefficients that indicate degrees of greenhouse gas effects caused by greenhouse gases converted into the proportion of equivalent degrees of CO_2. The coefficients are subjected to the *Second National Assessment Report* (1995) issued by the Intergovernmental Panel on Climate Change (IPCC).

[3] In the inventory submitted under the FCCC, removals by forest planted before 1990 are contained. Therefore, this value do not correspond to 13 Mt indicated in the annex of "Draft decision -/CMP.1 (Land use, land-use change and forestry) (FCCC/CP/2001/13/Add.1 p54) adopted in the decision 11/COP7.

for emissions of CO_2, CH_4, N_2O; FY1995 for emissions of HFCs, PFCs, and SF_6), it increased by 8.3%.

It should be noted that emissions of HFCs, PFCs and SF_6 in the period from 1990 to 1994 and emissions and removals by Land use, Land-use change and forestry sector after 1995 have not been estimated (NE).

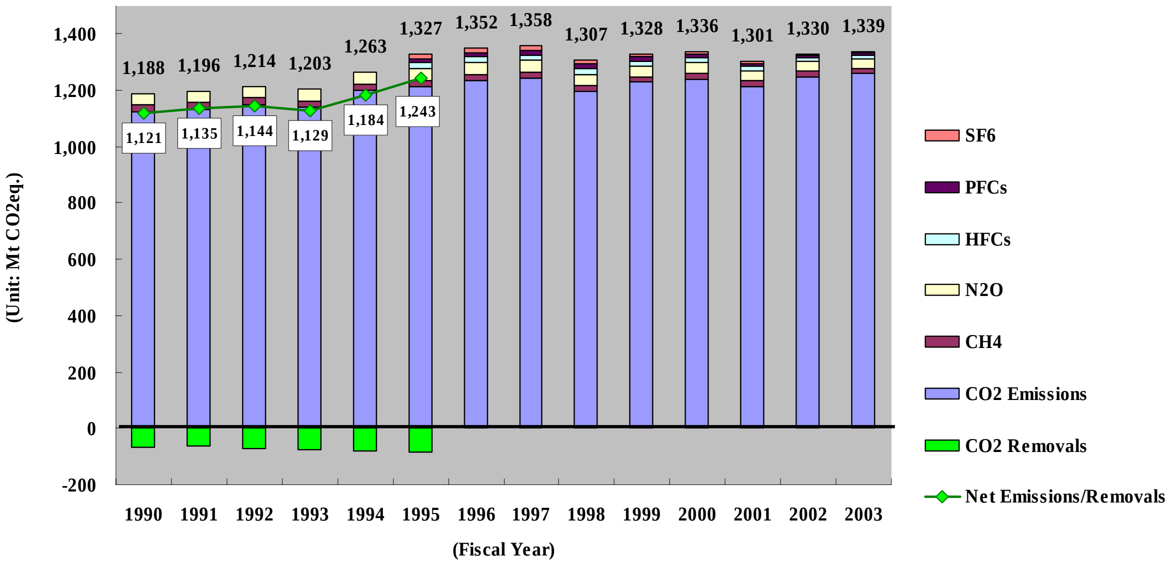

Figure 1 Trends in emission and removals of greenhouse gases in Japan

* Values in boxes represent net emissions or removals. No values appear after 1995, however, as carbon dioxide removals have not been estimated.

Table 1 Trends in emission and removals of greenhouse gases in Japan

[Mt CO2 eq.]	GWP	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
CO2 Emissions	1	1,122.3	1,131.4	1,148.9	1,138.7	1,198.2	1,213.1	1,234.8	1,242.0	1,195.2	1,228.4	1,239.0	1,213.6	1,247.8	1,259.4
Removals	1	-67.1	-61.6	-69.6	-74.3	-78.8	-83.7	NE	NE	NE	NE	NE	NE	NE	NE
CH4	21	24.9	24.8	24.7	24.6	24.2	23.5	22.9	22.1	21.5	21.1	20.7	20.2	19.5	19.3
N2O	310	40.6	40.1	40.2	39.9	40.8	40.8	41.5	41.9	40.6	35.1	37.5	34.6	34.7	34.6
HFCs	HFC-134a : 1,300 etc.	NE	NE	NE	NE	NE	20.2	19.9	19.8	19.3	19.8	18.5	15.8	12.9	12.3
PFCs	PFC-14 : 6,500 etc.	NE	NE	NE	NE	NE	12.6	15.3	16.9	16.6	14.9	13.7	11.5	9.8	9.0
SF6	23,900	NE	NE	NE	NE	NE	16.9	17.5	14.8	13.4	9.1	6.8	5.7	5.3	4.5
Gross Total		1,187.8	1,196.3	1,213.8	1,203.3	1,263.1	1,327.2	1,351.8	1,357.5	1,306.6	1,328.4	1,336.2	1,301.4	1,330.0	1,339.1
Net Total		1,120.7	1,134.7	1,144.3	1,128.9	1,184.3	1,243.5	1,351.8	1,357.5	1,306.6	1,328.4	1,336.2	1,301.4	1,330.0	1,339.1

* NE: Not Estimated

* CH_4 and N_2O emissions in Table 1 include emissions from Land Use, Land-Use Change and Forestry based on the estimation method decided by the UNFCCC. On the contrary, since emissions from Land Use, Land-Use Change and Forestry are regarded as RMU (removal unit) according to Article 3.3 of the Kyoto Protocol, they are not included in GHG emissions based on Kyoto Protocol (refer annex 8 table 1).

E.S. 3. Overview of Source and Sink Category Emission Estimates and Trends

The breakdown of emissions and removals of greenhouse gases in FY2003 by sector[4] shows that the Energy sector accounted for 89.5%, followed by Industrial processes at 5.6%, Solvents and other product use at 0.02%, Agriculture at 2.5% and Waste at 2.4%.

Removals by Land use, Land-use change and forestry in FY1995 were approximately 5.9% as a proportion of absolute value of total emissions/removals.

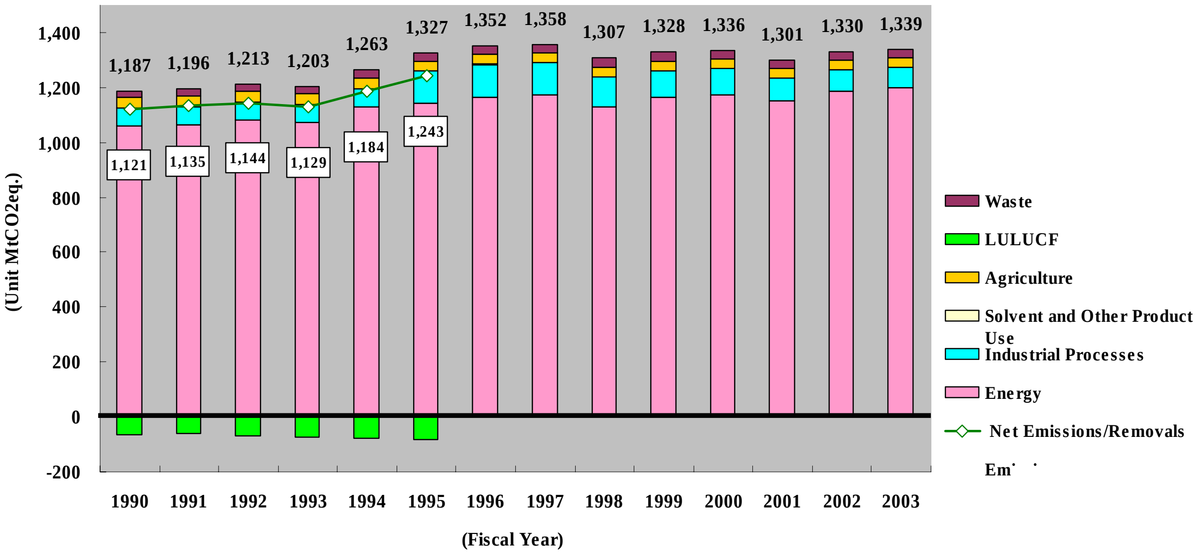

Figure 2　Trends in emissions and removals of greenhouse gases in each category

* Values in boxes represent net emissions or removals. No values appear after 1995, however, as carbon dioxide removals have not been estimated.

Table 2　Trends in emissions and removals of greenhouse gases in each category

[Mt CO_2 eq.]	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Energy	1,058.3	1,065.4	1,081.4	1,072.2	1,128.0	1,142.4	1,163.8	1,171.4	1,129.1	1,163.2	1,172.1	1,149.9	1,186.2	1,198.9
Industrial Processes	64.8	65.7	66.1	65.0	66.9	116.6	120.2	118.1	109.5	97.8	96.3	84.9	78.1	75.1
Solvent and Other Product Use	0.3	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.3	0.3	0.3	0.3
Agriculture	39.0	38.8	38.7	38.6	38.0	37.1	36.2	35.4	34.9	34.4	34.1	33.7	33.4	33.2
Land Use, Land Use Change and Forestry	-66.5	-61.0	-69.0	-73.9	-78.4	-83.3	NE	NE	NE	NE	NE	NE	NE	NE
Waste	24.9	25.5	26.6	26.6	29.3	30.3	31.2	32.3	32.8	32.7	33.4	32.5	31.9	31.6
Net Emissions/Removals	1,120.7	1,134.7	1,144.3	1,128.9	1,184.3	1,243.5	1,351.8	1,357.5	1,306.6	1,328.4	1,336.2	1,301.4	1,330.0	1,339.1
ABS	1,253.8	1,256.7	1,282.3	1,276.6	1,341.1	1,410.1	1,351.8	1,357.5	1,306.6	1,328.4	1,336.2	1,301.4	1,330.0	1,339.1
Emissions	1,187.2	1,195.7	1,213.3	1,202.8	1,262.7	1,326.8	1,351.8	1,357.5	1,306.6	1,328.4	1,336.2	1,301.4	1,330.0	1,339.1

*NE: Not Estimated

[4] It implies “Category” indicated in the *Revised 1996 IPCC Guidelines* and *CRF*.

E.S. 4. Other Information (Indirect Greenhouse Gases)

Under UNFCCC, it is required to report emissions of indirect greenhouse gases (NO_X, CO, NMVOC and SO_2), other than 6 types of greenhouse gases (CO_2, CH_4, N_2O, HFCs, PFCs and SF_6) which are not controlled by the Kyoto Protocol. Emission trends of these gases are indicated below.

Nitrogen oxide (NO_X) emissions in FY2003 were 201.5Gg, a decrease by 1.8% compared to FY1990, and by 0.6% compared to the previous year.

Carbon monoxide (CO) emissions in FY2003 were 344.4Gg, a decrease by 15.7% compared to FY1990, and by 0.2% compared to the previous year.

Non-methane volatile organic compounds (NMVOC) emissions in FY2003 were 172.7Gg, a decrease by 10.4% compared to FY1990, and an increase by 0.1% compared to the previous year.

Sulfur dioxide (SO_2) emissions in FY2003 were 84.9Gg, a decrease by 15.1% compared to FY1990, and by 0.6% compared to the previous year.

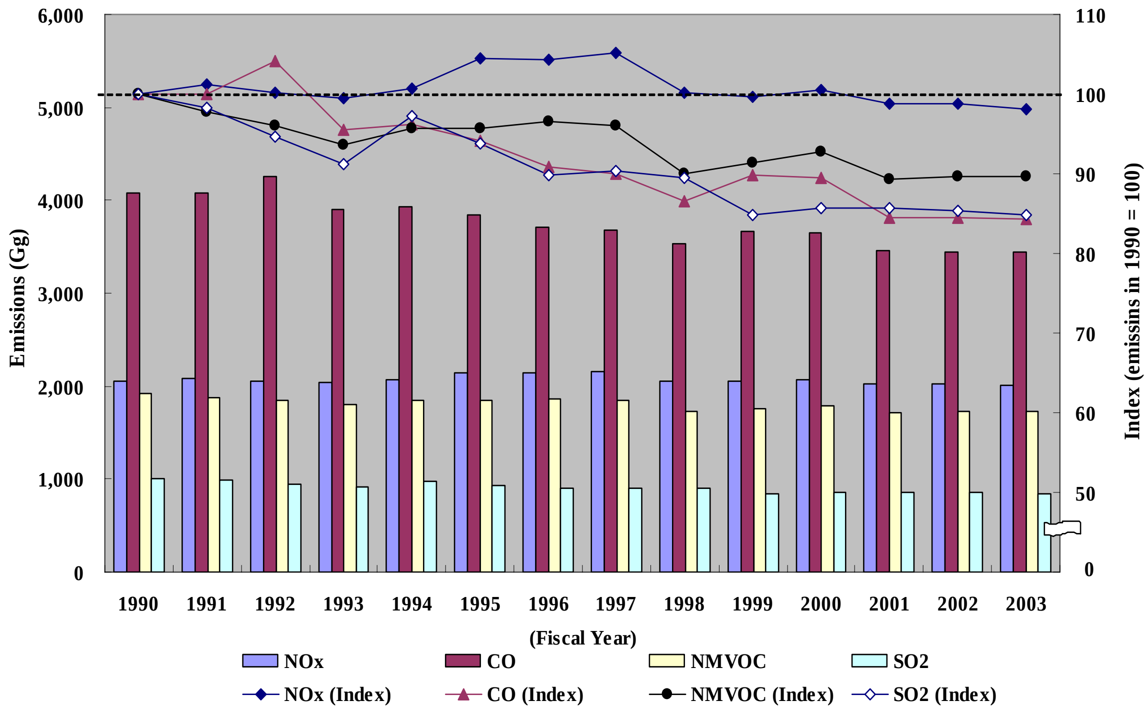

Figure 3 Trends in Emissions of Indirect Greenhouse Gases and SO_2

Chapter 1. Introduction and QA/QC plan

1.1. About the Inventories (1990-2003)

This National Inventory Report is to report the inventory of the emissions and removals of greenhouse gases and indirect greenhouse gases and SO_2 in Japan for fiscal 1990 through 2003 to the United Nations Framework Convention on Climate Change (UNFCCC) Secretariat, on the basis of Article 4 and 12 of the UNFCCC. For the submission of Japan's inventories, the trial use of the *UNFCCC Reporting Guidelines on Annual Inventories* has been determined by the Conference of the Parties (FCCC/SBSTA/2004/8), and the inventory will be reported in accordance with this guideline.

Methodologies for developing the inventory are described in the *Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories* (hereafter, *Revised 1996 IPCC Guidelines*) and the *Good Practice and Uncertainty Management in National Greenhouse Gas Inventories (2000)* (hereafter, *the Good Practice Guidance (2000)*), developed by the Intergovernmental Panel on Climate Change (IPCC), and the estimation methodologies of the emissions and removals of greenhouse gas should be in line with them. In 2003, the *IPCC Good Practice Guidance for Land Use, Land-Use Change, and Forestry* (hereafter, *LULUCF-GPG*), was published. Parties are required to seek to apply the *LULUCF-GPG* to their inventory reporting from 2005 and after ward.

1.2. QA/QC plan

1.2.1. Inventory compilation system

In Japan, the Ministry of the Environment (MOE) has annually compiled and submitted the national greenhouse gas inventory to UNFCCC secretariat under the UNFCCC in cooperation with relevant ministries, governmental agencies and organizations (see Figure 1-1).

The MOE has overall responsibility for the national inventory. In order to response to the international requirements and to reflect the latest scientific knowledge in the inventory, the MOE has convened and managed the Committee for the Greenhouse Gas Emissions Estimation Methods. On the basis of the results of the Committee's deliberations, the MOE compiles inventories including the estimation of GHGs emissions and removals, identification of key categories[1], and uncertainty assessment. The actual task of inventory compilation, including data input, calculation of emissions and removals and preparation of Common Reporting Format (CRF) and National Inventory Report (NIR), is achieved by Greenhouse Gas Inventory Office of Japan (GIO)[2], of the Center for Global Environmental Research of the National Institute for Environmental Studies.

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[1] The *IPCC Good Practice Guidance for Land Use, Land-Use Change and Forestry* (2003), which was welcomed in COP9, extends the key source analysis to LULUCF categories. In the latest UNFCCC reporting guidelines (FCCC/SBSTA/2004/8), the term "key source category" was revised to "key category". Japan adopts the term "key category" according to these guidelines, although it has not conducted key category analysis covering the LULUCF categories.

[2] GIO has consigned a part of task to private consultants.

The relevant ministries, governmental agencies and organizations concerned provide data for emission factors, activity data, etc., through the ways such as the publication of relevant statistics. They also offer assistance for the preparation of inventory, for example, by providing information necessary for the assessment of uncertainty. List of the relevant ministries, governmental agencies and organizations is presented below.

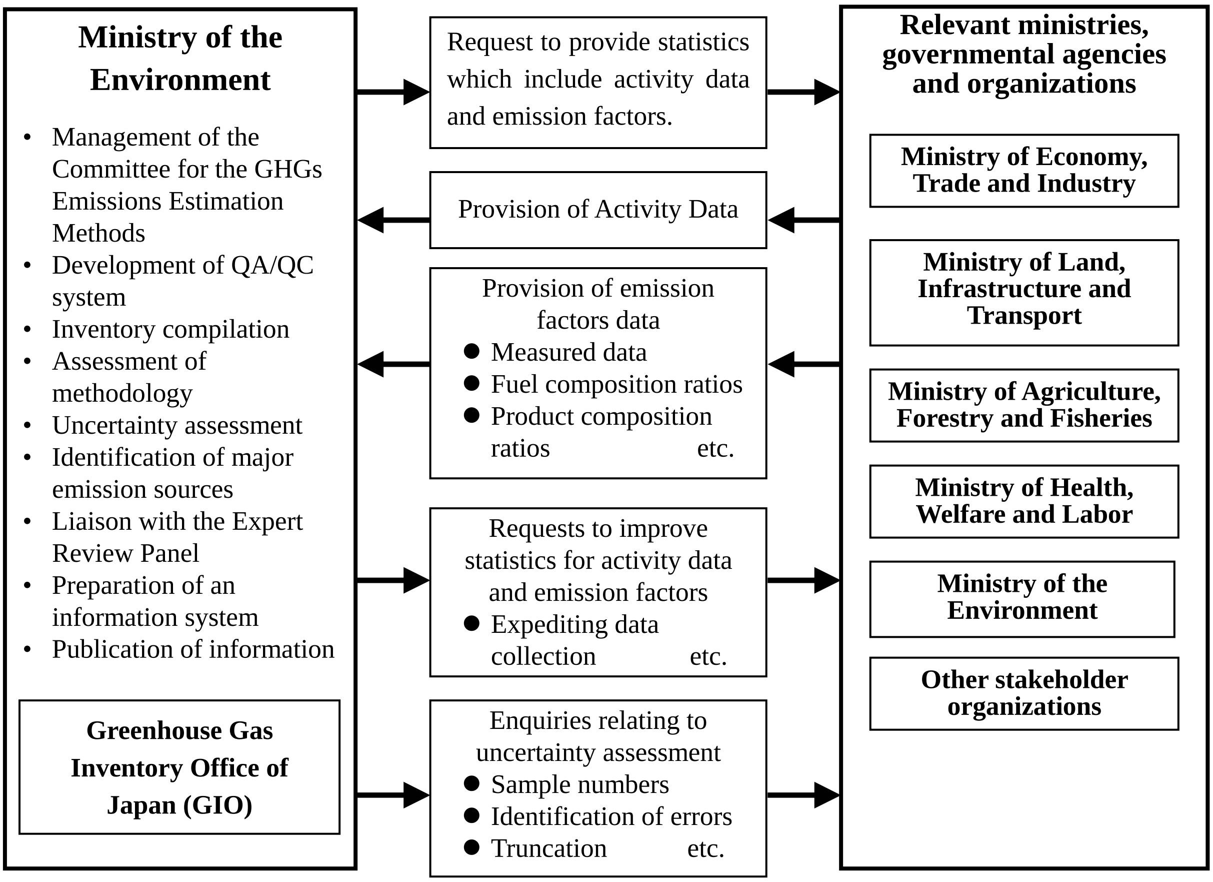

Figure 1-1 Institutional arrangement for the inventory preparation in Japan

Table 1-1 List of the relevant ministries

		Major data or statistics
Relevant ministries	Ministry of the Environment	Research of Air Pollutant Emissions from Stationary Sources / volume of waste in landfill / volume of incinerated waste / population using johkasou[3] / volume of human waste treated at human waste treatment facilities
	Ministry of Economy, Trade and Industry	General Energy Statistics / Yearbook of Production, Supply and Demand of Petroleum, Coal and Coke / Yearbook of Iron and Steel, Non-ferrous Metals, and Fabricated Metals Statistics / Yearbook of Chemical Industry Statistics / Yearbook of Ceramics and Building Materials Statistics / Census of Manufactures
	Ministry of Land, Infrastructure and Transport	Survey on Transport Energy / Statistical Yearbook of Motor Vehicle Transport / Statistical Yearbook of Air Transport
	Ministry of Agriculture, Forestry and Fisheries	Crop Statistics / Livestock Statistics / Vegetable Production and Shipment Statistics / Statistics of Arable and Planted Land Area
	Ministry of Health, Welfare and Labor	Statistics of Production by Pharmaceutical Industry

Table 1-2 List of the governmental agencies and organizations

		Major data or statistics
Relevant Organizations	Federation of Electric Power Companies	Volume of fuel consumption at pressurized fluidized-bed combustion
	Japan Coal Energy Center	Production volume of coal
	Japan Cement Association	Moisture content, purity and MgO content of limestone
	Japan Iron and Steel Federation	Emissions from coke furnace cover, desulfurization tower and regeneration desulfurization tower
	local public entity	Carbon content in each type of waste

1.2.2. Brief General Description of Methodologies and Data Sources Used

The methodology used in estimation of GHG emissions or removals is basically in accordance with the *Revised 1996 IPCC Guidelines* and the *Good Practice Guidance (2000)*. However, Japan's country-specific methodologies were used for "2.A.1. carbon dioxide emissions from cement production", "2.A.2. carbon dioxide emissions from lime production", "4.C. methane emissions from rice cultivation" and "6.A. methane emissions from solid waste disposal on land" etc., in order to reflect the actual situations of emissions in Japan.

Basically, actual measurements or estimates based on researches conducted in Japan were used for the emissions factors. However, the default values given in the *Revised 1996 IPCC Guidelines* and the *Good Practice Guidance (2000)* were used for categories from which emissions were thought to be quite low (such as "1.B.2.a.ii fugitive emissions from fuel (oil and natural gas")), and emission sources for which the reality of emissions is unsure (such as " 4.D.3. indirect emissions from soil in agricultural land").

[3] "Johkasou" is a system developed in Japan for on-site treatment of wastewater from households.

1.2.3. Brief Description of the Process of Inventory Preparation and Implementation of QA/QC

Japan has compiled an inventory by following the steps shown in Figure 1-2, in order to ensure and maintain the quality control for such as the completeness, accuracy and consistency of data. Submission of inventory to the UNFCCC secretariat is due on April 15th every year.[4] Dates overlapping between different steps are due to the fact that Japan implements more than one step contemporaneously to enhance working efficiency.

As shown in Figure 1-2, Japan has implemented QC activities, such as checking estimation accuracy and archiving documents, in each step of the inventory compilation process in accordance with *Good Practice Guidance (2000)* to manage the quality of inventories. Japan has implemented Step 2 [Expert review of previous inventories (Committee for the Greenhouse Gases Emissions Estimation Methods)] as QA activities, and in that step, it reviews data quality taking into account scientific knowledge and data availability.

[4] Annex I Parties have to submit their inventories within 6 weeks from the submission date, which is April 15th, to be eligible to participate in the Kyoto mechanism.

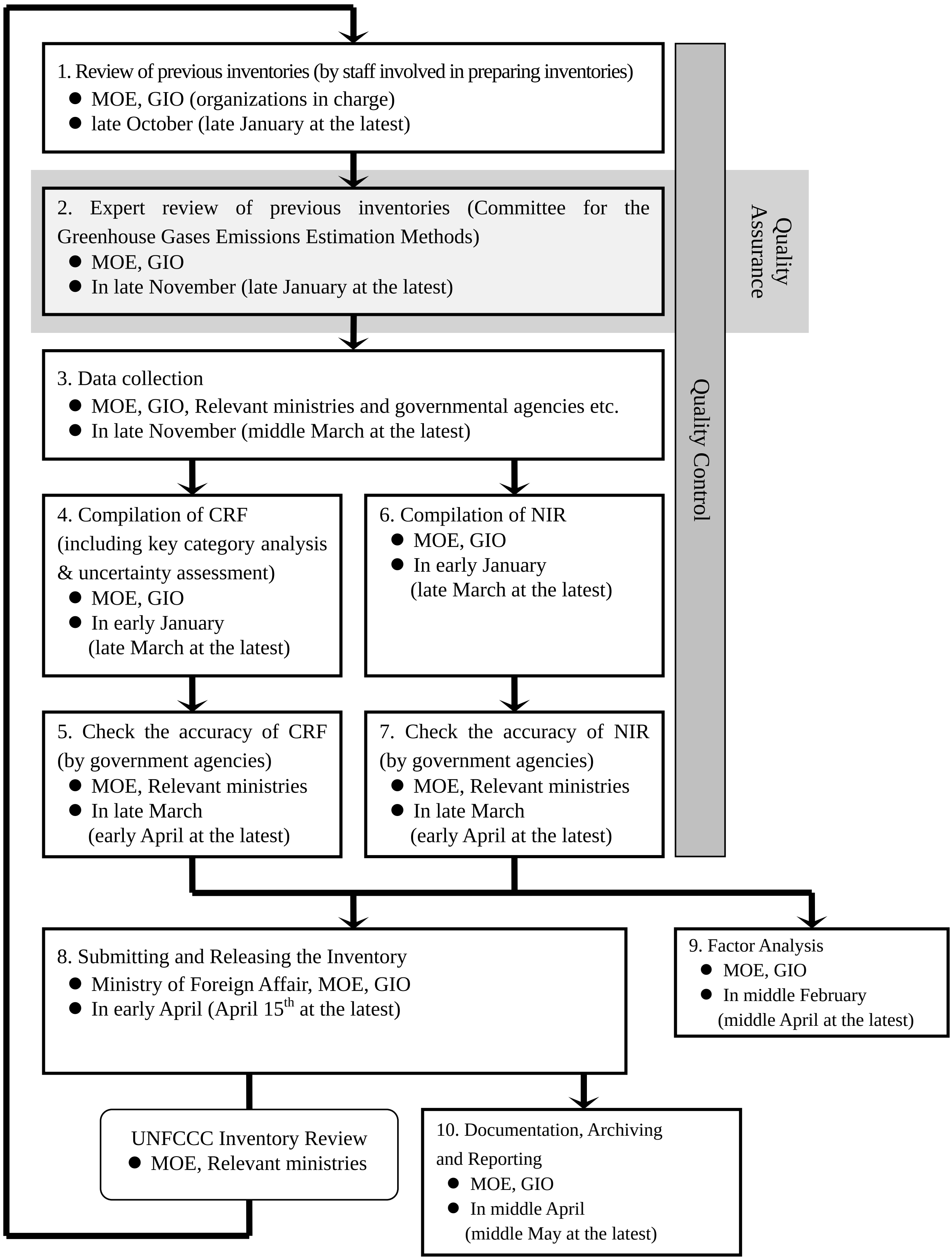

Figure 1-2 Process of the inventory compilation

1.2.4. Brief Description of Key Categories

Key categories were assessed in accordance with the *Good Practice Guidance (2000)* (Tier 1 level assessment or trend assessment and qualitative analysis).

The assessment using these methods (Tier1 Level Assessment, Tier1 Trend Assessment and Qualitative Analysis) resulted in the following table of 25 sources, which were determined as Japan's key categories in fiscal 2003. Refer to Annex 1 for more detailed results.

Table 1-3 Japan's key source categories in FY2003

	A IPCC Source Category		B Direct GHGs	Level	Trend	Qualitative Analysis
#1	1A Stationary Combustion	Solid Fuels	CO2	#1	#2	
#2	1A Stationary Combustion	Liquid Fuels	CO2	#2	#1	
#3	1A3 Mobile Combustion	b. Road Transportation	CO2	#3	#4	
#4	1A Stationary Combustion	Gaseous Fuels	CO2	#4	#3	
#5	2A Mineral Product	1. Cement Production	CO2	#5	#7	
#6	6C Waste Incineration		CO2	#6	#10	
#7	1A Stationary Combustion	Other Fuels	CO2	#7		
#8	1A3 Mobile Combustion	d. Navigation	CO2	#8		
#9	4B Manure Management		N2O	#9	#14	●
#10	1A3 Mobile Combustion	a. Civil Aviation	CO2	#10	#12	
#11	2A Mineral Product	3. Limestone and Dolomite Use	CO2	#11	#16	
#12	4A Enteric Fermentation		CH4	#12		
#13	1A3 Mobile Combustion	b. Road Transportation	N2O	#13		
#14	2E Production of Halocarbons and SF6	1. By-product Emissions (Production of HCFC-22)	HFCs		#5	
#15	2F(a) Consumption of Halocarbons	7. Electrical Equipment	SF6		#6	
#16	2B Chemical Industry	3. Adipic Acid Production	N2O		#8	●
#17	2F(a) Consumption of Halocarbons	5. Solvents	PFCs		#9	
#18	2E Production of Halocarbons and SF6	2. Fugitive Emissions	SF6		#11	
#19	1B Fugitive Emission	1a i. Coal Mining and Handling (under gr.)	CH4		#13	
#20	2F(a) Consumption of Halocarbons	1. Refrigeration and Air Conditioning Equipment	HFCs		#15	
#21	4C Rice Cultivation		CH4		#17	
#22	1A3 Mobile Combustion	a. Civil Aviation	CH4			●
#23	1A3 Mobile Combustion	a. Civil Aviation	N2O			●
#24	6B Wastewater Handling		N2O			●
#25	6C Waste Incineration		N2O			●

N.B. Figures recorded in the Level and Trend columns indicate the ranking of individual level and trend assessments.

1.3. Further Inventory Development

For further development of inventory, following issues need to be addressed. All issues indicated below are suggested in the Committee for the Greenhouse Gas Emissions Estimation Methods. Hence, some of them may not be required in the inventories submission under the UNFCCC. Therefore, it is important to tackle them with consideration of the priority.

1.3.1. Crosscutting Issues

- With regard to the sources reported as “NE”, its emission status needs to be considered for the theoretical possibility for emissions.

- Sources estimated with default values of the *Revised 1996 IPCC Guidelines* or *Good Practice Guidance (2000)* could be overestimated because the default values may not reflect the circumstances of Japan correctly. Therefore, the estimation methods need to be improved in accordance with expansion of the scientific country-specific information if it’s available.

- Japan has reported its emissions of greenhouse gases in fiscal year basis (April to March). However, the *Revised 1996 IPCC Guidelines* requires to report in calendar year basis in the course of calculation of greenhouse gas emissions and removals. During the in-country visit review in 2003 under UNFCCC, difficulties in converting the data to calendar year basis and possibility of counting on calendar year basis after 2004 were discussed. Expert Review Team (ERT) concluded that it would be preferable for Japan to continue to report to the UNFCCC on a fiscal year basis, but encourages Japan to continue its work on the possibilities for conversion[5].

1.3.2. Energy (Category1)

1.3.2.1. Fuel Combustion (CO_2)

- In the current inventories, emission factors of liquid fuels such as crude oil, oil products, refinery gas, etc., are fixed from 1990 to following years. Detailed analysis of the oil refinery sector of the inventories revealed that carbon content in crude oil input to refinery is not balanced with that in each oil product and refinery gas. Essentially, in the oil refinery sector, carbon input and output should be balanced. Hence, the current method has issues to be addressed. Fluctuations of emissions relating to this issue would amount to be a few percent of national emission, therefore, immediate actions need to be taken to address these issues.

- Carbon included in solvents emitted to atmosphere as NMVOC is converted to CO_2 by atmospheric oxidation in short time. Reporting these CO_2 emissions in the inventory is indicated in the new *UNFCCC Reporting Guidelines on Annual Inventories*[6] adopted in

[5] FCCC/WEB/IRI(2)/2003/JPN para.14
[6] FCCC/CP/2002/8

COP8. From 2004, inclusion of these emissions as part of inventory should be conducted, and the framework of CO_2 emission estimation including the emissions such as NMVOC emission from product use except for solvent, and cascade usage of by-product fuel should be reviewed.

- Discharged synthetic detergent and interfacial active agent within a watershed are decomposed in sewage works and generate greenhouse gases. In the current inventory, these emissions are not estimated. The estimation method of these emissions will be considered. One possible option may be the method to adjust the deduction ratio of fuel (naphtha and LPG) used as feedstock in chemical industry.

- In the current inventory, waste used as fuel in sectors other than the waste treatment may not be counted, including the usage of wasted plastic in blast furnaces. The *Revised 1996 IPCC Guidelines* mentions "Incineration of waste for waste-to-energy facilities should be reported here (category 1 energy sector) and not under Section 6.C."[7] However, these emissions are reported under Section 6.C. in Japan.

1.3.2.2. Fuel Combustion (Stationary Sources: CH_4, N_2O)

- In the estimation methods of activity data used for normal pressure fluidized bed boiler, adequacy of assumptions (boiler efficiency: 85%, annual utilization: 8,000 hours) needs to be reviewed.

1.3.2.3. Fuel Combustion (Mobile Sources: CH_4, N_2O)

- There are few measured data on N_2O emission factors of road transportation. These data are affected by the type of equipped catalyst, temperature of catalyst, and aged deterioration of catalyst. Therefore, development of the driving cycle (such as 10-15 mode) applied for measuring GHGs from automobile is needed, as well as the accumulation of measured data are needed.

- CH_4 and N_2O emissions from natural gas vehicles and motorcycles are not estimated. Methods of estimation for these emissions are needed as well as the establishing of these emission factors.

- Taking account of development and dissemination of advanced products derived from technical innovation (such as fuel-cell vehicles, natural gas vehicles, and low emission vehicles), estimation method for GHGs (CH_4 and N_2O) emissions from these vehicles needs to be developed. Furthermore, collection of activity data of natural gas vehicle, which is rising to the dissemination level, should be developed.

[7] The *Revised 1996 IPCC Guidelines* vol.1, p1.3, N.B. Remarks in parentheses are not cited.

1.3.3. Industrial Processes (Category2)

1.3.3.1. CO_2, CH_4 and N_2O

- *Good Practice Guidance (2000)* may need to be applied to the estimation of emissions from sources listed below. Adequacy of application of the *Good Practice Guidance (2000)* to these sources needs to be reviewed.
  - CO_2 emissions from lime production (category 2.A.2.)
  - CO_2 emissions from iron and steel production (category 2.C.1.)

- Carbon contained in the fuel for non-energy use as reduction agent in metal production may be failed to be counted. Therefore, estimation method needs to be reviewed.

1.3.3.2. F-gas

- There are few types of PFCs used in Japan for which 100-year GWP values are not yet approved by the COP. Information on current status of consumption of these gases is should be grasped and reported separately along with the knowledge of these PFCs' GWP.

- Reporting of F-gas is based on the documentation from the Chemical and Bio Sub-Group, Industrial Structure Council, the Ministry of Economy, Trade and Industry. The Chemical and Bio Sub-Group has estimated the emission of F-gas in accordance with the *Good Practice Guidance (2000)*.

- Some substances of F-gas are emitted from only few companies, and their aggregated data is reported without its details such as emissions by gases because of the confidentiality. However, some sources mentioned above have large amount of emissions. Since the code of practice for the handling of confidential information was adopted in COP, handling of these data along the code of practice would be needed.

- Credibility of estimation should be developed by evaluating mass-balance between actual emissions and potential emissions (including amount of production, export, import, shipment, consumption, stock, disposal, recovery, destruction, recycling, reclamation and emissions).

1.3.4. Agriculture (Category4)

- Since there is no single statistics for all crops in Japan, various statistics are used in compiling Japan's inventories. Definition of each crop in these statistics may be different. Hence, in calculating the total amount of farm products, it is important to take care of double counting and left out of data. The estimation for total growing area of farmland has same issues.

1.3.5. Land Use , Land-Use Change and Forestry (Category5)

- As it has been in the process of verifying the latest land area statistics and developing various parameters necessary for the estimation in the Forest land sector, emissions and removals have been decided to be reported as "NE" (Not Estimated) from 1996 onwards. It will be considered to incorporate the results of the data developed to the inventories as appropriate in the future. In addition, it is also under verification of the land area statistics and has been developing various parameters, which will be lead to be considered to reflect the developed data as appropriate in the Settlements sector.

- Key category analysis, uncertainty assessment and preparation of QA/QC plan have not been conducted under the inventory of the LULUCF sector in this submission. However, it is necessary to develop the national system as soon as possible since the implementation of these analyses and assessments have been laid down in the UNFCCC reporting guidelines, and they are also stipulated as the essential factors under the Kyoto Protocol.

- As the Ministry of the Environment has been preparing the inventory with cooperation from relevant ministries and agencies after establishing national system in the source category, there also is a necessity to develop national system for the preparation of the inventory in the LULUCF sector.

1.3.6. Waste (Category6)

- Discharged synthetic detergent and interfacial active agent within a watershed are decomposed in sewage works and generate greenhouse gases. In the current inventory, these emissions are not estimated. The review of these emission estimates will be conducted. One possible option may be the method to adjust the deduction ratio of fuel used as feedstock in chemical industry may be one option. (*Previously mentioned in 1.6.2.2.a. Fuel Combustion (CO_2)*)

- In the current inventory, waste used as fuel in sectors other than the waste treatment may not be counted, including the usage of wasted plastic in ballast furnaces. The *Revised 1996 IPCC Guidelines* mentions "Incineration of waste for waste-to-energy facilities should be reported here (category1 energy sector) and not under Section 6.C." However, these emissions are reported under Section 6.C. in Japan. (*Previously mentioned in 1.6.2.2.a. Fuel Combustion (CO_2)*)

- Generally, usage of recyclable resources encourages establishing a sound material-cycle society and is expected to decrease GHGs national total emissions. However, the method provided by the *Revised 1996 IPCC Guidelines*, in which emissions from waste-to-energy facilities should be reported under the energy sector, aims to estimate the emissions by sectors. If these emissions from recycling which were included in the waste sector are counted in the energy sector according to the *IPCC Guidelines*, it might discourage the incentive for promoting thermal recovery or chemical recycle. Therefore, the assessment which does not discourage the promotion of recycling should be considered separately from methods to estimation methods of inventories.

- In category 6.C.: “municipal solid waste incineration”, CO_2 emissions are estimated only from wasted plastics derived from fossil fuels, and incinerated synthetic fibers which should be estimated are not included in the activity data. Therefore, collection of the activity data should be improved.

1.4. General Uncertainty Evaluation, Including Data on the Overall Uncertainty for the Inventory Totals

1.4.1. Uncertainty of Japan’s Total Emissions

Total emissions in Japan for fiscal 2003 were approximately 1.34 billion tons (carbon dioxide equivalents). Uncertainty of total emissions has been assessed at 2% and uncertainty introduced into the trend in total national emissions has been assessed at 3%. Refer Annex 7 for details of assessment method and precise results.

Table 1-4 Uncertainty of Japan’s Total Emissions

IPCC Source Category	GHGs	Emissions [Gg CO2eq.] A	[%]	Combined Uncertainty [%] B	rank	Combined uncertainty as % of total national emissions C	rank
1A. Fuel Combustion (CO2)	CO2	1,188,099.7	88.7%	2%	9	1.94%	1
1A. Fuel Combustion (Stationary:CH4,N2O)	CH4、N2O	3,206.4	0.2%	46%	2	0.11%	7
1A. Fuel Combustion (Transport:CH4,N2O)	CO2、CH4、N2O	6,954.9	0.5%	166%	1	0.86%	2
1B. Fugitive Emissions from Fuels	CO2、CH4、N2O	589.8	0.0%	14%	6	0.01%	8
2. Industrial Processes (CO2,CH4,N2O)	CO2、CH4、N2O	49,310.9	3.7%	4%	8	0.13%	6
2. Industrial Processes (HFCs,PFCs,SF6)	HFCs、PFCs、SF6	25,801.6	1.9%	25%	4	0.47%	4
3. Solvent & other Product Use	N2O	320.8	0.0%	5%	7	0.00%	9
4. Agriculture	CH4、N2O	33,230.3	2.5%	18%	5	0.46%	5
6. Waste	CO2、CH4、N2O	31,615.4	2.4%	31%	3	0.73%	3
Total Emissions	(D)	1,339,129.9	100.0%	(E) 2%			

1) C = A × B / D

2) $E = \sqrt{C_1^2 + C_2^2 + \cdots\cdots}$

Hereafter, the same method for calculating uncertainty assessment has been used in each sector appearing in Tables 3 and follows.

1.4.2. Sources which have highly-contribute to the uncertainty of total emissions

“The proportion of the uncertainty of each emissions source to total emissions” (hereafter, “degree of contribution”) is useful in examining the contributions to the uncertainties of total emissions from individual sources. Table 1-5 shows the top 20 ranks in sources with a high degree of contribution to uncertainty of total emissions.

Table 1-5 Sources with a high degree of contribution to uncertainty of total emissions

#	IPCC Source Category	GHGs	Emissions [Gg CO2eq.] A	EF Uncertainty [%] a	AD Uncertainty [%] b	Combined Uncertainty [%] B	rank	Combined uncertainty as % of total national emissions C	rank
#3	1A. Fuel Combustion - Solid Fuels - Steam Coal (imported)	CO2	234,862.3	0.5%	6.8%	7%	146	1.19%	1
#12	1A. Fuel Combustion - Liquid Fuels - Gasoline	CO2	140,571.0	0.6%	8.5%	9%	140	0.90%	2
#31	1A. Fuel Combustion (Transport) - a. Civil Aviation	N2O	110.3	10000.0%	5.0%	10000%	1	0.82%	3
#25	1A. Fuel Combustion - Gaseous Fuels - LNG	CO2	108,835.3	2.3%	9.3%	10%	136	0.78%	4
#161	6. Waste - C. Waste Incineration - Industrial Solid Waste	CO2	10,155.4	–	–	71%	57	0.54%	5
#5	1A. Fuel Combustion - Solid Fuels - Coke	CO2	65,894.5	5.0%	8.2%	10%	135	0.47%	6
#158	6. Waste - C. Waste Incineration - Municipal Solid Waste	CO2	13,183.8	11.2%	44.8%	46%	95	0.45%	7
#16	1A. Fuel Combustion - Liquid Fuels - Diesel Oil or Gas Oil	CO2	100,178.7	0.4%	5.8%	6%	148	0.44%	8
#70	2. Industrial Processes - E. Production of F-gas - 1. By-product Emissions (HCFC-22)	HFCs	5,022.8	100.0%	5.0%	100%	40	0.38%	9
#19	1A. Fuel Combustion - Liquid Fuels - Heating Oil C	CO2	98,132.3	0.5%	4.3%	4%	160	0.32%	10
#27	1A. Fuel Combustion - Gaseous Fuels - Town Gas*	CO2	59,204.4	5.0%	3.9%	6%	147	0.28%	11
#15	1A. Fuel Combustion - Liquid Fuels - Kerosene	CO2	70,079.6	0.2%	5.2%	5%	154	0.27%	12
#33	1A. Fuel Combustion (Transport) - b. Road Transportation	N2O	6,429.7	50.0%	5.0%	50%	83	0.24%	13
#17	1A. Fuel Combustion - Liquid Fuels - Heating Oil A	CO2	81,690.6	0.6%	3.8%	4%	162	0.23%	14
#129	4. Agriculture - D. Agricultural Soils - 3. Indirect Emissions - N Leaching & Run-off	N2O	3,663.2	–	–	84%	50	0.23%	15
#8	1A. Fuel Combustion - Solid Fuels - Blast Furnace Gas	CO2	40,821.7	5.0%	5.0%	7%	143	0.22%	16
#124	4. Agriculture - D. Agricultural Soils - 1. Direct Soil Emissions - Synthetic Fertilizers	N2O	2,062.5	–	–	130%	24	0.20%	17
#107	4. Agriculture - B. Manure Management - Non-Dairy Cattle	N2O	3,641.1	–	–	72%	56	0.20%	18
#23	1A. Fuel Combustion - Liquid Fuels - Refinery Gas	CO2	32,940.4	1.0%	7.6%	8%	142	0.19%	19
#1	1A. Fuel Combustion - Solid Fuels - Coking Coal	CO2	26,049.3	0.9%	9.3%	9%	138	0.18%	20

1.5. General Assessment of the Completeness

In this inventory, emissions from some categories are not estimated and reported as “NE”. It should be noted that emissions from many of these categories are expected to be very small or the status of the emissions is not clearly defined. Major categories which should be studied in the future are listed below.

It should be noted that emissions of HFCs, PFCs and SF_6 in the period from 1990 to 1994 and emissions and removals by Land use , Land-use change and forestry sector after 1995 have not been estimated (NE).

➢ Energy

- CH_4 emissions from Low-Emission Vehicle (Natural Gas Vehicle)
- CH_4 and N_2O emissions from Railways (Solid Fuels, Other Fuels such as gasoline and heating oil)
- N_2O emissions from Coal Mining
- N_2O emissions from Solid Fuel Transformation
- Fugitive emissions of CO_2, CH_4 and N_2O from Venting and Flaring
  - ✧ Fugitive emissions of CO_2 and CH_4 from Venting at Gas Wells
  - ✧ Fugitive emissions of CO_2, CH_4 and N_2O from Flaring at Oil Wells and Gas Wells

➢ Industrial Processes

- CO_2 emissions from Soda Ash Product and Use (including Desulfurizing Facilities)
- CO_2 emissions from Carbide Production
  - ✧ CO_2 emissions from Silicon Carbide Production
  - ✧ CO_2 emissions from Calcium Carbide Production
- N_2O emissions from Ethylene Production
- N_2O emissions from Coke Production

➢ Agriculture

- CH_4 emissions from Enteric Fermentation for Buffalo, Camels and Llamas, and Mules and Asses
- CH_4 emissions from Manure Management for Buffalo, Camels and Llamas, and Mules and Asses
- N_2O emissions from Crop Residue and Cultivation of Histosols on Agricultural Soils
- CH_4 and N_2O emissions from Field Burning of Other Agricultural Residues

➢ Waste

- CO_2 emissions from Managed Waste Disposal on Land
- CO_2 emissions from Unmanaged Waste Disposal Sites

Chapter 2. Trends in GHGs Emissions and Removals

2.1. Description and Interpretation of Emission and Removal Trends for Aggregate Greenhouse Gases

2.1.1. Greenhouse Gas Emissions and Removals

Total greenhouse gas emission in fiscal 2003[1] (the sum of emissions of CO_2, CH_4, N_2O, HFCs, PFCs, and SF_6 converted to CO_2 equivalents by multiplying its global warming potential [GWP][2] respectively; excluding for carbon dioxide removals) was 1,339 million tons (in CO_2 equivalents), an increase by 12.8% compared to emissions (CO_2, CH_4, N_2O, excluding carbon dioxide removals) in FY1990 (Removals of carbon dioxide in FY1995 were 83.7 million tons[3], an increase by 24.7% from FY1990). Compared to emissions in the base year under the Kyoto Protocol (FY1990 for emissions of CO_2, CH_4, N_2O; FY1995 for emissions of HFCs, PFCs, and SF_6), it increased by 8.3%.

It should be noted that emissions of HFCs, PFCs, and SF_6 in the period from 1990 to 1994, and emissions and removals by Land Use, Land Use change and forestry sector after 1995 have not been estimated (NE).

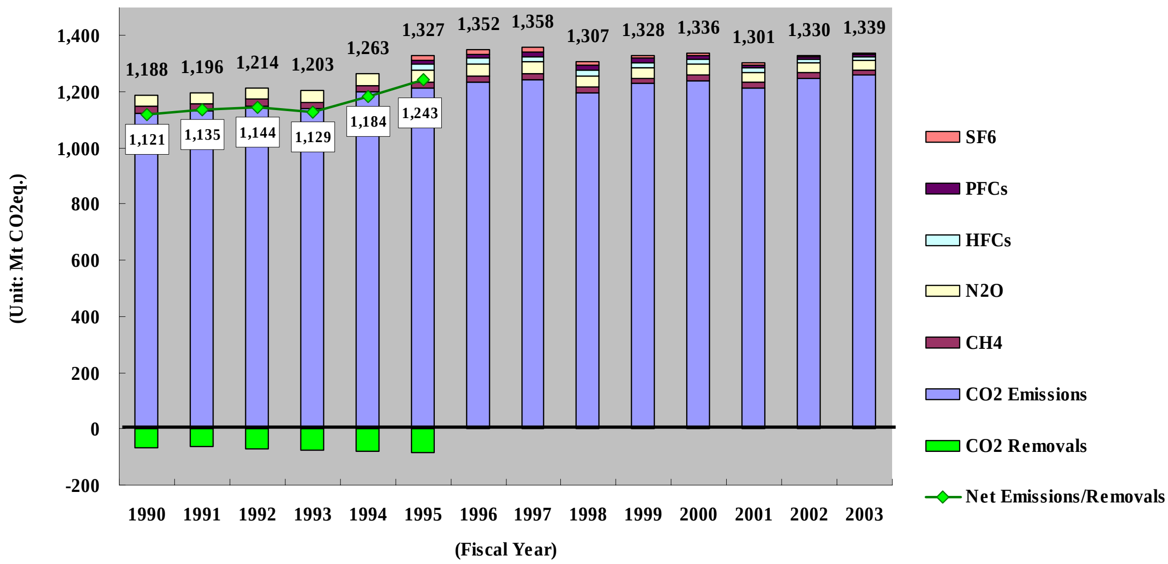

Figure 2-1 Trends in emission and removals of greenhouse gases in Japan

* Values in boxes represent net emissions or removals. No values appear after 1995, however, as carbon dioxide removals have not been estimated.

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[1] "Fiscal" is used because CO_2 is the primary GHGs emissions and estimated on the fiscal year basis; from April of the year to March of the next year.

[2] Global Warming Potential (GWP): It is the coefficients that indicate degrees of greenhouse gas effects caused by greenhouse gases converted into the proportion of equivalent degrees of CO_2. The coefficients are subjected to the *Second National Assessment Report* (1995) issued by the Intergovernmental Panel on Climate Change (IPCC).

[3] In the inventory submitted under the FCCC, removals by forest planted before 1990 are contained. Therefore, this value do not correspond to 13 Mt indicated in the annex of "Draft decision -/CMP.1 (Land Use, Land Use change and forestry) (FCCC/CP/2001/13/Add.1 p54) adopted in the decision 11/COP7.

2.1.2. CO_2 Emissions Per Capita

Total carbon dioxide emissions in fiscal 2003 were 1,259 million tons, giving an emission of 9.87 tons per capita. Compared to fiscal 1990, it represents an increase of 12.2% in total carbon dioxide emissions, and an increase of 8.7% in carbon dioxide emissions per capita. Carbon dioxide emissions compared to the previous year increased by 0.9% in total emissions and increased by 0.8% per capita.

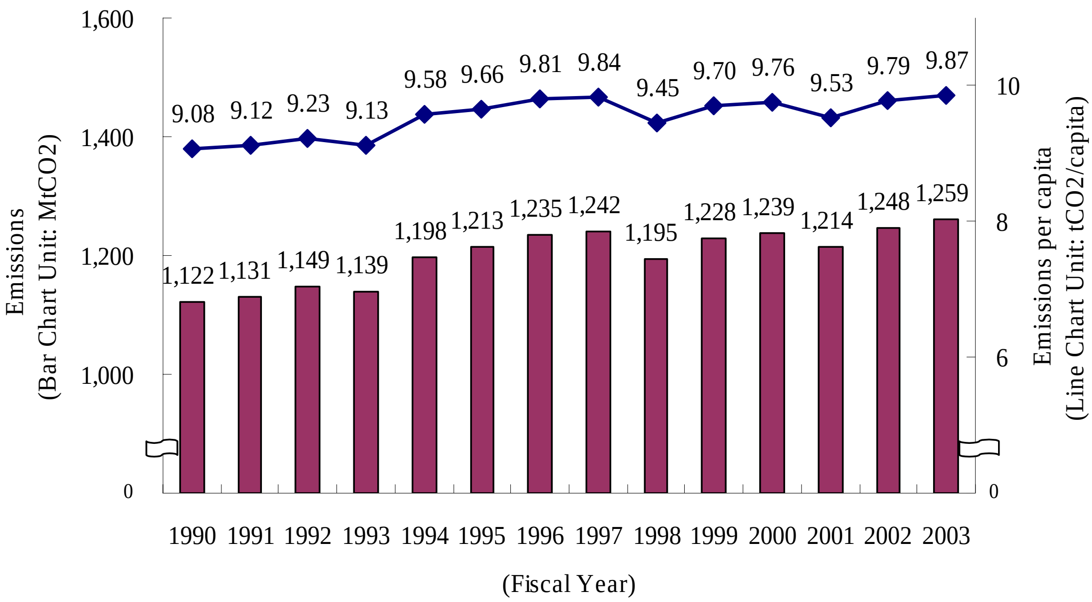

Figure 2-2 Trends in total CO_2 emissions and CO_2 emissions per capita

Source of population: Ministry of Public Management, Home Affairs, Posts and Telecommunications Japan, *Population Census*

MPMHAPTJ, *Annual Report on Current Population Estimates*

2.1.3. CO_2 Emissions per unit of GDP

Carbon dioxide emissions per unit of GDP in fiscal 2003 were 2,270 tons/billion yen, resulting in a decrease by 5.2% since fiscal 1990, and a decrease by 2.3% from the previous year.

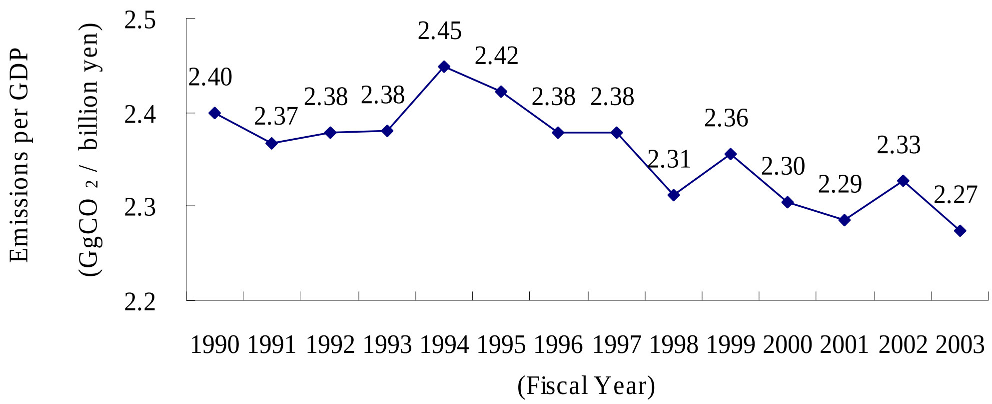

Figure 2-3 Trends in CO_2 emissions per unit of GDP

Source of GDP: website of Economic and Social Research Institute (Preliminary Estimates of National Expenditure Oct-Dec.2004, Fixed-based)

2.2. Description and Interpretation of Emission and Removal Trends by Gas

Emissions of carbon dioxide in FY2003 were 1,259 million tons, comprising 94.0% of the total. It represents an increase by 12.2% from fiscal 1990, and an increase by 0.9% in comparison with the previous year. Removals of CO_2 in FY1995[4] were 83.7 million tons, equivalent to6.3% of total annual greenhouse gas emissions. It represents an increase by 24.7% from FY1990, and an increase by 6.2% in comparison with the previous year.

Emissions in FY2003 of CH_4 were 19.3 million tons (in CO_2 eq.), comprising 1.4% of total emissions. The value represents a reduction by 22.7% from FY1990 and 1.2% in comparison with the previous year.

Emissions in FY2003 of N_2O were 34.6 million tons (in CO_2 eq.), comprising 2.6% of total emissions. The value represents a reduction by 14.7% from FY1990, and 0.2% in comparison with the previous year.

Emissions in CY2003 of HFCs were 12.3 million tons (in CO_2 eq.), comprising 0.9% of total emissions. The value represents a reduction by 39.2% on CY1995, and 4.7% in comparison with the previous year.

Emissions in CY2003 of PFCs were 9.0 million tons (in CO_2 eq.), comprising 0.7% of total emissions. The value represents a reduction by 28.2% from CY1995, and 8.3% in comparison with the previous year.

Emissions in CY2003 of SF_6 were 4.5 million tons (in CO_2 eq.), comprising 0.3% of total emissions. The value represents a reduction by 73.6% on CY1995, and 15.3% in comparison with the previous year.

Table 2-1 Trends in emissions and removals of greenhouse gas in Japan

[Mt CO2 eq.]	GWP	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
CO2 Emissions	1	1,122.3	1,131.4	1,148.9	1,138.7	1,198.2	1,213.1	1,234.8	1,242.0	1,195.2	1,228.4	1,239.0	1,213.6	1,247.8	1,259.4
Removals	1	-67.1	-61.6	-69.6	-74.3	-78.8	-83.7	NE	NE	NE	NE	NE	NE	NE	NE
CH4	21	24.9	24.8	24.7	24.6	24.2	23.5	22.9	22.1	21.5	21.1	20.7	20.2	19.5	19.3
N2O	310	40.6	40.1	40.2	39.9	40.8	40.8	41.5	41.9	40.6	35.1	37.5	34.6	34.7	34.6
HFCs	HFC-134a : 1,300 etc.	NE	NE	NE	NE	NE	20.2	19.9	19.8	19.3	19.8	18.5	15.8	12.9	12.3
PFCs	PFC-14 : 6,500 etc.	NE	NE	NE	NE	NE	12.6	15.3	16.9	16.6	14.9	13.7	11.5	9.8	9.0
SF6	23,900	NE	NE	NE	NE	NE	16.9	17.5	14.8	13.4	9.1	6.8	5.7	5.3	4.5
Gross Total		1,187.8	1,196.3	1,213.8	1,203.3	1,263.1	1,327.2	1,351.8	1,357.5	1,306.6	1,328.4	1,336.2	1,301.4	1,330.0	1,339.1
Net Total		1,120.7	1,134.7	1,144.3	1,128.9	1,184.3	1,243.5	1,351.8	1,357.5	1,306.6	1,328.4	1,336.2	1,301.4	1,330.0	1,339.1

* NE: Not Estimated
* CH_4 and N_2O emissions in Table 2-1 include emissions from Land Use, Land Use Change and Forestry based on the estimation method decided by the UNFCCC. On the contrary, since emissions from Land Use, Land Use Change and Forestry are regarded as RMU (removal unit) according to Article 3.3 of the Kyoto Protocol, they are not included in GHG emissions based on Kyoto Protocol

[4] Statistics on removals of CO_2 have not been updated. The most recently available data is therefore for FY1995.

(refer annex 8 table 1).

2.2.1. CO_2[5]

CO_2 emissions in FY2003 were 1,259 million tons, an increase by 12.2% from FY1990, and an increase by 0.9% in comparison with the previous year.

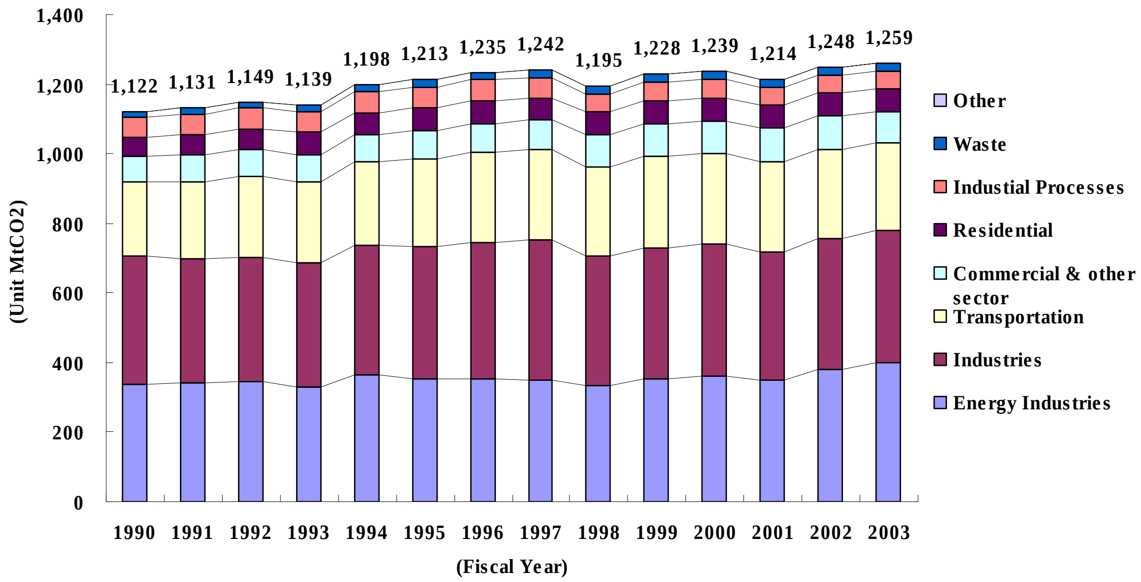

Figure 2-4 Trends in CO_2 emissions

The breakdown of CO_2 emissions in FY2003 shows that carbon dioxide emitted in association with the Fuel combustion accounted for 94% of the total, carbon dioxide from the Industrial processes accounted for 3.8%, and carbon dioxide from the Waste sector accounted for 1.9%.

The Energy industries sector accounts for 31.7% of emissions of CO_2 from the Fuel combustion, making it the single largest source of emissions followed by the Industries at 30.2% and the Transport sector at 20.1%.

Fluctuations in emissions by sector show that CO_2 emissions from the Fuel combustion in the Energy industries sector, which accounts for about 30% of CO_2 emissions, increased by 17.8% compared to FY1990, and increased by 5.0% compared to the previous year.

CO_2 emissions from the Fuel combustion in the industries increased by 3.3% compared to FY1990, and increased by 1.3% compared to the previous year.

CO_2 emissions from the Fuel combustion in the transportation increased by 20.1% compared to FY1990, and decreased by 0.9% compared to the previous year.

CO_2 emissions from the Fuel combustion in the commercial and other sector increased by 22.6% compared to FY1990, and decreased by 7.1% compared to the previous year.

CO_2 emissions from the Fuel combustion in the residential sector increased by 15.1%

[5] CO_2 associated with LUCF sector has been excluded.

compared to FY1990, and decreased by 3.2% compared to the previous year.

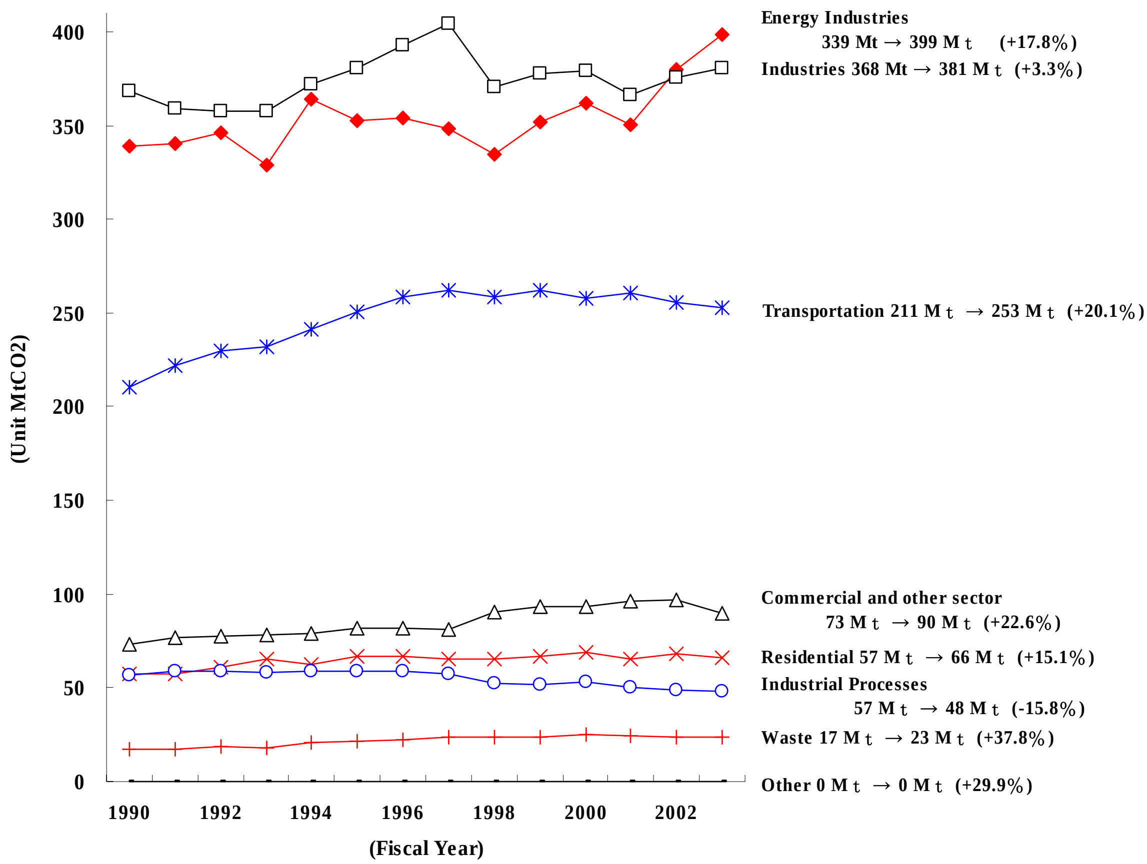

Figure 2-5 Trends in CO_2 emissions in each sector

Table 2-2 Trends in CO_2 emissions in each sector

[Gg CO2]

Category	1990	1995	2000	2002	2003
1A. Fuel Combustion	1,048,332.15	1,132,241.07	1,161,365.77	1,175,509.80	1,188,099.74
Energy Industry	338,571.89	352,633.52	362,159.09	379,656.59	398,776.60
Public Electricity & Heat Production	296,840.62	311,936.88	324,818.69	345,068.47	363,939.61
Petroleum Refining	14,321.90	16,479.79	16,322.87	16,361.12	16,481.43
Manufacture of Solid Fuel and Other Energy Industry	27,409.37	24,216.85	21,017.53	18,226.99	18,355.56
Industries	368,498.95	380,363.21	378,850.21	375,610.06	380,558.86
Manufacturing Industries &	335,046.99	346,464.86	349,059.49	345,819.34	350,768.14
Agriculture, Forestry and Fisheries	33,451.96	33,898.35	29,790.72	29,790.72	29,790.72
Transport	210,663.43	250,654.62	258,059.82	255,290.53	252,930.31
Civil Aviation	7,162.95	10,278.98	10,677.61	10,934.33	11,063.68
Road Transportation	189,204.04	225,179.46	231,897.37	229,236.27	227,177.66
Railways	941.98	828.30	707.44	668.81	628.69
Navigation	13,354.45	14,367.88	14,777.39	14,451.11	14,060.27
Commercial and Residential	130,597.88	148,589.72	162,296.66	164,952.63	155,833.98
Commercial & other sector	73,321.97	81,743.10	93,226.72	96,828.96	89,905.85
Residential	57,275.91	66,846.62	69,069.94	68,123.67	65,928.13
Other	0.00	0.00	0.00	0.00	0.00
1B. Fugitive Emissions from Fuel	0.51	0.60	0.61	0.64	0.67
2. Industrial Processes	57,008.97	59,213.29	52,797.32	48,716.11	47,986.38
Mineral Products	53,465.31	55,588.39	49,403.45	45,791.24	45,368.17
Chemical	3,543.66	3,624.90	3,393.87	2,924.87	2,618.21
6. Waste	16,935.48	21,627.24	24,794.08	23,536.68	23,339.20
Total	1,122,277.11	1,213,082.21	1,238,957.79	1,247,763.22	1,259,425.99

2.2.2. CH_4

Methane emissions in FY2003 were 19.3 million tons (in CO_2 equivalents), a decrease by 22.7 % compared to FY1990, and by 1.2% in comparison with the previous year.

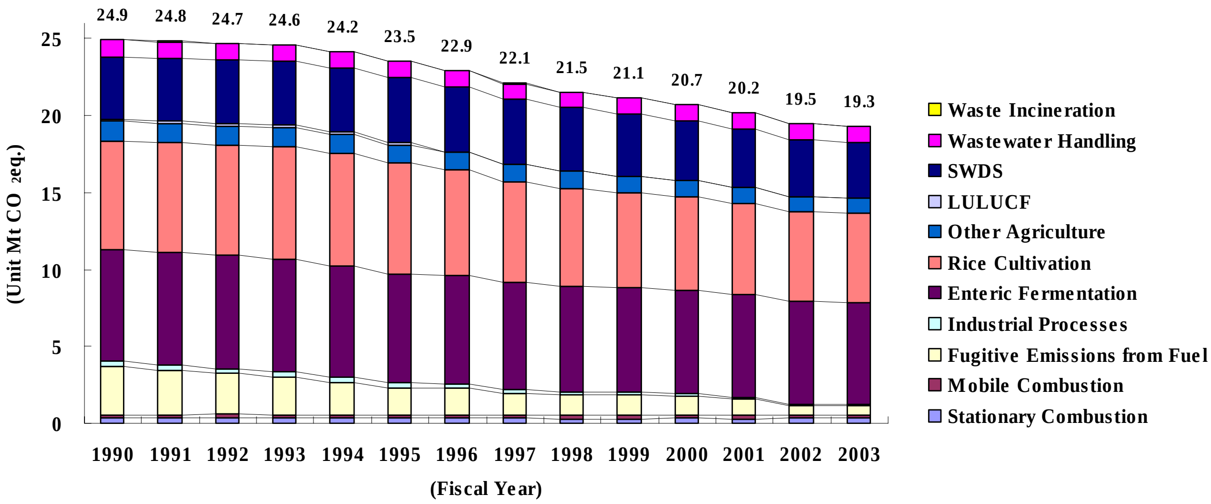

Figure 2-6 Trends in CH_4 emissions

The breakdown of methane emissions in FY2003 shows that methane emitted from enteric fermentation in livestock accounted for 34% of the total, making it the single largest source of emissions. It is followed by methane emissions from rice cultivation at 30%, and methane emissions from SWDS (Solid Waste Disposal Site) at 19%.

Table 2-3 Trends in CH_4 emissions

[Gg CO2eq.]

Category	1990	1995	2000	2002	2003
1A. Fuel Combustion	531.75	547.72	537.25	529.37	526.53
1A1. Energy Industries	-32.67	-35.60	-41.89	-41.89	-41.89
1A2. Industries	227.51	213.96	204.45	204.03	203.84
1A3. Transport	195.19	208.28	220.46	215.22	217.45
1A4. Residential / Institutional	141.72	161.09	154.22	152.01	147.14
1B. Fugitive Emissions from Fuels	3,176.12	1,761.47	1,220.46	603.74	589.17
1B1. Solid Fuels	2,806.43	1,344.68	769.13	118.34	93.86
1B2. Oil & Natural Gas	369.69	416.78	451.33	485.40	495.30
2. Industrial Processes	337.80	303.30	163.74	124.34	116.72
4. Agriculture	15,568.88	15,478.64	13,829.68	13,484.13	13,417.47
4A. Enteric Fermentation	7,249.10	7,118.91	6,759.12	6,672.13	6,615.72
4B. Manure Management	1,072.55	991.38	927.81	914.99	911.74
4C. Rice Cultivation	7,075.73	7,200.86	6,018.51	5,788.92	5,785.48
4D. Agricultural Soils	3.06	2.72	2.30	2.28	2.29
4F. Field Burning of Agricultural Residue	168.45	164.77	121.94	105.80	102.23
5. LULUCF	166.52	156.18	NE	NE	NE
6. Waste	5,154.16	5,280.43	4,969.15	4,769.76	4,635.28
6A. SWDS	4,044.84	4,238.80	3,927.55	3,720.76	3,594.25
6B. Wastewater Handling	1,095.78	1,029.04	1,028.96	1,038.23	1,029.80
6C. Waste Incineration	13.54	12.59	12.63	10.77	11.23
Total	24,935.24	23,527.74	20,720.27	19,511.34	19,285.17

2.2.3. N_2O

N_2O emissions in FY2003 were 34.6 million tons (in CO_2 equivalents), a decrease by 14.7% compared to FY1990, and by 0.2% in comparison with the previous year. In March 1999, N_2O abatement equipment came on stream in the adipic acid production plant, causing a sharp decline in emissions from the Industrial processes during the period from FY1998 to FY1999. In FY2000, N_2O emissions increased because of a decrease in operational rate of the abatement equipment. In 2001, N_2O emissions decreased with resuming the normal operation of the equipment.

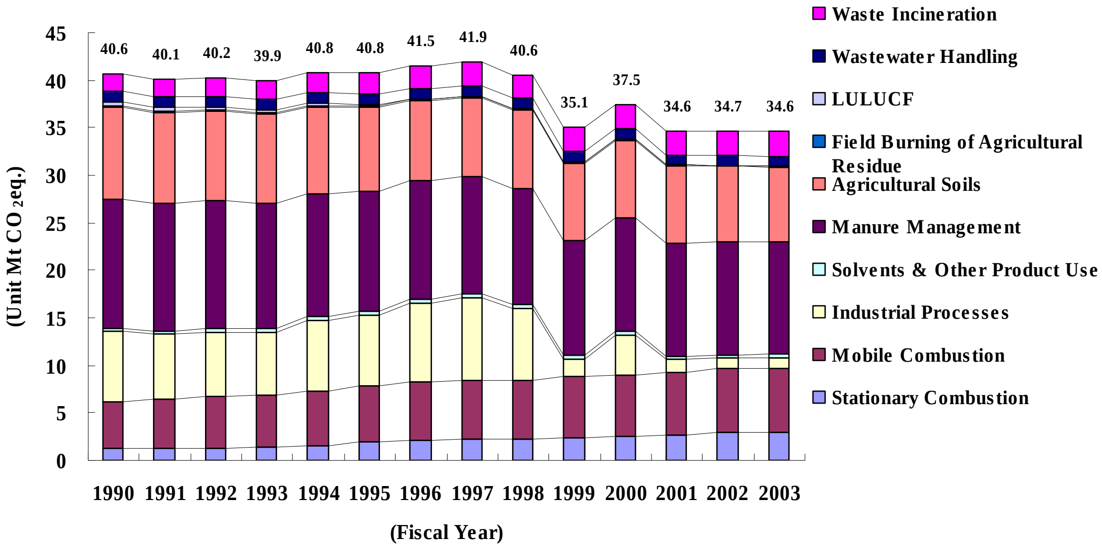

Figure 2-7 Trends in N_2O emissions

The breakdown of nitrous oxide emissions in FY2003 shows that emissions from manure management accounted for 34% of the total, making it the single largest source of emissions. It is followed by emissions from agricultural soils at 23%, and emissions from fuel combustion of motor vehicles and other mobile sources of 19%.

Table 2-4 Trends in N_2O emissions

[Gg CO2eq.]

Category	1990	1995	2000	2002	2003
1A. Fuel Combustion	6,218.89	7,866.27	8,971.81	9,603.57	9,634.81
1A1. Energy Industries	299.44	720.19	836.94	855.76	847.64
1A2. Industries	845.25	1,214.59	1,562.07	1,987.22	1,986.55
1A3. Transport	5,022.73	5,863.37	6,503.45	6,694.19	6,737.47
1A4. Residential / Institutional	51.46	68.11	69.35	66.40	63.16
1B. Fugitive Emissions from Fuel	0.00	0.00	0.00	0.00	0.00
2. Industrial Processes	7,415.74	7,367.31	4,248.29	1,183.59	1,207.81
3. Solvent & Other Product Use	287.07	437.58	340.99	334.05	320.83
4. Agriculture	23,426.62	21,588.45	20,259.42	19,923.78	19,812.88
4B. Manure Management	13,550.26	12,650.39	12,004.47	11,859.43	11,826.36
4D. Agricultural Soils	9,746.46	8,797.87	8,144.17	7,978.29	7,903.83
4F. Field Burning of Agricultural Residue	129.90	140.19	110.78	86.07	82.68
5. LULUCF	386.52	222.48	NE	NE	NE
6. Waste	2,854.11	3,363.21	3,643.72	3,639.64	3,640.90
6B. Wastewater Handling	1,097.88	1,093.37	1,051.81	1,006.93	996.88
6C. Waste Incineration	1,756.22	2,269.84	2,591.91	2,632.71	2,644.03
Total	40,588.95	40,845.29	37,464.23	34,684.64	34,617.24

2.2.4. HFCs

Emissions of HFCs in 2003[6] were 12.3 million tons (in CO_2 equivalents), a decrease by 39.2% compared to 1995, and by 4.7% in comparison with the previous year.

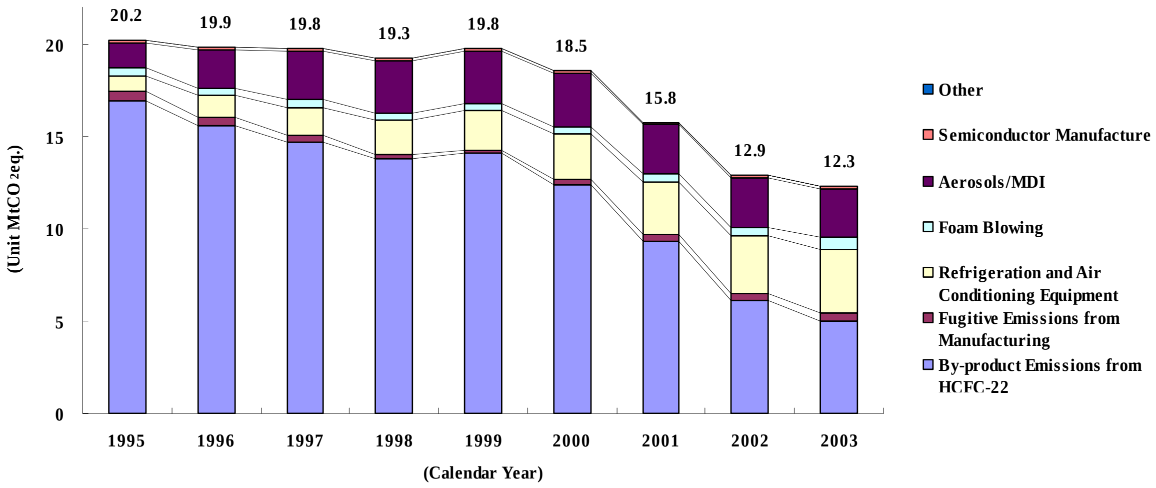

Figure 2-8 Trends in HFCs emissions

The breakdown of HFCs emissions in 2003 shows that by-product HFC-23 emission during production of HCFC-22 accounted for 41% of the total, followed by emissions from refrigerants of refrigeration and air conditioning equipment at 28%, and emissions from aerosols / MDI at 21%.

Table 2-5 Trends in HFCs emissions

[Gg CO2eq.]

Category	1995	2000	2001	2002	2003
2E. Productions of F-gas	17,456.50	12,654.54	9,709.42	6,484.42	5,462.21
2E1. By-product Emissions from Production of HCFC-22	16,965.00	12,402.00	9,336.60	6,095.70	5,022.81
2E2. Fugitive Emissions	491.50	252.54	372.82	388.72	439.40
2F. Consumption of F-gas	2,776.17	5,894.43	6,056.54	6,418.73	6,838.62
2F1. Refrigeration and Air Conditioning Equipment	809.13	2,449.23	2,817.91	3,161.55	3,447.96
2F2. Foam Blowing	456.96	437.71	413.01	446.68	653.12
2F4. Aerosols/MDI	1,365.00	2,849.54	2,702.77	2,692.33	2,624.06
2F6. Semiconductor Manufacture	145.08	157.95	122.85	118.17	113.49
2F8. Other	0.00	0.00	0.00	0.00	0.00
Total	20,232.67	18,548.97	15,765.96	12,903.15	12,300.83

6 Emissions of calendar year basis are adopted for HFCs, PFCs and SF_6.

2.2.5. PFCs

PFCs emissions in 2003 were 9.0 million tons (in CO_2 equivalents), a decrease by 28.2% compared to 1995, and by 8.3% in comparison with the previous year.

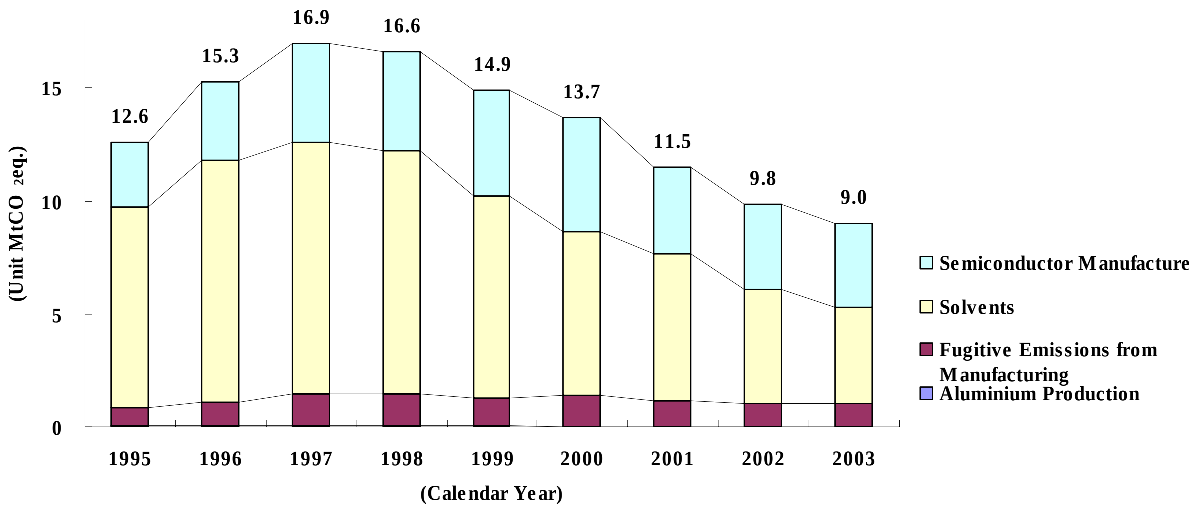

Figure 2-9 Trends in PFCs emissions

The breakdown of PFCs emissions in 2003 shows that emission from solvents in washing metals etc. accounted for 48% of the total, followed by emissions from semiconductor manufacture at 41%, and fugitive emissions from manufacturing at 11%.

Table 2-6 Trends in PFCs emissions

[Gg CO2eq.]

Category	1995	2000	2001	2002	2003
2C3. Aluminium Production	72.46	18.29	16.26	15.10	15.10
2E2. Fugitive Emissions	762.90	1,382.60	1,123.70	1,043.60	1,016.40
2F. Consumption of F-gas	11,737.70	12,284.90	10,360.00	8,786.50	7,995.40
2F5. Solvents	8,880.00	7,211.30	6,497.20	5,002.00	4,288.00
2F6. Semiconductor Manufacture	2,857.70	5,073.60	3,862.80	3,784.50	3,707.40
Total	12,573.06	13,685.79	11,499.96	9,845.20	9,026.90

2.2.6. SF_6

Emissions of SF_6 in 2003 were 4.5 million tons (in CO_2 equivalents), a decrease by 73.6% compared to 1995, and by 15.3% in comparison with the previous year.

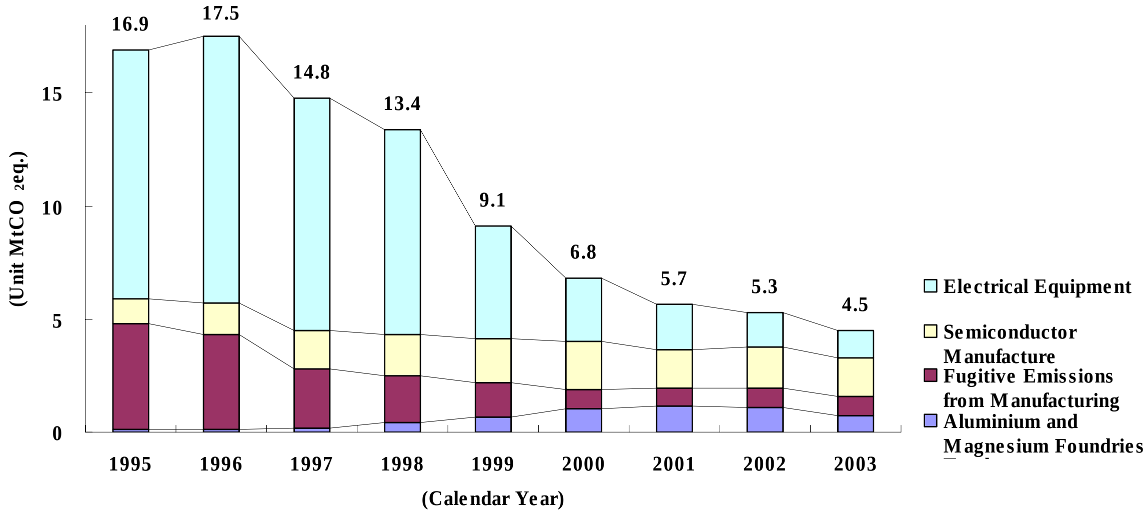

Figure 2-10 Trends in SF_6 emissions

The breakdown of SF_6 emissions in 2003 shows that emissions from semiconductor manufacture accounted for 38%, followed by emissions from the electrical equipment at approximately 27%, and fugitive emissions from manufacturing at 18%.

Table 2-7 Trends in SF_6 emissions

[Gg CO2eq.]

Category	1995	2000	2001	2002	2003
2C4. SF_6 Used in Aluminium and Magnesium Foun	119.50	1,027.70	1,147.20	1,123.30	740.90
2E2. Fugitive Emissions	4,708.30	860.40	788.70	836.50	812.60
2F. Consumption of F-gas	12,089.40	4,931.94	3,734.74	3,323.35	2,920.32
2F6. Semiconductor Manufacture	1,099.40	2,141.44	1,711.24	1,780.55	1,716.02
2F7. Electrical Equipment	10,990.00	2,790.50	2,023.50	1,542.80	1,204.30
Total	16,917.20	6,820.04	5,670.64	5,283.15	4,473.82

2.3. Description and Interpretation of Emission and Removal Trends by Categories

The breakdown of emissions and removals of greenhouse gases in FY2003 by sector[7] shows that the Energy sector accounted for 89.5%, followed by Industrial processes at 5.6%, Solvents and other product use at 0.02%, Agriculture at 2.5% and Waste at 2.4%.

Removals by Land Use, Land Use change and forestry in FY1995 were approximately 5.9% as a proportion of absolute value of total emissions/removals.

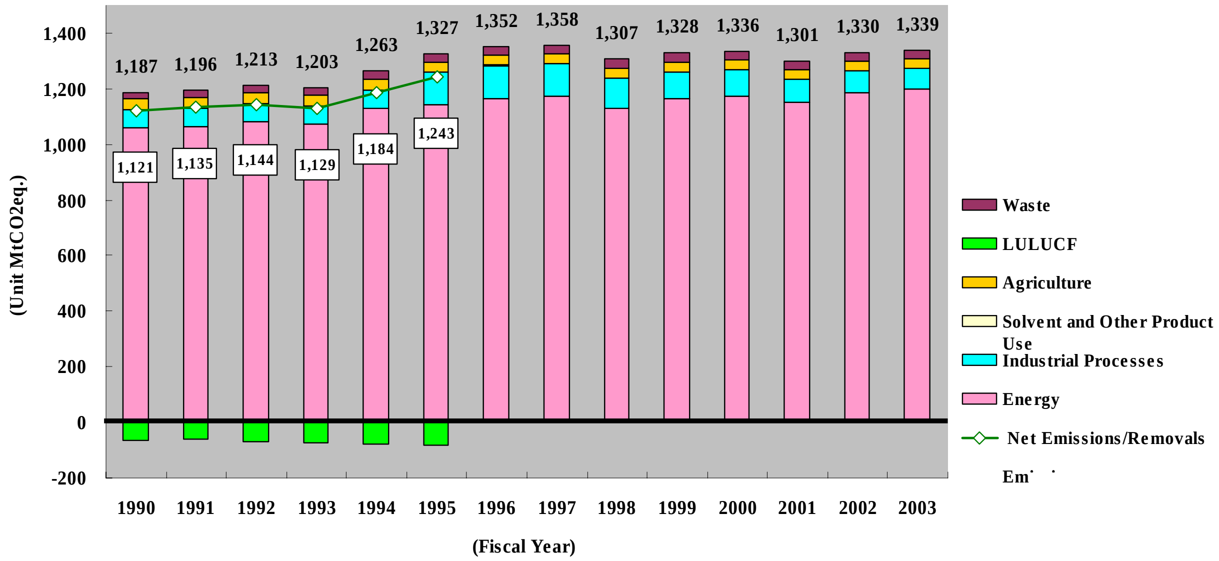

Figure 2-11 Trends in emissions and removals of greenhouse gases in each category

* Values in boxes represent net emissions or removals. No values appear after 1995, however, as carbon dioxide removals have not been estimated.

Table 2-8 Trends in emissions and removals of greenhouse gases in each category

[Mt CO_2 eq.]	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Energy	1,058.3	1,065.4	1,081.4	1,072.2	1,128.0	1,142.4	1,163.8	1,171.4	1,129.1	1,163.2	1,172.1	1,149.9	1,186.2	1,198.9
Industrial Processes	64.8	65.7	66.1	65.0	66.9	116.6	120.2	118.1	109.5	97.8	96.3	84.9	78.1	75.1
Solvent and Other Product Use	0.3	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.3	0.3	0.3	0.3
Agriculture	39.0	38.8	38.7	38.6	38.0	37.1	36.2	35.4	34.9	34.4	34.1	33.7	33.4	33.2
Land Use, Land Use Change and Forestry	-66.5	-61.0	-69.0	-73.9	-78.4	-83.3	NE	NE	NE	NE	NE	NE	NE	NE
Waste	24.9	25.5	26.6	26.6	29.3	30.3	31.2	32.3	32.8	32.7	33.4	32.5	31.9	31.6
Net Emissions/Removals	1,120.7	1,134.7	1,144.3	1,128.9	1,184.3	1,243.5	1,351.8	1,357.5	1,306.6	1,328.4	1,336.2	1,301.4	1,330.0	1,339.1
ABS	1,253.8	1,256.7	1,282.3	1,276.6	1,341.1	1,410.1	1,351.8	1,357.5	1,306.6	1,328.4	1,336.2	1,301.4	1,330.0	1,339.1
Emissions	1,187.2	1,195.7	1,213.3	1,202.8	1,262.7	1,326.8	1,351.8	1,357.5	1,306.6	1,328.4	1,336.2	1,301.4	1,330.0	1,339.1

*NE: Not Estimated

[7] It implies “Category” indicated in the *Revised 1996 IPCC Guidelines* and *CRF*.

2.3.1. Energy

Emissions from the Energy sector in FY2003 were 1,199 million tons (in CO_2 equivalents), an increase by 13.3% compared to FY1990, and an increase by 1.1% in comparison with the previous year.

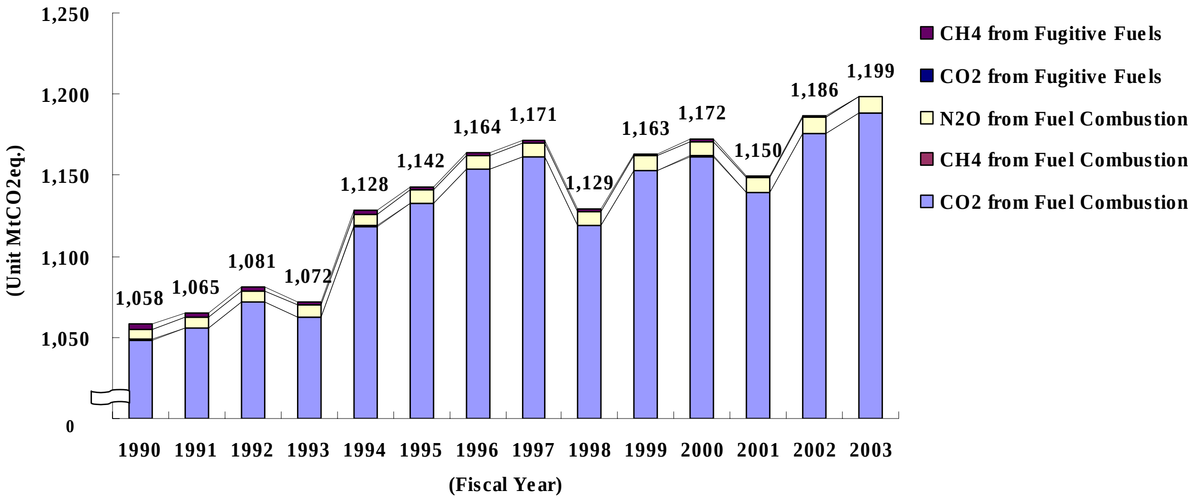

Figure 2-12 Trends in GHGs emissions from the Energy sector

The breakdown of emissions of greenhouse gases from the Energy sector in FY2003 shows that emission of CO_2 accounted for 99%, making it the single largest source of emissions.

Table 2-9 Trends in GHGs emissions from the Energy sector

[Gg CO_2eq.]

Source Category	1990	1995	2000	2002	2003
1A. Fuel Combustion	1,055,082.79	1,140,655.07	1,170,874.83	1,185,642.74	1,198,261.09
CO_2	1,048,332.15	1,132,241.07	1,161,365.77	1,175,509.80	1,188,099.74
CH_4	531.75	547.72	537.25	529.37	526.53
N_2O	6,218.89	7,866.27	8,971.81	9,603.57	9,634.81
1B. Fugitive Emissions from Fuel	3,176.63	1,762.07	1,221.07	604.38	589.83
CO_2	0.51	0.60	0.61	0.64	0.67
CH_4	3,176.12	1,761.47	1,220.46	603.74	589.17
Total	1,058,259.43	1,142,417.14	1,172,095.89	1,186,247.11	1,198,850.92

2.3.2. Industrial Processes

Emissions from the Industrial processes sector in FY2003 were 75.1 million tons (in CO_2 equivalents), an increase by 16.0% compared to FY1990, and a decrease by 3.8% in comparison with the previous year.

It should be noted that emissions of HFCs, PFCs, and sulfur hexafluoride have not been estimated (NE) through 1990 to 1994.

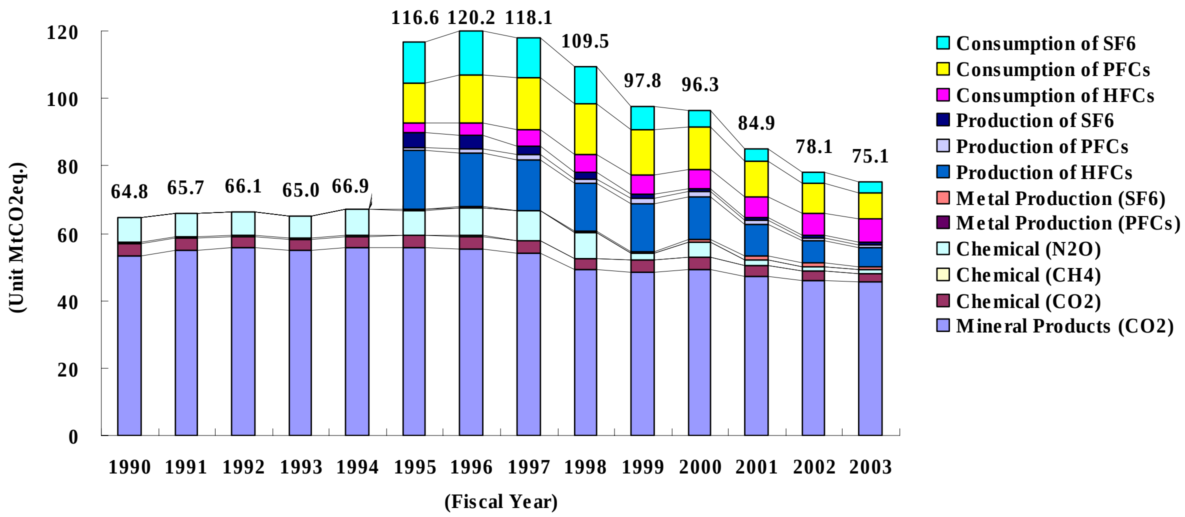

Figure 2-13 Trends in GHGs emissions from the Industrial processes sector

The breakdown of emissions of greenhouse gases from the Industrial processes sector in FY2003 shows that emissions from mineral products, such as CO_2 emissions from the limestone in cement production account for 60%, making it the single largest source of emissions followed by the emissions from the consumption of PFCs such as semiconductor manufacture at 11% and the consumption of HFCs at 9%.

Table 2-10 Trends in GHGs emissions in the Industrial processes sector

[Gg CO_2eq.]

Category	1990	1995	2000	2002	2003
2A. Mineral Products (CO2)	53,465.31	55,588.39	49,403.45	45,791.24	45,368.17
2B. Chemical Industry	11,297.21	11,295.50	7,805.90	4,232.80	3,942.74
CO_2	3,543.66	3,624.90	3,393.87	2,924.87	2,618.21
CH_4	337.80	303.30	163.74	124.34	116.72
N_2O	7,415.74	7,367.31	4,248.29	1,183.59	1,207.81
2C. Metal Production	0.00	191.96	1,045.99	1,138.40	756.00
PFCs	NE	72.46	18.29	15.10	15.10
SF_6	NE	119.50	1,027.70	1,123.30	740.90
2E. Production of F-gas	0.00	22,927.70	14,897.54	8,364.52	7,291.21
HFCs	NE	17,456.50	12,654.54	6,484.42	5,462.21
PFCs	NE	762.90	1,382.60	1,043.60	1,016.40
SF_6	NE	4,708.30	860.40	836.50	812.60
2F. Consumption of F-gas	0.00	26,603.27	23,111.27	18,528.58	17,754.34
HFCs	NE	2,776.17	5,894.43	6,418.73	6,838.62
PFCs	NE	11,737.70	12,284.90	8,786.50	7,995.40
SF_6	NE	12,089.40	4,931.94	3,323.35	2,920.32
Total	64,762.51	116,606.83	96,264.15	78,055.54	75,112.46

2.3.3. Solvent and Other Product Use

Emissions from the Solvents and other product use in FY2003 were 321 thousand tons (of CO_2 equivalents), an increase by 11.8% on FY1990, and a decrease by 4.0% in comparison with the previous year. The only substance included in calculations in this sector is laughing gas (nitrous oxide) used as a general anesthetic in hospitals.

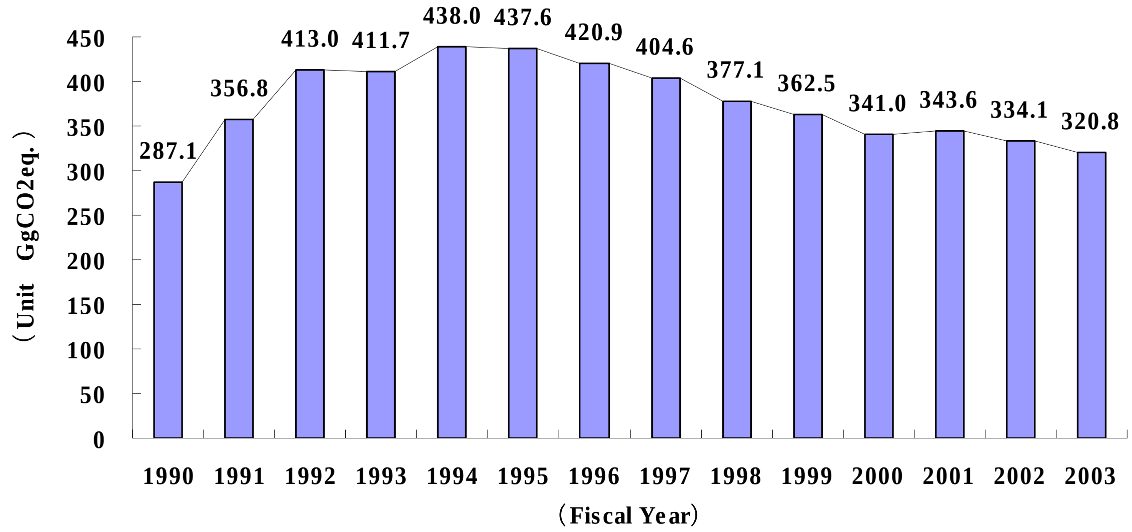

Figure 2-14　　Trends in GHGs emissions from the Solvent and other product use sector

2.3.4. Agriculture

Emissions from the Agriculture in FY2003 were 33.2 million tons (in CO_2 equivalents), a decrease by 14.8% compared to FY1990, and by 0.5% in comparison with the previous year.

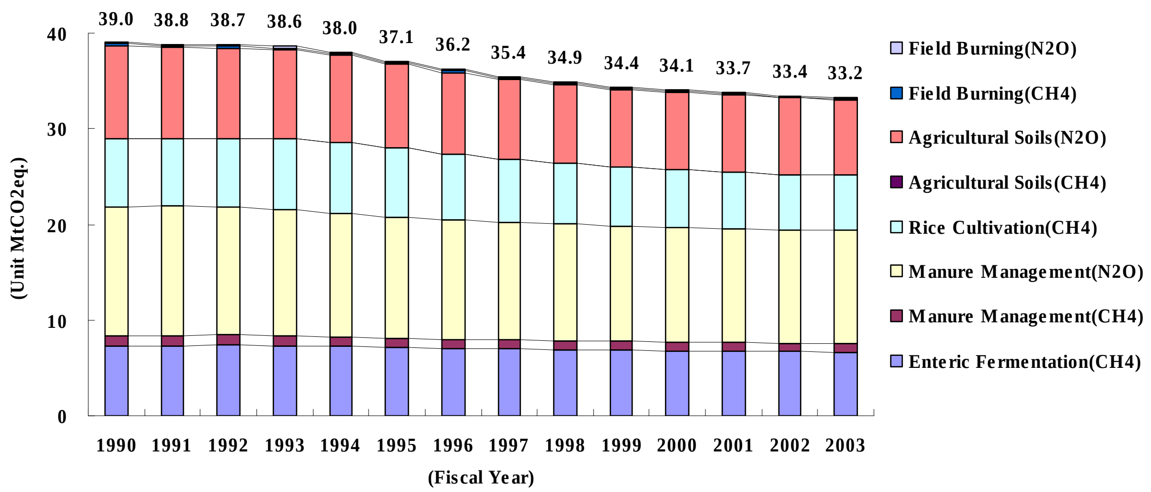

Figure 2-15　　Trends in GHGs emissions from the Agriculture sector

The breakdown of emissions of greenhouse gases from the Agriculture in FY2003 shows that N_2O emissions from manure management account for 36%, making it the single largest source followed by N_2O emissions from agricultural soils due to the nitrogen-based fertilizers at 24%, and CH_4 emissions from enteric fermentation at 20%.

Table 2-11 Trends in GHGs emissions from the Agriculture sector

[Gg CO_2eq.]

Category	1990	1995	2000	2002	2003
4A. Enteric Fermentation(CH4)	7,249.10	7,118.91	6,759.12	6,672.13	6,615.72
4B. Manure Management	14,622.80	13,641.77	12,932.28	12,774.42	12,738.10
CH_4	1,072.55	991.38	927.81	914.99	911.74
N_2O	13,550.26	12,650.39	12,004.47	11,859.43	11,826.36
4C. Rice Cultivation(CH4)	7,075.73	7,200.86	6,018.51	5,788.92	5,785.48
4D. Agricultural Soils	9,749.52	8,800.59	8,146.46	7,980.57	7,906.13
CH_4	3.06	2.72	2.30	2.28	2.29
N_2O	9,746.46	8,797.87	8,144.17	7,978.29	7,903.83
4F. Field Burning of Agricultural Residues	298.35	304.97	232.73	191.87	184.92
CH_4	168.45	164.77	121.94	105.80	102.23
N_2O	129.90	140.19	110.78	86.07	82.68
Total	38,995.50	37,067.09	34,089.10	33,407.91	33,230.35

2.3.5. Land Use, Land Use Change and Forestry

Net Removals (including CH_4 and N_2O emissions) in the Land Use, Land Use Change and Forestry in fiscal 1995 was 83.3 million tons, an increase by 25.2% on FY1990, and by 6.2% in comparison with the previous year. Emissions and removals since FY1996 have not been estimated (NE) because the data was not prepared.

In 1995, the category "Forest land" was net removal and other land use categories were net emissions.

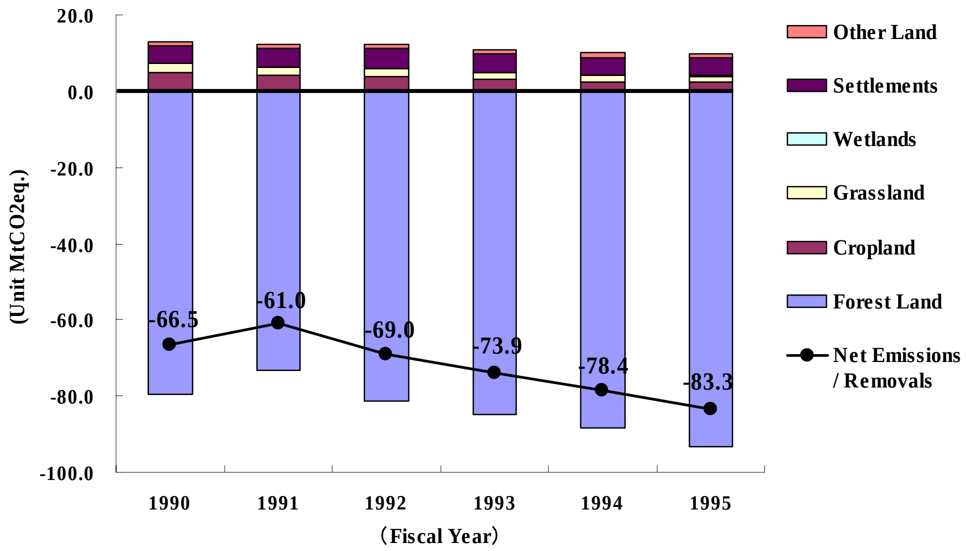

Figure 2-16 Trends in emissions and removals of GHGs from the LULUCF sector

Table 2-12 Trends in emissions and removals of GHGs from the LULUCF sector

[Mt CO2eq.]

	1990	1991	1992	1993	1994	1995
5A Forest Land	-79646.42	-73289.53	-81386.97	-84854.16	-88477.07	-93148.91
5B Cropland	4766.05	3998.15	3869.49	3162.70	2387.20	2298.01
5C Grassland	2473.81	2121.66	2029.53	1752.09	1796.55	1636.14
5D Wetlands	68.11	61.20	151.18	110.72	93.20	231.44
5E. Settlements	4654.18	4865.79	5200.77	4733.42	4631.93	4547.64
5F. Other Land	1141.45	1217.28	1091.54	1235.84	1155.48	1126.81
Total	-66542.82	-61025.46	-69044.45	-73859.39	-78412.72	-83308.87

2.3.6. Waste

Emissions from the Waste in FY2003 were 31.6 million tons (in CO_2 equivalents), an increase by 26.7% compared to FY1990, and a decrease by 1.0% in comparison with the previous year.

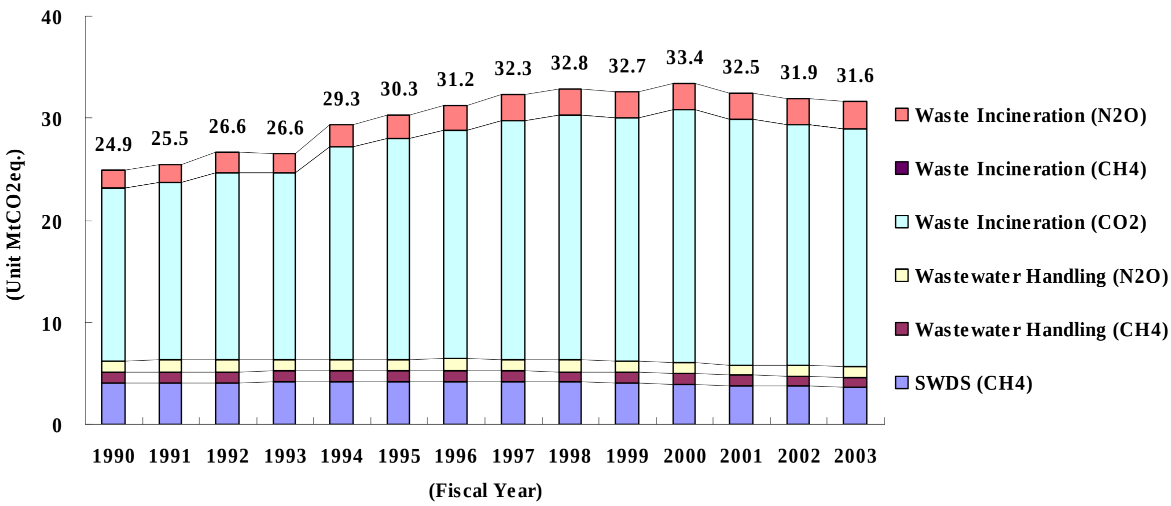

Figure 2-17 Trends in GHGs emissions from the Waste sector

The breakdown of GHGs emissions from the Waste in FY2003 shows that CO_2 emissions from waste derived from petrochemicals such as waste plastics and waste oil incineration, accounting for 74%, making it the single largest source of emissions. It is followed by CH_4 emissions from solid waste disposal sites at 11%, and N_2O emissions from combustion of waste (including waste products derived from substances other than fossil fuels) at 8%.

Table 2-13 Trends in GHGs emissions from the Waste sector

[Gg CO_2eq.]

Category	1990	1995	2000	2002	2003
6A. SWDS (CH_4)	4,044.84	4,238.80	3,927.55	3,720.76	3,594.25
6B. Wastewater Handling	2,193.66	2,122.41	2,080.77	2,045.16	2,026.68
CH_4	1,095.78	1,029.04	1,028.96	1,038.23	1,029.80
N_2O	1,097.88	1,093.37	1,051.81	1,006.93	996.88
6C. Waste Incineration	18,705.24	23,909.66	27,398.63	26,180.16	25,994.45
CO_2	16,935.48	21,627.24	24,794.08	23,536.68	23,339.20
CH_4	13.54	12.59	12.63	10.77	11.23
N_2O	1,756.22	2,269.84	2,591.91	2,632.71	2,644.03
Total	24,943.75	30,270.88	33,406.95	31,946.08	31,615.38

2.4. Description and Interpretation of Emission Trends for Indirect Greenhouse Gases and SO_2

Under UNFCCC, it is required to report emissions of indirect greenhouse gases (NO_X, CO, NMVOC and SO_2), other than 6 types of greenhouse gases (CO_2, CH_4, N_2O, HFCs, PFCs and SF_6) which are not controlled by the Kyoto Protocol. Emission trends of these gases are indicated below.

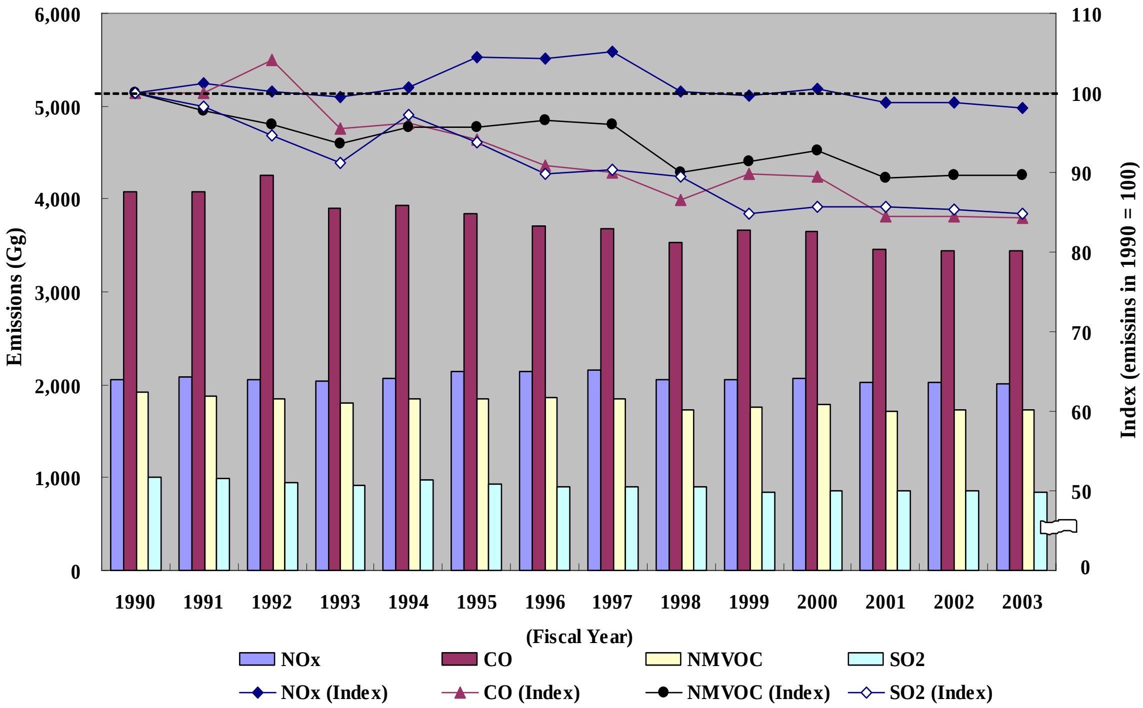

Figure 2-18 Trends in Emissions of Indirect Greenhouse Gases and SO_2

Nitrogen oxide (NO_X) emissions in FY2003 were 2,015 Gg, a decrease by 1.8% compared to FY1990, and by 0.6% compared to the previous year.

Carbon monoxide (CO) emissions inFY2003 were 3,444 Gg, a decrease by 15.7% compared to FY1990, and by 0.2% compared to the previous year.

Non-methane volatile organic compounds (NMVOC) emissions in FY2003 were 1,727 Gg, a decrease by 10.4% compared to FY1990, and an increase by 0.1% compared to the previous year.

Sulfur dioxide (SO_2) emissions inFY2003 were 849 Gg, a decrease by 15.1% compared to FY1990, and by 0.6% compared to the previous year.

Table 2-14 Trends in Emissions of Indirect Greenhouse Gases and SO_2

[Gg]

	1990	1995	2000	2002	2003
NOx	2,053.29	2,144.08	2,063.94	2,027.81	2,015.42
CO	4,086.17	3,848.97	3,653.63	3,450.04	3,444.12
NMVOC	1,926.94	1,842.77	1,787.48	1,726.07	1,727.19
SO_2	1,000.72	938.19	857.09	854.16	849.21

1990年：100

	1990	1995	2000	2002	2003
NOx	100.0	104.4	100.5	98.8	98.2
CO	100.0	94.2	89.4	84.4	84.3
NMVOC	100.0	95.6	92.8	89.6	89.6
SO_2	100.0	93.8	85.6	85.4	84.9

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Economic and Social Research Institute (http://www.esri.cao.go.jp/jp/sna/qe044-2/gdemenujb.html)

Chapter 7. Land Use, Land-Use Change and Forestry (CRF sector5)

7.1. Method of determining land use categories

7.1.1. Basic approach

- Land is classified according to the definitions in existing statistics. Subcategories are determined independently for Forest land and Cropland (Forest land: intensively managed forests / semi-natural forests / cut-over forests and lesser stocked forests / bamboo; Cropland: rice fields / crop fields / orchard).
- In accordance with Approach 1, "Land remaining Land" and "Land converted to Land" in each land use category are determined from existing statistics. When partial areas cannot be directly determined from statistics, these are estimated proportionately or by other means.
- The area of "Other land" which does not belong to any of the other five land use categories, is determined by taking the difference between the total area of national land and the total area belonging to the five land use categories.

7.1.2. Method of determining land use categories and areas

Table 7-1 shows the method of determining land use categories and areas in Japan by means of existing statistics.

Table 7-1 Method of determining land use categories and areas

Land use category	Method of determining land use category	Method of determining area
Forest	Forests under Forest Law Article 2.	Intensively managed forests, semi-natural forests, cut-over forests and lesser stocked forests and bamboo according to *Handbook of Forestry Statistics* by the Forestry Agency.
Cropland	Rice fields, crop fields and orchard.	Rice fields, crop fields and orchard according to *Statistics of Cultivated and Planted Area* by the Ministry of Agriculture, Forestry and Fisheries.
Grassland	Pasture land and grazed meadow land.	Pasture land according to *Statistics of Cultivated and Planted Area* by the Ministry of Agriculture, Forestry and Fisheries, and grazed meadow land according to *World Census of Agriculture and Forestry*, also by the Ministry of Agriculture, Forestry and Fisheries.
Wetlands	Bodies of water (such as dams), rivers, and waterways.	Bodies of water, rivers, and waterways according to *Land Use Status Survey* by the Ministry of Land, Infrastructure and Transport.
Settlements	Urban areas that do not constitute Forest land, Cropland, Grassland or Wetlands. Urban green areas are all wooded and planted areas that do not constitute Forest land.	Roads and residential land identified in *Land Use Status Survey* by the Ministry of Land, Infrastructure and Transport. The included figure for urban green areas is taken from *Urban Parks Status Survey*, also by the Ministry of Land, Infrastructure and Transport.
Other land	Any land that does not belong to the above land use categories.	Determined by subtracting the total area belonging to the other land use categories from the total area of national land according to *Land Use Status Survey* by the Ministry of Land, Infrastructure and Transport.

7.1.3. Survey method and due date of major land area statistics

Survey method and due date of major land area statistics are as below;

Table 7-2 survey method and due date of major land area statistics

Name of the statistics / census	Survey method	Survey due date	Frequency	Presiding ministry
Handbook of Forestry Statistics (Survey on the state of Forest Resources)	Complete count survey	March, 31th	Approximately every 5 years	Ministry of Agriculture, Forestry and Fisheries (Forestry Agency)
Statistics of Cultivated and Planted Area (Survey of cropland area)	Cropland area: Ground measurement survey (sample) Tabular survey (using documents from relevant agency and aerial photograph, etc.)	● 1990-2001 Cropland area: - August, 1st expansion area and converted area of cropland - August, 1st in the previous year - July, 31th ● After 2001 Cropland area: - July, 15th expansion area and converted area of cropland - July, 15th in the previous year - July, 14th	Every year	Ministry of Agriculture, Forestry and Fisheries of Japan,
World Census of Agriculture and Forestry (Survey of Forestry regions)	Complete count survey	August, 1st	Every 10 years	Ministry of Agriculture, Forestry and Fisheries of Japan,
Land Use Status Survey	Complete count survey	March, 31th	Every year	Ministry of Land, Infrastructure and Transport
Urban Parks Status Survey	Complete count survey	March, 31th	Every year	Ministry of Land, Infrastructure and Transport

7.2. Forest land (5.A.)

7.2.1. Forest land remaining Forest land (5.A.1.)

7.2.1.1. Living Biomass (5.A.1.1)

Carbon stock change in living biomass in Forest land remaining Forest land have been calculated, using method in accordance with the *LULUCF-GPG*.

Carbon stock change in living biomass in Forest land remaining Forest land Carbon stock change = Carbon stock increase - Carbon stock decrease = { Carbon stock change due to biomass growth - Carbon stock change due to commercial fellings, shiitake cultivation and fuelwood gathering - Carbon stock change due to fires - Carbon stock change due to other disturbance } * Carbon fraction

7.2.1.1.a. Carbon stock increase

• *Methodology*

The carbon stock change due to tree growth is calculated separately for intensively managed forests (single storied forests: sugi cedar etc.), semi-natural forests (beech, oak etc.), and others (cut-over forests and lesser stocked forests, bamboo), using the Tier 3 method in accordance with the decision tree in *LULUCF-GPG* (p. 3.18). The amounts of growth are determined by adding the above-ground biomass and below-ground biomass, using the biomass expansion factors.

Carbon stock change due to biomass growth rate = forest area * annual biomass growth rate = forest area * annual above-ground biomass growth rate * (1 + root-to-shoot ratio) = forest area * annual volume increment * wood density * biomass expansion factor for above-biomass * (1 + root-to-shoot ratio)

• *Parameters*

- Annual biomass growth rates

The annual biomass growth rates are calculated for each type of forest by multiplying the respective values for the wood density, biomass expansion factors and annual volume increment per hectare.

However, because data for some parameters do not exist in Japan, [biomass expansion factor for above-biomass * (1 + root-to-shoot ratio)] is assumed to be the [biomass expansion factor].

Table 7-3 Annual biomass growth rates by forest type (dm = dry matter)

Item	Unit	1990	1991	1992	1993	1994	1995
Intensively Managed Forests (sugi cedar etc.)	[t dm/ha]	5.03	4.96	4.96	4.96	4.96	4.96
Semi-Natural Forests (beech, oak etc.)	[t dm/ha]	2.05	1.94	1.94	1.94	1.94	1.94
Other	[t dm/ha]	0.00	0.00	0.00	0.00	0.00	0.00

Source: Forestry Agency

Table 7-4 Wood density by forest type (dm = dry matter)

Forest type	Wood density [t dm/m^3]
Intensively Managed Forests (single storied forests: sugi cedar etc.)	0.4
Semi-Natural Forests (beech, oak etc.)	0.6
Others (cut-over forests and lesser stocked forests, bamboo)	0.6

Source: Forestry Agency

Table 7-5 Biomass expansion factors by forest type

Forest type	Biomass expansion factor
Intensively Managed Forests (single storied forests: sugi cedar etc.)	1.7
Semi-Natural Forests (beech, oak etc.)	1.9
Others (Cut-over forests and lesser stocked forests, bamboo)	1.9

Source: Forestry Agency

Table 7-6 Annual increment in volume per unit area (hectare)

Forest type	Annual increment in volume per unit area [m^3/ha]	
	1990	1991 onwards
Intensively Managed Forests (single storied forests: sugi cedar etc.)	7.4	7.3
Semi-Natural Forests (beech, oak etc.)	1.8	1.7
Others (Cut-over forests and lesser stocked forests, bamboo)	0.0	0.0

Source: Based on the Forestry Agency's *Handbook of Forestry Statistics*

-Carbon fraction of dry matter

The default value given in the *LULUCF-GPG* has been adopted as the carbon fraction of dry matter.

Carbon fraction of dry matter
0.5

Source: *LULUCF-GPG, Page 3.25*

• ***Activity Data***

- Determining the total forest area

The forest area and accumulation are obtained by using *Handbook of Forestry Statistics* to find the total forest area for intensively managed forests, semi-natural forests, Cut-over forests and lesser stocked forests and bamboo. No updated figures were available for 1991 to 1994, so these data points are estimated by interpolation.

Table 7-7 Classifications in *Handbook of Forestry Statistics*

Forest type	*Handbook of Forestry Statistics* classifications	Notes
Intensively Managed Forests (single storied forests: sugi cedar etc.)	Forest land: Intensively Managed Forests	–
Semi-Natural Forests (beech, oak etc.)	Forest land: Semi-Natural forests	–
Others (Cut-over forests and lesser stocked forests, bamboo)	Cut-over forests and lesser stocked forests, bamboo	–

- Segregation of "Forest land remaining Forest land" and "Land converted to Forest land"

Forest land remaining Forest land is defined as forest area that has not been converted during the past 20 years, in accordance with *LULUCF-GPG*. The proportion of land that was unconverted over 20 years is determined by adding the annual proportions of land areas that were not converted from forest to other uses in each of the past 20 years, and the corresponding area in each year is estimated by multiplying this proportion by the area of forest land 20 years earlier.

"Land converted to Forest land" is determined by subtracting the unconverted forest area from the total forest area in each year. All of the land that was converted to forest land is assumed to be intensively managed forests.

7.2.1.1.b. Carbon stock decrease

1) Carbon stock change due to commercial fellings, shiitake cultivation and fuelwood gathering

• ***Methodology***

The carbon stock decrease due to commercial fellings, shiitake cultivation and fuelwood gathering is calculated separately for lumber (softwood and hardwood), logs for shiitake mushrooms and fuelwood, using the computation method given in *LULUCF-GPG*. The Tier 3 method is used because it is possible to estimate the logging volumes, timber densities and biomass expansion factors for Japan's own softwood and hardwood forests.

• ***Parameters***

- Wood density and biomass expansion factors

The biomass stock changes due to commercial fellings are calculated by multiplying the wood density and biomass expansion factors determined for softwood or hardwood forests. The values for intensively managed forest are applied for softwood, while the values for natural forest are applied for hardwood, logs for shiitake mushrooms and fuelwood.

Table 7-8 Wood density and biomass expansion factors used in estimating carbon stock decrease

Type		Wood density [t-dm/m^3]	Biomass expansion factor	Note
lumber	hardwood	0.4	1.7	Use values for intensively managed forest
	softwood	0.6	1.9	Use values for semi-natural forest
logs for shiitake mushrooms		0.6	1.9	Use values for semi-natural forest
fuelwood		0.6	1.9	Use values for semi-natural forest

Source: Forestry Agency

-Carbon fraction of dry matter

The default value given in the *LULUCF-GPG* has been adopted as the carbon fraction of dry matter.

Carbon fraction of dry matter
0.5

Source: *LULUCF-GPG, Page 3.25*

- Yield

Yield is assumed to correspond to 79% of standing timber.

• *Activity Data*

The timber supply volume stated in *Handbook of Forestry Statistics* is abated by the yield to determine activity data in cumulative carbon reduction resulting from timber cutting, etc.

2) Carbon stock change due to fires

• *Methodology*

The Tier 3 method given in *LULUCF-GPG* is used to determine the amount of loss due to fires. For national forest land, carbon emissions are calculated from the fire damaged timber volume. To calculate the fire damaged area of private forest land, the fire damaged area of national forest land is subtracted from the total fire damaged area. To determine the carbon emissions due to fire on private forest land, the average timber volume of private forest land is multiplied by the loss ratio, which is determined by calculating the ratio of fire damaged timber volume in national forests to average timber volume in national forests.

Carbon stock change due to fires

Carbon emissions due to national forest fires

= damaged timber volume in national forest * wood density for national forest

* biomass expansion factor for national forest * carbon fraction

Carbon emissions due to private forest fires

= (all area of forest damaged - area of national forest damaged)

* damaged timber volume per area in private forest

* wood density for private forest * loss ratio

* biomass expansion factor for private forest * carbon fraction

• *Parameters*

The values for average timber volume, wood density and biomass expansion factors on national and private forest land are determined as weighted averages using the ratios of intensively managed forest and semi-natural forests.

Table 7-9 Wood density and biomass expansion factors for national and private forest

Type	Wood density [t-dm/m^3]	Biomass expansion factor
National forest	0.53	1.83
Private forest	0.51	1.81

Source: Based on Forestry Agency data

Table 7-10 Average timber volume for national and private forest

Type	Unit	1990	1991	1992	1993	1994	1995
National forest	[m^3/ha]	119.02	120.57	122.13	123.69	125.24	126.80
Private forest	[m^3/ha]	136.86	140.47	144.08	147.69	151.30	154.91

Source: Based on the Forestry Agency's *Handbook of Forestry Statistics*

- Loss ratio

This is calculated from the ratio of fire damaged timber volume in national forests to average timber volume in national forests from 1990 until the most recent year.

• *Activity Data*

This is based on figures from *Handbook of Forestry Statistics* for the annual combustion loss area and damage to standing timber due to fire (area and timber volume) in national forests.

3) Carbon stock change due to other disturbance

• ***Methodology***

The Tier 3 method given in *LULUCF-GPG* is used to determine the amount of losses from damage due to disturbances other than fire. For national forest, carbon emissions are calculated from the volume of timber damaged by disturbances other than fire. After determining the area of disturbances other than fire on private forest, the average timber volume of private forest is multiplied by the loss ratio, which is determined by calculating the ratio of timber volume damaged by disturbances other than fire in national forests to average timber volume in national forests, in order to obtain the carbon emissions from disturbances other than fire.

• ***Parameters***

The values used for average timber volume, wood density and biomass expansion factors on national and private forest are the same as those indicated in “ 2) Carbon stock change due to fires”, which describes changes in biomass due to fire. The loss ratio is calculated from the ratio of timber volume damaged by disturbances other than fire in national forests to average timber volume in national forests from 1990 until the most recent year.

• ***Activity Data***

With regard to national forests, the figures given in *Handbook of Forestry Statistics* are used for standing timber that is damaged by causes other than fire each year on national forest. With regard to private forests, the figures stated in the same reference are used for the area damaged by weather-related disasters or legally recognized forest diseases and pests, etc. each year. It is not possible to directly identify the timber volume damaged by such causes except for pine weevil damage, so the damaged timber volume is calculated by multiplying the average timber volume of private forests by the loss ratio, which is based on the situation of damage in national forests.

7.2.1.2. Dead Organic Matter (5.A.1.2)

• ***Methodology***

For dead wood, Tier 1 method given in *LULUCF-GPG* (Page 3.18) is used and carbon stock change is reported as “0”.

For litter, Tier 1 method given in *LULUCF-GPG* (Page 3.18) is used and carbon stock change is reported as “0”.

7.2.1.3. Soil (5.A.1-)

7.2.1.3.a. Carbon stock change in mineral soils

- ***Methodology***

Tier 1 method given in *LULUCF-GPG* (Page 3.18) is used and carbon stock change is reported as "0" because carbon stock data reflected the effects of forest type, management intensity and disturbance regime is not available.

7.2.1.3.b. Carbon stock change in organic soils

- ***Methodology***

Carbon stock change in organic soils is reported as "NO" because default value of drained soils area is not given in *LULUCF-GPG* and it is assumed that these soils are not found in Japan.

7.2.2. Land converted Forest land (5.A.2)

7.2.2.1. Living Biomass (5.A.2.-)

Carbon stock change in living biomass in Land converted to Forest land is calculated, using Tier 2 method in accordance with the *LULUCF-GPG*.

Carbon stock change in living biomass in Land converted to Forest land Carbon stock change = {Carbon stock change due to biomass growth - Carbon stock change due to land conversion - Carbon stock change due to fellings, fuelwood gathering and disturbance} * Carbon fraction

7.2.2.1.a. Carbon stock change due to biomass growth

- ***Methodology***

Change in biomass is determined by multiplying the area which has been converted to forests within 20 years by the amount of growth in intensively managed forests.

Carbon stock change in living biomass in Land converted to Forest land Carbon stock change due to biomass growth = area which has been converted to forest * biomass growth rates

- ***Parameters***

The annual biomass growth rates for softwood and hardwood trees are used, since the proportions of softwood and hardwood tree planting are unknown. The carbon fraction is set at 0.50.

Table 7-11 Annual biomass growth rate by forest type (dm = dry matter)

Item	Unit	1990	1991	1992	1993	1994	1995
Single Storied Forests (sugi cedar etc.)	[t dm/ha]	5.03	4.96	4.96	4.96	4.96	4.96
Semi-Natural Forests (beech, oak etc.)	[t dm/ha]	2.05	1.94	1.94	1.94	1.94	1.94
Other	[t dm/ha]	0.00	0.00	0.00	0.00	0.00	0.00

Source: Forestry Agency

• ***Activity Data***

As stated in 7.2.1.1.a., the total area of "Land converted to Forest land" is derived by taking the difference between the annual area of "Forest land remaining Forest land" (based on the total forest area according to *Handbook of Forestry Statistics* and the area of reduction in forests according to *World Census of Agriculture and Forestry 2000* and the total forest area.

7.2.2.1.b. Carbon stock change due to land conversion

• ***Methodology***

Carbon stock change due to land conversion has been calculated as below, using method in accordance with the *LULUCF-GPG*.

Carbon stock change due to land conversion
Carbon stock change
= Carbon stocks after conversion - Carbon stocks before conversion

• ***Parameters***

Carbon stock after and before conversion is set as below.

Table 7-12 Biomass stock data for each land use category

Land use category			Biomass stocks [t-dm/ha]	Note
After conversion	Forest		0.00	Assume that biomass stocks immediately after conversion are "0".
Before conversion	Cropland	rice field	6.31	Use annual growth rate value given in Naoto Owa "*Nutrient Balance in Japan's Crops*".
		crop field	3.30	Use annual growth rate value given in Naoto Owa "*Nutrient Balance in Japan's Crops*".
		orchard	30.63	Calculate by multiplying average age and growth rate which are given in Daiyu Ito *et al* "*Estimating the Annual Carbon Balance in Warm-Temperature Deciduous Orchards in Japan*"
	Grassland		2.7	*LULUCF-GPG* Table 3.4.2 warm temperate wet
	Wetlands, Settlements and Other land		0.0	Assume that biomass stocks are "0".

• ***Activity Data***

As stated in 7.2.1.1.a., the total area of “Land converted to Forest land” is derived by taking the difference between the annual area of “Forest land remaining Forest land” (based on the total forest area according to *Handbook of Forestry Statistics* and the area of reduction in forests according to *World Census of Agriculture and Forestry 2000* and the total forest land area.

The area of Forest land converted from Cropland and Grassland is determined by using the area of formerly cultivated land which is planted in forests according to *Statistics of Cultivated and Planted Area*. In this reference, the area is only broken down into rice fields and other fields. Therefore, with regard to the area of fields other than rice fields which are planted in forests, the existing area ratios of crop fields, orchards, and pasture land are used to estimate the area of land converted to forests from each of these land uses.

The difference between the total area of Land converted to Forest land and the area converted from Cropland and Grassland to Forest land is considered to be the area converted from Wetlands, Settlements, and Other land, and this is recorded as a combined figure.

7.2.2.1.c. Carbon stock change due to fellings, fuelwood gathering and disturbance

Carbon stock change due to fellings, fuelwood gathering and disturbance have been included in “Forest land remaining Forest land”. Therefore, it is reported as “IE”.

7.2.2.2. Dead Organic Matter (5.A.2.-)

• ***Methodology and the Results***

For dead wood, Tier 1 method given in *LULUCF-GPG* (Page 3.18) is used and carbon stock change has been reported as “0”.

For litter, Tier 1 method given in *LULUCF-GPG* (Page 3.18) is used and carbon stock change has been reported as “0”.

7.2.2.3. Soils (5.A.2.-)

7.2.2.3.a. Carbon stock change in mineral soils

• ***Methodology***

Tier 1 method given in *LULUCF-GPG* (Page 3.18) is used because carbon stock data reflected the effects of forest type, management intensity and disturbance regime is not available.

Carbon stock change in mineral soils
Carbon stock change
= {Carbon stocks in forest mineral soils per area
- Carbon stocks in mineral soils per area (before conversion)}
* afforest land area / transition duration
Note:
Annual carbon stock change = cumulative carbon stocks for 20 years after conversion

• ***Parameters***

Parameters used in estimation are as bellows. Soil organic carbon in forests is applied to average soil carbon stocks at 30cm depth. Soil organic carbon in other lands is applied to the value for volcanic soil given in *LULUCF-GPG*.

Table 7-13 Soil carbon stocks

Category	Values used	Note
Forest land	90 (t-C/ha)	Value of soil carbon stocks at 30cm depth. Kazuhito Mosisada, Kenji Ono, Hidesato Kanomata "*Organic carbon stock in forest soil in Japan*" Geoderma 119 (2004) p.21-32
Rice field	1990~1993: 39.08 (t-C/ha) 1994~2003: 43.19 (t-C/ha)	Value of soil carbon stocks at 15cm depth. Makoto Nakai, "Carbon accumulation in soils due to soil management" Association for Advancement of Agricultural Science "Survey on method for quantification of amount of GHG emission cuts (2000)" Note: Because forest soil and soil depth taken as samples are not the same, Japan will consider using the values interchangeably.
Crop field	1990~1993: 49.15 (t-C/ha) 1994~2003: 51.83 (t-C/ha)	
Orchard	1990~1993: 42.90 (t-C/ha) 1994~2003: 55.15 (t-C/ha)	
Cropland (average)	1990~1993: 43.71 (t-C/ha) 1994~2003: 50.06 (t-C/ha)	
Pasture	1990~1993: 44.70 (t-C/ha) 1994~2003: 41.37 (t-C/ha)	
Wetlands	88.0(t-C/ha)	*LULUCF-GPG*, Page 3.76, table 3.3.3 warm temperate moist, wetland soil
Settlements	-	-
Other land	80.0(t-C/ha)	*LULUCF-GPG*, Page 3.76, table 3.3.3 warm temperate moist, volcanic soils

- Transition duration

Default value (20 years) given in *LULUCF-GPG* is used. It is assumed that soil organic carbon before 20 years is same as values for 1990.

• ***Activity Data***

The total converted area which is used to calculate biomass, along with the integrated values of the area converted to Forest land from rice fields, crop fields, orchards and Grassland, respectively, is considered to represent the area of land converted to forests over the past 20 years. The difference between the total converted area and the area converted from rice fields, crop fields, orchards, and Grasslands is considered to be the area converted from Wetlands, Settlements, and Other land (It is assumed that no land subject to new forest planting during the past 20 years has been converted to another use).

7.2.2.3.b. Carbon stock change in organic soils

• ***Methodology***

Same methodology as "Forest land remaining Forest land" is used.

7.3. Cropland (5.B)

7.3.1. Cropland remaining cropland (5.B.1)

7.3.1.1. Living biomass (5.B.1.-)

• ***Methodology***

The amount of change in biomass in perennial tree crops (fruit trees) is subject to calculation under *LULUCF-GPG*. However, in Japan, tree growth is limited by trimming trees for low height and high production, and managed by pruning lateral branches and improving tree shape. Therefore, carbon accumulation due to growth is not anticipated, and the annual carbon fixing volume of perennial tree crops in all orchards is stated as "NA."

7.3.1.2. Dead Organic matter (5.B.1.-)

Method is not given in *LULUCF-GPG*, although estimates input cell is found in CRF. Therefore, carbon stock change in dead organic matter is reported as "NE".

7.3.1.3. Soils (5.B.1.-)

• ***Methodology***

According to Tier 1 method given in *LULUCF-GPG,* carbon stock change in soils is reported as "0" because it is assumed that soil carbon stocks do not change due to agricultural management system.

7.3.2. Land converted to Cropland (5.B.2)

7.3.2.1. Living Biomass (5.B.2.-)

• ***Methodology***

According to *LULUCF-GPG* (page 3.84), only above-ground biomass is subject to calculation. The Tier 2 method is used for Forest land converted to Cropland. The Tier 1 method is used for other uses than Forest land converted to Cropland, using the provisional and default values for the amount of biomass accumulation.

$\Delta C_i = A_i(CR_a - CR_{b,i}) * CF$
σC_i : annual change in biomass from conversion to Cropland from initial land use type *i* [t-C/yr]
(*i* refers to Forest, Grassland, Wetlands, Settlements or Other land)
A_i: area of land converted annually to Cropland from land use type *i* [ha/yr]
CR_a: carbon reserves immediately following conversion to Cropland [t-dm/ha], default＝0
$CR_{b,i}$: carbon reserves in land use type *i* immediately before conversion to Cropland [t-dm/ha]
CF: carbon fraction[C/dm], default＝0.5
$CS_f = A_f * CR_f * CF$
CS_f : carbon stock in final cropland of type *f* in the year after conversion [t-C]
A_f: area of lands converted to final cropland type *f* [ha],the sum of all A_f equals A*i*
CR_f: above and belowground carbon accumulation rate of crops of type *f* [t-dm./ha/yr]
$CO_2 = (\Sigma\Delta C_i + \Sigma\Delta CS_f) * 44 / 12$

• *Parameters*

The following parameters are used to estimate changes in the biomass stock due to conversion and changes in stock due to biomass growth in converted land.

- Biomass stock immediately after conversion (CRa)
  - ✧ Content: Dry weight of biomass accumulated on one hectare of land immediately after conversion to Cropland.
  - ✧ Source: 0 [t-dm/ha] (default value stated in *LULUCF-GPG*)
- Biomass stock before conversion (CRb)
  - ✧ Content: Dry weight of biomass accumulated on one hectare of land before conversion to Cropland.
  - ✧ Sources:

    Forest: Calculated on the basis of “*World Census of Agriculture and Forestry*” by the Ministry of Agriculture, Forestry and Fisheries, and “*Handbook of Forestry Statistics*” by the Forestry Agency.

    Pasture land: 2.7 [t-dm/ha] (default value stated in *LULUCF-GPG*)

    Land other than forest and pasture: 0 [t_dm/ha] (assumed value)
- Biomass stock after conversion (CRf)
  - ✧ Content: Dry weight of biomass accumulated in one year on one hectare of Cropland after conversion, for each type of crop (f).
  - ✧ Sources:

    Annual crop production:

    Dry weight of above-ground portions other than harvestry, according to Naoto Owa, "*Nutrient Balance in Japan's Crops*", Environmentally Friendly Agricultural Research Association News, No. 33.

    Perennial tree crops (orchards):

Daiyu Ito, "*Estimating the Annual Carbon Balance in Warm-Temperature Deciduous Orchards in Japan*", Fruit Tree Experiment Station Report, No. 34, Supplement.

- Carbon ratio (CF)
  - ✧ Source: 0.5 (default value stated in *LULUCF-GPG*)

• *Activity Data*

For land that is converted to Cropland, the expansion area values stated in *Statistics of Cultivated and Planted Area* are used. Forest land that has been converted to Cropland is determined using *World Census of Agriculture and Forestry* and statistics based on Forestry Agency records. The respective converted areas are divided proportionately into rice fields, crop fields, orchards, and pasture land according to the current area ratios. The rice fields, crop fields, and orchards are allocated as Cropland, and the pasture land is allocated as Grassland.

7.3.2.2. Dead organic Matter (5.B.2.-)

Method is not given in *LULUCF-GPG*, although estimates input cell is found in CRF. Therefore, carbon stock change in dead organic matter is reported as “NE”.

7.3.3. Soils (5.B.2.-)

• *Methodology*

The Tier 2 method is used in calculation. Japan is not considered to have any soil that constitutes organic soil under *LULUCF-GPG*, so all soil is calculated as mineral soil.

$$\Delta SC = (SCc(t) - SCo(t-20)) / 20 * A$$

ΔSC : Change in soil carbon stock in Land converted to Cropland [t-C/yr]
SCc(t) : Soil carbon stocks per area at time (t) [t-C/ha]
SCo(t-20) : Soil carbon stocks per area before (t-20) years (before conversion) [t-C/ha]
A : Area of Land converted to Cropland over past 20 years [ha]

• *Parameters*

- Soil carbon stock (SC(t))

Data listed in Table 7-13 are applied. Soil carbon stocks before 20 years is applied values for 1990.

• *Activity Data*

The area of land that was converted to Cropland during the past 20 years is determined by subtracting the estimated area that was not converted during the past 20 years from the total area of Cropland in those years. In addition, the values of converted area in each land use category during each of the past 20 years are added up to estimate the converted area over 20 years for each land use category.

7.4. Grassland (5.C)

7.4.1. Grassland remaining grassland (5.C.1)

7.4.1.1.a. Living biomass (5.C.1.-)

• ***Methodology***

According to Tier 1, carbon stock change in living biomass is reported as “0”.

7.4.1.1.b. Dead Organic Matter (5.C.1.-)

• ***Methodology***

Method is not given in *LULUCF-GPG*, although estimates input cell is found in CRF. Therefore, carbon stock change in dead organic matter is reported as “NE”.

7.4.1.1.c. Soils (5.C.1.-)

• ***Methodology***

According to Tier 1 method given in *LULUCF-GPG*, carbon stock change in soils is reported as “0” because it is assumed that soil carbon stocks have not change due to management system during past 20 years.

7.4.2. Land converted to Grassland (5.C.2)

7.4.2.1. Living biomass (5.C.2.-)

• ***Methodology***

The Tier 2 method is used for Forest land and Cropland (rice fields) converted to pasture lands. The Tier 1 method is used for other uses than Forest land and Cropland (rice fields) converted to pasture lands.

$\Delta C_i = A_i(CR_a - CR_{b,i}) * CF$
σC_i : annual change in biomass from conversion to Grassland from initial land use type i [tC/yr]
(i refers to Forest, Grassland, Wetlands, Settlements or Other land)
A_i : area of land converted annually to grassland from land use type i [ha/yr]
CR_a : carbon reserves immediately following conversion to grassland [t-dm/ha], default＝0
$CR_{b,i}$:carbon reserves in land use type i immediately before conversion to grassland [t-dm/ha]
CF : carbon fraction[C/dm], default＝0.5
$CS_f = A_f * CR_f * CF$
CS_f: carbon stock in final grassland of type f in the year after conversion [tC]
A_f : area of lands converted to final grassland type f [ha],the sum of all A_f equals A_i
CR_f : above and belowground carbon accumulation rate [t-dm/ha/yr]
$CO_2 = (\Sigma\Delta C_i + \Sigma\Delta CS_f) * 44 / 12$

• ***Parameters***

The following parameters are used to estimate changes in the biomass stock due to conversion and changes in stock due to biomass growth in converted land.

- Biomass stock immediately after conversion (CRa)
  - ✧ Content: Dry weight of biomass accumulated on one hectare of land immediately after conversion to Grassland.
  - ✧ Source: 0 [t-dm/ha] (default value stated in *LULUCF-GPG*)
- Biomass stock before conversion (CRb)
  - ✧ Content: Dry weight of biomass accumulated on one hectare of land before conversion to Grassland.
  - ✧ Sources:

    Forest: Calculated on the basis of "*World Census of Agriculture and Forestry*" by the Ministry of Agriculture, Forestry and Fisheries, and "*Handbook of Forestry Statistics*" by the Forestry Agency.

    Rice fields: 6.31 [t-dm/ha]

    Crop fields: 3.30 [t-dm/ha] Use annual growth rate value given in Naoto Owa "*Nutrient Balance in Japan's Crops*".

    Orchard: 30.63 [t-dm/ha] Calculate by multiplying average age and growth rate which are given in Daiyu Ito *et al* "*Estimating the Annual Carbon Balance in Warm-Temperature Deciduous Orchards in Japan*"

    Land other than Forest, rice fields, crop fields and orchard: 0 [t-dm/ha] (assumed value)
- Biomass stock after conversion (CRf)
  - ✧ Content: Dry weight of biomass accumulated in one year on one hectare of Grassland after conversion, for each type of crop (f).

- ✧ Sources:
  13.5[t-dm/ha] (default value stated in *LULUCF-GPG*)

- Carbon ratio (CF)
  - ✧ Source: 0.5 (default value stated in *LULUCF-GPG*)

• *Activity Data*

The land that has been converted to pasture land is determined using the field expansion areas stated in *Statistics of Cultivated and Planted Area*. With regard to the land that has been converted from Forest land to Grassland, the area converted to Cropland (determined using *World Census of Agriculture and Forestry* and statistics based on Forestry Agency records) is divided proportionately into rice fields, crop fields, orchards and pasture land according to the area ratios, and the pasture land is allocated as Grassland.

7.4.2.2. Dead Organic Matter (5.C.2.-)

Method is not given in *LULUCF-GPG*, although estimates input cell is found in CRF. Therefore, carbon stock change in dead organic matter is reported as “NE”.

7.4.2.3. Soil (5.C.2.-)

• *Methodology*

The Tier 2 computation method is used. Japan is not considered to have any soil that constitutes organic soil under *LULUCF-GPG*, so all soil is calculated as mineral soil.

$$\Delta SC = (SCc(t) - SCo(t-20)) / 20 * A$$

ΔSC : Change in soil carbon stock in Land converted to pasture land [t-C/yr]
SCc(t) : Soil carbon stocks per area at time (t) [t-C/ha]
SCo(t-20) : Soil carbon stocks per area before (t-20) years (before conversion) [t-C/ha]
A : Area of land converted to pasture land over past 20 years [ha]

• *Parameters*

- Soil carbon content (Sc(t))

The soil carbon content stated in Table 7-13 is used. The 1990 values are used for the values of 20 years ago. For conversion to Grassland in conjunction with restoration, the same values as carbon content in Grassland are used.

• *Activity Data*

The area of land that was converted to Grassland during the past 20 years is determined by subtracting the estimated area that was not converted during the past 20 years from the total area of grassland in those years. In addition, the values of converted area in each land use category during each of the past 20 years are added up to estimate the converted area over 20 years for each land use category.

7.5. Wetlands (5.D)

7.5.1. Wetlands remaining wetlands (5.D.1)

7.5.1.1. Organic Soils Managed for Peat Extraction (5.D.1.-)

- ***Methodology***

It is assumed that there is virtually no activity that equates to peat extraction. Therefore, carbon stock change in organic soils managed for peat extraction is reported as "NO".

7.5.1.2. Flooded land remaining Flooded land (5.D.1.-)

- ***Methodology***

Tier 1 method is used.

$E(CO_2)tot = (Pf*Ef(CO_2)diff*A) + (Pi*Ei(CO_2)diff*A)$

$E(CH_4)tot$

$=(Pf*Ef(CH_4)diff*A)+(Pi*Ei(CH_4)diff*A)+(Pf*Ef(CH_4)b*A)+(Pi*Ei(CH_4)b*A)$

$E(N_2O)tot = (Pf*Ef(N_2O)diff*A) + (Pi*Ei(N_2O)diff*A)$

E(GHG)tot : GHG emissions from reservoirs per year [Gg-GHG/yr]
Pf : ice-free period [days]
Pi : period with ice cover [days]
Ef(GHG)diff : averaged daily diffusive emissions from airwater-interface during the ice-free period [Gg-GHG/ha/day]
Ei(GHG)diff : averaged daily diffusive emissions from airwater-interface during the ice-cover period [Gg-GHG/ha/day]
Ef(GHG)b : averaged bubbles emissions from air water-interface during the ice-free period [Gg-GHG/ha/day]
Ei(GHG)b : averaged bubbles emissions from air water-interface during the ice-free period [Gg-GHG/ha/day]
A : reservoir area [ha]

- ***Parameters***

- Periods of frozen and non-frozen bodies of water (Pf, Pi)
  - ✧ Content: Pf indicates the time period when the surfaces of reservoirs are not frozen over, and Pi indicates the time period when they are frozen over.
  - ✧ Source: Months in which the average temperature is below freezing in the respective prefecture, according to "*Japanese Climate Tables*" by the Japan Meteorological Agency, are assumed to be periods when the surfaces of

reservoirs are frozen over.

- Emission coefficients (Ef(GHG)diff, Ei(GHG)diff, Ef(GHG)b, Ei(GHG)b)
  - ✧ Content:
    Ef(GHG)diff, Ei(GHG)diff:
    Emission coefficients based on dispersion from the surfaces of reservoirs during time periods when the surfaces of reservoirs are frozen over or are not frozen over.
    Ef(GHG)b, Ei(GHG)b:
    Emission coefficients based on bubbles from the surfaces of reservoirs during time periods when the surfaces of reservoirs are frozen over or are not frozen over.
  - ✧ Source: Default values in *LULUCF-GPG*.

• ***Activity Data***

Figures from "*Dam Yearbook*" by the Japan Dam Foundation are used for the submerged area of existing dams in each prefecture.

Note: This category has not been calculated at the present time, as this will be treated in an appendix.

7.5.2. Land converted to Wetlands (5.D.2)

7.5.2.1. Organic Soils Managed for Peat Extraction (5.D.2.-)

• ***Methodology***

It is assumed that there is virtually no activity that equates to peat extraction. Therefore, carbon stock change in organic soils managed for peat extraction is reported as "NO".

7.5.3. Flooded land remaining Flooded land (5.D.2.-)

• ***Methodology***

Changes in biomass stock are calculated for land that has been converted to dams. The Tier 2 method is used, according to the method for biomass stated in "Lands converted to Cropland." No calculations are performed with regard to soil because no relevant method is indicated in *LULUCF-GPG*.

• ***Parameters***

- Amount of biomass accumulation immediately after conversion (GRa)
  - ✧ Content: Dry weight of biomass accumulated on one hectare of dam area immediately after conversion, expressed in t.
  - ✧ Source: 0 [t-dm/ha] (default value stated in *LULUCF-GPG*)

- Amount of biomass accumulation prior to conversion (GRb)
  - ✧ Content: Dry weight of biomass in forest or farmland prior to dam conversion.
  - ✧ Source:

    Forests: Calculated on the basis of "*World Census of Agriculture and Forestry*" by the Ministry of Agriculture, Forestry and Fisheries, and "*Handbook of Forestry Statistics*" by the Forestry Agency.

    Rice fields and crop fields: Calculated on the basis of Naoto Owa, "*Nutrient Balance in Japan's Crops*", Environmentally Friendly Agricultural Research Association News, No. 33.

    Orchards: Calculated on the basis of Daiyu Ito, "*Estimating the Annual Carbon Balance in Warm-Temperature Deciduous Orchards in Japan*", Fruit Tree Experiment Station Report, No. 34, Supplement.

• *Activity Data*

Figures from *Dam Yearbook* by the Japan Dam Foundation on changes over time in the submerged area of existing dams are used to calculate increases in the area of water bodies in each year. Figures on submerged area in *Dam Yearbook* also include dammed areas of natural lakes, so the water body changes which are not due to changes in land use are excluded.

Concerning the area by land use category (Forest land, Cropland, etc.) prior to dam conversion, the ratios of land that was converted to dams from Cropland (and Grassland) or Settlements are estimated according to the numbers of submerged dwellings and area of submerged Cropland in the case of certain large-scale dams. For the area that was converted to dams from Forest land, comparisons are performed with the estimated values from "*World Census of Agriculture and Forestry*" and statistics based on Forestry Agency records. In the case of inconsistencies, for example if the area of Forest land converted in that year is larger than the total area converted to dams, priority is given to the value for the area of converted Forest land, and discrepancies are adjusted within the scope of the cumulative total dam conversion area since 1990 (because the year of dam completion is not necessarily the same as the actual time of conversion).

As for the other categories, the area of converted Cropland is divided proportionately into Cropland and Grassland according to the current area ratios of land use categories. After deducting the areas converted from Forest land, Cropland, Grassland, and Settlements from the total dam conversion area, the remainder is considered to be the area converted from other land use categories.

7.6. Settlements (5.E)

7.6.1. Settlements remaining Settlements (5.E.1)

• *Methodology*

The amount of change in the carbon stock of trees in urban parks and greenery conservation zones, etc. is calculated using the Tier 1a method. At the present time, there is no data available for loss calculations or to distinguish between ages of more than 20 years and less than 20 years, so this was not calculated.

Carbon stock change in living biomass in Settlements remaining Settlements

$\Delta CSSLB = \Delta CSSG - \Delta CSSL$

ΔC_{SSLB} : Changes in carbon stocks in living biomass in Settlements remaining Settlements [t-C/yr]

ΔC_{SSG} : Changes in carbon stocks due to growth in living biomass in Settlements remaining Settlements [t-C/yr]

ΔC_{SSL} : Changes in carbon stocks due to losses in living biomass in Settlements remaining Settlements [t-C/yr]

Carbon stock change
= Crown cover area (less than or equal to 20 years since establishment)
 * growth per crown cover area - losses

• ***Parameters***

- Annual growth rate

The annual growth rate of trees in urban parks and greenery conservation zones, etc. is taken as 2.9 [t-C/ha crown cover/yr], the default value indicated in *LULUCF-GPG* (p. 3.297).

• ***Activity Data***

To determine the amount of activity regarding changes in the amount stored in trees in urban parks and greenery conservation zones, etc., the area of urban parks and greenery conservation zones, etc. as determined by the Ministry of Land, Infrastructure and Transport is multiplied by the forest area rate, which is calculated from the number of trees, park area, and other factors. In greenery conservation zones, etc., the forest area rate is assumed to be 100%.

7.6.2. Land converted to Settlements (5.E.2)

7.6.2.1. Living Biomass (5.E.2.-)

• ***Methodology***

According to *LULUCF-GPG*, only living biomass is addressed in this category and methods associated with dead organic matter and soils are not mentioned. Therefore, only carbon stock change in living biomass is estimated.

• *Parameters*

The following parameters are used to estimate changes in the biomass stock due to conversion.

- Biomass stock immediately after conversion (CRa)
  - ✧ Content: Dry weight of biomass accumulated on one hectare of land immediately after conversion to Settlements.
  - ✧ Source: 0 [t-dm/ha] (default value stated in *LULUCF-GPG*)
- Biomass stock before conversion (CRb)
  - ✧ Content: Dry weight of biomass accumulated on one hectare of land before conversion to Settlements.
  - ✧ Sources:

    Forest: Calculated on the basis of "*World Census of Agriculture and Forestry*" by the Ministry of Agriculture, Forestry and Fisheries, and "*Handbook of Forestry Statistics*" by the Forestry Agency.

    Rice fields: 6.31 [t-dm/ha]

    Crop fields: 3.30 [t-dm/ha] Use annual growth rate value given in Naoto Owa "*Nutrient Balance in Japan's Crops*".

    Orchard: 30.63 [t-dm/ha] Calculate by multiplying average age and growth rate which are given in Daiyu Ito *et al* "*Estimating the Annual Carbon Balance in Warm-Temperature Deciduous Orchards in Japan*"

    Grassland: 2.7 [t-dm/ha] (default value stated in *LULUCF-GPG*, Table 3.4.2)

• *Activity Data*

Only the area converted to Settlements from Forest land and Cropland is determined. Since no data is available on the area converted to Settlements from Wetlands or Other land use categories, no figures are recorded in those land use categories. Instead, they are reported as "IE" and recorded under "Other land remaining Other land."

- Conversion from Forest land

That portion of the area of converted Forest land (estimated according to "*World Census of Agriculture and Forestry*" and statistics based on Forestry Agency records) which has been converted to Settlements is considered to include land for construction or business sites, land for housing and vacation homes, land for golf courses and other leisure purposes, and land for public uses (excluding land converted to dams).

- Conversion from Cropland

For former rice fields, crop fields, and orchards (according to "*Area Statistics for Cultivated and Commercially Planted Land*"), the land converted to factories, roads, housing, and forest roads is used.

- Conversion from Grassland

For former pasture land and grazed meadow land constituting moved or converted Cropland which is converted to Settlements (according to "*Area Statistics for Cultivated* *and Commercially Planted Land*"), the land converted to factories, roads, housing, and forest roads is used.

7.7. Other land (5.F)

7.7.1. Other land remaining Other land (5.F.1)

According to *LULUCF-CRF*, change in carbon stocks and non-CO_2 emissions and removals are not considered for this category.

7.7.1.1. Land converted to Other land (5.F.2)

7.7.1.1.a. Living Biomass (5.F.2.-)

• ***Methodology***

According to the method used in "*Land converted to Cropland*", Tier 2 method is applied.

$\Delta C_i = A_i(CR_a - CR_{b,i})*CF$

ΔC_i : annual change in biomass from conversion to Other land from initial land use type *i* [t-C/yr]

A_i: area of land converted annually to Other land from land use type *i* [ha/yr]

CR_a: carbon reserves immediately following conversion to Other land [t-dm/ha], default＝0

$CR_{b,i}$: carbon reserves in land use type *i* immediately before conversion to Other land [t-dm/ha]

CF: carbon fraction[t-C/t-dm], default＝0.5

• ***Parameters***

The following parameters are used to estimate changes in the biomass stock due to conversion.

- Biomass stock immediately after conversion (CRa)
  - ✧ Content: Dry weight of biomass accumulated on one hectare of land immediately after conversion to Other land.
  - ✧ Source: 0 [t-dm/ha] (default value stated in *LULUCF-GPG*)
- Biomass stock before conversion (CRb)
  - ✧ Content: Dry weight of biomass accumulated on one hectare of land before conversion to Other land.
  - ✧ Sources:

    Forest: Calculated on the basis of "*World Census of Agriculture and Forestry*" by the Ministry of Agriculture, Forestry and Fisheries, and "*Handbook of Forestry Statistics*" by the Forestry Agency.

    Rice fields and crop fields: Use annual growth rate value given in Naoto Owa "*Nutrient Balance in Japan's Crops*".

Grassland: 2.7 [t-dm/ha] (default value stated in *LULUCF-GPG*, Table 3.4.2)

• *Activity Data*

Only the area converted from Forest land and Cropland to other land use categories is determined. Since no data is available on the area converted from Wetland and Settlements to other land use categories, no figures are recorded in those land use categories. Instead, they are reported as "IE" and recorded under "Other land remaining Other land."

- Conversion from Forest land

That portion of the area of converted Forest land (estimated according to “*World Census of Agriculture and Forestry*” and statistics based on Forestry Agency records) which has been used as a source of soil and stone or for other purposes is considered to be the area converted to Settlements.

- Conversion from Cropland

For former rice fields, crop fields, and orchards, the area classified as "other, natural disaster damage" is used according to “*Area Statistics for Cultivated and Commercially Planted Land*”.

- Conversion from Grassland

For former pasture land and grazed meadow land, the area of former pasture land classified as "other, natural disaster damage" (according to “*Area Statistics for Cultivated and Commercially Planted Land*”) and the area of former grazed meadow land which is classified as "other, classification unknown" (“*Moving and Conversion of Cropland*”) are used.

7.7.1.1.b. Soils (5.F.2.-)

• *Methodology*

The Tier 2 method is used, according to the method of "Lands converted to Cropland." Since Japan is not considered to have any soil that constitutes organic soil under *LULUCF-GPG*, all soil is calculated as mineral soil.

• *Parameters*

- Soil carbon content (SC(t))

The values stated in Table 7-13 are used for the soil carbon content before and after conversion. Since *LULUCF-GPG* does not give any default values for soil carbon content with regard to other types of land, the same values as Cropland are used for formerly cultivated land, and the default values for Grassland are used for the other types of land.

• *Activity Data*

The values of converted area in each land use category during each of the past 20 years are added up to estimate the area converted to Other land use during a 20-year period.

7.8. Non-CO_2 gases

7.8.1. Direct N_2O emissions from N fertilization (5.(I))

• ***Methodology***

It is assumed that volume of nitrogen-based fertilizer applied to forest soils is included in demand for nitrogen-based fertilizers in Agriculture sector, although fertilization application in Forest land may not conducted in Japan. Therefore, these sources have been reported as “IE”.

7.8.2. N_2O emissions from drainage of soils (5.(II))

• ***Methodology***

Data on drainage of forest soils and wetlands is not available. Therefore, these sources have been reported as “NE”.

7.8.3. N_2O emissions from disturbance associated with land-use conversion to cropland (5.(III))

• ***Methodology***

According to *LULUCF-GPG*, Tier 1 method is used.

• ***Parameters***

- ✧ N/C ratio for soils: 15 (default value stated in *LULUCF-GPG*, Page 3.94)
- ✧ N-N_2O emission factor for soils: 0.0125 [kg-N_2O-N/kg-N] (default value stated in *LULUCF-GPG*, Page 3.94)

• ***Activity Data***

Area of land converted to Cropland and carbon emissions from soils due to this conversion are used.

7.8.4. Carbon emissions from agricultural lime application (5.(IV))

• ***Methodology***

Data on lime application which is not associated with agricultural activity is not available. Therefore, these sources have been reported as “NE”.

7.8.5. Biomass burning (5.(V))

• ***Methodology***

For CO, CH_4, N_2O, NOx emissions due to fires, Tier 1 method is used.

GHG emissions due to fires
= carbon emissions due to fires * emission ratios (* N/C ratio)

• *Parameters*

The following values are applied to emission ratios for open burning of cleared forests.

CO: 0.06, CH_4: 0.012, N_2O: 0.007, NOx: 0.121
(default value stated in *LULUCF-GPG*, Table 3A.1.15)

• *Activity Data*

For activity in Forest land, the timber volume damaged by forest fire is used. For the remaining five categories, activity is determined based on carbon dioxide emissions in conjunction with conversion from Forest land, on the assumption that a certain proportion is burned.

Chapter 10. Recalculation and Improvements

10.1. Explanation and Justification for Recalculations

This section explains improvements on estimation of emissions and removals in the current inventory (submitted in 2005).

In accordance with the *Good Practice and Uncertainty Management in National Greenhouse Gas Inventories (2000)* (hereafter, *the Good Practice Guidance (2000)*) and the *IPCC Good Practice Guidance for Land Use, Land-Use Change and Forestry* (hereafter, *LULUCF-GPG*), recalculations of previously reported emissions and removals are recommended in the cases of 1) application of new estimation methods, 2) addition of new categories for emissions and removals and 3) data refinement. Major changes in the inventory submitted last year are indicated below.

10.1.1. General

In general, activity data for the latest year available at the time when the inventory is compiled are often revised in the year following the submission year because of such as the publication of data in the fiscal year basis. In the national inventory submitted this year, activity data in many sources for 2002 have been changed and as a result, the emissions from those sources for the inventory year have been recalculated.

10.1.2. Energy sector

10.1.2.1. 1.A. Fuel Combustion (Stationary Combustion): CO_2

Because the values in the energy balance table (*General Energy Statistics*) for fiscal years 1990–2002 that were used as activity data for "1.A. Fuel Combustion (Stationary Combustion): CO_2" were changed, emissions for these years were recalculated.

10.1.2.2. 1.A.3. Fuel Combustion (Mobile Combustion): CH_4 and N_2O

1) "1.A.3.a. Civil Aviation (Aviation gasoline): CH_4 and N_2O"

Previously, Japan had reported emissions for "1.A.3.a. Civil Aviation (Aviation gasoline): CH_4 and N_2O" as "NE" (Negligible) because they are small.

However, because a default values for the emission factors are indicated in the *Revised 1996 IPCC Guidelines* and it is possible to estimate emissions on the basis of activity data from *General Energy Statistics*, emissions are estimated using Tier 1 and reported for the first time.

10.1.2.3. 1.B. Fugitive emissions from fuels

1) Review of notation keys for "1.B.2.b.ii. Natural gas (Distribution): CO_2"

Japan has consumed natural gas and LNG in the production of town gas. However, the CO_2 content of natural gas is low; therefore, only small amounts of CO_2 are thought to be emitted. On this account, emissions for "1.B.2.b.ii. Natural gas (Distribution): CO_2" was reported as "NE" (Negligible).

However, emission factor for CO_2 is 0 according to a report by the Japan Gas Association; therefore, in accordance with the UNFCCC inventory reporting guidelines[1], we now report it as "NA".

10.1.3. Industrial process sector

1) Change in operating rate of N_2O decomposition unit for "2.B.3. Adipic acid production: N_2O"

An N_2O decomposition unit has been operational in Japan since March 1999 at an adipic acid production plant. Therefore, we have established an emission factor for estimating emissions for "2.B.3. Adipic acid production: N_2O" that takes into account "rate of generation of nitrous oxide", "rate of decomposition of nitrous oxide" and "operating rate of decomposition unit". Among these terms, number of hours worked of decomposition unit needs to be obtained in order to calculate "operating rate of decomposition unit". Because it was identified that N_2O decomposition unit shutdowns in 1990, 2000, and 2001 have been overlooked, data was revised for the relevant years.

2) Change in activity data used for calculation of HFCs, PFCs, and SF_6 emissions

Japan uses data provided by the Ministry of Economy, Trade & Industry to estimate emissions of HFCs, PFCs, and SF_6. In the national inventory submitted in 2005, the emission estimates were changed due to change in the activity data (for details, refer to Table 8(b) of CRF-2003-v01-JPN-2005.xls).

• ***General Remarks***

The updated data for 2001-2002 includes several corrections on the error in the data, such as the modification from provisional value to definite report value.

• ***Stationary refrigeration***

The inspection of emissions including estimated data from 1995 onwards were conducted in regard with the improvement in analytical methodologies, such as the refinement of duration periods of machineries.

• ***Solvents and semiconductor manufacturing***

The relevant data from 1995 onwards was updated.

[1] FCCC/SBSTA/2004/8 page 9, footnote 8: Even if emissions are considered to be negligible, Parties should either report the emission estimate if calculated or use the notation key "NE".

• ***Sectors except for the above***

Errors identified during the inspection of relevant data were corrected.

10.1.4. Agricultural sector

1) Recalculation of emissions for 2001 and 2002 associated with revision of data for the latest year

Emissions from the agricultural sector are based on three-year moving averages. In the national inventory submitted in 2005, emissions for 2001 and 2002 were recalculated because of revision of 2002 activity data.

2) "4.B.3., 4.B.4., 4.B.6. Manure management (sheep, goats, horses): N_2O"

Previously, Japan had not established emission factors for "4.B.3., 4.B.4., 4.B.6. Manure management (sheep, goats, horses): N_2O" and "NE" had been reported for this category.

However, a default value for the emission factor is indicated in the *Revised 1996 IPCC Guidelines*, while activity data can be obtained from FAO statistics. Therefore, emissions were estimated using Tier 1 and reported for the first time.

10.1.5. LULUCF sector

1) Recalculation using the LULUCF-GPG

Previously, Japan has not used the LULUCF-GPG for estimation of the emissions and removals of the LULUCF sector.

However, a trial use of the *UNFCCC Reporting Guidelines on Annual Inventories* (FCCC/SBSTA/2004/8) for the submission of inventory in 2005 has been adopted at COP9, which led Japan to recalculate its estimation of the emissions and removals in the LULUCF sector in accordance with the *LULUCF-GPG*.

10.1.6. Waste sector

1) Changes in categories of activity data and activity data for "6.B.1. Industrial Wastewater: CH_4"

Japan uses the volume of water used for treatment of products, by industrial sub-category, and the volume of water used for washing as activity data for "6.B.1. Industrial Wastewater: CH_4". Because industry classifications for industrial statistics were revised due to revision of Japanese Standard industry classifications in 2002, industry type categories of activity data and activity data by industry type were changed.

Table 10-1 Differences in industry type categories of activity data and activity data by industry type

Industry type	industry type category code	1990	1995	2000	2001	2002
Food	12	497.8	529.1	549.0	555.3	555.3
	9	593.0	681.8	583.5	588.1	705.0
Beverages, tobacco, animal feed	13	137.9	142.7	139.0	137.2	137.2
	10	137.9	142.7	139.0	137.2	129.0
Textiles (excluding Apparel, other textile products)	14	159.9	135.7	101.3	101.6	101.6
	11	164.8	138.2	101.8	102.1	89.8
Apparel, other textile products	15	2.2	4.0	2.5	2.3	2.3
	12	2.2	4.0	2.5	2.3	2.1
Pulp & paper/processed paper products	18	1,640.1	1,524.0	1,527.7	1,497.9	1,497.9
	15	1,699.7	1,589.2	1,582.7	1,556.6	1,546.2
Chemicals	20	693.6	645.0	667.2	712.7	712.7
	17	787.5	735.7	751.3	796.0	753.1
Petroleum and coal products	21	3.0	2.2	2.6	2.2	2.2
	18	3.0	2.2	2.6	2.2	1.7
Plastic products (except as noted elsewhere)	22	12.3	11.8	12.4	13.3	13.3
	19	12.3	11.7	12.4	13.3	11.6
Rubber products	23	0.9	0.9	0.6	0.7	0.7
	20	0.9	0.9	0.6	0.7	0.7
Leather tanning/leather products, fur	24	5.9	5.0	3.7	3.3	3.3
	21	5.9	5.0	3.7	3.3	2.8
Total	—	3,153.6	3,000.3	3,005.9	3,026.5	3,026.5
	—	3,407.2	3,311.4	3,180.0	3,201.8	3,242.0

Upper rows (shaded in gray): 2004 inventory values; lower rows: 2005 inventory values

2) Revision of estimation method for N_2O emissions from domestic and commercial wastewater at human-waste treatment plant

For "6.B.2", the N_2O emissions from human waste treatment plants were calculated by multiplying a weighted average of emission factors derived using the treatment capacity of each treatment process, based on *Research on Suppression Measures for Methane and Nitrous Oxide in the Waste Sector* in 1997, by the volume of human waste treated at human waste treatment plants.

However, in recent years, it is expected that the N_2O emissions per unit volume of human waste treated have been decreased since the equipment and maintenance technologies of high-load human waste treatment plants have been improved compared to those investigated in 1997. Therefore, the emission factors for N_2O emissions from these treatment processes were updated based on the results of the latest study on N_2O emissions from high-load denitrification and membrane separation treatment.

Moreover, it is assumed that the accuracy of estimated emissions from human waste treatment plants is higher when the amount of nitrogen treated in these plants is taken into account in an estimation method. Accordingly, the estimation method for relevant categories was changed to calculate the emissions by multiplying the volume of nitrogen treated in human waste treatment plants by emission factors, which is N_2O conversion ratio.

• *Previous estimation method*

The previous estimation equation is as follows.

$$E\ (kg\text{-}N_2O) = A\ (m^3) \times EF\ (kg\text{-}N_2O/m^3)$$

E: emissions, A: activity data (the amount of human waste treated in these plants),

EF: emission factor (N_2O emissions per $1m^3$ of human waste treated in these plants)

For emission factor, a weighted average of emission factors for N_2O emissions for each treatment process, including high load de-nitrification treatment, membrane separation and other treatments, was derived using the treatment capacity of each treatment process.

Activity data were derived from the amount of human waste treated at these plants, given in the Ministry of the Environment's *Waste Treatment in Japan*.

• *New estimation method*

The new estimation equation is as follows.

$$E\ (kg\text{-}N_2O) = A\ (m^3) \times C\ (mg/l) \times EF\ (kg\ N_2O\text{-}N/kg\text{-}N) \times 44 / 28 \times 10^{-3}$$

E: emissions, A: activity data (the amount of human waste treated in these plants),

C: treated nitrogen concentration (the amount of nitrogen contained in 1L of human waste)

EF: emission factor (the amount of nitrogen that becomes N_2O for 1 kg of nitrogen contained in human waste)

The treated nitrogen concentration is based on the weighted average of the amount of nitrogen contained in collected human waste and sewage in sewerage tank derived using the volume of collected human waste and sewage in sewerage tank treated at human waste treatment plants.

For emission factor, a weighted average of emission factors for nitrous oxide emissions for each treatment process, including high load de-nitrification treatment and membrane separation, was derived using the treatment capacity of each treatment process.

Activity data were derived from the volume of human waste treated at these plants (the sum of collected human waste and sewage in sewerage tank), given in the Ministry of the Environment's *Waste Treatment in Japan*.

Previous and new emission factors are as follows.

Table 10-2 Previous and new N_2O emission factors

Treatment method	Previous emission factor [kg-N_2O/m^3]	New emission factor [kg-N_2O-N/kg-N]		
		FY1990–1994	FY1995–2002	FY2003
High-load denitrification	0.45 [a]	0.042 [a]	Interpolated from values for 1994 and 2003	0.0019 [c]
Membrane separation	0.45 [a]	0.042 [a]	Interpolated from values for 1994 and 2003	0.0016 [c]
Others	0.00001 [b]	0.0000029 [b]		

a : Use median value of actual measurements at 13 plants given in Tanaka, Inoue, Osako, Yamada, and Watanabe *B-16(7) Research into Limiting Generation of Methane and Nitrous Oxide from the Waste Sector* FY1997 Global Environment Research Fund Outcome Report

b : Tanaka, Inoue, Matsuzawa, Osako, and Watanabe *B-2(1) Research into Volumes Released from Waste Treatment Plants* FY1994 Global Environment Research Fund Outcome Report

c : Use median value of actual measurements at 13 plants given in Omura, Kawakubo, and Yamada. *Study of Emission Factors for N_2O from High-load Human Waste Management.* Journal of Waste Management, 57 (260).

• *Variance in emissions due to revision of estimation method*

Variance in emissions due to revision of estimation method is shown in the following.

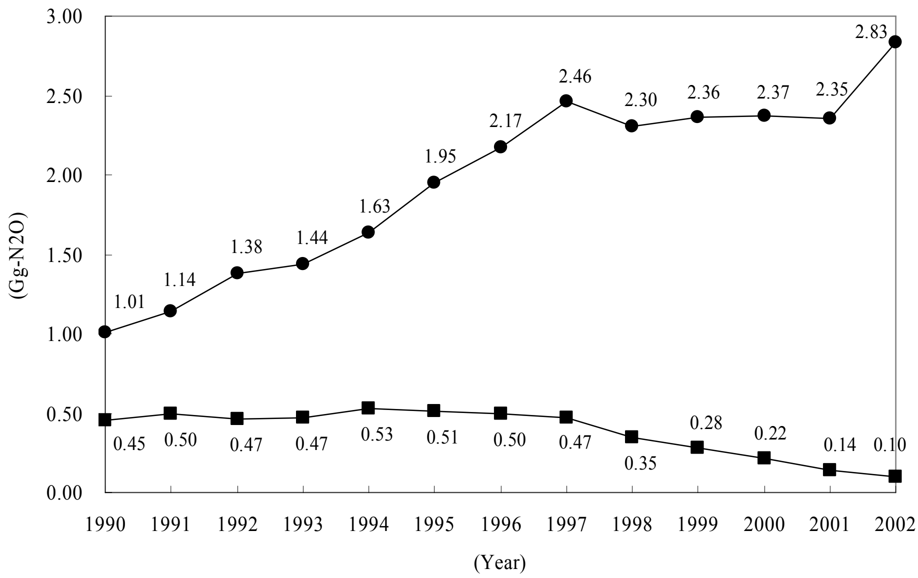

Figure 10-1 Variance in emissions for “6.B.2.- N_2O emissions from domestic and commercial wastewater (human-waste treatment plant)” using previous estimation method (circles) and new one (squares)

Note 1) Pre-revision N_2O emissions tend to be higher because high-load denitrification treatment and membrane separation treatment, which feature high emission factors, are increasingly being used in Japan. In fiscal 1990, these two methods accounted for 7.5% of overall sewage treatment, whereas by fiscal 2002, the proportion had risen to 21.9%.

Note 2) Post revision N_2O emissions tend to be lower because 1) the revision of the emission factor reflects improved technologies in high-load raw sewage treatment plants, 2) the amount of nitrogen contained in raw sewage collected by night soil carriers and in septic tank sludge is tending to decrease, and 3) the amount of septic tank sludge treated at raw sewage treatment plants is increasing compared to the amount of relatively low nitrogen concentration raw sewage.

3) Revision of estimation method for "6.C.- Industrial Waste Incineration (sewage sludge): N_2O"

In Japan, N_2O emission for "6.C. Industrial Waste Incineration (sewage sludge)" has been estimated by multiplying the amount of sewage sludge incinerated by a weighted average of emission factors derived using the amount of sewage sludge incinerated by flocculant type.

Recent research shows that the N_2O emissions can be reduced by applying a high temperature combustion (over 850 degree) in place of the normal temperature combustion (about 800 degree) to sewage sludge incineration. The Kyoto Protocol Target Attainment Plan (2004) lists the improvement of combustion process at sewage sludge incineration facilities as a means of reducing N_2O emissions, by for instance incorporating this means in a design guideline, the use of a high temperature combustion is spreading steadily. By fiscal 2002, the adoption rate had reached 33.4%. However, the effect of N_2O emission suppression using high-temperature combustion technique is not reflected in the current inventory because the N_2O emission for the relevant category was not estimated based on combustion temperature. In view of this situation, it is thought that different N_2O emission factors for sewage sludge incineration should be established for different combustion temperatures.

Therefore, emission factors for the relevant category are established on the basis of flocculant and furnace types rather than applying weighted average. Among these, different emission factors have been established for different combustion temperatures in the case of polymeric flocculant /fluidized bed furnace combination.

• *Previous estimation method*

The previous estimation equation is as follows:

$$E\ (kg\text{-}N_2O) = A\ (t) \times EF\ (kg\text{-}N_2O/t)$$

E: emissions, A: activity data (the amount of sewage sludge incinerated),

EF: emission factor (N_2O emissions per 1tonne of sewage sludge incinerated)

For emission factor, a weighted average of emission factors based on actual measurements of N_2O concentrations for each facility, was derived using the amount of sewage sludge incinerated by flocculant type (High-molecular-weight flocculant / Fluidized bed incinerator, High-molecular-weight flocculant / Multiple hearth, Lime Sludge, and Other).

For activity data, the amount of sewage sludge incinerated by type of flocculant (High-molecular-weight flocculant / Fluidized bed incinerator, High-molecular-weight flocculant / Multiple hearth, Lime Sludge, and Other), given in the Ministry of Land, Infrastructure and Transport have been used.

- ***New estimation method***

The new estimation equation is as follows:

$$E\ (kg\text{-}N_2O) = \Sigma Ai(t) \times EFi\ (kg\text{-}N_2O/t)$$

E: emission mass, A: activity data (the amount of sewage sludge incinerated),

EF: emission factor (N_2O emissions per 1tonne of sewage sludge incinerated)

i: Type of treatment process and combustion temperature (High-molecular-weight flocculant / Fluidized bed incinerator, High-molecular-weight flocculant / Multiple hearth, Lime Sludge, and Other)

For emission factor, a weighted average of emission factors based on actual measurements of N_2O concentrations for each facility, was derived using the amount of sewage sludge incinerated by flocculant type (High-molecular-weight flocculant / Fluidized bed incinerator, High-molecular-weight flocculant / Multiple hearth, Lime Sludge, and Other). Emission factor for “high-molecular-weight flocculant / fluidized bed incinerator” is established according to combustion temperature (high temperature combustion [at about 800 degree] and normal temperature combustion [at about 850 degree]).

The activity data was the same as that used as for the previous estimation method, namely the amount of sewage sludge incinerated by type of flocculant (High-molecular-weight flocculant / Fluidized bed incinerator, High-molecular-weight flocculant / Multiple hearth, Lime Sludge, and Other), given in the Ministry of Land, Infrastructure and Transport have been used. However, as separate emission factors were established based on flocculant types, furnace types, and combustion temperature, subdivided activity data based on flocculant type, furnace type, and combustion temperature were used.

Previous and new emission factors are as follows.

Table 10-3 Previous and new N_2O emission factors

Flocculant type	Furnace type	Combustion temperature	Previous emission factor [g-N_2O/t]	New emission factor [g-N_2O/t]
polymeric	fluidized bed	normal combustion	903	1,508
polymeric	fluidized bed	high combustion	903	645
polymeric	multi-stage	—	903	882
other	—	—	903	882
Lime-based	—	—	903	294

• ***Variance in emissions due to revision of estimation method***

Variance in emissions due to revision of estimation method is shown in the following.

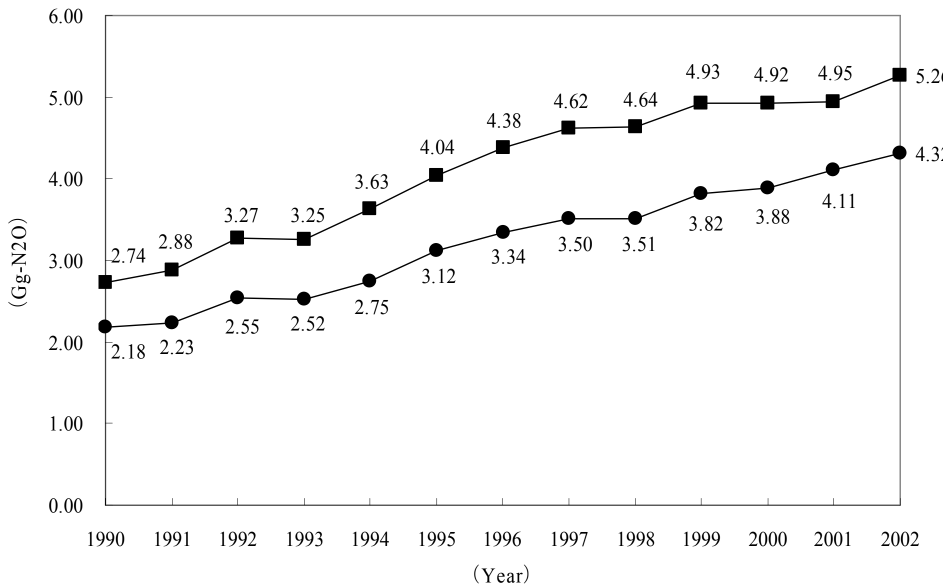

Figure 10-2 Variance in emissions for "6.C. Industrial Waste Incineration (sewage sludge)" using previous estimation method (circles) and new one (squares)

10.2. Implications for Emission Levels

Table 10-4 shows the changes made to the overall emission estimates due to the recalculations indicated in “Section 10.1. Explanation and Justification for Recalculations”.

Total emissions excluding the LULUCF sector in the base year (1990) under the UNFCCC increased by 0.04%, and the total emissions in year 2002 decreased by 0.06% compared to the data reported in last year.

Table 10-4 Difference between the inventories submitted in 2004 and 2005 for emissions (unexpurgated edition)

[Mt CO_2eq.]

		1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
CO_2	JNGI2004[1)]	1,038.4	1,047.5	1,063.3	1,048.6	1,104.6	1,116.4	1,234.8	1,242.0	1,195.2	1,228.4	1,239.0	1,213.8	1,247.6
with LULUCF[3)]	JNGI2005[2)]	1,055.2	1,069.8	1,079.4	1,064.4	1,119.4	1,129.4	1,234.8	1,242.0	1,195.2	1,228.4	1,239.0	1,213.6	1,247.8
	difference	*1.62%*	*2.13%*	*1.51%*	*1.50%*	*1.33%*	*1.17%*	*0.00%*	*0.00%*	*0.00%*	*0.00%*	*0.00%*	*-0.01%*	*0.01%*
CO_2	JNGI2004	1,122.3	1,131.4	1,148.9	1,138.7	1,198.2	1,213.1	1,234.8	1,242.0	1,195.2	1,228.4	1,239.0	1,213.8	1,247.6
without LULUCF	JNGI2005	1,122.3	1,131.4	1,148.9	1,138.7	1,198.2	1,213.1	1,234.8	1,242.0	1,195.2	1,228.4	1,239.0	1,213.6	1,247.8
	difference	*0.00%*	*0.00%*	*0.00%*	*0.00%*	*0.00%*	*0.00%*	*0.00%*	*0.00%*	*0.00%*	*0.00%*	*0.00%*	*-0.01%*	*0.01%*
CH_4	JNGI2004	24.8	24.7	24.5	24.5	24.1	23.4	22.9	22.1	21.5	21.1	20.7	20.2	19.5
	JNGI2005	24.9	24.8	24.7	24.6	24.2	23.5	22.9	22.1	21.5	21.1	20.7	20.2	19.5
	difference	*0.56%*	*0.47%*	*0.50%*	*0.46%*	*0.44%*	*0.44%*	*0.13%*	*0.15%*	*0.15%*	*0.08%*	*0.09%*	*-0.02%*	*-0.11%*
N_2O	JNGI2004	40.2	39.7	40.0	39.7	40.6	40.8	41.7	42.2	40.8	35.1	37.8	35.1	35.4
	JNGI2005	40.6	40.1	40.2	39.9	40.8	40.8	41.5	41.9	40.6	35.1	37.5	34.6	34.7
	difference	*0.98%*	*0.91%*	*0.71%*	*0.60%*	*0.41%*	*0.15%*	*-0.46%*	*-0.63%*	*-0.61%*	*0.01%*	*-0.81%*	*-1.42%*	*-1.99%*
HFCs	JNGI2004	NE	NE	NE	NE	NE	20.2	19.9	19.8	19.3	19.8	18.6	15.9	13.3
	JNGI2005	NE	NE	NE	NE	NE	20.2	19.9	19.8	19.3	19.8	18.5	15.8	12.9
	difference	*NA*	*NA*	*NA*	*NA*	*NA*	*0.02%*	*0.03%*	*0.01%*	*-0.04%*	*-0.09%*	*-0.28%*	*-0.71%*	*-3.19%*
PFCs	JNGI2004	NE	NE	NE	NE	NE	12.6	15.2	16.9	16.5	14.9	13.9	11.7	9.6
	JNGI2005	NE	NE	NE	NE	NE	12.6	15.3	16.9	16.6	14.9	13.7	11.5	9.8
	difference	*NA*	*NA*	*NA*	*NA*	*NA*	*-0.14%*	*0.20%*	*0.01%*	*0.48%*	*0.10%*	*-1.34%*	*-1.72%*	*2.11%*
SF_6	JNGI2004	NE	NE	NE	NE	NE	16.9	17.5	14.8	13.4	9.1	6.8	5.7	5.3
	JNGI2005	NE	NE	NE	NE	NE	16.9	17.5	14.8	13.4	9.1	6.8	5.7	5.3
	difference	*NA*	*NA*	*NA*	*NA*	*NA*	*0.00%*	*0.00%*	*0.01%*	*-0.01%*	*0.03%*	*0.01%*	*0.00%*	*-0.12%*
Total	JNGI2004	1,103.4	1,111.9	1,127.8	1,112.8	1,169.3	1,230.3	1,352.0	1,357.8	1,306.7	1,328.4	1,336.7	1,302.3	1,330.8
with LULUCF	JNGI2005	1,120.7	1,134.7	1,144.3	1,128.9	1,184.3	1,243.5	1,351.8	1,357.5	1,306.6	1,328.4	1,336.2	1,301.4	1,330.0
	difference	*1.57%*	*2.05%*	*1.46%*	*1.45%*	*1.28%*	*1.07%*	*-0.01%*	*-0.02%*	*-0.01%*	*0.00%*	*-0.04%*	*-0.07%*	*-0.06%*
Total	JNGI2004	1,187.3	1,195.8	1,213.4	1,202.9	1,262.8	1,327.0	1,352.0	1,357.8	1,306.7	1,328.4	1,336.7	1,302.3	1,330.8
without LULUCF	JNGI2005	1,187.8	1,196.3	1,213.8	1,203.3	1,263.1	1,327.2	1,351.8	1,357.5	1,306.6	1,328.4	1,336.2	1,301.4	1,330.0
	difference	*0.04%*	*0.04%*	*0.03%*	*0.03%*	*0.02%*	*0.01%*	*-0.01%*	*-0.02%*	*-0.01%*	*0.00%*	*-0.04%*	*-0.07%*	*-0.06%*

1) JNGI2004: Japan National GHG Inventory submitted in 2004

2) JNGI2005: Japan National GHG Inventory submitted in 2005

3) LULUCF: Land Use, Land-Use Change and Forestry

10.3. Implication for Emission Trends, including Time Series Consistency

Table 10-5 shows the changes made to the emission trends during a period from 1990 to 2002 due to the recalculations indicated in “Section 10.1. Explanation and Justification for Recalculations”. Since the emissions of HFCs, PFCs and SF_6 prior to 1995 are not reported, a comparison of these emissions between 1995 and 2002 was performed.

Total emissions excluding the LULUCF sector decreased by approximately 0.8 million tons (in CO_2 equivalents) and by 0.1 points compared to the data reported in last year.

Table 10-5 Comparison of emissions trends between the inventories submitted in 2004 and 2005 excluding the LULUCF sector

		Trend [Mt CO_2eq.]			Trend (%)		
		JNGI2004	JNGI2005	Difference	JNGI2004	JNGI2005	Difference
CO_2	1)	125.3	125.5	0.2	11.2%	11.2%	0.0%
CH_4	1)	-5.3	-5.3	0.0	-21.2%	-21.4%	-0.2%
N_2O	1)	-4.8	-5.5	-0.7	-12.0%	-13.7%	-1.8%
HFCs	2)	-6.9	-7.3	-0.4	-34.1%	-36.2%	-2.1%
PFCs	2)	-2.9	-2.7	0.2	-23.4%	-21.7%	1.7%
SF_6	2)	-11.6	-11.6	0.0	-68.7%	-68.8%	0.0%
Total	3)	93.8	93.0	-0.8	7.6%	7.5%	-0.1%

1) Comparison of emissions between 1990 and 2002

2) Comparison of emissions between 1995 and 2002

3) Comparison of emissions between the base year of the Kyoto Protocol (CO_2, CH_4, N_2O: 1990 HFCs, PFCs, SF_6: 1995) and 2002

10.4. Recalculations, including in response to the review process, and planned improvements to the inventory

10.4.1. Improvements from inventory submitted last year

The major improvements carried out since submission of last year's inventory are listed below.

10.4.1.1. Methodology for estimating emissions of GHGs

(a) Estimation of emissions of CH_4 and N_2O from "1.A.3.a. Civil Aviation (Aviation gasoline)" was newly conducted.

(b) Notation keys used for CO_2 emissions from "1.B.2.b.ii. Natural Gas (Distribution)" were revised.

(c) For estimating N_2O emissions from "2.B.3. Adipic Acid Production", the operating rate of decomposition unit was revised.

(d) Activity data used for estimating emissions of HFCs, PFCs, SF_6 were revised.

(e) Estimation of emissions of N_2O from "4.B.3., 4.B.4., 4.B.6. Manure Management (sheep, goats and horses)" was newly conducted.

(f) For estimation of the LULUCF sector (Category 5), LULUCF-GPG and the *UNFCCC Reporting Guidelines on Annual Inventories* which has been adopted in the COP9 were adapted.

(g) For N_2O emissions from "6.B.2. Wastewater Handling (Human-waste treatment plant)", an estimation method representing the actual condition of the emissions more realistically was newly adopted.

(h) For N_2O emissions from "6.C. Industrial Waste Incineration (sewage sludge)", an estimation method representing the actual condition of the emissions more realistically was newly adopted.

* For further information, please see "10.1 Explanation and justification of recalculation".

10.4.1.2. National Inventory Report (NIR)

(a) Flow diagram of inventory compilation process is provided in "Chapter 1: Introduction".

(b) Description of estimation method and emission trend for "2.B.3. Adipic acid production" identified as key is provided in "Chapter 4: Industrial Processes (CRF sector 2)".

(c) With the application of the *LULUCF-GPG*, overall revision of the description on the estimation methodologies in "Chapter 7: Land Use, Land-Use Change and Forestry (CRF sector5)" was conducted.

(d) For the key category analysis, in addition to Tier 1 Level Assessment and Trend Assessment, qualitative analysis was conducted and its related description is added in "Annex 1: Key Categories".

(e) Description of methodology for estimating emissions of Precursors is added in "Annex 3: Other detailed methodological descriptions for individual source or sink categories".

(f) List of categories not estimated is added in "Annex 5: Assessment of Completeness and (Potential) Sources and Sinks of Greenhouse Gas Emissions and Removals Excluded"

(g) Description of inventory compilation system and QA/QC plan is added in "Annex 6: Additional information to be considered as part of the NIR submission or other useful reference information"

(h) Description of methodologies and results of uncertainty assessment were integrated as Annex 7.

10.4.1.3. Common Reporting Format (CRF)

(a) Notation keys were revised as follows.

Table 10-6 Notation keys changed in 2005 inventory

<table>
<tr><th>Sheet name</th><th>Emission classification</th><th>Pre-change</th><th>Post-change</th></tr>
<tr><td rowspan="3">Table 1.A(a)s1</td><td>1.A.1.a. Public Electricity and Heat Production (Other Fuels): CH_4, N_2O emissions</td><td>0.00</td><td>NO</td></tr>
<tr><td>1.A.1.b. Petroleum Refining (Other Fuels): CH_4, N_2O emissions</td><td>0.00</td><td>NO</td></tr>
<tr><td>1.A.1.c. Manufacture of Solid Fuels and Other Energy Industries (Other Fuels): CH_4, N_2O emissions</td><td>0.00</td><td>NO</td></tr>
<tr><td rowspan="6">Table 1.A(a)s2</td><td>1.A.2.a. Iron and Steel (Other Fuels): CH_4, N_2O emissions</td><td>0.00</td><td>NO</td></tr>
<tr><td>1.A.2.b. Non-Ferrous Metals (Other Fuels): CH_4, N_2O emissions</td><td>0.00</td><td>NO</td></tr>
<tr><td>1.A.2.c. Chemicals (Other Fuels): CH_4, N_2O emissions</td><td>0.00</td><td>NO</td></tr>
<tr><td>1.A.2.d. Pulp, Paper and Print (Other Fuels): CH_4, N_2O emissions</td><td>0.00</td><td>NO</td></tr>
<tr><td>1.A.2.e. Food Processing, Beverages and Tobacco (Other Fuels): CH_4, N_2O emissions</td><td>0.00</td><td>NO</td></tr>
<tr><td>1.A.2.f. Other (Other Fuels) : CH_4, N_2O emissions</td><td>0.00</td><td>NO</td></tr>
<tr><td rowspan="2">Table 1.A(a)s3</td><td>1.A.3.a. Civil Aviation (Aviation Gasoline): CH_4, N_2O emissions</td><td>NE</td><td>calculated value</td></tr>
<tr><td>1.A.3.e. Other Transportation (Liquid Fuels): activity amount, CO_2 emissions</td><td>calculated value</td><td>NO</td></tr>
<tr><td rowspan="3">Table 1.A(a)s4</td><td>1.A.4.a. Commercial/Institutional (Other Fuels): CH_4, N_2O emissions</td><td>0.00</td><td>NO</td></tr>
<tr><td>1.A.4.b. Residential (Other Fuels): CH_4, N_2O emissions</td><td>0.00</td><td>NO</td></tr>
<tr><td>1.A.4.c. Agriculture/Forestry/Fisheries (Other Fuels): CH_4, N_2O emissions</td><td>0.00</td><td>NO</td></tr>
<tr><td>Table 1.B.2</td><td>1.B.2.b.ii. Natural Gas (Distribution): CO_2 emissions</td><td>0.00</td><td>NE</td></tr>
<tr><td>Table 1.C</td><td>Residual Fuel Oil: activity amount</td><td>NE</td><td>IE</td></tr>
<tr><td>Table 2(I)s2</td><td>2.F.3. Fire Extinguishers: HFC emissions (A)</td><td>IE</td><td>NE</td></tr>
<tr><td>Table 2(I).A-Gs1</td><td>2.B.3. Adipic Acid Production: activity amount</td><td>calculated value</td><td>C</td></tr>
<tr><td rowspan="2">Table 3</td><td>3.B. Degreasing and Dry Cleaning: CO_2 emissions</td><td>NO</td><td>NE</td></tr>
<tr><td>3.B. Degreasing and Dry Cleaning: N_2O emissions</td><td>NO</td><td>NA</td></tr>
<tr><td rowspan="2">Table 3.A-D</td><td>3.B. Degreasing and Dry Cleaning: CO_2 emission factor</td><td>NO</td><td>NE</td></tr>
<tr><td>3.B. Degreasing and Dry Cleaning: N_2O emission factor</td><td>NO</td><td>NA</td></tr>
<tr><td rowspan="6">Table 4s1</td><td>4.A.2. Enteric Fermentation (Buffalo): CH_4 emissions</td><td>0.00</td><td>NO</td></tr>
<tr><td>4.A.5. Enteric Fermentation (Camels and Llamas): CH_4 emissions</td><td>0.00</td><td>NO</td></tr>
<tr><td>4.A.7. Enteric Fermentation (Mules and Asses): CH_4 emissions</td><td>0.00</td><td>NO</td></tr>
<tr><td>4.B.2. Manure Management (Buffalo): CH_4 emissions</td><td>0.00</td><td>NO</td></tr>
<tr><td>4.B.5. Manure Management (Camels and Llamas): CH_4 emissions</td><td>0.00</td><td>NO</td></tr>
<tr><td>4.B.7. Manure Management (Mules and Asses): CH_4 emissions</td><td>0.00</td><td>NO</td></tr>
<tr><td>Table 4.B(b)</td><td>4.B. Sheep: activity amount</td><td>NE</td><td>calculated value</td></tr>
</table>

(b) The sub-category of “4.B.13. Manure Management (Other)” was changed in Table 4s2.

(c) The sub-category of “Other” was added in Table 4.B(b).

(d) For the LULUCF sector, CRF included in the *UNFCCC Reporting Guidelines on Annual Inventories* (FCCC/SBSTA/2004/8) was applied.

10.4.2. Further Inventory Development

See Chapter 1 (Section 1.6.2 Further Inventory Development).

Annex 5. Assessment of Completeness and (Potential) Sources and Sinks of Greenhouse Gas Emissions and Removals Excluded

5.1. Assessment of Completeness

Current inventory is submitted in accordance with the common reporting format (CRF), which requires entering emission and removal data or a notation key[1] such as “NO”, “NE”, or “NA” for all sources. This chapter presents the definition of notation keys and decision trees for the application of them, both of which are based on the UNFCCC reporting Guidelines (FCCC/CP/1999/7, FCCC/CP/2002/8 or FCCC/SBSTA/2004/8) and the results of Committee for Greenhouse Gases Emissions Estimation Methods in 2002.

This chapter also reports source categories which have not been estimated because i) applicability of IPCC default values is not assured, ii) default methodologies and default values are not provided, iii) activity data is not available, iv) actual condition of GHG emissions or removals is not understood clearly.

5.2. Definition of Notation Keys

When reviewing the appropriateness of applying notation keys shown in the UNFCCC reporting guideline, it is necessary to establish a common concept for an application of these keys for each sector, but unclear points described in Table 1 are found as below regarding the use of the notation keys.

- The explanation of “NO” in the UNFCCC reporting guidelines can be taken that “NO” may be applied to both situations when there are no emissions or removals because the activities do not exist in Japan, and when emissions or removals do not occur in principle although the activities do exist.

- The first sentence of the “NA” explanation in the UNFCCC reporting guidelines seems to imply that “NA” may be applied to both situations as for “NO”. However, because the second sentence states that “If categories... are shaded, they do not need to be filled in”, it also seems to mean that “NA” is applied only when the activities exist but there are no emissions or removals in principle.

[1] These were called "standard indicators" in FCCC/CP/1999/7, but were changed to "notation keys" in FCCC/CP/2002/8.

Table 1 Notation keys indicated in UNFCCC reporting guidelines

Notation Key	Explanation
NO (Not Occurring)	“NO” (not occurring) for emissions by sources and removals by sinks of greenhouse gases that do not occur for a particular gas or source/sink category within a country;
NE (Not Estimated)	“NE” (not estimated) for existing emissions by sources and removals by sinks of greenhouse gases which have not been estimated. Where “NE” is used in an inventory for emissions or removals of CO_2, CH_4, N_2O, HFCs, PFCs or SF_6, the Party should indicate why emissions could not be estimated, using the completeness table of the common reporting format;
NA (Not Applicable)	“NA” (not applicable) for activities in a given source/sink category that do not result in emissions or removals of a specific gas. If categories in the common reporting format for which “NA” is applicable are shaded, they do not need to be filled in;
IE (Included Elsewhere)	“IE” (included elsewhere) for emissions by sources and removals by sinks of greenhouse gases estimated but included elsewhere in the inventory instead of the expected source/sink category. Where “IE” is used in an inventory, the Party should indicate, using the completeness table of the common reporting format, where in the inventory the emissions or removals from the displaced source/sink category have been included and the Party should give the reasons for this inclusion deviating from the expected category;
C (Confidential)	“C” (confidential) for emissions by sources and removals by sinks of greenhouse gases which could lead to the disclosure of confidential information, given the provisions of paragraph 19 above; (para 19: Emissions and removals should be reported on the most disaggregated level of each source/sink category, taking into account that a minimum level of aggregation may be required to protect confidential business and military information.

Source : UNFCCC reporting guidelines on annual inventories (FCCC/CP/1999/7)

* The notation key “0” was deleted at COP8 from the revised UNFCCC reporting guidelines (FCCC/CP/2002/8).

In the Committee for Greenhouse Gases Emissions Estimation Methods in 2002, the meanings of the notation keys are defined based on the following policy (as shown in Table 2).

- It was decided that “NA” is applied when the activity does exist in Japan, but in principle there are no GHG emissions or removals, while “NO” will apply when the activity itself does not exist and there are no emissions or removals.

If the UNFCCC reporting guidelines are revised in future, the review of the definitions of notation keys and the way to fill them in CRF will be conducted.

Table 2 Definition of Notation Keys

Notation Key	Definition
NO (Not Occurring)	Used when there are no activities that are linked to emissions or removals for a certain source.
NE (Not Estimated)	Used when the emissions or removals of a certain source cannot be estimated.
NA (Not Applicable)	Used when an activity associated with a certain source does exist, but in principle it accompanies no occurrence of specific GHG emissions or removals. “NA” is not applied when there are no GHG emissions or removals because the GHGs in raw materials have been removed.
IE (Included Elsewhere)	IE is used when an emissions or removals are already included in other sources. For assuring the completeness of CRF, the sources in which the emissions or removals are included and the reasons for including it elsewhere are to be recorded in the table.
C (Confidential)	Used for confidential information relating to business or the military. However, in consideration of transparency in calculation of emissions or removals, information will be reported to the extent that it does not hinder business or other operations (for example, reporting the aggregated total of several substances).

5.3. Decision Tree for Application of Notation Keys

Decision tree for the application of notation keys, based on UNFCCC reporting Guidelines (FCCC/CP/1999/7, FCCC/CP/2002/8 or FCCC/SBSTA/2004/8) and the results of Committee for Greenhouse Gases Emissions Estimation Methods in 2002, is shown in Figure 1.

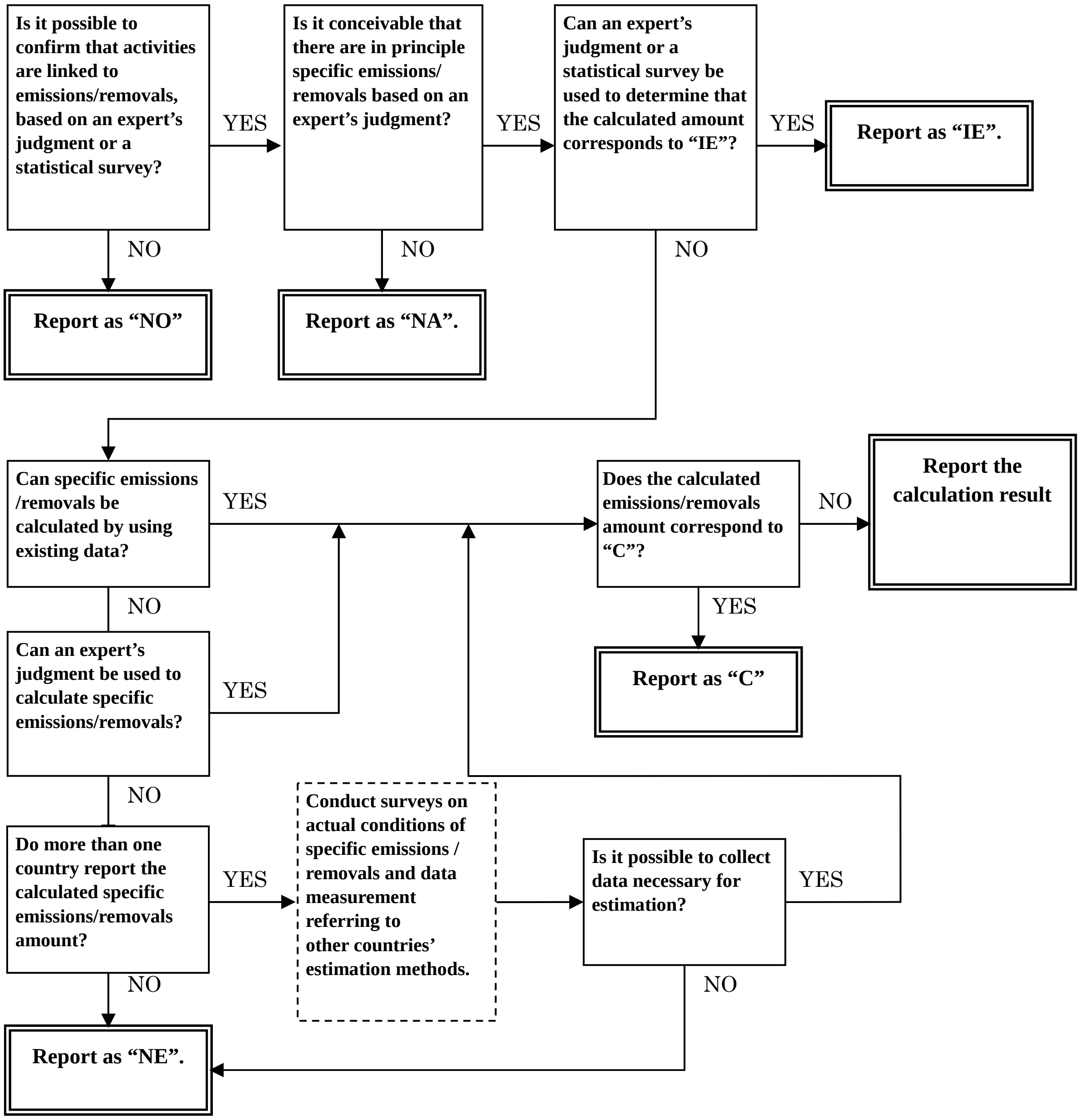

Figure 1 Decision tree for application of notation keys

5.4. Categories not estimated in Japan's inventory

Categories not estimated in Japan's inventory are listed below. It should be noted that emissions of HFCs, PFCs and SF_6 in the period from 1990 to 1994 and emissions and removals by Land Use, Land-Use Change and Forestry sector after 1995 have not been estimated (NE).

Code	Sector	Source category				Gas
1	Energy	Fuel Combustion	Mobile Combustion	Civil Aviation	Aviation Gasoline	CH_4
2	Energy	Fuel Combustion	Mobile Combustion	Civil Aviation	Aviation Gasoline	N_2O
3	Energy	Fuel Combustion	Mobile Combustion	Road Transportation	Natural Gas	CH_4
4	Energy	Fuel Combustion	Mobile Combustion	Road Transportation	Natural Gas	N_2O
5	Energy	Fuel Combustion	Mobile Combustion	Road Transportation	Other Fuels (Methanol)	CH_4
6	Energy	Fuel Combustion	Mobile Combustion	Road Transportation	Other Fuels (Methanol)	N_2O
7	Energy	Fuel Combustion	Mobile Combustion	Railways	Solid Fuels	CH_4
8	Energy	Fuel Combustion	Mobile Combustion	Railways	Solid Fuels	N_2O
9	Energy	Fuel Combustion	Mobile Combustion	Railways	Other Fuels	CH_4
10	Energy	Fuel Combustion	Mobile Combustion	Railways	Other Fuels	N_2O
11	Energy	Fuel Combustion	Solid Fuels	Navigation	Coal	CO_2
12	Energy	Fuel Combustion	Solid Fuels	Navigation	Coal	CH_4
13	Energy	Fuel Combustion	Solid Fuels	Navigation	Coal	N_2O
14	Energy	Fugitive Emissions from Fuels	Solid Fuels	Coal Mining		CO_2
15	Energy	Fugitive Emissions from Fuels	Solid Fuels	Coal Mining		N_2O
16	Energy	Fugitive Emissions from Fuels	Solid Fuels	Solid Fuel Transformation		CO_2
17	Energy	Fugitive Emissions from Fuels	Solid Fuels	Solid Fuel Transformation		CH_4
18	Energy	Fugitive Emissions from Fuels	Solid Fuels	Solid Fuel Transformation		N_2O
19	Energy	Fugitive Emissions from Fuels	Oil and Natural Gas	Oil	Refining/Storage	CO_2
20	Energy	Fugitive Emissions from Fuels	Oil and Natural Gas	Oil	Distribution of Oil Products	CO_2
21	Energy	Fugitive Emissions from Fuels	Oil and Natural Gas	Oil	Distribution of Oil Products	CH_4
22	Energy	Fugitive Emissions from Fuels	Oil and Natural Gas	Natural Gas	Other Leakage(at industrial plants and power station)	CO_2
23	Energy	Fugitive Emissions from Fuels	Oil and Natural Gas	Natural Gas	Other Leakage(at industrial plants and power station)	CH_4
24	Energy	Fugitive Emissions from Fuels	Oil and Natural Gas	Natural Gas	Other Leakage(in residential and commercial sectors)	CO_2
25	Energy	Fugitive Emissions from Fuels	Oil and Natural Gas	Natural Gas	Other Leakage(in residential and commercial sectors)	CH_4
26	Energy	Fugitive Emissions from Fuels	Oil and Natural Gas	Venting	Gas	CO_2
27	Energy	Fugitive Emissions from Fuels	Oil and Natural Gas	Venting	Gas	CH_4
28	Energy	Fugitive Emissions from Fuels	Oil and Natural Gas	Flaring	Oil	CO_2
29	Energy	Fugitive Emissions from Fuels	Oil and Natural Gas	Flaring	Oil	CH_4
30	Energy	Fugitive Emissions from Fuels	Oil and Natural Gas	Flaring	Oil	N_2O
31	Energy	Fugitive Emissions from Fuels	Oil and Natural Gas	Flaring	Gas	CO_2
32	Energy	Fugitive Emissions from Fuels	Oil and Natural Gas	Flaring	Gas	CH_4
33	Energy	Fugitive Emissions from Fuels	Oil and Natural Gas	Flaring	Gas	N_2O
34	Energy	Fugitive Emissions from Fuels	Oil and Natural Gas	Flaring	Combined	CO_2
35	Energy	Fugitive Emissions from Fuels	Oil and Natural Gas	Flaring	Combined	CH_4
36	Energy	Fugitive Emissions from Fuels	Oil and Natural Gas	Flaring	Combined	N_2O
37	Energy	International Bunkers	Marine・Diesel Oil			CO_2
38	Energy	International Bunkers	Marine・Diesel Oil			CH_4
39	Energy	International Bunkers	Marine・Diesel Oil			N_2O
40	Energy	International Bunkers	Marine・Heavy Oil			CO_2
41	Energy	International Bunkers	Marine・Heavy Oil			CH_4
42	Energy	International Bunkers	Marine・Heavy Oil			N_2O
43	Industrial Processes	Mineral Products	Soda Ash	Soda Ash Production		CO_2
44	Industrial Processes	Mineral Products	Soda Ash	Soda Ash Use（Including desulfurization equipment）		CO_2
45	Industrial Processes	Mineral Products	Asphalt roofing			CO_2
46	Industrial Processes	Mineral Products	Road Paving with Asphalt			CO_2
47	Industrial Processes	Chemical Industry	Ammonia Production			CH_4
48	Industrial Processes	Chemical Industry	Carbide Production	Silicon Carbide		CO_2
49	Industrial Processes	Chemical Industry	Carbide Production	Calcium Carbide		CO_2
50	Industrial Processes	Chemical Industry	Carbide Production	Calcium Carbide		CH_4

Code	Sector	Source category				Gas
51	Industrial Processes	Chemical Industry	Other	Ethylene		N_2O
52	Industrial Processes	Chemical Industry	Other	Coke		CO_2
53	Industrial Processes	Chemical Industry	Other	Coke		N_2O
54	Industrial Processes	Metal Production	Iron and Steel Production	Coke		CO_2
55	Industrial Processes	Metal Production	Aluminium Production			CH_4
56	Industrial Processes	Metal Production	Aluminium Production			PFCs
57	Industrial Processes	Metal Production	SF_6 Used in Aluminium and Magnesium Foundries	Aluminium Foundries		SF_6
58	Industrial Processes	Consumption of Halocarbons and SF_6	Refrigeration and Air Conditioning Equipment	Commercial Refrigeration	Manufacturing/Stocks/Disposal	PFCs
59	Industrial Processes	Consumption of Halocarbons and SF_6	Refrigeration and Air Conditioning Equipment	Automatic Vender Machine	Manufacturing/Stocks/Disposal	PFCs
60	Industrial Processes	Consumption of Halocarbons and SF_6	Refrigeration and Air Conditioning Equipment	Transport Refrigeration	Manufacturing/Stocks/Disposal	HFCs
61	Industrial Processes	Consumption of Halocarbons and SF_6	Refrigeration and Air Conditioning Equipment	Transport Refrigeration	Manufacturing/Stocks/Disposal	PFCs
62	Industrial Processes	Consumption of Halocarbons and SF_6	Refrigeration and Air Conditioning Equipment	Industrial Refrigeration	Manufacturing/Stocks/Disposal	PFCs
63	Industrial Processes	Consumption of Halocarbons and SF_6	Refrigeration and Air Conditioning Equipment	Stationary Air-Conditioning	Manufacturing/Stocks/Disposal	PFCs
64	Industrial Processes	Consumption of Halocarbons and SF_6	Refrigeration and Air Conditioning Equipment	Mobile Air-Conditioning	Manufacturing/Stocks/Disposal	PFCs
65	Industrial Processes	Consumption of Halocarbons and SF_6	Foam Blowing	Hard Form	Stocks and Disposal of Urethane Foam	HFCs
66	Industrial Processes	Consumption of Halocarbons and SF_6	Foam Blowing	Hard Form	Stocks and Disposal of Polystyrene Foam	HFCs
67	Industrial Processes	Consumption of Halocarbons and SF_6	Fire Extinguishers		Manufacturing/Stocks/Disposal	HFCs
68	Industrial Processes	Consumption of Halocarbons and SF_6	Fire Extinguishers		Manufacturing/Stocks/Disposal	PFCs
69	Industrial Processes	Consumption of Halocarbons and SF_6	Fire Extinguishers		Manufacturing/Stocks/Disposal	SF_6
70	Industrial Processes	Consumption of Halocarbons and SF_6	Aerosols/Metered Dose Inhalers	Aerosols	Manufacturing/Disposal	HFCs
71	Industrial Processes	Consumption of Halocarbons and SF_6	Aerosols/Metered Dose Inhalers	Metered Dose Inhalers	Manufacturing/Stocks/Disposal	HFCs
72	Industrial Processes	Consumption of Halocarbons and SF_6	Solvents		Manufacturing/Stocks/Disposal	HFCs
73	Industrial Processes	Consumption of Halocarbons and SF_6	Solvents		Manufacturing/Disposal	PFCs
74	Industrial Processes	Consumption of Halocarbons and SF_6	Semiconductors		Manufacturing/Disposal	HFCs
75	Industrial Processes	Consumption of Halocarbons and SF_6	Semiconductors		Manufacturing/Disposal	PFCs
76	Industrial Processes	Consumption of Halocarbons and SF_6	Semiconductors		Manufacturing/Disposal	SF_6
77	Industrial Processes	Consumption of Halocarbons and SF_6	Other	Other (Research, Medical Use, etc.)	Manufacturing/Disposal	HFCs
78	Industrial Processes	Consumption of Halocarbons and SF_6	Other	Other (Research, Medical Use, etc.)	Manufacturing/Stocks/Disposal	PFCs
79	Industrial Processes	Consumption of Halocarbons and SF_6	Other	Other (Research, Medical Use, etc.)	Manufacturing/Stocks/Disposal	SF_6
80	Solvent and Other Product Use	Degreasing and Dry-Cleaning				CO_2
81	Solvent and Other Product Use	Other	Fire Extinguishers			N_2O
82	Solvent and Other Product Use	Other	Other Use of N_2O			CO_2
83	Solvent and Other Product Use	Other	Other Use of N_2O			N_2O
84	Agriculture	Enteric Fermentation	Buffalo			CH_4
85	Agriculture	Enteric Fermentation	Camels and Llamas			CH_4
86	Agriculture	Enteric Fermentation	Mules and Asses			CH_4
87	Agriculture	Enteric Fermentation	Poultry			CH_4
88	Agriculture	Manure Management	Buffalo			CH_4
89	Agriculture	Manure Management	Camels and Llamas			CH_4
90	Agriculture	Manure Management	Mules and Asses			CH_4
91	Agriculture	Manure Management	Sheep, Goats & Horses			N_2O
92	Agriculture	Agricultural Soils	Direct Soil Emissions	Crop Residue		N_2O
93	Agriculture	Agricultural Soils	Direct Soil Emissions	Cultivation of Histosols		N_2O
94	Agriculture	Field Burning of Agricultural Residues	Other			CH_4
95	Agriculture	Field Burning of Agricultural Residues	Other			N_2O
96	LULUCF	Cropland Remaiing Cropland	Dead Organic Matter			CO_2
97	LULUCF	Land Converted to Cropland	Dead Organic Matter			CO_2
98	LULUCF	Grassland Remaining Grassland	Dead Organic Matter			CO_2
99	LULUCF	Land Converted to Grassland	Dead Organic Matter			CO_2
100	LULUCF	Wetlands Remaing Wetlands	Living Biomass			CO_2
101	LULUCF	Wetlands Remaing Wetlands	Dead Organic Matter			CO_2
102	LULUCF	Wetlands Remaing Wetlands	Soils (Flooded Land)			CO_2
103	LULUCF	Land Converted to Wetlands	Living Biomass			CO_2
104	LULUCF	Land Converted to Wetlands	Dead Organic Matter			CO_2
105	LULUCF	Settlements remaining Settlements	Dead Organic Matter			CO_2
106	LULUCF	Settlements remaining Settlements	Soils			CO_2
107	LULUCF	Land Converted to Settlements	Dead Organic Matter			CO_2
108	LULUCF	Land Converted to Settlements	Soils			CO_2
109	LULUCF	Land Converted to Other Land	Dead Organic Matter			CO_2
110	LULUCF	N2O emissions from drainage of soils				N_2O
111	LULUCF	Carbon emissions from agricultural lime application				CO_2
112	Waste	Solid Waste Disposal on Land	Managed Waste Disposal on Land			CO_2
113	Waste	Solid Waste Disposal on Land	Unmanaged Waste Disposal Sites			CO_2
114	Waste	Solid Waste Disposal on Land	Unmanaged Waste Disposal Sites			CH_4
115	Waste	Wastewater Handling	Industrial Wastewater			N_2O

Annex 9. Hierarchical Structure of the LULUCF Sector Inventory File System

Multiple MS Excel files have been used when estimating Japanese inventory. The explanation of each MS Excel file and the hierarchical structure of the LULUCF sector inventory file system are shown below.

Table 1 Explanation of each MS Excel file

Category	ファイル名	内容
	CRF(LULUCF)-1990-v01-JPN-2005.xls ～ CRF(LULUCF)-2003-v01-JPN-2005.xls	Common reporting format provided by UNFCCC secretariat
5. Land Use, Land-Use Change and Forestry	5-AD-2005.xls	Activity Data of Category 5 (LULUCF)
	5-EF-2005.xls	Emission Factors of Category 5 (LULUCF)
	5A-CO2-2005.xls	CO2 emissions and removals from Forest land
	5B-CO2-2005.xls	CO2 emissions and removals from Cropland
	5C-CO2-2005.xls	CO2 emissions and removals from Grassland
	5D-CO2-2005.xls	CO2 emissions and removals from Wetlands
	5E-CO2-2005.xls	CO2 emissions and removals from Settlements
	5(III)-N2O-2005.xls	N2O emissions from Disturbance Associated with Land-Use Conversion to Cropland
	5(V)-Burning-2005.xls	CO2, CH4 and N2O emissions from Biomass Burning

Hierarchical Structure of Inventory File System

NOTES
*This chart shows the hierarchical of Japanese National GHGs Inventory ("JNGI") filing system.
*Although the explanations of calculations are given both in English and Japanese, some files have only Japanese explanation.
*Files containing "CRF" in their name are Common Reporting Format.
*Arrows indicate data link between files(series).

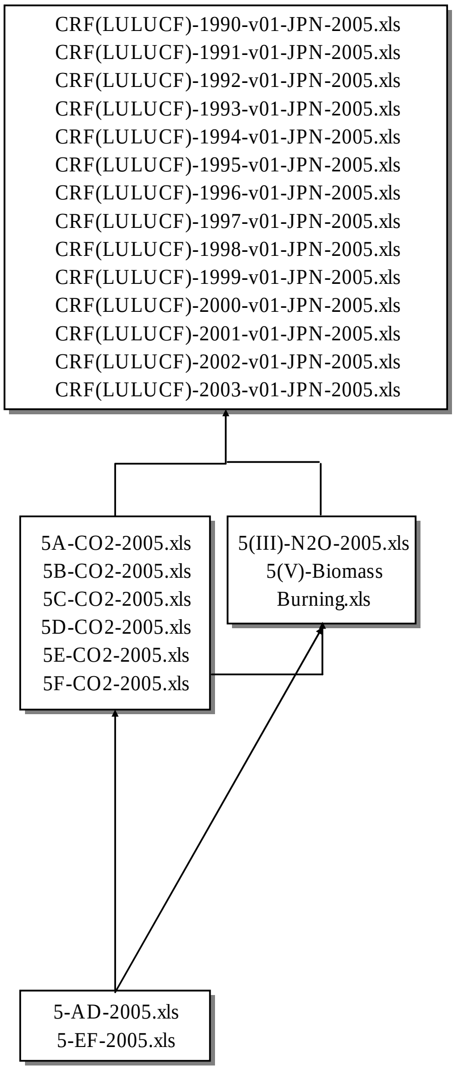

Figure 1 Hierarchical structure of Japan's LULUCF Inventory File System

Annex 10. Summary of Common Reporting Format for LULUCF

10.1. Emissions and Removals for LULUCF in 1990

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 [1]	CH_4	N_2O	HFCs [2]	PFCs [2]	SF_6 [2]	Total
	CO_2 equivalent (Gg)						
5. Land Use, Land-Use Change and Forestry[1]	-67095.86	166.52	386.52				-66542.82
A. Forest Land	-79661.07	13.30	1.35				-79646.42
B. Cropland	4367.43	26.32	372.30				4766.05
C. Grassland	2469.74	3.70	0.38				2473.81
D. Wetlands	66.35	1.60	0.16				68.11
E. Settlements	4534.00	109.11	11.07				4654.18
F. Other Land	1127.69	12.49	1.27				1141.45
G. Other	NE	NE	NE				NE

10.2. Emissions and Removals for LULUCF in 1991

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 (1)	CH_4	N_2O	HFCs (2)	PFCs (2)	SF_6 (2)	Total
	CO_2 equivalent (Gg)						
5. Land Use, Land-Use Change and Forestry(1)	-61558.77	175.59	357.72				-61025.46
A. Forest Land	-73321.04	28.61	2.90				-73289.53
B. Cropland	3641.86	14.88	341.41				3998.15
C. Grassland	2119.32	2.12	0.22				2121.66
D. Wetlands	59.60	1.46	0.15				61.20
E. Settlements	4740.00	114.20	11.59				4865.79
F. Other Land	1201.49	14.33	1.45				1217.28
G. Other	NE	NE	NE				NE

10.3. Emissions and Removals for LULUCF in 1992

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 [1]	CH_4	N_2O	HFCs [2]	PFCs [2]	SF_6 [2]	Total
	CO_2 equivalent (Gg)						
5. Land Use, Land-Use Change and Forestry[1]	-69562.31	181.59	336.27				-69044.45
A. Forest Land	-81413.58	24.16	2.45				-81386.97
B. Cropland	3532.88	17.04	319.57				3869.49
C. Grassland	2026.79	2.48	0.25				2029.53
D. Wetlands	147.22	3.60	0.37				151.18
E. Settlements	5065.68	122.64	12.45				5200.77
F. Other Land	1078.69	11.67	1.18				1091.54
G. Other	NE	NE	NE				NE

10.4. Emissions and Removals for LULUCF in 1993

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 (1)	CH_4	N_2O	HFCs (2)	PFCs (2)	SF_6 (2)	Total
	CO_2 equivalent (Gg)						
5. Land Use, Land-Use Change and Forestry(1)	-74342.50	172.51	310.60				-73859.39
A. Forest Land	-84893.45	35.66	3.62				-84854.16
B. Cropland	2862.95	6.05	293.71				3162.70
C. Grassland	1751.10	0.89	0.09				1752.09
D. Wetlands	107.82	2.64	0.27				110.72
E. Settlements	4609.33	112.66	11.43				4733.42
F. Other Land	1219.75	14.61	1.48				1235.84
G. Other	NE	NE	NE				NE

10.5. Emissions and Removals for LULUCF in 1994

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 [1]	CH_4	N_2O	HFCs [2]	PFCs [2]	SF_6 [2]	Total
	CO_2 equivalent (Gg)						
5. Land Use, Land-Use Change and Forestry[1]	-78810.91	163.22	234.97				-78412.72
A. Forest Land	-88510.10	29.99	3.04				-88477.07
B. Cropland	2162.26	5.93	219.01				2387.20
C. Grassland	1795.57	0.89	0.09				1796.55
D. Wetlands	90.75	2.22	0.23				93.20
E. Settlements	4509.78	110.89	11.25				4631.93
F. Other Land	1140.82	13.31	1.35				1155.48
G. Other	NE	NE	NE				NE

10.6. Emissions and Removals for LULUCF in 1995

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 [(1)]	CH_4	N_2O	HFCs [(2)]	PFCs [(2)]	SF_6 [(2)]	Total
	CO_2 equivalent (Gg)						
5. Land Use, Land-Use Change and Forestry[(1)]	-83687.52	156.18	222.48				-83308.87
A. Forest Land	-93173.63	22.45	2.28				-93148.91
B. Cropland	2084.59	6.17	207.26				2298.01
C. Grassland	1635.11	0.93	0.09				1636.14
D. Wetlands	225.36	5.52	0.56				231.44
E. Settlements	4427.26	109.29	11.09				4547.64
F. Other Land	1113.79	11.82	1.20				1126.81
G. Other	NE	NE	NE				NE

10.7. Emissions and Removals for LULUCF in 1996

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 [(1)]	CH_4	N_2O	HFCs [(2)]	PFCs [(2)]	SF_6 [(2)]	Total
	CO_2 equivalent (Gg)						
5. Land Use, Land-Use Change and Forestry[(1)]	3291.88	NE	199.90				NE
A. Forest Land	NE	NE	NE				NE
B. Cropland	1792.73	NE	199.90				1992.63
C. Grassland	1460.03	NE	NE				1460.03
D. Wetlands	0.00	NE	NE				0.00
E. Settlements	-9.69	NE	NE				-9.69
F. Other Land	48.80	NE	NE				48.80
G. Other	NE	NE	NE				NE

10.8. Emissions and Removals for LULUCF in 1997

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 [(1)]	CH_4	N_2O	HFCs [(2)]	PFCs [(2)]	SF_6 [(2)]	Total
	CO_2 equivalent (Gg)						
5. Land Use, Land-Use Change and Forestry[(1)]	3038.88	NE	194.00				NE
A. Forest Land	NE	NE	NE				NE
B. Cropland	1741.22	NE	194.00				1935.22
C. Grassland	1292.59	NE	NE				1292.59
D. Wetlands	0.00	NE	NE				0.00
E. Settlements	-32.80	NE	NE				-32.80
F. Other Land	37.87	NE	NE				37.87
G. Other	NE	NE	NE				NE

10.9. Emissions and Removals for LULUCF in 1998

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 [1]	CH_4	N_2O	HFCs [2]	PFCs [2]	SF_6 [2]	Total
	CO_2 equivalent (Gg)						
5. Land Use, Land-Use Change and Forestry[1]	2813.62	NE	189.31				NE
A. Forest Land	NE	NE	NE				NE
B. Cropland	1700.20	NE	189.31				1889.51
C. Grassland	1155.64	NE	NE				1155.64
D. Wetlands	0.00	NE	NE				0.00
E. Settlements	-75.61	NE	NE				-75.61
F. Other Land	33.39	NE	NE				33.39
G. Other	NE	NE	NE				NE

10.10. Emissions and Removals for LULUCF in 1999

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 [1]	CH_4	N_2O	HFCs [2]	PFCs [2]	SF_6 [2]	Total
	CO_2 equivalent (Gg)						
5. Land Use, Land-Use Change and Forestry[1]	2642.60	NE	187.79				NE
A. Forest Land	NE	NE	NE				NE
B. Cropland	1658.78	NE	187.79				1846.57
C. Grassland	1078.34	NE	NE				1078.34
D. Wetlands	0.00	NE	NE				0.00
E. Settlements	-121.62	NE	NE				-121.62
F. Other Land	27.10	NE	NE				27.10
G. Other	NE	NE	NE				NE

10.11. Emissions and Removals for LULUCF in 2000

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 [(1)]	CH_4	N_2O	HFCs [(2)]	PFCs [(2)]	SF_6 [(2)]	Total
	CO_2 equivalent (Gg)						
5. Land Use, Land-Use Change and Forestry[(1)]	2481.76	NE	183.26				NE
A. Forest Land	NE	NE	NE				NE
B. Cropland	1626.32	NE	183.26				1809.58
C. Grassland	1003.82	NE	NE				1003.82
D. Wetlands	0.00	NE	NE				0.00
E. Settlements	-149.20	NE	NE				-149.20
F. Other Land	0.83	NE	NE				0.83
G. Other	NE	NE	NE				NE

10.12. Emissions and Removals for LULUCF in 2001

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 [1]	CH_4	N_2O	HFCs [2]	PFCs [2]	SF_6 [2]	Total
	CO_2 equivalent (Gg)						
5. Land Use, Land-Use Change and Forestry[1]	2388.54	NE	181.20				NE
A. Forest Land	NE	NE	NE				NE
B. Cropland	1629.52	NE	181.20				1810.72
C. Grassland	941.97	NE	NE				941.97
D. Wetlands	0.00	NE	NE				0.00
E. Settlements	-187.38	NE	NE				-187.38
F. Other Land	4.43	NE	NE				4.43
G. Other	NE	NE	NE				NE

10.13. Emissions and Removals for LULUCF in 2002

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 [1]	CH_4	N_2O	HFCs [2]	PFCs [2]	SF_6 [2]	Total
	CO_2 equivalent (Gg)						
5. Land Use, Land-Use Change and Forestry[1]	2278.15	NE	180.78				NE
A. Forest Land	NE	NE	NE				NE
B. Cropland	1624.42	NE	180.78				1805.20
C. Grassland	903.27	NE	NE				903.27
D. Wetlands	0.00	NE	NE				0.00
E. Settlements	-216.69	NE	NE				-216.69
F. Other Land	-32.85	NE	NE				-32.85
G. Other	NE	NE	NE				NE

10.14. Emissions and Removals for LULUCF in 2003

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 [1]	CH_4	N_2O	HFCs [2]	PFCs [2]	SF_6 [2]	Total
	CO_2 equivalent (Gg)						
5. Land Use, Land-Use Change and Forestry[1]	2159.90	NE	180.24				NE
A. Forest Land	NE	NE	NE				NE
B. Cropland	1619.72	NE	180.24				1799.96
C. Grassland	836.41	NE	NE				836.41
D. Wetlands	0.00	NE	NE				0.00
E. Settlements	-232.94	NE	NE				-232.94
F. Other Land	-63.29	NE	NE				-63.29
G. Other	NE	NE	NE				NE