TURKEY Greenhouse Gas Inventory,1990 to 2005

Annual Report for submission under the Framework Convention on Climate Change

National Inventory Report

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Data sheet

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Note: The sections pertaining to the related sectors in this report and the CRF tables are prepared by the related organizations.

Executive Summary

The United Nations Framework Convention on Climate Change (UNFCCC) was ratified by TURKEY in 2004. As a party to the convention, TURKEY prepared its first national inventory report (NIR) and CRF tables for the period 1990 – 2004 and submitted to UNFCCC in 2006. Turkey has prepared its second NIR for the year 2005.

TURKEY is committed to develop, periodically update and make available national inventories of anthropogenic GHG emissions by sources and removals by sinks of greenhouse gases not controlled by the *Montreal Protocol* using the comparable methodologies.

This report presents the national inventory of greenhouse gas (GHG) emissions and removals from 1990 to 2005. Emissions of the five direct greenhouse gases were covered in the report. These were:

- Carbon dioxide
- Methane
- Nitrous oxide
- Hydrofluorocarbons
- Sulphur hexafluoride.

These gases contribute directly to climate change owing to their positive radiative forcing effect. Also the following four indirect greenhouse gases were reported:

- Nitrogen oxides (reported as NO_2)
- Carbon monoxide
- Non-methane volatile organic compounds (NMVOC)
- Sulphur dioxide.

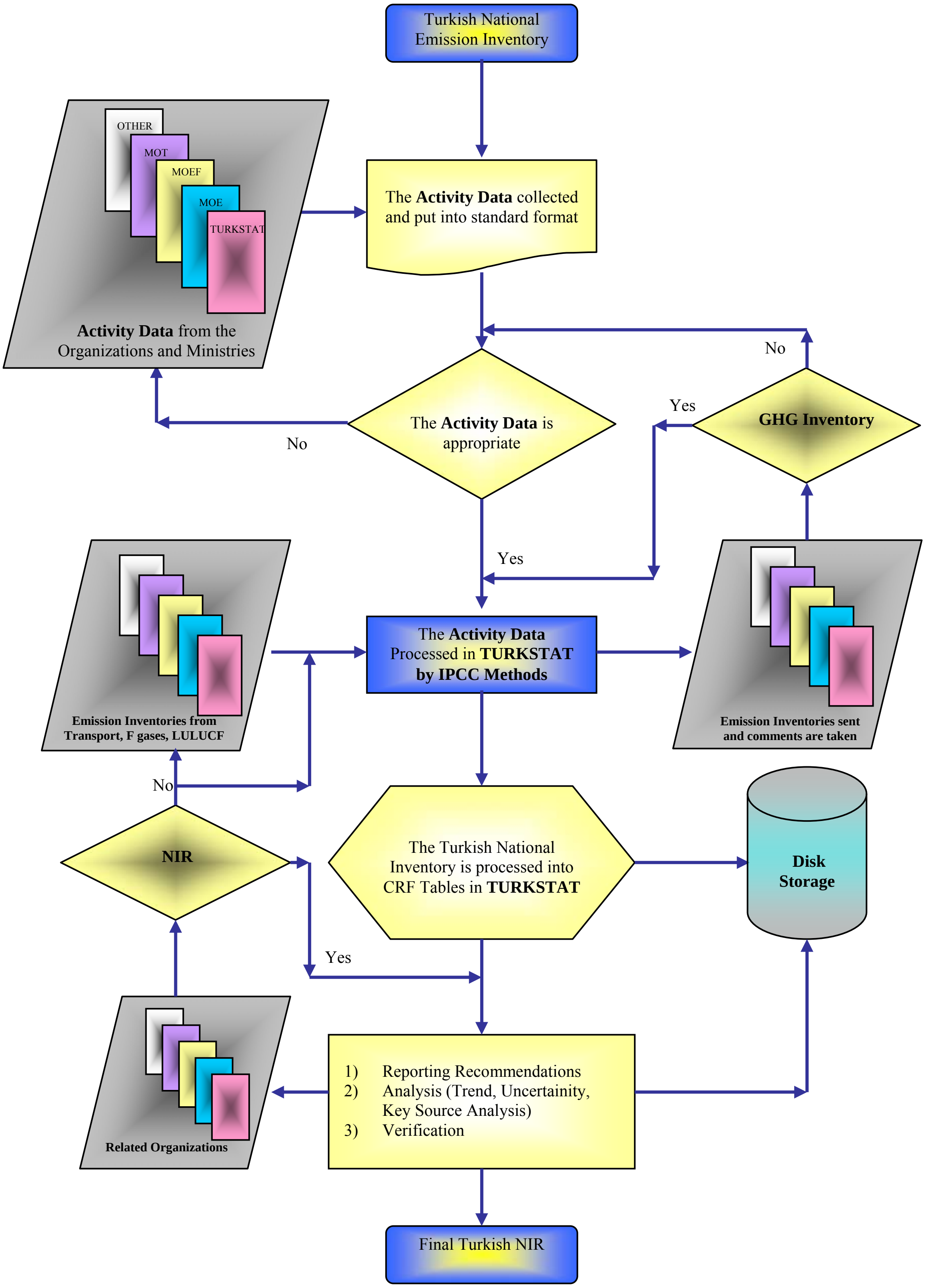
The Turkish Greenhouse Gas Inventory is, now, submitted to the UNFCCC in the form of the Common Reporting Format which was attached to this report in the form of XLS, XML and MDB (as backup) files. It should be noted that in this report, carbon dioxide emissions and removals were reported separately and removals were reported with a negative sign.

In this National Inventory Report, the source categories according to the IPCC methodology, i.e. energy, industrial processes, agriculture, land-use, land use change and forestry (LULUCF), and wastes were considered. Solvent and other product use were not considered due to the lack of activity data.

The Turkish Statistical Institute is designated to be responsible for the national inventory of greenhouse gases in Turkey, The inventory was prepared as a joint work by Turkish Statistical Institute, Ministry of Agriculture and Rural Affairs, Ministry of Environment and Forestry, Ministry of Transportation, Ministry of Energy and Natural Resources, Turkish Technology Development Foundation and some universities. The CRF reporter for each source categories were prepared by related organizations and combined by Ministry of Environment and Forestry and TURKSTAT.

The CRF data sets also contain key source, trend and uncertainty analysis. The key source category is one that is prioritised within the national inventory system because its estimate has a significant influence on a country's total inventory of direct greenhouse gases in terms of the absolute level of emissions and removals. In addition to key source analysis, the emission estimates have been prepared through the investigation of emissions trends. This trend assessment identifies source categories for which significant uncertainty in the estimate would have considerable affected on overall emission trends, and therefore identifies source categories that diverge from the overall trend in national emissions. Quantitative estimates of the uncertainties in the emissions were calculated using direct expert judgement. The total uncertainty is 12.1%, because of the high uncertain data of CO_2 uptake by forest.

NATIONAL EMISSION INVENTORY SYSTEM



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List of Abbreviations

COP	Conference of the Parties
CRF	Common Reporting Format
EEA	European Environmental Agency
EF	Emission Factor
GHG	Greenhouse Gas
GPG	Good Practice Guidance
IEA	International Energy Agency
IPCC	Intergovernmental Panel on Climate Change
ITU	İstanbul Technical University
LULUCF	Land Use and Land Use Change and Forestry
MARA	Ministry of Agriculture and Rural Affairs
MENR	Ministry of Energy and Natural Resources
MOEF	Ministry of Environment and Forestry
MOT	Ministry of Transport
NSCR	Non-Selective Catalytic Reduction
OSD	Turkish Automotive Manufacturers Association
PETDER	Petroleum Manufacturers Association of Turkey
QA	Quality Assurance
QC	Quality Control
SHW	State Hydraulic Works
TCMA	Turkish Cement Manufacturers' Association
TPP	Thermal Power Plant
TTGV	Turkish Technology Development Foundations
TURKSTAT	Turkish Statistical Institute
UNFCCC	United Nations Framework Convention on Climate Change

Chapter 1

1. Introduction

The United Nations Framework Convention on Climate Change (UNFCCC) was ratified by Turkey in 2004. As a Party to the Convention, Turkey has prepared its second national inventory report and CRF tables for the year 2005. As an Annex I party to Convention, Turkey is required to develop annual inventories on greenhouse gas (GHG) emissions by sources and removals by sinks of greenhouse gases not controlled by the *Montreal Protocol* using the methodology approved by the UNFCCC.

In Turkey, the major actor of the GHG inventory is the Turkish Statistical Institute (TURKSTAT). National emission inventory and Common Reporting Format Reporter (CRFR) tables have been prepared in accordance with the UNFCCC Reporting Guidelines on Annual Inventories as adopted by the Conference of the Parties to the Convention (COP). The methodologies used in the calculation of emissions are based on the *Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories* (IPCC Guidelines) and the *IPCC Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories* (Good Practice Guidance) prepared by the Intergovernmental Panel on Climate Change (IPCC). As recommended by the IPCC Guidelines, country specific methods have been used in electricity production and road transportation.

The inventory does not cover all the sources required by the IPCC guidelines.

Emissions and removals from land use change and forestry are provided by the Ministry of Agriculture and Rural Affairs (MARA), and Ministry of Environment and Forestry (MOEF).

This National GHG Inventory Report presents on the basic GHGs – carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), GHG precursors (NOx, CO, NMVOCs), sulphur dioxide (SO_2), and the emissions of Hydrofluorocarbons (HFCs) and Sulphur hexafluoride (SF_6).

This report presents greenhouse gas emissions for the years 1990-2005, and discusses the trends, fluctuations and changes in the estimates. The annexes containing source categories, fuel types, emission factors and references, describe in detail the methodology of the estimates and how the Greenhouse Gas Inventory relates to the IPCC Guidelines. The annexes also include sections on the estimation of uncertainties, key source and trend analysis.

It should be noted that in this report, carbon dioxide emissions and removals were reported separately and that carbon dioxide removals were reported with a negative sign.

According to the IPCC Good Practice Guidance, a key source category is one that is prioritised within the national inventory system because its estimation has a significant influence on a country's total inventory of direct greenhouse gases in terms of the absolute level of emissions. The results of this study has shown that Public Electricity and Heat Production (Electricity Production) (CO_2), Road Transportation (CO_2), Cement Industry (CO_2), Solid Waste Disposal (CH_4), Other industries (CO_2), Enteric Fermentation (CH_4), Residential usage of natural gas, LPG, lignite, hard coal and wood (CO_2), Manufacture of solid fuels and other energy industries (CO_2), Iron and Steel Industry (CO_2), Fertilizer

Industry (CO_2), Chemical industry (CO_2), Nitric Acid Production (N_2O), Petroleum refining (CO_2), Civil Aviation (Transport) (CO_2), Non-Ferrous Metal Industry (CO_2), Sugar Industry (CO_2), Mining Activities (CH_4) and Navigation (CO_2) were determined as key sources in 2005 according to the IPCC GPG (2000).

In addition to key source analysis, the emissions trends have been estimated for the year of 2005. This trend assessment identifies source categories for which significant uncertainty in the estimate would have considerable affected on overall emission trends, and therefore identifies source categories that diverge from the overall trend in national emissions. According to the base year considerations, the highest trends were seen in fuel combustion and industrial sectors. The percentage change of emissions according to the fuel combustion and industrial activities were seen to have increased throughout the years.

Quantitative estimates of the uncertainties in the emissions were calculated using direct expert judgement. It can be concluded that the total uncertainty is 12.1% because of the high uncertain data of CO_2 uptake by forest.

The general procedure for uncertainty analysis was:

- Uncertainties of each activity were allocated by using emission factor and activity rate uncertainties.
- A calculation was set up to estimate the emission of each CO_2, CH_4, N_20, HFCs and SF_6 gases.
- The uncertainties used for the industrial processes data were estimated by the statistical difference between entire supply and institutional inventory demand.
- The uncertainties for sectoral energy usage were estimated by MENR.
- The uncertainties of agricultural activities were estimated by TURKSTAT experts.
- The uncertainties of transport sectors were estimated by ITU.

Chapter 2

2. Greenhouse Gas Emissions

The national GHG inventory preparation was divided into the following basic activities:

- Collecting the data,
- Processing the activity data,
- Choosing the emission factors for estimating,
- Determination of the key GHG emission sources,
- Evaluation of the result (uncertainty and trend analysis).

The inventory can be modified in regard to the country specific circumstances. Every year, some changes occur that affect directly the activities above listed.

As the input data collection was considered, the inventory reflects the changes in the organization and management of data sources. These sources are as follows:

- Energy balance tables from the Ministry of Energy and Natural Resources,
- Industrial Production from Industry and Business Statistics Department in TURKSTAT,
- Agricultural Production from the Agriculture and Environment Statistics Department in TURKSTAT and land use and land use change data from Ministry of Agriculture and Rural Affairs,
- Data on the forest from the Ministry of Environment and Forestry
- Data on solid waste from the Environmental Statistics Group in TURKSTAT,
- Transport data from General Directorate of Railways, Harbors and Airports,
- Data on HFCs and SF_6 from Ministry of Environment and Forestry

Some organizations and universities should also be added to the above institutions. Because, the emission estimations, CRF table preparation and reports submission were done in cooperation with related Ministries. These were Turkish Technology Development Foundation for HFCs and SF_6, İstanbul University (Prof. Dr.Ünal Asan) for forestry and İstanbul Technical University (Prof. Dr. Cem Soruşbay and Prof. Dr. Metin Ergeneman) for transportation.

The basic source for emission factors for these inventories was the IPCC Revised Guidelines.

The data confidentiality was one of the important problems. This problem was solved by aggregated reporting, without mentioning the quantities or production. This approach was quite uncertain.

Table 2.1 gives summary data for greenhouse gas emissions for the years 1990-2005. The inventory for the year 1990 and 2005 revealed that the overall GHG emissions expressed in CO_2 equivalent were correspondingly 170.06 and 312.31 million tones not taking into account the sector Land use Change and Forestry (LUCF).

Table 2.1 represents the emission trends of the basic GHGs, the overall emissions (not taking into account the LUCF) and the relative share of the overall emissions to the emissions from the year 1990 (referred to as 100 %).

Table 2.1. Aggregated GHG emissions by sectors (CO_2 eq.)

Total (million tones)	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**
Energy	132.13	137.96	144.27	150.78	148.62	160.79	178.96	191.39	190.62	190.61	212.55	196.02	204.02	218.00	227.43	241.45
Industrial Processes	13.07	15.22	17.23	18.59	16.93	21.64	22.45	22.17	22.62	21.45	22.23	21.20	23.42	24.12	26.45	25.29
Solvent and Other Product Use	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
Agriculture	18.47	19.04	18.84	18.62	18.32	17.97	17.98	16.84	16.70	16.74	16.13	15.77	14.77	14.80	15.18	15.82
Waste	6.39	9.74	13.29	15.99	16.59	20.31	22.69	25.12	26.69	27.97	29.04	29.11	28.41	29.36	27.55	29.75
Total (w/o land use)	**170.06**	**181.96**	**193.64**	**203.98**	**200.46**	**220.72**	**242.09**	**255.51**	**256.63**	**256.78**	**279.96**	**262.10**	**270.62**	**286.28**	**296.60**	**312.31**
Change Comp.to 1990 % (w/o land use)	**-**	**7.0**	**13.9**	**19.9**	**17.9**	**29.8**	**42.4**	**50.3**	**50.9**	**51.0**	**64.6**	**54.1**	**59.1**	**68.3**	**74.4**	**83.6**
Land use and land use change	**-44.09**	**-55.57**	**-59.72**	**-59.16**	**-60.47**	**-60.74**	**-61.07**	**-63.09**	**-64.29**	**-65.02**	**-65.61**	**-70.48**	**-67.04**	**-65.75**	**-73.24**	**-69.49**

Unit: Million tones

The analysis of Table 2.1 shows that in 2005, the emissions from the energy sector was the largest portion with 77.3%, the emissions from the waste disposal was the second largest one with a value of 9.5%, and the emissions from industrial processes with an 8.1% shares the third place.

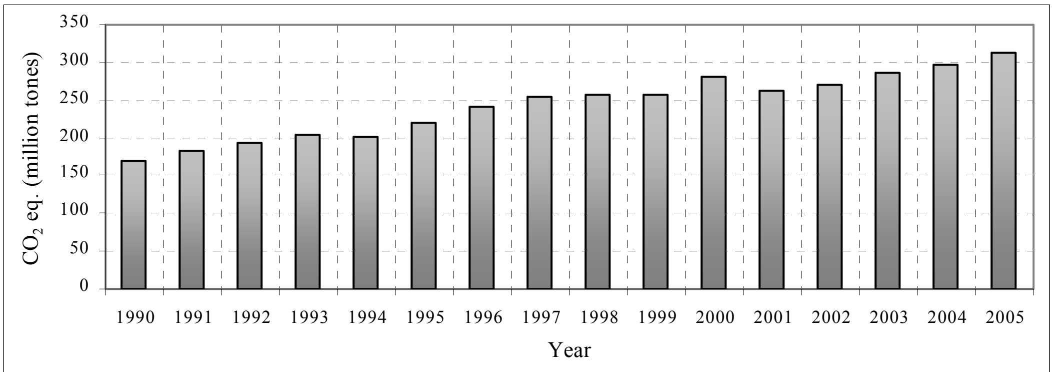


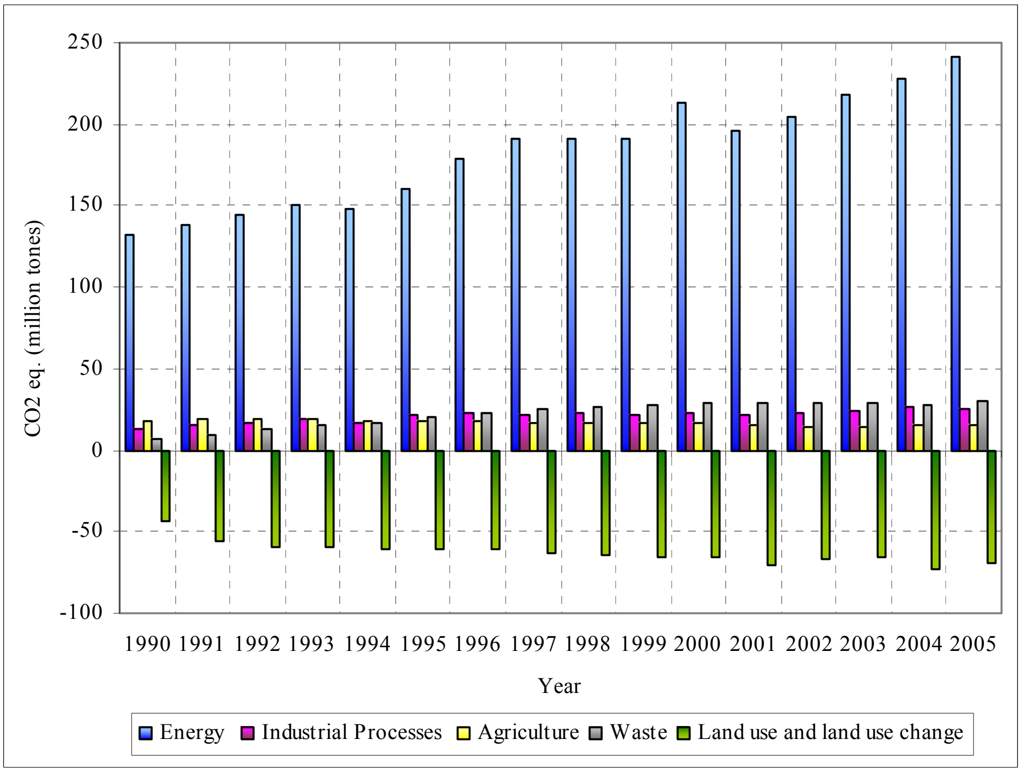
Figure 2.1. Overall greenhouse gases emission trend (without LUCF)

Figure 2.1 presents the trend of the overall emissions during the period 1990-2005. It can be seen that the emissions for the year 2005 were 83.6% more than the emission of year 1990.

Table 2.2. Aggregated GHG emissions without LUCF (CO_2 eq.)

Total	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
CO_2	139.59	146.55	152.93	160.91	159.10	171.85	190.67	203.72	202.71	201.71	223.81	207.38	216.43	230.99	241.88	256.33
CH_4	29.21	33.17	36.66	38.98	39.19	42.54	44.99	46.45	47.71	48.83	49.27	48.70	46.87	47.76	46.29	49.32
N_20	1.26	2.25	4.04	4.09	2.17	6.33	6.07	4.73	5.56	5.72	5.74	4.84	5.41	5.25	5.49	3.43
HFCs	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.82	0.87	1.42	1.81	2.23	2.38
SF_6	0.00	0.00	0.00	0.00	0.00	0.00	0.37	0.61	0.66	0.52	0.32	0.31	0.48	0.48	0.70	0.86
Total (without LUCF)	**170.06**	**181.96**	**193.64**	**203.98**	**200.46**	**220.72**	**242.09**	**255.51**	**256.63**	**256.78**	**279.96**	**262.10**	**270.62**	**286.28**	**296.60**	**312.31**

Unit: Million tones



Unit: Million tones

Figure 2.2 Greenhouse gases emission trend by sectors

Figure 2.2 presents the energy sector that forms the largest share of the overall emissions between the year 1990 and 2005.

Table 2.3. Contribution of sectors to the total emission (CO_2 eq.)

%	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Energy	104.9	109.1	107.7	104.1	106.2	100.5	98.9	99.5	99.1	99.4	99.2	102.3	100.2	98.9	101.8	99.4
Industrial Processes	10.4	12.0	12.9	12.8	12.1	13.5	12.4	11.5	11.8	11.2	10.4	11.1	11.5	10.9	11.8	10.4
Agriculture	14.7	15.1	14.1	12.9	13.1	11.2	9.9	8.8	8.7	8.7	7.5	8.2	7.3	6.7	6.8	6.5
Waste	5.1	7.7	9.9	11.0	11.9	12.7	12.5	13.1	13.9	14.6	13.5	15.2	14.0	13.3	12.3	12.3
LUCF	-35.0	-44.0	-44.6	-40.9	-43.2	-38.0	-33.7	-32.8	-33.4	-33.9	-30.6	-36.8	-32.9	-29.8	-32.8	-28.6

Unit: (%)

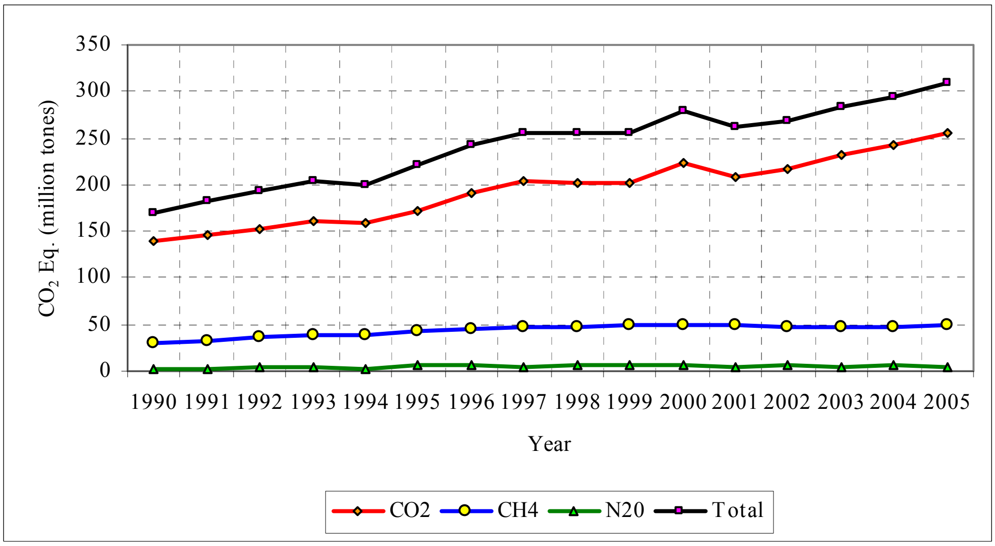


Figure 2.3. Emission trend of main GHGs (CO_2 eq.)

It can be seen from Figure 2.3 that the trend of the basis GHGs show an increase up to the year 2005. This change was mainly the result of the changes accruing in energy sector and industrial processes. The emission from the waste was constant compared to other sector. However, the agricultural emission was reversely decreasing throughout the years. The result may be inferred in Table 2.3 and Figure 2.2.

There were some points in the methodology and the input data, which were;

- The emission from the combustion of biomass was separated in 2005.
- Certain parts were presented as aggregated quantities due to data confidentiality of the industrial sector such as limestone and dolomite use. If the number of the sector is less than three, the production data is confidential in accordance with law. Therefore, the data of limestone and dolomite use was aggregated to the "Mineral Products" and "IE" was used due to the aggregation.
- When assessing the emissions of F-gases only the actual emissions of the HFCs and SF_6 were taken into account. Because the usage of PFCs was not present in Turkey even in aluminium production.
- The solid waste data were gathered from all municipalities. However, the annual survey has been done discontinously. Only the data for years 1994, 1995, 1996, 1997, 1998, 2001, 2002, 2003, 2004 and 2005 were available. Others were estimated by regression analysis.
- The local energy conversion factors were applied for the reference approach on calculations of domestic lignite, hard coal and petroleum products. Average conversion factors for lignite and hardcoal were changing for each year owing to the quality and quantity of these fuels and quantity for petroleum products.
- Emissions from *International Bunkers* were not included in the emissions owing to the lack of data.
- The transport of fuels was not a part of the energy balance of Turkey and emissions were not estimated.
- The emission from the combustion of fuels in iron and steel industry was only the result of burning of fuels in large scale iron and steel production industries. The emission from the small and medium scale enterprises were included in other industries since their fuel combustion can not be obtained separately.

Chapter 3

3. Energy

3.1. Fuel Combustion

The major source of GHGs in Turkey was the fossil fuel combustion. For that reason, this sector was evaluated carefully. The uncertainties and the possible errors in collecting activity data, in selecting emission factors and in estimating emissions were decreased with expert groups' studies. The emission factors (given in annex) for energy consumption are consistent with the IPCC methodology. Some uncertainty was introduced in emission factors and in activity data owing to the variations of the content, process and consumption of fuels. Fuel consumption data were taken from the Ministry of Energy and Natural Resources (MENR; 2006) which is compatible with the IEA system of international energy statistics though there were some small differences in reporting conventions. Administrative sources have been used for preparing this balance sheet except, animal and vegetal wastes which are calculated using estimation methods. Statistics for energy are gathered by various divisions of the government and different annual reports are prepared by various bodies within the Ministry of Energy and Natural Resources for energy production, use and power generation. MENR is responsible organisation for preparing annual energy balance tables.

According to the IPCC, the emission from the energy sector mainly comprises the fuel combustion. As can almost be seen in all countries, the energy sector in Turkey has also the key position for the emission of GHGs. Approximately 90% of the total CO_2 emission was emitted from the energy consumptions. During the calculation of GHGs emissions in energy sector, the sub-sectors were categorized owing to the energy balance tables. These sectors were energy industries, manufacturing industries, transport and other sectors (including residential, agriculture). The emission from the energy sector except for transport sectors and public electricity production were estimated by IPCC Tier 1 approach. However, for these two sectors, the tier 2/3 methodology for computations on a fuel consumption basis in different activities has been compiled.

The results (for transport) were indicating effects of certain improvements in near and long term transportation technologies and strategies for future reductions in transport based GHG emissions. Transportation sector consists of road transportation, domestic civil aviation, railways and national navigation. Emissions from international aviation that cannot be allocated to the national inventory were usually reported separately as unallocated emissions. The fuel consumption data related to aviation was provided only for the domestic consumption. Therefore no results were provided in this work for unallocated emissions resulting from international aviation. The limitation of the available data was not allow any estimation for navigation sector using methodology other than Tier 1. Methods of calculation were based on the IPCC recommendations. Some modifications were made for road transportation according to country specific conditions. The received data was verified and examined for consistencies. Fuel consumption data was obtained from the Ministry of Energy and Natural Resources which was considered as the most accurate data and used for the computations to estimate GHG emissions. Other information was received from Turkish

Automotive Manufacturers Association (OSD), Petroleum Manufacturers Association of Turkey (PETDER) and Turkish State Railways Research Planning and Coordination Department (Soruşbay and Ergeneman, 2006).

Carbon Dioxide (CO_2): CO_2 is the most important GHG owing to the overall responsibilities of 60% Earth's Greenhouse effect. As can be seen from Figure 3.1, the distribution of CO_2 emission from the combustion of fuels by sectors is not changing considerably until the year 1994. There was a slow increase. However, between the year 1995 and 1997, the increase was sharp. While, the trend involves a position steady for the years 1997, 1998 and 1999 and it reaches its highest value in 2000 with a 207 million tones value. After this year, the CO_2 emission decreases then it shows a steady increase until 2005 with a value of 236 million tones.

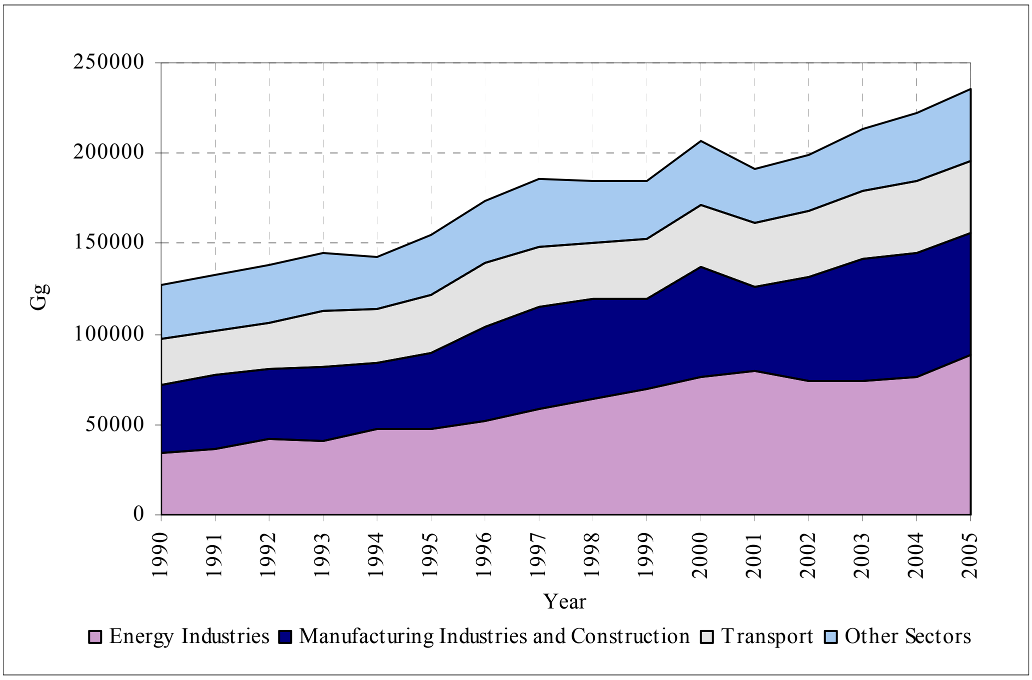


Figure 3.1. CO_2 emission from the combustion of fuels by sectors

In Turkey, the highest emission increase was observed in electricity production with 160.3%. Then it was followed by manufacturing industries with 78.8%, transport with 56.1% and others with 36.5%. The total CO_2 increase in 2005 compared to year 1990 was 86.3%. The CO_2 emission distribution was given in Figure 3.2. The increase in CO_2 emissions was closely linked to the increase in the population.

The CO_2 emission and conversion factors which is consistent with IPCC were used in calculations (Table 3.1).

Nitrous Oxides (N_20): N_20 emission from fuel combustion was increased approximately 52.3% during the period under considerations as seen in Figure 3.3. The highest increase compared to 1990 was observed in transport sector with a value of 151.95%. The increase in manufacturing industries was around 67.49%. As a result, the increase in energy demand causes the increase in N_2O emission.

Table 3.1. Emission and Conversion Factors for CO_2

CO_2 Emission	CO_2 EF Unit: tC/TJ	Efficiency	C-CO_2
Hard Coal	25,8	0,980	3,6667
Lignite	27,6	0,980	3,6667
Asphaltt	25,8	0,980	3,6667
Second Fuel Coal	25,8	0,980	3,6667
Petroleum Coke	25,8	0,980	3,6667
Natural Gas	15,3	0,995	3,6667
Petroleum	20,0	0,990	3,6667
(Residual Fuel Oil)	21,1	0,990	3,6667
(Gas / Diesel Oil)	20,2	0,990	3,6667
(Gasoline)	18,9	0,990	3,6667
(LPG)	17,2	0,990	3,6667
(Refinery Gas)	20,0	0,990	3,6667
(Jet Kerosene)	19,5	0,990	3,6667
(Naphta)	20,0	0,990	3,6667

Methane (CH_4): CH_4 emission from fuel combustion was decreased considerably during the time. The total decreased amount was around 20%. The main reason was the shifting up hard coal and lignite usage into natural gas as fuel consumption of residential areas.

It can be seen from Figure 3.3 that the other gases emission trend involves a peak in 1998 and then it shows a decline until the year of 2005. The main reason, as explained above, was the shifting of fuel coal to natural gas in residential consumption. In the transport sector, some type of emission (as CO) also shows a decline trend due to increasing usage of LPG. Moreover, the consumption of diesel was decreasing after the year 1998.

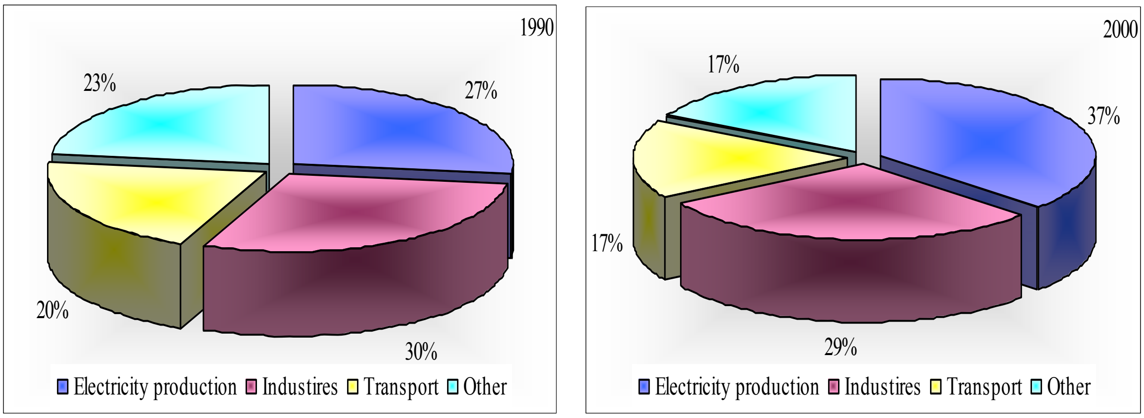


Figure 3.2. CO_2 emission distribution by sectors

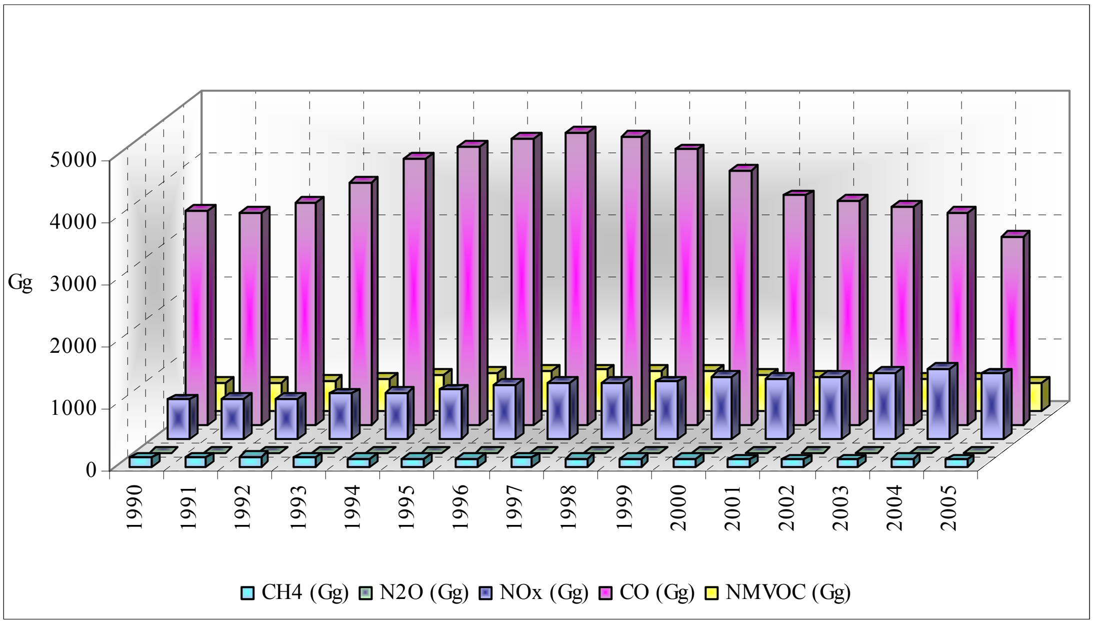


Figure 3.3. CH_4, N_20, NO_X, CO, NMVOC emissions from fuel combustion

The activity data were gathered from the energy balance tables prepared by Ministry of Energy and Natural Resources (MENR). The experts of MENR construct energy balance tables in energy conversion units and original mass units. The experts consider the imported and exported fuel materials significantly. However, there were some small inconsistencies in tables compared with those provided to international organisations. The main reason was the updated energy balance tables which were used for preparing the Turkish National Emission Inventories and Turkish National Inventory Reports.

3.1.1 Energy Industries (1.A.1)

Source Category Description: This source category mainly includes the electricity generation and the use of fossil fuels for petroleum refining. The main fossil fuels used by Turkey were the hard coal, lignite and natural gas. For this sector general fuel consumption data were taken from Energy Balance Tables (MENR, 2006).

Methodological Issues: The fuel consumption data was applied to emission factors (EF) to give an estimation of the direct and indirect greenhouse gas emission. For thermal power plants, the individual emission data were calculated by Electricity Generation Corporation. In order to make estimation for these sectors, the characteristics of each type of fuel consumption was considered separately. The aggregated emission data, were, then compared with the emission estimated by simple multiplication of consumption and EF. The main aim was to increase the quality of the emission estimation and to obtain the country specific emission factors.

Uncertainties and time-series consistency: The activity data for energy sectors were, completely gathered from Energy Balance Tables. After calculating the emissions from all sectors, the GWP weighted emission of CO_2, N_2O and CH_4 were multiplied by source specific data uncertainty to obtain overall uncertainty. The approach to produce quantitative uncertainty estimates was to use expert judgement as described in IPCC Good Practice Guidance and Uncertainty Management (2000) Reference. Sectoral expert calculated the uncertainty and combined with their judgement to minimise the risk of bias. The main judgement of the activity data was depending on mass balance considerations. The combine uncertainties in emission factors and activity data were explained in annex in detail.

Table 3.2. Time series consistency of emission factor for (1.A.1)

Source Category	GHGs	Fuel Type	Comments on time series consistency
1.A.1	CO_2	All Fuels	* EF were not vary until 2004 for (1.A.1.a). For 2005, Country Specific EFs have been used for (1.A.1.a) and Electricity Generation Corporation have been responsible for (1.A.1.a) calculations. Others were all constant over the entire time series.
1.A.1	N_20, CH_4	All Fuels	* EF were not vary until 2004 for (1.A.1.a). For 2005, Country Specific EFs have been used for (1.A.1.a) and Electricity Generation Corporation have been responsible for (1.A.1.a) calculations. Others were all constant over the entire time series.

Source-specific QA/QC and verification: Turkish emission inventory working group had the same mind as to implement quality assurance and quality control (QA/QC) procedures with good practice. However, some sub-sectors as thermal power plants data were source-specific and in detail. Therefore more advance methodology was selected for this sector. For (1.A.1) group, fuel supply statistics were available and collected from energy balance tables. The reference approaches with correcting for stock change, import and exports was calculated. Except for “Thermal Power Plants”, which “bottom-up” approach was selected for emission estimation, fuel combustion by source category was not available. The fuel delivery statistics for (1.A.1.b) was available by source category. Therefore, GHGs emissions were estimated by using Tier 1 approach by using IPCC Good Practice Guidance (2000).

Recalculation: There was no change in sector 1.A.1 per pollutant for 1990-2005.

3.1.1.1 Public Electricity and Heat Production (1.A.1.a)

Source Category Description: This section, which is prepared by the Electricity Generation Corporation, is very important because, "Public Electricity and Heat Production" (1.A.1.a) was a key category in terms of emissions level for CO_2 emissions of lignite, natural gas, hard coal and residual fuel-oil consumption. The CO_2 emission from the combustion of hard coal, lignite and natural gas was considerably high throughout the years. In Turkey, the quality of domestic lignite and hard coal are not good. However, the fuels lignite and coal were shifted to natural gas. As a result of, the emission trend involves a decrease after the year 1998.

In 2005, electricity production kept its major role in GHG emissions. The generation capacity reached to 39 GW with 5% increase from the previous year and 138% from 1990 values. As it was in the past years, electricity generation has grown rapidly in this year too. It increased from 151 TWh in 2004 to 162 TWh in 2005 with annual average growth rate of 7.3%. The production in 1990 was 57.5 TWh. The share of electricity generation by fuel types realized as natural gas 45.3%, coal 26,7%, hydro other renewables 24.6% and oil 3.4%. Because of water stresses and limited rainfall in the last few years, hydropower production decreased from 46.1 TWh in 2004 and to 39.6 TWh in 2005, although some increase in hydropower capacity. The high demand in electricity had to be met by thermal power production, increasing their share in the energy balances. In 2005, thermal power production produced 122 TWh of electricity, meeting 75% of the demand with 67% share of total installed capacity.

In 2004, the net electricity consumption in the country was 121 TWh, per capita net consumption was 1703 kWh and per capita gross consumption was 2108 kWh, these amounts reached 130 TWh, 1808 kWh and 2231 kWh respectively in 2005, an increase of over 7% per annum.

Total Primary Energy Supply (TPES) in Turkey was 90.4 Mtoe with an increase of 2.8% from the previous year and of 72.4% from 1990 levels. Oil accounted for the largest share of energy demand with 34.5%, followed by natural gas with 27.7%, hard coal with 13.9%, lignite with 10.7%, non-commercial fuels with 5.9%, hydro and other renewables with 5.3% and secondary coal with 2% in 2005.

Primary energy production increased by % 0.8 from 24.3 million tons of oil equivalent (Mtoe) in 2004 to 24.5 Mtoe in 2005, and provided 29% of overall energy supply. The production of almost all energy sources, excluding animal & vegetal waste and hydraulic energy, has increased. Local oil and natural gas production is relatively small, and the main domestic energy source is coal, mostly lignite, with a production amounted to 57.7 million tons (Mt) in 2005. Primary energy production was composed of coal (45.6%), oil and natural gas 13.1%, hydro and geothermal electricity (14.2%), other renewable sources (5.4%) and non-commercial sources (21.7%) of primary energy production in 2005.

Methodological Issues: The basic source for emission factors for the inventories was the IPCC Guidelines. NOx emissions are calculated by using country specific emission factors and greenhouse gas emissions (CO_2, CH_4, N_2O, CO and NMVOC) are calculated using IPCC emission factors. In calculation of country specific emission factors, two methods are used. If the related thermal power plant (TPP) has a continuous measurement equipment, the measured values are used which are automatically sent to the related division, otherwise fuel characteristics of the TPP are used and an emission factor is calculated. In lack or inadequacy of data, the value measured by universities or private companies using portable equipments are also used. All the data are originally obtained via questionnaires, yearly reports and then evaluated by the relevant department within the Ministry.

Emission factors of NOx emissions are computed using measured emission values for the TPPs having continuous measurement equipments according the formula below;

$$EF\ (kg\ ,NOx\ /GJ) = \frac{MEV\ (mg/Nm3) \times 10\text{-}6\ (kg/mg) \times FGR\ (Nm3/h)}{HI\ (Kcal/h) \times 4.187\text{x}10\text{-}6\ (GJ/\ Kcal)}$$

where:

EF : Emission Factor
MEV : Measured Emission Values
FGFR : Flue Gas Flow Rate
HI : Heat input

For other greenhouse gases (CO2, CH4, N2O, CO and NMVOC), IPCC emission factors are used.
All the emissions are calculated as in the following formula:

$$\text{Emissions (ton)} = \frac{\text{Input Activity (GJ) x Emission Factor (kg/Gj)}}{1000}$$

Fraction of oxidized carbon values were taken from the IPCC Guidelines for coal, oil and gas.

3.1.1.2 Petroleum refining (1.A.1.b)

"Petroleum refining" (1.A.1.b) was a key category in terms of emissions level for CO_2 emissions of residual fuel-oil and refinery gas consumption. The contribution to total CO_2 emission from petroleum refining was ranging between 2.3% and 3.3% throughout the years. Fuel inputs in refinery power stations were taken from energy balance tables of MENR. The emission factors were default from the IPCC Methodology. The uncertainty of activity data were estimated by MENR experts.

3.1.1.3 Manufacture of solid fuels and other energy industries (1.A.1.c)

This section was not separated from the Electricity and Heat Production. Therefore it was considered within part 1.A.1.a or 1.B.1.a. Although some parties have considered hard coal and lignite mining within this section, Turkey does not.

3.1.2 Manufacturing industries and construction (1.A.2)

Source Category Description: This source category consists of sub-source categories defined in close harmony with the IPCC categorisations. However, Pulp, Paper and Print (1.A.2.d) and Food Processing, Beverages and Tobacco (1.A.2.e) were considered in part “other (1.A.2.f)”. For the years between 1990 and 2004, “Cement Production”, “Sugar Production”, “Fertilizer Industries” and “Other Industries” was given as aggregated. But, it was separated in 2005. Although the sub-source category head was seen as “Cement Production, Sugar, Fertilizer and Other Industries”, it was the other industries for year 2005. In 2005, (1.A.2.f) was separated into 4 sub-source categories as seen below:

- Cement Production
- Sugar
- Fertilizer
- Other Industries

The industries’ process combustion and power generation were not separated in the energy balance tables.

Methodological Issues: The fuel consumption data was applied to emission factors (EF) to give estimations of the greenhouse gase emission. The MENR tables were used to obtain relevant activity data. The emission factors were given in annex.

Uncertainties and time-series consistency: The approach to produce quantitative uncertainty estimates was to use expert judgement as described in IPCC Good Practice Guidance and Uncertainty Management (2000) Reference. Sectoral expert calculated the uncertainty and combined with their judgement to minimise the risk of bias. The main judgement of the activity data was depending on mass balance considerations. The combine uncertainties in emission factors and activity data were explained in annex in detail.

Table 3.3. Time series consistency of emission factor for (1.A.2)

Source Category	GHGs	Fuel Type	Comments on time series consistency
1.A.2	CO_2	All Fuels	* All EF were constant over the entire time series.
1.A.2	N_20, CH_4	All Fuels	* All EF were constant over the entire time series.

Source-specific QA/QC and verification: This source category was covered by the general QA/QC of the greenhouse gas inventory. The fuel supply statistics were available for this group sectors. However, Pulp, Paper and Print (1.A.2.d) and Food Processing, Beverages and Tobacco (1.A.2.e) were considered in part "other (1.A.2.f)", because data for these two sub-group sources were not separable. Except for (1.A.2.e) and (1.A.2.f), the fuel delivery statistics were available by source category. Therefore, GHGs emissions were estimated by using Tier 1 approach by using IPCC Good Practice Guidance (2000).

Recalculation: There wasn't any change in sector 1.A.2 for 1990-2005.

3.1.2.1 Iron and Steel Industries (1.A.2.a)

The source category "Manufacturing industries and construction – iron and steel" was a key category, in terms of CO_2 emissions. The relevant fuel-use amounts, including those for secondary fuel coal in iron and steel industries were taken from energy balance tables of MENR. The emission from the Iron and steel industry was very high compared to other sectors. The main reason was the burning of coal during the processing. The emission from the combustion of fuels in iron and steel industry was only the result of burning of fuels in large scale iron and steel production industries. The emission from small and medium scale enterprises were included in other industries since their fuel combustion could not be obtained separately.

3.1.2.2 Non - Ferrous Metal (1.A.2.b)

The source category "Non –Ferrous Metal" was a key category, in terms of CO_2 emission from Natural Gas burning. The CO_2 emission compared to total CO_2 emission from the combustion of petroleum was ranging between 0.4% and 0.6%.

3.1.2.3 Chemicals (1.A.2.c)

The source category "chemicals" was a key category, in terms of CO_2 emissions from Residual fuel-oil and natural gas burning.

3.1.2.4 Pulp, Paper and Print (1.A.2.d)

The energy consumption for production of pulp, paper and printed products was not separated in the energy balance tables. Therefore emissions from use of regular fuels in process combustion, and emissions generated by plants in own-power generation, were not been listed separately. They were summarised under other (1.A.2.f).

3.1.2.5 Food Processing, Beverages and Tobacco (1.A.2.e)

This section was also summarised under other (1.A.2.f). Because the fuels used in process combustion and power generation was not separated in energy balance tables and aggregated into part "other (1.A.2.f)".

3.1.2.6 Other – Cement Production (1.A.2.f)

Cement production involves considerable fuel substitutions in burning of clinkers. In the process, the fuels as lignite, hard coal, coke and petroleum coke were used. The source category "Cement Production" was a key category in terms of CO_2 emissions.

3.1.2.7 Other – Sugar (1.A.2.f)

The source category "Sugar Industries" was a key category in terms of CO_2 emissions. The fuel input data for Energy Balance Tables has been taken by MENR from annual progress report of manufacturing industries.

3.1.2.8 Other – Fertilizer (1.A.2.f)

The source category "Fertilizer" was a key category in terms of CO_2 emissions from natural gases. The fuel input data for Energy Balances Tables has been taken by MENR from annual progress report of manufacturing industries.

3.1.2.8 Other (1.A.2.f)

The source category "Other" was a key category in terms of CO_2 emissions from hard coal, natural gas, residual fuel-oil, LPG, gas/diesel oil. The fuel input data for Energy Balance Tables has been taken by MENR from annual progress report of manufacturing industries.

3.1.3 TRANSPORT (1.A.3)

Overview of Transport Sector

Turkey is surrounded by the Black Sea on the north and the Mediterranean Sea on the south it connects the Balkans to the Middle East, Central Asia to the Caucasus and the Black Sea countries with the Mediterranean countries. Due to this geographical conditions, Turkey is just located on the main artery of traffic between Asia and Europe. As a result, the transport is a very important sector. Since it is also concerning with the economy, production, employment and regional development.

As a consequence, the demand of transport has grown significantly over the past five decades. These transportation activities were mostly conducted by road and railways. In 2004, as an example, 98% of passenger transportation and almost 100% of freight transportation were conducted by these two modes.

While the demand of transport increased, the share of the transportation sector in total final energy consumption decreased from 21% to 20% from the year series of 1990 to 2004. Within the same period, the share of total equivalent CO_2 emissions from transport was also decreased from 20.5% to 18.2% (Figure 3.4). However, total $C0_2$ emissions from the transport sector changed from 25955 kt to 40458 kt during the years 1990-2004 with an increase of 55.8%. This corresponds to a change from 0.46 ton CO_2 per capita in 1990 to 0.56 ton CO_2 per capita in 2004 in terms of CO_2 emissions from the transport sector.

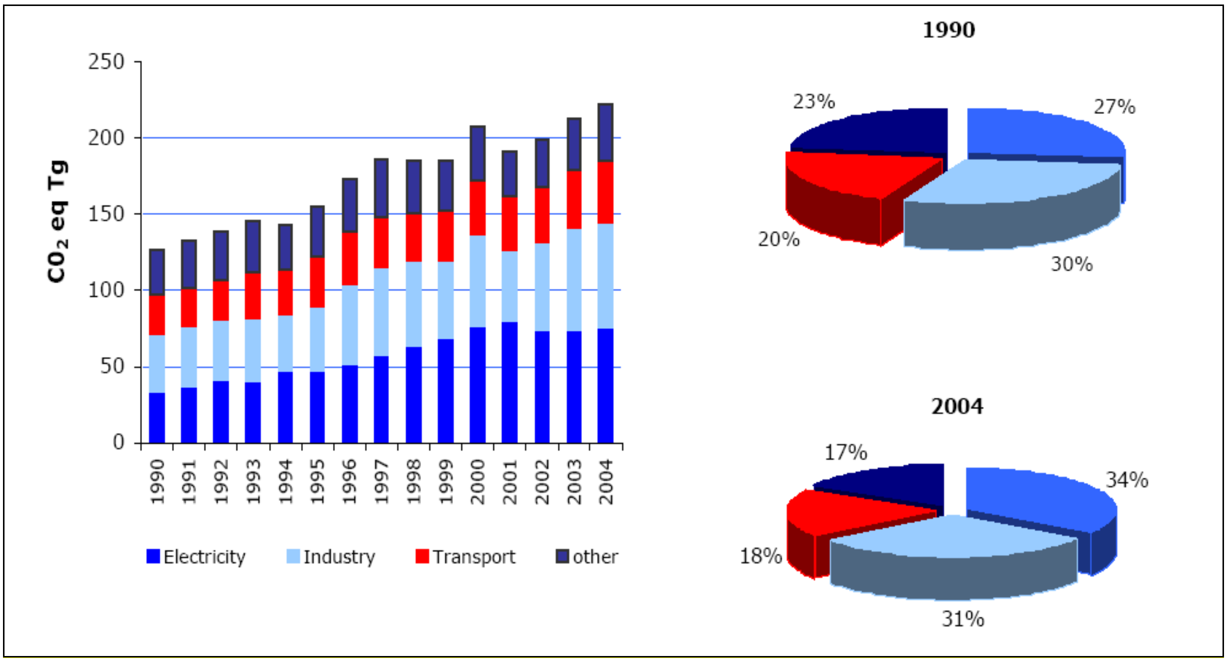


Figure 3.4. Change of Share of the Transport within the Total Final Energy Consumption

This decrease mentioned above indicates a tendency towards more efficient energy consumption in this sector. The factors underlying this efficiency are explained by alternative fuel usage with low carbon content and by increased amount of use of diesel-fuelled and LPG-fuelled passenger vehicles. These are more efficient than equivalent gasoline powered passenger cars, bringing CO_2 emission levels down per unit distance travelled. Figure 3.5 shows the increasing trend of gasoline vehicles using different fuels during the years 1990-2004.

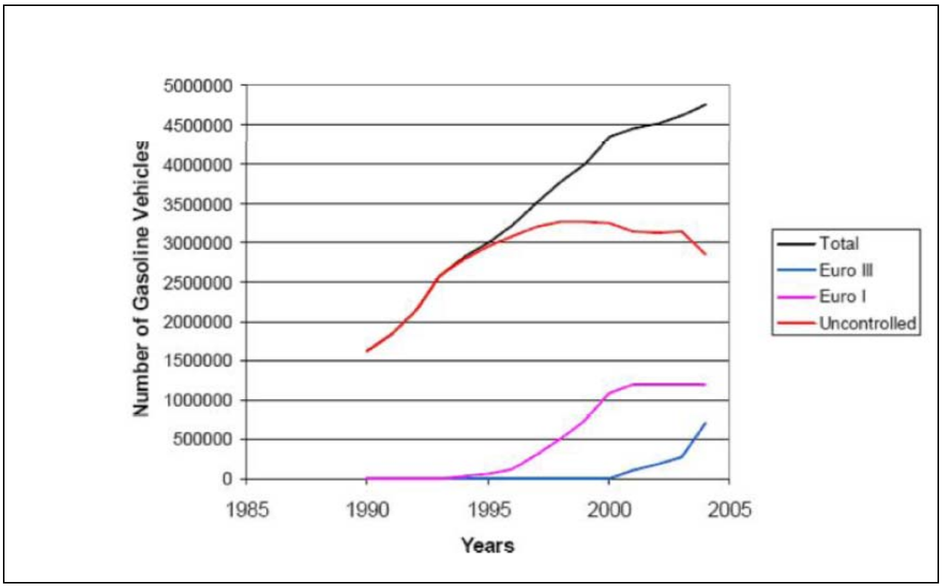


Figure 3.5. Number of Vehicles Using Different Fuels along the Years 1990-2004

Methods, Activity Data, Emission Factors and Uncertainties
Ministry of Transport, Ministry of Energy, Ministry of Public Work and Settlements, The Association of Petroleum Industry (PETDER) and Automotive Manufacturer Association (OSD) are the data suppliers of transport sector for the estimation of GHGs resulted from transport sector.

Methods Used In Calculation:
IPCC Tier 1 and Tier 2/3 Approaches were used for estimation of the GHGs. For Tier 1 Approaches, the amount of annual energy consumption, the calorific values of the fuels, and C content of the fuels were used as activity data. Then, by considering production technology and operational conditions of the vehicles, some re-calculation was done according to Tier 2/3 Approaches to improve the quality of the calculation of road ways, railways and domestic aviation.

The Uncertainties in Calculation:
In uncertainties are coming from different lack of information summarized below:

- There weren't any country specific emission factors, but an investigation project on this subject is going on,
- Amount of km done by different type of vehicles were not known,
- Number of electricity generators and amount of diesel oil used in this sector was not known,
- Amount of diesel oil used for house heating was not known,
- Technical producing specifications of the airplanes were not well known,
- In aviation sector, fuel used in domestic line and consumed in international line couldn't be separated yet, but discussion on this subject is going on,

- The quality of freight and passenger data was not well known.

- The energy consuming data coming from Ministry of Energy and data from PETDER were not coincide each other,

- Unregistered borderline trade of petroleum products.

Due to explained reasons, there are some uncertainties in calculation. For domestic aviation, the total uncertainty was accepted as 15 %. 7% of it was coming from emission factors and 7% of it was coming from activity data. For railways, the total uncertainties were assumed same with domestic aviation. But, the effect of emission factors was more than it and it was accepted about 10%.

Activity Data:
In general, petroleum products such as gasoline, diesel-oil and recently some considerable amounts of LPG are used in road transportation for energy need. Jet kerosene is used in aviation. Diesel-oil and residual fuel oil are used in both rail transport and national navigation. Table 3.4 shows the sectorial distribution of fuel consumption between 1990 and 2005.

From rail transport points of view, fuel oil usage amount continued up to 1998. Then, it was stopped due to electrification of the rail lines. However, the usage of diesel oil increased continuously during this period. But because of economical reasons, it stayed nearly the same within the next following two years. As a result of this, the consumption in railway sector decreased 17.5% in 2001 compared with the consumption of the year before. The policy precautions were taken in this sector gave an increase in transportation activities. As a consequence, consumption trend increased steadily from 2003 to 2005. And finally, the consumption of 2005 was about 20.3% more than the consumption of 2004.

From road transport point of view, up to year 1997, only diesel oil and gasoline were used. In 1998, LPG was started to consume with a 4%. But, this amount rose steadily and reached to 12% of the total usages of road transport sector in 2000. Then, diesel oil consumption and LPG consumption increased 1.9% and 7.9% respectively, and gasoline consumption declined 2.9% in 2005 comparing with 2004.

Fuel consumption raised steadily in civil aviation sector up to year 1999. As a consequence of economical reasons, fuel consumption values declined from 1999 to 2002. However, the re-arrangement policy of Ministry of Transport was given a sudden improvement in civil aviation sector. Then again, the fuel consumption started to increase. Table 1 showed a sharp decrease in fuel usage in 2005, which was 15% less then the year before. This was due to renewal of the Turkish air fleet and adjustment to the body of current law of environment of the European Union. Another reason was assumed coming from the number of increase in hired aircraft for foreign companies.

In navigation sector, the fuel oil consumption was more than diesel oil consumption from 1990 to 1998. But then, diesel oil usages were always more then fuel oil usages along the years 1999-2005. Only since the economical reasons, between 1999 and 2002, the consumption values were stayed nearly stable. The stipulation applied to this sector such as declining of some taxes resulted activation in this sector. Then, fuel usage amount increased again. Amount of increase in usage of diesel oil in 2005 was 7.7% more than the usage of 2004.

Table 3.4. Fuel Consumption in Transport Sector Between 1990 and 2005 (tonnes)

Year	**Type of Transport**	**Type of Fuel**				
		Fuel Oil	**Gas/Diesel Oil**	**Gasoline**	**LPG**	**Jet Kerosene**
1990	Rail Transport	25000	162062			
	National Navigation	90000	69376			
	Domestic Aviation					292223
	Road Transport		4954663	2698435		
	Total	**115000**	**5186101**	**2698435**		**292223**
1991	Rail Transport	30000	165000			
	National Navigation	95000	75000			
	Domestic Aviation					330900
	Road Transport		4573530	2619631		
	Total	**125000**	**4813530**	**2619631**		**330900**
1992	Rail Transport	30000	156000			
	National Navigation	120000	80000			
	Domestic Aviation					350945
	Road Transport		4426348	2946504		
	Total	**150000**	**4662348**	**2946504**		**350945**
1993	Rail Transport	22784	183000			
	National Navigation	120977	87000			
	Domestic Aviation					468153
	Road Transport		5478490	3533735		
	Total	**143761**	**5748490**	**3533735**		**468153**
1994	Rail Transport	19409	194000			
	National Navigation	103059	92000			
	Domestic Aviation					521906
	Road Transport		4912182	3555025		
	Total	**122468**	**5198182**	**3555025**		**521906**
1995	Rail Transport	21550	194000			
	National Navigation	133918	93724			
	Domestic Aviation					867237
	Road Transport		5245145	3945675		
	Total	**155468**	**5532869**	**3945675**		**867237**
1996	Rail Transport	22300	198300			
	National Navigation	124774	94356			
	Domestic Aviation					956326
	Road Transport		5507139	4259870		
	Total	**147074**	**5799795**	**4259870**		**956326**
1997	Rail Transport	25000	198000			
	National Navigation	123190	95500			
	Domestic Aviation					1009831
	Road Transport		4448150	4388170	405000	
	Total	**148190**	**4741650**	**4388170**	**405000**	**1009831**

Year	Type of Transport	Type of Fuel				
		Fuel Oil	Gas/Diesel Oil	Gasoline	LPG	Jet Kerosene
1998	Rail Transport	5000	200000			
	National Navigation	122300	105000			
	Domestic Aviation					1038409
	Road Transport		3542895	4545391	550000	
	Total	**127300**	**3847895**	**4545391**	**550000**	**1038409**
1999	Rail Transport		200000			
	National Navigation	101000	105000			
	Domestic Aviation					899443
	Road Transport		4358322	4305850	705073	
	Total	**101000**	**4663322**	**4305850**	**705073**	**899443**
2000	Rail Transport		200000			
	National Navigation	90000	105000			
	Domestic Aviation					970991
	Road Transport		4942353	3655455	1307492	
	Total	**90000**	**5247353**	**3655455**	**1307492**	**970991**
2001	Rail Transport		165000			
	National Navigation	95000	155000			
	Domestic Aviation					1055046
	Road Transport		5327839	3171274	1302331	
	Total	**95000**	**5647839**	**3171274**	**1302331**	**1055046**
2002	Rail Transport		172000			
	National Navigation	97800	159000			
	Domestic Aviation					340695
	Road Transport		5728410	3143248	1095436	
	Total	**97800**	**6059410**	**3143248**	**1095436**	**340695**
2003	Rail Transport		177000			
	National Navigation	104300	174000			
	Domestic Aviation					850483
	Road Transport		6193132	2958066	1212668	
	Total	**104300**	**6544132**	**2958066**	**1212668**	**850483**
2004	Rail Transport		177000			
	National Navigation	109300	274000			
	Domestic Aviation					1526855
	Road Transport		6682964	2961803	1260207	
	Total	**109300**	**7133964**	**2961803**	**1260207**	**1526855**
2005	Rail Transport		**213000**			
	National Navigation	**110500**	**295000**			
	Domestic Aviation					**1284529**
	Road Transport		**6812260**	**2874758**	**1360000**	
	Total	110500	7320260	2874758	1360000	1284529

The change of road fleet of Turkey between 1990 and 2004 are given in Figure 3.6. Great part of this fleet is passenger car. It takes 60% of total vehicles in 2004. The number of pick-up and farm tractor follows the passenger car with their increasing number. In addition, the number of cars per 1000 capita is 80 (Figure 3.7). Comparing with other countries, the number of cars is fairly below the saturation level, it is likely to go up within the next 10 years.

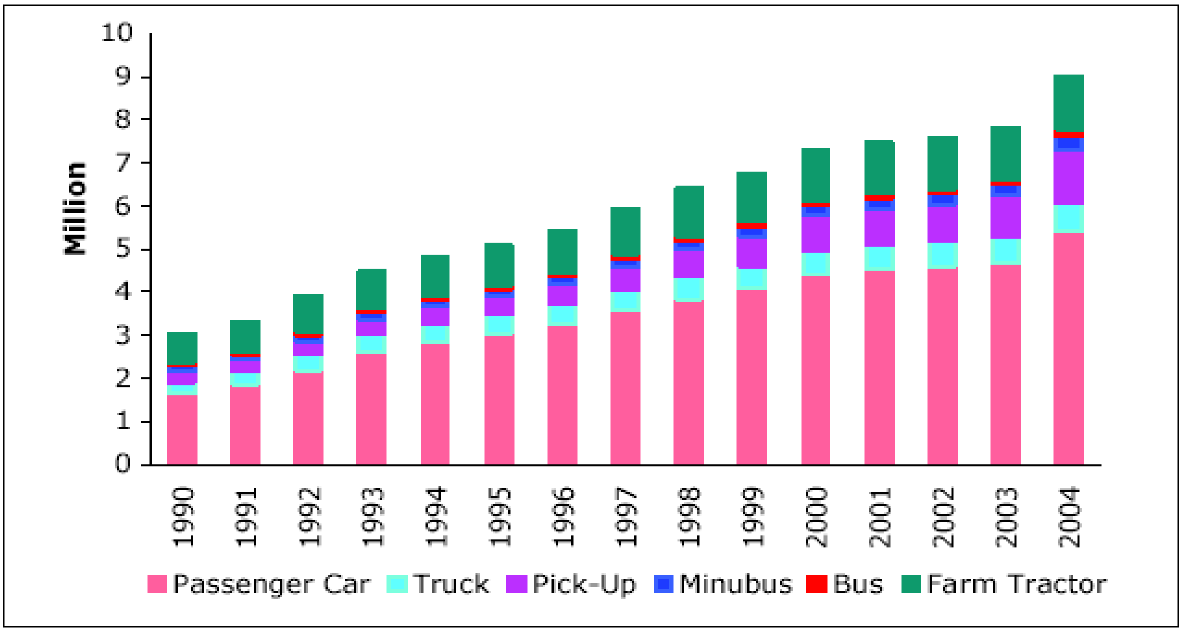


Figure 3.6 The number of Change of Vehicles during years 1990-2005

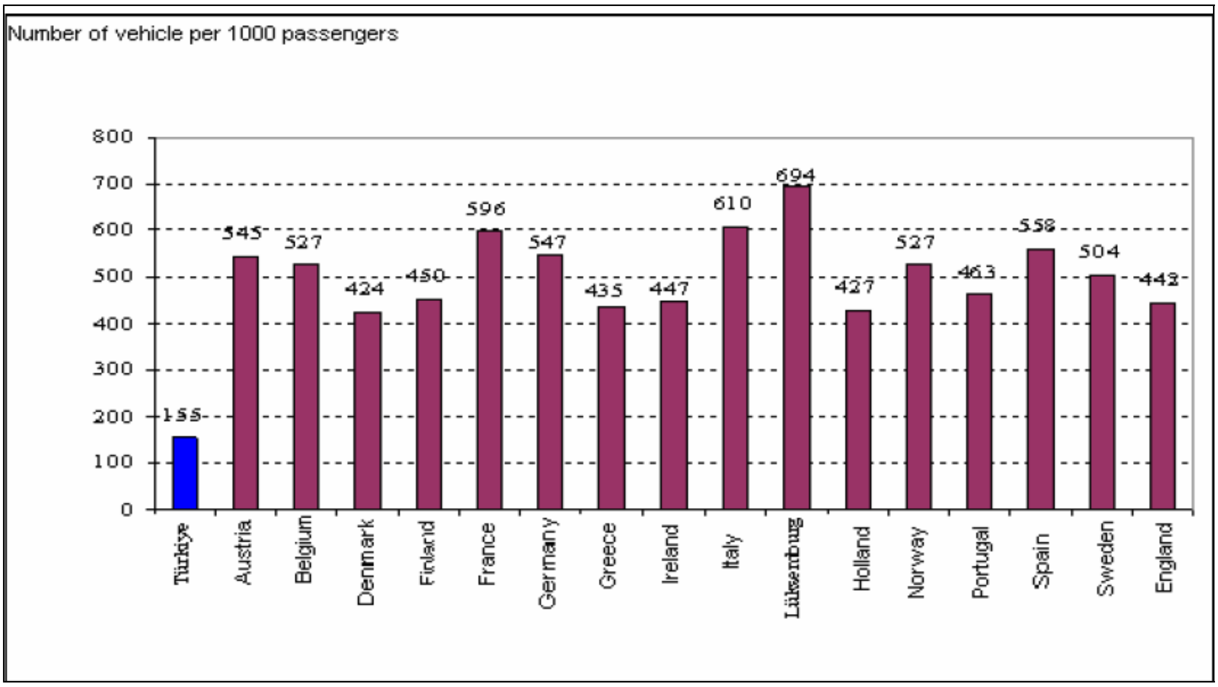


Figure 3.7. Number of Vehicles per 1000 Capita in Different Countiries

There are more than 400 coastal facilities in our country, such as; ports, boat harbors, docks, fishermen's shelters, distributed on a coastline of 8333 kilometers. There are three types of ports ownership. One port owner is DG of Turkish Railways (TCDD). The second one is private sector. The third one is municipalities. According to this, 7 ports belonging to TCDD and 13 ports belonging to public and private enterprises handle most of the goods traffic in Turkey. These 20 ports handle around 60% of the total ports and 70% of dry cargo in Turkey and there is an increase of 10% in activity in these ports. Considering only dry cargo, there is an annual increase of %15. This increase mostly involves container traffic. In the below Table

3.5, 3.6, the development of sea fleet between 1990 and 2003 and development in seaborne freight transport are given.

Table 3.5. Number of Change of Ships between 1993 and 2003

Year	Number of Ships
1993	1.012
1994	1.050
1995	1.143
1996	1.179
1997	1.197
1998	1.204
1999	1.242
2000	1.270
2001	1.261
2002	1.185
2003	1.151

Table 3.6. Development in seaborne Transport (millions tons)

Years	Total	Export	İmport
2002	125	39	86
2003	140	41	99
2004	152	47	105
2005	182	54	127

Turkish civil aviation operators have flights to 38 points within the country and 103 points abroad. The operated Turkish Airports are given in Figure 3.8. Year 2004 air traffic is given as example (Table 3.7). By the end of 2005, the number of carried passengers increased by 38 % in domestic lines with regard to the year 2004. Between the years 2004 and 2005, there is an increase of cargo capacity by 20 % in the domestic lines and by 8 % in the international lines. The shares of Turkish air carriers have increased in the international carriage from 18% in 2002 to 56% by the end of 2005. (Figure 3.9 and Table 3.8)

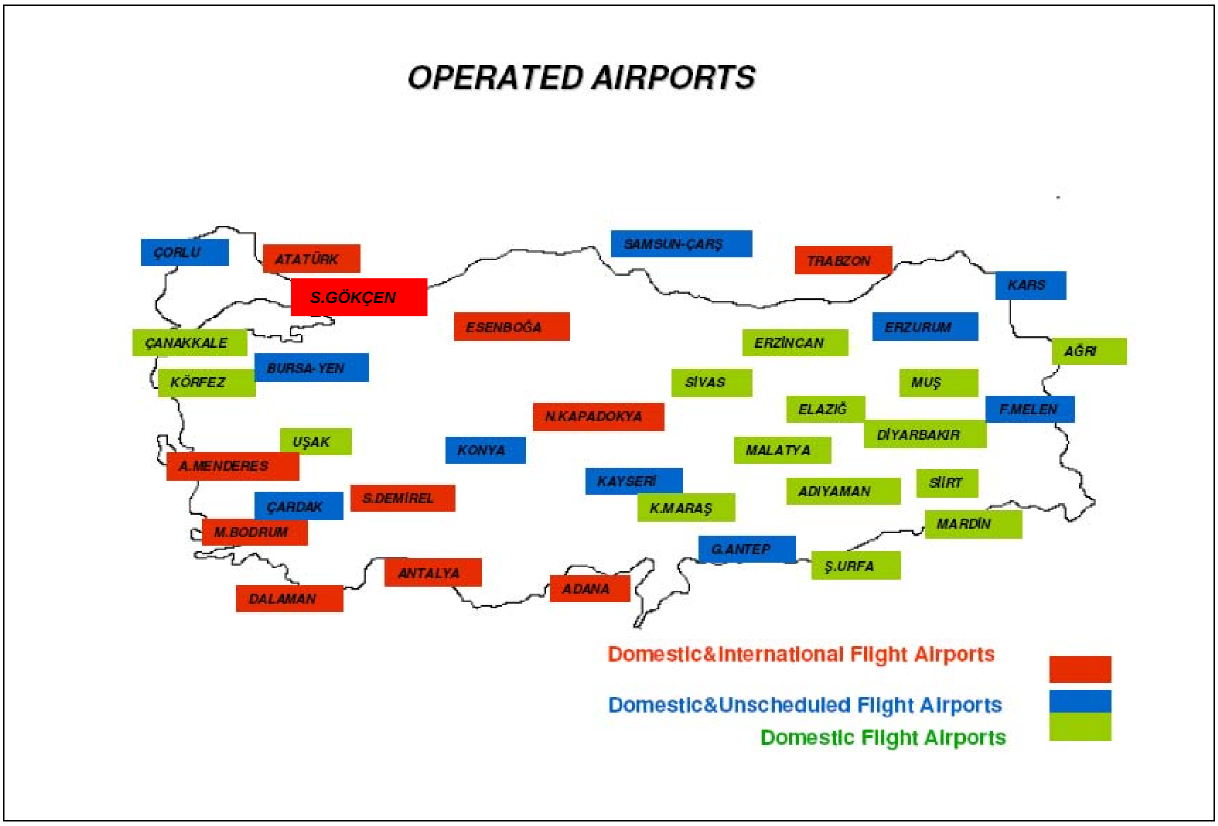


Figure 3.8. Operated Airports (2004)

Table 3.7. Air Traffic occurred in Turkish Airport in the 2004

Name of Airport	*1.1.1 Number of Air Traffic*		
	Domestic Line	**International Line**	**TOTAL**
ATATÜRK	72.479	115.008	187.487
SABİHA GÖKÇEN	3.237	5.746	8.983
ESENBOĞA	29.359	12.539	41.898
A.MENDERES	16.991	11.744	28.735
ANTALYA	14.455	74.105	88.560
DALAMAN	5.215	15.863	21.078
ADANA	10.767	2.890	13.657
TRABZON	6.332	1.514	7.846
MİLAS – BODRUM	5.613	10.516	16.129
S.DEMİREL	219	35	254
NEVŞEHİR – KAP.	205	142	347
ADIYAMAN	20		20
AĞRI	235		235
BURSA-YENİŞEHİR	1275	194	1469
ÇANAKKALE	441	4	445
ÇARDAK	701	7	708
ÇORLU	874	204	1.078
DİYARBAKIR	4.011	136	4.147
ELAZIĞ	665		665
ERZİNCAN	1.091		1.091
ERZURUM	2.638	200	2.838
GAZİANTEP	4.040	329	4.369
K.MARAŞ	4		4
KARS	986		986
KAYSERİ	2.876	1.340	4.216
KONYA	1.539	149	1.688
KÖRFEZ	637		637
MALATYA	1.756		1.756
MARDİN	339	1	340
MUŞ	416		416
SAMSUN-ÇARŞAMBA	2.789	600	3.389
SİİRT	44		44
SİVAS	226		226
ŞANLIURFA	556		556
FERİT MELEN	2.904	20	2924
TOTAL	**195.6935**	**253.286**	**449.221**
OVERFLIGHT	**191.056**		

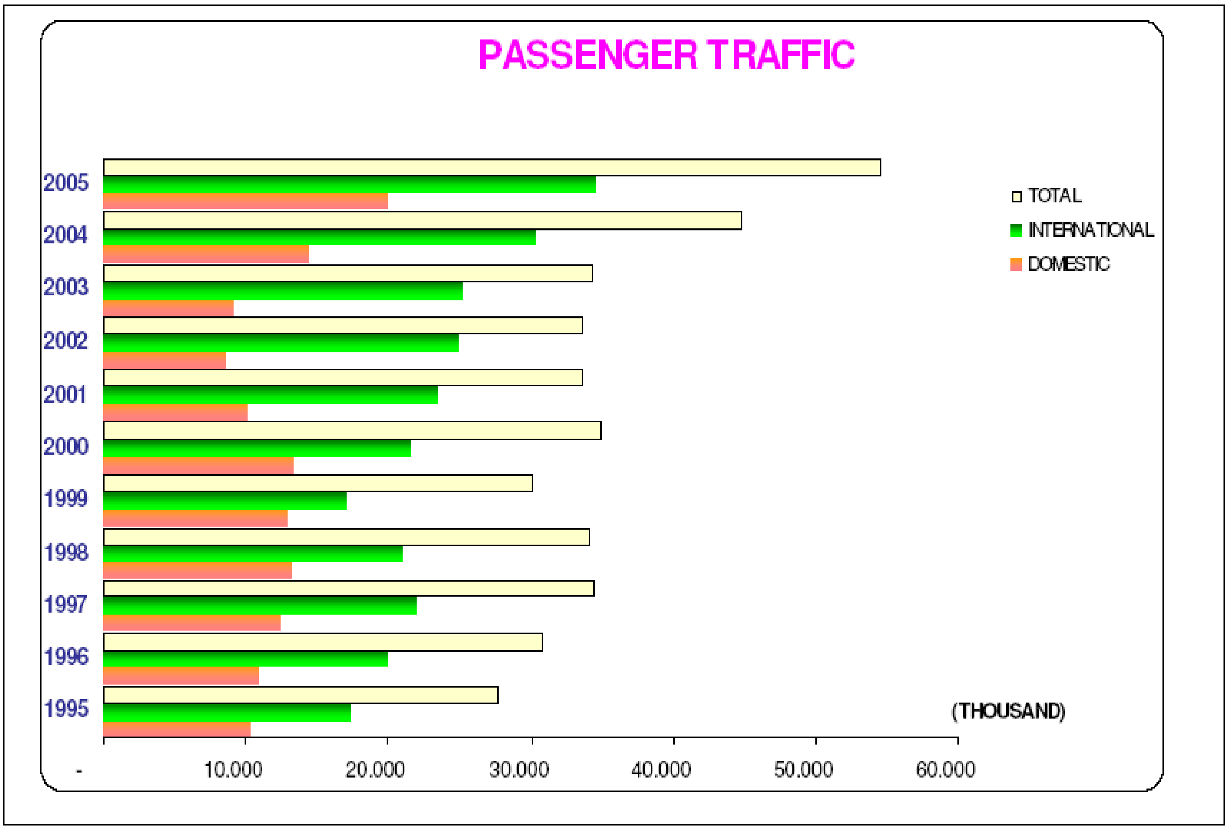


Figure 3.9. Passenger Traffic Between 1995 and 2005

Table 3.8. Operational Facilities between 1995 and 2005

OPERATIONAL FACILITIES	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Aircraft Traffic (Thousand)	348	372	404	415	389	391	374	371	368	441	534
Domestic	169	176	197	218	213	201	168	155	154	193	257
International	179	196	207	197	176	190	206	216	214	248	277
OVERFLIGHT	123	124	125	131	149	152	149	156	154	191	206
Passenger Traffic (Thousand))	27.767	30.781	34.397	34.200	30.012	34.973	33.620	33.625	34.267	44.789	54.526
Domestic	10.347	10.863	12.414	13.239	12.932	13.339	10.057	8.698	9.125	14.428	19.943
Incoming	5.145	5.425	6.189	6.617	6.477	6.664	5.150	4.418	4.622	7.286	10.078
Outgoing	5.202	5.438	6.225	6.622	6.455	6.675	4.907	4.280	4.503	7.142	9.865
International	17.420	19.918	21.983	20.961	17.080	21.634	23.563	24.927	25.142	30.361	34.583
Incoming	8.656	9.936	10.896	10.330	8.484	10.655	11.796	12.546	12.661	15.056	17.041
Outgoing	8.764	9.982	11.087	10.631	8.596	10.979	11.767	12.381	12.481	15.305	17.542
Ttansit Passenger (Thousand)	265	229	301	452	384	1.593	2.293	2.316	2.084	2.108	2.182
CARGO-MAIL-BAGGAGE TRAFFIC (Thousand Tonnes)	577	652	792	726	686	796	764	880	931	1.126	331
Domestic	172	182	212	210	218	226	172	181	189	263	72
Incoming	84	90	105	104	108	117	86	91	95	133	36
Outgoing	88	92	107	106	110	109	86	90	94	130	36
International	405	470	580	516	468	570	592	699	742	863	259
Incoming	179	205	241	235	217	275	260	304	331	400	119
Outgoing	226	265	339	281	251	295	332	395	411	463	140

In order to increase the share of the railways in the passenger and freight transport and to give a competitive power against other modes of transport, the provision of the fast, economical and reliable railway transport was decided. Then, the budgetary funds allocated to the railways are augmented by 400% between the years 2003 – 2006. Regarding the current works for restructuring and modernization of railways, high-speed train projects gain importance in order to increase the share of rail for passenger transport in previous years. Also existing lines are being modernized for interoperability.

Table 3.9, Table 3.10 and Table 3.11 gives rail line development, freight and passenger transport between 1999 and 2005, respectively (Figure 3.10).

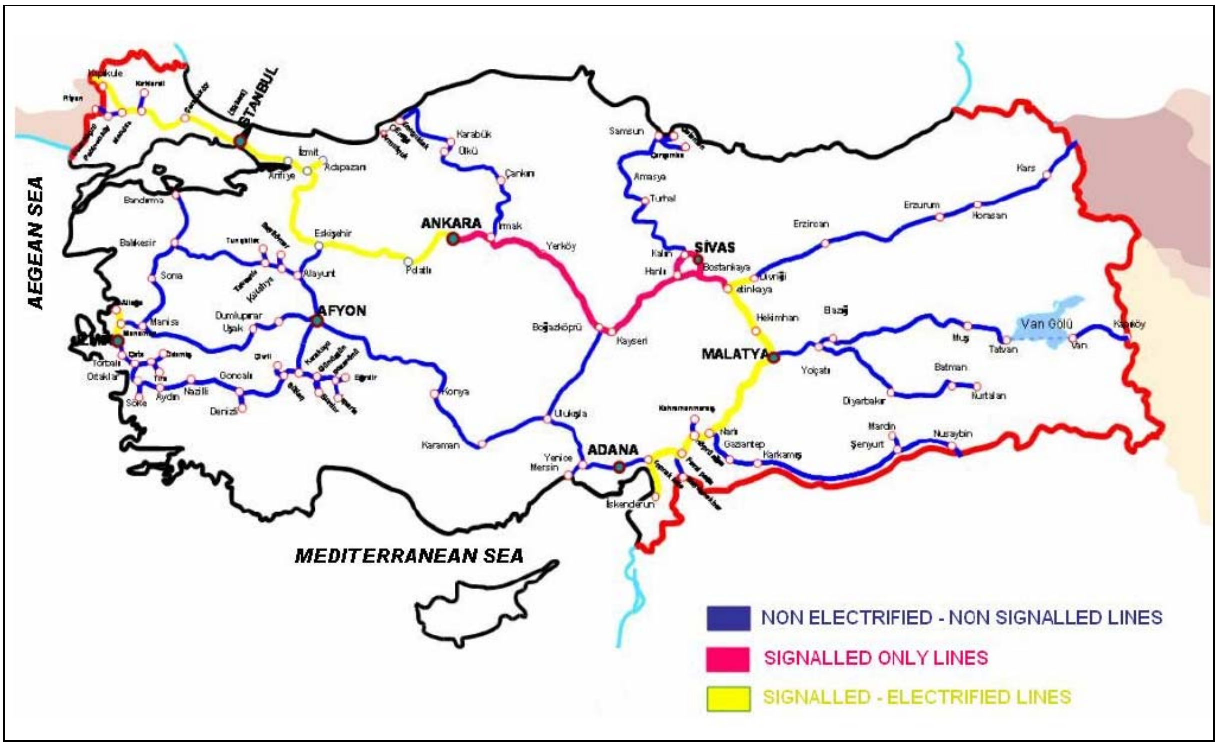


Figure 3.10. Present Situation of TCDD Rail Lines

Table 3.9. Rail Line Development along years 1999-2006

Year	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2006
Electrified (km)	1.033	1.093	1.093	1.824	2.065	2.065	2.133	2.122	2.122	2.122	2.336
Total (km)	10.413	10.386	10.466	10.508	10.508	10.508	10.993	10.922	10.940	10.948	10.984

Table 3.10. Freight Traffic by Railway from 1999-2005

YIL	Domestic (1000 tonnes)	International (1000 tonnes)	TOTAL (1000 tonnes)
1999	14.182	1.213	15.395
2000	17.034	1.353	18.387
2001	13.323	927	14.250
2002	13.015	1.301	14.316
2003	13.914	1.715	15.629
2004	15.302	2.300	17.602
2005	15.878	2.906	18.784

Table 3.11. Number of Passengers Carried by Different Type of Train from 1999-2005

Year	Suburban (1000)	Main Line (1000)	International (1000)	TOTAL (1000)
1999	72.873	25.955	103	98.931
2000	61.128	24.131	84	85.343
2001	51.899	24.284	139	76.323
2002	48.453	24.500	135	73.088
2003	49.522	27.342	129	76.993
2004	50.590	26.050	116	76.756
2005	52.495	23.668	143	76.306

The tables and figures given above were used in calculation of emissions.

Emission Factors:

Carbon emission factors, CH4 emission factors, N2O emission factors, NOX emission factors, CO emission factors, NMVOC emission factors, SO2 emission factors for all modes of transport, sulphur content of the fuels and emission factors of passenger cars working with gasoline are given below in respectively. All of them used in Tier 1 and Tier 2/3 Approaches of IPCC for the calculation of GHGs emissions resulted from transport sector, (Tables 3.12-3.21).

Table 3.12. Carbon Emission Factor Used in Calculation between 1990 and 2005 (tC/TJ)

Tape of Fuel	Domestic Aviation	Road Transport	Rail Transport	National Navigation
Gasoline	18.9	18.9		
Gas/Diesel-Oil		20.2	20.2	20.2
LPG		17.2		
Residual Fuel-Oil			21.1	21.1
Jet Kerosene	19.5			

Table 3.13. Emission Factor for CH_4 (kg/TJ)

Tape of Fuel	Domestic Aviation	Road Transport	Rail Transport	National Navigation
Gasoline		20		
Gas/Diessel-Oil		5	5	5
Jet Kerosen	0.5			

Table 3.14. Emission Factor for N_2O (kg/TJ)

Tape of Fuel	Domestic Aviation	Road Transport	Rail Transport	National Navigation
Gasoline		0.6		
Gas/Diessel-Oil		0.6	0.6	0.6
Jet Kerosen	2			

Table 3.15. Emission Factor for NO_X (kg/TJ)

Tape of Fuel	Domestic Aviation	Road Transport	Rail Transport	National Navigation
Gasoline		600		
Gas/Diessel-Oil		800	1200	1500
Jet Kerosen	300			

Table 3.16. Emission Factor for CO (kg/TJ)

Tape of Fuel	Domestic Aviation	Road Transport	Rail Transport	National Navigation
Gasoline		800		
Gas/Diessel-Oil		1000	1000	1000
Jet Kerosen	100			

Table 3.17. Emission Factor for NMVOC (kg/TJ)

Tape of Fuel	Domestic Aviation	Road Transport	Rail Transport	National Navigation
Gasoline		1500		
Gas/Diessel-Oil		200	200	200
Jet Kerosen	50			

Table 3.18. Emission Factor for SO_2 (kg/TJ)

Tape of Fuel	Domestic Aviation	Road Transport	Rail Transport	National Navigation
Gasoline	22.321	22.321		
Gas/Diesel-Oil		69.236	69.236	69.236
Residual Fuel-Oil				746.454
Jet Kerosen	11.213			

Table 3.19. Sulphur Content of Fuel (%)

Tape of Fuel	Domestic Aviation	Road Transport	Rail Transport	National Navigation
Gasoline	0.1	0.1		
Gas/Diesel-Oil		0.3	0.3	0.3
Residual Fuel-Oil				3
Jet Kerosen	0.05			

Table 3.20. Calorific Values of Fuel Used In Calculation between 1990 and 2005 (Terajoule/Kilotonne)

Tape of Fuel	Domestic Aviation	Road Transport	Rail Transport	National Navigation
Gasoline		44.8		
Gas/Diesel-Oil		43.33	43.33	43.33
LPG				
Residual Fuel-Oil			40.19	40.19
Jet Kerosene	44.59			

Table 3.21. Number of Passenger Cars Working with Gasoline, Their Emission Technology and Their Emission Factor

Passenger Cars (Gasoline)								
Year	Emission Technology	No of Vehicles	Emission Factor (g/km)					
			CO2	NOx	CH4	NMVOC	CO	N2O
2004	Euro III	345530	205	0,5	0,02	0,5	2,9	0,05
	Euro I	379212	205	0,5	0,02	0,5	2,9	0,05
	15.04	805826	200	2,3	0,07	4,5	19	0,005
	UC	2437662	270	2,2	0,07	5,3	46	0,005
2003	Euro III	88495	205	0,5	0,02	0,5	2,9	0,05
	Euro I	379212	205	0,5	0,02	0,5	2,9	0,05
	15.04	805826	200	2,3	0,07	4,5	19	0,005
	UC	2549659	270	2,2	0,07	5,3	46	0,005

GHG Emissions Resulted from Transport Sector during Years 1990- 2005

As seen above, energy usage level of transport sector grew steadily during 1990-2005 except some years. The declines in consumption level and so in emissions level observed during 1994-1999 and 2001 are the results of economic crisis. The factors underlining these fluctuations include not only economical crisis but also impact of taxes and majors introduced in this sector. In this part, the emissions and their fluctuations will try to be explained.

Figure 3.11 shows the CO_2 emission trends between 1990 and 2005. In 2005, the share of CO_2 emissions from road transport in total CO_2 emissions in the transport sector is 85.17% (Figure 3.12). This is followed by emissions from civil aviation (10%), shipping (3.15%) and railways (1.67%). The trend for the year series from 1990 to 2004 shows a gradual and consistent rise with an increase of approximately 0.9 million tons of CO_2 per year.

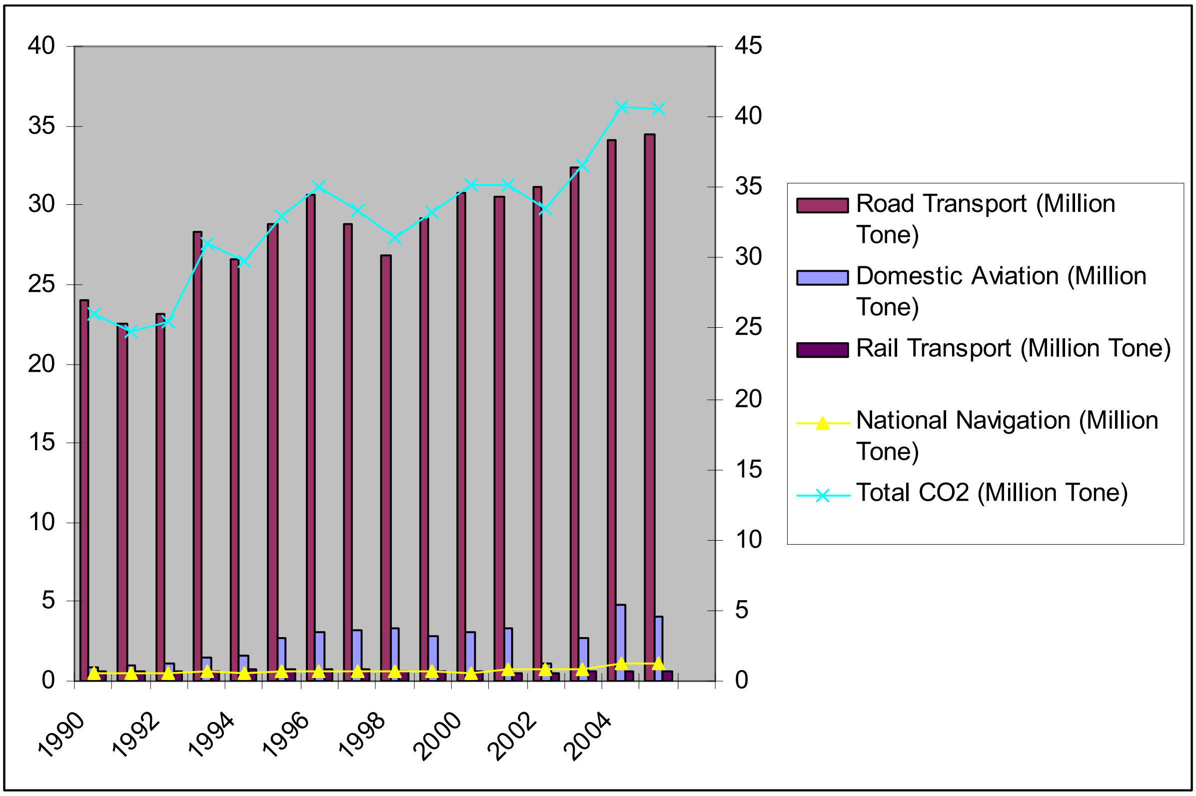


Figure 3.11. The Rate of Change of CO_2 Emissions Coming from Different Modes of Transport

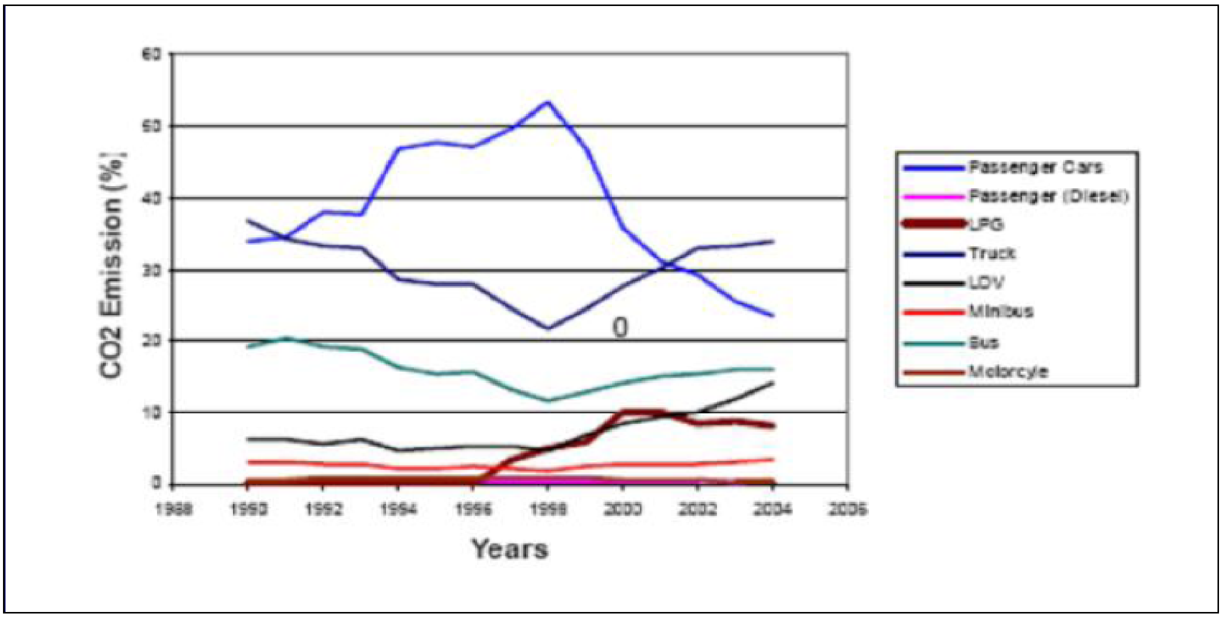


Figure 3.12. Distribution of CO_2 Emissions from Different Types of Transportation Vehicles

In the road transport sector, Turkish Government supported to use of more efficient energy consumption vehicles as a result of this shift to new technology in engines and the use of alternative fuel sources led to a decrease in emissions per vehicle km. The total decrease in CO_2 emissions per vehicle km throughout the period 1900-2004 is 8.7%.

Furthermore, the reduction of CO_2 emissions due to the removal of about 320,000 old vehicles from registers by providing a tax advantage to consumers in 2003 and 2004 resulted in a reduction of 4.87 % in CO_2 emissions (Figure 3.13).

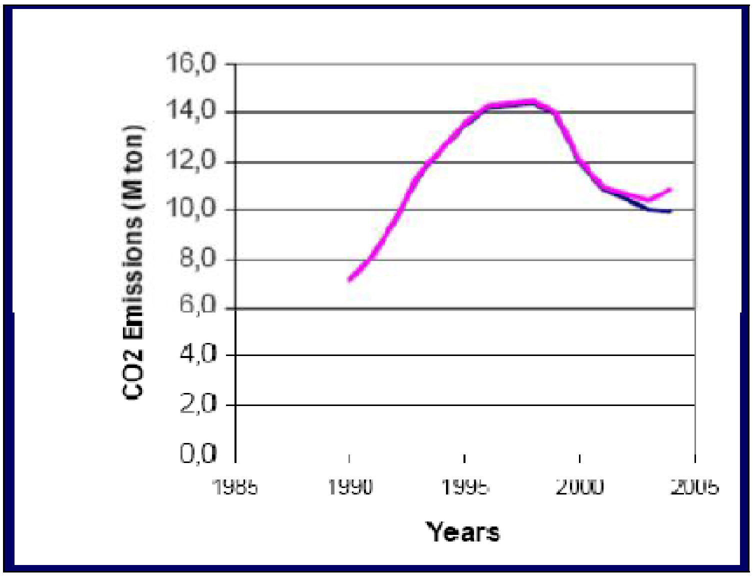


Figure 3.13. Change of CO_2 Emission Due to Removal of Old Cars

Although the rate of increase from road transport is at the moment higher than aviation, the potential for domestic aviation in Turkey is present due to the recent popularization of the domestic aviation sector in Turkey. Data of near future will be able to emphasize this trend more clearly.

For CH4 emissions the major contributor is the road transport producing almost all the emissions. As shown in Figure 3.14, CH_4 from road transport does not follow the fuel consumption trend and start reducing after the year 1998. Furthermore, it is nearly stable from 2003-2005. This can be explained by the reduction in gasoline consumption in road transport and switching to diesel fuel where there is a factor of 4 between the *emission factors* of the two fuels.

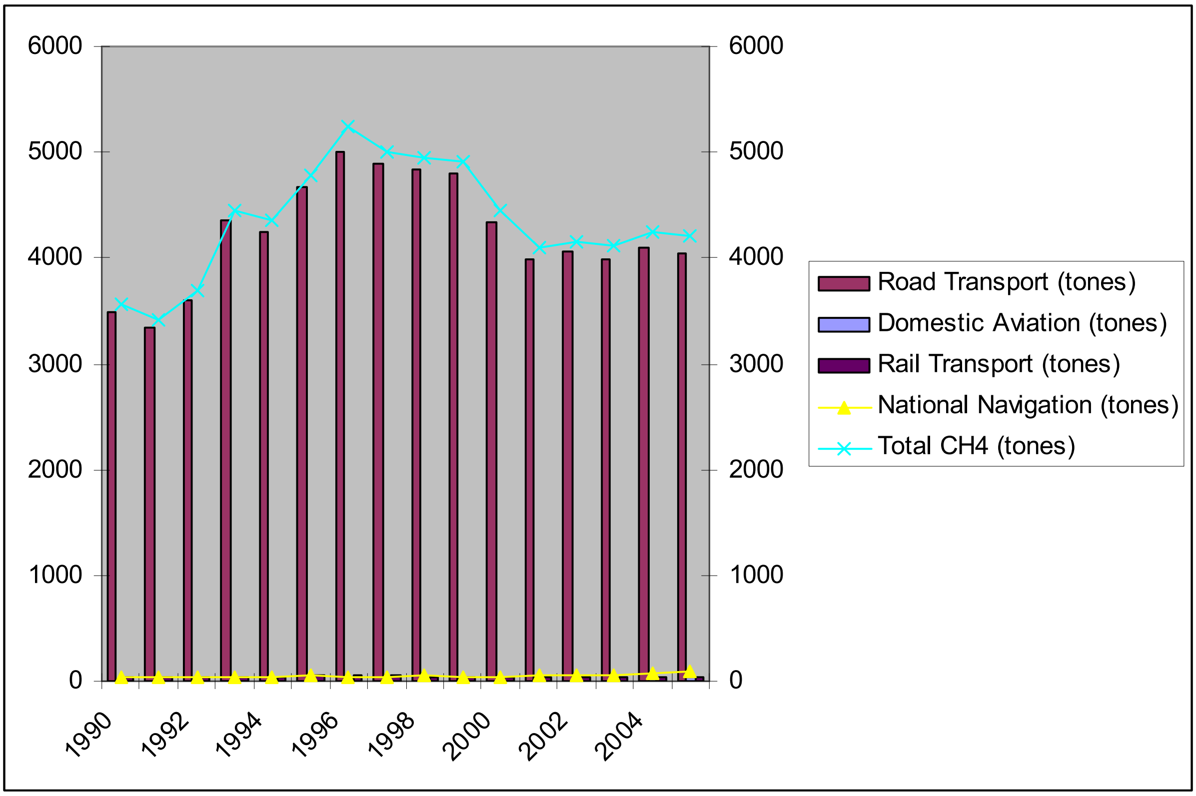


Figure 3.14. The Rate of Change of CH_4 Resulted From Transportation Sectors

Road transport is again the major source for N_2O emissions with 59,84 % contribution in the year 2005, but national aviation shows a strong trend of increase which reaches to 35,26 % in 2004 (Figure 3.15).

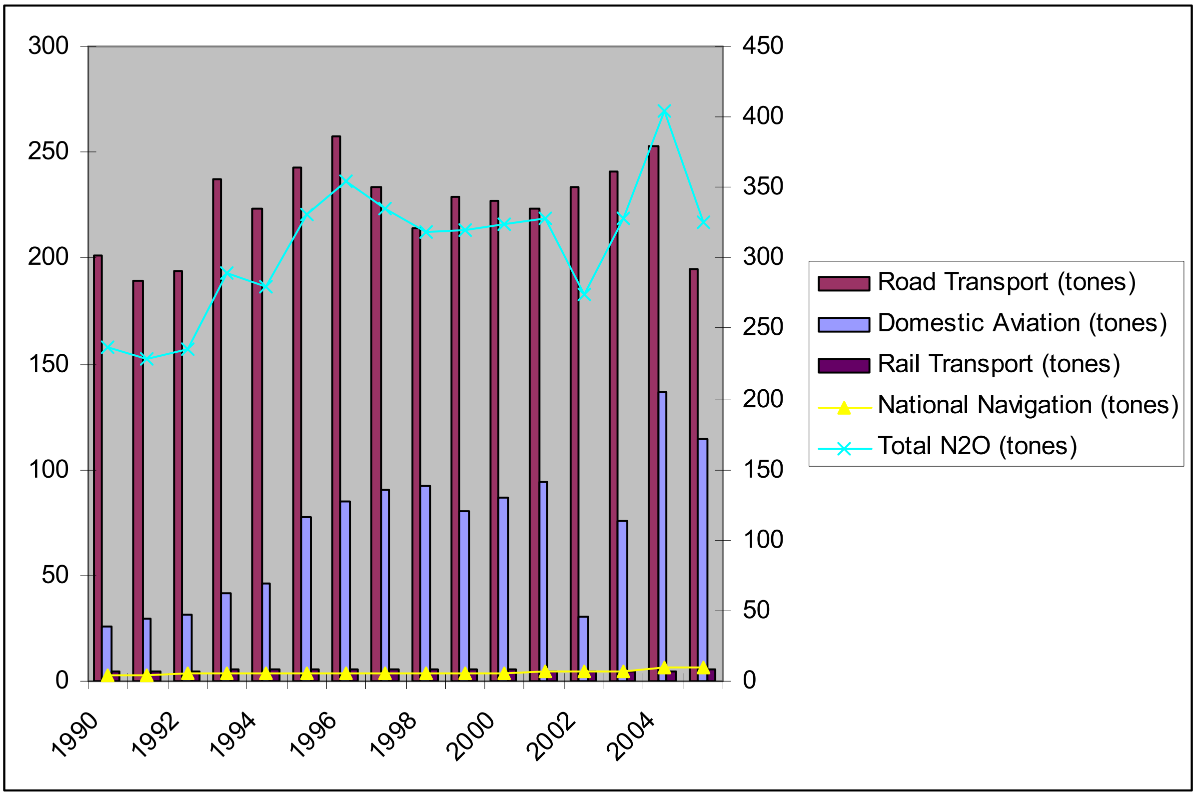


Figure 3.15. The Rate of Change of N_2O Resulted From Transportation Sectors

For NOx, CO and NMVOC emissions road transport is again the major contributor as indicated in Figures 3.16, 3.17, 3.18 and 3.19. For CO and NMVOC curves, drop after the year 1998 is again due to the increase of diesel fuel usage instead of gasoline in road transportation, although the total fuel consumption is increased. This difference arises due to the lower emission factors for diesel fuel compared to gasoline for both CO (1000 kg/TJ instead of 8000 kg/TJ for gasoline) and NMVOC (200 kg/TJ instead of 1500 kg/TJ for gasoline) emissions.

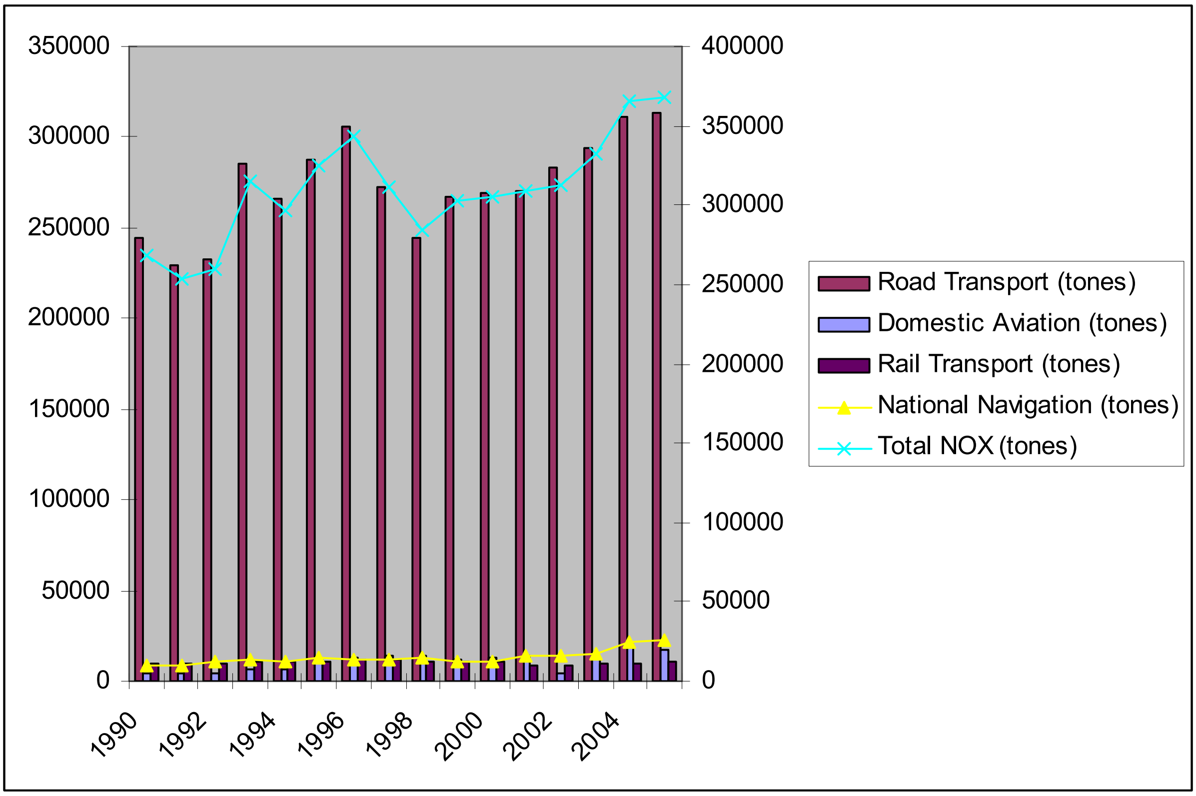


Figure 3.16. The Rate of Change of NO_X Resulted From Transportation Sectors

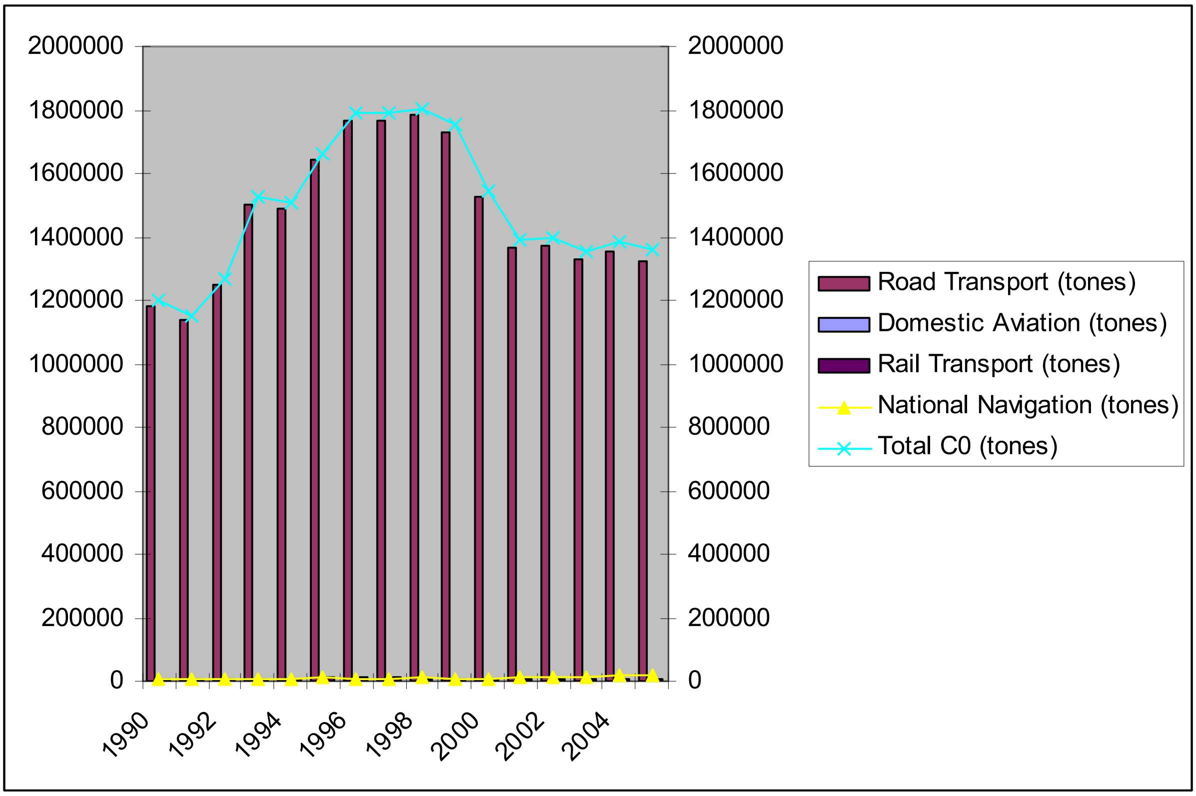


Figure 3.17. The Rate of Change of CO Resulted From Transportation Sectors

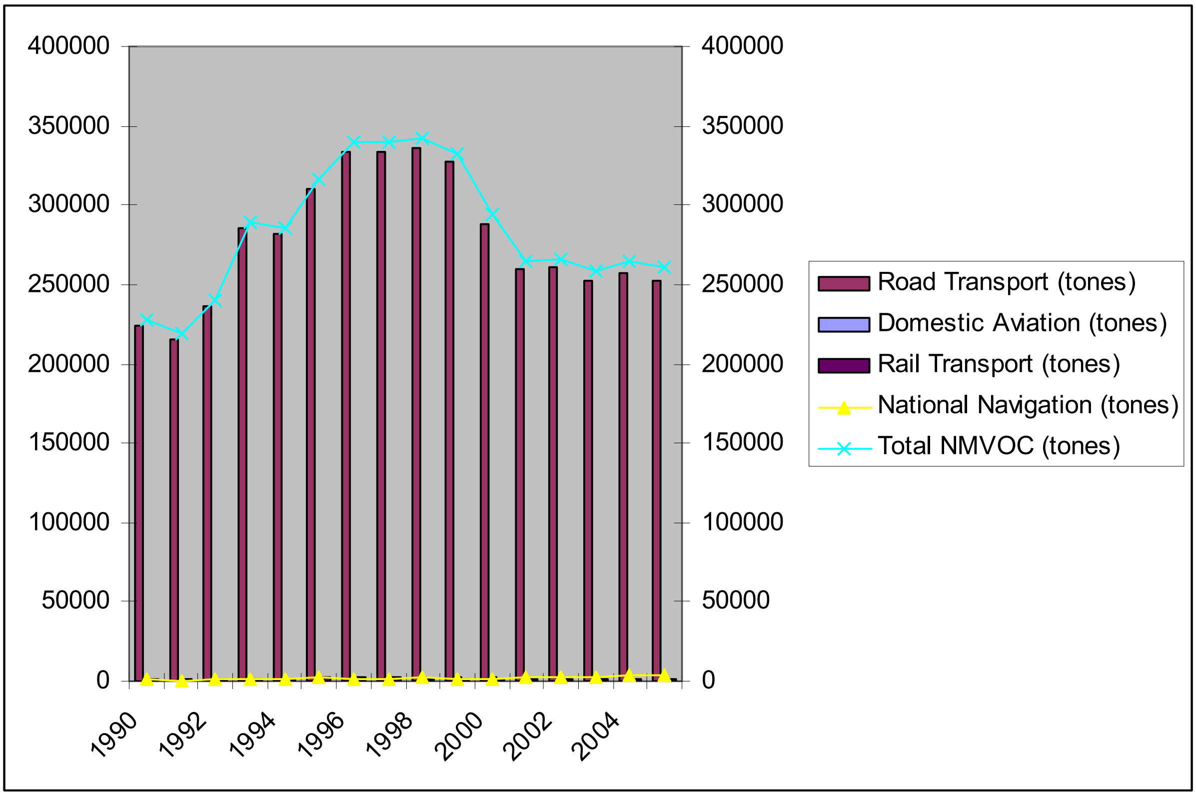


Figure 3.18. The Rate of Change of NMVOC Resulted From Transportation Sectors

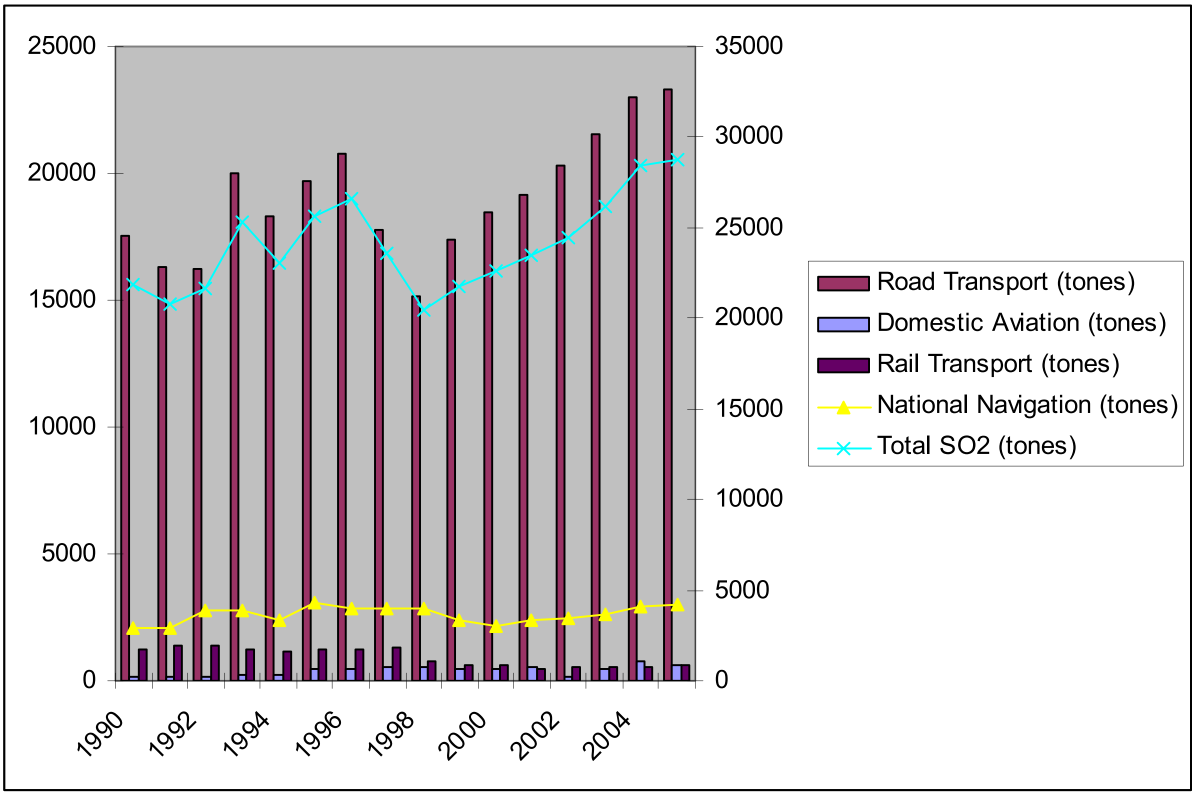


Figure 3.19. The Rate of Change of SO_2 Resulted From Transportation Sectors

3.1.3.1. Civil Aviation (1.C.1.A)

Emissions from international aviation were not estimated and separated from domestic aviation due to lack of fuel registration data. But the discussion about this subject for separation is going on. For that reason, calculation done for aviation by Tier 2 is only including domestic aviation.

3.1.3.2 Navigation (1.C.1.B)

Emission from international bunkers were not estimated and separated from domestic aviation due to again lack of fuel registration data. But the discussion on this subject for separation is going on.

3.1.3.3 International Bunkers (1.C.1)

According to IPCC Guidelines, international aviation and marine bunker fuel emissions should be excluded from national totals and reported only for informational purposes.

3.1.3.4 Planned Improvements

And finally, in order to determine energy-related country specific emissions from transport sector; a project was submitted to Turkish Scientific Research Authority (TUBITAK) by the Ministry of Transport in collaboration with Istanbul Technical University-Mechanical Engineering Faculty and TUBİTAK- MAM Research Institute. The project was approved and started in October 2006. One of the aims of this study is to determine steps for management of GHGs Emissions resulted from transport. Second aim is to determine country specific emissions of transport sector. Third aim is to determine impacts of usage of bio-diesel and hybrid engines in transport to reduce the GHGs emission.

3.1.4 Other Sectors (1.A.4)

Source Category Description: The emissions that were included in this category mainly arise from Residential (emission from fuel combustion in households including institutional) and Agriculture (emissions from fuel combustion in agriculture including forestry and fisheries) sectors. Therefore, (1.A.4.a) was considered with (1.A.4.b) due to the energy balance tables.

Methodological Issues: The methodology used for emissions calculation was identical that used for the combustion of fuels in “Manufacturing Industries and Constructions – 1.A.2” sectors.

Uncertainties and time-series consistency: The approach to produce quantitative uncertainty estimates was to use expert judgement as described in IPCC Good Practice Guidance and Uncertainty Management (2000) Reference.

Table 3.22. Time series consistency of emission factor for (1.A.4)

Source Category	GHGs	Fuel Type	Comments on time series consistency
1.A.4	CO_2	All Fuels	* All EFs were constant over the entire time series.
1.A.4	N_20, CH_4	All Fuels	* All EFs were constant over the entire time series.

Source-specific QA/QC and verification: This source category was covered by the general QA/QC of the greenhouse gas inventory.

Recalculation: There wasn't any change in sector 1.A.2 for 1990-2005.

3.1.4.1 Commercial/Institutional (1.A.4.a)

The energy consumption of commercial/institutional was not separated in the energy balance tables. Therefore emissions from use of fuels were not been listed separately. They were given under Residential (1.A.4.b).

3.1.4.2 Residential (1.A.4.b)

The source category "Residential" was a key category in terms of CO_2 from natural gas, LPG, Lignite, hard coal, asphalt and in terms of CH_4 emissions from wood. The relevant fuel-use amounts were taken from energy balance tables. Although, residential and institutional fuel used amount were not separable in tables, the high percentage of fuel was consumed in households. The residential contribution to total CO_2 emission from the lignite and petroleum consumption was almost the same with a value of 7.3% in 1990. However, these ratios for lignite and petroleum in latest year were considerably decreasing. The main reason is the shifting from lignite to natural gas.

3.1.4.3 Agriculture/Forestry/Fisheries (1.A.4.c)

The source category "Agriculture/Forestry/Fisheries" were not including mobile sources. Such emissions were included instead in transport emissions (1.A.3). This source category was a key category in terms of CO_2 from gas/diesel oil.

3.1.5 Other Sectors (1.A.5)

This source category was not considered owing to lack of occurrence.

3.2 Fugitive Emission from Fuels

During all stages of fuel production and use, from extraction of fossil fuels to their final use, fuel components can be released as fugitive emissions. CH_4 emission was the most important emission within the source category "solid fuels", especially "Coal Mining and Handling (1.B.1.a)". The other sub-sector was not considered due to not occurring (as 1.B.2) or not having available data (as 1.B.1.b).

Methane (CH_4): In Turkey, the main fugitive emissions were the CH_4 from the coal mining, especially the lignite and hard coal mining from underground and surface mines. The percent of extracted coal from underground mines was approximately 4.5%.

The emission factors of underground and surface mines differ considerably. IPCC Tier 1 approach was used for the emission. The emission from the coal mining was given in Table 3.23 and Figure 3.20. Moreover, the total amount of extracted coal was also given in Figure 3.21.

As shown in Figure 3.20 and Table 3.23, the CH_4 emission from coal mining changed between 58.54 Gg and 77.72 Gg. The highest CH_4 emission was observed in 1998 and the lowest emission was observed in 2004.

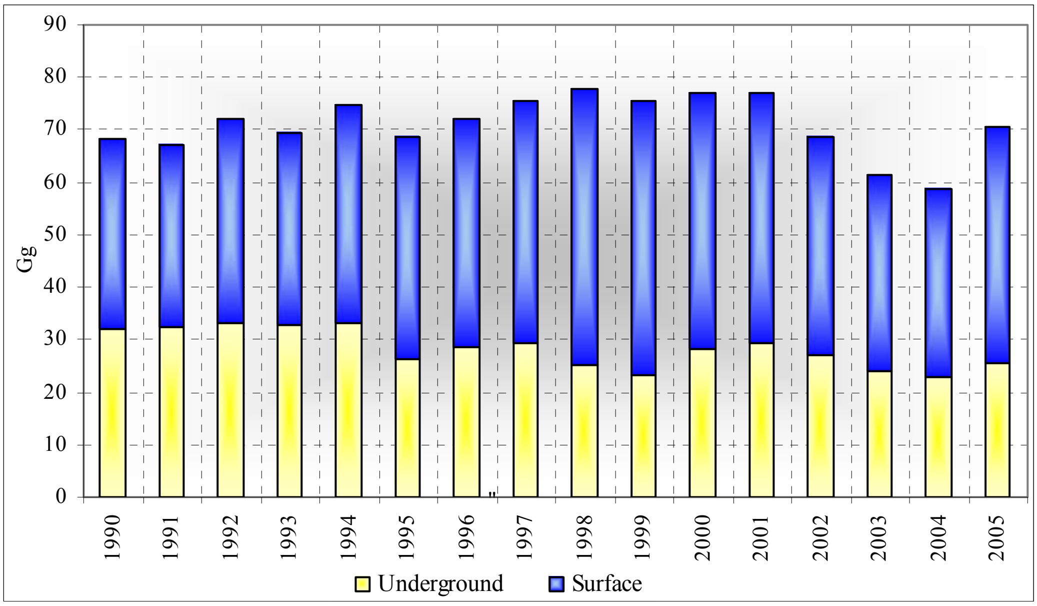


Figure 3.20. CH_4 emissions from coal mining

Table 3.23. CH_4 emissions from coal mining

Unit: Gg	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Underground	32.19	32.38	33.18	32.70	33.29	26.36	28.62	29.46	25.28	23.33	28.05	29.24	27.19	24.14	22.82	25.44
Surface	35.93	34.85	39.08	36.80	41.43	42.47	43.35	46.16	52.44	52.30	48.94	47.92	41.54	37.39	35.72	45.16

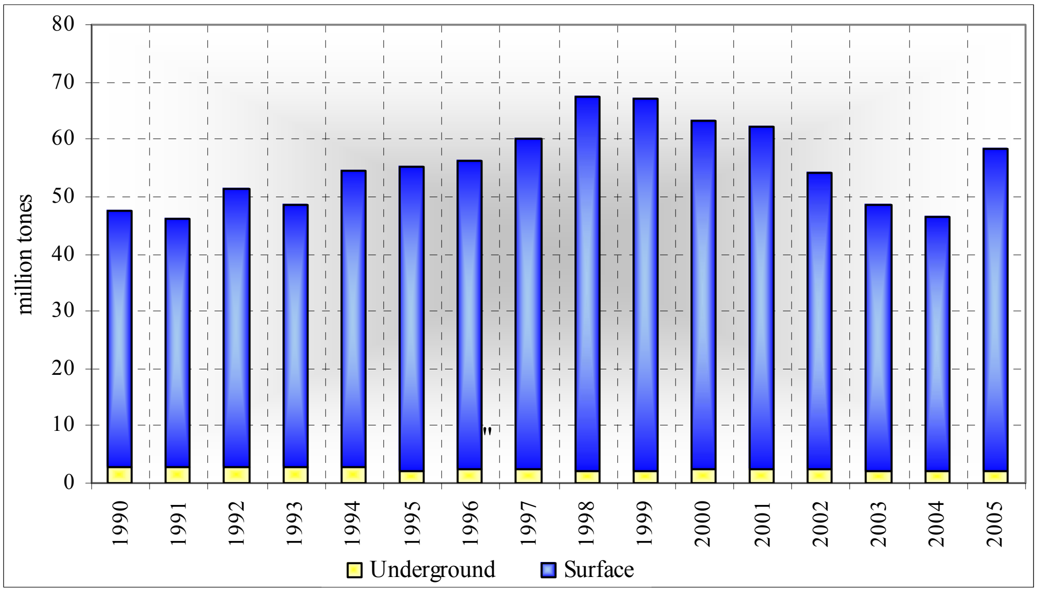


Figure 3.21. Coal mining

The underground coal mining was decreased throughout the years. In 1990, approximately 5.8% of the total extracted coal was obtained from underground mining. However, this ratio in 2005 was only 3.8%. The coal mining has decreased since 1990. The main reason was the shifting of fuel coal to natural gas in residential areas.

During surface and underground mining, methane escaping was not related to any specific conditions. Therefore, default IPCC emission factors were used to calculate methane emissions.

Activity data of the coal extraction was taken from the energy balances of MENR.

3.2.1 Solid Fuels (1.B.1)

Although this source category "Solid fuels" (1.B.1) consists of three sub- source categories "Coal mining and handling" (1.B.1.a), "Solid fuel transformation" (1.B.1.b) and "Other" (1.B.1.c). The most important one is “Coal Mining and Handling (1.B.1.a)”.

Source Category Description: This source category was covering CH_4 emissions which occur during the surface and underground production of solid fuels. The emissions due to combustions of those fuels to support product activities was not included in this section.

Methodological Issues: The methodology used for emissions calculation was IPCC simplest method. Methane emission was estimated by multiplying coal production with methane emission factors. The EFs were given in annex. Turkey couldn’t use Tier 2 or Tier 3 method “Country or Basin Specific Method” due to lack of basin specific information. For that reason the EFs were accepted as (17.5 m^3/tones for underground mining) and (1.2 m^3/tones for surface mining). The methane emission from surface mining was a key category. The underground mining was not significant; therefore Tier 1 methodology was used according to the IPCC Good Practice.

Uncertainties and time-series consistency: The approach to produce quantitative uncertainty estimates was to use expert judgement as described in IPCC Good Practice Guidance and Uncertainty Management Reference.

Table 3.24. Time series consistency of emission factor for (1.B.1)

Source Category	GHGs	Fuel Type	Comments on time series consistency
1.B.1	CH_4	Solid Fuels	* All EFs were constant over the entire time series.

Source-specific QA/QC and verification: This source category was covered by the general QA/QC of the greenhouse gas inventory.

Recalculation: There wasn't any change in sector 1.B.1 for 1990-2005.

3.2.1.1 Coal Mining and Handling (1.B.1.a)

The source category "Coal Mining and Handling" was a key category in terms of CH_4 emissions from surface solid fuel production. The data were gathered from MENR. The average percent of extracted coal from underground mines was approximately 4.5% for the years 1990-2005. For year 2005, the percentage was even lower than the average with a value of 3.8%.

Chapter 4

4. Industrial Processes

4.1. Overview

The GHG emissions from Industrial Processes are released as a result of manufacturing processes. It means this category includes only emissions from processes and not from fuel combustion used to supply energy for carrying out the processes. For that reason, emission from industrial processes are referred to as "non - combustion".

The TURKSTAT was the basic data source for the quantities of materials and goods produced. During the preparation of the inventories, owing to the data confidentiality (i.e., number of related industries which were less than 3), some emissions were given as aggregated into upper IPCC level in CRFR and NIR. Turkish Statistical Law has been published in the Official Gazette on 18 November 2005 related to this issue and it includes the legal private law. It means, the private information cannot be announced as information except for 3 of the same private category being aggregated. Therefore, the information given in the CRF Tables and NIR were not including any confidentiality since it was aggregated to upper IPCC category.

The emissions were calculated according to the following equation 4.1:

$$\textbf{Emissions = Production* Emission factor} \qquad (4.1)$$

The emission factors given in annex for the current inventories were the default from the IPCC Guidelines emission factors.

According to the IPCC categorization of this source, this section also includes emissions from the use of HFCs and SF_6. In Turkey, there was no use of PFCs.

Carbon Dioxide (CO_2): In industrial processes, 85% of the CO_2 emission was coming from the cement production (See Table 4.1), which was also one of the key sources. The main emission source was the clinker production. From the table, it might be concluded that the highest emission ratio was observed in 2005 with an approximate value of 18.5 million tones CO_2.

Table 4.1. CO_2 emission contribution of cement production (%)

1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
80.15	82.31	82.65	81.25	83.07	83.75	82.15	80.81	83.99	86.44	88.18	88.89	86.10	86.12	85.33	91.52

In 2005, the other CO_2 emission sources in industries were ammonia production, lime production, soda ash production and use, iron and steel production and ferroalloys production with 2.92%, 2.17%, 1.64%, 1.57% and 0.16%, respectively.

The total CO_2 emission from the Industrial Processes was given in Figure 4.1. According to this figure, the trend involves a steady increase.

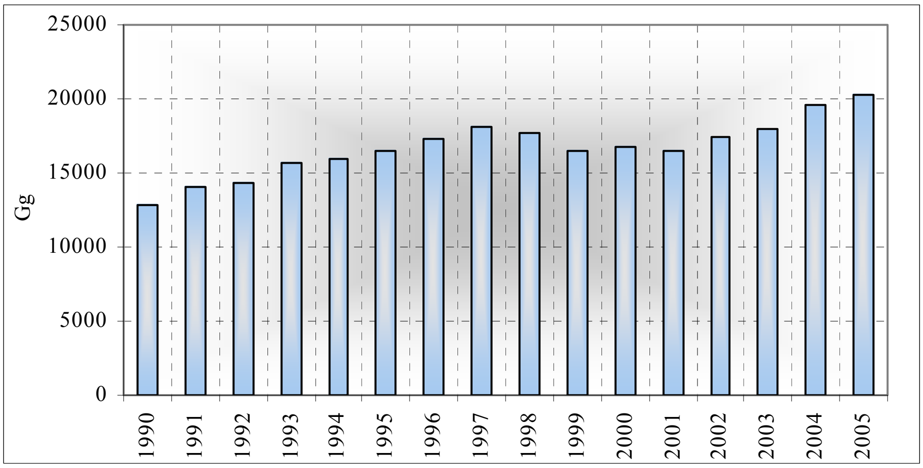


Figure 4.1. CO_2 emissions from industrial processes

Nitrous Oxides (N_20): The source of N_20 emission was the chemical industry, especially the nitric acid production. Between the years 1990 and 2005, the N_2O emission trend shows a great variety and fluctuations. The main reason was the nitric acid demands changes in domestic markets. This was also affecting the NO_X emissions. The main emission sources for NO_X can be categorized as follows: Glass production, road paving with asphalt, nitric acid production, other chemical productions, iron and steel production, aluminium industry, pulp and paper, petroleum industry. The NO_X emission from glass production and petroleum industry was estimated by the CORINAIR methodology. The IPCC Guidelines don't provide methodology for estimating the emissions for these processes. For the other industrial processes, the emission factors are the default from the IPCC Guidelines. Until the year 1993, the NO_X emission trend shows an increase; afterwards it involves great variations. In Turkey, the highest NO_X emission sources were the pulp and paper and nitric acid production.

Methane (CH_4): In Turkey, the main source of the CH_4 emission was the Chemical Industry. The annual base emissions from the industries were range between 0.7 and 2.5 Gg. As can be seen in Figure 4.2, there was steep change in 2005 compared to 1990.

The other GHGs emissions for this sector were also given in the following Figure 4.2.

The main sources of CO emissions were road paving with asphalt, asphalt roofing, ammonia production, other chemical productions, aluminium industry, iron and steel production, petroleum industry, pulp and paper.

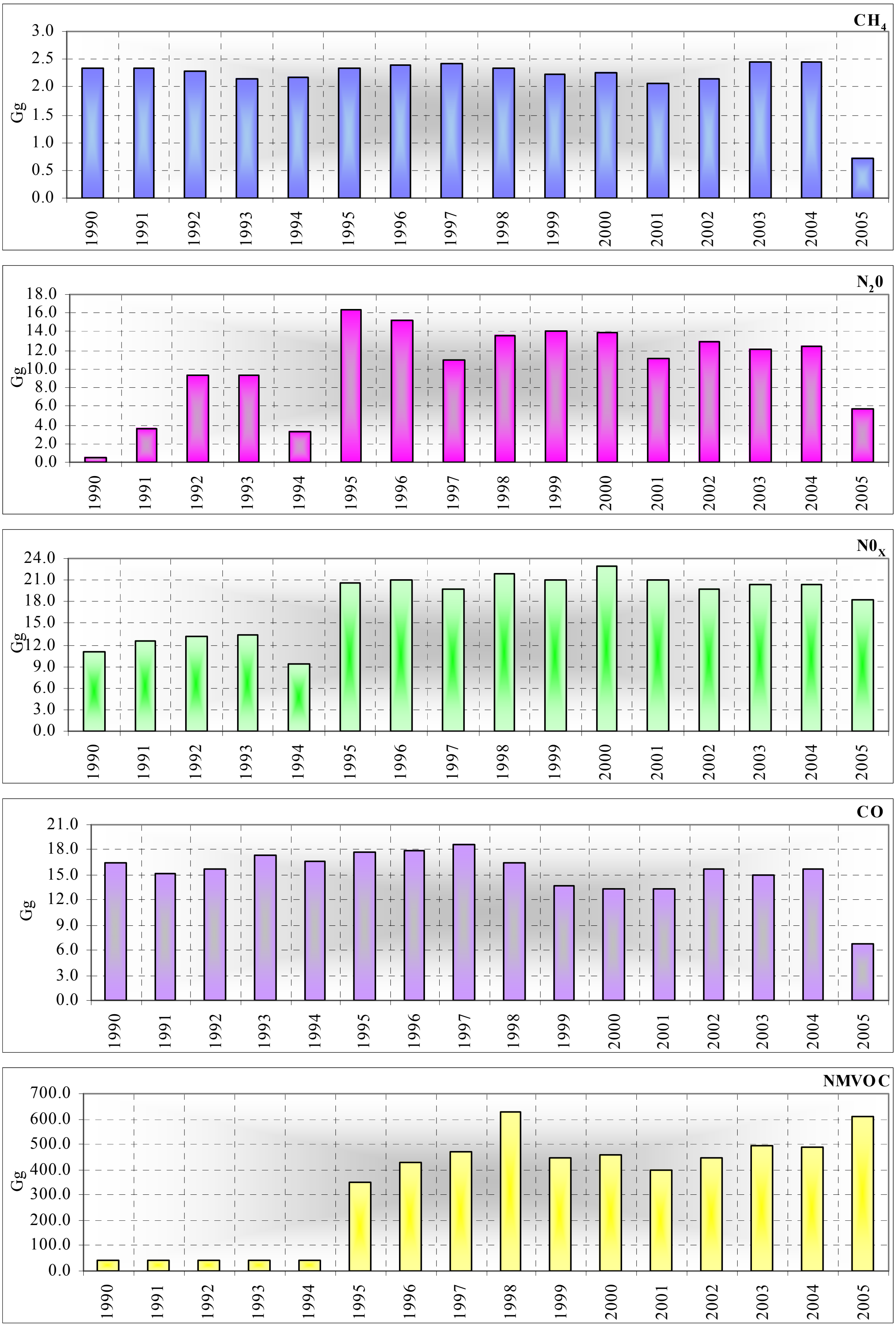


Figure 4.2. CH_4, N_20, NO_X, CO, NMVOC emissions from industrial processes

The CORINAIR methodology was used for estimating the CO emission from petroleum industry. The IPCC Guidelines don't provide methodology for estimating the emission for this process. For the other industrial processes, the emission factors were the default from the IPCC. The highest CO emission source was the aluminium industry. CO emission range was changing between 13.26 Gg (in 2001) to 18.64 Gg (in 1997).

Finally, the main sources of NMVOC emissions were road paving with asphalt, asphalt roofing, ammonia production, other chemical productions, iron and steel production, petroleum industry, pulp and paper, food and drink. The highest NMVOC emission was coming from the food and drink industries. The emission trend involves fluctuations throughout the years. The CORINAIR methodology was used for estimating the NMVOC emission from petroleum industry. The IPCC Guidelines don't provide methodology for estimating the emission for this process.

The CORINAIR emission factors for NO_X, CO and NMVOC were given in the following Table 4.2.

Table 4.2. CORINAIR emission factor

Glass production type	Emission factor (kg NO_X/tones production)
Plain glass	10
Bottle	5
others	6

Gases	Emission factor from petroleum industry
NOX	0.05 kg/m^{3} *
CO	0.08 kg/m^{3} *
NMVOC	0.25 g/kg

There's no production of PFC, HFC and SF6 in Turkey. All demand is met by import. The methodology has been based on the IPCC Guidelines and the IPCC Good Practice Guidance. Inventory calculations have been based on the raw import data provided by Undersecreteriat of Customs.

4.2. Mineral Products (2.A)

Source Category Description: This source category, mainly, includes the cement production, lime production, soda ash production and use, asphalt roofing, road paving with asphalt and glass production. Emissions of GHG from industrial processes were reported under (2.A). Fuel combustion's emissions were reported under CRF source category (1.A). The industrial processes also gave rise to emissions of NO_X, N_20, NMVOC, CO and SO_2. The main activity data provider was TURKSTAT and TCMA (Turkish Cement Manufacturers' Association). In TURKSTAT, the annual industrial production data were formed by monthly industrial production survey.

Methodological Issues: The production data was applied to emission factors (EF) to give an estimation of the direct and indirect greenhouse gas emissions.

Uncertainties and time-series consistency: The activity data for industrial processes were almost gathered from TURKSTAT industrial production survey results. The approach to produce quantitative uncertainty estimates was to use expert judgement as described in IPCC Good Practice Guidance and Uncertainty Management (2000) Reference. Sectoral expert calculated the uncertainty and combined with their judgement to minimise the risk of bias. The uncertainties in emission factors and activity data were explained in annex in detail.

Table 4.3. Time series consistency of emission factor for (2.A)

Source Category	GHGs	Comments on time series consistency
2.A	CO_2	* EFs were not vary until 2004 for (2.A). For 2005, EFs were taken as 0.51instead of 0.51025 for (2.A.1). Others were all constant over the entire time series.
2.A	NO_X, CO, NMVOC, SO_2	* All EFs were constant over the entire time series.

Source-specific QA/QC and verification: This source category was covered by the general QA/QC of the greenhouse gas inventory

Recalculation: There was no main change in sector 2.A per pollutant for 1990-2005.

4.2.1 Cement Production (2.A.1)

Cement is produced by grinding a mixture of calcium carbonate (CaCO3), silica, alumina, iron oxides and then heating the ground material in a kiln. The calcium oxide subsequently reacts with the other raw materials to form clinker. The clinker is cooled after addition of other raw materials. The methodology used for estimating CO_2 emissions from calcinations is the IPCC Tier 1 approach (IPCC, 2000). Although the clinker production data were available, CaO content in clinker from individual plants or companies were not known. Therefore, Country Specific CaO content was not formed for Tier 2 methodology. The EF was consistent for the years between 1990 and 2004. However, EF was taken as 0.51 instead of 0.51025 for year 2005 CO_2 emission estimation.

This sector was a key category in terms of CO_2 emissions from kiln production. The activity data were gathered from Turkish Cement Manufacturers' Association.

There are 41 integrated cement plants in Turkey, which produce clinker and final product cement. There are also 18 cement plants in Turkey producing only cement from the clinker and final product cement. The clinker production capacity was around 39 million tones in 2005, whereas the actual production was 36.4 million tones. In Turkey, about 90 % of the cement kilns (not the plants) are based on dry systems (with or without pre-calciner). The remaining 10% covers semi-wet (Lepol) or wet systems.

Main fuel for this sector was lignite and petroleum-coke. In Turkey, cement plants can co-incinerate waste via securing a licence from the Turkish Ministry of Environment and Forestry. The licence requires stack gas emissions and analyses according to the regulation prepared in accordance with the “EU incineration of waste directive 2000/76/EC. Wastes co-incinerated by licence are: waste plastics, used tyres, waste oils (Class I and Class II), industrial sludge and tank bottom sludge. Sulphur is not a main emission item in cement sector. However, as given in the 1996 IPCC Revised Guidelines (Section 2.3.3.) SO_2 emission was also estimated according to the processes originated from sulphur in the raw material.

4.2.2 Lime Production (2.A.2)

Lime (CaO) is manufactured by the calcination. The calcination results in the evaluation of carbon dioxide. The use of production data was simpler and more reliable than the consumption data. For that reason the production data from TURKSTAT was used for the emission calculations. The time series of emission factors were consistent. This section was not a key category. However, there was a high uncertain activity data. The uncertainty for the activity rates used was estimated as 34 %. This experts' assessment took account of the following error sources:

- Uncertainty in collecting and transferring data,
- Uncertainties in determination of activity rates, since some of the data can only be estimated, using industrial plant data.

Moreover, there were not country-specific data on CaO and MgO content.

4.2.3 Lime Stone and Dolomite Use (2.A.3)

Basically, limestone and dolomite are added to sinter where they are calcinated. For the year 2005, the CO_2 emission was aggregated to lime production (2.A.2). Because number of related industries was less than 3 and the emission from production value privacy according to the Regulations was summed (2.A.2) up. This source category was not a key category.

4.2.4 Soda Ash Production and Use (2.A.4)

Soda ash use results in CO_2 emissions. The Turkish Statistical Institute (TURKSTAT) determines the total amounts of soda ash produced in Turkey. This source category was not a key category. Emission estimation was based on production of soda-ash.

4.2.5 Asphalt Roofing (2.A.5)

Emissions of CO_2 were not estimated from this source as there was no methodology available. Emissions from this source category were extremely small in relation to national emissions.

4.2.6 Road Paving with Asphalt (2.A.6)

As far as known, this source category “Road paving with asphalt” produces no direct greenhouse-gas emissions and was thus not a key category.

4.2.7 Other – Glass Production (2.A.7)

Emission from glass production were reported under (2.A.7). The source category Mineral products: glass production was not a key category. The currently valid IPPC Good Practice Guidance contains no proposals or information relative to calculation of process-related CO_2 emissions for the glass industry.

4.3. Chemical Industry (2.B)

Source Category Description: This source category, mainly, includes the ammonia production, nitric acid production, adipic acid production, carbide production and other chemicals (carbon black, ethylene, dichloroethylene, styrene, methonal) production. The main activity data provider was TURKSTAT. In TURKSTAT, the annual industrial production data were formed by monthly industrial production survey.

Methodological Issues: The production data was applied to emission factors (EF) to give an estimation of the direct and indirect greenhouse gas emission.

Uncertainties and time-series consistency: The activity data for industrial processes were almost gathered from TURKSTAT industrial production survey results. The approach to produce quantitative uncertainty estimates was to use expert judgement as described in IPCC Good Practice Guidance and Uncertainty Management (2000) Reference. Sectoral expert calculated the uncertainty and combined with their judgement to minimise the risk of bias. The uncertainties in emission factors and activity data were explained in annex in detail.

Table 4.4. Time series consistency of emission factor for (2.B)

Source Category	GHGs	Comments on time series consistency
2.B	CO_2, CH_4, N_20	* All EFs were constant over the entire time series.
2.B	NO_X, CO, NMVOC, SO_2	* All EFs were constant over the entire time series.

Source-specific QA/QC and verification: This source category is covered by the general QA/QC of the greenhouse gas inventory

Recalculation: There was no change in sector 2.B per pollutant for 1990-2005.

4.3.1 Ammonia Production (2.B.1)

The source category was not a key category. Ammonia is produced on the basis of hydrogen and nitrogen. The amount of ammonia produced in Turkey was determined by TURKSTAT via monthly inventories. And, the emissions were calculated as follows (4.2):

Emission (kt) = Ammonia production quantity (kt) x emission factor (kt/kt) (4.2)

Due to a lack of plant-specific data, an emission factor of 1600 kg CO_2 /t NH_3 – the proposed default factor – was used.

4.3.2 Nitric Acid Production (2.B.2)

The numbers of nitric acid plants were, only, 3 in 2005. At the beginning of 1990s, there was no catalytic reduction. However for the latest year, the plants were equipped with non-selective catalytic reduction. For the consistency and IPCC GPG (2000), section 3.2 for older plants without NSCR, the (EF) was taken as 19 kg/t. Basically, the nitric and ammonium productions were used for artificial fertilizers. The values given below on the figures were intermediate products and were directly used for fertilizer productions (either nitric acid basis fertilizers or ammonia basis fertilizers).

The needs for agricultural activities (domestic markets) have determined the production quantity of fertilizers. Therefore the trends for either ammonia or nitric acid basis fertilizers produced according to the agricultural demand. The regions of these production plants are also different.

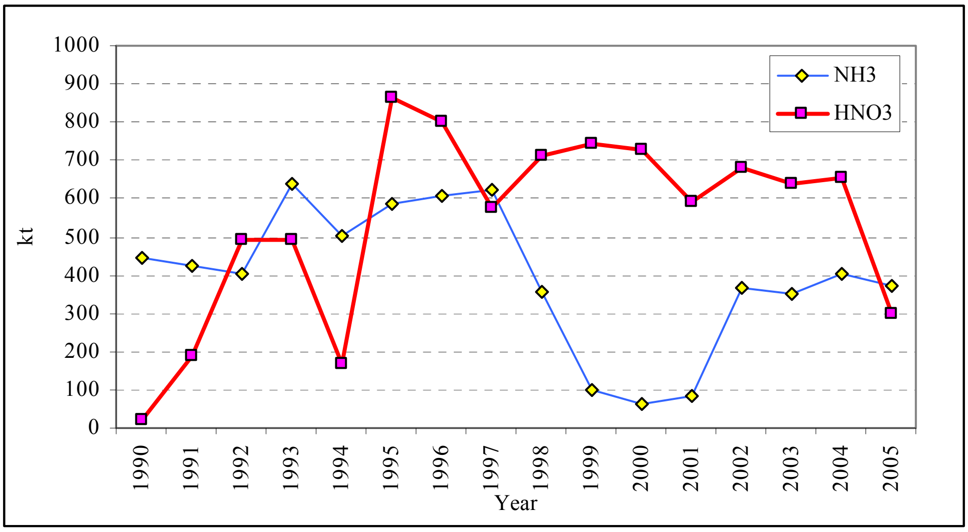


Figure 4.3. NH_3 and HNO_3 production in industries

The production data for NH_3 and HNO_3 were almost gathered from TURKSTAT industrial production survey results. This sector (Nitric Acid Production) was a key category in terms of N_2O emissions.

4.3.3 Adipic Acid Production (2.B.3)

The source category was not a key category. The N_20 emission from this sector was considerably small. Therefore it was included in part (2.B.2). This chemical was also used for fertilizer production.

4.3.4 Carbide Production (2.B.4)

There was no carbide production in 2005 according to the TURKSTAT industrial production survey results. Therefore, it was not considered for 2005.

4.3.5 Emission from Other Chemical Production (2.B.5)

This section was including carbon black, ethylene, dichloroethylene, styrene and methanol production. The numbers of related industries were less than 3, therefore emissions were not given as separate per each product. This section was not a key category in terms of emissions.

4.4. Metal Production (2.C)

Source Category Description: This source category, mainly, includes iron and steel production and ferroalloys production. The main activity data provider was TURKSTAT. In TURKSTAT, the annual industrial production data were formed by monthly industrial production survey.

Methodological Issues: The production data was applied to emission factors (EF) to give an estimation of the direct and indirect greenhouse gas emissions.

Uncertainties and time-series consistency: The activity data for industrial processes were almost gathered from TURKSTAT industrial production survey results. The approach to produce quantitative uncertainty estimates was to use expert judgement as described in IPCC Good Practice Guidance and Uncertainty Management (2000) Reference. Sectoral expert calculated the uncertainty and combined with their judgement to minimise the risk of bias. The uncertainties in emission factors and activity data were explained in annex in detail.

Table 4.5. Time series consistency of emission factor for (2.C)

Source Category	GHGs	Comments on time series consistency
2.C	CO_2	* All EFs were constant over the entire time series.
2.C	NO_X, CO, NMVOC, SO_2	* All EFs were constant over the entire time series.

Source-specific QA/QC and verification: This source category was covered by the general QA/QC of the greenhouse gas inventory

Recalculation: There was no change in sector 2.C per pollutant for 1990-2005.

4.4.1 Iron and Steel Production (2.C.1)

The Turkish iron and steel industry produces steel in integrated steel plants with basic oxygen furnaces and by electric arc furnaces. There were three integrated steel plants and 18 electric arc furnaces. There was high energy consumption in this sector. The emissions from energy consumption were reported under CRF category 1.A.2. The emission from production was not a key category.

4.4.2 Ferroalloys Production (2.C.2)

This category was not a key category. The CO_2 emission from this sector was considerably small.

4.4.3 Aluminium Production (2.C.3)

In 2005, there was no aluminium production reported. Therefore, it was not relevant to Turkey for year 2005. Therefore, the value was taken as “0”.

4.4.4 SF6 used in Aluminium and Magnesium Foundries (2.C.4)

Data collection and methodology studies are being carried out. This category is planned to be reflected on the National Inventory on following years.

4.4.5 Other Metal production (2.C.5)

This category was not relevant to Turkey.

4.5. Other Production (2.D)

Source Category Description: This source category, mainly, includes pulp and paper production and food and drink. The main activity data provider was TURKSTAT. In TURKSTAT, the annual industrial production data were formed by monthly industrial production survey.

Methodological Issues: The production data was applied to emission factors (EF) to give an estimation of the direct and indirect greenhouse gas emissions.

Uncertainties and time-series consistency: The activity data for industrial processes were almost gathered from TURKSTAT industrial production survey results. The approach to produce quantitative uncertainty estimates was to use expert judgement as described in IPCC Good Practice Guidance and Uncertainty Management (2000) Reference. Sectoral expert calculated the uncertainty and combined with their judgement to minimise the risk of bias. The uncertainties in emission factors and activity data were explained in annex in detail.

Table 4.6. Time series consistency of emission factor for (2.D)

Source Category	GHGs	Comments on time series consistency
2.D	NO_X, CO, NMVOC, SO_2	* All EFs were constant over the entire time series.

Source-specific QA/QC and verification: This source category was covered by the general QA/QC of the greenhouse gas inventory

Recalculation: There was no change in sector 2.D per pollutant for 1990-2005.

4.5.1 Pulp and Paper Production (2.D.1)

The source category (2.D.1) was not a key source with regard to production of pulp and paper. All emissions of direct GH gases from the pulp and paper industry in Turkey resulted from combustion of fuels; for this reason, they were reported as energy-related emissions in section (1.A.2.f). Production data was taken from TURKSTAT.

4.5.2 Food and Drink (2.D.2)

A number of food and drink manufacturing processes (such as: whisky, wine, bear, beverage, meal, fish, sugar, margarine, cake, biscuits, bread, animal's feed productions and etc.) gave rise to emissions of NMVOC. This source category was not a key category.

4.6. Production of Halocarbons and SF_6 (2.E)

This category was not relevant to Turkey.

4.7 Consumption of Halocarbons and SF_6 (2.F)

This section is prepared by the Turkish Technology Development Foundation (TTGV) and updated by Ministry of Environment and Forestry. There's no production of PFC, HFC and SF6 in Turkey. All demand is met by import. The methodology has been based on the IPCC Guidelines and the IPCC Good Practice Guidance. Inventory calculations have been based on the raw import data provided by Undersecreteriat of Customs.

HFCs

IPCC emission factors have been used for estimating the emissions. HFCs are mostly consumed in the production processes. For that reason its emission is considered as fugitive emission and replaced in the production of HFCs. The accepted factors are 0.5% for usage and 100% for service operations.

A major portion of HFCs are used in refrigeration sector. HFCs are being used as alternatives to CFCs since 1999 mainly in refrigeration sector. Minor increases over the years are because of this transition. The minor increase in 2005 also depends on this factor. Import licenses are registered by the Ministry of Environment and Forestry so all data is reliable. HFC data has been classified according to the company's name and the activity. When necessary, companies have been asked (i.e. leather industry) to clarify the emission rates.

PFCs

Data is being collected form the aluminium production plant and metal foundries and it will be reflected to National Inventory on following years. In addition to this, there's an ongoing technology renewing project in the plant which will reduce the PFC emissions from electrolytic cell process.

From the data provided by the Undersecreteriat of Customs, PFC imports figures are negligible so they are not reflected on the tables. Most of the importers in metal industry are smaller foundries. Amount of emission by metal industry is equal to amount used as stated in guidelines.

SF_6

A major portion of SF6 is used in electrical instruments. The increase in the import data from 2004 is mainly because of the increasing amount of circuit breakers being installed in Turkey. Unfortunately there's no reliable data source on SF6 imports, both for amounts coming as gas and inside electrical equipment. However Ministry of Environment and Forestry have began working on collection of the data together with related institutions. After a licensing and data collection system is established more reliable data will be obtained and previous years' data will be recalculated if possible.

The only available data for electrical equipments is the imported SF6 data. There is no information about the number and the capacity of the used, imported or exported equipments and the number of destroyed equipments. The imported amount has been assumed as completely emitted. Since, electrical equipment production is the main consumer of SF6, this assumption has led to high emission rates which thought to be less in practice.

SF6 data has been classified according to the company's name and the activity. When necessary, companies have been asked (i.e. leather industry) to clarify the emission rates.

Also, use of SF6 in fire extinguisher is a source of error due to lack of information whether it is used in fixed or portable systems.

Leather industry is a new sector which uses SF6 and not listed in guidelines. It has been determined that SF6 is used to prevent wrinkling during processing of leathers. In the same way as metal, all SF6 used in leather industry has been taken as equal to amount emitted.

SF6 imported by laboratories, universities, medical industries have also been calculated in the same way and it has been assumed that all SF6 is emitted in two years in equal amounts as suggested in guidelines. Amounts imported by unidentified users have also been calculated in the same way.

SF6 used in "fire extinguishers" has been calculated by contacting the importing company. Emission factor of fire extinguishers depends on whether they are used is fixed systems or portable systems. Since there is no data about the place, according to the interview with the importer, it has been assumed that 2/3 of the imported amount is used in fixed systems and 1/3 is used in portable systems. Emission factors have been taken as %60 and %35 for portable and fixed systems respectively.

4.8. Other (2.G)

Source Category Description: This source category, mainly, includes petroleum industry. The main activity data provider was TURKSTAT.

Methodological Issues: The methodology of this source category was the same as industrial processes.

Uncertainties and time-series consistency: The experts provided the uncertainty estimates.

Table 4.7. Time series consistency of emission factor for (2.G)

Source Category	GHGs	Comments on time series consistency
2.G	NO_X, CO, NMVOC	* All EFs were constant over the entire time series.

Source-specific QA/QC and verification: This source category was covered by the general QA/QC of the greenhouse gas inventory

Recalculation: There was no change in sector 2.G per pollutant for 1990-2005.

4.8.1 Petroleum Industry (2.G)

This source category was not a key category in terms of emissions level. All emissions of direct GH gases from this industry in Turkey resulted from combustion of fuels; for this reason, they were reported as energy-related emissions in section (1.A.2.b). However, the industrial processes in this category also emit NO_X, CO and NMVOC during production processes rather than the fugitive emission. Therefore, the emissions were reported under industrial processes.

Chapter 5

5. Solvent and Other Product Use

This category includes particularly emissions of CO_2, N_20 and NMVOC (IPCC Guidelines don't provide methodology for estimating the emissions of NMVOCs) from the use of solvents. It was very difficult to gather the information from the consumption sources of solvent. The lack of data for solvent use hinders to estimate the CO_2, N_20 and NMVOC emissions. Therefore, this section, which contains the following activities

- Paint applications
- Degreasing and dry cleaning
- Chemical products, manufacture and processing
- Other
  - Use of N_20 for anaesthesia
  - N_20 from fire extinguishers
  - N_20 from aerosol cans
  - Other use of N_2O

were skipped by TURKSTAT.

Chapter 6

6. Agriculture

6.1. Overview

In Turkey, the GHG emissions from agriculture activities are released as a result of the production and processing of agricultural crop, animal population (enteric fermentation, manure management) and field burning of agricultural residue.

The processes and activities of the agricultural activities were mainly sources of CH_4. However, the field burning of agricultural residues emitted N_2O, CO and NO_X.

Most of the activity data was collected and provided by the TURKSTAT. The parameters and emission factors for estimating the GHG emissions from this sector were from the IPCC guidelines.

Methane (CH_4): In this sector, the highest methane emission was the results of the enteric fermentation. It could be seen from Figure 6.1 that, the CH_4 emission trend is decreasing after the year 1990. The main reason was determined as the decreasing number of livestock (Table 6.1).

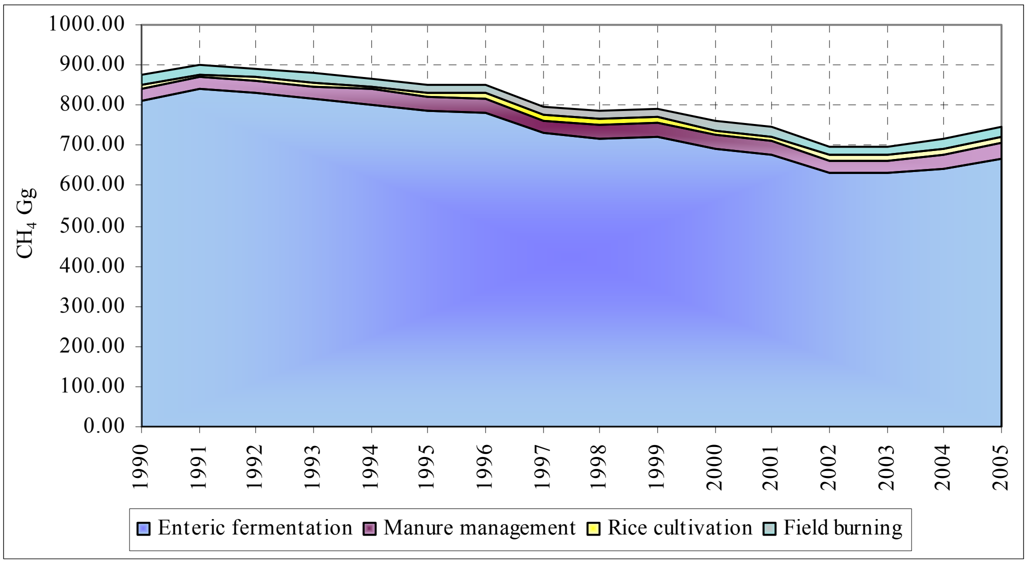


Figure 6.1. CH_4 emission trend from agricultural activities

The Ministry of Environment and Forestry prohibit farmer from burning the agricultural residue. Most of the farmers adapt the regulations, but the total quantity was not known. Therefore, the residue of the agricultural crops was still estimated as burned.

Table 6.1. The number of animals (1000)

Unit: (*1000)	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Dairy Cattle	1013	1254	1337	1442	1512	1702	1795	1715	1733	1782	1806	1854	1860	1941	2109	2355
Other Cattle	10364	10719	10613	10468	10389	10087	10091	9470	9298	9272	8955	8694	7944	7848	7960	8171
Buffalo	371	366	352	316	305	255	235	194	176	165	146	138	121	113	104	105
Sheep	40553	40432	39416	37541	35646	33791	33072	30238	29435	30256	28492	26972	25174	25432	25201	25304
Goats	10926	10764	10454	10133	9564	9111	8951	8376	8057	7774	7201	7022	6780	6772	6610	6517
Camels	2	2	2	2	2	2	2	1	1	1	1	1	1	1	1	1
Horse	513	496	483	450	437	415	391	345	330	309	271	271	249	227	212	208
Mules&Dankeys	1187	1136	1075	1013	978	900	843	782	736	680	588	559	512	490	452	423
Swine	12	10	12	9	8	5	5	5	5	3	3	3	4	7	4	2
Poultry	98848	141918	155437	181120	186591	131960	155693	169896	240108	242714	260769	219887	248009	279680	298897	319220

Table 6.2. The percent of animal according to the climate region
and manure management and enteric fermentation emission factors, 2005

Unit of EF (kg CH_4/head/y)	cool (%)	Tempe. (%)	Manure Cool EF	Manure Tempe. EF	Enteric EF
Dairy Cattle	71,4	28,6	7	16	56
Other Cattle	73,2	26,8	1	1	44
Buffalo	77,8	22,2	1	2	55
Sheep	73,2	26,8	0.1	0.16	5
Goats	47,3	52,7	0.11	0.17	5
Camels	23,8	76,2	1.3	1.9	46
Horse	61,1	38,9	1.1	1.6	18
Mules&Dankeys	63,6	36,4	0.6	0.9	10
Swine	64,4	35,6	1	4	1
Poultry	72,1	27,9	0.012	0.018	-

Turkey’s climate is considerable changing from region to region. As the annual average air temperature is considered, Turkey’s provinces are in cool (0 and 14 degrees centigrade) and temperate (15 and 25 degrees centigrade) climatic region. The used emission factor for manure management and enteric fermentation were according to the IPCC guidelines and the percent of the animal distribution were given in Table 6.2.

Direct emissions of nitrous oxide from agricultural soils (including the application of fertilizers and manure, the fixation by crops), were not estimated due to lack of data.

The emission from the field burning of agricultural residue was determined as one of the important emission sources. The result was seen in Figure 6.2. However, the emission trend shows fluctuations between 1990 and 2005. The highest CO emission from field burning was seen in 2005 with a value of 561.94 Gg. For N_20 and NO_X, the highest emissions were determined as 0.51 Gg and 12.86 Gg in 2005, respectively.

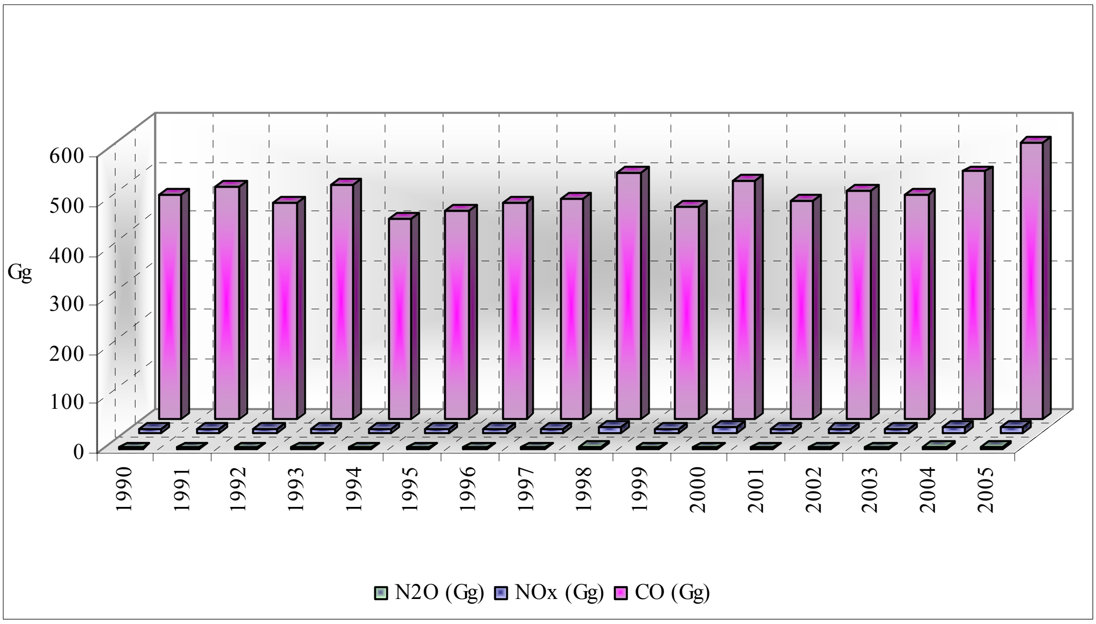


Figure 6.2. N_2O, NO_X and CO emissions from field burning of agricultural residues

6.1. Enteric Fermentation (4.A)

Source Category Description: Enteric fermentation is a digestive process whereby carbohydrates are broken down by micro-organism into simple molecules. The main product is the CH_4 gases. All type of animals produces CH_4 during and/or after feed intake. The highest methane emission in Agricultural sector in Turkey was the results of the enteric fermentation. The CH_4 emission has been decreasing since 1990. The main reason was the decreasing number of livestock. The main activity data (the population of animals) provider was TURKSTAT (provincial animal statistics).

Methodological Issues: The provincial animal population data collected from TURKSTAT was categorized according to the climate of province, then applying to appropriate emission factors (EF) to give an estimation of CH_4 emission. The methane emission factors were default IPCC Tier 1 factors. Although IPCC-GPG (2000) calls for the more detailed Tier 2 method to be used in cases in which a country has listed methane emissions from animal husbandry as a key source for its inventories. The cattle and sheep emission factors were not studied according to the IPCC Tier 2 methods. Because the nutrient requirements, feed intake and CH_4 conversion rates for feeding types were showing big differences even in provincial level. The rough CS emission factor estimation by experts almost resulted in IPCC Tier 1 factors.

Uncertainties and time-series consistency: The activity data for this section were almost gathered from TURKSTAT agricultural statistics. The approach to produce quantitative uncertainty estimates was to use expert judgement as described in IPCC Good Practice Guidance and Uncertainty Management (2000) Reference. Agricultural expert calculated the uncertainty and combined with their judgement to minimise the risk of bias. The uncertainties in emission factors and activity data were explained in annex in detail.

Table 6.3. Time series consistency of emission factor for (4.A)

Source Category	GHGs	Comments on time series consistency
4.A	CH_4	* All EFs were constant over the entire time series as given in Table 6.2.

Source-specific QA/QC and verification: This source category was covered by the general QA/QC of the greenhouse gas inventory

Recalculation: There was no change in sector 4.A per pollutant for 1990-2005.

6.2. Manure Management (4.B)

Source Category Description: Animal manure is composed of organic materials and it decomposes in an anaerobic environment and methanogenic bacteria produce methane (CH_4). This source category was not a key category.

Methodological Issues: The provincial animal population data collected from TURKSTAT was categorized according to the climate of province, then applying to appropriate emission factors (EF) to give an estimation of CH_4 emission from manure management. The methane emission factors were default IPCC Tier 1 factors. Since, there were no significant share of emission and detailed information on animal characteristics. The method chosen depended on data availability. The (N_20) estimates in this section was not considered, because of lack of information on manure storage and treatment

Uncertainties and time-series consistency: The approach to produce quantitative uncertainty estimates was to use expert judgement as described in IPCC Good Practice Guidance and Uncertainty Management (2000) Reference.

Table 6.4. Time series consistency of emission factor for (4.B)

Source Category	GHGs	Comments on time series consistency
4.B	CH_4	* All EFs were constant over the entire time series as given in Table 6.2.

Source-specific QA/QC and verification: This source category was covered by the general QA/QC of the greenhouse gas inventory

Recalculation: There was no change in sector 4.B per pollutant for 1990-2005.

6.3. Rice Cultivation (4.C)

Source Category Description: Anaerobic decomposition of organic material in flooded rice fields produces methane (CH_4), which escapes to the atmosphere primarily by transport through the rice plants. This source category was not a key category in Turkey.

Methodological Issues: The rice harvested area (in Turkey, Water Management Regime was irrigated and flood type was continues) collected from TURKSTAT and then applied to appropriate emission factors (EF) to give an estimation of CH_4 emission from rice production. The methane emission factors were default IPCC factors.

Uncertainties and time-series consistency: The approach to produce quantitative uncertainty estimates was to use expert judgement as described in IPCC Good Practice Guidance and Uncertainty Management (2000) Reference.

Table 6.5. Time series consistency of emission factor for (4.C)

Source Category	GHGs	Comments on time series consistency
4.C	CH_4, CO, N_20, NO_x	* All EFs were constant over the entire time series

Source-specific QA/QC and verification: This source category was covered by the general QA/QC of the greenhouse gas inventory

Recalculation: There was no change in sector 4.F per pollutant for 1990-2005.

6.4. Agricultural Soils (4.D)

This category includes particularly emissions of N_2O from mainly the input of application of synthetic fertilizers. It is very difficult to gather the information from sources. The lack of data hinders to estimate the N_2O emissions. Therefore, this section was skipped.

6.5. Prescribed Burning of Savannas (4.E)

This category is not relevant to Turkey.

6.6. Field Burning of Agricultural Residues (4.F)

Source Category Description: Although the burning of agricultural residues considered a net source of carbon dioxide because the carbon released to the atmosphere is reabsorbed during the growing season, this burning is a net source of emission of CH_4, CO, N_20 and NO_x. This source category was not a key category in Turkey.

Methodological Issues: The emissions from agricultural residue burning were considered under agriculture. The estimates were derived from IPCC emission factor and from crop production including wheat, barley, maize, oat and rye. The statistical data (activity data) were gathered from TURKSTAT.

Uncertainties and time-series consistency: The approach to produce quantitative uncertainty estimates was to use expert judgement as described in IPCC Good Practice Guidance and Uncertainty Management (2000) Reference.

Table 6.6. Time series consistency of emission factor for (4.6)

Source Category	GHGs	Comments on time series consistency
4.F	CH_4	* All EFs were constant over the entire time series

Source-specific QA/QC and verification: This source category was covered by the general QA/QC of the greenhouse gas inventory

Recalculation: There was no change in sector 4.C per pollutant for 1990-2005.

6.7. Other (4.G)

This category was not relevant to Turkey.

Chapter 7

7. Land Use, Land Use Change and Forestry

This section was prepared by Ministry of Environment and Forestry

7.1. Overview of Sector

This sector includes both sources and sinks of CO_2 . During the 1990-2005 period , removals by LULUCF increase intermittently (Figure 7.1).

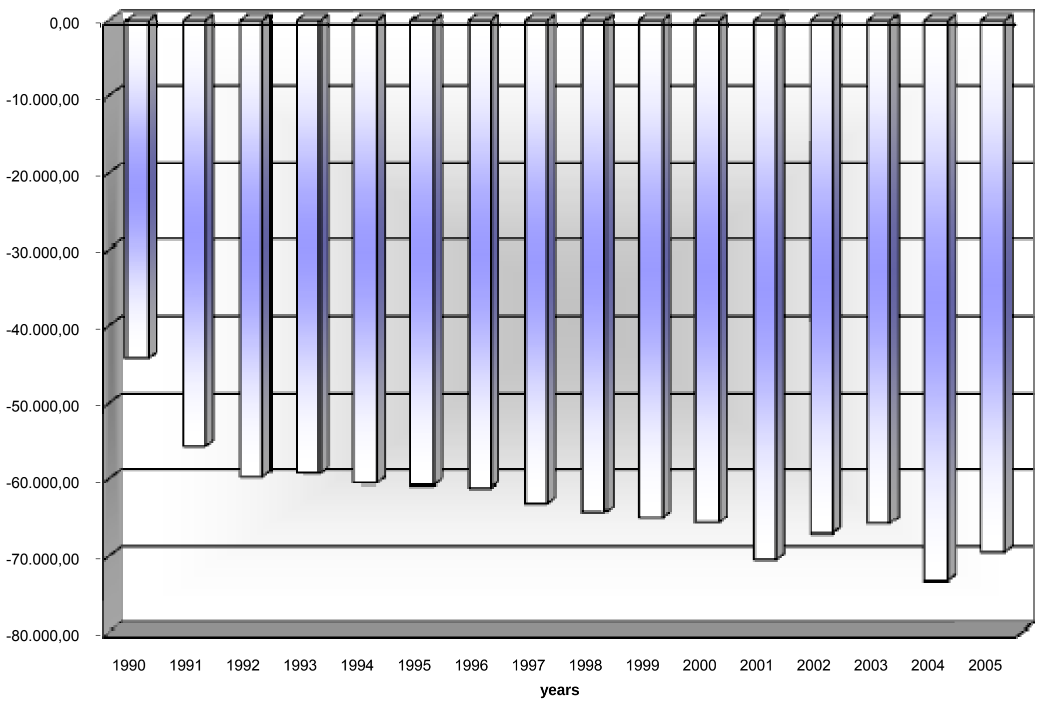


Figure 7.1 CO_2 removals by LULUCF during 1990-2005 period in Turkey

As shown in the Figure , LULUCF sector in Turkey performs as a net sink over the period , at an average 62.797,88 Gg/year.

Emissions from LULUCF arises from biomass burning in the forest lands. Other greenhouse gasses amounts change depending on the burned forest areas and there is no definite and significant trend for the other gasses (Table 7.1 and Figure 7.2).

Table 7.1 Changes in the Other Greenhouse Gasses Caused by Forest Fires Between the years of 1990-2004

Years	Greenhouse Gasses			
	CH4 Gg	CO Gg	N2O Gg	NO_x Gg
1990	0,00267	0,01334	0,00156	0,02690
1991	0,00157	0,00784	0,00092	0,01582
1992	0,00237	0,01187	0,00139	0,02394
1993	0,00299	0,01494	0,00174	0,03013
1994	0,00740	0,03701	0,00432	0,07463
1995	0,00149	0,00745	0,00087	0,01502
1996	0,00290	0,01448	0,00169	0,02921
1997	0,00123	0,00613	0,00072	0,01236
1998	0,00131	0,00656	0,00077	0,01324
1999	0,00113	0,00563	0,00066	0,01136
2000	0,00512	0,02558	0,00298	0,05158
2001	0,00144	0,00718	0,00084	0,01447
2002	0,00165	0,00826	0,00096	0,01666
2003	0,00129	0,00645	0,00075	0,01300
2004	0,00095	0,00473	0,00055	0,00954
2005	0,00030	0,00153	0,00017	0,00310

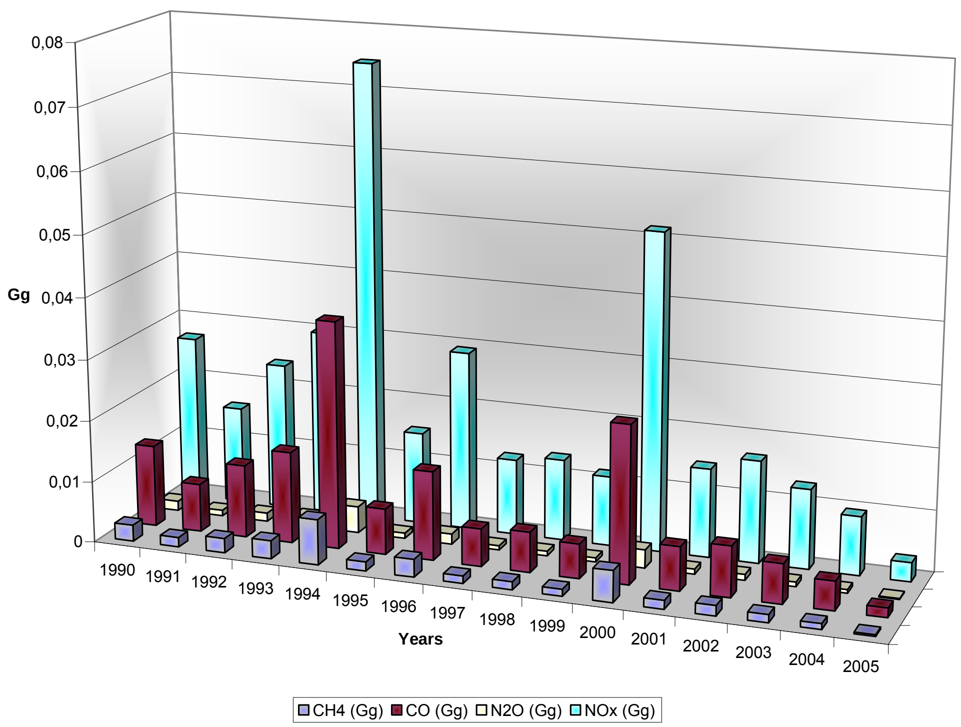


Figure 7.2 Other greenhouse gasses from forest fires between 1990-2004 years

Due to accounted as a carbon lost from forest fires in the total carbon lost , CO2 emissions were not considered here to avoid double counting in the LULUCF inventory.

Table 7.2 Comparison of emissions and removals in 1990-2005 period in Turkey

Years	Net removals from LULUCF(CO_2 Equivalent - Gg)	TOTAL GHG Emissions(CO_2 Equivalent -Gg)	Percentage of net removals from LULUCF in Total GHG Emissions (%)
1990	-44.086,92	170.059,31	25,92
1991	-55.572,63	181.963,99	30,54
1992	-59.718,55	193.636,03	30,84
1993	-59.160,16	203.980,19	29,00
1994	-60.466,38	200.464,98	30,16
1995	-60.736,83	220.719,57	27,51
1996	-61.066,23	242.092,35	25,22
1997	-63.087,07	255.513,66	24,69
1998	-64.285,99	256.633,77	25,04
1999	-65.024,93	256.776,03	25,32
2000	-65.609,05	279.957,01	23,43
2001	-70.481,69	262.098,51	26,89
2002	-67.038,90	270.617,48	24,77
2003	-65.753,39	286.282,76	22,96
2004	-73.244,45	296.602,13	24,69
2005	-69.432,92	312.968,70	22,18

As it is seen on the table 7.2, however there was an increasing course in total GHG emisssions, the average percentage of net removals from LULUCF was 26,19 % during the 1990-2005 period.

The methodology adviced in the IPCC Good Practice Guidance for land Use, Land Use Change and Forestry, 2003 was followed to estimate removals/emissions from LULUCF .

According to the Guidance, a climate map of Turkey was firstly prepared and used a base for all land use category (Figure 7.3).

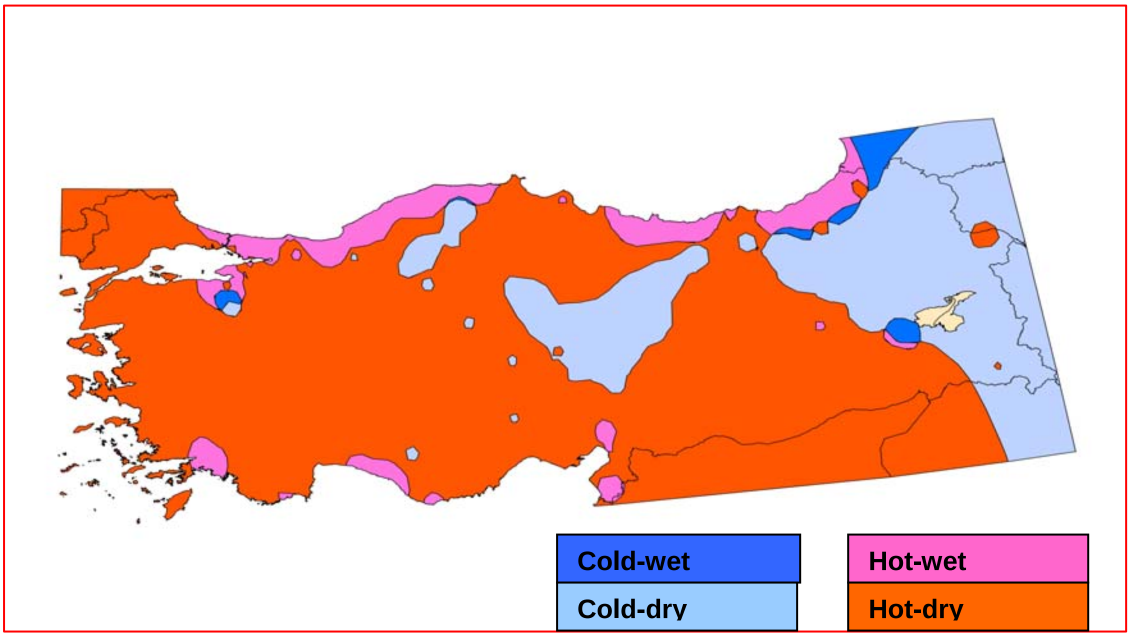


Figure 7.3 Climate zones of Turkey due to LULUCF Guidance

Recalculation of LULUCF -GHG inventory

For the 1990-2004 period, there were some changes in the carbon uptake values of forests after sending the first LULUCF-CRF tables to the UNFCCC Secreteriat. These changes were occured due to amendements of the annual volume increment and dead organic matter and emisssions from forest fires values. The volume and volume increments of the trees slimmer than 8 cm. and felling residues in the dead organic matter not taken into account in the first calculation were counted in the second calculation. The same way, emissions from forest fires were improved. The amended values of forestry for the 1990-2004 were processed into the CRF Reporter tables and sent to the Secreteriat in January 2007. Thus, any recalculations are not reported because the amendements were made within the same time series (1990-2004) .

Uncertainty
The uncertainty levels of the LULUCF inventory are satated in each land use section.

Completeness
As regards the inventory completeness, sinks and sources that could not be reported in the CRF tables are charted as follows:

Sink/source category	GHG	Explanation
Forest lands, soils	CO2	Lack of adequate data on the carbon stocks in the soil organic matter
Forest lands, litter	CO2	Lack of adequate data on the carbon stocks in the litter
Forest lands, soils	N2O	N fertilization does not occur in the forestry activities
Forest lands, drained organic soils	CO2	Drainage does not occur in the forests
Limestone application in croplands	CO2	Limestone application does not occur in the agricultural lands.
Croplands, drainage of soils	N_2O	No available data
Croplands, biomass burning	CO2, CH4 and N2O	No available data
Croplands, disturbance associated with land use conversion to cropland	N_2O	No available data

7.2 Forest Land (5.A)

The inventory studies related forest lands were accomplished by the Ministry of Environment, the Department of Research and Development, Forest Research Directorates and Istanbul University , Forestry Faculty (Prof. Dr. Unal ASAN) .

7.2.1 Source/sink category description

According to the figures given by the Forest Management Planning Department of the General Directorate of Forestry, Turkey has 21,2 millions ha forest area approximately with regard to its own forestry legislative. Since all the woody areas having more than 3 ha magnitudes are accepted in forest regime disregarding their crown closure, this figure differs with the figure given in FAO's (10,225 Mill. Ha. for the year of 2000) resources. FAO's figures cover the woody areas having more than %40 crown closure only. Because of the forcing situation initiating from the protective rules of constitution and forestry regulations current in Turkey, the figures given by forestry organisation were accepted and used during the estimation of net annual amount of carbon uptake or release in the forests of Turkey.

The figures concerning forest resources in Turkey for 2005 year are given in table 7.3:

Table 7.3 Forest inventory results of Turkey at the end of 2005 (x1000000)

Areas

Tree Species	High Forests (Ha)			Coppices (Ha)			TOTAL (Ha)		
	Normal[1]	Degraded[2]	Total	Normal	Degraded	Total	Normal	Degraded	Total
Coniferous	7.093	5.687	12.779				7.093	5.687	12.779
Deciduous	1.887	0.882	2.769	1.683	4.017	5.700	3.569	4.900	8.469
Total	8.979	6.569	15.548	1.683	4.017	5.700	10.662	10.586	21.248

Growing Stock

Tree Species	High Forests (m^3)			Coppices(m^3)[3]			TOTAL (m^3)		
	Normal	Degraded	Total	Normal	Degraded	Total	Normal	Degraded	Total
Coniferous	826.920	51.045	877.965				826.920	51.045	877.965
Deciduous	310.301	14.781	325.082	95.157	32.013	127.170	381.669	38.791	420.459
Total	1137.221	65.825	1.203.047	95.157	32.013	127.170	1.208.589	89.836	1.298.424

Annual Volume Increment

Tree Species	High Forests (m^3)			Coppices (m^3)[3]			TOTAL (m^3)		
	Normal	Degraded	Total	Normal	Dedraded	Total	Normal	Degraded	Total
Coniferous	22.430	1.168	23.598				22.430	1.168	23.598
Deciduous	7.714	0.368	8.081	5.236	1.243	6.479	11.640	1.300	12.940
Total	3.143	1.536	31.679	5.236	1.243	6.479	34.070	2.468	36.538

Source: Forest Management Planning Department of General Directorate of Forestry.

1)Crown closure between 0,11-1,00

2)Crown closure between 0,01-0,10

3)0,75 coefficient was used in order to convert the ster volume into M3 volume

Pinus brutia, P. nigra and, P.silvestris are the most important coniferous species among the other coniferous such as 4 kinds of Abies, Picea orientalis, Cedrus libani atc. In portion of these three pine species is more than 80 % as in totally volume of growing stock. Fagus orientalis and 22 Quercus spp have 80% ratio in total volume of the deciduous trees such as Tilia, Ulmus, Alnus, Castanea species.

Olden Data Concerning the Forest Resources

There are only two documents concerning the national forest inventory results in Turkey. The first document showing the 1972 situation was presented in 1980, and the second one prepared at the end of 2004 . Because of the absence of regular national forest inventory works in Turkey, both of the results were obtained basing on the summaries of management plans data renewed in each 10 years time interval.

Forest data given in first document is shown in Table 7.4:

Table 7.4: Forest inventory results of Turkey at the end of 1972

Table 7.4.A: Areas (*1000000)

Tree Species	High Forests (Ha)			Coppices (Ha)			TOTAL (Ha)		
	Normal[1]	Degraded[2]	Total	Normal	Degraded	Total	Normal	Degraded	Total
Coniferous	5,170	4,260	9,430				5,170	4,260	9,430
Deciduous	1,007	0,498	1,505	2,679	6,585	9,265	3,686	7,083	10,769
Total	6,177	4,758	10,935	2,679	6,585	9,265	8,856	11,343	20,199

Table 7.4.B: Growing Stock (*1000000)

Tree Species	High Forests (m^3)			Coppices (m^3)[3]			TOTAL (m^3)		
	Normal	Degraded	Total	Normal	Degraded	Total	Normal	Degraded	Total
Coniferous	548,559	44,417	592,976				548,559	44,417	592,976
Deciduous	210,033	9,942	219,975	117,734	45,506	163,240	327,768	55,448	383,215
Total	758,592	54,359	812,951	117,734	45,506	163,240	876,326	99,865	976,191

Table 7.4.C: Annual Volume Increment (*1000000)

Tree Species	High Forests (m^3)			Coppices (m^3)[3]			TOTAL (m^3)		
	Normal	Degraded	Total	Normal	Degraded	Total	Normal	Degraded	Total
Coniferous	15,593	1,093	16,686				15,593	1,093	16,686
Deciduous	5,199	0,251	5,450	6,418	1,486	7,904	11,616	1,737	13,353
Total	20,792	1,344	22,135	6,418	1,486	7,904	27,209	2,830	30,039

Source: Türkiye Orman Envanteri - Ankara 1980 Bülteni (Forest Inventory of Turkey-Ankara,1980 Bulletin).

1) Crown Closure between 0,11 – 1,00
2) Crown Closure between 0,01 – 0,10
3) 0,75 coefficient was used in order to convert the ster volume into cubic meter (m^3) volume

Table7. 5: Forest inventory results of Turkey at the end of 2004

Table 7.5.A: Areas (*1000000)

Tree Species	High Forests (Ha)			Coppices (Ha)			TOTAL (Ha)		
	Normal[1]	Degraded[2]	Total	Normal	Degraded	Total	Normal	Degraded	Total
Coniferous	7,083	5,689	12,772				7,083	5,689	12,772
Deciduous	1,857	0,810	2,667	1,681	4,068	5,749	3,538	4,878	8,416
Total	8,940	6,499	15,439	1,681	4,068	5,749	10,621	10,567	21,188

Table 7.5.B: Growing Stock (*1000000)

Tree Species	High Forests (m^3)			Coppices (m^3)[3]			TOTAL (m^3)		
	Normal	Degraded	Total	Normal	Degraded	Total	Normal	Degraded	Total
Coniferous	818,556	51,070	869,626				818,556	51,070	869,626
Deciduous	310,014	14,367	324,381	70,464	23,654	94,118	380,478	38,021	418,499
Total	1128,570	65,437	1194,007	70,464	23,654	94,118	1199,034	89,091	1288,125

Table 7.5.C: Annual Volume Increment (*1000000)

Tree Species	High Forests (m^3)			Coppices (m^3)[3]			TOTAL (m^3)		
	Normal	Degraded	Total	Normal	Degraded	Total	Normal	Degraded	Total
Coniferous	22,235	1,165	23,400				22,235	1,165	23,400
Deciduous	7,674	0,353	8,027	3,926	0,929	4,855	11,600	1,282	12,882
Total	29,909	1,518	31,427	3,926	0,929	4,855	33,835	2,447	36,282

Source: Forest Management Planning Department of General Directorate of Forestry.

1) Crown Closure between 0,11 – 1,00
2) Crown Closure between 0,01 – 0,10
3) 0,75 coefficients was used in order to convert the ster volume into cubic meter (m^3) volume

The changes and plus/minus differences among the forest forms and tree species between the years of 1972 and 2004 are outlined in Table 7.6.

Table7.6: Differences between forest inventory results of Turkey for the years of 2004 and 1972

Table 7.6.A: Arial changes among the forest forms and tree species (*1000000)

Tree Species	High Forests (Ha)			Coppices (Ha)			TOTAL (Ha)		
	Normal[1]	Degraded[2]	Total	Normal	Degraded	Total	Normal	Degraded	Total
Coniferous	2,023	1,464	3,487				2,023	1,464	3,487
Deciduous	0,740	0,278	1,018	-0,998	-2,517	-3,515	-0,258	-2,239	-2,497
Total	2,763	1,742	4,505	-0,998	-2,517	-3,515	1,765	-0,775	0,990

Table 7.6.B: Growing Stock changes among the forest forms and tree species (*1000000)

Tree Species	High Forests (m^3)			Coppices (m^3)[3]			TOTAL (m^3)		
	Normal	Degraded	Total	Normal	Degraded	Total	Normal	Degraded	Total
Coniferous	269,998	6,653	276,519				269,998	6,653	276,519
Deciduous	99,980	4,425	104,406	-23,783	-13,967	-37,750	76,198	-9,542	66,656
Total	369,978	11,078	380,925	-23,783	-13,967	-37,750	346,196	-2,889	343,175

Table 7.6.C: Annual Volume Increment changes among the forest forms and tree species (*1000000)

Tree Species	High Forests (m^3)			Coppices (m^3)[3]			TOTAL (m^3)		
	Normal	**Degraded**	**Total**	**Normal**	**Degraded**	**Total**	**Normal**	**Degraded**	**Total**
Coniferous	6,642	0,072	6,714				6,642	0,072	6,714
Deciduous	2,475	0,102	2,577	-1,183	-0,247	-1,430	1,292	-0,145	1,147
Total	9,117	0,174	9,291	-1,183	-0,247	-1,430	7,934	-0,073	7,861

Source: Forest Management Planning Department of General Directorate of Forestry.
1) Crown Closure between 0,11 – 1,00
2) Crown Closure between 0,01 – 0,10
3) 0,75 coefficients was used in order to convert the ster volume into cubic meter (m^3) volume

The last columns of Tables 7.6.A, B, C are compiled in Table 7.7 in order to find the average changes annually.

Table 7.7: Total and average changes on forest resources between the years of 1972 and 2004

Tree Species	Change on Area (Ha) (*1000000)		Change on Growing Stock (m^3) (*1000000)		Change on Annual Increment (m^3) (*1000000)	
	Total	**Average**	**Total**	**Average**	**Total**	**Average**
Coniferous	3,487	0,109	276,519	8,641	6,714	0,210
Deciduous	-2,497	-0,078	66,656	2,083	1,147	0,036
Total	0,990	0,031	343,175	10,724	7,861	0,246

Evaluation of Table 7.6 and 7.7 can be outlined as below:

1-Total amount of areas, growing stocks and volume increments of the coppice forests reduced while high forests were increasing. Highest amount of decrease occurred in degraded coppices.
2-Total amount of growing stocks and annual volume increment of the coniferous and deciduous tree species increased. More than 80% of the increase occurred on coniferous tree species.
3-Total increase on area is 0,99 Mill. Ha; on growing stock and volume increment are 343,175 and 7,861 Mill m^3 respectively.
4-Althoug the reduction on the areas of deciduous tree species, total growing stock and current annual increment accrued because of conversion the coppices into high forests, and leaving of tree cuttings on some olden managed forests for nature protection.

According to the results of these two inventories, forest areas increased (0,99/20,199)= 5% while the growing stock volume (343,175/976,191)= 35%, and annual volume increment (7,861/ 30,039)= 29% were getting high during the 32 years time period between the years of 1972-2004.

Considerable reasons of these changes are:

1-Moving to province centres from the rural areas;
2-Giving up old fashion goat breeding and cattle grazing in the forests and the meadows adjacent to forests;
3-Abandonment of some forest lands occupying on steep slopes and having non-economic management conditions;
4-Changing considerations on forestry applications towards multi functional use of forest resources in the framework of sustainable forest management concept;
5-Converting of coppices into high forests;
6-Afforestration activities on the bare lands and degraded forests accomplished by the Forestry Service

All the factors focused here played affecting roles on these increases.

Almost whole of the Turkey's forests is natural forest and categorized under the temperate climate zone. In this zone, there are 4 sub-climate type are identified (Figure 7.3).

For estimating carbon stocks in the forest areas, this category is divided into Category 5.A.1 Forest remaining Forest Land and Category 5.A.2 Land cenverted to Forest Land. Each sub-categorizes are separated out into coniferous and deciduous and then managed and unmanaged forest. The distribution of Turkey's forests due to climate and mangement types and tree species in 2005 is presented hereunder:

Table 7.8 The distribution of Turkey's forests in 2005

Subcategories in 2005	**Management Units**	**Area of forest land**
		(kha)
Hot-dry managed coniferous	1625	8798,69
Hot-dry managed deciduous	779	3531,14
Hot-dry unmanaged coniferous	829	2882,81
Hot-dry unmanaged deciduous	368	1018,35
Sub-Total	**3601**	**16230,98**
Hot-wet managed coniferous	403	1055,38
Hot-wet managed deciduous	525	1005,21
Hot-wet unmanaged coniferous	190	368,88
Hot-wet unmanaget deciduous	316	530,34
Sub-Total	**1434**	**2959,82**
Cold -dry managed coniferous	141	882,50
Cold -dry managed deciduous	66	480,24
Cold -dry unmanaged coniferous	56	263,04
Cold -dry unmanaged deciduous	44	179,93
Sub-Total	**307**	**1805,71**
Cold –wet managed coniferous	28	121,97
Cold –wet managed deciduous	16	58,94
Cold –wet unmanaged coniferous	12	23,57
Cold –wet unmanaged deciduous	13	47,51
Sub-Total	**69**	**251,99**
managed coniferous	2197	10858,55
managed deciduous	1386	5075,53
unmanaged coniferous	1087	3538,30
unmanaged deciduous	741	1776,12
Coniferous	3284	14396,84
Decidoous	2127	6851,65
Grand total	**5411**	**21248,49**

All forest statistics were obtained from the General Directorate of Forestry under the Ministry of Environment and Forestry.

Data on Forest Fires:

The information about the forest fires is received from the Department of Forest Protection and Fighting Fires of General Directorate of Forestry and written on the table 7.9:

Table 7.9 Forest Fires in 2005

Fire Number	Total area (Ha)	Fire Types		Standing Volume To fires Exposed		
		Ground Vegetation (ha)	Crown (ha)	M^3	Ster	Total
1530	2821,116	837,611	1983,58	176100,6	37901	204526,3

These statistics contain forest area exposed to fire, fire type and standing volume with bark removed from forest because of the fire. Non-CO_2 greenhouse gasses emitted by wildfire were calculated based on the biomass burned with 45% burning productivity . This rate was taken from IPCC Guidance table 3A.1.12.

Existing document concerning the forest resources and forestry activities permitted to second level communication(Tier 2 methods) mainly during the calculation of carbon uptake and the other greenhouse gasses inventory. Since there is no adequate and baseline data on land use changes concerning the olden time, first level communication (Tier 1 methods) were applied for the estimation of carbon sequestrations and greenhouse gasses emissions between the years 1990-2004.

The required data on the dead organic matter cover the dead trees and felling residues(harvesting waste) for the forests older than 20 years old.Litter amounts were not included into calculations because of the absence of specific researches in this scope. Carbon contents in the forest soils were not considered too due to same reason. Thus , both of these carbon pools were not taken into account because of the lack of document suitable for these purposes. Due to the extraordinary pecularities among the geographical regions in Turkey (southern and western parts of the country have Mediterranean forest conditions while the northern part looks like typical west European forests) default values for these pools given in the Guidance annexes rables could not be used.

7.2.2 Methodology

Carbon stocks in living biomass in the forest areas were evaluated as two category divided into 5.A.1 Forest remaining Forest Land and 5.A.2 Land converted to Forest Land (Table 7.10).

Table 7.10. Annual change of net carbon stocks in the forest areas of Turkey with regard to sub-categories, 2005

Tree Species	Change of Carbon Stocks in the Pools of Forest Lands Remaining Forest Lands				Change of Carbon Stocks in the Pools of Forest Lands Converted to Forest Lands			
	Areas kha	In Living Biomass Gg	In Dead Organic Matter Gg	In Forest Soil Gg	Areas kHa	In Living Biomass Gg	In Dead Organic Matter Gg	In Forest Soil Gg
Managed Coniferous	10394,29	6395,50	583,19	0	464,09	424,23	0	0
Managed Deciduous	5041,60	3281,60	272,61	0	34,09	29,53	0	0
Managed Total	15435,89	9677,11	855,80	0	498,18	453,76	0	0
Unmanaged Coniferous	3410,61	1648,72	10,11	0	127,69	143,72	0	0
Unmanaged Deciduous	1754,76	1157,78	5,08	0	21,36	18,56	0	0
Unmanaged Total	5165,37	2806,50	15,19	0	149,05	162,28	0	0
TOTAL	**20601,26**	**12483,61**	**870,99**	**0**	**647,24**	**616,04**	**0**	**0**

Table 7.11. Annual change of net carbon stocks and CO_2 equivalents in the whole forests of Turkey, 2005

Tree Species	Areas kHa	In Living Biomass Gg	In Dead Organic Matter Gg	In Forest Soil Gg	TOTAL Gg	CO_2 Equivalent (Removal) Gg
Managed Coniferous	10858,386	6819,730	583,188	0	7402,918	27144,033
Managed Deciduous	5075,690	3311,138	272,608	0	3583,746	13140,402
Managed Total	15934,076	10130,868	855,796	0	10986,664	40284,435
Unmanaged Coniferous	3538,296	1792,442	10,114	0	1802,556	6609,370
Unmanaged Deciduous	1776,123	1176,337	5,077	0	1181,414	4331,852
Unmanaged Total	5314,419	2968,779	15,191	0	2983,970	10941,223
TOTAL	**21248,495**	**13099,648**	**870,987**	**0**	**13970,634**	**51225,658**

Net carbon sequestration and removals between the years 1990-2005 in the forests of Turkey are outlined in table 7.12 and shown in Figure 7.4.

Table 7.12: Net carbon sequestration and removals between the years 1990-2005 in the forests of Turkey

Years	Carbon Increases		Carbon Lost			Net carbon sequestration Ton/year *(1000)	CO_2 Equivalent Gg/year
	Living biomass Ton/year *(1000)	Dead organic matter Ton/year *(1000)	Commercial Cutting Ton/year *(1000)	Fuel Wood Gathering Ton/year *(1000)	Other *(Forest Fires) Ton/year *(1000)		
1990	17017,048	966,586	4291,567	1468,152	200,063	12023,852	44087,456
1991	17139,718	934,880	4141,355	1468,152	117,647	12347,444	45273,960
1992	17263,340	930,375	4120,013	1468,152	178,080	12427,470	45567,390
1993	17387,921	935,399	4143,817	1468,152	224,099	12487,252	45786,589
1994	17513,470	811,289	3555,830	1468,152	555,088	12745,689	46734,195
1995	17639,993	945,449	4191,431	1468,152	111,751	12814,108	46985,062
1996	17767,500	946,141	4194,709	1468,152	217,242	12833,538	47056,305
1997	17895,997	868,868	3828,619	1468,152	91,952	13376,142	49045,855
1998	18025,494	837,278	3678,955	1468,152	98,474	13617,191	49929,701
1999	18155,998	822,955	3611,100	1468,152	84,498	13815,203	50655,745
2000	18287,518	824,514	3618,487	1468,152	369,102	13656,291	50073,066
2001	18420,061	780,334	3409,176	1468,152	107,646	14215,421	52123,211
2002	18553,637	851,658	3747,083	1468,152	123,951	14066,109	51575,732
2003	18688,253	828,904	3639,287	1468,152	96,727	14312,991	52480,968
2004	18823,919	888,387	3921,089	1468,152	70,987	14252,078	52257,618
2005	18538,821	870,987	3897,604	1518,506	23,064	13970,634	51225,658

*Other carbon lost from insect and fungus disturbances are not included

Net carbon uptake was calculated by taking commercial cutting, fuel wood gathering and biomass lost from forest fires out the aboveground and belowground living biomass.

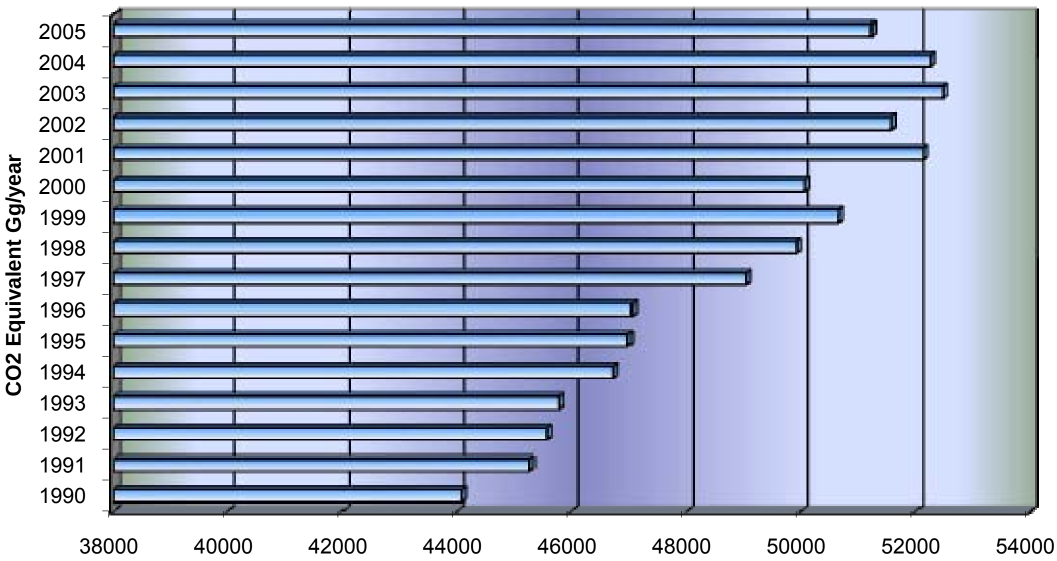


Figure 7.4 Net carbon removals between the years 1990-2005 in the forests of Turkey

Note: *in 2005, although the forest areas was increased , it was seen some decrease in the carbon stocks . This decrease comes from the methodology followed.*

According to the Guidance, the annual carbon sequestration in the forests is estimated based on the annual increment of the trees. Root the Shoot (R) expansion factor is used to convert aboveground biomass to the whole trees' biomass(including roots) and this factor is in inverse relations with aboveground biomass of forest in hectar . Since R coefficients have not developed yet for Turkey , default values of R in the Guidance for temperate forests (Table 3A.1.8) were used.

Table 3A.1.8 Average Belowground Biomass Ratio(Root-Shoot Ratio,R) in Natural Regeneration by Broad Category(tonnes dry matter/tonne dry matter) (To be used for R in Equation 3.2.5)

	Vegetation type	Aboveground biomass (t/ha)	Mean	SD	Lower range	Upper range	References
İbreli orman / plantasyon	İbreli orman / plantasyon	<50	0.46	0.21	0.21	1.06	2, 8, 43, 44, 54, 61, 75
	İbreli orman / plantasyon	50 – 150	0.32	0.08	0.24	0.50	6, 36, 54, 55, 58, 61
	İbreli orman / plantasyon	>150	0.23	0.09	0.12	0.49	1, 6, 20, 40, 53, 61, 67, 77, 79
Ilıman yapraklı orman/plantasyon	Meşe ormanı	>70	0.35	0.25	0.20	1.16	15, 60, 64, 67
	Okaliptüs plantasyonu	<50	0.45	0.15	0.29	0.81	9, 51, 59
	Okaliptüs plantasyonu	50-150	0.35	0.23	0.15	0.81	4, 9, 59, 66, 76
	Okaliptüs orman/plantasyonu	>150	0.20	0.08	0.10	0.33	4, 9, 16, 66
	Diğer yapraklı ormanlar	<75	0.43	0.24	0.12	0.93	30, 45, 46, 62
	Diğer yapraklı ormanlar	75-150	0.26	0.10	0.13	0.52	30, 36, 45, 46, 62, 77, 78, 81
	Diğer yapraklı ormanlar	>150	0.24	0.05	0.17	0.30	3, 26, 30, 37, 67, 78, 81

Forest resource statistics show that Turkish forests are getting in good conditions in terms of the aboveground biomass increase.That's why R coefficient used is getting smaller. For instance, while %46 of R is used for the 45 tonne/ha of aboveground biomass , %32 of R is used for the 60 tonne/ha of that. So in 2005, the total biomass increment and carbon uptake in the forests were calculated less than those of 2004 year because aboveground biomass increment was multiplied by the lesser value of the R coefficient.

Removals and emissions related to Forest land have been calculated following the Equation 3.2.1 of IPCC GPG 2003.

EQUATION 3.2.1 $\Delta CFF = (\Delta CFFLB + \Delta CFFDOM + \Delta CFFSoils)$

Annual Increase In Carbon Stocks Due To Bıomass Increment In Forest Land

Removals (annual increase in carbon stocks due to biomass growth) have been calculated following the Equation 3.2.4 and 3.2.5 of IPCC GPG 2003.

$\Delta C_{FF-LB} = (C_{t2} - C_{t1}) / (t_2 - t_1)$ (Equation 3.2.3)

$C=[V*D*BEF_2] * (1+R)*CF$

$G_{TOTAL} = G_W * (1+R)$ (Equation 3.2.5)

$G_W = I_V * D * BEF_1$

$G_{TOTAL} = [(I_V * D* BEF_1) * (1+R)]$

For annual increase in carbon stocks due to biomass growth, both the national and default data were used. National forestry data are mainly come from the General Directorate of Forestry.

- area of forest land: It exists for each management class in the forest management plans (Tier 2).
- Average annual net increment in volume suitable for industrial processing (Iv): It exists for each management class in the forest management plans (Tier 2).
- basic wood density (D): It is determined for all fundemental tree species which form a stand in the Turkey's forests (Table 7.13)(Tier 2). This coefficient was determined as :

  -0,496 for mixed but largely coniferous forests

  -0,638 for mixed but largely deciduous forests

Table 7.13 The ovendry weight of Turkey's fundamental tree species

Coniferous		Ovendry weight (g/cm^3)	Deciduous		Ovendry weight (g/cm^3)
Pinus brutia	Kızılçam	0,530	Fagus orientalis	Kayın	0.640
Pinus nigra	Karaçam	0,516	Quercus robur	Meşe	0.650
Pinus silvetris	Sarıçam	0,496	Carpinus	Gürgen	0.790
Abies bornmülleriana	Göknar	0,400	Alnus barbata	Kızılağaç	0.490
Picea orientalis	Ladin	0,401	Populus nigra	Karakavak	0.410
Cedrus libani	Sedir	0,480	Castanea sativa	Kestane	0.590
Juniperus excelsa	Ardıç	0,508	Fraxinusexcelsior	Dişbudak	0,650
Pinus pinea	Fıstıkçamı	0,465	Tilia grandiflora	Ihlamur	0.490
Cupressus sempervi.	Servi	0,480	Platanus orientalis	Çınar	0.580
Pinus halepensis	Halepçamı	0,514	Eucalyptus rostrata	Okaliptüs	0.547
Pinus maritima	Sahilçamı	0,430	Liquidambar orientalis	Sığla	0.680
Pinus radiata	P.Radiata	0,380	Robinia pseudoacaccia	Yalancı akasya	0.720

Source: AS ve Ark. (2001)

- biomass expansion factor for conversion of annual net increment (including bark) to aboveground tree biomass increment (BEF_1 and BEF_2): Calculated for both coniferous and deciduous species seperately(Tier 2).

Table 7.14 Comparison of BEF1 and BEF2 coefficients between LULUCF Guidance and those calculated for Turkey to use for the natural and plantation forest located in the temperate zone

Tree Species	Data resource	BEF_2	Uncertainty %	BEF_1	Uncertainty %
Coniferous	in LULUCF Guidance	1,30 (1,15-3,40)	-	1,15 (1,05-1,20)	-
	Calculated for Turkey	1,24 (1,08-1,39)	12,27	1,22 (1,15-1,29)	14,72
Deciduous	İn LULUCF Guidance	1,40 (1,15-3,40)	-	1,20 (1,10-1,30)	-
	Calculated for Turkey	1,26 (1,08-1,40)	10,94	1,24 (1,06-1,42)	5,69

Source: ASAN Ünal,2006

- Root-to-shoot ratio (R) : Default data used for temperate zone in the Guidance (Table 3A) and accounted distinctly for each management class based on the growing stock in hectar.
- Carbon fraction of dry matter (CF): Default value of Guidance (0.5) has been used for carbon fraction of dry matter (CF).

Annual Decrease in Carbon Stocks Due to Biomass Loss in Forest Land

Annual decrease in carbon stocks due to biomass loss in forest land have been calculated following the Equation 3.2.6 of LULUCF Guidance.

Equation 3.2.6 $\Delta CFFL = L_{fellings} + L_{fuelwood} + L_{other\ losses}$

Annual Carbon Loss Due To Commercial Felling

Equation 3.2.7 $L_{fellings} = H \bullet D \bullet BEF2 \bullet (1 - fBL) \bullet CF$

H: Wood harvesting data includes the planned harvests as well whole wood harvests evaluated as industrial harvesting due to biotic and abiotic harms (Tier 2).

Annual Carbon Loss Due To Fuelwood Gathering

Equation 3.2.8 $L_{fuelwood} = FG \bullet D \bullet BEF2 \bullet CF$

FG = Fuelwood gathering and illegal cutting data obtained from the General Directorate of Forestry and 8th Five Years Development Plan is used here (Tier 1).

Annual Other Losses Of Carbon

Equation 3.2.9 $L_{other\ losses} = A_{disturbance} \bullet BW \bullet (1 - fBL) \bullet CF$

$A_{disturbance}$ = Forest areas burnt by fires were taken into account (Tear 1).
BW = It is estimated that average biomass in the fired areas could be burned with 45% percent of burning productivity. This biomass did not cover the litter. Relevant burning rate was fixed to the Guidance(Tables 3A.1.12) (Tear 1).

Annual Change In Carbon Stocks In Dead Organic Matter In Forest Land

Equation 3.2.10 $\Delta CFFDOM = \Delta CFFDW + \Delta CFF\ LT$

Dead organic matter as a carbon pool divided into dead wood and litter. Dead wood data in the "Forest remaining Forest Land" was reached from forest management plans and added to the felling residues data.

But there is no sufficient data on the litter in the Turkey's forests , the carbon stock change in the litter was assumed as zero according to the Guidance.

Annual Change In Carbon Stocks In Dead Wood In Forest Land

Equation 3.2.11 $\Delta CFFDW = [A \bullet (Binto - Bout)] \bullet CF$

Binto = Calculated from the forest management plans and the felling residues was added to it.

Bout = Decay period of dead wood in forest areas was assumed as an average of 10 years. 1/10 of dead wood was decreased in each year.

7.2.3 Uncertainty and time–series consistency

To estimate the uncertainty levels in parameters and formulas, LULUCF Guidance recommends to use the 5.2.1 and 5.2.2 equations :

Equation 5.2.1 $U_{toplam} = \sqrt{U_1^2 + U_2^2 + ... + U_n^2}$

Equation 5.2.2 $U_E = \dfrac{\sqrt{(U_1 \bullet E_1)^2 + (U_2 \bullet E_2)^2 + ... + (U_n \bullet E_n)^2}}{|E_1 + E_2 + ... + E_n|}$

Whole designated uncertainty levels are expressed as follow:

Table 7.15 Uncertainty estimates of parameters

Parameters	Uncertainty (%)
Ovendry weight -Coniferous -Deciduos	 20 26
-BEF1 Coniferous Deciduous -BEF2 Coniferous Deciduous	 15 6 12 11
f_{BL}	43
Dead wood	44
Root the shoot (R)	30
CF	2
Aboveground biomass -Coniferous -Deciduos	 40 41

Uncertainty According To The Expert View :

For parameters related areas from the GDF source.................……..% 0,03;
For parameters related volume from the GDF source.......…………..%10;
For parameters related volume increment from the GDF source ...…%10;
For parameters related commercial wood volume from SPO............%5 ;
For parameters related fuel wood gathering from SPO.......….........%15;
For parameters related burned forest areas from SPO........………...%10;

Table 7.16 Uncertainty of equations

Equations	Uncertainty (%)
Forest remaining forest land -Annual living biomass increment -Coniferous -Deciduous	 40 41
-Annual living biomass lost -Coniferous -Deciduous	 73 69
-Dead organic matter	44
-Forest fires	87

Time series consistency:

Since there are two forest inventory carried out by the General Directorate of Forestry for 1972 and 2004 years, the data on the forest areas, growing stocks and annual volume increments during 1990-2004 period were calculated by interpolation between these two inventory data. Thus, the annual increase of forest areas were assumed as linear as well growing stocks and volume increments were accepted to increase with the compound interest basis.

The statistics on the forest fires and commercial roundwood production were taken from the General Directorate of Forestry.

Also, fuelwood gathering data is reached from utilizing the State Planning Organization's source and it is accepted as the same quantity for each year.

7.2.4 Planned Improvements

It was seen during the preparation of GHG inventory of LULUCF , there is a need to improve the forest resources inventory studies, the quality assurance of relevant data and increase the researches to obtain the country specific data. For this aim, a project has been started to set carbon stocks changes in the forest soils and litter by the Turkish Western Blacksea Forestry Research Directorate . Also planned activities are:
-Establishment of the permanent team to work for the LULUCF studies and improving the capacity of the concerned staffs and institutions.
-A project to monitor the carbon stocks in the Turkey's forests.

-7.3.&7.4.&7.5.&7.6.&7.7.& Croplands (CRF sector 5.B), Grasslands (CRF sector 5.C), Wetlands (CRF sector 5.D), Settlements (CRF sector 5.E), Other lands (CRF sector 5.F)

The removals from these 5 types of land uses were calculated by the Ministry of Agriculture and Rural Affairs , General Directorate of Agricultural Production and Development, Remote Sensing and Agricultural Land Information Centre(UTABIM) and Harran University, Agricultural Faculty (Assoc. Prof. Halil KIRNAK).

7.3 Croplands (5.B):

Calculation of carbon uptakes by croplands under LULUCF guides is based on soil map which is in digital format for whole Turkey, climate data which also is digital format, land use change data which is in tabular digital format.

1. **Soil map**: The soil survey studies in Turkey were initiated in 1960. The soil survey and soil orders studies of whole lands of country were completed by using 1:25000 map scales. This study was updated in 1980. The study was done based on US soil taxonomy system. All maps were digitized in 1999, and attributes of soils were connected with polygons via help of GIS. This is the only digital soil map available in Turkey.
2. **Climate data**: The meteorological measurements were being made at 260 point at local stations in Turkey. Each station reflects its own characteristic. Point based meteorological data was converted to regional data using local statistical methods by help of GIS (ArcGIS). Later, overlap analysis in GIS was done to form climatic zones mentioned in LULUCF Guidance (Figure 7.3).

7.3.1 Cropland Remaining Cropland

Tier 1 approach was used for estimating carbon uptake from cropland. While calculating C changes in soils, we only considered mineral soils since area of the organic soils in Turkey was insignificant compared to the area of the mineral soils. The area of the organic soils was only about 0.3% of all soils in Turkey. Besides, three was no lime application in Turkey based on state statistics records The Turkish Statistics Institute (TURKSTAT) and Ministry of Agriculture and Rural Affaires. Therefore, ΔC_{soil} is equal to $\Delta C_{CCmineral}$. We have no country specific data for stock change factors. The relative stock change factors such as F_{LU}, F_{MG}, and F_I were selected based on climate regime from Table 3.3.4 of LULUCF guidance.

Concerning calculation of CO2 removals by biomass , the land where converted from annual crop to permanent crop was taken in to consideration. Also calculation CO2 comes from soil, this transformation was taken into consideration as high tillage to less tillage.

TURKSTAT and Ministry of Agriculture and Rural Affairs collaborated on collection of farmer records for each cultivated crops yearly. These records were collected by town branches of Ministry of Agriculture and Village Affairs and were sent to TURKSTAT year by year. The records were gathered in the scale of town and consisted of whole crops grown in the town. Again, since all these records were kept in a suitable database format, any queries could be made and printed. In this study, land use data were obtained from TURKSTAT.

As a result, land use change data which was in tabular digital format was used in this study. Digital land use data based on map was not available for Turkey. Total area of croplands in Turkey was not considered. Only amount of land where was converted from annual crop to permanent crop on town scale was taken into consideration year by year. Average area converted from annual crop lands to the permanent crop lands for year 1990 to 2005 is about 2.322.581 ha.(Table 7.17).

Table 7.17 Annual crop lands converted to permanent cropland

	Year	Area (Hectare)
1	1991	2.078.977
2	1992	2.075.876
3	1993	2.126.516
4	1994	2.149.600
5	1995	2.193.689
6	1996	2.209.369
7	1997	2.238.606
8	1998	2.258.673
9	1999	2.286.478
10	2000	2.309.663
11	2001	2.334.258
12	2002	2.524.969
13	2003	2.594.926
14	2004	2.510.280
15	2005	2.946.832
	Total	34.838.711
	Average	2.322.581

Land use changes on agricultural land in Turkey are pretty high. Main land use changes on croplands are non irrigated arable land to irrigated land, annual crops to permanent crops (orchards). Turkish agricultural policies are supporting fruit production from 1990 to now. Because of this support and irrigation projects, permanent crop productions are being extended. This transformation is very big advantage for carbon uptake in agricultural land. Also there is some land use changes from other land use type to settlement area. We haven't available data on that area. But generally it is not easy to convert arable land to settlement because of very strict law. However, land where converted from annual crop to permanent crop are taken in to consideration, it is assumed that there is no any change on remaining arable land. Also it is obvious; cropland is positive effect on green house gasses emissions.

7.4 Grasslands or range lands (5.C)

Tier 2 approaches were used. It was also assumed that 75% of annual biomass growth of perennial woody biomass was lost. It means that $L_{perennial} = G_{perennial} * 0.75$ based on expert knowledge in Turkey. In the calculations of C stocks originated from soils, only mineral soils were considered. Default stock change factors were selected from LULUCF guidance.

Grasslands and range lands data are not available in digital format or tabular digital format for Turkey. Maybe there are some inventory information concerning grasslands but this data is not based on real, some times bare rock was registered as range land. So this data are not taken into consideration. However a range land rehabilitation project is being applied by Ministry of Agriculture and Rural Affairs. We have taken in to consideration the land where rehabilitated under the project year to year. So instead of total area of range land, yearly rehabilitated area was taken in to consideration. For example 1000 hectare area are rehabilitated at 2005, we assumed that 1000 hectare area of range land converted from over grazing to less grazing. This number effects only the year 2006. Because of that 2004 is smaller then before.

The grassland areas taken in to consideration during the calculation of carbon uptake by these lands are given below.

Table 7.18 Grassland areas considered for inventory between 2000-2005 years in Turkey

Year	2000	2001	2002	2003	2004	2005	Area of total project (Ha)
TOTAL	**660.8**	**881.1**	**6,810.80**	**9,771.30**	**72,502.34**	**81,613.77**	**172,240.11**

7.5 Flooded land areas (5.D)

CO2 emissions associated with peat extractions was assumed to be zero since three was no peat production from wetlands in Turkey. The C stock change is originated only from land converted to flooded land (reservoirs) in wetlands under the conditions of Turkey.

In order to determine area of flooded land (Reservoirs), list of the dams constructed between 1990 and 2004 was taken from State Hydraulic Department and Former General Directorate of Rural Affairs. The water surface area of dams constructed both agricultural and hydropowers were measured on the digital hydraulic map of Turkey by using GIS techniques.

7.6 Settlements (5.E)

Tier “1a” approach was used. This approach uses changes in C stocks per tree crown cover area as a removal factor.

CORINE 2000 data base was used to determine the crown areas of trees located on settlements areas. CORINE 2000 data base considers only lands bigger then 25 ha. Based on this limitation tree planted area in Cities in the year of 2000 were tabulated below. Total planted area was 16173 ha. We assume that %50 percentage of this plantation cover was before 1990. And then an equal increments rate was accepted and distributed to the years.

Table 7.19 Increment in plantation on year base in urban.

Year	Area (Ha)
1990	8,086.50
1991	8,895.15
1992	9,703.80
1993	10,512.45
1994	11,321.10
1995	12,129.75

1996	12,938.40
1997	13,747.05
1998	14,555.70
1999	15,364.35
2000	16,173.00

7.7 Other lands (5.F)

In Turkey, there is no land area converted to other land based on TURKSTAT database. After 1990 marginal land were not opened to cultivated land so that no calculation was done under this category.

7.8 Uncertainty

Land use data which was used in this study is based on field survey. Each town was taken up with crop types for each parcel by field trip. It means this data are not generated by using satellite images or any other mapping tools. So there should be some uncertainty which belong to town. Those numbers are given in the national report. Concerning range land, this area where was used in calculations is 100% correct number. But we haven't information about remaining rang land. It is same for flooded land, the area which was generated by using dams' data, is correct but remaining wetland area is unknown. Also settlements information is not sufficient.

Cropland Remaining Cropland

$\Delta C_{CC} = \Delta C_{CCLB} + \Delta C_{CCsoils}$

Change in carbon stocks in living biomass

$\Delta C_{CCLB} = A * (G-L)$

Annual area of cropland with perennial woody biomass comes from administrative records of State Statistical Department (TURKSTAT). Based on expert judgment, an uncertainty in the area estimates of 10% was accepted. Annual growth rate of perennial woody biomass (G) and annual carbon stock in biomass removed (L) were default coefficients given in Table 3.3.2 of the Guidance. Therefore, a default uncertainty level of 75% of the parameter value has been assigned.

$$U\Phi = \frac{\sqrt{(U_{C_G} \bullet C_G)^2 + (UC_L \bullet C_L)^2}}{|C_G + C_L|} \qquad U_{TOTAL} = \sqrt{U_1^2 + U_2^2 + ... + U_n^2}$$

Change in carbon stocks in mineral soils

$\Delta C_{CCmineral} = (SOC_0 - SOC_{(0-T)})\ A$

$SOC_0 = SOC_{ref} * F_{LU(0)} * F_{MG(0)} * F_{I(0)}$

$SOC_{(0-T)} = SOC_{ref} * F_{LU(0-T)} * F_{MG(0-T)}*F_{I(0-T)}$

The default reference soil organic C stocks were obtained from Table 3.3.3 of LULUCF Guidance with an uncertainty of 95%. The uncertainty of F_{LU} is 11% (Table 3.3.4) for long-term cultivated management practices. F_{MG} was chosen as 1.0 with zero uncertainty based on Table 3.3.4 for full tillage practices. F_I was assigned to 0.915 with 6% uncertainty based on Table 3.3.4 for “low“organic matter input.

Grassland remaining grassland

$\Delta C_{GG} = \Delta C_{GGLB} + \Delta C_{GGsoils}$

Annual change in C stocks in living biomass in grassland remaining grassland

$\Delta C_{GGLB} = \Delta B_{grass} * CF$

$\Delta B_{grass} = A * (Ggrass-Lgrass)$

Default emission factor of G and L are provided from Guidance tables with 75% of uncertainty. The uncertainty in land area covered with grass was accepted as 10% based on expert knowledge.

Annual change in C stocks in mineral soils in grassland remaining grassland

$\Delta C_{GGmineral} = (SOC_0-SOC_{(0-T)})\ A$

$SOC_0 = SOC_{ref} * F_{LU(0)} * F_{MG(0)}*F_{I(0)}$

$SOC_{(0-T)} = SOC_{ref} * F_{LU(0-T)} * F_{MG(0-T)}*F_{I(0-T)}$

The default reference soil organic C stock was obtained from Table 3.4.4 of Guidance with an uncertainty of 95%. The F_{LU} was chosen as 1.0 with zero uncertainty based on Table 3.4.5 for all level and all climate regimes. F_{MG} was 0.95 with 12% uncertainty based on Table 3.4.5 for moderately degraded grassland. F_I was assigned to 1 with zero uncertainty based on Table 3.4.5 for nominal level.

Total change in C stocks in land converted to grassland

$\Delta C_{LG} = \Delta C_{LGLB} + \Delta C_{LGsoils}$

Changes in carbon stocks in living biomass in land converted to grassland

$\Delta C_{LGLB}=(L_{conversion}+\Delta C_{growth})A$

$L_{conversion}= C_{after} – C_{before}$

A carbon stock in biomass immediately after conversion is assumed to be zero, i.e., the land is cleared of all vegetation before planting crops. The uncertainty of C_{after} was assumed zero based on LULUCF Guidance. If initial land use is CL, the uncertainty of C_{before} is 75% based on Table 3.4.8. The uncertainty value of ΔC_{growth} was 75% based on Table 3.4.9. Again, the uncertainty of area of land converted to grassland was assumed 10% baswed on expert judgments.

Changes in carbon stocks in soils in land converted to grassland

$\Delta C_{LGsoils} = \Delta C_{LGmineral} - \Delta C_{LGorganic} - \Delta C_{LGlime}$

We have only $\Delta C_{LGmineral}$ factor. So, the uncertainty of $\Delta C_{LGmineral}$ factor was calculated based on Tables given in Guidance. The default reference soil organic C stock was obtained from LULUCF with an uncertainty of 95%. The uncertainty of F_{LU} was zero based on Table given in the Guidance. $F_{MG\ (0\text{-}T)}$ was 0.7 with 50% uncertainty based on Table 3.4.5 for severely degraded level while the uncertainty of $F_{MG\ (0)}$ was 12%. F_I was assigned to 1 with zero uncertainty based on Table 3.4.5 for nominal level.

1.2 WETLANDS

Land converted to flooded land (reservoirs)

$\Delta C_{LW\ flood\ LB} = CF\ (B_{after} - B_{before})\ A$

The uncertainties of A, B_{after}, B_{before}, and CF were 10%, 0%, 75% and 75%, respectively, based on the Guidance and expert judgment.

1.3 SETTLEMENTS

Annual C stock change in Living biomass in settlements remaining settlements

$\Delta C_{SSLB} = \Delta B_{SSG} - \Delta B_{SSL}$

$\Delta C_{SSG} = A*CRW$

The uncertainty of CWR(crown cover area-based growth rate) based on Tier 1a was 50% according to Guidance. The uncertainty in A was accepted as 10% based on expert judgment.

Table 7.20 :Uncertainty values in the GHG inventory of croplands, grasslands, wetlands and settlements

Years	$U_{\Delta c}$ (cropland remaining cropland_living_biomass)	$U_{\Delta c}$ (cropland_remaining_cropland_mineral soils)	$U_{\Delta c}$ (grassland_remaining_grassland_livingbiomass)	$U_{\Delta c}$ (grassland_remaining_mineral_soils)	$U_{\Delta c}$ (Land_converted_to_grasland_soil)	$U_{\Delta c}$ (Land_converted_to_grassland_in living and dead biomass)	$U_{\Delta c}$ (settlemnts_remaining_settlemnts_livingbiomass)	$U_{\Delta c}$ (wetland)	U_{Total}
2004	0,572304541		0,74	0,71	0,96	0,55		0,76	0,45
2003	0,571703537	0,73	0,74	0,71	0,96	0,55		0,76	0,64
2002	0,57208291	0,73	0,74	0,71	0,96	0,55		0,76	0,52
2001	0,573772515	0,73	0,74	0,71	0,96	0,55		0,76	0,47
2000	0,573772515	0,73	0,74	0,71	0,96	0,55	0,51	0,76	0,52
1999	0,573772515	0,73					0,51	0,76	0,56
1998	0,573772515	0,73					0,51	0,76	0,56
1997	0,573772515	0,73					0,51	0,76	0,56
1996	0,573772515	0,73					0,51	0,76	0,55
1995	0,573772515	0,73					0,51	0,76	0,56
1994	0,571065557	0,73					0,51	0,76	0,55
1993	0,571065557	0,73					0,51	0,76	0,55
1992	0,570149342	0,73					0,51	0,76	0,51
1991	0,569217315	0,72					0,51	0,76	0,72

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7.9. Planned Improvements

CORINE -2000 Land Cover project is recognised as an important data set for Turkey regarding themes like soil, geology, climate and land use.

The studies on CORINE-2000 are still continued by National Knowledge Center under the supervision of Ministry of Agriculture and Village Affaires. The digital land use maps will be completed in June of 2007. It can be considered an important step, criteria and success for LULUCF since the year of 2000 can be used as a reference point for both in the projections of other years and in the test of methodology developed.

Chapter 8

8. Waste

8.1 OVERVIEW

Emission from this sector is mainly occurring from the disposal of waste. The most important GHG produced in this sector is CH_4 (methane). In addition to methane, solid waste incineration in this sector could also produce CO_2 and other GHG. Although there was one hazardous waste inceneration plant and 2 medical waste incineration plants in Turkey, emissions from waste incineration was not included in this report since the methodology for hazardous waste inceneration was not clear due to different characteristics of waste. Moreover, wastewater was also not handled within the inventory due to lack of data.

8.2 Solid Waste Disposal on Land (6.A)

Source Category Description: This sector includes emissions from managed waste disposal and unmanaged waste disposal sites landfills. This category is including CH_4 emissions from municipal solid waste disposal on land.This sector was a key category in terms of CH_4 emissions from waste disposal.

Methodological Issues: The disposed of solid waste emits CH_4 as a result of the processes of anaerobic and aerobic decomposition of organic mater contained in the waste. The default methodology recommended in the IPCC Guidelines was used for estimating the volumes of methane emitted in Turkey.

Although, this sector was a key category. Estimation of CH_4 emission using the First Order Decay (FOD) method was not possible. Either individual landfill or group of specific landfills detail were not known as a time series. For some years, it is possible to obtain the results of FOD. However, for consistency, the Tier 1 methodology was selected and used.

Both controlled and uncontrolled landfills were considered in the estimations. The annual data on municipal solid waste disposal on landfills were produced by TURKSTAT via Municipal Solid Waste Statistics Survey. The data were gathered from all municipalities. However, the annual survey has been done discontinuously. Only the data for years 1994, 1995, 1996, 1997, 1998, 2001, 2002, 2003 and 2004 were available. For 2005, only controlled landfill activity data was gathered from Waste Disposal and Recovery Facilities Statistisc Survey. Others were estimated by regression analysis. The used regression models were linear, logarithmic, quadratic, cubic, power and exponential. The best fit model is determined as quadratic and cubic models. The R^2 values for each model were given in Table 8.1. As shown in this table, the standard errors for power and exponential regression model were very small. R^2 values were also small. It means, the estimation did not fit for some years. The results could be seen from Figure 8.2. The missing data were estimated by using the cubic model. In Turkey, there was only one control landfill site for year 1992 and 1993 but data on waste disposal amount for those years were not available, 1994 waste disposal amount was used for emission estimations for 1992 and 1993. In 1999 and 2000, only one new controlled landfill site started to operate. Therefore, the quantity of waste disposal on controlled landfill sites was assumed as same as waste disposed on controlled landfill sites in 2001. However, the regression model was prefered to estimate the waste disposed in uncontrolled landfill in 1999 and 2000.

Table 8.1 Regression model results

	Linear	Logarithmic	Quadratic	Cubic	Power	Exponential
R square	0.64	0.76	0.95	0.97	0.74	0.61
Standard Err.	1722.44	1411.12	673.29	575.07	0.07	0.08

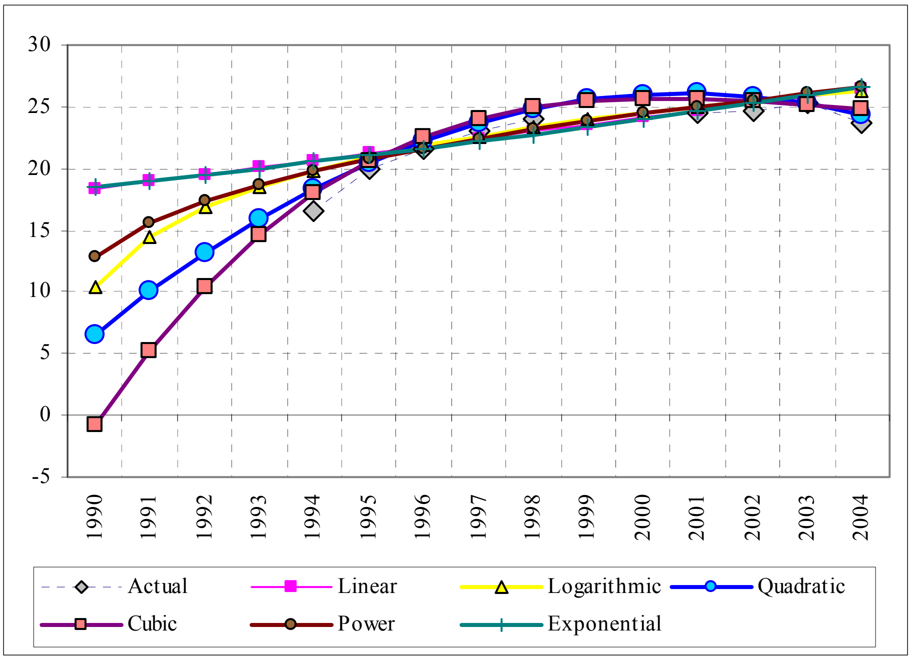

Figure 8.1 Best Fit Regression Model

The recovery of methane and its subsequent utilization was not considered in these calculations due to the lack of data.

As seen in Figure 8.2, CH_4 emissions from solid waste disposal increased from 304 Gg to 1417 Gg during the period 1990 and 2005. Since 2000, the emission was relatively stable.

Uncertainties and time-series consistency: The approach to produce quantitative uncertainty estimates was to use expert judgement as described in IPCC Good Practice Guidance and Uncertainty Management (2000) Reference.

Table 8.2. Time series consistency of emission factor for (6.A)

Source Category	GHGs	Comments on time series consistency
6.A	CH_4	* All EFs were constant over the entire time series

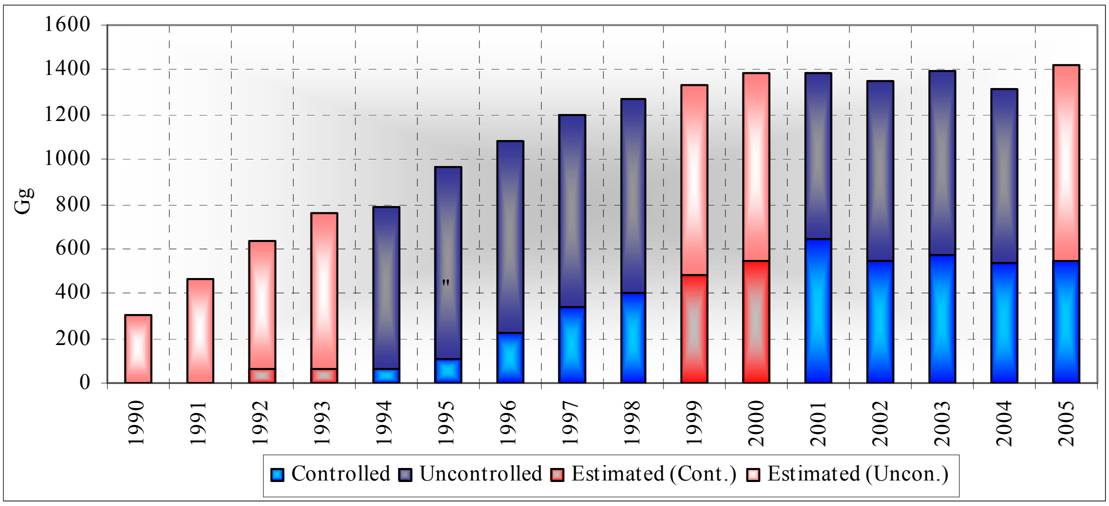

Figure 8.2 CH_4 emission trends from waste disposal

Source-specific QA/QC and verification: This source category was covered by the general QA/QC of the greenhouse gas inventory.

Recalculation: There was no change in sector 6.A per pollutant for 1990-2005.

8.2 Wastewater Handling (6.B)

This sector was not handled in this inventory due to lack of data.

8.3 Waste Incineration (6.C)

Although there was one hazardous waste inceneration plant and 2 medical waste incineration plants in Turkey, emissions from waste incineration was not included in this report and CRFR, since the methodology for hazardous waste inceneration was not clear due to different characteristics of waste.

8.4 Other (6.D)

This category was not relevant to Turkey.

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Annex 1

A1. Key Categories

According to the IPCC Good Practice Guidance, a key source category is one that is prioritised within the national inventory system because its estimate has a significant influence on a country's total inventory of direct greenhouse gases in terms of the absolute level of emissions. The results of this study has shown that

- Public Electricity and Heat Production (Electricity Production) (CO_2),
- Road Transportation (CO_2),
- Cement Industry (CO_2),
- Solid Waste Disposal (CH_4),
- Other industries (CO_2),
- Enteric Fermentation (CH_4),
- Residential usage of natural gas, LPG, lignite, hard coal and wood (CO_2),
- Manufacture of solid fuels and other energy industries (CO_2),
- Iron and Steel Industry (CO_2),
- Fertilizer Industry (CO_2),
- Chemical industry (CO_2),
- Nitric Acid Production (N_2O),
- Petroleum refining (CO_2),
- Civil Aviation (Transport) (CO_2),
- Non-Ferrous Metal Industry (CO_2),
- Sugar Industry (CO_2),
- Mining Activities (CH_4),
- Navigation (CO_2)

were determined as key sources in 2005 according to the IPCC GPG (2000).

The key source categories were determined by using Tier 1 level and Trend Assessment and it was evaluated according to the qualitative criteria.

The contribution of each source category to the total national inventory level was calculated according to Equation A1.1.

Source Category Level Assessment = Source Category Estimate / Total Estimate

$$\mathbf{L_{x,t} = E_{x,t} / E_t * 100} \quad \text{(A1.1)}$$

Where,

$L_{x,t}$: Level assessment for source x in year t
$E_{x,t}$: Emission estimate of source category x in year t
E_t : Total inventory estimate in year t

After the necessary level assessment were computed, key source categories were those that summed together in descending order of magnitude, add up to over %95 of the total cumulative of level assessment. The following spreadsheet was used for the key source categories.

Table A1.1 Tier 1 Key Source Categories

A	B	C	D	E	F
Source Category	FUEL	GAS	2005 EMIS.	LEVEL Assessment (contribution)	CUMULATIVE TOTAL (%)
Example (1.A.1.a)	-	-	Input Data		Input Data
	-	-	Gg	%	&
Total			$\sum(E_{x,t})$		**100**

ANNEX 1

Table A1.2 Key Source Categories

2005 KSA					
CATEGORY	**FUEL**	**GAS**	**EMISSION**	**CONTRIBUTION (%)**	**COMMUTATIVE CONTRIBUTION**
Public Electricity and Heat Production	Lignite	CO_2	33609,3	10,8	10,8
Public Electricity and Heat Production	Natural Gas	CO_2	32802,0	10,5	21,3
Road Transportation	Gas / Diesel oil	CO_2	21644,0	6,9	28,2
Cement Production (Mineral Products)		CO_2	18554,8	5,9	34,1
Waste (landfill)		CH_4	18306,9	5,9	40,0
Other Industries	Hard Coal	CO_2	17827,8	5,7	45,7
Enteric Fermentation		CH_4	13950,6	4,5	50,2
Residential	Natural Gas	CO_2	12771,2	4,1	54,3
Waste (control landfill)		CH_4	11445,4	3,7	57,9
Public Electricity and Heat Production	Hard Coal	CO_2	11010,0	3,5	61,5
Manufacture of Solid Fuels and Other Energy Industries	Gas / Diesel oil	CO_2	9226,8	3,0	64,4
Road Transportation	Gasoline	CO_2	8835,8	2,8	67,2
Iron and Steel	Second Fuel Coal	CO_2	8588,3	2,7	70,0
Other Industries	Natural Gas	CO_2	8155,6	2,6	72,6
Residential	LPG	CO_2	6968,0	2,2	74,8
Cement Production	Petroleum Coke	CO_2	6289,2	2,0	76,8
Residential	Lignite	CO_2	6087,8	1,9	78,8
Public Electricity and Heat Production	Residual Fuel Oil	CO_2	5856,0	1,9	80,7
Cement Production	Hard Coal	CO_2	5008,1	1,6	82,3
Other Industries	Residual Fuel Oil	CO_2	4268,9	1,4	83,6
Civil Aviation	Jet Kerosene	CO_2	4054,4	1,3	84,9
Road Transportation	LPG	CO_2	4037,5	1,3	86,2
Petroleum Refining	Residual Fuel Oil	CO_2	2746,0	0,9	87,1
Residential	Hard Coal	CO_2	2486,1	0,8	87,9
Chemicals	Residual Fuel Oil	CO_2	2432,0	0,8	88,7
Emission of HFCs		HFC-134a	2379,0	0,8	89,4
Cement Production	Lignite	CO_2	2175,9	0,7	90,1
Petroleum Refining	Refinery Gas	CO_2	1992,6	0,6	90,8
Nitric Acid Production (Chemical Industry)		N_20	1760,0	0,6	91,3
Chemicals	Natural Gas	CO_2	1716,8	0,5	91,9
Fertilizer	Natural Gas	CO_2	1299,1	0,4	92,3
Non-Ferrous Metals	Natural Gas	CO_2	1216,0	0,4	92,7
Residential	wood	CH_4	1093,5	0,4	93,0
Sugar	Lignite	CO_2	1085,7	0,3	93,4
Other Industries	LPG	CO_2	1049,1	0,3	93,7
Residential	Asphalt	CO_2	1001,4	0,3	94,1
Mining (Surface)		CH_4	948,4	0,3	94,4

ANNEX 1

Table A1.2 Key Source Categories

2005 KSA					
Navigation	Gas / Diesel oil	CO_2	937,3	0,3	94,7
Other Industries	Gas / Diesel oil	CO_2	923,2	0,3	95,0
Non-Ferrous Metals	Residual Fuel Oil	CO_2	861,4	0,3	95,2
Emission of SF_6		SF_6	858,7	0,3	95,5
Manure Management		CH_4	833,9	0,3	95,8
Residential	Residual Fuel Oil	CO_2	816,7	0,3	96,0
Railways	Gas / Diesel oil	CO_2	676,8	0,2	96,2
Ammonia Production (Chemical Industry)		CO_2	592,9	0,2	96,4
Mining (underground)		CH_4	534,3	0,2	96,6
Other Industries	Lignite	CO_2	523,9	0,2	96,8
Residual Burning		CH_4	523,7	0,2	96,9
Iron and Steel	Residual Fuel Oil	CO_2	490,8	0,2	97,1
Road Transportation	Gas / Diesel oil	N_20	471,3	0,2	97,3
Lime Production (Mineral Products)		CO_2	440,7	0,1	97,4
Residential	Second Fuel Coal	CO_2	418,7	0,1	97,5
Residential	Lignite	CH_4	386,7	0,1	97,6
Rice Cultivation		CH_4	357,0	0,1	97,8
Navigation	Residual Fuel Oil	CO_2	340,2	0,1	97,9
Soda Ash Production and Use (Mineral Products)		CO_2	332,6	0,1	98,0
Iron and Steel Production (Metal Production)		CO_2	319,0	0,1	98,1
Residential	waste of animal, plant	CH_4	311,0	0,1	98,2
Other Industries	Second Fuel Coal	CO_2	299,1	0,1	98,3
Sugar	Residual Fuel Oil	CO_2	291,5	0,1	98,4
Sugar	Natural Gas	CO_2	282,1	0,1	98,5
Public Electricity and Heat Production	Naphta	CO_2	276,0	0,1	98,5
Fertilizer	Residual Fuel Oil	CO_2	239,9	0,1	98,6
Non-Ferrous Metals	Hard Coal	CO_2	237,5	0,1	98,7
Iron and Steel	Hard Coal	CO_2	233,0	0,1	98,8
Other Industries	Asphalt	CO_2	229,8	0,1	98,8
Residential	wood	N_20	215,2	0,1	98,9
Cement Production	LPG	CO_2	205,1	0,1	99,0
Chemicals	Lignite	CO_2	203,4	0,1	99,0
Other Industries	Petroleum Coke	CO_2	191,1	0,1	99,1
Cement Production	Natural Gas	CO_2	181,3	0,1	99,2
Sugar	Hard Coal	CO_2	176,1	0,1	99,2
Road Transportation	Gasoline	N_20	170,2	0,1	99,3
Residential	Hard Coal	CH_4	168,9	0,1	99,3
Cement Production	Residual Fuel Oil	CO_2	166,3	0,1	99,4
Residual Burning		N_20	158,2	0,1	99,4
Public Electricity and Heat Production	Lignite	N_20	146,9	0,0	99,5

Table A1.2 Key Source Categories

2005 KSA					
Petroleum Refining	Gas / Diesel oil	CO_2	137,8	0,0	99,5
Sugar	Second Fuel Coal	CO_2	125,7	0,0	99,6
Residential	Gas / Diesel oil	CO_2	89,5	0,0	99,6
Public Electricity and Heat Production	Gas / Diesel oil	CO_2	89,0	0,0	99,6
Other Industries	Hard Coal	N_20	83,5	0,0	99,7
Residential	Asphalt	CH_4	68,1	0,0	99,7
Residential	waste of animal, plant	N_20	61,2	0,0	99,7
Cement Production	Second Fuel Coal	CO_2	59,8	0,0	99,7
Non-Ferrous Metals	Second Fuel Coal	CO_2	54,3	0,0	99,7
Road Transportation	Gasoline	CH_4	52,9	0,0	99,7
Public Electricity and Heat Production	Hard Coal	N_20	51,2	0,0	99,8
Road Transportation	Gas / Diesel oil	CH_4	40,6	0,0	99,8
Other Industries	Hard Coal	CH_4	40,4	0,0	99,8
Iron and Steel	Second Fuel Coal	N_20	40,2	0,0	99,8
Public Electricity and Heat Production	LPG	CO_2	37,4	0,0	99,8
Ferroalloys Production (Metal Production)		CO_2	33,4	0,0	99,8
Cement Production	Petroleum Coke	N_20	29,4	0,0	99,8
Residential	Second Fuel Coal	CH_4	28,5	0,0	99,8
Residential	Lignite	N_20	26,6	0,0	99,9
Road Transportation	LPG	CH_4	25,8	0,0	99,9
Residential	Natural Gas	CH_4	24,0	0,0	99,9
Cement Production	Hard Coal	N_20	23,4	0,0	99,9
Residential	LPG	CH_4	23,4	0,0	99,9
Manufacture of Solid Fuels and Other Energy Industries	Gas / Diesel oil	N_20	23,4	0,0	99,9
Residential	LPG	N_20	20,8	0,0	99,9
Iron and Steel	Second Fuel Coal	CH_4	19,5	0,0	99,9
Public Electricity and Heat Production	Natural Gas	N_20	18,3	0,0	99,9
Other Industries	Natural Gas	CH_4	15,3	0,0	99,9
Other Chemicals Production (Chemical Industry)		CH_4	14,9	0,0	99,9
Public Electricity and Heat Production	Residual Fuel Oil	N_20	14,9	0,0	99,9
Cement Production	Petroleum Coke	CH_4	14,2	0,0	99,9
Iron and Steel	Natural Gas	CO_2	13,3	0,0	99,9
Manufacture of Solid Fuels and Other Energy Industries	Gas / Diesel oil	CH_4	13,2	0,0	99,9
Public Electricity and Heat Production	Natural Gas	CH_4	12,3	0,0	99,9
Residential	Hard Coal	N_20	11,6	0,0	99,9
Cement Production	Hard Coal	CH_4	11,3	0,0	99,9
Civil Aviation	Jet Kerosene	N_20	10,4	0,0	100,0
Other Industries	Residual Fuel Oil	N_20	10,4	0,0	100,0
Cement Production	Lignite	N_20	9,5	0,0	100,0
Public Electricity and Heat Production	Lignite	CH_4	7,1	0,0	100,0

Table A1.2 Key Source Categories

2005 KSA					
Residential	Natural Gas	N_20	7,1	0,0	100,0
Petroleum Refining	Residual Fuel Oil	N_20	6,7	0,0	100,0
Chemicals	Residual Fuel Oil	N_20	5,9	0,0	100,0
Petroleum Refining	Refinery Gas	N_20	5,1	0,0	100,0
Public Electricity and Heat Production	Residual Fuel Oil	CH_4	5,1	0,0	100,0
Sugar	Lignite	N_20	4,8	0,0	100,0
Residential	Asphalt	N_20	4,7	0,0	100,0
Cement Production	Lignite	CH_4	4,6	0,0	100,0
Other Industries	Natural Gas	N_20	4,5	0,0	100,0
Chemicals	Natural Gas	CH_4	3,2	0,0	100,0
Other Industries	LPG	N_20	3,1	0,0	100,0
Railways	Gas / Diesel oil	N_20	3,0	0,0	100,0
Public Electricity and Heat Production	Hard Coal	CH_4	2,5	0,0	100,0
Fertilizer	Natural Gas	CH_4	2,4	0,0	100,0
Navigation	Gas / Diesel oil	N_20	2,4	0,0	100,0
Other Industries	Gas / Diesel oil	N_20	2,3	0,0	100,0
Other Industries	Residual Fuel Oil	CH_4	2,3	0,0	100,0
Sugar	Lignite	CH_4	2,3	0,0	100,0
Other Industries	Lignite	N_20	2,3	0,0	100,0
Non-Ferrous Metals	Natural Gas	CH_4	2,3	0,0	100,0
Petroleum Refining	Residual Fuel Oil	CH_4	2,3	0,0	100,0
Residential	Residual Fuel Oil	CH_4	2,2	0,0	100,0
Non-Ferrous Metals	Residual Fuel Oil	N_20	2,1	0,0	100,0
Residential	Residual Fuel Oil	N_20	2,0	0,0	100,0
Residential	Second Fuel Coal	N_20	2,0	0,0	100,0
Petroleum Refining	Refinery Gas	CH_4	1,7	0,0	100,0
Other Industries	Second Fuel Coal	N_20	1,4	0,0	100,0
Navigation	Gas / Diesel oil	CH_4	1,3	0,0	100,0
Chemicals	Residual Fuel Oil	CH_4	1,3	0,0	100,0
Iron and Steel	Residual Fuel Oil	N_20	1,2	0,0	100,0
Non-Ferrous Metals	Hard Coal	N_20	1,1	0,0	100,0
Other Industries	Lignite	CH_4	1,1	0,0	100,0
Iron and Steel	Hard Coal	N_20	1,1	0,0	100,0
Other Industries	Asphalt	N_20	1,1	0,0	100,0
Chemicals	Natural Gas	N_20	1,0	0,0	100,0
Other Industries	Petroleum Coke	N_20	0,9	0,0	100,0
Chemicals	Lignite	N_20	0,9	0,0	100,0
Cement Production	Gas / Diesel oil	CO_2	0,9	0,0	100,0
Limestone and Dolomite Use (Mineral Products)		CO_2	0,9	0,0	100,0
Sugar	Hard Coal	N_20	0,8	0,0	100,0

Table A1.2 Key Source Categories

2005 KSA					
Navigation	Residual Fuel Oil	N_20	0,8	0,0	100,0
Civil Aviation	Jet Kerosene	CH_4	0,8	0,0	100,0
Fertilizer	Natural Gas	N_20	0,7	0,0	100,0
Sugar	Residual Fuel Oil	N_20	0,7	0,0	100,0
Public Electricity and Heat Production	Naphta	N_20	0,7	0,0	100,0
Other Industries	LPG	CH_4	0,7	0,0	100,0
Other Industries	Second Fuel Coal	CH_4	0,7	0,0	100,0
Non-Ferrous Metals	Natural Gas	N_20	0,7	0,0	100,0
Railways	Gas / Diesel oil	CH_4	0,6	0,0	100,0
Petroleum Refining	Gasoline	CO_2	0,6	0,0	100,0
Cement Production	LPG	N_20	0,6	0,0	100,0
Sugar	Second Fuel Coal	N_20	0,6	0,0	100,0
Fertilizer	Residual Fuel Oil	N_20	0,6	0,0	100,0
Non-Ferrous Metals	Hard Coal	CH_4	0,5	0,0	100,0
Sugar	Natural Gas	CH_4	0,5	0,0	100,0
Other Industries	Gas / Diesel oil	CH_4	0,5	0,0	100,0
Iron and Steel	Hard Coal	CH_4	0,5	0,0	100,0
Other Industries	Asphalt	CH_4	0,5	0,0	100,0
Non-Ferrous Metals	Residual Fuel Oil	CH_4	0,5	0,0	100,0
Navigation	Residual Fuel Oil	CH_4	0,5	0,0	100,0
Other Industries	Petroleum Coke	CH_4	0,4	0,0	100,0
Chemicals	Lignite	CH_4	0,4	0,0	100,0
Cement Production	Residual Fuel Oil	N_20	0,4	0,0	100,0
Sugar	Hard Coal	CH_4	0,4	0,0	100,0
Petroleum Refining	Gas / Diesel oil	N_20	0,3	0,0	100,0
Cement Production	Natural Gas	CH_4	0,3	0,0	100,0
Public Electricity and Heat Production	Gas / Diesel oil	N_20	0,3	0,0	100,0
Sugar	Second Fuel Coal	CH_4	0,3	0,0	100,0
Cement Production	Second Fuel Coal	N_20	0,3	0,0	100,0
Iron and Steel	Residual Fuel Oil	CH_4	0,3	0,0	100,0
Residential	Gas / Diesel oil	CH_4	0,3	0,0	100,0
Non-Ferrous Metals	Second Fuel Coal	N_20	0,3	0,0	100,0
Fertilizer	Gas / Diesel oil	CO_2	0,2	0,0	100,0
Public Electricity and Heat Production	Naphta	CH_4	0,2	0,0	100,0
Residential	Gas / Diesel oil	N_20	0,2	0,0	100,0
Public Electricity and Heat Production	LPG	N_20	0,2	0,0	100,0
Petroleum Refining	LPG	CO_2	0,2	0,0	100,0
Sugar	Residual Fuel Oil	CH_4	0,2	0,0	100,0
Sugar	Natural Gas	N_20	0,2	0,0	100,0
Cement Production	LPG	CH_4	0,1	0,0	100,0

ANNEX 1

Table A1.2 Key Source Categories

2005 KSA					
Cement Production	Second Fuel Coal	CH_4	0,1	0,0	100,0
Fertilizer	Residual Fuel Oil	CH_4	0,1	0,0	100,0
Non-Ferrous Metals	Second Fuel Coal	CH_4	0,1	0,0	100,0
Petroleum Refining	Gas / Diesel oil	CH_4	0,1	0,0	100,0
Cement Production	Natural Gas	N_20	0,1	0,0	100,0
Cement Production	Residual Fuel Oil	CH_4	0,1	0,0	100,0
Public Electricity and Heat Production	Gas / Diesel oil	CH_4	0,1	0,0	100,0
Changes in Forest and Other Woody Biomass Stocks		N_20	0,1	0,0	100,0
Public Electricity and Heat Production	LPG	CH_4	0,0	0,0	100,0
Iron and Steel	Natural Gas	CH_4	0,0	0,0	100,0
Iron and Steel	Natural Gas	N_20	0,0	0,0	100,0
Cement Production	Gas / Diesel oil	N_20	0,0	0,0	100,0
Petroleum Refining	Gasoline	N_20	0,0	0,0	100,0
Fertilizer	Gas / Diesel oil	N_20	0,0	0,0	100,0
Petroleum Refining	LPG	N_20	0,0	0,0	100,0
Petroleum Refining	Gasoline	CH_4	0,0	0,0	100,0
Cement Production	Gas / Diesel oil	CH_4	0,0	0,0	100,0
Petroleum Refining	LPG	CH_4	0,0	0,0	100,0
Fertilizer	Gas / Diesel oil	CH_4	0,0	0,0	100,0
Railways	Hard Coal	CO_2	0,0	0,0	100,0
Navigation	Hard Coal	CO_2	0,0	0,0	100,0
Non-Ferrous Metals	Lignite	CO_2	0,0	0,0	100,0
Fertilizer	Lignite	CO_2	0,0	0,0	100,0
Railways	Lignite	CO_2	0,0	0,0	100,0
Cement Production	Asphalt	CO_2	0,0	0,0	100,0
Fertilizer	Second Fuel Coal	CO_2	0,0	0,0	100,0
Non-Ferrous Metals	Petroleum Coke	CO_2	0,0	0,0	100,0
Railways	Residual Fuel Oil	CO_2	0,0	0,0	100,0
Iron and Steel	Gas / Diesel oil	CO_2	0,0	0,0	100,0
Non-Ferrous Metals	Gas / Diesel oil	CO_2	0,0	0,0	100,0
Other Industries	Refinery Gas	CO_2	0,0	0,0	100,0
Fertilizer	Naphta	CO_2	0,0	0,0	100,0
Railways	Hard Coal	CH_4	0,0	0,0	100,0
Navigation	Hard Coal	CH_4	0,0	0,0	100,0
Non-Ferrous Metals	Lignite	CH_4	0,0	0,0	100,0
Fertilizer	Lignite	CH_4	0,0	0,0	100,0
Railways	Lignite	CH_4	0,0	0,0	100,0
Cement Production	Asphalt	CH_4	0,0	0,0	100,0
Fertilizer	Second Fuel Coal	CH_4	0,0	0,0	100,0
Non-Ferrous Metals	Petroleum Coke	CH_4	0,0	0,0	100,0

Table A1.2 Key Source Categories

2005 KSA					
Railways	Residual Fuel Oil	CH_4	0,0	0,0	100,0
Iron and Steel	Gas / Diesel oil	CH_4	0,0	0,0	100,0
Non-Ferrous Metals	Gas / Diesel oil	CH_4	0,0	0,0	100,0
Other Industries	Refinery Gas	CH_4	0,0	0,0	100,0
Fertilizer	Naphta	CH_4	0,0	0,0	100,0
Railways	Hard Coal	N_20	0,0	0,0	100,0
Navigation	Hard Coal	N_20	0,0	0,0	100,0
Non-Ferrous Metals	Lignite	N_20	0,0	0,0	100,0
Fertilizer	Lignite	N_20	0,0	0,0	100,0
Railways	Lignite	N_20	0,0	0,0	100,0
Cement Production	Asphalt	N_20	0,0	0,0	100,0
Fertilizer	Second Fuel Coal	N_20	0,0	0,0	100,0
Non-Ferrous Metals	Petroleum Coke	N_20	0,0	0,0	100,0
Railways	Residual Fuel Oil	N_20	0,0	0,0	100,0
Iron and Steel	Gas / Diesel oil	N_20	0,0	0,0	100,0
Non-Ferrous Metals	Gas / Diesel oil	N_20	0,0	0,0	100,0
Road Transportation	LPG	N_20	0,0	0,0	100,0
Other Industries	Refinery Gas	N_20	0,0	0,0	100,0
Fertilizer	Naphta	N_20	0,0	0,0	100,0
Carbide Production (Chemical Industry)		CO_2	0,0	0,0	100,0
Aluminium Production (Metal Production)		CO_2	0,0	0,0	100,0
TOTAL			312312		

Annex 2

A2. Discussion of Methodology

Turkey's greenhouse gas emission inventory is in accordance with the Revised 1996 IPCC Guidelines. Emission factors used for this national inventory were provided in Annex 2. The emission factors as given in the following Table A2.1 were;

Table A2.1 Emission Factors used for Turkish National Emission Inventory

Sector	Gas	Unit	Emission Factor
Energy			
Hard Coal	CO_2	tC/TJ	25,8
Lignite	CO_2	tC/TJ	27,6
Asphalt	CO_2	tC/TJ	25,8
Secondary Fuel Coal	CO_2	tC/TJ	25,8
Petroleum Coke	CO_2	tC/TJ	25,8
Petroleum	CO_2	tC/TJ	20,0
Natural Gases	CO_2	tC/TJ	15,3
Jet Kerosene	CO_2	tC/TJ	19,5
Energy - Electricity Production			
Hard Coal	CH_4	KG/TJ	1,0
Lignite	CH_4	KG/TJ	1,0
Asphalt	CH_4	KG/TJ	1,0
Secondary Fuel Coal	CH_4	KG/TJ	1,0
Petroleum Coke	CH_4	KG/TJ	1,0
Petroleum	CH_4	KG/TJ	3,0
Natural Gas	CH_4	KG/TJ	1,0
Energy - Industry			
Hard Coal	CH_4	KG/TJ	10,0
Lignite	CH_4	KG/TJ	10,0
Asphalt	CH_4	KG/TJ	10,0
Secondary Fuel Coal	CH_4	KG/TJ	10,0
Petroleum Coke	CH_4	KG/TJ	10,0
Petroleum	CH_4	KG/TJ	2,0
Natural Gas	CH_4	KG/TJ	5,0
Energy - Other			
Hard Coal	CH_4	KG/TJ	300,0
Lignite	CH_4	KG/TJ	300,0
Asphalt	CH_4	KG/TJ	300,0
Secondary Fuel Coal	CH_4	KG/TJ	300,0
Petroleum Coke	CH_4	KG/TJ	300,0
Petroleum (Residential)	CH_4	KG/TJ	10,0
Petroleum (Agriculture)	CH_4	KG/TJ	5,0
Natural Gas	CH_4	KG/TJ	5,0
Bomass (Residential)	CH_4	KG/TJ	300,0
Energy - Transport			
Hard Coal	CH_4	KG/TJ	10,0
Lignite	CH_4	KG/TJ	10,0
Asphalt	CH_4	KG/TJ	10,0
Secondary Fuel Coal	CH_4	KG/TJ	10,0
Petroleum Coke	CH_4	KG/TJ	10,0
Petroleum	CH_4	KG/TJ	5,0
Natural Gas	CH_4	KG/TJ	50,0
Jet Kerosene	CH_4	KG/TJ	0,5
Fuel-oil	CH_4	KG/TJ	5,0
Diesel	CH_4	KG/TJ	5,0
Gasoline	CH_4	KG/TJ	20,0
Energy - Electricity Production			
Hard Coal	N_20	KG/TJ	1,4
Lignite	N_20	KG/TJ	1,4
Asphalt	N_20	KG/TJ	1,4
Secondary Fuel Coal	N_20	KG/TJ	1,4
Petroleum Coke	N_20	KG/TJ	1,4
Petroleum	N_20	KG/TJ	0,6
Natural Gas	N_20	KG/TJ	0,1
Energy - Industry			
Hard Coal	N_20	KG/TJ	1,4
Lignite	N_20	KG/TJ	1,4
Asphalt	N_20	KG/TJ	1,4
Secondary Fuel Coal	N_20	KG/TJ	1,4
Petroleum Coke	N_20	KG/TJ	1,4
Petroleum	N_20	KG/TJ	0,6
Energy - Industry			
Natural Gas	N_20	KG/TJ	0,1
Energy - Other			
Hard Coal	N_20	KG/TJ	1,4
Lignite	N_20	KG/TJ	1,4
Asphalt	N_20	KG/TJ	1,4
Secondary Fuel Coal	N_20	KG/TJ	1,4
Petroleum Coke	N_20	KG/TJ	1,4
Petroleum (Residential)	N_20	KG/TJ	0,6
Petroleum (Agriculture)	N_20	KG/TJ	0,6
Natural Gas	N_20	KG/TJ	0,1
Bomass (Residential)	N_20	KG/TJ	4,0
Energy - Transport			
Hard Coal	N_20	KG/TJ	1,4
Lignite	N_20	KG/TJ	1,4
Asphalt	N_20	KG/TJ	1,4
Secondary Fuel Coal	N_20	KG/TJ	1,4
Petroleum Coke	N_20	KG/TJ	1,4
Petroleum	N_20	KG/TJ	0,6
Natural Gas	N_20	KG/TJ	0,1
Jet Kerosene	N_20	KG/TJ	2,0
Fuel-oil	N_20	KG/TJ	0,6
Diesel	N_20	KG/TJ	0,6
Gasoline	N_20	KG/TJ	0,6
Energy - Electricity Production			
Hard Coal	NO_X	KG/TJ	300,0
Lignite	NO_X	KG/TJ	300,0
Asphalt	NO_X	KG/TJ	300,0
Secondary Fuel Coal	NO_X	KG/TJ	300,0
Petroleum Coke	NO_X	KG/TJ	300,0
Petroleum	NO_X	KG/TJ	200,0
Natural Gas	NO_X	KG/TJ	150,0
Energy - Industry			
Hard Coal	NO_X	KG/TJ	300,0
Lignite	NO_X	KG/TJ	300,0
Asphalt	NO_X	KG/TJ	300,0
Secondary Fuel Coal	NO_X	KG/TJ	300,0
Petroleum Coke	NO_X	KG/TJ	300,0
Petroleum	NO_X	KG/TJ	200,0
Natural Gas	NO_X	KG/TJ	150,0
Energy - Other			
Hard Coal	NO_X	KG/TJ	100,0
Lignite	NO_X	KG/TJ	100,0
Asphalt	NO_X	KG/TJ	100,0
Secondary Fuel Coal	NO_X	KG/TJ	100,0
Petroleum Coke	NO_X	KG/TJ	100,0
Petroleum (Residential)	NO_X	KG/TJ	100,0
Petroleum (Agriculture)	NO_X	KG/TJ	1200,0
Natural Gas	NO_X	KG/TJ	50,0
Bomass (Residential)	NO_X	KG/TJ	100,0
Energy - Transport			
Hard Coal	NO_X	KG/TJ	300,0
Lignite	NO_X	KG/TJ	300,0
Asphalt	NO_X	KG/TJ	300,0
Secondary Fuel Coal	NO_X	KG/TJ	300,0
Petroleum Coke	NO_X	KG/TJ	300,0
Natural Gas	NO_X	KG/TJ	600,0
Jet Kerosene	NO_X	KG/TJ	300,0
Fuel-oil (Railway)	NO_X	KG/TJ	1200,0
Diesel (Railway)	NO_X	KG/TJ	1200,0
Gasoline	NO_X	KG/TJ	600,0
Fuel-oil (Navigation)	NO_X	KG/TJ	1500,0

Table A2.1 Emission Factors used for Turkish National Emission Inventory

Sector	Gas	Unit	Emission Factor
Energy - Transport			
Diesel (Navigation)	NO_X	KG/TJ	1500,0
Fuel-oil (Road Trans.)	NO_X	KG/TJ	800,0
Diesel (Road Trans.)	NO_X	KG/TJ	800,0
Energy - Electricity Production			
Hard Coal	CO	KG/TJ	20,0
Lignite	CO	KG/TJ	20,0
Asphalt	CO	KG/TJ	20,0
Secondary Fuel Coal	CO	KG/TJ	20,0
Petroleum Coke	CO	KG/TJ	20,0
Petroleum	CO	KG/TJ	15,0
Natural Gas	CO	KG/TJ	20,0
Energy - Industry			
Hard Coal	CO	KG/TJ	150,0
Lignite	CO	KG/TJ	150,0
Asphalt	CO	KG/TJ	150,0
Secondary Fuel Coal	CO	KG/TJ	150,0
Petroleum Coke	CO	KG/TJ	150,0
Petroleum	CO	KG/TJ	10,0
Natural Gas	CO	KG/TJ	30,0
Energy - Other			
Hard Coal	CO	KG/TJ	2000,0
Lignite	CO	KG/TJ	2000,0
Asphalt	CO	KG/TJ	2000,0
Secondary Fuel Coal	CO	KG/TJ	2000,0
Petroleum Coke	CO	KG/TJ	2000,0
Petroleum (Residential)	CO	KG/TJ	20,0
Petroleum (Agriculture)	CO	KG/TJ	1000,0
Natural Gas	CO	KG/TJ	50,0
Bomass (Residential)	CO	KG/TJ	5000,0
Energy - Transport			
Hard Coal	CO	KG/TJ	150,0
Lignite	CO	KG/TJ	150,0
Asphalt	CO	KG/TJ	150,0
Secondary Fuel Coal	CO	KG/TJ	150,0
Petroleum Coke	CO	KG/TJ	150,0
Petroleum	CO	KG/TJ	1000,0
Natural Gas	CO	KG/TJ	400,0
Jet Kerosene	CO	KG/TJ	100,0
Fuel-oil	CO	KG/TJ	1000,0
Diesel	CO	KG/TJ	1000,0
Gasoline	CO	KG/TJ	8000,0
Energy - Electricity Production			
Hard Coal	NMVOC	KG/TJ	5,0
Lignite	NMVOC	KG/TJ	5,0
Asphalt	NMVOC	KG/TJ	5,0
Secondary Fuel Coal	NMVOC	KG/TJ	5,0
Petroleum Coke	NMVOC	KG/TJ	5,0
Petroleum	NMVOC	KG/TJ	5,0
Natural Gas	NMVOC	KG/TJ	5,0
Energy - Industry			
Hard Coal	NMVOC	KG/TJ	20,0
Lignite	NMVOC	KG/TJ	20,0
Asphalt	NMVOC	KG/TJ	20,0
Secondary Fuel Coal	NMVOC	KG/TJ	20,0
Petroleum Coke	NMVOC	KG/TJ	20,0
Petroleum	NMVOC	KG/TJ	5,0
Natural Gas	NMVOC	KG/TJ	5,0
Energy - Other			
Hard Coal	NMVOC	KG/TJ	200,0
Lignite	NMVOC	KG/TJ	200,0
Asphalt	NMVOC	KG/TJ	200,0
Secondary Fuel Coal	NMVOC	KG/TJ	200,0
Petroleum Coke	NMVOC	KG/TJ	200,0
Petroleum (Residential)	NMVOC	KG/TJ	5,0
Petroleum (Agriculture)	NMVOC	KG/TJ	200,0
Natural Gas	NMVOC	KG/TJ	5,0
Bomass (Residential)	NMVOC	KG/TJ	600,0

Sector	Gas	Unit	Emission Factor
Energy - Transport			
Hard Coal	NMVOC	KG/TJ	20,0
Lignite	NMVOC	KG/TJ	20,0
Asphalt	NMVOC	KG/TJ	20,0
Secondary Fuel Coal	NMVOC	KG/TJ	20,0
Petroleum Coke	NMVOC	KG/TJ	20,0
Petroleum	NMVOC	KG/TJ	200,0
Natural Gas	NMVOC	KG/TJ	5,0
Jet Kerosene	NMVOC	KG/TJ	50,0
Fuel-oil	NMVOC	KG/TJ	200,0
Diesel	NMVOC	KG/TJ	200,0
Gasoline	NMVOC	KG/TJ	1500,0
Energy - Fugitive Emission			
Coal Mining			
Underground mining	CH_4	m^3/tones	17,5
Surface mining	CH_4	m^3/tones	1,2
Industrial Processes			
Cement Production			
Clinker	CO_2	tone CO_2/tonne	0,51
Lime Production			
CaO Production	CO_2	Kg CO_2/tonne	0,91
Limestone and Dolomite Use			
limestone	CO_2	Kg CO_2/tonne	440*f
Dolomite	CO_2	Kg CO_2/tonne	477*f
Note: f is the fractional purity, which is taken as 1			
Soda Ash Production and Use			
Soda Ash Use (Na_2CO_3)	CO_2	Kg CO_2/tonne	415,0
Road Paving with Asphalt			
Asphalt plant	NO_X	Kg/tonne	0,084
Asphalt plant	CO_2	Kg/tonne	0,035
Asphalt plant	NMVOC	Kg/tonne	0,023
Road Surface	MNVOC	Kg/tonne	320
Asphalt Roofing Production			
Asphalt Roofing	MNVOC	Kg/tonne	0,16
Asphalt Roofing	CO	Kg/tonne	0,0095
Ammonia Production			
NH_3	CO_2	tonne CO_2/tonne	1,6
Desulphurisation	TOC	Kg/tonne	3,6
Carbondioxide regenerator	TOC	Kg/tonne	0,5
Condensate steam stripper	TOC	Kg/tonne	0,6
Desulphurisation	CO	Kg/tonne	6,9
Carbondioxide regenerator	CO	Kg/tonne	1,0
Nitric Acid Production			
Nitric Acid	N_20	Kg/tonne	19,0
Nitric Acid	NO_X	Kg/tonne	12,0
Calcium Carbid Production			
limestone	CO_2	Kg/tonne	760,0
Reduction	CO_2	Kg/tonne	1090,0
Use of product	CO_2	Kg/tonne	1100,0
Production of Other Chemicals			
Carbon Black	CH_4	g/Kg	11,0
Ethylene	CH_4	g/Kg	1,0
Styrene	CH_4	g/Kg	4,0
Methanol	CH_4	g/Kg	2,0
Coke	CH_4	g/Kg	0,5
Carbon Black	NO_X	Kg/tonne	0,4
Acrylonitrite	NMVOC	Kg/tonne	1,0
Etylene	NMVOC	Kg/tonne	1,4
Propylene	NMVOC	Kg/tonne	1,4
Carbon Black	NMVOC	Kg/tonne	40,0
Formaldehyde	NMVOC	Kg/tonne	5,0
Phtalic anthydride	NMVOC	Kg/tonne	6,0
Polypropylene	NMVOC	Kg/tonne	12,0
Polystyrene	NMVOC	Kg/tonne	5,4
Polyethene-low density	NMVOC	Kg/tonne	3,0
Polyethene-high density	NMVOC	Kg/tonne	6,4
Polyvinylchloride	NMVOC	Kg/tonne	8,5
Styrene	NMVOC	Kg/tonne	18,0

Table A2.1 Emission Factors used for Turkish National Emission Inventory

Sector	Gas	Unit	Emission Factor
Production of Other Chemicals			
Styrene butadiene	NMVOC	Kg/tonne	5,8
Carbon Black	CO	Kg/tonne	10,0
Iron and Steel			
Iron Production	CO_2	tonne/tonne	1,6
Steel Production	CO_2	tonne/tonne	1,6
Ferrochromium	CO_2	tonne/tonne	1,3
Ferromanganese	CO_2	tonne/tonne	1,6
Iron production-Pig Iron Tap.	NMVOC	g/tonne	20,0
Iron production-Blast Fur.	NMVOC	g/tonne	100,0
Steel Production	NMVOC	g/tonne	30,0
Iron production-Pig Iron Tap.	CO	g/tonne	112,0
Iron production-Blast Fur.	CO	g/tonne	1330,0
Steel Production	CO	g/tonne	1,0
Iron production	NO_X	g/tonne	76,0
Steel Production	NO_X	g/tonne	40,0
Aluminium			
Aluminium Production	CO_2	tonne/tonne	1,8
Aluminium Production	NO_X	Kg/tonne	2,15
Aluminium Production	CO	Kg/tonne	135,0
Pulp and Paper			
Pulp and Paper Production	NOX	Kg/tonne	1,5
Pulp and Paper Production	VOC	Kg/tonne	3,7
Pulp and Paper Production	CO	Kg/tonne	5,6
Alcoholic Beverages			
Wine	NMVOC	Kg/Liter	0,08
Beer	NMVOC	Kg/Liter	0,035
Spirits (unspecified)	NMVOC	Kg/Liter	15,0
Whiskey	NMVOC	Kg/Liter	15,0
Bread making and other food			
Meat, fish and poultry	NMVOC	Kg/tonne	0,3
Sugar	NMVOC	Kg/tonne	10,0
Margarine-solid cooking fats	NMVOC	Kg/tonne	10,0
Cakes, biscuits, bre.cereals	NMVOC	Kg/tonne	1,0
Bread	NMVOC	Kg/tonne	8,0
Animal feed	NMVOC	Kg/tonne	1,0
Agriculture			
Enteric Fermentation			
Dairy Cattle	CH_4	Kg/head/year	56,0
Other Cattle	CH_4	Kg/head/year	44,0

Sector	Gas	Unit	Emission Factor
Enteric Fermentation			
Buffalo	CH_4	Kg/head/year	55,0
Sheep	CH_4	Kg/head/year	5,0
Goats	CH_4	Kg/head/year	5,0
Camels	CH_4	Kg/head/year	46,0
Horse	CH_4	Kg/head/year	18,0
Swine	CH_4	Kg/head/year	1,0
Mules&Dankeys	CH_4	Kg/head/year	10,0
Manure Mangement			
Dairy Cattle (Clim.R. Temp.)	CH_4	Kg/head/year	16,0
Other Cattle (Clim.R. Temp.)	CH_4	Kg/head/year	1,0
Buffalo (Clim.R. Temp.)	CH_4	Kg/head/year	2,0
Sheep (Clim.R. Temp.)	CH_4	Kg/head/year	0,2
Goats (Clim.R. Temp.)	CH_4	Kg/head/year	0,17
Camels (Clim.R. Temp.)	CH_4	Kg/head/year	1,9
Horse (Clim.R. Temp.)	CH_4	Kg/head/year	1,6
Mules&Dankeys (C.R.Temp.	CH_4	Kg/head/year	0,9
Swine (Clim.R. Temp.)	CH_4	Kg/head/year	4,0
Poultry (Clim.R. Temp.)	CH_4	Kg/head/year	0,018
Rice Cultivation			
Rice	CH_4	g/m^2	20,0
Note: Integrated emission factor (arithmetic mean)			
Agricultural Burning			
Wheat, Barley, Maize, Oat, Rye	CH_4	Emission Ratios*	0,05
Wheat, Barley, Maize, Oat, Rye	CO	Emission Ratios*	0,06
Wheat, Barley, Maize, Oat, Rye	N_20	Emission Ratios*	0,007
Wheat, Barley, Maize, Oat, Rye	NO_X	Emission Ratios*	0,121
Note: Dry Matter fraction (arithmetic mean)			
Waste			
CH_4 emission from waste disposal side			
$= (MSW_T * MSW_F * MCF * DOC * DOC_F * F * 16/12 - R) \times (1-OX)$			
MSW_T	*Collected*	*Gg/year*	-
MSW_F	*Fraction*	-	*1,0*
MCF (Uncont. Landfill)	*Corr. Fact.*	-	*0,6*
MCF (Cont. Landfill)	*Corr. Fact.*	-	*1,0*
DOC	*Deg.Org.C*	-	*0,15*
DOC_F	*Fraction*	-	*0,77*
F	*Fra.in land*	-	*0,5*
R	*Recovered*	*Gg/year*	-
OX	*Oxi. Fact.*	-	*0,0*

Annex 3

A3. Quality Assurance and Quality Control

After the ratification of the United Nations Framework Convention on Climate Change. The political measures and policies in Turkey have increased fairly. Some working groups were formed for the air quality management. One of the working groups was “the GHG Emission Inventory Working Group”. The coordination was under the responsibilities of TURKSTAT. The member of this groups were the Ministry of Environment and Forestry, Ministry of Energy and Natural Resources, Ministry of Transport, Ministry of Energy and Natural Sources, Turkish Electricity Generation Transmission Corporation, universities and other related organizations. The main aim of this working group was to improve the GHG emission inventories.

TURKSTAT was responsible for preparing the Turkey’s greenhouse gas inventory (GHGI). The inventory was compiled by the related organizations after the study was completed. The critics and their data correction were reflected to the national inventory. The Energy Balance tables were also compiled and there were some small corrections. The consistency check and the corrections were reflected to the CRF tables before the submission. The Ministry of Energy and Natural Resources published these tables as officially.

The industrial establishments directly submit their industrial production data to TURKSTAT by seasonal and annual questionnaires. The necessary production data for the emission inventory was gathered from the related department of TURKSTAT. Moreover, the biggest establishments which have high GHGs also asked for compilations of these production data such as cement productions industries.

The database system was also computerized. The energy balance tables were only copied to the Excell base programme and the calculations were automatically made by programme at detail level and due to the each fuel type as the requirement of CRF Reporter. The emission factor and all used data could also be seen within the programme. Except for the energy, the activity data have to be entered the database. It was always checked by a second group.

Control of quality of the inventory by experts was carried out both on the basis of the emission factors and activity data.

There was also internal quality control, these were;

- control of consistency to ensure data integrity, its correctness and completeness;
- determination and correction of errors,
- documentation and archiving of material used for the inventory preparation and QC activities.

Annex 4

A4. Reference and Sectoral Approach

A4.1 Reference Approach

The *Reference Approach* is the method for determining the CO_2 emissions from combustion of total domestic fuels. Therefore, first step in this approach is to calculate the apparent fuel consumption. This could be done using the following formula:

extraction + imports - exports - change (increase/decrease) in stocks (A4.1)

The emission factors are related to all type of fuel that enter domestic consumption at the level of sources without regard to specific kinds of fuel burned in the consumer part of the energy balance.

In the equation (A4.1), each fuel emission is presented in units of Gg. The conversion to energy units - TJ is done using conversion factors provided in the IPCC Guidelines. A domestic conversion factor was only applied for lignite, hard coal and petroleum products. In years between 1990 and 2005, annual average conversion factor of these fuels were changing according to the quality and/or quantity of fuels (Table A4.1).

Table A4.1. Conversion Factors for Turkey - (Reference Approach)

(TJ/Gg)	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Hardcoal	31.43	30.85	29.56	28.58	28.17	28.92	28.45	28.23	28.41	28.40	26.79	26.26	26.75	26.75	27.30	26.98
Lignite	8.91	9.06	8.88	9.01	8.45	8.47	8.52	8.67	8.20	8.05	8.14	7.84	8.40	8.61	8.83	6.90
Petroleum	44.08	44.14	44.00	43.94	43.95	43.98	43.76	43.79	43.78	43.72	43.52	43.67	43.49	43.42	43.44	43.43

Country specific emission factors were used for comparative estimation of CO_2 emissions. The differences tend to vary within 7% except for 1990, which was around 10%. The main reason was the reference approach uses data on crude oil, lignite and hard coal as the average "calorific values" and "carbon content". However sectoral approach uses the individual "calorific values" and "carbon content" in each sector. The annual differences could be seen from Table A4.2.

Table A4.2. Comparison of CO_2 from Fuel combustion
(Sectoral and Reference Approach difference)

1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
10.54	-4.37	0.18	3.71	4.83	4.70	3.11	1.66	5.08	3.30	2.58	-1.35	3.25	4.42	1.97	6.89

The above differences could also be owing to the differences in the methodological approach and activity data.

A4.2 Sectoral Approach

The *Sectoral Approach* is considerably demanding input data and requires information on fuel consumption according to type of sectors. The biggest advantage of this method is the possibility of analyzing the structure of emissions. The calculations by using sectoral approach should be more exact, because the emission factors employed are specific for each type of consumed fuel.

The GHG emissions from fuel combustion derive from two types of sources: stationary and mobile. The stationary sources include the industrial processes, energy production, services, agriculture and residential sector. The mobile sources include transport and other motor vehicles. All these sources grouped according to the IPCC requirements which were reflected in CRF tables. The GHG emissions were estimated by grouping the fuel types into 4 categories - liquid, solid, gaseous and biomass.

The GHGs emissions in the energy sector were the main key sources in the inventory.

Emissions from *International Bunkers* were not included in the emissions owing to the lack of data. Moreover, the transport of fuels was not a part of the energy balance of the country and emissions were not estimated.

Annex 5

A5. Completeness

The following sources were not estimated in Turkey owing to the reasons ordered below;

Table A5.1. GHGs and sources were not considered in Turkey's Inventory

GHG	Sector	Source/sink category	Explanation
N_2O	1 Energy	1.AA.3.B Road Transportation	The value is considered as zero due to too small value
CO_2	2 Industrial Processes	2.A.5 Asphalt Roofing	No methodology available
CO_2	2 Industrial Processes	2.A.6 Road Paving with Asphalt	No methodology available
CO_2	2 Industrial Processes	2.B.5.2 Ethylene	Considered negligible
CO_2	2 Industrial Processes	2.D.2 Food and Drink	Considered negligible
CO_2	3 Solvent and Other Product Use	3.A Paint Application	The lack of data for solvent use hinder to estimate the CO_2, N_20 and NMVOC
CO_2	3 Solvent and Other Product Use	3.B Degreasing and Dry Cleaning	The lack of data for solvent use hinder to estimate the CO_2, N_20 and NMVOC
CO_2	3 Solvent and Other Product Use	3.C Chemical Products, Manufacture and Processing	The lack of data for solvent use hinder to estimate the CO_2 N_20 and NMVOC
N_2O	3 Solvent and Other Product Use	3.B Degreasing and Dry Cleaning	The lack of data for solvent use hinder to estimate the CO_2, N_20 and NMVOC
N_2O	3 Solvent and Other Product Use	3.D.1 Use of N2O for Anaesthesia	The lack of data for solvent use hinder to estimate the CO_2, N_20 and NMVOC
N_2O	3 Solvent and Other Product Use	3.D.2 Fire Extinguishers	The lack of data for solvent use hinder to estimate the CO_2, N_20 and NMVOC
N_2O	3 Solvent and Other Product Use	3.D.3 N2O from Aerosol Cans	The lack of data for solvent use hinder to estimate the CO_2, N_20 and NMVOC
N_2O	3 Solvent and Other Product Use	3.D.4 Other Use of N2O	The lack of data for solvent use hinder to estimate the CO_2, N_20 and NMVOC
N_2O	4 Agriculture	4.D.1.1 Synthetic Fertilizers	The necessary activity data is not known to calculate
N_2O	4 Agriculture	4.D.1.2 Animal Manure Applied to Soils	The necessary activity data is not known to calculate
N_2O	4 Agriculture	4.D.2 Pasture, Range and Paddock Manure	The necessary activity data is not known to calculate
CH_4	6 Waste	6.B.2.1 Domestic and Commercial (w/o human sewage)	The activity data is not known to calculate
CO_2	6 Waste	6.A.1 Managed Waste Disposal on Land	No methodology available
CO_2	6 Waste	6.A.2.1 deep (>5 m)	The methodological knowledge is not sufficient to calculate
CO_2	6 Waste	6.A.2.2 shallow (<5 m)	The methodological knowledge is not sufficient to calculate
N_2O	6 Waste	6.B.2.1 Domestic and Commercial (w/o human sewage)	The activity data is not known to calculate

Annex 6

A6. Trend Analysis

One of the major component part of the inventories is the determination of year to base year differences in national emission.

In the Following Table A6.1., the annual trend analyses compared to year 1990 were given. The aim was to observe the changes in the sectors. The basic formula used for the trend analysis was

$$T_x^t = L_x^t * [((E_x^t - E_x^o)/ E_x^t) - ((E^t_{tot} - E^o_{tot})/ E^t_{tot})] \qquad (D1)$$

where,

x	: the category
t	: year t
o	: base year
tot	: total emission
T	: trend assessment (%)
L	: emission contribution (%)
E	: emission (unit)

The annual results could be seen in the following Tables A6.1.

ANNEX 6

Table A6.2. Trend Analysis

2005 VS. 1990 TREND ANALYSIS

CATEGORY	FUEL	GAS	EMISSION 2005	CONTRIBUTION (%)	EMISSION 1990	TREND ASSESMENT	CONTRIBUTION	CUMULATIVE TOTAL	TREND
Public Electricity and Heat Production	Lignite	CO_2	33609,27	10,8	20662,22	0,7561	2,0%	2,0%	38,5%
Public Electricity and Heat Production	Natural Gas	CO_2	32802,00	10,5	5435,89	3,9785	10,6%	12,6%	83,4%
Road Transportation	Gas / Diesel oil	CO_2	21644,02	6,9	15742,61	1,2670	3,4%	16,0%	27,3%
Cement Production (Mineral Products)		CO_2	18554,80	5,9	10333,37	0,0736	0,2%	16,2%	44,3%
Waste (landfill)		CH_4	18306,92	5,9	6386,46	1,1469	3,1%	19,3%	65,1%
Other Industries	Hard Coal	CO_2	17827,79	5,7	1266,53	2,7027	7,2%	26,5%	92,9%
Enteric Fermentation		CH_4	13950,62	4,5	17046,76	3,0260	8,1%	34,6%	-22,2%
Residential	Natural Gas	CO_2	12771,20	4,1	104,21	2,1933	5,9%	40,4%	99,2%
Waste (control landfill)		CH_4	11445,42	3,7	0,00	1,9955	5,3%	45,7%	100,0%
Public Electricity and Heat Production	Hard Coal	CO_2	11010,01	3,5	851,45	1,6470	4,4%	50,1%	92,3%
Manufacture of Solid Fuels and Other Energy Industries	Gas / Diesel oil	CO_2	9226,75	3,0	5795,38	0,2470	0,7%	50,8%	37,2%
Road Transportation	Gasoline	CO_2	8835,84	2,8	8293,32	1,1149	3,0%	53,8%	6,1%
Iron and Steel	Second Fuel Coal	CO_2	8588,30	2,7	7681,10	0,9621	2,6%	56,3%	10,6%
Other Industries	Natural Gas	CO_2	8155,64	2,6	678,42	1,2047	3,2%	59,6%	91,7%
Residential	LPG	CO_2	6968,04	2,2	4772,19	0,3131	0,8%	60,4%	31,5%
Cement Production	Petroleum Coke	CO_2	6289,22	2,0	941,03	0,7952	2,1%	62,5%	85,0%
Residential	Lignite	CO_2	6087,81	1,9	9276,74	1,9089	5,1%	67,6%	-52,4%
Public Electricity and Heat Production	Residual Fuel Oil	CO_2	5855,96	1,9	3311,30	0,0393	0,1%	67,7%	43,5%
Cement Production	Hard Coal	CO_2	5008,14	1,6	2653,20	0,0236	0,1%	67,8%	47,0%
Other Industries	Residual Fuel Oil	CO_2	4268,90	1,4	4212,15	0,6044	1,6%	69,4%	1,3%
Civil Aviation	Jet Kerosene	CO_2	4054,36	1,3	904,59	0,4172	1,1%	70,5%	77,7%
Road Transportation	LPG	CO_2	4037,52	1,3	0,00	0,7039	1,9%	72,4%	100,0%
Petroleum Refining	Residual Fuel Oil	CO_2	2746,01	0,9	2277,75	0,2506	0,7%	73,1%	17,1%
Residential	Hard Coal	CO_2	2486,07	0,8	3845,79	0,7979	2,1%	75,2%	-54,7%
Chemicals	Residual Fuel Oil	CO_2	2432,03	0,8	1984,26	0,2113	0,6%	75,8%	18,4%
Emission of HFCs		HFC-134a	2379,00	0,8	0,00	0,4148	1,1%	76,9%	100,0%
Cement Production	Lignite	CO_2	2175,91	0,7	2453,05	0,4061	1,1%	77,9%	-12,7%
Petroleum Refining	Refinery Gas	CO_2	1992,56	0,6	1403,84	0,1021	0,3%	78,2%	29,5%
Nitric Acid Production (Chemical Industry)		N_20	1759,97	0,6	128,08	0,2658	0,7%	78,9%	92,7%
Chemicals	Natural Gas	CO_2	1716,83	0,5	0,00	0,2993	0,8%	79,7%	100,0%
Fertilizer	Natural Gas	CO_2	1299,10	0,4	1048,47	0,1092	0,3%	80,0%	19,3%
Non-Ferrous Metals	Natural Gas	CO_2	1215,99	0,4	0,00	0,2120	0,6%	80,6%	100,0%
Residential	wood	CH_4	1093,50	0,4	1414,06	0,2621	0,7%	81,3%	-29,3%
Sugar	Lignite	CO_2	1085,67	0,3	1775,11	0,3791	1,0%	82,3%	-63,5%
Other Industries	LPG	CO_2	1049,11	0,3	129,70	0,1414	0,4%	82,7%	87,6%
Residential	Asphalt	CO_2	1001,43	0,3	390,56	0,0495	0,1%	82,8%	61,0%
Mining (Surface)		CH_4	948,37	0,3	754,43	0,0762	0,2%	83,0%	20,5%
Navigation	Gas / Diesel oil	CO_2	937,28	0,3	219,01	0,0933	0,2%	83,3%	76,6%
Other Industries	Gas / Diesel oil	CO_2	923,20	0,3	292,99	0,0671	0,2%	83,4%	68,3%
Non-Ferrous Metals	Residual Fuel Oil	CO_2	861,37	0,3	731,31	0,0840	0,2%	83,7%	15,1%
Emission of SF6		SF_6	858,73	0,3	0,00	0,1497	0,4%	84,1%	100,0%
Manure Management		CH_4	833,94	0,3	613,63	0,0511	0,1%	84,2%	26,4%
Residential	Residual Fuel Oil	CO_2	816,73	0,3	3754,89	1,0599	2,8%	87,0%	-359,7%
Railways	Gas / Diesel oil	CO_2	676,75	0,2	404,58	0,0116	0,0%	87,1%	40,2%
Ammonia Production (Chemical Industry)		CO_2	592,93	0,2	713,47	0,1251	0,3%	87,4%	-20,3%
Mining (underground)		CH_4	534,31	0,2	675,89	0,1233	0,3%	87,7%	-26,5%
Other Industries	Lignite	CO_2	523,95	0,2	5086,15	1,5372	4,1%	91,8%	-870,7%
Residual Burning		CH_4	523,71	0,2	454,59	0,0542	0,1%	92,0%	13,2%
Iron and Steel	Residual Fuel Oil	CO_2	490,83	0,2	1702,29	0,4595	1,2%	93,2%	-246,8%
Road Transportation	Gas / Diesel oil	N_20	471,34	0,2	157,94	0,0316	0,1%	93,3%	66,5%

Table A6.2. Trend Analysis

2005 VS. 1990 TREND ANALYSIS									
Lime Production (Mineral Products)		CO_2	440,68	0,1	645,09	0,1297	0,3%	93,6%	-46,4%
Residential	Second Fuel Coal	CO_2	418,74	0,1	635,01	0,1303	0,3%	94,0%	-51,6%
Residential	Lignite	CH_4	386,72	0,1	589,29	0,1213	0,3%	94,3%	-52,4%
Rice Cultivation		CH_4	357,00	0,1	222,60	0,0090	0,0%	94,3%	37,6%
Navigation	Residual Fuel Oil	CO_2	340,15	0,1	275,27	0,0288	0,1%	94,4%	19,1%
Soda Ash Production and Use (Mineral Products)		CO_2	332,57	0,1	106,30	0,0239	0,1%	94,5%	68,0%
Iron and Steel Production (Metal Production)		CO_2	318,98	0,1	770,23	0,1910	0,5%	95,0%	-141,5%
Residential	waste of animal, plant	CH_4	311,04	0,1	487,15	0,1018	0,3%	95,2%	-56,6%
Other Industries	Second Fuel Coal	CO_2	299,07	0,1	527,11	0,1166	0,3%	95,6%	-76,2%
Sugar	Residual Fuel Oil	CO_2	291,52	0,1	400,87	0,0775	0,2%	95,8%	-37,5%
Sugar	Natural Gas	CO_2	282,13	0,1	0,00	0,0492	0,1%	95,9%	100,0%
Public Electricity and Heat Production	Naphta	CO_2	276,05	0,1	0,00	0,0481	0,1%	96,0%	100,0%
Fertilizer	Residual Fuel Oil	CO_2	239,95	0,1	0,00	0,0418	0,1%	96,1%	100,0%
Non-Ferrous Metals	Hard Coal	CO_2	237,52	0,1	0,00	0,0414	0,1%	96,2%	100,0%
Iron and Steel	Hard Coal	CO_2	233,01	0,1	0,00	0,0406	0,1%	96,3%	100,0%
Other Industries	Asphalt	CO_2	229,83	0,1	25,04	0,0321	0,1%	96,4%	89,1%
Residential	wood	N_20	215,23	0,1	278,32	0,0516	0,1%	96,6%	-29,3%
Cement Production	LPG	CO_2	205,11	0,1	0,00	0,0358	0,1%	96,7%	100,0%
Chemicals	Lignite	CO_2	203,40	0,1	529,42	0,1341	0,4%	97,0%	-160,3%
Other Industries	Petroleum Coke	CO_2	191,06	0,1	0,00	0,0333	0,1%	97,1%	100,0%
Cement Production	Natural Gas	CO_2	181,29	0,1	2,13	0,0309	0,1%	97,2%	98,8%
Sugar	Hard Coal	CO_2	176,10	0,1	248,42	0,0488	0,1%	97,3%	-41,1%
Road Transportation	Gasoline	N_20	170,18	0,1	88,93	0,0012	0,0%	97,3%	47,7%
Residential	Hard Coal	CH_4	168,94	0,1	261,34	0,0542	0,1%	97,5%	-54,7%
Cement Production	Residual Fuel Oil	CO_2	166,28	0,1	1473,79	0,4429	1,2%	98,7%	-786,3%
Residual Burning		N_20	158,17	0,1	135,51	0,0158	0,0%	98,7%	14,3%
Public Electricity and Heat Production	Lignite	N_20	146,94	0,0	90,42	0,0033	0,0%	98,7%	38,5%
Petroleum Refining	Gas / Diesel oil	CO_2	137,77	0,0	5,63	0,0222	0,1%	98,8%	95,9%
Sugar	Second Fuel Coal	CO_2	125,70	0,0	149,44	0,0259	0,1%	98,8%	-18,9%
Residential	Gas / Diesel oil	CO_2	89,46	0,0	626,23	0,1849	0,5%	99,3%	-600,0%
Public Electricity and Heat Production	Gas / Diesel oil	CO_2	89,04	0,0	64,60	0,0052	0,0%	99,3%	27,5%
Other Industries	Hard Coal	N_20	83,46	0,0	5,93	0,0127	0,0%	99,4%	92,9%
Residential	Asphalt	CH_4	68,05	0,0	26,54	0,0034	0,0%	99,4%	61,0%
Residential	waste of animal, plant	N_20	61,22	0,0	95,88	0,0200	0,1%	99,4%	-56,6%
Cement Production	Second Fuel Coal	CO_2	59,78	0,0	0,00	0,0104	0,0%	99,5%	100,0%
Non-Ferrous Metals	Second Fuel Coal	CO_2	54,34	0,0	73,36	0,0140	0,0%	99,5%	-35,0%
Road Transportation	Gasoline	CH_4	52,87	0,0	47,03	0,0058	0,0%	99,5%	11,1%
Public Electricity and Heat Production	Hard Coal	N_20	51,15	0,0	3,99	0,0076	0,0%	99,5%	92,2%
Road Transportation	Gas / Diesel oil	CH_4	40,62	0,0	20,88	0,0004	0,0%	99,5%	48,6%
Other Industries	Hard Coal	CH_4	40,38	0,0	2,87	0,0061	0,0%	99,6%	92,9%
Iron and Steel	Second Fuel Coal	N_20	40,20	0,0	35,96	0,0045	0,0%	99,6%	10,6%
Public Electricity and Heat Production	LPG	CO_2	37,37	0,0	0,00	0,0065	0,0%	99,6%	100,0%
Ferroalloys Production (Metal Production)		CO_2	33,43	0,0	81,17	0,0202	0,1%	99,6%	-142,8%
Cement Production	Petroleum Coke	N_20	29,44	0,0	4,41	0,0037	0,0%	99,7%	85,0%
Residential	Second Fuel Coal	CH_4	28,46	0,0	43,15	0,0089	0,0%	99,7%	-51,6%
Residential	Lignite	N_20	26,64	0,0	40,60	0,0084	0,0%	99,7%	-52,4%
Road Transportation	LPG	CH_4	25,81	0,0	0,00	0,0045	0,0%	99,7%	100,0%
Residential	Natural Gas	CH_4	24,05	0,0	0,20	0,0041	0,0%	99,7%	99,2%
Cement Production	Hard Coal	N_20	23,44	0,0	12,42	0,0001	0,0%	99,7%	47,0%
Residential	LPG	CH_4	23,44	0,0	15,10	0,0007	0,0%	99,7%	35,6%
Manufacture of Solid Fuels and Other Energy Industries	Gas / Diesel oil	N_20	23,40	0,0	14,85	0,0007	0,0%	99,7%	36,6%
Residential	LPG	N_20	20,76	0,0	13,38	0,0007	0,0%	99,7%	35,6%
Iron and Steel	Second Fuel Coal	CH_4	19,45	0,0	17,40	0,0022	0,0%	99,7%	10,6%

Table A6.2. Trend Analysis

2005 VS. 1990 TREND ANALYSIS

Public Electricity and Heat Production	Natural Gas	N_2O	18,29	0,0	3,02	0,0022	0,0%	99,7%	83,5%
Other Industries	Natural Gas	CH_4	15,34	0,0	1,28	0,0023	0,0%	99,7%	91,7%
Other Chemicals Production (Chemical Industry)		CH_4	14,95	0,0	49,39	0,0132	0,0%	99,8%	-230,4%
Public Electricity and Heat Production	Residual Fuel Oil	N_2O	14,88	0,0	8,48	0,0001	0,0%	99,8%	43,0%
Cement Production	Petroleum Coke	CH_4	14,25	0,0	2,13	0,0018	0,0%	99,8%	85,0%
Iron and Steel	Natural Gas	CO_2	13,30	0,0	0,00	0,0023	0,0%	99,8%	100,0%
Manufacture of Solid Fuels and Other Energy Industries	Gas / Diesel oil	CH_4	13,21	0,0	8,38	0,0004	0,0%	99,8%	36,6%
Public Electricity and Heat Production	Natural Gas	CH_4	12,35	0,0	2,05	0,0015	0,0%	99,8%	83,4%
Residential	Hard Coal	N_2O	11,64	0,0	18,00	0,0037	0,0%	99,8%	-54,7%
Cement Production	Hard Coal	CH_4	11,34	0,0	6,01	0,0001	0,0%	99,8%	47,0%
Civil Aviation	Jet Kerosene	N_2O	10,37	0,0	9,08	0,0011	0,0%	99,8%	12,4%
Other Industries	Residual Fuel Oil	N_2O	10,37	0,0	10,68	0,0016	0,0%	99,8%	-3,1%
Cement Production	Lignite	N_2O	9,52	0,0	10,73	0,0018	0,0%	99,8%	-12,7%
Public Electricity and Heat Production	Lignite	CH_4	7,12	0,0	4,38	0,0002	0,0%	99,8%	38,5%
Residential	Natural Gas	N_2O	7,10	0,0	0,06	0,0012	0,0%	99,8%	99,2%
Petroleum Refining	Residual Fuel Oil	N_2O	6,67	0,0	5,71	0,0007	0,0%	99,8%	14,4%
Chemicals	Residual Fuel Oil	N_2O	5,91	0,0	5,08	0,0006	0,0%	99,8%	13,9%
Petroleum Refining	Refinery Gas	N_2O	5,10	0,0	3,71	0,0003	0,0%	99,8%	27,3%
Public Electricity and Heat Production	Residual Fuel Oil	CH_4	5,08	0,0	2,87	0,0000	0,0%	99,8%	43,5%
Sugar	Lignite	N_2O	4,75	0,0	7,77	0,0017	0,0%	99,8%	-63,5%
Residential	Asphalt	N_2O	4,69	0,0	1,83	0,0002	0,0%	99,8%	61,0%
Cement Production	Lignite	CH_4	4,61	0,0	5,19	0,0009	0,0%	99,8%	-12,7%
Other Industries	Natural Gas	N_2O	4,53	0,0	0,38	0,0007	0,0%	99,8%	91,7%
Chemicals	Natural Gas	CH_4	3,23	0,0	0,00	0,0006	0,0%	99,8%	100,0%
Other Industries	LPG	N_2O	3,13	0,0	0,40	0,0004	0,0%	99,8%	87,1%
Railways	Gas / Diesel oil	N_2O	3,03	0,0	2,94	0,0004	0,0%	99,8%	3,2%
Public Electricity and Heat Production	Hard Coal	CH_4	2,48	0,0	0,19	0,0004	0,0%	99,8%	92,2%
Fertilizer	Natural Gas	CH_4	2,44	0,0	1,97	0,0002	0,0%	99,8%	19,3%
Navigation	Gas / Diesel oil	N_2O	2,38	0,0	0,56	0,0002	0,0%	99,8%	76,5%
Other Industries	Gas / Diesel oil	N_2O	2,34	0,0	0,78	0,0002	0,0%	99,8%	66,9%
Other Industries	Residual Fuel Oil	CH_4	2,34	0,0	2,41	0,0004	0,0%	99,8%	-3,1%
Sugar	Lignite	CH_4	2,30	0,0	3,76	0,0008	0,0%	99,8%	-63,5%
Other Industries	Lignite	N_2O	2,29	0,0	22,26	0,0067	0,0%	99,9%	-870,7%
Non-Ferrous Metals	Natural Gas	CH_4	2,29	0,0	0,00	0,0004	0,0%	99,9%	100,0%
Petroleum Refining	Residual Fuel Oil	CH_4	2,26	0,0	1,93	0,0002	0,0%	99,9%	14,4%
Residential	Residual Fuel Oil	CH_4	2,24	0,0	9,69	0,0027	0,0%	99,9%	-332,6%
Non-Ferrous Metals	Residual Fuel Oil	N_2O	2,09	0,0	1,87	0,0002	0,0%	99,9%	10,7%
Residential	Residual Fuel Oil	N_2O	1,98	0,0	8,58	0,0024	0,0%	99,9%	-332,6%
Residential	Second Fuel Coal	N_2O	1,96	0,0	2,97	0,0006	0,0%	99,9%	-51,6%
Petroleum Refining	Refinery Gas	CH_4	1,73	0,0	1,26	0,0001	0,0%	99,9%	27,3%
Other Industries	Second Fuel Coal	N_2O	1,40	0,0	2,47	0,0005	0,0%	99,9%	-76,2%
Navigation	Gas / Diesel oil	CH_4	1,34	0,0	0,12	0,0002	0,0%	99,9%	90,9%
Chemicals	Residual Fuel Oil	CH_4	1,33	0,0	1,15	0,0001	0,0%	99,9%	13,9%
Iron and Steel	Residual Fuel Oil	N_2O	1,19	0,0	4,36	0,0012	0,0%	99,9%	-265,7%
Non-Ferrous Metals	Hard Coal	N_2O	1,11	0,0	0,00	0,0002	0,0%	99,9%	100,0%
Other Industries	Lignite	CH_4	1,11	0,0	10,77	0,0033	0,0%	99,9%	-870,7%
Iron and Steel	Hard Coal	N_2O	1,09	0,0	0,00	0,0002	0,0%	99,9%	100,0%
Other Industries	Asphalt	N_2O	1,08	0,0	0,12	0,0002	0,0%	99,9%	89,1%
Chemicals	Natural Gas	N_2O	0,95	0,0	0,00	0,0002	0,0%	99,9%	100,0%
Other Industries	Petroleum Coke	N_2O	0,89	0,0	0,00	0,0002	0,0%	99,9%	100,0%
Chemicals	Lignite	N_2O	0,89	0,0	2,32	0,0006	0,0%	99,9%	-160,3%
Cement Production	Gas / Diesel oil	CO_2	0,86	0,0	76,06	0,0242	0,1%	100,0%	-8732,7%
Limestone and Dolomite Use (Mineral Products)		CO_2	0,85	0,0	21,52	0,0067	0,0%	100,0%	-2430,2%

ANNEX 6

Table A6.2. Trend Analysis

2005 VS. 1990 TREND ANALYSIS

Sugar	Hard Coal	N_20	0,82	0,0	1,16	0,0002	0,0%	100,0%	-41,1%
Navigation	Residual Fuel Oil	N_20	0,81	0,0	0,67	0,0001	0,0%	100,0%	16,7%
Civil Aviation	Jet Kerosene	CH_4	0,79	0,0	1,31	0,0003	0,0%	100,0%	-64,8%
Fertilizer	Natural Gas	N_20	0,72	0,0	0,58	0,0001	0,0%	100,0%	19,3%
Sugar	Residual Fuel Oil	N_20	0,71	0,0	1,02	0,0002	0,0%	100,0%	-43,6%
Public Electricity and Heat Production	Naphta	N_20	0,71	0,0	0,00	0,0001	0,0%	100,0%	100,0%
Other Industries	LPG	CH_4	0,71	0,0	0,09	0,0001	0,0%	100,0%	87,1%
Other Industries	Second Fuel Coal	CH_4	0,68	0,0	1,19	0,0003	0,0%	100,0%	-76,2%
Non-Ferrous Metals	Natural Gas	N_20	0,68	0,0	0,00	0,0001	0,0%	100,0%	100,0%
Railways	Gas / Diesel oil	CH_4	0,64	0,0	0,64	0,0001	0,0%	100,0%	0,9%
Petroleum Refining	Gasoline	CO_2	0,63	0,0	1,88	0,0005	0,0%	100,0%	-198,6%
Cement Production	LPG	N_20	0,61	0,0	0,00	0,0001	0,0%	100,0%	100,0%
Sugar	Second Fuel Coal	N_20	0,59	0,0	0,70	0,0001	0,0%	100,0%	-18,9%
Fertilizer	Residual Fuel Oil	N_20	0,58	0,0	0,00	0,0001	0,0%	100,0%	100,0%
Non-Ferrous Metals	Hard Coal	CH_4	0,54	0,0	0,00	0,0001	0,0%	100,0%	100,0%
Sugar	Natural Gas	CH_4	0,53	0,0	0,00	0,0001	0,0%	100,0%	100,0%
Other Industries	Gas / Diesel oil	CH_4	0,53	0,0	0,18	0,0000	0,0%	100,0%	66,9%
Iron and Steel	Hard Coal	CH_4	0,53	0,0	0,00	0,0001	0,0%	100,0%	100,0%
Other Industries	Asphalt	CH_4	0,52	0,0	0,06	0,0001	0,0%	100,0%	89,1%
Non-Ferrous Metals	Residual Fuel Oil	CH_4	0,47	0,0	0,42	0,0001	0,0%	100,0%	10,7%
Navigation	Residual Fuel Oil	CH_4	0,47	0,0	0,15	0,0000	0,0%	100,0%	68,4%
Other Industries	Petroleum Coke	CH_4	0,43	0,0	0,00	0,0001	0,0%	100,0%	100,0%
Chemicals	Lignite	CH_4	0,43	0,0	1,12	0,0003	0,0%	100,0%	-160,3%
Cement Production	Residual Fuel Oil	N_20	0,40	0,0	3,74	0,0011	0,0%	100,0%	-825,7%
Sugar	Hard Coal	CH_4	0,40	0,0	0,56	0,0001	0,0%	100,0%	-41,1%
Petroleum Refining	Gas / Diesel oil	N_20	0,35	0,0	0,01	0,0001	0,0%	100,0%	95,8%
Cement Production	Natural Gas	CH_4	0,34	0,0	0,00	0,0001	0,0%	100,0%	98,8%
Public Electricity and Heat Production	Gas / Diesel oil	N_20	0,31	0,0	0,17	0,0000	0,0%	100,0%	44,3%
Sugar	Second Fuel Coal	CH_4	0,28	0,0	0,34	0,0001	0,0%	100,0%	-18,9%
Cement Production	Second Fuel Coal	N_20	0,28	0,0	0,00	0,0000	0,0%	100,0%	100,0%
Iron and Steel	Residual Fuel Oil	CH_4	0,27	0,0	0,98	0,0003	0,0%	100,0%	-265,7%
Residential	Gas / Diesel oil	CH_4	0,26	0,0	1,69	0,0005	0,0%	100,0%	-558,6%
Non-Ferrous Metals	Second Fuel Coal	N_20	0,25	0,0	0,34	0,0001	0,0%	100,0%	-35,0%
Fertilizer	Gas / Diesel oil	CO_2	0,24	0,0	0,00	0,0000	0,0%	100,0%	100,0%
Public Electricity and Heat Production	Naphta	CH_4	0,24	0,0	0,00	0,0000	0,0%	100,0%	100,0%
Residential	Gas / Diesel oil	N_20	0,23	0,0	1,49	0,0004	0,0%	100,0%	-558,6%
Public Electricity and Heat Production	LPG	N_20	0,22	0,0	0,00	0,0000	0,0%	100,0%	100,0%
Petroleum Refining	LPG	CO_2	0,21	0,0	0,14	0,0000	0,0%	100,0%	33,6%
Sugar	Residual Fuel Oil	CH_4	0,16	0,0	0,23	0,0000	0,0%	100,0%	-43,6%
Sugar	Natural Gas	N_20	0,16	0,0	0,00	0,0000	0,0%	100,0%	100,0%
Cement Production	LPG	CH_4	0,14	0,0	0,00	0,0000	0,0%	100,0%	100,0%
Cement Production	Second Fuel Coal	CH_4	0,14	0,0	0,00	0,0000	0,0%	100,0%	100,0%
Fertilizer	Residual Fuel Oil	CH_4	0,13	0,0	0,00	0,0000	0,0%	100,0%	100,0%
Non-Ferrous Metals	Second Fuel Coal	CH_4	0,12	0,0	0,17	0,0000	0,0%	100,0%	-35,0%
Petroleum Refining	Gas / Diesel oil	CH_4	0,12	0,0	0,00	0,0000	0,0%	100,0%	95,8%
Cement Production	Natural Gas	N_20	0,10	0,0	0,00	0,0000	0,0%	100,0%	98,8%
Cement Production	Residual Fuel Oil	CH_4	0,09	0,0	0,84	0,0003	0,0%	100,0%	-825,7%
Public Electricity and Heat Production	Gas / Diesel oil	CH_4	0,08	0,0	0,06	0,0000	0,0%	100,0%	30,4%
Changes in Forest and Other Woody Biomass Stocks		N_20	0,06	0,0	0,48	0,0001	0,0%	100,0%	-769,6%
Public Electricity and Heat Production	LPG	CH_4	0,03	0,0	0,00	0,0000	0,0%	100,0%	100,0%
Iron and Steel	Natural Gas	CH_4	0,03	0,0	0,00	0,0000	0,0%	100,0%	100,0%
Iron and Steel	Natural Gas	N_20	0,01	0,0	0,00	0,0000	0,0%	100,0%	100,0%
Cement Production	Gas / Diesel oil	N_20	0,00	0,0	0,20	0,0001	0,0%	100,0%	-9125,1%

Table A6.2. Trend Analysis

2005 VS. 1990 TREND ANALYSIS										
Petroleum Refining	Gasoline	N_2O	0,00	0,0	0,01	0,0000	0,0%	100,0%	-208,3%
Fertilizer	Gas / Diesel oil	N_2O	0,00	0,0	0,00	0,0000	0,0%	100,0%	100,0%
Petroleum Refining	LPG	N_2O	0,00	0,0	0,00	0,0000	0,0%	100,0%	31,4%
Petroleum Refining	Gasoline	CH_4	0,00	0,0	0,00	0,0000	0,0%	100,0%	-208,3%
Cement Production	Gas / Diesel oil	CH_4	0,00	0,0	0,05	0,0000	0,0%	100,0%	-9125,1%
Petroleum Refining	LPG	CH_4	0,00	0,0	0,00	0,0000	0,0%	100,0%	31,4%
Fertilizer	Gas / Diesel oil	CH_4	0,00	0,0	0,00	0,0000	0,0%	100,0%	100,0%
Railways	Hard Coal	CO_2	0,00	0,0	29,73	0,0000	0,0%	100,0%	-
Navigation	Hard Coal	CO_2	0,00	0,0	3,19	0,0000	0,0%	100,0%	-
Non-Ferrous Metals	Lignite	CO_2	0,00	0,0	59,79	0,0000	0,0%	100,0%	-
Fertilizer	Lignite	CO_2	0,00	0,0	634,06	0,0000	0,0%	100,0%	-
Railways	Lignite	CO_2	0,00	0,0	21,87	0,0000	0,0%	100,0%	-
Cement Production	Asphalt	CO_2	0,00	0,0	63,42	0,0000	0,0%	100,0%	-
Fertilizer	Second Fuel Coal	CO_2	0,00	0,0	2,72	0,0000	0,0%	100,0%	-
Non-Ferrous Metals	Petroleum Coke	CO_2	0,00	0,0	103,25	0,0000	0,0%	100,0%	-
Railways	Residual Fuel Oil	CO_2	0,00	0,0	60,47	0,0000	0,0%	100,0%	-
Iron and Steel	Gas / Diesel oil	CO_2	0,00	0,0	18,63	0,0000	0,0%	100,0%	-
Non-Ferrous Metals	Gas / Diesel oil	CO_2	0,00	0,0	42,91	0,0000	0,0%	100,0%	-
Other Industries	Refinery Gas	CO_2	0,00	0,0	1,05	0,0000	0,0%	100,0%	-
Fertilizer	Naphta	CO_2	0,00	0,0	463,51	0,0000	0,0%	100,0%	-
Railways	Hard Coal	CH_4	0,00	0,0	0,07	0,0000	0,0%	100,0%	-
Navigation	Hard Coal	CH_4	0,00	0,0	0,00	0,0000	0,0%	100,0%	-
Non-Ferrous Metals	Lignite	CH_4	0,00	0,0	0,13	0,0000	0,0%	100,0%	-
Fertilizer	Lignite	CH_4	0,00	0,0	1,34	0,0000	0,0%	100,0%	-
Railways	Lignite	CH_4	0,00	0,0	0,05	0,0000	0,0%	100,0%	-
Cement Production	Asphalt	CH_4	0,00	0,0	0,14	0,0000	0,0%	100,0%	-
Fertilizer	Second Fuel Coal	CH_4	0,00	0,0	0,01	0,0000	0,0%	100,0%	-
Non-Ferrous Metals	Petroleum Coke	CH_4	0,00	0,0	0,23	0,0000	0,0%	100,0%	-
Railways	Residual Fuel Oil	CH_4	0,00	0,0	0,09	0,0000	0,0%	100,0%	-
Iron and Steel	Gas / Diesel oil	CH_4	0,00	0,0	0,01	0,0000	0,0%	100,0%	-
Non-Ferrous Metals	Gas / Diesel oil	CH_4	0,00	0,0	0,03	0,0000	0,0%	100,0%	-
Other Industries	Refinery Gas	CH_4	0,00	0,0	0,00	0,0000	0,0%	100,0%	-
Fertilizer	Naphta	CH_4	0,00	0,0	0,28	0,0000	0,0%	100,0%	-
Railways	Hard Coal	N_2O	0,00	0,0	0,39	0,0000	0,0%	100,0%	-
Navigation	Hard Coal	N_2O	0,00	0,0	0,01	0,0000	0,0%	100,0%	-
Non-Ferrous Metals	Lignite	N_2O	0,00	0,0	0,26	0,0000	0,0%	100,0%	-
Fertilizer	Lignite	N_2O	0,00	0,0	2,77	0,0000	0,0%	100,0%	-
Railways	Lignite	N_2O	0,00	0,0	0,27	0,0000	0,0%	100,0%	-
Cement Production	Asphalt	N_2O	0,00	0,0	0,30	0,0000	0,0%	100,0%	-
Fertilizer	Second Fuel Coal	N_2O	0,00	0,0	0,01	0,0000	0,0%	100,0%	-
Non-Ferrous Metals	Petroleum Coke	N_2O	0,00	0,0	0,48	0,0000	0,0%	100,0%	-
Railways	Residual Fuel Oil	N_2O	0,00	0,0	0,42	0,0000	0,0%	100,0%	-
Iron and Steel	Gas / Diesel oil	N_2O	0,00	0,0	0,05	0,0000	0,0%	100,0%	-
Non-Ferrous Metals	Gas / Diesel oil	N_2O	0,00	0,0	0,11	0,0000	0,0%	100,0%	-
Road Transportation	LPG	N_2O	0,00	0,0	0,00	0,0000	0,0%	100,0%	-
Other Industries	Refinery Gas	N_2O	0,00	0,0	0,00	0,0000	0,0%	100,0%	-
Fertilizer	Naphta	N_2O	0,00	0,0	1,24	0,0000	0,0%	100,0%	-
Carbide Production (Chemical Industry)		CO_2	0,00	0,0	112,25	0,0000	0,0%	100,0%	-
Aluminium Production (Metal Production)		CO_2	0,00	0,0	109,62	0,0000	0,0%	100,0%	-
TOTAL			312312		170059	37,4651	100,0%		

Annex 7

A7. Uncertainties

Quantitative estimates of the uncertainties in the emissions were calculated using direct expert judgement. It can be concluded that the total uncertainty is 12.1% according to the high certain data of energy production. The emissions from all sectors were calculated by summing the GWP weighted emissions of CO_2, N_20, CH_4, HFCs and SF_6 gases.

The general procedure for uncertainty analysis was:

- Uncertainties of each activity were allocated by using emission factor and activity rate uncertainties.
- A calculation was set up to estimate the emission of each CO_2, CH_4, N_20, HFCs and SF_6 gases.
- The uncertainties used for the industrial processes data were estimated from the statistical difference between entire supply and institutional inventory demand.
- The uncertainties for sectorial energy usage were estimated by MENR experts.
- The uncertainties of agricultural activities were estimated by TURKSTAT experts.
- The uncertainties of transport sectors were estimated by MOT experts.
- The uncertainties of LULUCF were estimated by MOEF experts.

The highest combined uncertainties were seen in the industrial processes (especially chemical productions), burning of agricultural residue, solid waste, coal mining and fuel combustion (basically the usage of hard coal in electricity production and residential areas).

The results were given in Table A7.1

Uncertainty estimates are an essential element of a complete emissions inventory. It is not intended dispute the validity of the inventory estimates, but to help prioritise efforts to improve the accuracy of inventories in the future. Uncertainties of the inventories are, mainly derived from measured data. However, it is not practical to measure every energy sources in this way. As in Turkey, experts have enough knowledge about sources to determine their uncertainty. Expert judgement in this way minimise the risk of bias and it discusses how to combine uncertainties in emission factors and activity data to estimate source category and total uncertainties in inventories. Once the uncertainties in the source categories have been determined, they may be combined to provide uncertainty estimates for the entire inventory. Tier 1 method was used for correlation over time. However, it did not account for correlation and dependency between source categories. The following Table A1 was used for calculating Total Tier 1 Uncertainty of Turkish Emission inventory.

Table A7.1 Tier 1 Uncertainty Calculation (IPCC GPG-Table6.1, 2000)

A	B	C	D	E	F	G	H	I
Source Category	FUEL	GAS	1990 EMIS.	2005 EMIS.	Activity data Unc. (%)	Emis fact. Unc. (%)	Combined Unc. (%)	Combined uncertainty as % of total national emissions in year 2005
	-	-	Input Data	Input Data	Input Data	Input Data	$\sqrt{F^2+G^2}$	$\frac{H \bullet E}{\sum E}$
	-	-	Gg CO_2 Equ.	Gg CO_2 Equ.	%	%	%	&
Example (1.A.1.a)	Hard Coal	CO_2						
				$\sum D$	$\sum E$			Total Uncertainty $\sqrt{\sum H^2}$

Table A7.2 Uncertainties, 2005

CATEGORY	FUEL	GAS	1990 EMIS.	2005 EMIS.	Activity data Unc. (%)	Emıs fact. Unc. (%)	Combıned Unc. (%)	Combined uncertainty as % of total national emissions in year 2005
Public Electricity and Heat Production	Lignite	CO_2	20662,22	33609,27	5,30	3,0	6,1	0,8
Public Electricity and Heat Production	Natural Gas	CO_2	5435,89	32802,00	0,00	3,0	3,0	0,4
Road Transportation	Gas / Diesel oil	CO_2	15742,61	21644,02	0,00	5,0	5,0	0,4
Cement Production (Mineral Products)		CO_2	10333,37	18554,80	0,00	5,0	5,0	0,4
Waste (landfill)		CH_4	6386,46	18306,92	15,00	19,0	24,2	1,8
Other Industries	Hard Coal	CO_2	1266,53	17827,79	7,00	3,0	7,6	0,6
Enteric Fermentation		CH_4	17046,76	13950,62	6,30	1,0	6,4	0,4
Residential	Natural Gas	CO_2	104,21	12771,20	0,00	3,0	3,0	0,2
Waste (control landfill)		CH_4	0,00	11445,42	15,00	19,0	24,2	1,1
Public Electricity and Heat Production	Hard Coal	CO_2	851,45	11010,01	7,00	3,0	7,6	0,3
Manufacture of Solid Fuels and Other Energy Industries	Gas / Diesel oil	CO_2	5795,38	9226,75	0,00	5,0	5,0	0,2
Road Transportation	Gasoline	CO_2	8293,32	8835,84	0,00	3,0	3,0	0,1
Iron and Steel	Second Fuel Coal	CO_2	7681,10	8588,30	7,00	3,0	7,6	0,3
Other Industries	Natural Gas	CO_2	678,42	8155,64	0,00	3,0	3,0	0,1
Residential	LPG	CO_2	4772,19	6968,04	2,50	5,0	5,6	0,2
Cement Production	Petroleum Coke	CO_2	941,03	6289,22	0,00	3,0	3,0	0,1
Residential	Lignite	CO_2	9276,74	6087,81	5,30	3,0	6,1	0,2
Public Electricity and Heat Production	Residual Fuel Oil	CO_2	3311,30	5855,96	2,50	3,0	3,9	0,1
Cement Production	Hard Coal	CO_2	2653,20	5008,14	7,00	3,0	7,6	0,2
Other Industries	Residual Fuel Oil	CO_2	4212,15	4268,90	2,50	3,0	3,9	0,1
Civil Aviation	Jet Kerosene	CO_2	904,59	4054,36	0,00	3,0	3,0	0,1
Road Transportation	LPG	CO_2	0,00	4037,52	2,50	5,0	5,6	0,1
Petroleum Refining	Residual Fuel Oil	CO_2	2277,75	2746,01	2,50	3,0	3,9	0,0
Residential	Hard Coal	CO_2	3845,79	2486,07	7,00	3,0	7,6	0,1
Chemicals	Residual Fuel Oil	CO_2	1984,26	2432,03	2,50	3,0	3,9	0,0
Emission of HFCs		HFC-134a	0,00	2379,00	40,00	20,0	44,7	0,4
Cement Production	Lignite	CO_2	2453,05	2175,91	5,30	3,0	6,1	0,1
Petroleum Refining	Refinery Gas	CO_2	1403,84	1992,56	0,00	3,0	3,0	0,0
Nitric Acid Production (Chemical Industry)		N_20	128,08	1759,97	8,91	1,0	9,0	0,1
Chemicals	Natural Gas	CO_2	0,00	1716,83	0,00	3,0	3,0	0,0
Fertilizer	Natural Gas	CO_2	1048,47	1299,10	0,00	3,0	3,0	0,0
Non-Ferrous Metals	Natural Gas	CO_2	0,00	1215,99	0,00	3,0	3,0	0,0
Residential	wood (biomass)	CH_4	1414,06	1093,50	0,00	16,0	16,0	0,1
Sugar	Lignite	CO_2	1775,11	1085,67	5,30	3,0	6,1	0,0
Other Industries	LPG	CO_2	129,70	1049,11	2,50	5,0	5,6	0,0

Table A7.2 Uncertainties, 2005

CATEGORY	FUEL	GAS	1990 EMIS.	2005 EMIS.	Activity data Unc. (%)	Emıs fact. Unc. (%)	Combıned Unc. (%)	Combined uncertainty as % of total national emissions in year 2005
Residential	Asphalt	CO_2	390,56	1001,43	0,00	20,0	20,0	0,1
Mining (Surface)		CH_4	754,43	948,37	5,00	20,0	20,6	0,1
Navigation	Gas / Diesel oil	CO_2	219,01	937,28	0,00	5,0	5,0	0,0
Other Industries	Gas / Diesel oil	CO_2	292,99	923,20	0,00	5,0	5,0	0,0
Non-Ferrous Metals	Residual Fuel Oil	CO_2	731,31	861,37	2,50	3,0	3,9	0,0
Emission of SF6		SF_6	0,00	858,73	40,00	20,0	44,7	0,2
Manure Management		CH_4	613,63	833,94	6,30	1,0	6,4	0,0
Residential	Residual Fuel Oil	CO_2	3754,89	816,73	2,50	3,0	3,9	0,0
Railways	Gas / Diesel oil	CO_2	404,58	676,75	0,00	5,0	5,0	0,0
Ammonia Production (Chemical Industry)		CO_2	713,47	592,93	24,00	1,0	24,0	0,1
Mining (underground)		CH_4	675,89	534,31	5,00	20,0	20,6	0,0
Other Industries	Lignite	CO_2	5086,15	523,95	5,30	3,0	6,1	0,0
Residual Burning		CH_4	454,59	523,71	25,00	14,0	28,7	0,1
Iron and Steel	Residual Fuel Oil	CO_2	1702,29	490,83	2,50	3,0	3,9	0,0
Road Transportation	Gas / Diesel oil	N_20	157,94	471,34	0,00	10,0	10,0	0,0
Lime Production (Mineral Products)		CO_2	645,09	440,68	34,00	1,0	34,0	0,1
Residential	Second Fuel Coal	CO_2	635,01	418,74	7,00	3,0	7,6	0,0
Residential	Lignite	CH_4	589,29	386,72	5,30	16,0	16,9	0,0
Rice Cultivation		CH_4	222,60	357,00	10,00	20,0	22,4	0,0
Navigation	Residual Fuel Oil	CO_2	275,27	340,15	2,50	3,0	3,9	0,0
Soda Ash Production and Use (Mineral Products)		CO_2	106,30	332,57	45,00	1,0	45,0	0,1
Iron and Steel Production (Metal Production)		CO_2	770,23	318,98	0,00	1,0	1,0	0,0
Residential	waste of animal, p	CH_4	487,15	311,04	0,00	16,0	16,0	0,0
Other Industries	Second Fuel Coal	CO_2	527,11	299,07	7,00	3,0	7,6	0,0
Sugar	Residual Fuel Oil	CO_2	400,87	291,52	2,50	3,0	3,9	0,0
Sugar	Natural Gas	CO_2	0,00	282,13	0,00	3,0	3,0	0,0
Public Electricity and Heat Production	Naphta	CO_2	0,00	276,05	2,50	3,0	3,9	0,0
Fertilizer	Residual Fuel Oil	CO_2	0,00	239,95	2,50	3,0	3,9	0,0
Non-Ferrous Metals	Hard Coal	CO_2	0,00	237,52	7,00	3,0	7,6	0,0
Iron and Steel	Hard Coal	CO_2	0,00	233,01	7,00	3,0	7,6	0,0
Other Industries	Asphalt	CO_2	25,04	229,83	0,00	20,0	20,0	0,0
Residential	wood (biomass)	N_20	278,32	215,23	0,00	45,0	45,0	0,0
Cement Production	LPG	CO_2	0,00	205,11	2,50	5,0	5,6	0,0
Chemicals	Lignite	CO_2	529,42	203,40	5,30	3,0	6,1	0,0
Other Industries	Petroleum Coke	CO_2	0,00	191,06	0,00	3,0	3,0	0,0

Table A7.2 Uncertainties, 2005

CATEGORY	FUEL	GAS	1990 EMIS.	2005 EMIS.	Activity data Unc. (%)	Emis fact. Unc. (%)	Combined Unc. (%)	Combined uncertainty as % of total national emissions in year 2005
Cement Production	Natural Gas	CO_2	2,13	181,29	0,00	3,0	3,0	0,0
Sugar	Hard Coal	CO_2	248,42	176,10	7,00	3,0	7,6	0,0
Road Transportation	Gasoline	N_20	88,93	170,18	0,00	16,0	16,0	0,0
Residential	Hard Coal	CH_4	261,34	168,94	7,00	16,0	17,5	0,0
Cement Production	Residual Fuel Oil	CO_2	1473,79	166,28	2,50	3,0	3,9	0,0
Residual Burning		N_20	135,51	158,17	25,00	20,0	32,0	0,0
Public Electricity and Heat Production	Lignite	N_20	90,42	146,94	5,30	20,0	20,7	0,0
Petroleum Refining	Gas / Diesel oil	CO_2	5,63	137,77	0,00	5,0	5,0	0,0
Sugar	Second Fuel Coal	CO_2	149,44	125,70	7,00	3,0	7,6	0,0
Residential	Gas / Diesel oil	CO_2	626,23	89,46	0,00	5,0	5,0	0,0
Public Electricity and Heat Production	Gas / Diesel oil	CO_2	64,60	89,04	0,00	5,0	5,0	0,0
Other Industries	Hard Coal	N_20	5,93	83,46	7,00	20,0	21,2	0,0
Residential	Asphalt	CH_4	26,54	68,05	0,00	20,0	20,0	0,0
Residential	waste of animal, p	N_20	95,88	61,22	0,00	45,0	45,0	0,0
Cement Production	Second Fuel Coal	CO_2	0,00	59,78	7,00	3,0	7,6	0,0
Non-Ferrous Metals	Second Fuel Coal	CO_2	73,36	54,34	7,00	3,0	7,6	0,0
Road Transportation	Gasoline	CH_4	47,03	52,87	0,00	10,0	10,0	0,0
Public Electricity and Heat Production	Hard Coal	N_20	3,99	51,15	7,00	20,0	21,2	0,0
Road Transportation	Gas / Diesel oil	CH_4	20,88	40,62	0,00	10,0	10,0	0,0
Other Industries	Hard Coal	CH_4	2,87	40,38	7,00	16,0	17,5	0,0
Iron and Steel	Second Fuel Coal	N_20	35,96	40,20	7,00	20,0	21,2	0,0
Public Electricity and Heat Production	LPG	CO_2	0,00	37,37	2,50	5,0	5,6	0,0
Ferroalloys Production (Metal Production)		CO_2	81,17	33,43	0,00	1,0	1,0	0,0
Cement Production	Petroleum Coke	N_20	4,41	29,44	0,00	20,0	20,0	0,0
Residential	Second Fuel Coal	CH_4	43,15	28,46	7,00	16,0	17,5	0,0
Residential	Lignite	N_20	40,60	26,64	5,30	20,0	20,7	0,0
Road Transportation	LPG	CH_4	0,00	25,81	2,50	10,0	10,3	0,0
Residential	Natural Gas	CH_4	0,20	24,05	0,00	16,0	16,0	0,0
Cement Production	Hard Coal	N_20	12,42	23,44	7,00	20,0	21,2	0,0
Residential	LPG	CH_4	15,10	23,44	2,50	10,0	10,3	0,0
Manufacture of Solid Fuels and Other Energy Industries	Gas / Diesel oil	N_20	14,85	23,40	0,00	10,0	10,0	0,0
Residential	LPG	N_20	13,38	20,76	2,50	16,0	16,2	0,0
Iron and Steel	Second Fuel Coal	CH_4	17,40	19,45	7,00	16,0	17,5	0,0
Public Electricity and Heat Production	Natural Gas	N_20	3,02	18,29	0,00	20,0	20,0	0,0
Other Industries	Natural Gas	CH_4	1,28	15,34	0,00	16,0	16,0	0,0

Table A7.2 Uncertainties, 2005

CATEGORY	FUEL	GAS	1990 EMIS.	2005 EMIS.	Activity data Unc. (%)	Emis fact. Unc. (%)	Combined Unc. (%)	Combined uncertainty as % of total national emissions in year 2005
Other Chemicals Production (Chemical Industry)		CH_4	49,39	14,95	60,00	1,0	60,0	0,0
Public Electricity and Heat Production	Residual Fuel Oil	N_20	8,48	14,88	2,50	16,0	16,2	0,0
Cement Production	Petroleum Coke	CH_4	2,13	14,25	0,00	16,0	16,0	0,0
Iron and Steel	Natural Gas	CO_2	0,00	13,30	0,00	3,0	3,0	0,0
Manufacture of Solid Fuels and Other Energy Industries	Gas / Diesel oil	CH_4	8,38	13,21	0,00	10,0	10,0	0,0
Public Electricity and Heat Production	Natural Gas	CH_4	2,05	12,35	0,00	16,0	16,0	0,0
Residential	Hard Coal	N_20	18,00	11,64	7,00	20,0	21,2	0,0
Cement Production	Hard Coal	CH_4	6,01	11,34	7,00	16,0	17,5	0,0
Civil Aviation	Jet Kerosene	N_20	9,08	10,37	0,00	10,0	10,0	0,0
Other Industries	Residual Fuel Oil	N_20	10,68	10,37	2,50	16,0	16,2	0,0
Cement Production	Lignite	N_20	10,73	9,52	5,30	20,0	20,7	0,0
Public Electricity and Heat Production	Lignite	CH_4	4,38	7,12	5,30	16,0	16,9	0,0
Residential	Natural Gas	N_20	0,06	7,10	0,00	20,0	20,0	0,0
Petroleum Refining	Residual Fuel Oil	N_20	5,71	6,67	2,50	16,0	16,2	0,0
Chemicals	Residual Fuel Oil	N_20	5,08	5,91	2,50	16,0	16,2	0,0
Petroleum Refining	Refinery Gas	N_20	3,71	5,10	0,00	16,0	16,0	0,0
Public Electricity and Heat Production	Residual Fuel Oil	CH_4	2,87	5,08	2,50	10,0	10,3	0,0
Sugar	Lignite	N_20	7,77	4,75	5,30	20,0	20,7	0,0
Residential	Asphalt	N_20	1,83	4,69	0,00	20,0	20,0	0,0
Cement Production	Lignite	CH_4	5,19	4,61	5,30	16,0	16,9	0,0
Other Industries	Natural Gas	N_20	0,38	4,53	0,00	20,0	20,0	0,0
Chemicals	Natural Gas	CH_4	0,00	3,23	0,00	16,0	16,0	0,0
Other Industries	LPG	N_20	0,40	3,13	2,50	16,0	16,2	0,0
Railways	Gas / Diesel oil	N_20	2,94	3,03	0,00	10,0	10,0	0,0
Public Electricity and Heat Production	Hard Coal	CH_4	0,19	2,48	7,00	16,0	17,5	0,0
Fertilizer	Natural Gas	CH_4	1,97	2,44	0,00	16,0	16,0	0,0
Navigation	Gas / Diesel oil	N_20	0,56	2,38	0,00	10,0	10,0	0,0
Other Industries	Gas / Diesel oil	N_20	0,78	2,34	0,00	10,0	10,0	0,0
Other Industries	Residual Fuel Oil	CH_4	2,41	2,34	2,50	10,0	10,3	0,0
Sugar	Lignite	CH_4	3,76	2,30	5,30	16,0	16,9	0,0
Other Industries	Lignite	N_20	22,26	2,29	5,30	20,0	20,7	0,0
Non-Ferrous Metals	Natural Gas	CH_4	0,00	2,29	0,00	16,0	16,0	0,0
Petroleum Refining	Residual Fuel Oil	CH_4	1,93	2,26	2,50	10,0	10,3	0,0
Residential	Residual Fuel Oil	CH_4	9,69	2,24	2,50	16,0	16,2	0,0
Non-Ferrous Metals	Residual Fuel Oil	N_20	1,87	2,09	2,50	16,0	16,2	0,0

Table A7.2 Uncertainties, 2005

CATEGORY	FUEL	GAS	1990 EMIS.	2005 EMIS.	Activity data Unc. (%)	Emis fact. Unc. (%)	Combined Unc. (%)	Combined uncertainty as % of total national emissions in year 2005
Residential	Residual Fuel Oil	N_20	8,58	1,98	2,50	16,0	16,2	0,0
Residential	Second Fuel Coal	N_20	2,97	1,96	7,00	20,0	21,2	0,0
Petroleum Refining	Refinery Gas	CH_4	1,26	1,73	0,00	10,0	10,0	0,0
Other Industries	Second Fuel Coal	N_20	2,47	1,40	7,00	20,0	21,2	0,0
Navigation	Gas / Diesel oil	CH_4	0,12	1,34	0,00	10,0	10,0	0,0
Chemicals	Residual Fuel Oil	CH_4	1,15	1,33	2,50	10,0	10,3	0,0
Iron and Steel	Residual Fuel Oil	N_20	4,36	1,19	2,50	16,0	16,2	0,0
Non-Ferrous Metals	Hard Coal	N_20	0,00	1,11	7,00	20,0	21,2	0,0
Other Industries	Lignite	CH_4	10,77	1,11	5,30	16,0	16,9	0,0
Iron and Steel	Hard Coal	N_20	0,00	1,09	7,00	20,0	21,2	0,0
Other Industries	Asphalt	N_20	0,12	1,08	0,00	20,0	20,0	0,0
Chemicals	Natural Gas	N_20	0,00	0,95	0,00	20,0	20,0	0,0
Other Industries	Petroleum Coke	N_20	0,00	0,89	0,00	20,0	20,0	0,0
Chemicals	Lignite	N_20	2,32	0,89	5,30	20,0	20,7	0,0
Cement Production	Gas / Diesel oil	CO_2	76,06	0,86	0,00	5,0	5,0	0,0
Limestone and Dolomite Use (Mineral Products)		CO_2	21,52	0,85	35,00	1,0	35,0	0,0
Sugar	Hard Coal	N_20	1,16	0,82	7,00	20,0	21,2	0,0
Navigation	Residual Fuel Oil	N_20	0,67	0,81	2,50	16,0	16,2	0,0
Civil Aviation	Jet Kerosene	CH_4	1,31	0,79	0,00	10,0	10,0	0,0
Fertilizer	Natural Gas	N_20	0,58	0,72	0,00	20,0	20,0	0,0
Sugar	Residual Fuel Oil	N_20	1,02	0,71	2,50	16,0	16,2	0,0
Public Electricity and Heat Production	Naphta	N_20	0,00	0,71	2,50	16,0	16,2	0,0
Other Industries	LPG	CH_4	0,09	0,71	2,50	10,0	10,3	0,0
Other Industries	Second Fuel Coal	CH_4	1,19	0,68	7,00	16,0	17,5	0,0
Non-Ferrous Metals	Natural Gas	N_20	0,00	0,68	0,00	20,0	20,0	0,0
Railways	Gas / Diesel oil	CH_4	0,64	0,64	0,00	10,0	10,0	0,0
Petroleum Refining	Gasoline	CO_2	1,88	0,63	0,00	3,0	3,0	0,0
Cement Production	LPG	N_20	0,00	0,61	2,50	16,0	16,2	0,0
Sugar	Second Fuel Coal	N_20	0,70	0,59	7,00	20,0	21,2	0,0
Fertilizer	Residual Fuel Oil	N_20	0,00	0,58	2,50	16,0	16,2	0,0
Non-Ferrous Metals	Hard Coal	CH_4	0,00	0,54	7,00	16,0	17,5	0,0
Sugar	Natural Gas	CH_4	0,00	0,53	0,00	16,0	16,0	0,0
Other Industries	Gas / Diesel oil	CH_4	0,18	0,53	0,00	10,0	10,0	0,0
Iron and Steel	Hard Coal	CH_4	0,00	0,53	7,00	16,0	17,5	0,0
Other Industries	Asphalt	CH_4	0,06	0,52	0,00	20,0	20,0	0,0

Table A7.2 Uncertainties, 2005

CATEGORY	FUEL	GAS	1990 EMIS.	2005 EMIS.	Activity data Unc. (%)	Emis fact. Unc. (%)	Combined Unc. (%)	Combined uncertainty as % of total national emissions in year 2005
Non-Ferrous Metals	Residual Fuel Oil	CH_4	0,42	0,47	2,50	10,0	10,3	0,0
Navigation	Residual Fuel Oil	CH_4	0,15	0,47	2,50	10,0	10,3	0,0
Other Industries	Petroleum Coke	CH_4	0,00	0,43	0,00	16,0	16,0	0,0
Chemicals	Lignite	CH_4	1,12	0,43	5,30	16,0	16,9	0,0
Cement Production	Residual Fuel Oil	N_20	3,74	0,40	2,50	16,0	16,2	0,0
Sugar	Hard Coal	CH_4	0,56	0,40	7,00	16,0	17,5	0,0
Petroleum Refining	Gas / Diesel oil	N_20	0,01	0,35	0,00	10,0	10,0	0,0
Cement Production	Natural Gas	CH_4	0,00	0,34	0,00	16,0	16,0	0,0
Public Electricity and Heat Production	Gas / Diesel oil	N_20	0,17	0,31	0,00	10,0	10,0	0,0
Sugar	Second Fuel Coal	CH_4	0,34	0,28	7,00	16,0	17,5	0,0
Cement Production	Second Fuel Coal	N_20	0,00	0,28	7,00	20,0	21,2	0,0
Iron and Steel	Residual Fuel Oil	CH_4	0,98	0,27	2,50	10,0	10,3	0,0
Residential	Gas / Diesel oil	CH_4	1,69	0,26	0,00	10,0	10,0	0,0
Non-Ferrous Metals	Second Fuel Coal	N_20	0,34	0,25	7,00	20,0	21,2	0,0
Fertilizer	Gas / Diesel oil	CO_2	0,00	0,24	0,00	5,0	5,0	0,0
Public Electricity and Heat Production	Naphta	CH_4	0,00	0,24	2,50	10,0	10,3	0,0
Residential	Gas / Diesel oil	N_20	1,49	0,23	0,00	10,0	10,0	0,0
Public Electricity and Heat Production	LPG	N_20	0,00	0,22	2,50	16,0	16,2	0,0
Petroleum Refining	LPG	CO_2	0,14	0,21	2,50	5,0	5,6	0,0
Sugar	Residual Fuel Oil	CH_4	0,23	0,16	2,50	10,0	10,3	0,0
Sugar	Natural Gas	N_20	0,00	0,16	0,00	20,0	20,0	0,0
Cement Production	LPG	CH_4	0,00	0,14	2,50	10,0	10,3	0,0
Cement Production	Second Fuel Coal	CH_4	0,00	0,14	7,00	16,0	17,5	0,0
Fertilizer	Residual Fuel Oil	CH_4	0,00	0,13	2,50	10,0	10,3	0,0
Non-Ferrous Metals	Second Fuel Coal	CH_4	0,17	0,12	7,00	16,0	17,5	0,0
Petroleum Refining	Gas / Diesel oil	CH_4	0,00	0,12	0,00	10,0	10,0	0,0
Cement Production	Natural Gas	N_20	0,00	0,10	0,00	20,0	20,0	0,0
Cement Production	Residual Fuel Oil	CH_4	0,84	0,09	2,50	10,0	10,3	0,0
Public Electricity and Heat Production	Gas / Diesel oil	CH_4	0,06	0,08	0,00	10,0	10,0	0,0
Changes in Forest and Other Woody Biomass Stocks		N_20	0,48	0,06	10,00	10,0	14,1	0,0
Public Electricity and Heat Production	LPG	CH_4	0,00	0,03	2,50	10,0	10,3	0,0
Iron and Steel	Natural Gas	CH_4	0,00	0,03	0,00	16,0	16,0	0,0
Iron and Steel	Natural Gas	N_20	0,00	0,01	0,00	20,0	20,0	0,0
Cement Production	Gas / Diesel oil	N_20	0,20	0,00	0,00	10,0	10,0	0,0
Petroleum Refining	Gasoline	N_20	0,01	0,00	0,00	16,0	16,0	0,0

Table A7.2 Uncertainties, 2005

CATEGORY	FUEL	GAS	1990 EMIS.	2005 EMIS.	Activity data Unc. (%)	Emis fact. Unc. (%)	Combined Unc. (%)	Combined uncertainty as % of total national emissions in year 2005
Fertilizer	Gas / Diesel oil	N_20	0,00	0,00	0,00	10,0	10,0	0,0
Petroleum Refining	LPG	N_20	0,00	0,00	2,50	16,0	16,2	0,0
Petroleum Refining	Gasoline	CH_4	0,00	0,00	0,00	10,0	10,0	0,0
Cement Production	Gas / Diesel oil	CH_4	0,05	0,00	0,00	10,0	10,0	0,0
Petroleum Refining	LPG	CH_4	0,00	0,00	2,50	10,0	10,3	0,0
Fertilizer	Gas / Diesel oil	CH_4	0,00	0,00	0,00	10,0	10,0	0,0
Railways	Hard Coal	CO_2	29,73	0,00	7,00	3,0	7,6	0,0
Navigation	Hard Coal	CO_2	3,19	0,00	7,00	3,0	7,6	0,0
Non-Ferrous Metals	Lignite	CO_2	59,79	0,00	5,30	3,0	6,1	0,0
Fertilizer	Lignite	CO_2	634,06	0,00	5,30	3,0	6,1	0,0
Railways	Lignite	CO_2	21,87	0,00	5,30	3,0	6,1	0,0
Cement Production	Asphalt	CO_2	63,42	0,00	0,00	20,0	20,0	0,0
Fertilizer	Second Fuel Coal	CO_2	2,72	0,00	7,00	3,0	7,6	0,0
Non-Ferrous Metals	Petroleum Coke	CO_2	103,25	0,00	0,00	3,0	3,0	0,0
Railways	Residual Fuel Oil	CO_2	60,47	0,00	2,50	3,0	3,9	0,0
Iron and Steel	Gas / Diesel oil	CO_2	18,63	0,00	0,00	5,0	5,0	0,0
Non-Ferrous Metals	Gas / Diesel oil	CO_2	42,91	0,00	0,00	5,0	5,0	0,0
Other Industries	Refinery Gas	CO_2	1,05	0,00	0,00	3,0	3,0	0,0
Fertilizer	Naphta	CO_2	463,51	0,00	2,50	3,0	3,9	0,0
Railways	Hard Coal	CH_4	0,07	0,00	7,00	16,0	17,5	0,0
Navigation	Hard Coal	CH_4	0,00	0,00	7,00	16,0	17,5	0,0
Non-Ferrous Metals	Lignite	CH_4	0,13	0,00	5,30	16,0	16,9	0,0
Fertilizer	Lignite	CH_4	1,34	0,00	5,30	16,0	16,9	0,0
Railways	Lignite	CH_4	0,05	0,00	5,30	16,0	16,9	0,0
Cement Production	Asphalt	CH_4	0,14	0,00	0,00	20,0	20,0	0,0
Fertilizer	Second Fuel Coal	CH_4	0,01	0,00	7,00	16,0	17,5	0,0
Non-Ferrous Metals	Petroleum Coke	CH_4	0,23	0,00	0,00	16,0	16,0	0,0
Railways	Residual Fuel Oil	CH_4	0,09	0,00	2,50	10,0	10,3	0,0
Iron and Steel	Gas / Diesel oil	CH_4	0,01	0,00	0,00	10,0	10,0	0,0
Non-Ferrous Metals	Gas / Diesel oil	CH_4	0,03	0,00	0,00	10,0	10,0	0,0
Other Industries	Refinery Gas	CH_4	0,00	0,00	0,00	10,0	10,0	0,0
Fertilizer	Naphta	CH_4	0,28	0,00	2,50	10,0	10,3	0,0
Railways	Hard Coal	N_20	0,39	0,00	7,00	20,0	21,2	0,0
Navigation	Hard Coal	N_20	0,01	0,00	7,00	20,0	21,2	0,0
Non-Ferrous Metals	Lignite	N_20	0,26	0,00	5,30	20,0	20,7	0,0

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Table A7.2 Uncertainties, 2005

CATEGORY	FUEL	GAS	1990 EMIS.	2005 EMIS.	Activity data Unc. (%)	Emıs fact. Unc. (%)	Combıned Unc. (%)	Combined uncertainty as % of total national emissions in year 2005
Fertilizer	Lignite	N_20	2,77	0,00	5,30	20,0	20,7	0,0
Railways	Lignite	N_20	0,27	0,00	5,30	20,0	20,7	0,0
Cement Production	Asphalt	N_20	0,30	0,00	0,00	20,0	20,0	0,0
Fertilizer	Second Fuel Coal	N_20	0,01	0,00	7,00	20,0	21,2	0,0
Non-Ferrous Metals	Petroleum Coke	N_20	0,48	0,00	0,00	20,0	20,0	0,0
Railways	Residual Fuel Oil	N_20	0,42	0,00	2,50	16,0	16,2	0,0
Iron and Steel	Gas / Diesel oil	N_20	0,05	0,00	0,00	10,0	10,0	0,0
Non-Ferrous Metals	Gas / Diesel oil	N_20	0,11	0,00	0,00	10,0	10,0	0,0
Road Transportation	LPG	N_20	0,00	0,00	2,50	16,0	16,2	0,0
Other Industries	Refinery Gas	N_20	0,00	0,00	0,00	16,0	16,0	0,0
Fertilizer	Naphta	N_20	1,24	0,00	2,50	16,0	16,2	0,0
Carbide Production (Chemical Industry)		CO_2	112,25	0,00	45,00	1,0	45,0	0,0
Aluminium Production (Metal Production)		CO_2	109,62	0,00	0,00	1,0	1,0	0,0
Land Use, Land-Use Change and Forestry		CO_2	-44087,46	-69494,98	40,00	10,0	41,2	-11,8
Total			125971	242817				12,1