National Inventory Report

Greenhouse Gas Sources and Sinks in the Republic of Moldova

1990–2005

Submission to the United Nations
Framework Convention on Climate Change

2009

MINISTRY OF ENVIRONMENT
AND NATURAL RESOURCES

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FOREWORD

On March 16, 1995, the Republic of Moldova ratified the United Nations Framework Convention on Climate Change (UNFCCC). In conformity with Articles 4(1)(a) and 12(1)(a) of the Convention, the non-Annex I Parties shall report to the Conference of the Parties (COP) data on emissions by source and removals by sinks of all greenhouse gases (GHG) not controlled by the Montreal Protocol.

This Report has been developed within the Project "Republic of Moldova: Enabling Activities for the Preparation of the Second National Communication under the United Nations Framework Climate Change Convention (UNFCCC)" implemented by the Ministry of Environment and Natural Resources (MENR) and United Nations Environment Programme (UNEP), with financial support of the Global Environment Facility (GEF), from November 2005 through September 2008.

The National Inventory Report (NIR) reflects the efforts made by the National Inventory Team during 2005-2008, including previous results obtained under the UNDP-GEF Regional Project "Capacity Building for Improving the Quality of Greenhouse Gas Inventories (Europe/CIS region)" finalized with the National Inventory Report: 1990-2002, Greenhouse Gas Sources and Sinks in the Republic of Moldova (non-published), as well as the accomplishments of the UNDP-GEF Project "Republic of Moldova: Enabling Activities for the Preparation of the First National Communication under the United Nations Framework Climate Change Convention", finalized with the preparation of the national inventory for the period from 1990 through 1998, included in the First National Communication of the Republic of Moldova (submitted to UNFCCC Secretariat on November 13, 2000). Besides the inventory results, the NIR contains additional relevant data, as well as the analysis of recent trends in GHG emissions and removals in the Republic of Moldova, the analysis of key categories, additional sectoral information used in emission inventory, data regarding activities related to inventory quality control and uncertainty management.

Since the publication of the first national inventory covering the time series 1990 through 1998, an impressive number of persons in the Republic of Moldova expressed interest for the climate change phenomenon, and particularly, for greenhouse gas emissions. Though this interest entailed numerous research activities, only a limited number were focused on the process of quantitative evaluation of emissions and development of national emission factors, inclusive under the UNDP-GEF Regional Project "Capacity Building for Improving the Quality of Greenhouse Gas Inventories (Europe/CIS region)". Despite the fact that there will always be emissions evaluation associated uncertainties, the monitoring process will continue, both in the Republic of Moldova, and internationally, in view of improving the quality of inventory and reducing the greenhouse gas associated uncertainties.

In January 2006 international experts representing the countries of Central Europe and CIS region performed an independent external peer review of the quality of the national inventory of the Republic of Moldova for 1990-2002, and an independent intern peer review of the quality of the national inventory of the Republic of Moldova for the 1990-2005 time periods was made in June - July 2008 by relevant national experts, previously not involved in the national inventory compilation activities, representing universities (Technical University of Moldova) and post-university education institutions (Agribusiness and Rural Development Management Institute), various research and development institutes (Institute of Pedology, Agrochemistry and Soil Protection "N. Dimo", Forest Research and Management Institute), as well as environmental public authorities (State Ecological Inspectorate). The findings of these peer reviews allowed to identify the priority areas, both in view of improving the quality of data, and methodological approaches and emission factors used in evaluation of emissions by types of sources and removals by types of sinks within the greenhouse gas national inventory of the Republic of Moldova.

Dr. Vasile Scorpan
April 30, 2009
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Ministry of Environment and Natural Resources
of the Republic of Moldova

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We would like to thank the staff of the National Bureau of Statistics, in particular Ms. Elena Orlova and Ms. Valentina Comarnitchi for their contribution to analysis and interpretation of statistic data. We would like also to specially thank the staff of the Environment Pollution Prevention Department of the Ministry of Environment and Natural Resources, Mr. Mihai Iftodi and Ms. Tamara Guvir, for their help in collecting activity data on waste management and waste water treatment. We also want to thank Mr. Sergiu Robu, scientific secretary of the Energy Institute of the ASM for his contribution to GHG inventory Quality Assurance in Energy Sector; Dr. engineer Andrei Chiciuc, lecturer at the Electromechanics and Metrology Department of the Technical University of Moldova for his contribution to GHG inventory Quality Assurance in Industrial Processes and Solvents and Other Products Use Sectors; professor, PhD Nicolae Bucataru, Agribusiness and Rural Development Management Institute for his contribution to GHG inventory Quality Assurance in Agriculture Sector, source categories 4A 'Enteric Fermentation' and 4B 'Manure Management'; professor, PhD Valerian Cerbari, Institute of Pedology, Agrochemistry and Soil Protection "N. Dimo", for his contribution to GHG inventory Quality Assurance in Agriculture Sector, source category 4D 'Agricultural Soils'; Mr. Dumitru Galupa, Director of the Forest Research and Management Institute, for his contribution to the GHG inventory Quality Assurance in Land Use, Land-Use Change and Forestry Sector and Mr. Constantin Mogureanu, chief of Soil, Waste and Chemical Substances Inspection Division of the State Ecological Inspectorate for his contribution to the GHG inventory Quality Assurance in Waste Sector.

This chapter would be incomplete, without thanks to Dr. Vasile Scorpan, project manager, UNEP-GEF Project "Republic of Moldova: Enabling Activities for the Preparation of the Second National Communication under the United Nations Framework Climate Change Convention (UNFCCC)", for his continuous successful involvement during project implementation in activities stipulated in the Terms of Reference of the National Inventory Team.

LIST OF ACRONYMS, ABBREVIATIONS AND UNITS

A	Area of forestlands remaining forestlands
ABS	Acrilonitril Butadien Styrene
AD	Activity Data
Al	Aluminium
Al_2O_3	Aluminium oxide
Area (T)	Total annual area harvested of crop *T*
Area burnt (T)	Annual area of crop *T* burnt (stubble fields burning)
AR_4	The Forth IPCC Assessment Report
ASH	Ash content of the manure in percent
ASM	Academy of Science of Moldova
a. s.	active substance
ATD	Atmospheric Deposition
ATULBN	Administrative-Territorial Units on the Left Bank of Dniester
B	Billion
B_0	Maximum methane producing capacity
$BCEF_I$	Biomass expansion factor for conversion of annual net increment to aboveground tree biomass increment
BOD	Biochemical Oxygen Demand
BOF	Basic Oxygen Furnaces
BNS	National Bureau of Statistics
BW	Average live body weight of animal
^0C	Celsius degrees
C	Carbon
c	Flight cycle: cruise
Ca	Animal Feeding Situation Coefficient
CA	Hornbeam species (Carpinus ssp.)
CASA	Civil Aviation State Administration
$CaCO_3$	Limestone
$CaCO_3 \bullet MgCO_3$	Dolomite
CaO	Lime
CaO•MgO	Dolomite lime
C_f	Burning coefficient (used to keep account of incomplete burning related aspects)
CCO	Climate Change Office
CDM	Clean Development Mechanism of the Kyoto Protocol
CF	Carbon fraction in biomass
CF_4	Perfluoromethane
C_2F_6	Hexafluoroethane
C_3F_8	Perfluorpropan
C_4F_{10}	Perfluorbutan
$c\text{-}C_4F_8$	Perfluorociclobutan
C_5F_{12}	Perfluoropentan
C_6F_{14}	Perfluorohexan
CFC	Chlorofluorocarbons
CHP	Combined Heat and Power Plant
CH_4	Methane
$C_6H_{12}O_6$	Glucose
C_2H_5OH	Ethanol
CIS	Commonwealth of Independent States
CKD	Cement Kiln Dust
CO	Carbon monoxide

CO_2	Carbon dioxide
$CO(NH_2)_2$	Urea (carbamide)
COP	Conference of the Parties
CORINAIR	Atmospheric Emission Inventory Guidebook, developed by European Environment Agency
cm	centimetre
cm^2	square centimetre
CR	Crop Residues
$Crop_{(T)}$	Harvested annual dry matter yield for crop *T*
CS	Country specific
D	Default
D_{ind}	Degradable organic component in wastewater
dal	dekalitre
DE	Digestible energy
dm	dry matter
DOC	Degradable Organic Carbon
DOC_F	Dissimilated DOC fraction
DRY	Dry matter fraction of harvested crop
DS	Fraction of organic component removed with sludge
EAF	Electric Arc Furnace
EBs	Energy Balances
EE	Eastern Europe
EF	Emission Factor
eq	Equivalent
EV_{milk}	Energy value for milk
EU	European Union
f	Force
F	Methane fraction in biogas
F_{AM}	Annual amaunt of N incorporated in soil with manure
F_{COMP}	Annual amount of total compost N applied to soils
F_{CR}	Annual amount of N in crop residues returned to soils
F_I	Stock change factor for input of organic matter from crop residues, organic fertilizer and other sources depending on soil management systems used
F_{LU}	Stock change factor for land-use systems or sub-system for a particular land-use
F_{MG}	Stock change for management regime
F_{ON}	Annual amount of managed animal manure, compost, sewage sludge and other organic N additions applied to soils
F_{OOA}	Annual amount of other organic amendments used as fertiliser
F_{PRP}	Annual amount of urine and dung N deposited by grazing animals on pasture, ange and paddock
F_{SEW}	Annual amount of total sewage N that is applied to soils
F_{SOM}	Annual amount of N in mineral soils that is mineralized, in association with loss of soil C from soil organic matter as a result of changes to land use or management
F_{SN}	Annual amount of synthetic fertilizer N applied to soils
F_{AO}	Food and Agriculture Organization of the United Nations
Fe_2O_3	Iron oxide
F_G	Volume of fuel wood gathering
FNC	First National Communication
FOD	First Order Decay
FR	Species of ash tree (Fraxinus spp.)
Frac	Fraction
$Frac_{GASF}$	Fraction of synthetic fertiliser N that volatilises as NH3 and NOx
$Frac_{GASM}$	Fraction of managed manure nitrogen that volatilizes as NH3 and NOx
$Frac_{LEACH}$	Fraction of managed manure nitrogen losses due to runoff and leaching
$Frac_{Renew\ (T)}$	Fraction of total area under crop *T* that is renewed annually

$Frac_{Remove (T)}$	Fraction of above-ground residues of crop *T* removed annually for purposes such as feed, fuel for heating and cooking, bedding and construction
g	grams
G_w	Average annual above and belowground biomass increment
GPG	Good Practice Guidance
Gcal	Gigacalory
GDP	Gross Domestic Product
GE	Gross Energy
GEF	Global Environment Fund
GHG	Greenhouse Gases
Gg	Gigagram = 10^9 gram
GWP	Global Warming Potential
H	Annually extracted volume, round wood
ha	hectare
HDP	High Density Polyethylene
HFCs	Hydrofluorocarbons
hl	hectolitre
HNO_3	Nitric acid
HP	Horsepower
I_v	Average annual net increment in volume suitable for industrial processing
IE	Included Elsewhere
IP	Industrial Processes
IPCC	Intergovernmental Panel for Climate Change
JSC	Joint Stock Company
k	Methane generation rate constant
kg	kilogram
km	kilometre
km^2	square kilometre
kPa	kilopascal
KS	Key Sources
kt	kilotonne
kW	kilowatt
kWh	kilowatt-hour
l	litre
L	Level
$L_{fellings}$	Annual carbon loss due to commercial fellings
L_0	Methane Generation Potential
LBD	Left Bank of Dniester river
LDP	Low Density Polyethylene
LDLP	Low Density Linear Polyethylene
LRCA	Land Relations and Cadastre Agency
Ltd.	Limited Liability Company
LTO	Cycle: Landing / Take Off
LULUCF	Land Use, Land-Use Change and Forests
m	metre
m^2	square metre
m^3	cubic metre
MAFI	Ministry of Agriculture and Food Industry
MCF	Methane Correction Factor
MD	Moldova
MoD	Ministry of Defence
MDL	Moldavian Lei
MERN	Ministry of Environment and Natural Resources
MET	Ministry of Economy and Trade
MH	Ministry of Health

MgO	magnesia
mg	milligram
mil.	million
MIA	Ministry of Internal Affaire
MID	Ministry of Information Development
MII	Ministry of Industry and Infrastructure
MJ	Megajoule
MMS	Manure Management Systems
mm	millimetres
MOP	Meeting of the Parties to the Kyoto Protocol
MR	Methane emissions recovered from wastewater treatment and sludge
$MS_{(T,S)}$	Fraction of total annual nitrogen excretion for each livestock species/category *T* that is managed in manure management system *S*
MSAU	Moldovan State Agricultural University
MSW	Municipal Solid Wastes
MSU	Moldovan State University
MTPP	Moldovan Thermal Power Plant in Dnestrovsk
MTR	Ministry of Transport and Roads
MW_{anim}	Mature body weight of an adult animal
MW	Megawatt
N	Nitrogen
$N_{(T)}$	Number of head of livestock species/category *T* in the country
N_2	Molecular nitrogen
$N_{AG(T)}$	N content of above-ground residues for crop *T*
$N_{BG\ (T)}$	N content of below-ground residues for crop *T*
$N_{bedding\ MS}$	Amount of nitrogen from bedding to be applied for solid storage
$N_{MMS\ Avb}$	Amount of managed manure nitrogen available for application to managed soils
Na_2CO_3	Natron
NA	Non Applicable
NBS	National Bureau of Statistics
NC	National Communication
N_{ex}	Nitrogen excretion rate
NaOH	Sodium Hydroxide (caustic soda)
NE	Non Estimated
NE_a	Net Energy for animal activity
NE_g	Net Energy needed for growth
NE_l	Net Energy for lactation
NE_m	Net Energy required by the animal for maintenance
NE_p	Net Energy required for pregnancy
NE_{work}	Net Energy for work
NE_{wool}	Net Energy required to produce a year of wool
NH_3	Ammonia
NH_4^+	Ammonium
NH_4NO_3	Ammonia Nitrate
$NH_4H_2PO_4$	Monoammonium phosphate
$(NH_4)_2HPO_4$	Diammonium phosphate
NGO	Non-Governmental Organisation
NIR	National Inventory Report
NIS	National Inventory System
NIT	National Inventory Team
NITL	National Inventory Team Leader
NMVOC	Non Methane Volatile Organic Compounds
NO	Not Occurring
NO_x	Nitrogen Oxides
NO_3^-	Nitrate

N_2O	Nitrous oxide
N_2O_{ATD}	Indirect emissions of N_2O produced from deposition of nitrogen as ammonia (NH_3), oxides of N (NO_x), and their products $NH_4 + NH_3$ onto soils and the surface of waters
N_2O_{CR}	N_2O emissions from crop residues returned to soils annually
N_2O_{DIR}	Direct emissions of N_2O
N_2O_{IND}	Indirect emissions of N_2O
N_2O_{L}	Indirect N_2O emissions due to leaching and runoff from manure management in the country
N_2O_{ON}	N_2O emissions from applied organic N fertilizer
N_2O_{PRP}	N_2O emissions from urine and dung inputs to grazed soils
N_2O_{SN}	N_2O emissions from synthetic fertilizer N
N_2O_{SOM}	N_2O emissions from nitrogen mineralization associated with loss of soil carbon due to land management change
O_3	Ozone
ODP	Ozone Depleting Potential
ODS	Ozone Depleting Substances
OHF	Open Hearth Furnace
ON	Organic Nitrogen
OS	Other species
PA	Species of sycamore maple tree (Acer spp.)
P_{EQ}	Population equivalent number
Pag.	Page
PFCs	Perfluorocarbons
PhD	Doctor of Philosophy
PI	Species of pine (Pinus spp.)
PJ	Petajoule = 10^{15} Joule
PL	Species of poplar (Populus spp.)
PPP	Purchasing Power Parity
ppm	parts per million of volume
q	quintal
QU	Species of oak (Quercus spp.)
R	Root-to-shoot ratio
$R_{AG(T)}$	Ratio of above-ground residues dry matter to harvested yield for crop *T*
RB	Species of acacia (Robinia spp.)
$R_{BG(T)}$	Ratio of below-ground residues to harvested yield for crop *T*
RBD	Right Bank of Dniester river
REG	Ratio of net energy available for growth in a diet to digestible energy consumed
REM	Ratio of net energy available in diet for maintenance to digestible energy consumed;
RM	Republic of Moldova
S	Manure Management Systems
SAR	IPCC Second Assessment Report
SE	State Enterprise
SEI	Stat Ecological Inspectorate
SF_6	Sulphur hexafluoride
SHS	State Hydrometeorological Service
SiO_2	Silicon oxide
SM	Emissions from sludge treatment
SN	Synthetic Nitrogen fertilisers
SNC	Second National Communication
SO_2	Sulphur dioxide
SOC	Soil Organic Carbon
SOPU	Solvents and Other Products Use
SS_{ix}	Fraction of anaerobically treated sludge
SW	Species of willow (Salix spp.)

SWDS	Solid Waste Disposal Sites
SY	Statistical Yearbooks
t	tonne
T	Trend
T1	Tier 1 methodological approach
T2	Tier 2 methodological approach
TAM	Typical animal mass
TAR	IPCC Third Assessment Report
t.c.e.	tonnes of coal equivalent
TI	Species of linden tree (Tilia spp.)
TJ	Terajoule = 10^{12} Joule
TM	Emissions from wastewater and sludge treatment
TOS	Total organic waste in sludge
TOW	Total organic waste in wastewater
TUM	Technical University of Moldova
UL	Species of elm tree (Ulmus spp.)
UNDP	United Nations Development Program
UNFCCC	United Nations Framework Convention on Climate Change
UNEP	United Nations Environment Program
USA	United States of America
US EPA	United States Environment Protection Agency
US $	US Dollar
VS	Volatile solid excretion per day
W	Animal Body Weight
W_{ind}	Amount of wastewater generated per unit of industrial output
WB	World Bank
WE	Western Europe
WG	Daily weight gain
WM	Emissions from wastewater handling
WS_{ix}	Fraction of wastewater treated anaerobically
Y_m	Methane conversion factor
$Yield_T$	Harvested fresh yield for crop *T*
%	Percent

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EXECUTIVE SUMMARY

The Convention, Kyoto Protocol and the Party Commitments

The ultimate objective of the United Nations Framework Convention on Climate Change (UNFCCC) is aimed to achieve stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system. To-date 196 countries are Parties to the Convention. The Republic of Moldova signed the UNFCCC on June 12, 1992 and it was ratified by the Parliament on March 16, 1995.

Article 4, paragraph 1(a) and Article 12, paragraph 1(a) of the UNFCCC stipulate that each Party has to make available to the Conference of the Parties (COP) a national inventory of anthropogenic emissions by sources and removals by sinks of all greenhouse gases not controlled by the Montreal Protocol, to the extent its capacities permit, using comparable methodologies to be agreed upon by the Conference of the Parties; also a general description of steps taken or envisaged by the Party to implement the Convention; and any other information that the Party considers relevant to the achievement of the objective of the Convention and suitable for inclusion in its communication, including, if feasible, material relevant for calculations of global emission trends".

The main mechanism for making this information available is national communications. COP 2 (Geneva, 1996) adopted the Guidelines on national communications from non-Annex I Parties (Decision 10/CP 2). In conformity with the respective Guidelines, in 1998-2000 under the *UNDP-GEF Project "Enabling Activities for the preparation of the FNC under the UNFCCC"*, Republic of Moldova developed its First National Communication to UNFCCC (including a national GHG inventory for a time series from 1990 through 1998), submitted to the COP 6 (Hague, 2000).

The COP 8 (New Delhi, 2002) adopted new Guidelines on national communications from non-Annex I Parties (Decision 17/CP 8). In conformity with these Guidelines, in 2005-2009 under the *UNEP-GEF Project "Enabling Activities for the preparation of the SNC under the UNFCCC"*, Republic of Moldova developed its Second National Communication under the UNFCCC (including a national GHG inventory for 1990-2005 time periods).

The COP 3 (Kyoto, 1997) adopted the Kyoto Protocol, representing an instrument setting binding targets for the Parties under Convention, by committing industrialized countries and economies in transition included in Annex I to Convention, to reduce total emissions of direct GHG by at least 5 percent, against 1990 levels over the five-year period 2008-2012. The Republic of Moldova ratified the Kyoto Protocol on February 13, 2003 (the official date of accession was April 22, 2003). As a non-Annex I Party, the Republic of Moldova has no commitments to reduce GHG emissions under this Protocol.

At present, international negotiations focus on future commitments of the Convention parties for post-Kyoto period (after 2012).

Process for Inventory Preparation in the Republic of Moldova

The Ministry of Environment and Natural Resources (MENR) of the Republic of Moldova is the state authority responsible for development and promotion of policies and strategies addressing environment protection, rational use of natural resources and biodiversity conservation. On behalf of the Government of the Republic of Moldova, MENR is in charge for implementation of international environment treaties to which Moldova is a Part (including Rio Conventions). Within the MENR, the Climate Change Office is totally responsible for National Communications and National Inventory Reports preparation activities. The GHG Inventory Team is responsible for estimating emissions by categories of sources and removals by categories of sinks, key source analysis, quality assurance and quality control activities, uncertainty assessment, documentation and archiving of the information related to GHG inventory preparation process.

In the process of preparing the national GHG inventory, the Climate Change Office employed a centralized approach. The national GHG inventory consists of the National Inventory Report (NIR) and the Inventory itself in the IPCC standard reporting framework – a series of standardized Sectoral and Summary Report Tables (IPCC, 1997; revised in 2005). The Report was drafted in compliance with UNFCCC Reporting Guidelines on Annual Inventories and has the following structure: Summary, Chapter 1 'Introduction', Chapter 2 'Greenhouse Gas Emission Trends', Chapter 3 'Energy', Chapter 4 'Industrial Processes', Chapter 5 'Solvents and Other Products Use', Chapter 6 'Agriculture', Chapter 7 'Land Use, Land Use Change and Forests', Chapter 8 'Waste', Chapter 9 'Recalculations and Improvements', 'References' and 'Annexes'.

Direct (CO_2, CH_4, N_2O, HFC and SF_6) and indirect (NOx, CO, COVNM and SO_2) GHG emissions were estimated in compliance with methodologies provided for in the Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories (IPCC, 1997), Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories (IPCC, 2000), Good Practice Guidance for Land Use, Land-Use Change and Forestry (IPCC, 2003), EMEP/CORINAIR Emission Inventory Guidebook (CORINAIR, 1996, 1999, 2005) and 2006 IPCC Guidelines for National Greenhouse Gas Inventories (IPCC, 2006).

Activity data used in this report are based on officially published data, such as national and international statistic publications; scientific literature; national legislation acts; data provided by ministries and subordinated institutions; central administrative authorities, private sector and businesses associations.

The results of the key sources analysis carried out following a Tier 1 methodological approach, by use of the Key Source Calculation Tool developed by the US Environment Protection Agency (US EPA), revealed 18 key categories by level and 16 key categories by trend (including LULUCF categories), as well as 17 key categories by level and 13 key categories by trend (excluding LULUCF categories).

As a part of continuous efforts to develop an accurate, complete, consistent, transparent and reliable inventory, in 2005, under the *UNDP-GEF Regional Project „Capacity Building for Improving the Quality of Greenhouse Gas Inventories (Europe/CIS region)"*, the Republic of Moldova developed a *Quality Assurance and Quality Control Plan* and a *Procedures Manual for Quality Assurance and Quality Control*.

The key attributes of the *Quality Assurance and Quality Control Plan* include detailed Tier 1 (general procedures) and Tier 2 (source-specific) procedures and standard verification and quality control forms and checklists, that serve to standardize the process of implementing quality assurance and quality control activities meant to ensure the quality of the national inventory; peer reviews (technical audits) carried out by experts not directly involved in the national inventory drafting and development process; activity data quality check, inclusive by comparing data obtained from different sources, as well as further documentation of the national inventory development process.

Inventory quality assurance activities were supported by experts representing: the Institute of Energy of the Academy of Sciences of Moldova (ASM) – Sector 1 'Energy'; Technical University of Moldova – Sector 2 'Industrial Processes' and Sector 3 'Solvents and Other Products Use'; Institute of Pedology, Agrochemistry and Soil Protection 'N. Dimo' and Institute of Agribusiness and Rural Development Management – Sector 4 'Agriculture'; Forest Research and Management Institute – Sector 5 'Land Use, Land-Use Change and Forestry'; State Ecological Inspectorate – Sector 6 'Waste'.

Although the NIR is intended to be comprehensive, certain sources have been identified yet excluded from the estimates presented for various reasons. Generally speaking, sources not accounted for this inventory are excluded due to data limitations or a lack of thorough understanding of the emission process. The National Inventory Team is continually working to improve upon the understanding of such sources and seeking to find the data required to estimate related emissions. As such improvements are made new emission sources are quantified and included in the Inventory.

Greenhouse Gas Emission Trends

In 2005, the Republic of Moldova contributed with approximately 11,883.5 kt CO_2 eq. to GHG emissions, which is 1.7 percent increase over the 2004 emissions (11,680.9 kt CO_2 eq.). In 2005 the Republic of Moldova achieved an economic growth, the annual GDP increased by 7.5 percent against the previous year (2004). This entailed an 8 percent decrease in the Republic of Moldova's GHG intensity – the amount of GHG emitted per unit of economic activity, or in other words overall quantity of national GHG emissions expressed in CO_2 eq. divided by the real value of the GDP (0.98 kt CO_2 eq. /million US $ (PPP) of GDP in 2005, respectively 1.07 kt CO_2 eq. / million US $ (PPP) of GDP in 2004). In comparison with the base year level (42,889.3 kt CO_2 eq. in 1990), the Republic of Moldova has reduced its GHG emissions by 72.3 percent (11, 883.8 kt CO_2 eq. in 2005).

Table S-1 shows the Republic of Moldova's total GHG emissions from 1990 to 2005, along with several primary indicators: Gross Domestic Product (in billion lei (current prices) and billion US $, including US $ [PPP]), the annual GDP real change rate (percent), population (thousand population), consumption and total import of energy (thousand tonnes of coal equivalent), electricity production, import and consumption (million kWh), heat consumption (thousand Gcal).

From the table, it is evident that the 72.3 percent decrease in GHG emissions over the past 16 years is in full consistency with a drop in some important economic and social indicators: consumption of primary energy resources – by 77.2 percent, consumption of electricity – by 67.4 percent, consumption of heat – by 85.3 percent, the GDP dropping by 49.4 percent, population number – by 4.9 percent, etc.

The significant reduction in national GHG emissions (by 72.3 percent) over the period for the time series from 1990 through 2005 is a consequence, first of all, of the economic crisis characteristic for transition to market economy (1991-2000) in the Republic of Moldova after the break up of the Soviet Union.

The decrease by 70.9 percent in GHG emissions per capita (Figure S-1) is also caused by a significant reduction of more polluting fossil fuels consumption (in particular, coal and residual fuel oil) in favour of less polluting fossil fuels (natural gases) used for generation of electricity and heat.

Table S-1: Republic of Moldova's GHG Emissions and Accompanying Variables, 1990-2005

Indicators	1990	1995	2000	2001	2002	2003	2004	2005
Total GHG emissions, kt CO_2 eq.	**42,886.0**	**16,758.2**	**9,840.0**	**10,824.7**	**10,966.6**	**11,530.6**	**11,680.9**	**11,883.5**
compared to 1990, %	100.0	-60.9	-77.1	-74.8	-74.4	-73.1	-72.8	-72.3
% to the previous year		-15.6	-9.1	10.0	1.3	5.1	1.3	1.7
GDP, B MDL (in current prices) [1]	**13.00**	**6.48**	**16.02**	**19.05**	**22.56**	**27.62**	**32.03**	**37.65**
compared to 1990, %	100.0	-60.6	-65.6	-63.5	-60.5	-57.1	-53.2	-49.4
% to the previous year		-1.4	2.1	6.1	7.8	6.6	7.4	7.5
GDP, B US $ [2]	**2.32**	**1.44**	**1.29**	**1.48**	**1.66**	**1.98**	**2.60**	**2.99**
compared to 1990, %	100.0	-37.9	-44.4	-36.2	-28.3	-14.6	12.0	28.8
% to the previous year		23.8	9.8	14.9	12.3	19.2	31.1	15.0
GDP, B US $ (PPP)	**22.76**	**7.59**	**7.69**	**8.35**	**9.14**	**9.71**	**10.92**	**12.08**
compared to 1990, %	100.0	-66.7	-66.2	-63.3	-59.9	-57.3	-52.0	-46.9
% to the previous year		23.8	3.7	8.6	9.4	6.3	12.4	10.6
GHG intensity, kt CO_2 eq,/mil. $ (PPP) GDP	**1.88**	**2.21**	**1.28**	**1.30**	**1.20**	**1.19**	**1.07**	**0.98**
compared to 1990, %	100.0	17.2	-32.1	-31.2	-36.3	-37.0	-43.2	-47.8
% to the previous year		21.8	-12.3	1.3	-7.4	-1.1	-9.9	-8.0
GHG efficiency, $ (PPP) GDP/kt GHG in CO_2 eq.	**0.53**	**0.45**	**0.78**	**0.77**	**0.83**	**0.84**	**0.93**	**1.02**
compared to 1990, %	100.0	-14.7	47.2	45.4	57.0	58.7	76.1	91.5
% to the previous year		-17.9	14.0	-1.2	8.0	1.1	11.0	8.7
Population, thousand inhabitants [1]	**4,361.6**	**4,347.9**	**4,281.5**	**4,264.3**	**4,247.7**	**4,241.5**	**3,937.7**	**4,147.3**
compared to 1990, %	100.0	-0.3	-1.8	-2.2	-2.6	-2.8	-9.7	-4.9
% to the previous year		-0.1	-0.3	-0.4	-0.4	-0.1	-7.2	5.3
GHG per capita, t CO_2 eq./inhabitant	**9.83**	**3.85**	**2.30**	**2.54**	**2.58**	**2.72**	**2.97**	**2.87**
compared to 1990, %	100.0	-60.8	-76.6	-74.2	-73.7	-72.4	-69.8	-70.9
% to the previous year		-15.5	-8.8	10.5	1.7	5.3	9.1	-3.4
Consumed energy, thousand t.c.e. [1]	**14269**	**5085**	**2647**	**2479**	**2701**	**2826**	**3065**	**3257**
compared to 1990, %	100.0	-64.4	-81.4	-82.6	-81.1	-80.2	-78.5	-77.2
% to the previous year		9.7	-20.2	-6.3	9.0	4.6	8.5	6.3
Imported energy, thousand t.c.e. [1]	**16703**	**5109**	**2535**	**2394**	**2549**	**2795**	**2996**	**3123**
compared to 1990, %	100.0	-69.4	-84.8	-85.7	-84.7	-83.3	-82.1	-81.3
% to the previous year		11.0	-18.0	-5.6	6.5	9.7	7.2	4.2
Produced electricity, mil kWh [1]	**15,690.3**	**1,181.4**	**904.0**	**1,262.8**	**1,179.8**	**1,045.7**	**1,022.1**	**1,228.9**
compared to 1990, %	100.0	-92.5	-94.2	-92.0	-92.5	-93.3	-93.5	-92.2
% to the previous year		-4.8	-20.5	39.7	-6.6	-11.4	-2.3	20.2
Imported electricity, mil kWh [1]	**4,488.9**	**4,324.0**	**2,482.1**	**2,138.0**	**2,613.8**	**3,590.6**	**3,367.5**	**2,973.8**
compared to 1990, %	100.0	-3.7	-44.7	-52.4	-41.8	-20.0	-25.0	-33.8
% to the previous year		-5.6	-6.8	-13.9	22.3	37.4	-6.2	-11.7
Consumed electricity, mil kWh [1]	**11,425.9**	**4,143.8**	**2,479.0**	**2,521.5**	**3,410.2**	**4,340.5**	**3,900.9**	**3,729.6**
compared to 1990, %	100.0	-63.7	-78.3	-77.9	-70.2	-62.0	-65.9	-67.4
% to the previous year		-4.7	-5.3	1.7	35.2	27.3	-10.1	-4.4
Consumed heat, thousand Gcal [3]	**20,983.0**	**6,126.0**	**2,673.0**	**2,809.0**	**2,699.0**	**2,799.0**	**2,686.0**	**3,084.0**
compared to 1990, %	100.0	-70.8	-87.3	-86.6	-87.1	-86.7	-87.2	-85.3
% to the previous year		-8.0	-31.4	5.1	-3.9	3.7	-4.0	14.8

References : [1] Statistical Yearbooks of the Republic of Moldova for 1991 (P. 42, 71, 236-238), 1994 (P. 52, 198, 271-274), 1999 (P. 42, 241, 309-311) and 2007 (P. 33, 257, 314-318), supplemented by Statistical Yearbooks of the Administrative-Territorial Units on the Left Bank of Dniester river (Transnistria) for 2006 (pag.18-19) and 2007 (P. 18-19); [2] World Bank and United Nations Economic Commission for Europe data bases; [3] Energy Balance of the Republic of Moldova for 1990 and 1993-2005.

Table S-2 show national direct GHG emissions of the Republic of Moldova in 2005. The share of CO_2 emissions in the total direct GHG emissions was 63.8 percent, CH_4 contributed with 24.3 percent, while N_2O emissions accounted for 11.8 percent of the total, the share of F-gases being totally insignificant (Figure S-2).

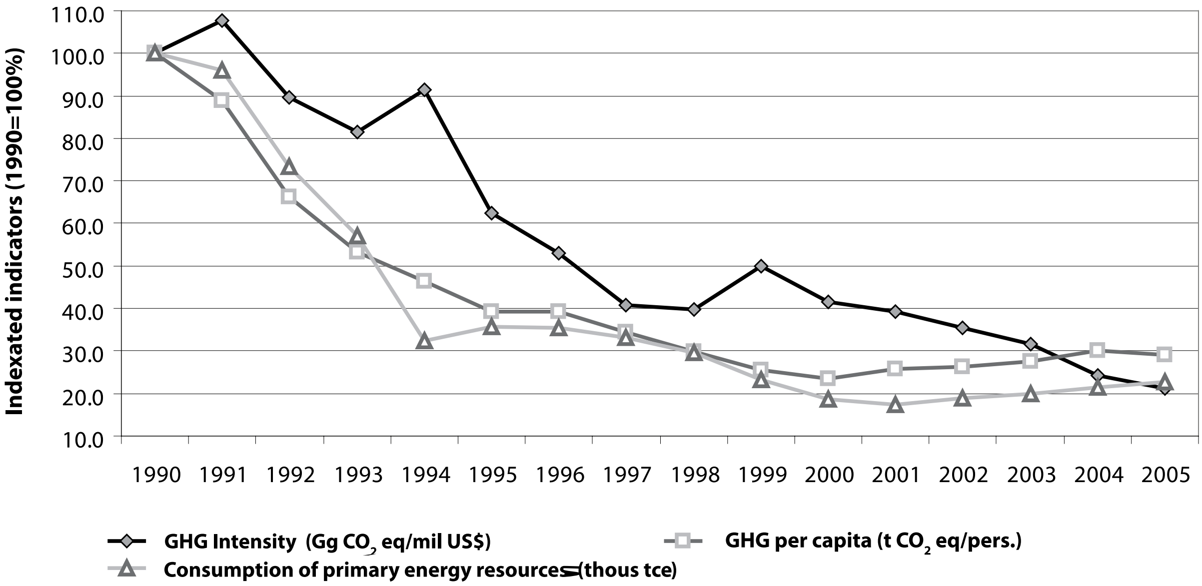

Figure S-1: Trends in GHG Emissions per Capita and per Unit GDP, 1990-2005

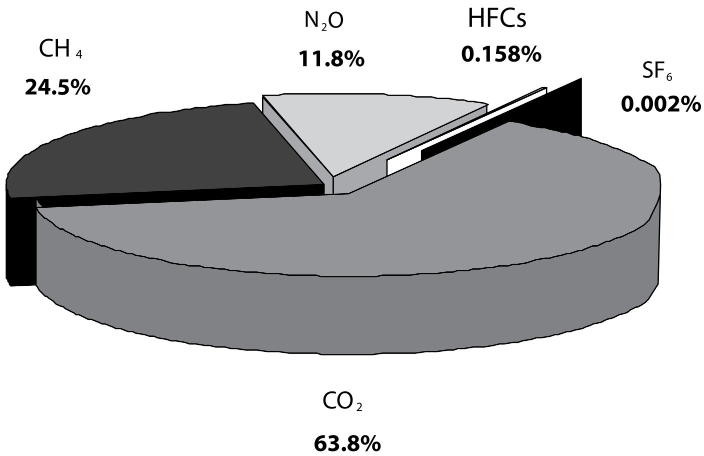

Figure S-2: Republic of Moldova's GHG Emissions by Gas, 2005

Table S-2: Republic of Moldova's GHG Emissions by Gas and Sector, 2005

Greenhouse Gas Categories	CO_2	CH_4		N_2O		HFC		SF_6		CO_2
	Gg	Gg	Gg CO_2 eq	Gg	Gg CO_2 eq	Gg	Gg CO_2 eq	Gg	Gg CO_2 eq	Gg CO_2 eq
Total	**7,576.5774**	**137.3247**	**2,883.8187**	**4.5292**	**1,404.0594**	**0.0139**	**18.7189**	**0.0000**	**0.2839**	**11,883.4583**
1. Energy	**6,986.1381**	**33.0165**	**693.3471**	**0.1462**	**45.3232**	**NO**	**NO**	**NO**	**NO**	**7,724.8084**
A. Fuel Combustion Activities	6,984.2572	1.9685	41.3382	0.1462	45.3180					7,070.9133
1. Energy Industries	2,986.5715	0.0584	1.2256	0.0064	1.9774					2,989.7745
2. Manufacturing Industries and Construction	396.3804	0.0102	0.2149	0.0013	0.3989					396.9942
3. Transport	1,610.9493	0.3573	7.5024	0.1163	36.0651					1,654.5168
4. Other Sectors	1,872.3084	1.5365	32.2659	0.0211	6.5339					1,911.1082
5. Other (Other Works and Needs in Energy Sector)	118.0475	0.0062	0.1295	0.0011	0.3426					118.5196
B. Fugitive Emissions from Fuels	1.8809	31.0480	652.0090	0.0000	0.0052					653.8950
1. Solid Fuels	NO	NO	NO	NO	NO					NO
2. Oil and Natural Gas	1.8809	31.0480	652.0090	0.0000	0.0052					653.8950
2. Industrial Processes	**541.4561**	**0.9437**	**19.8167**	**0.0052**	**1.6246**	**0.0139**	**18.7189**	**0.0000**	**0.2839**	**581.9002**
A. Mineral Products	416.8380	0.0003	0.0068	0.0000	0.0000					416.8448
B. Chemical Industry	NO. NE	NO, NE	NO, NE	NO, NE	NO, NE					NO, NE
C. Metal Production	83.8512	0.9433	19.8098	0.0052	1.6246					105.2857
D. Other Production	40.7669	NO, NE	NO, NE	NO, NE	NO, NE					40.7669
E. Production of Halocarbons and SF_6						NO	NO	NO	NO	NO
F. Consumption of Halocarbons and SF_6						0.0139	18.7189	0.0000	0.2839	19.0028
3. Solvents and Other Products Use	**48.9833**	**0.0000**	**0.0000**	**0.0001**	**0.0189**	**0.0000**	**0.0000**	**0.0000**	**0.0000**	**49.0022**
A. Paint Application	17.9812									17.9812
B. Degreasing and Dry Cleaning	1.2401									1.2401
C. Chemical Products, Manufacture and Processing	0.2931									0.2931
D. Other	29.4689			0.0001	0.0189					29.4878
4. Agriculture		**41.1160**	**863.4353**	**4.0786**	**1,264.3548**	**NO**	**NO**	**NO**	**NO**	**2,127.7901**
A. Enteric Fermentation		37.7552	792.8592							792.8592
B. Manure management		3.3608	70.5761	1.8229	565.1074					635.6835
C. Rice Cultivation		NO	NO							0.0000
D. Agricultural Soils				2.2556	699.2474					699.2474
E. Prescribed Burning of Savannas		NO	NO	NO	NO					NO
F. Field Burning of Agricultural Residues		IE	IE	IE	IE					IE
5. LULUCF	**-1,381.4077**	**0.0116**	**0.2445**	**0.0003**	**0.1007**	**NO**	**NO**	**NO**	**NO**	**-1,381.0626**
A. Forest Land	-2,246.2332	0.0008	0.0164	0.0000	0.0134					-2,246.2034
B. Cropland	1,684.2815	0.0109	0.2281	0.0003	0.0873					1,684.5968
C. Grassland	-819.4560	NE	NE	NE	NE					-819.4560
D. Wetlands	NE	NE	NE	NE	NE					NE
E. Settlements	IE	NE	NE	NE	NE					NE, IE
6. Waste		**62.2486**	**1,307.2196**	**0.2992**	**92.7379**	**NO**	**NO**	**NO**	**NO**	**1,399.9575**
A. Solid Waste Disposal on Land		56.4860	1,186.2060		0.0000					1,186.2060
B. Wastewater Handling		5.7626	121.0136	0.2992	92.7379					213.7515
C. Waste Incineration	NO, NE	NO, NE	NO, NE	NO, NE	NO, NE					NO, NE
7. Other	**NO, NE**	**NO, NE**	**NO, NE**	**NO, NE**	**NO, NE**	**NO, NE**	**NO, NE**	**NO, NE**	**NO, NE**	**NO, NE**
International Bunkers	63.9592	0.0010	0.0203	0.0021	0.6589					64.6384
CO_2 emissions from biomass	295.0374									295.0374

Abbreviations: IE – Included Elsewhere; NE – Not Estimated; NO – Not Occurring

In 2005, in the Republic of Moldova, approximately 59.5 percent of the total national direct GHG emissions originated from fossil fuel combustion, while fugitive emissions from oil and natural gas accounted for 5.5 percent of the total, so the share of Energy Sector accounting for circa 65 percent of the total national direct GHG emissions. Other relevant GHG sources are represented by Agriculture Sector (17.9 percent of the total), Waste Sector (11.8 percent of the total) and Industrial Processes Sector (4.9 percent of the total) (Figure S-3).

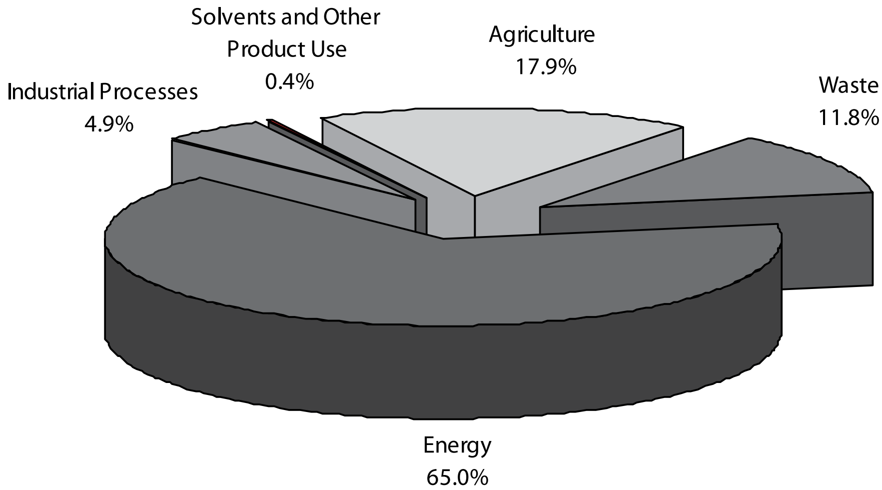

Figure S-3: Sectoral Breakdown of the Republic of Moldova's GHG Emissions, 2005

In conformity with the IPCC reporting requirements, Land Use, Land-Use Change and Forestry Sector was excluded from the national total. In 2005, this sector contributed to removing 1381.1 Gg CO_2 eq. Inclusion of this contribution into the total, would reduce national GHG emissions by 12 percent.

The table below shows the evolution of total GHG emissions and removals in the Republic of Moldova for the time series from 1990 through 2005.

As it can be noted from Table S-3, total emissions (excluding LULUCF) have reduced during the period under review by 72.3 percent, from 42,886.0 Gg CO_2 eq. in 1990 to 11,883.5 Gg CO_2 eq. in 2005 (however, increasing by 1.7 percent against the 2004 year level). To be noted that during the period under review, the GHG emissions in Energy Sector have decreased by 77.6 percent (however, increasing by 3.1 percent against the 2004 year level), emissions in Industrial Processes Sector have decreased by circa 56.9 percent (however, a significant increase, by 21.3 percent against the 2004 year level occurred in 2005), emissions in Solvents and Other Products Use Sector decreased by 25.3 percent (increasing in 2005 by 2.5 percent, compared to 2004 year level), emissions in Agriculture Sector decreased by 60.0 percent (in 2005 emissions decreased by 3.8 percent, compared to 2004), net removals in LULUCF Sector decreased by 17.5 percent (however, an increase by 4.7 percent against the 2004 year level occurred in 2005), respectively, emissions in Waste Sector decreased by 14.0 percent (decreasing in 2005 by 3.6 percent, against the 2004 year level) (Table S-3).

The most significant reduction of GHG emissions by source categories during the period under review take place in: 1A1 'Energy Industries' (-84.6 percent), 1A2 'Manufacturing Industries and Constructions' (-81.9 percent), 1A1 'Other Sectors' (-76.2 percent), 2A 'Mineral Products' (-66.9 percent), 4B 'Manure Management' (-62.6 percent), 4D 'Agricultural Soils' (-59.3 percent), 1A3 'Transport' (-59.2 percent), 4A 'Enteric Fermentation' (-58.3 percent). On the other hand, the increase in national emissions in 2004-2005 occurred due to increase of emissions in the following source categories 2F 'Consumption of halocarbons and sulphur hexafluoride' (+42.3 percent), 2A 'Mineral Products' (+27.1 percent), 1A2 'Manufacturing Industries and Constructions' (+24.1 percent), 2D2 'Other Production' (+11.7 percent), 6B 'Wastewater Handling' (+8.2 percent), 1B2 'Fugitive Emissions from Oil and Natural Gas' (+5.9 percent), 2C1 'Steel Production' (+3.5 percent), 3A-D 'Solvents and Other Products' (+2.5 percent).

Table S-3: Republic of Moldova's GHG Emission Trends by Sector in 1990-2005, Gg CO_2 equivalent

	1990	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
National Total (excluding LULUCF)	**42886.02**	**16758.16**	**16771.33**	**14650.82**	**12605.12**	**10822.35**	**9839.95**	**10824.72**	**10966.56**	**11530.56**	**11680.86**	**11883.46**
National Total (including LULUCF)	41212.82	16002.16	16031.71	13325.88	11448.63	9511.40	8486.80	9436.42	9734.67	10216.65	10361.81	10502.40
1. Energy	**34520.39**	**11135.71**	**11430.27**	**9526.58**	**7938.33**	**6184.74**	**5437.82**	**6639.87**	**6738.33**	**7328.40**	**7490.74**	**7724.81**
A. Fuel Combustion Activities	33837.46	10579.72	10825.94	9028.46	7472.10	5719.66	4934.43	6139.74	6196.09	6755.07	6873.21	7070.91
1. Energy Industries	19393.29	6931.76	7057.97	5370.04	4427.55	3318.36	2653.71	3416.58	3048.93	2927.52	2944.22	2989.77
2. Manufacturing Industries and Construct.	2195.89	316.65	261.86	299.44	259.78	237.33	258.17	286.11	284.99	301.38	319.80	396.99
3. Transport	4055.61	1328.52	1298.13	1321.21	1153.33	784.87	848.27	926.43	1157.96	1451.78	1621.59	1654.52
4. Other Sectors	8037.78	1829.47	2062.55	1901.70	1538.61	1322.54	1122.76	1447.33	1639.70	1956.66	1864.60	1911.11
5. Other (other works and needs in energy)	154.90	173.32	145.42	136.07	92.83	56.56	51.51	63.29	64.52	117.73	123.00	118.52
B. Fugitive Emissions from Fuels	682.93	555.98	604.33	498.12	466.22	465.08	503.40	500.13	542.24	573.33	617.53	653.90
1. Solid Fuels	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
2. Oil and Natural Gas	682.93	555.98	604.33	498.12	466.22	465.08	503.40	500.13	542.24	573.33	617.53	653.90
2. Industrial Processes	**1348.75**	**380.65**	**389.81**	**434.97**	**354.72**	**339.26**	**325.60**	**331.13**	**344.10**	**408.04**	**479.52**	**581.90**
A. Mineral Products	1257.91	302.72	305.55	331.59	268.58	250.96	217.93	211.17	268.05	287.28	327.90	416.84
B. Chemical Industry	NO, NE	NO, NE	NO, NE	NO, NE	NO, NE	NO, NE	NO, NE	NO, NE	NO, NE	NO, NE	NO, NE	NO, NE
C. Metal Production	71.20	65.98	67.21	81.43	72.14	79.96	91.22	97.15	51.56	89.01	101.77	105.29
D. Other Production	19.64	11.95	17.05	21.95	14.00	8.34	12.25	17.40	16.93	21.72	36.50	40.77
E. Production of Halocarbons and SF_6	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
F. Consumption of Halocarbons and SF_6	NO, NE	NO, NE	NO, NE	NO, NE	NO, NE	NO, NE	4.21	5.41	7.56	10.02	13.35	19.00
3. Solvents and Other Products Use	**65.62**	**28.06**	**28.21**	**29.88**	**30.39**	**29.77**	**33.06**	**34.71**	**40.78**	**41.67**	**47.82**	**49.00**
A. Paint Application	30.18	1.94	2.14	2.96	2.99	2.93	6.74	7.68	12.43	12.49	18.79	17.98
B. Degreasing and Dry Cleaning	2.00	0.22	0.66	0.93	0.35	0.95	0.34	0.60	1.19	2.28	1.23	1.24
C. Chemical Products, Manufacture andProcessing	0.55	0.03	0.02	0.02	0.02	0.03	0.10	0.13	0.19	0.16	0.22	0.29
D. Other	32.89	25.88	25.39	25.97	27.03	25.85	25.89	26.30	26.96	26.74	27.58	29.49
4. Agriculture	**5323.92**	**3386.18**	**3046.47**	**2839.22**	**2518.31**	**2438.03**	**2312.19**	**2215.97**	**2313.91**	**2253.13**	**2210.72**	**2127.79**
A. Enteric Fermentation	1903.41	1384.63	1236.76	1077.79	982.91	961.84	903.06	872.37	912.70	894.14	843.96	792.86
B. Manure Management	1701.94	1088.95	1013.06	926.93	811.74	838.44	762.67	666.24	686.94	708.73	665.77	635.68
C. Rice Cultivation	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
D. Agricultural Soils	1718.57	912.60	796.65	834.50	723.66	637.75	646.46	677.36	714.27	650.27	700.99	699.25
E. Prescribed Burning of Savannas	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
F. Field Burning of Agricultural Residues	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE
5. LULUCF	**-1673.20**	**-756.00**	**-739.62**	**-1324.94**	**-1156.49**	**-1310.95**	**-1353.15**	**-1388.30**	**-1231.89**	**-1313.91**	**-1319.04**	**-1381.06**
A. Forest Land	-2197.15	-1620.79	-1705.09	-2132.20	-2027.77	-2111.13	-2140.32	-2195.22	-2134.76	-2135.76	-2183.42	-2246.20
B. Cropland	1310.45	1484.33	1543.58	1536.19	1574.69	1596.57	1612.69	1651.03	1683.34	1689.93	1691.54	1684.60
C. Grassland	-786.50	-619.54	-578.12	-728.93	-703.41	-796.38	-825.53	-844.11	-780.47	-868.08	-827.16	-819.46
D. Wetlands	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
E. Settlements	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE
6. Waste	**1627.34**	**1827.57**	**1876.57**	**1820.17**	**1763.38**	**1830.55**	**1731.28**	**1603.04**	**1529.44**	**1499.32**	**1452.05**	**1399.96**
A. Solid Waste Disposal on Land	1321.13	1616.58	1670.25	1611.88	1560.89	1636.00	1536.42	1403.31	1327.01	1294.20	1254.51	1186.21
B. Wastewater Handling	306.21	210.98	206.32	208.29	202.49	194.55	194.86	199.72	202.42	205.12	197.54	213.75
C. Waste Incineration	NO, NE	NO, NE	NO, NE	NO, NE	NO, NE	NO, NE	NO, NE	NO, NE	NO, NE	NO, NE	NO, NE	NO, NE
7. Other	NO, NE	NO, NE	NO, NE	NO, NE	NO, NE	NO, NE	NO, NE	NO, NE	NO, NE	NO, NE	NO, NE	NO, NE
International Bunkers	220.43	42.46	66.62	76.52	73.32	73.26	66.95	58.81	59.30	70.80	67.95	64.64
CO_2 emissions from biomass	210.83	645.57	615.34	322.44	409.18	373.60	367.86	353.09	389.50	359.79	296.51	295.04

Abbreviations: IE – Included Elsewhere; NE – Not Estimated; NO– Not Occurring

Emission Trends for Ozone and Aerosol Precursors

The reporting requirements of the UNFCCC request that information be provided on indirect greenhouse gases, which include carbon monoxide (CO), nitrogen oxides (NO_x), non-methane volatile organic compounds (NMVOC) and sulphur dioxide (SO_2). These gases do not have a direct global warming effect, but indirectly affect terrestrial radiation absorption by influencing the formation and destruction of tropospheric and stratospheric ozone, or, in the case of SO_2, by affecting the absorption characteristics of the atmosphere. Additionally, some of these gases may react with other chemical compounds in the atmosphere to form compounds that are greenhouse gases. These gases are produced when carbon-containing fuels are combusted incompletely (CO); are created by lightning, fires, fossil fuel combustion, and in the stratosphere (NO_x); emitted from transportation, industrial processes and consumption of organic solvents (NMVOC); emitted from coal combustion for power generation and the metals industry (SO_2).

The national inventory of the Republic of Moldova includes emissions of the following ozone and aerosol precursors: NOx, CO, NMVOC and SO_2. In 1990-2005, NO_x emissions decreased by 77.1 percent: from 137.74 Gg in 1990 to 31.58 Gg in 2005; CO emissions decreased by 73.1 percent: from 429.05 Gg in 1990, to 115.22 Gg in 2005; NMVOC emissions decreased by 59.0 percent: from 103.12 Gg in 1990 to 42.25 Gg in 2005, while SO_2 emissions deceased by 96.0 percent: from 294.97 Gg in 1990, to 11.79 Gg in 2005 (Figure S-4).

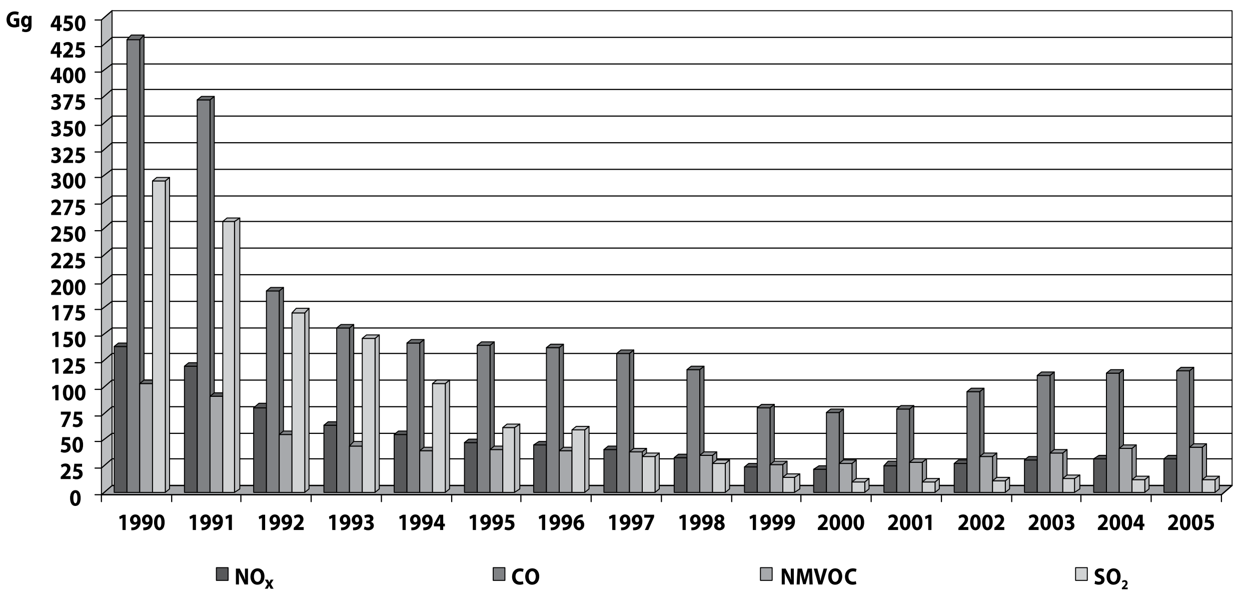

Figure S-4: Emission Trends for Ozone and Aerosol Precursors in the Republic of Moldova, 1990-2005

1. INTRODUCTION

1.1 GHG Inventories and Climate Change

1.1.1 Climate Change and Greenhouse Effect

Under the UNFCCC, climate change is defined as „*a change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods*". Human activities change atmospheric concentrations and distribution of greenhouse gases and aerosols. These changes can produce a radiant force by changing the solar radiation reflection and absorption, or emission and absorption of terrestrial radiation (IPCC, 1996).

Box 1-1: Climate Change Phenomena

To better understand the definition of climate change it is important to perceive the difference between the notions of weather and climate. Weather is a condition of the atmosphere at a certain time and in a certain place, perceived as a modification of temperature, air pressure, humidity, wind speed, nebulosity and precipitations. The notion of weather is used when the above-mentioned conditions are related to short periods of time. The notion of climate usually refers to the mean state of weather in a certain region of the world persisting a longer period of time (at least 30 years). So, climate may be defined as a weather pattern characteristic to a certain region of the world. Elements of the climate are: precipitations, temperature, humidity, solar radiation, speed of the wind and such phenomenon as fog, frost, hoarfrost, hail and other. Climate change refer to long term changes in weather patterns caused by natural phenomena (astronomic: solar activity, influence of some planets etc.; geological-geophysical: change of the Earth's axis angle, change of the Earth orbit and other; geographical: changes in the active surface structure - volcanic eruptions, massive land slides), as well as phenomena of anthropogenic nature (induced by humans), such as pollution of terrestrial atmosphere (change of the global atmosphere composition by generation of GHG).

In conformity with the 4th Assessment Report of the Intergovernmental Panel on Climate Change (IPCC, 2007), it is expected that the climate change phenomenon will have different impact in different regions of the world. It is expected that in the next 100 years global air surface temperature will increase by circa 1.8-4.0^{0}C (in 1901-2000 the average global air surface temperature increased by 0.6^{0}C), and the sea level will raise respectively, by circa 0.18-0.59 m (in 1961-1992 the average sea level raised at a rate of 1.8 mm/year, and starting 1993, at a rate of 3.1 mm/year); the frequency of natural disasters (floods, droughts, heat waves, hurricanes, tornados, etc.) will also grow. In some regions their impact can be devastating, while other regions could benefit from climate change. The impact will depend on the form and magnitude of these changes, and in the case of adverse effects, of the ability of natural and anthropogenic systems to adapt to climate change.

In other words, the greenhouse effect of the atmosphere is similar to the effect that can be observed in greenhouses, when the function of the glass or polyethylene is taken over by the greenhouse gases. Short-wave solar radiation freely penetrates the greenhouse gases, reaching the Earth surface, and warming it.

Long-wave radiation (infrared rays) emitted by the surface of the Earth is captured by these gases and partially send back to the Earth surface. As a consequence, the average atmospheric temperature is by 33°C warmer than it could have been in the absence of the greenhouse effect. Basically, this phenomenon makes life on Earth possible.

1.1.2 Climate Change in the Republic of Moldova

Changes in temperature and precipitations in the Republic of Moldova are measured within the hydro-meteorological monitoring network, since 1886. In conformity with the State Hydrometeorological Service (SHS) data, the average air temperature at the Chisinau meteorological station during the instrumental record was continuously increasing. So, during 1886-2007 this increase represented circa 1^{0}C (Table 1-1). The amount of precipitations during 1891-2007 was also growing, increasing by 60 mm, or circa 11 percent.

Table 1-1: Dynamics of Average Annual Temperature and Amount of Precipitations at the Chisinau Meteorological Station

Times series	Air temperature	Times series	Amount of precipitations
1886-1960	+0.5 °C	1891-1960	+40 mm (+8%)
1960-2007	+0.5 °C	1960-2007	+20 mm (+3%)
1886-2007	+1.0 °C	1891-2007	+60 mm (+11%)

Higher temperatures in winter, spring and summer in the Republic of Moldova is a peculiarity of the past 100 years (Table 1-2). So, the average winter air temperature at the Chisinau meteorological station was 1.3°C higher, in spring it was higher by 0.9°C, in summer – by 0.7°C, while in autumn it was higher by as little as 0.2°C. In the past 100 years the average air temperature increased by 0.8°C. The amount of precipitations in the past 100 years also increased by 56 mm, or 12 percent, however, this increase is different by seasons. The biggest increase occurred in autumn (by 32 mm), while in spring it even diminished by 5 mm (Table 1-2).

Table 1-2: Dynamics of Average Annual Air Temperature and Amount of Precipitations in the Past 100 Years at Chisinau Meteorological Station

Season	Air temperature	Amount of precipitations
Winter	+1.3 °C	+9 mm (+9%)
Spring	+0.9 °C	-5 mm (-4%)
Summer	+0.7 °C	+20 mm (+11%)
Autumn	+0.2 °C	+32 mm (+30%)
Annual	+0.8 °C	+56 mm (+12%)

During the instrumental record period the warmest year was 2007, when the average annual air temperature was 12.1°C, by 2.6°C higher than the normal level. The coldest year was 1933, when the average annual air temperature was 7.2°C, by 2.3°C lower than the normal level (Figure 1-1). The most humid year was 1912, when the amount of precipitations reached 915 mm, or by 75 percent above the norm. The year with the highest deficit of precipitations was 1896, with as little as 301 mm, or 58 percent of the norm (Figure 1-2).

The analysis of data provided by the National Hydrometeorological Data Fund for the instrumental record period (1890-2007) revealed that of 117 years, 22 years were marked by serious droughts during the vegetation period (April-September), and 18 years were marked by close to drought conditions (mild droughts). Droughts for two continuous years occurred 3 times, and droughts for three continuous years occurred twice. It has been stated that average frequency of droughts in the Republic of Moldova in 10 years time span is 1-2 droughts in the North; 2-3 droughts in the central part and 5-6 droughts in the South. It should be noted that in 1990–2007 time span, 9 years (1990, 1992, 1994, 1996, 1999, 2000, 2001, 2003 and 2007) were marked by droughts of various intensity, which contributed to a significant reduction of crops yield. In 1990, 1992 and 2003 the droughts continued during the entire vegetation period (April-September), while in other years the droughts occurred in summer. The disastrous drought of 2007 affected over 80 percent of the territory of the country, being the most severe drought in the entire instrumental record period. By its core agro-meteorological indicators, this drought surpassed the drought of 1946, causing catastrophic damage to national economy.

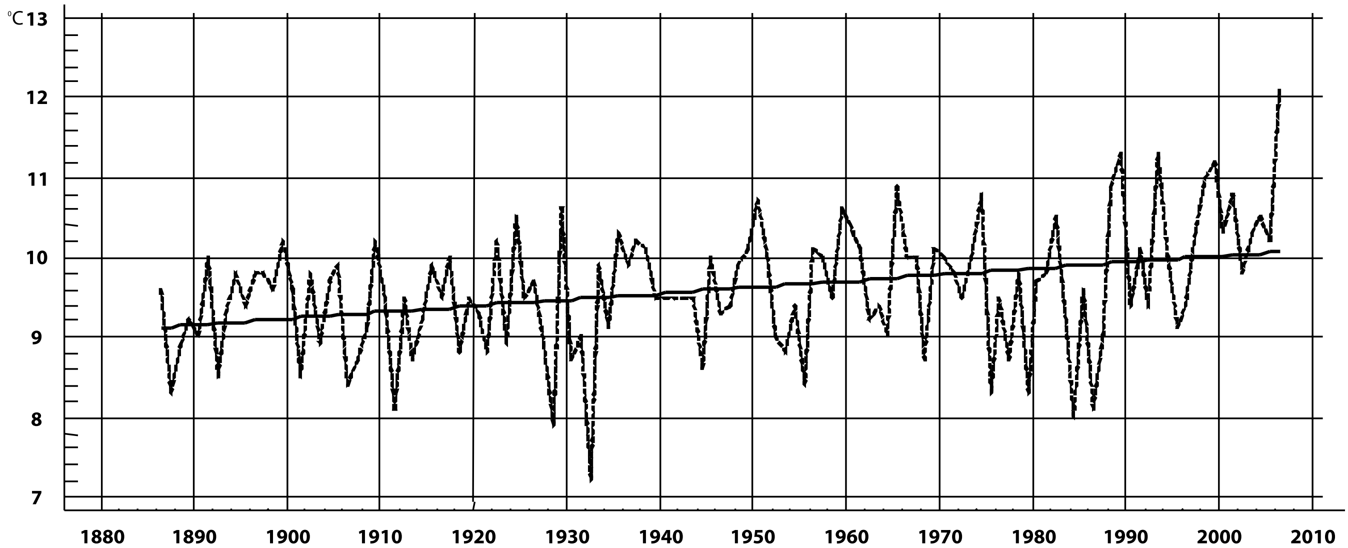

Figure 1-1: Change of Average Annual Air Temperature (in °C) at Chisinau Meteorological Station (1886 - 2007): Broken Line – Actual Course; Continuous Line – Secular Course

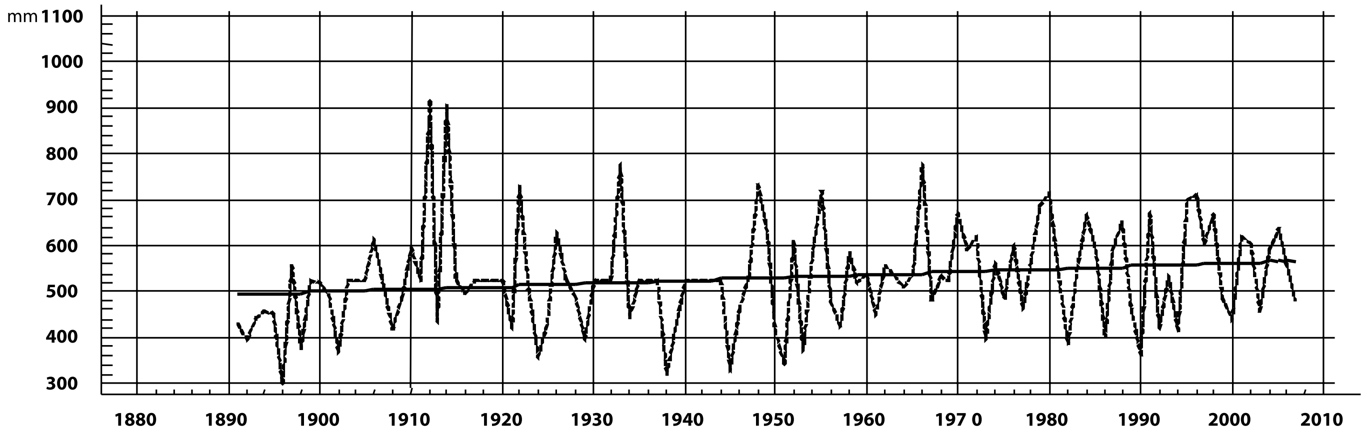

Figure 1-2: Change in Annual Amount of Precipitations (in mm) at Chisinau Meteorological Station (1891 - 2007): Broken Line – Real Course and Continuous Line – Secular Course

1.1.3 Greenhouse Gases

The most important greenhouse gas in atmosphere is water vapours (H_2O), responsible for approximately 2/3 of the total greenhouse effect. The content of water in atmosphere is not directly influenced by anthropogenic activities, but rather is determined by the cycle of water in nature, expressed in a simpler way, as a difference between evaporation and precipitations. Carbon dioxide (CO_2) has a 30 percent share in the greenhouse effect, while methane (CH_4), nitrous oxide (N_2O) and ozone (O_3) taken together account for 3 percent. The group of artificial substances (man-made): chlorofluorocarbons (CFC) and their substitute, hydrofluorocarbons (HCFC, HFC) and other substances, as well as perfluorocarbons (PFCs) and sulphur hexafluoride (SF_6) are also attributed to direct GHG.

There are other photochemically active gases, such as carbon monoxide (CO), nitrogen oxides (NO_x) and non-methane volatile organic compounds (NMVOC) (include substances such as: propane, butane and ethane), which are not attributed to direct GHG, but have an indirect contribution to greenhouse effect. Such gases influence the formation and destruction of ozone in the atmosphere in the presence of solar rays (ultraviolet radiation) and are considered to be ozone precursors in the troposphere.

Though GHG are considered to be natural components of the air, their presence in atmosphere is strongly affected by anthropogenic activities. Increased concentrations of GHG in atmosphere (caused by emissions of anthropogenic origin) contribute to strengthening of greenhouse effect thus leading to additional warming of the atmosphere. The GHG concentration in atmosphere is determined by the difference between GHG emissions and removals. It has been stated with certainty that GHG concentration in atmosphere have increased significantly in comparison with pre-industrial period. So, since 1750 the concentration of CO_2 increased by 35 percent, concentration of CH_4 - by 143 percent, and concentration of N_2O – by 18 percent (Table 1-3).

Table 1-3: Atmospheric Concentration, Concentration Change Rate and Direct GHG Lifetime in Atmosphere

Variables	CO_2	CH_4	N_2O	SF_6	CF_4
Pre-industrial atmospheric concentration (year 1750)	278 ppm	0.715 ppm	0.270 ppm	0 ppt	40 ppt
Current atmospheric concentration (at 2005 level)	379 ppm	1.774 ppm	0.319 ppm	5.6 ppt	74 ppt
Atmospheric concentration change rate	1.4 ppm/year	0.005ppm/year	0.26 ppm /year	linear	linear
GHG lifetime in atmosphere	50-200	12	114	3200	>50000

To a great extent these trends can be attributed to human activities — in particular, to fossil fuels combustion and continuous deforestation of forest lands.

Globally, the amount of annual emissions of carbon dioxide is circa 23.9 Gt, which in the past 45 years has increased more than significantly (by circa 3.7 times). The most important sources of carbon dioxide emissions are fossil fuel combustion, deforestation and industrial processes (for example, cement production). The carbon dioxide lifetime in atmosphere vary between 50 and 200 years. It can be removed from atmosphere through a complex set of natural sinks mechanisms. Also, it is considered that circa 40 percent of the emitted carbon dioxide can be absorbed by oceans. Photosynthesis, in particular in sea vegetation and plankton is an important, though transitory, mechanism of CO_2 emissions removal, because after the perishing of plants, carbon dioxide is again emitted into the atmosphere.

Concentration of methane in atmosphere is affected by anthropogenic activities such as rice cultivation, animal breeding (enteric fermentation and manure management), coal, oil and natural gas extraction, transportation and distribution of natural gases, solid waste disposal on lands, biomass combustion, etc. The break down of methane in the atmosphere takes place through chemical reactions (by means of OH radicals). The lifetime of CH_4 in atmosphere is circa 12 years. In comparison with the pre-industrial period, CH_4concentration in atmosphere increased by circa 143 percent (Table 1-3). The annual accumulation rate of CH_4 in atmosphere is 40 and 60 Mt, or approximately 10 percent of total global CH_4 emissions (Thompson et al., 1992). Approximately half of annual global methane emissions are generated from anthropogenic activities. To stabilize methane concentrations at their current level, it is necessary to reduce these emissions by circa 8 percent (IPCC, 1996).

It has been stated that circa 1/3 of the atmospheric N_2O is of anthropogenic origin, coming from use of synthetic nitrogen fertiliser, soil cultivation, animal breeding (manure management), wastewater handling, adipic acid and nitric acid production, fossil fuels combustion, waste incineration and biomass burning. The other 2/3 of the atmospheric N_2O comes from the soil and denitrification of water in anaerobic conditions. N_2O breaks down photochemically in atmosphere. It should be noted that atmospheric concentration of nitrous oxide increased by circa 18 percent compared to pre-industrial periods levels (Table 1-3). Global annual N_2O emissions from all sources are estimated at circa 10.0-17.5 Mt (IPCC, 1996).

PFC (perfluorocarbones), HFC (hydrofluorocarbones) and SF_6 (sulphur hexafluoride) are GHG of anthropogenic origin. HFC is preponderantly used to replace ozone depleting chemical substances, but it is also emitted in the process of HCFC-22 production. PFC and SF_6 are emitted in various industrial processes, including aluminium and magnesia production, production of semiconductors, in transmission and distribution of electric power, etc. All these gases have a long lifetime in atmosphere and are characterized by a considerable infrared radiation absorption capacity, so that in the future it might have a considerable impact on the global warming.

1.1.4 Global Warming Potential

The radiative forcing[1] effect of a gas in the atmosphere is the reflection of its ability to cause atmospheric warming. Direct effects occur when the gas itself is a GHG, while indirect radiative forcing occurs when chemical transformation of the original gas produces a gas or gases that are GHGs or when a gas influences the atmospheric lifetimes of other gases. The concept of "Global Warming Potential" (GWP) has been developed to allow scientists and policy-makers to compare the ability of each GHG to trap heat in the atmosphere relative to another gas. By definition, a GWP is the time-integrated change in radiative forcing due to the instantaneous release of 1 kg of gas expressed relative to the radiative forcing from the release of 1 kg of CO_2. In other words, GWP is a relative measure of a warming effect that the emission of a radiative gas (i.e., GHG) might have on the surface of troposphere. The GWP of a GHG takes into account both the instantaneous radiative forcing due to an incremental concentration increase and the lifetime of the gas. This report relate to the GWP for a period of 100 years recommended by the IPCC (IPCC Second Assessment Report, 1996) and adopted at the COP 3 (Table 1-4).

1.1.5 Convention, Kyoto Protocol and Party's Commitments

The UNFCCC was adopted on May 9, 1992 at the UN Conference on Environment and Sustainable Development in Rio de Janeiro, being regarded as a response of the international community to the global warming phenomenon caused by the increased concentrations of greenhouse gases.

The overall objective of the UNFCCC is aimed at stabilizing greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system. To-date 196 countries are Parties to the Convention. The Republic of Moldova signed the UNFCCC on June 12, 1992 and it was ratified by the Parliament on March 16, 1995.

1 The term 'radiative forcing' refers to the amount of heat-trapping potential for any given GHG. It is measured in units of power (watt) per unit of area (m^2)

Table 1-4: GWP for a Period of 100 Years and the Atmospheric Lifetimes

GHG	Chemical formula	Lifetime	SAR	TAR	AR4
Carbon dioxide	CO_2	50-200	1	1	1
Methane	CH_4	12	21	23	25
Nitrous oxide	N_2O	120	310	296	298
Sulphur hexafluoride	SF_6	3200	23900	22200	22800
Hydrofluorocarbones (HFC)					
HFC-23	CHF_3	264	11700	12000	14800
HFC-32	CH_2F_3	5.6	650	550	675
HFC-43-10mee	$C_5H_2F_{10}$	17.1	1300	1500	1640
HFC-125	C_2HF_5	32.6	2800	3400	3500
HFC-134a	$C_2H_2F_2$ (CH_2FCF_3)	14.6	1300	1300	1430
HFC-143a	$C_2H_3F_3$ (CF_3CH_3)	48.3	3800	4300	4470
HFC-152a	C_2H4F_2 (CH_3CHF_2)	1.5	140	120	124
HFC-227ea	C_3HF_7	36.5	2900	3500	3220
HFC-236fa	$C_3H_2F_6$	209	6300	9400	9810
Perfluorocarbones (PFC)					
Perfluoromethane	CF_4	50000	6500	5700	7390
Perfluoroethane	C_2F_6	10000	9200	11900	12200
Perfluoropropane	C_3F_8	2600	7000	8600	8860
Perfluorohexane	C_6F_{14}	3200	7400	9000	9300

Source: SAR – Second Assessment Report (IPCC, 1996), TAR – Third Assessment Report (IPCC, 2001) and AR4 – Fourth Assessment Report (IPCC, 2007).

Article 4, paragraph 1(a) and Article 12, paragraph 1(a), (b) and (c) of the UNFCCC stipulate that each Party has to develop, periodically update, publish and make available to the Conference of the Parties (COP), national inventories of anthropogenic emissions by sources and removals by sinks of all greenhouse gases not controlled by the Montreal Protocol, to the extent its capacities permit, using comparable methodologies to be agreed upon by the Conference of the Parties; also a general description of steps taken or envisaged by the Party to implement the Convention; and any other information that the Party considers relevant to the achievement of the objective of the Convention and suitable for inclusion in its communication, including, if feasible, material relevant for calculations of global emission trends.

The main mechanism for making this information available is national communications. COP 2 (Geneva, 1996) adopted the Guidelines on national communications by non-Annex I Parties (Decision 10/CP 2). In conformity with the Guidelines, in 1998-2000, under the UNDP-GEF Project "Republic of Moldova: Enabling Activities for the Preparation of the FNC under the UNFCCC", the Republic of Moldova developed the First National Communication to the UNFCCC (including a national greenhouse gas emissions inventory for the time series 1990 through 1998), made available at the COP 6 (Hague, 2000).

COP 8 (New Delhi, 2002) adopted a new Guidelines on national communications from non-Annex I Parties to the Convention (Decision 17/CP 8). In conformity with this document, in 2005-2008 under the UNEP-GEF Project "Republic of Moldova: Enabling Activities for the Preparation of the SNC under the UNFCCC", the Republic of Moldova developed the Second National Communication to the UNFCCC.

The COP 3 (Kyoto, 1997) adopted the Kyoto Protocol, representing an instrument setting binding targets for the Convention Parties, by committing industrialized countries and economies in transition included in Annex I to Convention, to reduce total emissions of direct GHG by at least 5 percent, against 1990 levels over the five-year period 2008-2012.

The Republic of Moldova ratified the Kyoto Protocol on February 13, 2003 (the official date of accession was April 22, 2003). It should be noted however, that as a non-Annex I Party, the Republic of Moldova has no commitments to reduce emissions under the Protocol.

Detailed principles regarding implementation of the Kyoto Protocol were outlined at COP 7 (Marrakesh, 2001), covered in Marrakesh Accords. COP 11 (Montreal, 2005), which also served as the first Meeting of the Parties to Kyoto Protocol (COP/MOP), adopted the Kyoto Protocol implementation rules, previously discussed in Marrakesh. At present, international negotiations focus on future commitments of the Convention Parties for post-Kyoto period (after 2012).

1.1.6 Republic of Moldova's Contribution to Global Warming

In 1990, Republic of Moldova contributes only about 0.3 percent of total global GHG emissions. Within the 1990-2005, the total national GHG emissions (excluding LULUCF) decreased by 72.3 percent (Figure 1-3), which is much more than in some Annex I Parties to Convention.

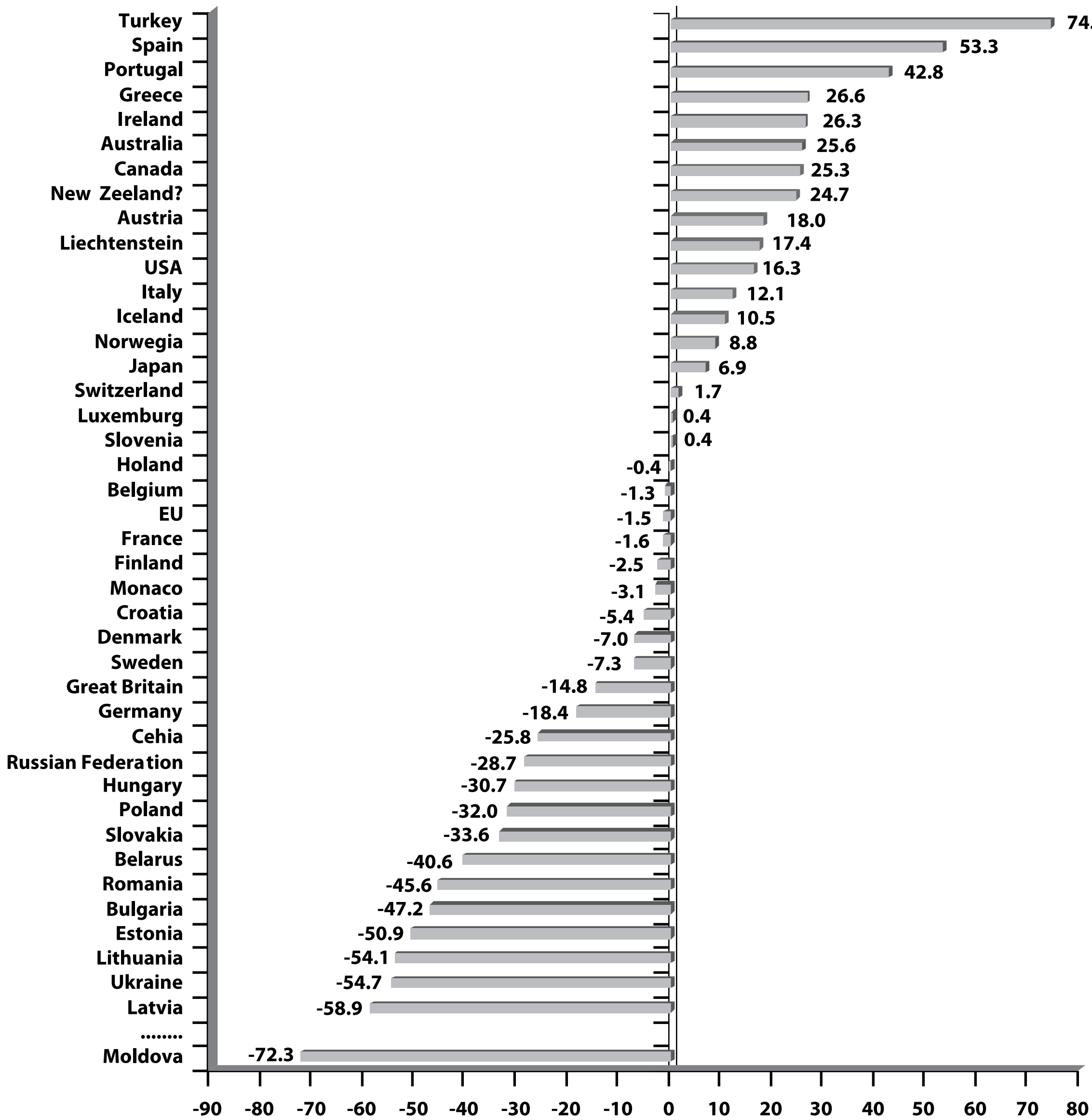

Figure 1-3: Change in Aggregate GHG Emissions for Annex I Parties and the Republic of Moldova, 1990-2005 (change relative to 1990, %)
(Source: **http://unfccc.int/resource/docs/2007/sbi/eng/30.pdf**)

1.2 Institutional Arrangements for Inventory Preparation

1.2.1 National Inventory System

The Ministry of Environment and Natural Resources (MENR) of the Republic of Moldova (RM) is the state authority responsible for development and promotion of policies and strategies addressing environment protection, rational use of natural resources and biodiversity conservation. On behalf of the Government of RM, MENR is in charge for implementation of international environment treaties to which RM is a Part (including Rio Conventions). Representatives of MERN and subordinated institutions also act as GEF and UNFCCC Focal Points.

In view of implementing and accomplishing the UNFCCC provisions, as well as mechanisms and provisions of Kyoto Protocol based on Order No. 21 as of February 11, 2004, the Climate Change Office (CCO) was established under the Ministry of Ecology, Constructions and Territory Development of the Republic of Moldova (reorganized into MENR based on Government Decree No. 357 as of April 23, 2005 'On reorganization of ministries and central administration authorities of the Republic of Moldova').

The main tasks of the CCO are: (a) providing logistical support to the Government, central and local public administration authorities, non-government and academic organizations, in activities implemented and promoted by the RM under the UNFCCC and Kyoto Protocol; and (b) implementing climate change related projects and programs providing for such activities as: GHG emissions evaluations and national inventory reports preparation; development and implementation of GHG emissions mitigation activities; development and implementation of measures aimed to adapt to climate change; assessment of the climate change impact on environment and socio-economic components; cooperation, promotion and implementation of activities and projects under the Clean Development Mechanism (CDM) of the Kyoto Protocol; implementation and facilitation of activities aimed at building awareness and information among civil society, relevant experts and decision makers in climate change related issues, etc.

The National Inventory System (NIS) includes all institutional and legal arrangements associated with the national inventory preparation process, as well as reporting this information on the national and international level. This process implies preliminary planning and preparation activities such as for example, defining specific responsibilities within the inventory preparation process (such responsibilities are described in section 1.2.2 'Institutional and Legal Arrangements', while Section 1.3 'Process for Inventory Preparation' provides more details about the inventory preparation process).

1.2.2 Institutional and Legal Arrangements

Within the MERN, the Climate Change Office (CCO) is totally responsible for the activities related to preparation of National Communications (NCs) and National Inventory Reports (NIRs). Figure 1-3 outlines the responsibilities and arrangements for the National Inventory System (NIS) of the Republic of Moldova.

Within the CCO the National Inventory Team (NIT) is responsible for estimating emissions by categories of sources and removals by categories of sinks, Key Sources Analysis, QA & QC procedures, uncertainties assessment, documentation, reporting and archiving of data related to inventory preparation process.

Below is a brief description of functional responsibilities of the participants in the process:

The National Inventory Team Leader (NITL), a full time employee in the CCO, is responsible for the inventory preparation process coordination, including supervision of estimating emissions by individual categories of sources and removals by individual categories of sinks, KSA, uncertainty analysis interpretation, QA&QC activities coordination, documentation and archiving the data used in the inventory preparation process, synthesis of sectoral reports - serving as basis for the NIR compilation.

The national experts (hired on a contract basis) are responsible for estimating emissions by individual categories of sources and removals by individual categories of sinks at sectoral level (Energy Sector, Industrial Processes Sector, Solvents and Other Products Use Sector, Agriculture Sector, LULUCF Sector and Waste Sector). The national experts are also responsible for development components of the NIR's sectoral chapters. They are also responsible for the AD collection, application of decision trees in terms of selecting suitable assessment methods and EFs, estimating emission uncertainties by individual categories of sources, as well as for taking correction measures as a response to QA&QC activities.

The activity data (AD) needed for inventory is available in the Statistical Yearbooks (SY), Energy Balances (EBs) and other sectoral statistic publications of the National Bureau of Statistics (NBS). Additional statistical data (unpublished) may be provided at request, in conformity with provisions of the Law No. 412 as of 09.12.2004 on 'Official Statistics', Article 9 (2), item a) and b), according to which "the official statistics authorities must disseminate statistical data to users in the amount, manner and terms specified in the statistical works programme", as well as to "to ensure access of all users to non-confidential statistic on equal conditions in terms of amount and terms of dissemination".

Other relevant AD are collected at request, from various partner organizations (Ministry of Transports and Roads (MTR), reorganised in 2008 into the Transport Agency, Ministry of Industry and Infrastructure (MII), reorganised in 2008 by a merger with the Ministry of Economy and Trade (MET), Ministry of Information Development (MID), Ministry of Agriculture and Food Industry (MAFI), Ministry of Defence (MoD), Ministry of Health (MH), Ministry of Internal Affaire (MIA), Academy of Sciences of Moldova (ASM), Forest Agency "Moldsilva", Agroindustrial Agency "Moldova-Vin", Land Relations and Cadastre Agency (LRCA), Civil Aviation State Administration (CASA), Customs Service (CS), State Ecological Inspectorate (SEI), Ozone Office under the MENR, IPROCOM State Projections Institute, "Moldavian Railways" State Enterprise, "Moldova-Gaz" J.S.C., "Lafarge-Ciment" J.S.C., etc.), based on the provisions of the Law on Access to Information, adopted by the Decision of the Parliament No. 982-XIV as of 11.05.2000 (Figure 1-4).

So, Article 1 of the Law on Access to Information regulates the relationships between information providers and individual / legal entity in the process of ensuring and implementing the constitutional right of access to information; principles, conditions, ways and manner of accomplishing access to official data owned by information providers; aspects of access to and protection of personal information within the scope of access to such data; rights of data solicitants, including petitioners of personal data; obligations of information providers in the process of ensuring access to official information; ways to protect the right to access to information. Article 4 (1) stipulates that "anyone, under this law's conditions, has the right to look for, receive and make public official information". According to Article 6 (1), "official information are deemed to be all information owned and available to information providers, developed, selected, processed, consolidated and /or adopted by authorities or official persons or made available to them by other legal entities". This Article is a review of information bearing documents as stipulated by the provisions of this law. Article 7 refers to cases of limited access to official information. Rights of data solicitants are reflected in Article 10, while Article 11 refers to the obligations of information provider. According to Article 13 (1), ways of access to information are the following: hearing of information which can be provided verbally; document review on the premises of the institution; issuing a copy of the requested document or information; issuing a copy of the document, information translated into a different language than the language of the original, for an additional charge; sending by mail (including e-mail) of a copy of the document, information, a copy of the translated document, information into a different language, at the solicitant's request, for a payment. Article 13(2) stipulate that extracts from registers, documents, information, as per solicitant's request, can be made available to the solicitant in a reasonable and acceptable to the solicitant form. Article 16 of the Law refers to the requirements that have to be met to ensure access to information: the requested information or documents shall be made available to the solicitant from the moment it becomes available for issuing, but not later than 15 working days from the date the application for access to information is registered; the leadership of the public institution may extend the term of providing the information, or document by 5 working days if: (1) the request refers to a very big volume of information requiring their selection; (2) additional consultations are needed to satisfy the request. The solicitant will be informed about any extension of the information delivery term and about the reasons for such extension 5 days prior to the expiry of the initial term. The Law also refers to cases when access to information is denied, to payments for official information provision, to modalities of protecting the right for access to information and prosecution in court of information providers' actions. Also, a series of laws contain provisions pertaining to wide public to environment protection related information. So, Article 29 (3) of the Law on Natural Resources, adopted by the Parliament Decision No. 1102-XIII as of 06.02.1997, stipulates that „Government, local public authorities, state bodies assigned with natural resources management and environment protection, as well as businesses, shall make public valid and accessible information regarding natural resources use and environment protection activities". Article 23 of the Forestry Code, adopted by the Parliament Decision No. 887 as of 21.06.1996, stipulates that citizens and NGO-s are entitled to receive information from the state forestry authorities and environment protection bodies about forestry and hunting resources, planned and accomplished conservation measures and use of such resources. The Regulation regarding trading and regulated use of halogenated hydrocarbons that deplete the ozone layer, approved by the Law of the Republic of Moldova No. 852-XV as of 14.02.2002, stipulates the procedure of presenting by the MENR of information regarding production, import, export, trading and use (recycled and reclaimed quantities of controlled substances) of halogenated hydrocarbons that deplete the ozone layer, regulated by Montreal Protocol.

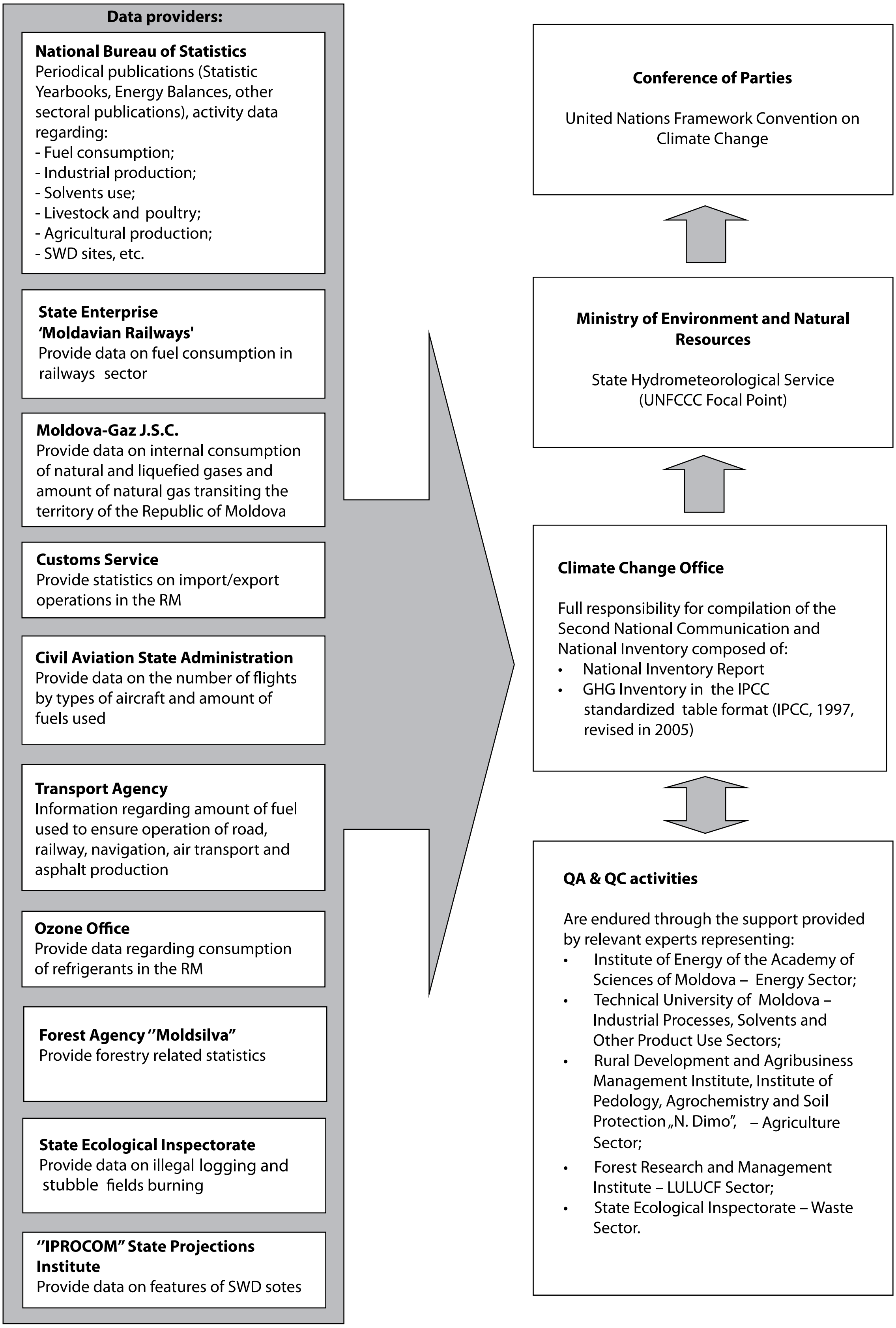

Figure 1-4: Institutional Arrangements for the National Inventory System

1.3 Process for Inventory Preparation

The Climate Change Office adopted a centralized approach to the process of preparing the national inventory comprising the NIR and standard estimation and reporting tables (IPCC, 1997, 2005). The National Inventory preparation process is outlined in Figure 1-5.

The NITL is responsible for compiling the estimations and ensuring consistency and quality of the inventory by producing the NIR. Estimation of emissions by individual source categories and removals by individual sink categories is the responsibility of national experts who are more competent about individual features of source/sink categories. The national experts, under direct coordination of the NITL, decide, by applying decision trees, on employing the best estimation methodology, collect AD needed for estimation. For most source categories methodologies used in the previous inventory cycle are applied. Under such circumstances it was needed to collect new AD for a more recent period under review or for the entire period under review if historical AD were amended or recalculated. If a new source/sink category was to be assessed, or a higher Tier methodology had to be used, then the NITL and national experts would decide on which assessment methodology to use, collect most reasonable AD and EFs, calculate GHG emissions, assess uncertainties, ensured implementation of verification, QA/QC procedures acting on behalf of educational, academic institutions, ministries and subordinated institutions, central public authorities and/or private sector. National experts produced explanatory texts for the research on estimation of emissions by individual source categories and removals by individual sink categories, as well as provided the bibliography used. NITL was responsible for collecting and reviewing these materials, used in drafting the NIR sectoral chapters (Chapter 3 'Energy', Chapter 4 'Industrial Processes', Chapter 5 'Solvents and Other Products Use', Chapter 6 'Agriculture', Chapter 7 'LULUCF', Chapter 8 'Waste'). The NITL was also responsible for drafting other chapters (Chapter 1 'Introduction', Chapter 2 'Trends in National GHG Emissions', Chapter 9 'Recalculations', 'Bibliography' and 'Annexes'), as well as for the KSA, compatible with GPG (IPCC, 2000) and GPG for Land Use, Change in Land Use and Forestry Sector (IPCC, 2003) requirements.

The NIR was produced in compliance with UNFCCC reporting guidelines on annual inventories. In addition to NIR, IPCC standard common reporting format tables were filled-in (IPCC, 1997; revised in 2005). NITL had the task to monitor the process of development the standard IPCC standard common reporting format tables, to ensure the consistency of results.

The national experts accomplished the uncertainties analysis, as well as verification and QA/QC activities, in close cooperation with the NITL. The QA/QC Plan produced in 2005 within the UNDP-GEF Regional Project "Capacity Building for Improving the Quality of the National GHG Inventories (Central Europe and CIS region)" complies with the GPG (IPCC, 2000) requirements.

During the peer reviews (QA procedure), the draft version of the NIR was sent to a group of independent experts (who did not previously participate in the national inventory preparation). The purpose of the inventory peer reviews was to receive from relevant experts in the areas of major interest comments on quality of the work done, in particular on relevance of methodological approaches, EFs and AD used. The received comments were reviewed and estimations and explanatory notes to them were corrected.

Following the final review, after the incorporation of comments received in the process of peer reviews, the Climate Change Office prepared the final version of the National Inventory Report, which was then electronically processed, printed and published. Once published, the National Inventory Report and the Second National Communication are submitted by the MENR to the COP, in conformity with international commitments of the Republic of Moldova under the UNFCCC.

1.4. Methodologies and Data Sources

The national inventory is structured to match the reporting requirement of the UNFCCC and is divided into six main sectors: (1) Energy, (2) Industrial Processes, (3) Solvents and Other Products Use, (4) Agriculture, (5) Land Use, Land-Use Change and Forestry and (6) Waste. Each of these sectors is further subdivided within the inventory (Table 1-5).

Emissions of direct (CO_2, CH_4, N_2O, HFC and SF_6) and indirect (NO_x, CO, NMVOC, SO_2) greenhouse gases were estimated based on methodologies contained in the Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories (IPCC, 1997), Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories (IPCC, 2000), Good Practice Guidance for Land Use, Land-Use Change and Forestry (IPCC, 2003), Atmospheric Emissions Inventory Guidebook (CORINAIR, 1996, 1999, 2005) and 2006 IPCC Guidelines for National Greenhouse Gas Inventories (IPCC, 2006).

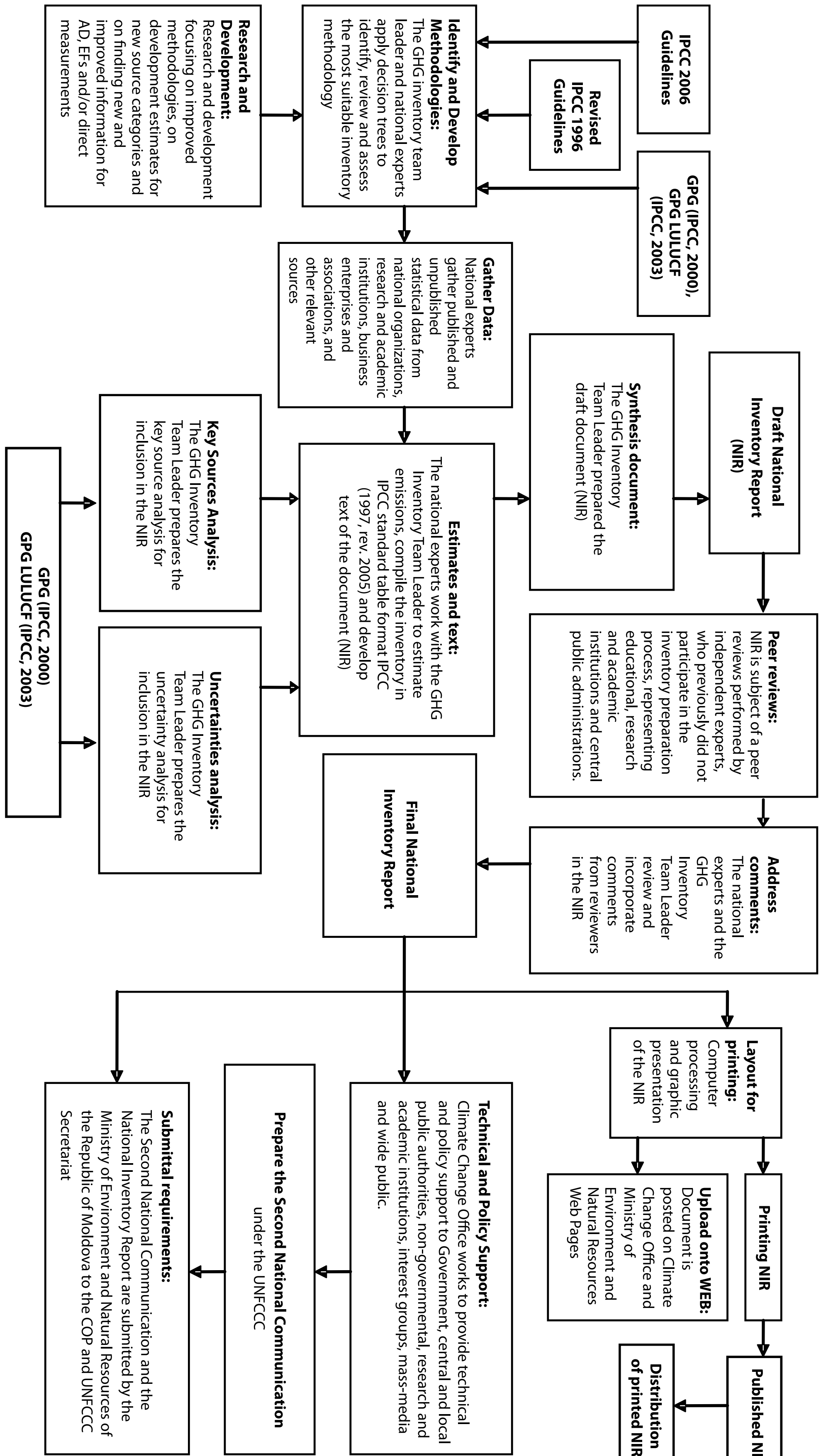

Figure 1-5: Inventory Process in the Republic of Moldova

In general, an emission and removals inventory can be defined as a comprehensive account of anthropogenic sources of emissions and removals by sinks and associated data from source categories within the inventory area over a specified time frame. It can be prepared "top-down", "bottom-up", or using a combination approach. The Republic of Moldova's national inventory is prepared using a "top-down" approach, providing estimates at a sectoral level of segregation without attribution to individual emitters. The CCO is continuously working to improve accuracy, completeness and transparency of its inventory. Comprehensive bottom-up inventory is neither practicable nor possible at the present time, although for some sectors, estimates are derived from detailed source specific data.

To the extent possible, AD used in this report are based on officially published data: national (SY of the RM, respectively of the Administrative-Territorial Units from the Left Bank of Dniester river (ATULBD), Energy Balances (EBs), etc.) and international statistical publications (International Statistic Yearbook of Iron and Steel, UN FAO database), publications of academic, research and development institutions (Institute of Pedology, Agrochemistry and Soil Protection "N. Dimo", Institute of Ecology and Geography, Institute of Energy, Forest Research and Management Institute, etc.), AD provided by ministries and subordinated institutions (MET, MID, MAFI, MoD, MH, MIA, CASA, MERN, SEI, SHS, Ozone Office) and central public authorities (National Bureau of Statistics, Transport Agency, Forestry Agency "Moldsilva", "Moldova-Vin" Agency, Agency for Land Relations and Cadastre, Customs Service), data obtained from enterprises and businesses associations (State Enterprise "Moldavian Railways", "Moldova-Gas" J.S.C., "Lafarge-Ciment" J.S.C.), legislation acts (*National Complex Program of Enhancing Soil Fertility in 2001-2020*, approved by the Government Decree No. 591 as of 20.06.2000; C*omplex Program for Reclamation of Degraded Lands and Enhancing Soils Fertility. Part I Reclamation of degraded lands*, approved by the Government Decree No. 636 as of 26.05.2003 and C*omplex Program for Reclamation of Degraded Lands and Enhancing Soils Fertility, Part II Enhancing Soils Fertility*, approved by the Government Decree No. 841 as of 26.07.2004).

1.5. Key Categories

According to GPG (IPCC, 2000, 2003), it is *good practice* to identify *key categories*, as it helps prioritize efforts and improve the overall quality of the national inventory.

A "key category" is defined as a "*source or sink category, that is prioritized 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 trend in emissions, or both.*" By definition, key categories include those sources that have the greatest contribution to the absolute level of national emissions. In addition, when an entire time series of emissions estimates is prepared, a thorough investigation of key categories must also account for the influence of trends of individual sources and sink categories.

Table 1-6 presents the key categories for the Republic of Moldova inventory based on the Tier 1 methodological approach [with LULUCF: 18 key categories by level (L) and 16 key categories by trend (T); without LULUCF: 17 key categories by level (L) and 13 key categories by trend (T)] using emissions data for the 1990-2005 period.

Following the recommendations set in the GPG (IPCC, 2000, 2003), the inventory was first disaggregated by source and sink categories which further were used to identify key categories. Source categories were defined in conformity with the following guidelines: (1) IPCC categories should be used with emissions specified in CO_2 equivalent units according to standard GWP; (2) a category should be identified for each gas emitted by the sources, since the methods, emission factors, and related uncertainties differ for each gas; (3) source categories that use the same emission factors based on common assumptions should be aggregated before analysis.

Key categories were identified from two perspectives: the first analysis the emission contribution that each category makes to the national total (with and without LULUCF); and the second perspective analysis the trend of emission contributions from each category to identify where the greatest absolute changes (either increases or reductions) have taken place over a given time (with and without LULUCF categories). The percent contributions to both level levels and trends in emissions are calculated and sorted from greatest to least. A cumulative total is calculated for both approaches. IPCC has determined that a cumulative contribution threshold of 95% for both level and trend assessments is a reasonable approximation of 90% uncertainty for the Tier 1 method of determining key categories (IPCC, 2000). The 95% cumulative contribution threshold has been used in this analysis to define an upper boundary for the key category identification. Therefore, when source and/or sink contributions are sorted in decreasing order of importance, those that contribute to 95% of the cumulative total are considered quantitatively to be key.

The Key Sources Analysis (KSA) was carried out using the Key Source Estimation Tool developed by the United States Environment Protection Agency (US EPA)

Table 1-5: Summary of Methods and Emission Factors Used for Inventory Preparation Process in the Republic of Moldova

Categories by sources and sinks	CO_2		CH_4		N_2O		HFC		PFC		SF_6	
	Method	EF	Method	EF	Method	EF	Method	EF	Method	EF	Method	EF
1. Energy	T1	D, CS	T1	D	T1	D						
A. Fuel Combustion Activities	T1	D, CS	T1	D	T1	D						
1. Energy Industries	T1	D, CS	T1	D	T1	D						
2. Manufacturing Industries and Construction	T1	D, CS	T1	D	T1	D						
3. Transport	T1	D, CS	T1	D	T1	D						
4. Other Sectors	T1	D, CS	T1	D	T1	D						
5. Other (other works and needs in energy sector)	T1	D, CS	T1	D	T1	D						
B. Fugitive Emissions from Oil and Natural Gas	T1	D, CS	T1	D	T1	D						
1. Solid fuels	NO, NE	NO, NE	NO, NE	NO, NE	NO, NE	NO, NE						
2. Oil and Natural Gas	T1	D, CS	T1	D	T1	D						
2. Industrial Processes	T2, T1	D, CS	T1	D	T1	D	T2, T1	D	NO,NE	NO,NE	T2, T1	D
A. Mineral Products	T2, T1	D, CS	NA	NA	NA	NA						
B. Chemical Industries	NO, NE	NO, NE	NO, NE	NO, NE	NO, NE	NO, NE						
C. Metal production	T1	D	T1	D	T1	D						
D. Other production	T1	D, CS	NA	NA	NA	NA						
E. Production of halocarbons and SF_6							NO,NE	NO,NE	NO,NE	NO,NE	NO,NE	NO,NE
F. Consumption of halocarbons and SF_6							T2, T1	D	NO,NE	NO,NE	T2, T1	D
3. Solvents and Other Products Use	C	D	NA	NA	C	D						
A. Paint application	C	D	NA	NA	NA	NA						
B. Degreasing and dry cleaning	C	D	NA	NA	NA	NA						
C. Chemical Products, Manufacture and Processing	C	D	NA	NA	NA	NA						
D. Other	C	D	NA	NA	C	D						
4. Agriculture			T2, T1	D, CS	T2, T1	D, CS						
A. Enteric fermentation			T2, T1	D, CS	NA	NA						
B. Manure management			T2, T1	D, CS	T2, T1	D, CS						
C. Rice cultivation			NO	NO	NA	NA						
D. Agricultural soils			NA	NA	T1	D, CS						
E. Prescribed burning of savannas			NO	NO	NA	NA						
F. Field burning of agricultural residues			IE	IE	IE	IE						
5. LULUCF	T2, T1	D, CS	T1	D	T1	D						
A. Forest lands	T2, T1	D, CS	T1	D	T1	D						
B. Croplands	T2, T1	D, CS	T1	D	T1	D						
C. Grasslands	T2, T1	D, CS	NE	NE	NE	NE						
D. Wetlands	NE	NE	NE	NE	NE	NE						
E. Settlements	IE	IE	NE	NE	NE	NE						
6. Waste			T2, T1	D, CS	T1	D						
A. Solid Waste Disposal on Land			T2, T1	D, CS	NA	NA						
B. Wastewater Handling			T1	D, CS	T1	D						
C. Waste Incineration			NO, NE	NO, NE	NO, NE	NO, NE						
7. Other	NO, NE	NO, NE	NO, NE	NO, NE	NO, NE	NO, NE						
International bunkers	T2, T1	D, CS	T1	D	T1	D						
CO_2 emissions from biomass	T1	D, CS										

Abbreviations: T1 – Tier 1 method; T2 – Tier 2 method; C – CORINAIR; CS –Country Specific; D –Default Use; IE – Included Elsewhere; NA – Not Applicable; NE –Not Estimates; NO – Not Occurring

Table 1-6: Summary Overview of the Republic of Moldova's Key Source Categories (1990-2005) Based on Tier 1 Approach

IPCC classification	Key Categories by Sources and Sinks	Gas	Tier 1 approach				2005 emissions / removals, Gg CO_2 eq.
			with LULUCF		without LULUCF		
			L	T	L	T	
1A	Stationary Fuel Combustion – Natural Gas	CO_2	X	X	X	X	4441.8224
5A	Forest Land	CO_2	X	X			-2246.2332
5B	Cropland	CO_2	X	X			1684.2815
1A3b	Road Transportation	CO_2	X	X	X	X	1459.4096
6A	Solid Waste Disposal on Land	CH_4	X	X	X	X	1186.2060
5C	Grassland	CO_2	X	X			-819.4560
4A	Enteric Fermentation	CH_4	X	X	X	X	792.8592
1B2	Fugitive Emissions from Oil and Natural Gas	CH_4	X	X	X	X	652.0090
4D	Direct Emissions from Agricultural Soils	N_2O	X	X	X	X	560.1846
4B	Direct Emissions from Manure Management	N_2O	X	X	X	X	469.1675
1A	Stationary Fuel Combustion – Coal	CO_2	X	X	X	X	450.0661
2A1	Cement Production	CO_2	X	X	X	X	373.2628
7	CO_2 Emissions from Biomass	CO_2	X	X	X	X	295.0374
1A	Stationary Fuel Combustion –Oil	CO_2	X	X	X	X	231.9371
1A4c	Mobile Fuel Combustion: Agriculture/Forestry/Fishing	CO_2	X	X	X	X	177.6497
4D	Indirect Emissions from Agricultural Soils	N_2O	X	X	X		139.0628
6B	Wastewater Handling	CH_4	X		X		121.0136
1A3c	Railways	CO_2	X		X		115.1175
1A5	Mobile Fuel Combustion: Other Works and Needs in Energy Sector	CO_2			X	X	107.9239
4B	Indirect Emissions from Manure Management	N_2O			X		95.9399
Sub-total Without LULUCF							11668.6691
Total Emissions Without LULUCF							11883.4583
Percent of Total Without LULUCF							98.2%
Sub-total With LULUCF							10287.2613
Total Emissions With LULUCF							10502.3958
Percent of Total With LULUCF							98.0%

Abbreviations: L – Level Assessment; T – Trend Assessment.

1.6. Quality Assurance and Quality Control

As per recommendations of the GPG (IPCC, 2000), national inventories have to be transparent, consistent, comparable, complete, accurate, well documented, assessed for uncertainties, subject to verification and QA/QC.

Good Practice Guidance (IPCC, 2000) defines the QA/QC terms as follows:

Quality Control (QC) is a system of routine technical activities to measure and control the quality of the inventory as it is being developed. A basic QC system should provide routine and consistent checks to ensure data integrity, correctness, and completeness; identify and address errors and omissions; and document and archive inventory material and record all QC activities;

Quality Assurance (QA) comprises a planned system of review procedures conducted by personnel not directly involved in the inventory compilation and development process.

As a part of continuous efforts to develop a transparent and reliable inventory, within the 2003-2005 under the UNDP-GEF Regional Project "Capacity Building for Improving the Quality of Greenhouse Gases National Inventories (Central Europe and CIS region)", Republic of Moldova developed a Quality Assurance and Quality Control Plan and the Procedures Manual for Quality Assurance and Quality Control.

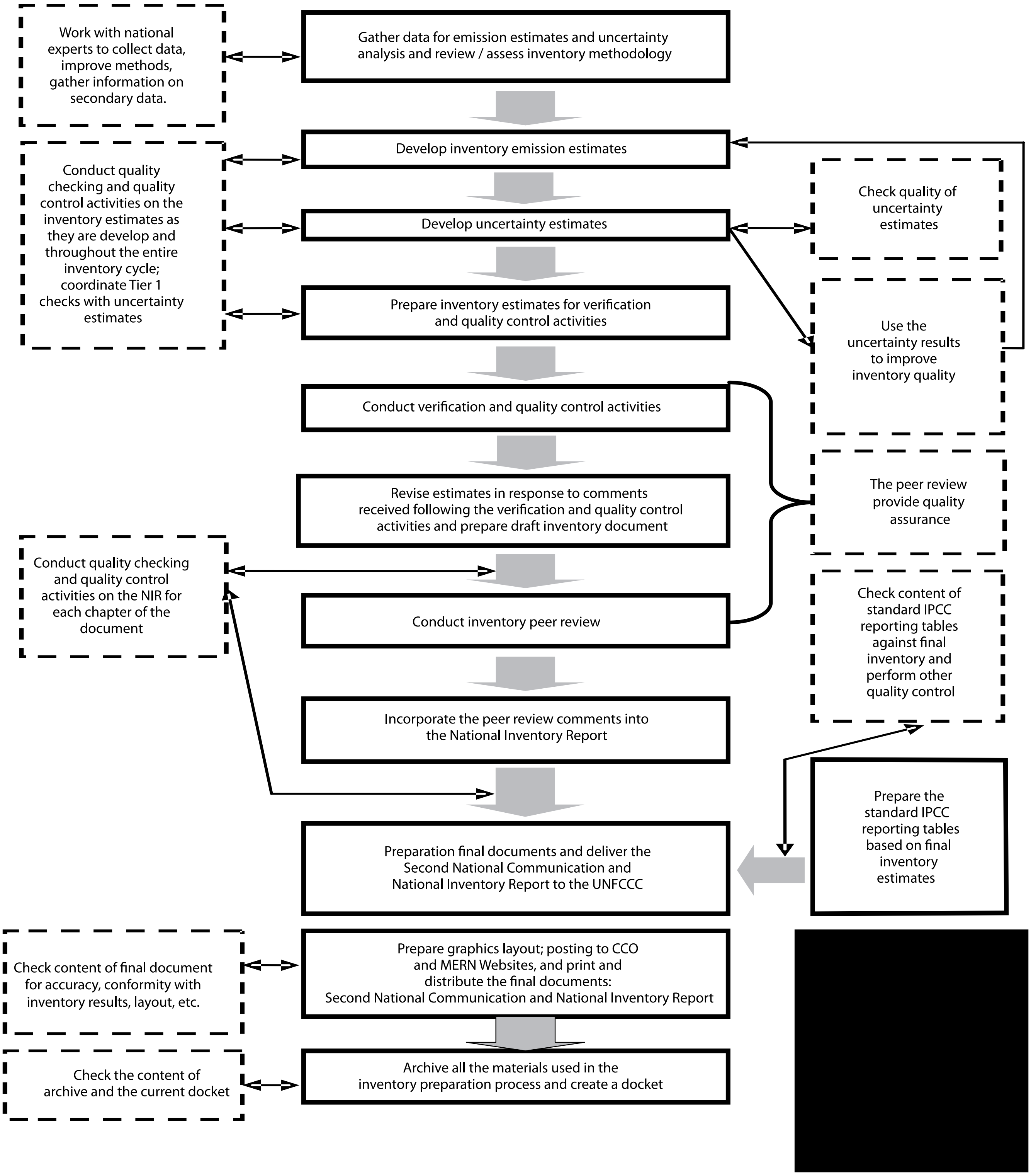

Figure 1-6: The Role of QA/QC Activities in the Inventory Preparing Process

The key attributes of the Quality Assurance and Quality Control Plan include detailed Tier 1 (general procedures) and Tier 2 (source-specific) procedures (Figure 1-6) and standard verification and quality control forms and check-lists (Annex 6), that serve to standardize the process of implementing quality assurance and quality control activities meant to ensure the quality of the national inventory; peer review carried out by experts not directly involved in the national inventory development process; data quality check, as well as the documentation and archiving of all materials used in inventory preparation process.

It is well known that inventory development implies huge amounts of information that has to be gathered, handled and stored. The process sustainability is ensured through a good management and archiving of materials used along the inventory process.

In the Republic of Moldova, the National Inventory Team has a sufficiently transparent documentation allowing to fully reproducing the GHG emissions estimates. A standard system for documenting and archiving numeric and qualitative information, in compliance with the Revised 1996 IPCC Guidelines (IPCC, 1997) and GPG (IPCC, 2000) recommendations was used.

The activity data sources were documented by inserting references to these into the inventory document text. Estimation methods & emission factors sources and their selection justification are documented in the corresponding chapters of the NIR. Recalculations made are documented and argued both in sectoral Chapters (3-8), as well as in the Chapter 9 'Recalculations and Improvements' of the NIR.

Individual source categories related documentation include: (1) list of personnel responsible for estimates and individual responsibilities as per Terms of Reference; (2) reference sources for the activity data used; (3); justification of emission factors estimation methods selection; (4) samples of GHG emissions estimation process (in Excel format); (5) uncertainties analysis results by individual source categories; (6) annexes; (7) references.

Materials used in the inventory development process were archived both electronically and on hard copies. As the entity responsible for the national inventory development, the CCO holds all documentation used for its compilation.

Summing up, one can assert that transparency and credibility of a national inventory are ensured through: (1) the ability to demonstrate, through appropriate documentation, transparency of inventory development process; (2) further improvements of the inventory process and its basic products; and (3) ensuring that the inventory process employed consistent approaches allowing to obtain comparable results for all source categories. It is obvious that in comparison with the previous inventory cycles, by continuous integration of QA/QC activities, the Republic of Moldova ensured a better quality inventory.

1.7. Inventory Uncertainty

Uncertainty estimates are an essential element of a complete and transparent emissions inventory. Uncertainty information is not intended to dispute the validity of inventory estimates, but to help prioritize efforts to improve the accuracy of future inventories and guide future decisions on methodological choice. While the Republic of Moldova's Inventory calculates its emission estimates with the highest possible accuracy, uncertainties are associated to a varying degree with the development of emission estimates for any inventory. Some of current estimates, such as those for CO_2 emissions from energy-related activities and cement processing, are considered to have minimal uncertainty associated with them. For some other categories of emissions, however, a lack of data or an incomplete understanding of how emissions are generated increases the uncertainty surrounding the estimates presented. Despite these uncertainties, the UNFCCC reporting guidelines follow the recommendation in the Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories and require that countries provide single point estimates of uncertainty for each gas and emission or removal source category. Within the discussion of each emission source, specific factors affecting the uncertainty associated with the estimates are discussed.

Additional research in the following areas could help reduce uncertainty in the Republic of Moldova's Inventory:

Incorporating excluded emission sources. Quantitative estimates for some of the sources and sinks of GHG emissions are not available at this time. In particular, emissions from a number of categories in Industrial Processes Sector and Land Use, Land-Use Changes and Forestry Sector are not included in the inventory because data are incomplete.

Improving the accuracy of emission factors. Further research is needed in some cases to improve the accuracy of emission factors used to calculate emissions from a variety of sources. For example, the accuracy of current emission factors applied to CH_4 from oil and natural gas, emissions of CO_2 from solvents and other products use, indirect N_2O emissions from waste management and indirect N_2O emissions from agricultural soils is highly uncertain.

Collecting detailed activity data. Although methodologies exist for estimating emissions for some sources, problems arise in obtaining activity data at a level of detail in which aggregate emission factor can be applied. For example, the ability to estimate emissions of F-gases from Industrial Processes Sector is limited due to lack of activity data regarding national F-gases consumption or average equipment leak rates.

The overall inventory uncertainty was estimated using a Tier 1 methodological approach (IPCC, 2000). An estimate of the overall quantitative uncertainty, ±16.0 percent level uncertainty and ±3.9 percent trend uncertainty, are shown in Table 1-7, as well as in the Annex 7 of the NIR that includes more information on the uncertainty analysis performed for selected source categories.

Table 1-7: Estimated Overall National Inventory Quantitative Uncertainty, %

Indicator	CO_2	CH_4	N_2O	Total
Level Uncertainty	±14.1	±48.6	±22.0	±16.0
Trend Uncertainty	±3.3	±17.6	±5.3	±3.9

Emissions evaluated under the Republic of Moldova's GHG Inventory reflect current best estimates; in some cases, however, estimates are based on approximate methodologies, assumptions, and incomplete data. As new information become available in the future, the Republic of Moldova will continue to improve and revise its emission estimates.

1.8. Completeness Assessment

The National Inventory, for the most part, is a complete inventory of direct and indirect GHGs required under the UNFCCC (CO_2, CH_4, N_2O, HFCs, SF_6; no PFCs emissions have not been registered so far in the RM; CO, NO_x, NMVOC and SO_2).

Despite the effort to cover all existent sources and sinks, the inventory still has some gaps, most being determined by lack of activity data needed to estimate certain emissions and removals, such as: emissions of CO_2 from the 2A3 'Lime and Dolomite Use'; emissions of F-gases (HFC, PFC andSF_6) from 2F2 'Foam Blowing', 2F3 'Fire Extinguishes', 2F5 'Solvents' and 2F6 'Other Applications With ODS'; CO_2 emissions and removals from 5D 'Wetlands'; and GHG emissions from 6C 'Waste Incineration' (in particular, from medical waste).

As part of the improvement plan, efforts are continuously being made to identify and assess relevant new sources and sinks for which cost-effective estimation methods are available. Further details on the completeness of the inventory can be found in Annex 5.

2. GREENHOUSE GAS EMISSION TRENDS, 1990-2005

2.1 Summary of Emission Trends

Between 1990 and 2005, the evolution of total direct greenhouse gas emissions expressed in CO_2 equivalent, revealed a decreasing trend in the Republic of Moldova, reducing by circa 72.3 percent: from 42886.0 Gg CO_2 equivalent in 1990 to 11883.5 Gg CO_2 equivalent in 2005 (Figure 2-1).

The most significant emissions reductions have been registered under the following source categories: 1A1 'Energy Industries' (-84.6 percent), 1A2 'Manufacturing Industries and Constructions' (-81.9 percent), 1A4 'Other Sectors' (-76.2 percent), 2A 'Mineral Products' (-66.9 percent), 4B 'Manure Management' (-62.6 percent), 4D 'Agricultural Soils' (-59.3 percent), 1A3 'Transport' (-59.2 percent), 4A 'Enteric Fermentation' (-58.3 percent) etc. Between 2004 and 2005 total emissions increased in the Republic of Moldova by circa 3.1 percent, in particular due to increased emissions from the source categories 2F 'Consumption of HFCs and SF_6' (+42.3 percent), 2A 'Mineral Products' (+27.1 percent), 1A2 'Manufacturing Industries and Constructions' (+24.1 percent), 2D2 'Other Products' (+11.7 percent), 6B 'Wastewater Handling' (+8.2 percent), 1B2 'Fugitive Emissions From Oil and Natural Gas' (+5.9 percent), 2C1 'Steel Production' (+3.5 percent), 3A-D 'Solvents and Other Products Use' (+2.5 percent), etc.

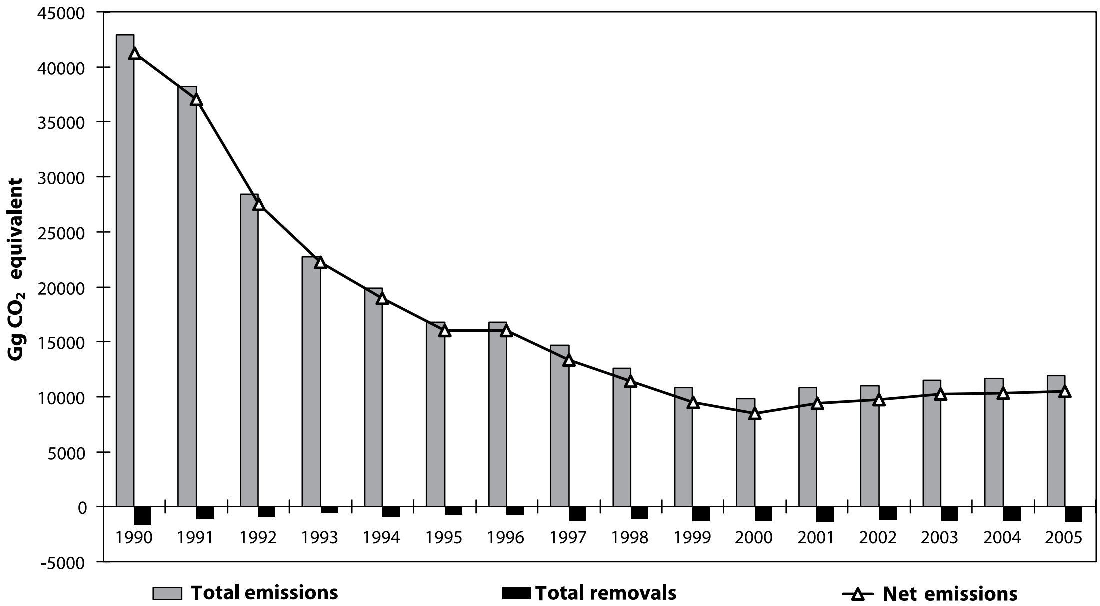

Figure 2-1: Greenhouse Gas Emission and Sink Trends in the Republic of Moldova, 1990-2005

2.2 Emission Trends by Gas

In the time series from 1990 through 2005, the total CO_2 emissions (without LULUCF) decreased by circa 78.2 percent: from 34765.3 Gg in 1990, to 7576.6 Gg in 2005. Reduction of CO_2 emissions is even more significant, if contribution of LULUCF Sector is considered, circa 81.3 percent: from 33080.8 Gg in 1990, to 6195.2 Gg in 2005 (Table 2-1).

Table 2-1: Greenhouse Gas Emission Trends in the Republic of Moldova's in Gg CO_2 eq., 1990-2005

	1990	1991	1992	1993	1994	1995	1996	1997
CO_2 (without LULUCF)	34765.28	30343.62	21197.71	16317.45	13704.76	10852.00	11092.66	9380.50
CO_2 (with LULUCF)	33088.79	29184.86	20279.14	15772.25	12829.33	10093.24	10350.88	8051.67
CH_4 (without LULUCF)	4766.08	4571.88	4416.79	4057.75	4026.04	3920.22	3875.33	3507.32
CH_4 (with LULUCF)	4768.39	4573.85	4418.62	4060.43	4027.81	3922.22	3876.88	3510.13
N_2O (without LULUCF)	3354.66	3259.97	2761.74	2385.69	2116.82	1985.93	1803.34	1763.00
N_2O (with LULUCF)	3355.64	3260.75	2762.45	2386.76	2117.53	1986.70	1803.94	1764.08
HFCs	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO
SF_6	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO
Total (without LULUCF)	42886.02	38175.48	28376.24	22760.89	19847.63	16758.16	16771.33	14650.82
Total (with LULUCF)	41212.82	37019.46	27460.21	22219.44	18974.66	16002.16	16031.71	13325.88
	1998	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**
CO_2 (without LULUCF)	7759.55	6008.48	5206.70	6415.19	6484.98	7086.39	7283.96	7576.58
CO_2 (with LULUCF)	6599.56	4694.30	3852.41	5025.16	5252.71	5772.36	5964.54	6195.17
CH_4 (without LULUCF)	3292.29	3347.72	3209.71	3026.60	3031.39	3025.00	2961.96	2883.82
CH_4 (with LULUCF)	3294.80	3350.04	3210.53	3027.81	3031.65	3025.07	2962.18	2884.06
N_2O (without LULUCF)	1553.28	1466.15	1419.33	1377.52	1442.63	1409.15	1421.59	1404.06
N_2O (with LULUCF)	1554.27	1467.06	1419.65	1378.04	1442.75	1409.20	1421.75	1404.16
HFCs	NE, NO	NE, NO	4.21	5.41	7.56	10.02	13.07	18.72
SF_6	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	0.01	0.28	0.28
Total (without LULUCF)	12605.12	10822.35	9839.95	10824.72	10966.56	11530.56	11680.85	11883.46
Total (with LULUCF)	11448.63	9511.40	8486.80	9436.42	9734.67	10216.65	10361.81	10502.40

Abbreviations: NE – 'Not Estimated'; NO – 'Not Occurring'.

Emissions of CH_4 (without LULUCF) have decreased by circa 39.5 percent: from 4766.1 Gg CO_2 eq. in 1990, to 2883.8 Gg CO_2 eq. in 2005, while emissions of N_2O (without LULUCF) decreased by circa 58.1 percent: from 3354.7 Gg CO_2 eq. in 1990, to 1404.1 Gg CO_2 eq. in 2005. Halocarbons emissions (in particular HFCs, as no PFCs emissions have been registered so far in the Republic of Moldova) and sulphur hexafluoride (SF_6) emissions commenced in 2000, considered as a reference year for F-gases in the Republic of Moldova. Evolution of these emissions denotes a steady trend towards increase, though their share in the total national emissions structure is insignificant for now.

CO_2 continue to contribute most to the total national direct greenhouse gas emissions in the Republic of Moldova. Figure 2-2 shows the variation of the share of direct GHG emissions by gas in the structure of total national emissions in 1990 and 2005.

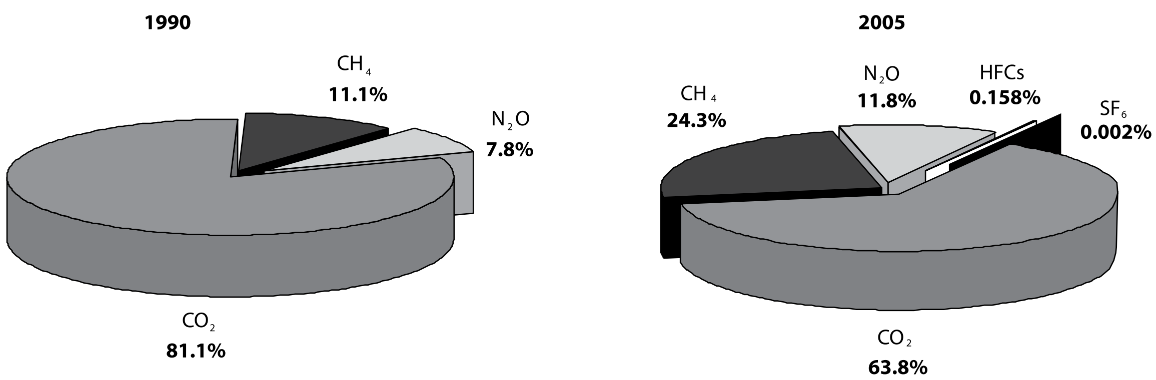

Figure 2-2: Republic of Moldova's GHG Emissions by Gas, 1990 and 2005

In 2005, source categories of CO_2 having the biggest share in the total dioxide of carbon emissions in the Republic of Moldova were: 1A1 'Energy Industries' (2986.57 Gg or 39.4 percent of the total), 1A3b 'Road Transport' (1459.41 Gg or 19.3 percent of the total), 1A4b 'Residential Sector' (1327.44 Gg or 17.5 percent of the total), 1A2 'Manufacturing Industries and Constructions' (396.38 Gg or 5.2 percent of the total), 2A1 'Cement Production' (373.26 Gg or 4.9 percent of the total) and 1A4a 'Institutional and Commercial Sectors' (361.52 Gg or 4.8 percent of the total) (Figure 2-3).

In 2005, the source categories of CH_4 having the biggest share in the total methane emissions in the Republic of Moldova were: 6A 'Solid Waste Disposal on Land' (1186.21 Gg CO_2 eq. or 41.1 percent of the total), 4A 'Enteric Fermentation' (792.86 Gg CO_2 eq. or 27.5 percent of the total), 1B2 'Fugitive Emissions From Oil and Natural Gas' (652.01 Gg CO_2 eq. or 22.6 percent of the total) and 6B 'Wastewater Handling' (121.01 Gg CO_2 eq. or 4.2 percent of the total) (Figure 2-4).

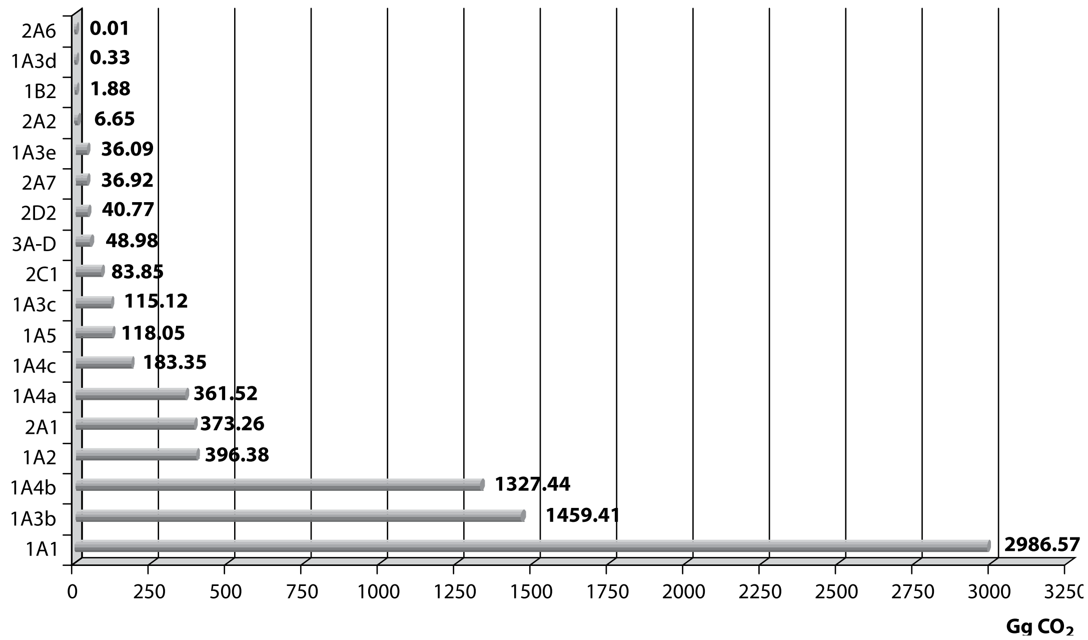

Figure 2-3: 2005 Source Categories of CO_2 in the Republic of Moldova

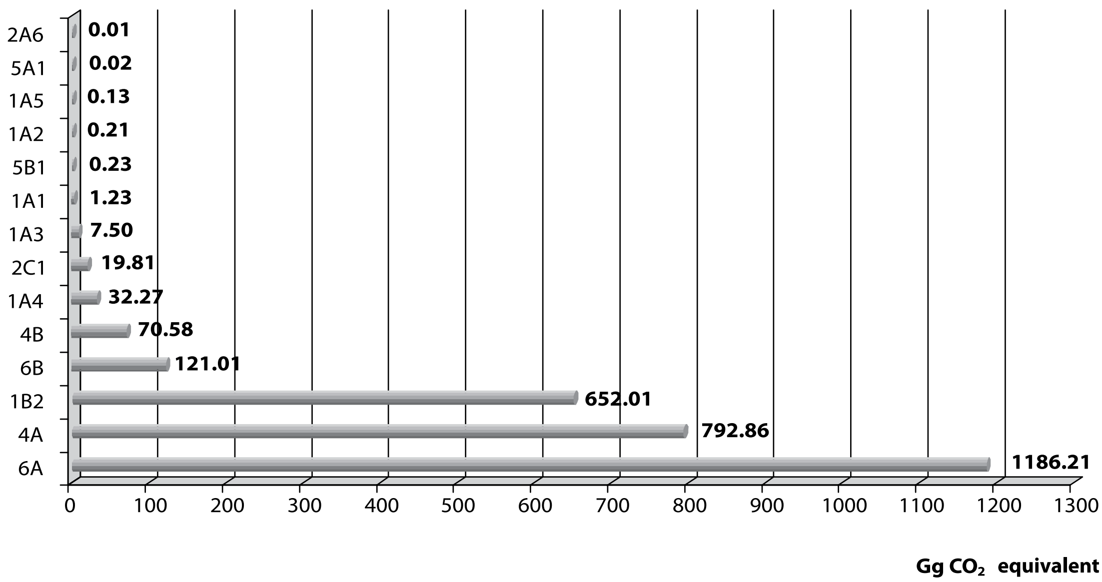

Figure 2-4: 2005 Source Categories of CH_4 in the Republic of Moldova

In 2005, the source categories of N_2O having the biggest share in the total nitrous oxide emissions in the Republic of Moldova were: 4D 'Agricultural Soils' (699.25 Gg CO_2 eq. or 49.8 percent of the total), 4B 'Manure Management' (565.11 Gg CO_2 eq. or 40.2 percent of the total), 6B 'Wastewater Handling' (92,74 Gg CO_2 eq. or 6.6 percent of the total) and 1A3 Transport (36.07 Gg CO_2 eq. or 2.6 percent of the total) (Figure 2-5).

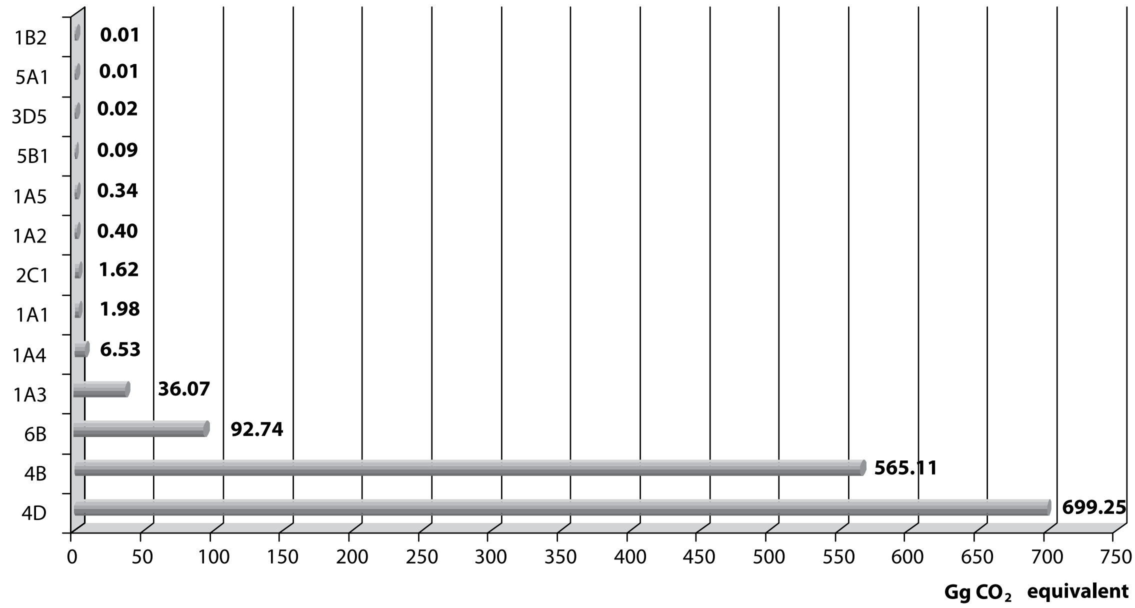

Figure 2-5: 2005 Source Categories of N_2O in the Republic of Moldova

2.3 Emission Trends by Category

According to the UNFCCC Reporting Guidelines, emissions estimates are grouped into six large IPCC categories: Energy Sector, Industrial Processes Sector, Solvents and Other Products Use Sector, Agriculture Sector, Land Use, Land-Use Change and Forestry Sector and Waste Sector (Table 2-2).

Interpretation of GHG emissions inventory results under Land Use, Land-Use Change and Forestry Sector is somewhat different from other sectors: positive figures indicate that this sector is a net source, while negative figures state that the sector is a net source of removals.

Table 2-2: Greenhouse Gas Emission and Sink Trends in the Republic of Moldova by Sector in Gg CO_2 eq., 1990-2005

	1990	1991	1992	1993	1994	1995	1996	1997
1. Energy	34520.39	30220.38	21384.24	16475.22	13975.19	11135.71	11430.27	9526.58
2. IP	1348.75	1103.55	575.77	516.87	382.14	380.65	389.81	434.97
3. SOPU	65.62	59.68	46.88	37.07	31.29	28.06	28.21	29.88
4. Agriculture	5323.92	5035.34	4494.45	3839.78	3599.75	3386.18	3046.47	2839.22
5. LULUCF	-1673.20	-1156.02	-916.03	-541.45	-872.97	-756.00	-739.62	-1324.94
6. Waste	1627.34	1756.53	1874.89	1891.95	1859.26	1827.57	1876.57	1820.17
	1998	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**
1. Energy	7938.33	6184.74	5437.82	6639.87	6738.33	7328.40	7490.74	7724.81
2. IP	354.72	339.26	325.60	331.13	344.10	408.04	479.52	581.90
3. SOPU	30.39	29.77	33.06	34.71	40.78	41.67	47.82	49.00
4. Agriculture	2518.31	2438.03	2312.19	2215.97	2313.91	2253.13	2210.72	2127.79
5. LULUCF	-1156.49	-1310.95	-1353.15	-1388.30	-1231.89	-1313.91	-1319.04	-1381.06
6. Waste	1763.38	1830.55	1731.28	1603.04	1529.44	1499.32	1452.05	1399.96

In the time series 1990 through 2005, total direct emissions and removals in the Republic of Moldova tended to decrease, so emissions under Energy Sector decreased by circa 77.6 percent (but increased by 3.1 percent in 2004), Industrial Processes Sector – by circa 56.9 percent (a significant increase by 21.3 percent, against the level of year 2004), Solvents and Other Products Use Sector – by circa 25.3 percent (a 2.5 percent increase against the level of year 2004), Agriculture Sector – by 60.0 percent (decrease by 3.8 percent against the level of year 2004), Land Use, Land-Use Change and Forestry Sector – by 17.5 percent (a 4.7 percent increase against the level of year 2004), Waste Sector – by 14.0 percent (decrease by 3.6 percent against the level of year 2004) (Table 2-2).

Energy Sector is the most important source of national direct GHG emissions (without LULUCF), its share varying from 80.5 percent to 65.0 percent over the time series from 1990 through 2005. Other relevant sources are represented by Agriculture Sector (having a share of 12.4 percent in 1990 and respectively 17.9 percent in 2005), Waste Sector (3.8 percent in 1990 and respectively 11.8 percent in 2005), and Industrial Processes Sector (3.1 percent in 1990 and respectively 4.9 percent in 2005) (Figure 2-6).

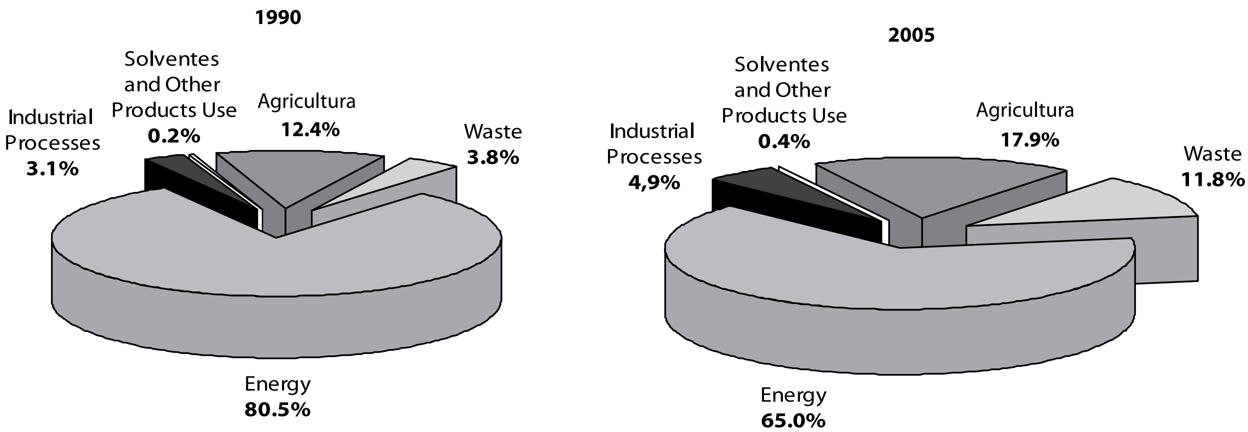

Figure 2-6: Sectoral Breakdown of the Republic of Moldova's GHG Emissions in 1990 and 2005

2.3.1 Energy Sector

Energy-related activities are by far the largest source of GHG emissions in the Republic of Moldova. The Energy Sector includes emissions of all GHGs from fuel combustion for the primary purpose of delivering energy. Emissions in this sector are classified as either fuel combustion (91.5 percent of total emissions per sector in 2005) or fugitive releases (8.5 percent of total emissions per sector in 2005). Fugitive emissions are defined as intentional or unintentional releases of GHGs from the production, processing, transmission, storage, and delivery of fossil fuels.

Overall, fuel combustion and fugitive emissions accounted for 65 per cent of total Republic of Moldova's GHG emissions in 2005. Between 1990 and 2005, total GHG emissions from Energy Sector decreased by circa 77.6 percent: from 34520.39 Gg CO_2 eq. in 1990 to la 7724.81 Gg CO_2 eq. in 2005 (Table 2-3, Figure 2-7).

Table 2-3: GHG Emissions from Energy Sector by IPCC Sub-Sectors in the Republic of Moldova for selected years

SOURCE CATEGORIES	1990	1995	2000	2004	2005
	Gg CO_2 eq				
1. Energy	34520.3934	11135.7054	5437.8217	7490.7434	7724.8084
A. Fuel Combustion	33837.4613	10579.7236	4934.4264	6873.2101	7070.9133
A.1. Energy Industries	19393.2858	6931.7635	2653.7086	2944.2215	2989.7745
A.2. Manufacturing industries and constructions	2195.8930	316.6535	258.1721	319.8028	396.9942
A.3. Transport	4055.6062	1328.5183	848.2701	1621.5871	1654.5168
A.4. Other Sectors	8037.7787	1829.4654	1122.7638	1864.5957	1911.1082
A.5. Other	154.8976	173.3229	51.5118	123.0030	118.5196
B. Fugitive Emissions	682.9320	555.9818	503.3952	617.5333	653.8950
B.2. Fugitive Emissions from Oil and Natural Gas	682.9320	555.9818	503.3952	617.5333	653.8950

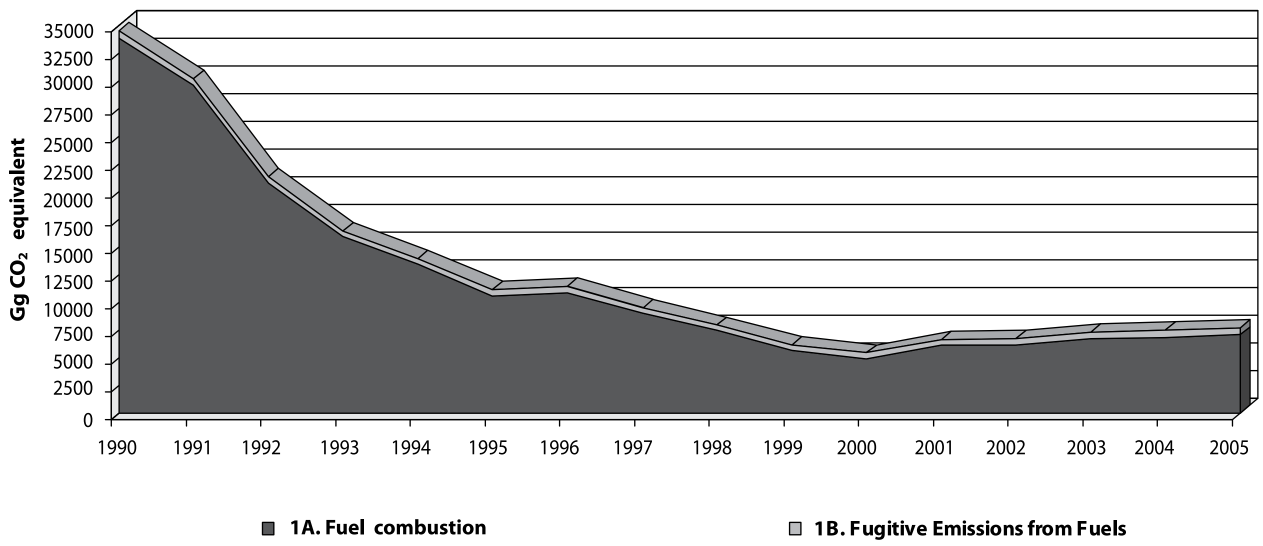

Figure 2-7: Energy GHG Emissions by IPCC category in the Republic of Moldova, 1990-2005

The 1A1 'Energy Industries' grouped in the Energy Sector, contribute more than any other category to the Republic of Moldova's emissions, accounting for circa 38.7 percent of the total per sector in 2005 (56.2 percent in 1990). Other relevant categories are represented by 1A4 'Other Sectors', accounting for 24.7 percent of the total per sector in 2005 (23.3 percent in 1990), 1A3 'Transport', accounting for circa 21.4 percent of the total in 2005 (11.7 percent in 1990) and 1B2 'Fugitive Emissions' accounting for 8.5 percent of the total in 2005 (2.0 percent in 1990) (Figure 2-8).

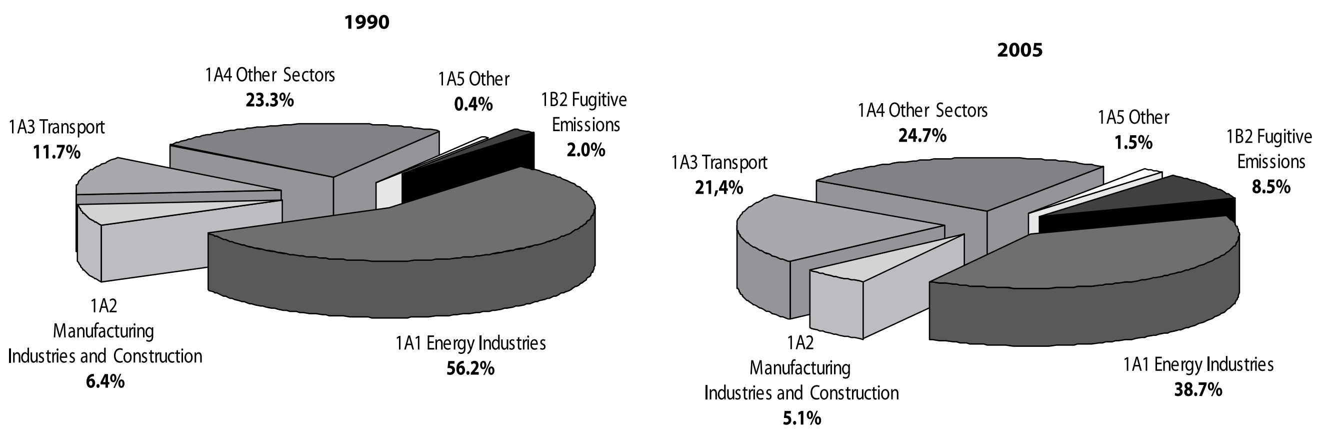

Figure 2-8: Energy Sector Greenhouse Gas Sources in the Republic of Moldova in 1990 and 2005

Fuel combustion

Between 1990 and 2005, fuel combustion-related emissions decreased by 79.1 percent: from 33837.5 Gg CO_2 eq. in 1990, to 7070.9 Gg CO_2 eq. in 2005 (Table 2-3). Fuel combustion emissions are divided into the following IPCC sub-sectors: 1A1 'Energy Industries', 1A2 'Manufacturing Industries and Constructions', 1A3 'Transport' (1A3a 'Aviation', 1A3b 'Roads', 1A3c 'Railways', 1A3d 'Navigation', 1A3e 'Pipelines'), 1A4 'Other Sectors' (1A4a 'Institutional and Commercial', 1A4b 'Residential' and 1A4c 'Agriculture/ Forestry/ Fishing') and 1A5 'Other' (other works and needs in energy sector, including military transport).

Energy Industries (2005 GHG emissions, 2989.77 Gg CO_2 eq.)

The 'Energy Industries' sub-sector accounts for the largest portion of Republic of Moldova's fuel combustion emissions (38.7 percent of the total in 2005, 56.2 percent in 1990). Emissions included in this sub-sector are from stationary sources producing and processing energy (inclusive public electricity and heat production). Between 1990 and 2005, GHG emissions originated from 1A1 'Energy Industries' decreased by 84.6 percent: from 19393.29 Gg CO_2 eq. in 1990, to 2989.77 Gg CO_2 eq. in 2005. However, between 2004 and 2005, the respective emissions increased by 1.5 percent (Table 2-3).

In 1990, 35.1 percent from the total carbon dioxide emissions within 1A1 'Energy Industries' originated from liquid fuel combustion, 33.1 percent from solid fuel combustion and 31.8 percent from gaseous fuel combustion (Table 2-4). By 2005 the share of natural gas in the structure of CO_2 emissions from 1A1 'Energy Industries' reached 97.6 percent of the total, the share of other types of fuels decreasing more than significantly: 2.0 percent – liquid fuels (i.e., Residual Fuel Oil, Diesel Oil, NGL, Kerosene) and as little as 0.4 percent - solid fuels (Anthracite, Bituminous Coal, Lignite, Coking Coal).

Table 2-4: CO_2 emissions from 1A1 'Energy Industries' in the Republic of Moldova for selected years, Gg

	1990	1995	2000	2004	2005
Solid fuels combustion	6394.4000	2183.1189	1.1820	14.6774	12.3896
Liquid fuels combustion	6785.7400	1067.4143	143.2291	62.2841	59.2146
Gaseous fuels combustion	6152.6300	3663.0845	2506.4509	2863.9835	2914.9673
Total CO_2 emissions from fuel combustion	19332.7700	6913.6176	2650.8620	2940.9450	2986.5715

The reduction of CO_2 emissions between 1990 and 2005 is most frequently associated with a drastic drop in solid fuel consumption for electricity production, in particular at Moldovan Thermal Power Plant in Dnestrovsc (MTPP), which since 1999 does not use coal. The main fuel currently used in the Republic of Moldova for electricity production is natural gases, which has less GHG intensity (emissions per unit electricity) of all fuels (i.e., coal, residual fuel oil).

Manufacturing Industries and Construction (2005 GHG emissions, 396.99 Gg CO_2 eq.)

Emissions from 'Manufacturing Industries and Construction' sub-sector include the combustion of fossil fuels by the iron and steel, non-ferrous metals, chemicals, cement, construction, mining and all manufacturing industries. Overall, this sub-sector was responsible for 5.1 per cent of Energy Sector's total GHG emissions for 2005 (6.4 percent in 1990). Between 1990 through 2005 emissions from this source category decreased by circa 81.9 percent: from 2195.89 Gg CO_2 eq. in 1990, to 396.99 Gg CO_2 eq. in 2005. However, between 2004 and 2005 respective emissions increased by circa 24.1 percent (Table 2-3).

In 1990, 67.9 percent from the total carbon dioxide emissions within 1A2 'Manufacturing Industries and Construction' originated from stationary liquid fuel combustion, 22.7 percent from gaseous fuel combustion and 9.4 percent from solid fuel combustion (Table 2-5). By 2005, the share of natural gas in the structure of CO_2 emissions covered by the source category 1A2 'Manufacturing Industries and Construction' reached 86.3 percent of the total, the share of other types of fuel decreasing significantly: the share of solid fuels (Anthracite, Coking Coal, Bituminous Coal, Lignite) – 5.0 percent and the share of liquid fuels (Residual Fuel Oil, Diesel Oil, Gasoline, Liquefied Petroleum Gases) – 8.7 percent. The reduction of CO_2 emissions between 1990 and 2005 is most frequently associated with considerable reduction in liquid fuel consumption (residual fuel oil and diesel oil) and solid fuel (anthracite and coking coal). Between 1990 and 2005, there have been also changes in the emissions produced by the various categories within the 'Manufacturing Industries and Construction' sub-sector. This can be attributed to product demands, fuel switching, and changes in manufacturing operations.

Table 2-5: CO_2 Emissions from 1A2 'Manufacturing Industries and Construction' in the Republic of Moldova for selected years, Gg

	1990	1995	2000	2004	2005
Solid fuels combustion	204.6881	45.8130	19.9224	17.6240	19.9660
Liquid fuels combustion	1486.3593	97.1065	34.5368	37.6063	34.4961
Gaseous fuels combustion	497.6811	172.8587	203.2514	264.0369	341.9183
Total CO_2 emissions from fuel combustion	2188.7285	315.7781	257.7106	319.2672	396.3804

Transport (2005 GHG emissions, 1654.52 Gg CO_2 eq.)

Transport is a large and diverse sub-sector, accounting for 21.4 percent of the total sectoral GHG emission in 2005 (11.7 percent in 1990). This sub-sector includes emissions from fuel combustion for the transport of passengers and freight in the following sub-categories: road transportation, railways, navigation and other (pipeline transportation, which includes combustion emissions primarily from natural gas transport).

From 1990 to 2005, GHG emissions from 1.A.3 'Transport', decreased by circa 59.2 percent: from 4055.61 Gg CO_2 eq. in 1990, to 1654.52 Gg CO_2 eq. in 2005. However, between 2004 and 2005, respective emissions increased by 2.0 percent (Table 2-6).

In 1990, 84.8 percent of total GHG emissions originated from 1A3 'Transport' sub-sector resulted from 1A3b 'Road transport', 12.5 percent from 1A3c 'Railways', 2.2 percent from 1A3e 'Pipeline Transportation' and only 0.5 percent from 1A3d 'Navigation' (Figure 2-9).

Table 2-6: GHG Emissions from the Transport Sub-sector by Category in the Republic of Moldova for selected years

Source categories	1990	1995	2000	2004	2005
	Gg CO_2 eq				
1A3 Transport	4055.6062	1328.5183	848.2701	1621.5871	1654.5168
1A3b Road Transportation	3438.2863	1083.0985	734.6764	1457.2197	1489.0584
1A3c Railways	507.0418	161.6583	82.9941	126.0804	129.0329
1A3d Navigation	19.0998	0.1815	0.2069	0.2961	0.3343
1A3e Pipeline Transportation	91.1782	83.5800	30.3927	37.9909	36.0914

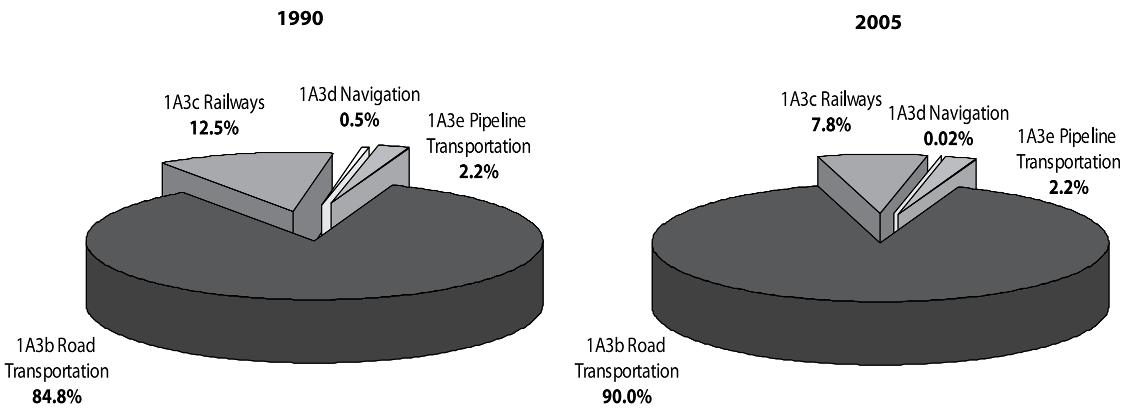

Figure 2-9: Transport Sub-sector Greenhouse Gas Sources in the Republic of Moldova in 1990 and 2005

By 2005, the share of 1A3b 'Road Transportation' reached 90.0 percent of the total sub-sectoral GHG emissions, the share of 1A3c 'Railways' and 1A3d 'Navigation' reducing to circa 7.8 percent and respectively 0.02 percent of the total, while the share of the source category 1A3e 'Pipeline Transportation' remained unchanged, circa 2.2 percent of the total.

Other Sectors (2005 GHG emissions, 1911.11 Gg CO_2 eq.)

The 'Other Sectors' sub-sector comprises fuel combustion emissions from the residential, institutional and commercial categories, as well as stationary fuel combustion from the agriculture (inclusive for transportation needs), forestry and fishing categories. Overall, this sub-sector accounted for 24.7 percent of the total sectoral GHG emission in 2005 (23.3 percent in 1990) and exhibited a decrease of 76.2 percent between 1990 and 2005: from 8037.78 Gg CO_2 eq. in 1990, to 1911.11 Gg CO_2 eq. in 2005. However, between 2004 and 2005, respective emissions increased by 2.5 percent (Table 2-7).

In 1990, 57.9 percent of total GHG emissions originated from 1A4 'Other Sectors' sub-sector resulted from 1A4b 'Residential', 24.3 percent from 1A4c 'Agricultural / Forestry / Fishing', and 17.7 percent from 1A4a 'Institutional and Commercial'. By 2005, the share of 1A4b and 1A4a in the structure of total GHG emissions originated from 1A4 'Other Sectors' reached 71.2 percent and respectively 19.1 percent of the total, while the share of 1A4c decreased up to 9.6 percent of the total (Figure 2-10).

Table 2-7: GHG Emissions from 'Other Sectors' Sub-sector by Category in the Republic of Moldova for selected years

Source categories	1990	1995	2000	2004	2005
	Gg CO_2 eq				
1A4 Other sectors	8037.7787	1829.4654	1122.7639	1864.5957	1911.1082
1A4a Institutional/Commercial	1424.0685	395.0255	212.3073	395.2562	365.3157
1A4b Residential	4657.3239	712.4244	666.0628	1252.3923	1361.4120
1A4c Agriculture/Forestry/Fishing	1956.3862	722.0155	244.3937	216.9473	184.3805

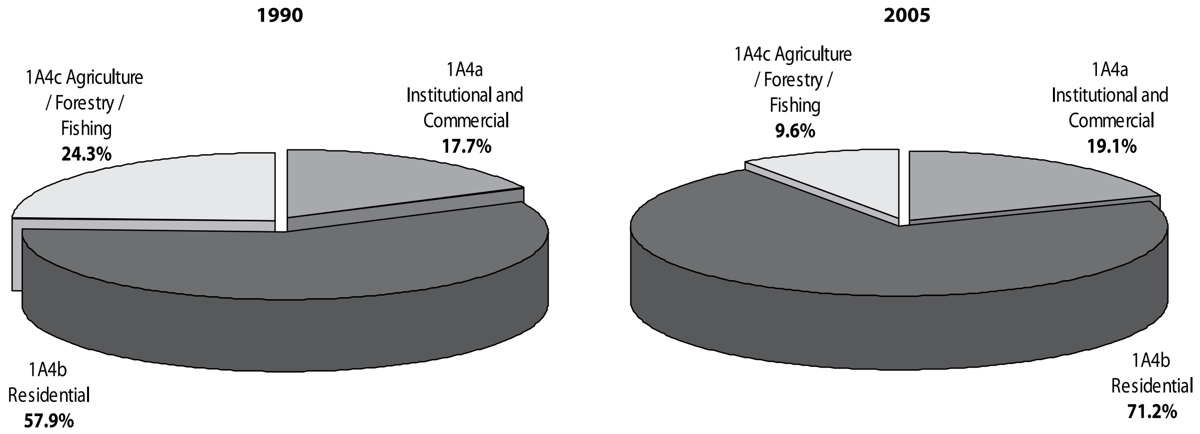

Figure 2-10: 'Other Sectors' Sub-sector Greenhouse Gas Sources in the Republic of Moldova in 1990 and 2005

Commercial and Institutional (2005 GHG emissions, 365.32 Gg CO_2 eq.)

Emissions covered by this sub-sector preponderantly result from the stationary combustion of fuels used for heating the commercial and institutional premises. Overall, the 1.A4.a 'Institutional and Commercial' category accounted for 4.7 percent of the total sectoral GHG emission in 2005 (4.1 percent in 1990) and exhibited a decrease of 74.3 percent: from 1424.07 Gg CO_2 eq. in 1990, to 365.32 Gg CO_2 eq. in 2005. Between 2004 and 2005, respective emissions decreased by 7.6 percent (Table 2-7).

In 1990, 81.1 percent of CO_2 emissions originated from 1A4a 'Institutional and Commercial' resulted from solid fuels combustion, 13.2 percent from liquid fuels combustion and 5.6 percent from gaseous fuels combustion (Table 2-8). By 2005, the share of solid and liquid fuels in the structure of total CO_2 emissions originated from the category 1A4a 'Institutional and Commercial' decreased up to 58.4 percent, respectively 1.7 percent of the total, while the share of natural gases increased up to 39.9 percent of the total.

The reduction of CO_2 emissions between 1990 and 2005 is most frequently associated with a drastic drop in liquid and solid fuel consumption, as well as with the fuel switching, from more to less GHG intensity fuels (the share of solid and liquid fuels decreased significantly, while the share of natural gases increased).

Residential (2005 GHG emissions, 1361.41Gg CO_2 eq.)

Emissions covered by this sub-sector preponderantly result from the combustion of fuels to heat residential buildings. Overall, the 1.A4.b 'Residential' source category accounted for 17.6 percent of the total sectoral GHG emission in 2005 (13.5 percent in 1990) and exhibited a decrease of 70.8 percent: from 4657.32 Gg CO_2 eq. in 1990, to 1361.41 Gg CO_2 eq. in 2005. Between 2004 and 2005, respective emissions increased by 8.7 percent (Table 2-7).

Table 2-8: CO_2 Emissions from 1A4a 'Institutional and Commercial' Source Category in the Republic of Moldova for selected years, Gg

	1990	1995	2000	2004	2005
Solid Fuels Combustion	1146.0452	331.2165	150.8716	251.2682	211.0987
Liquid Fuels Combustion	186.6671	27.8673	28.9304	12.5625	6.0556
Gaseous Fuels Combustion	79.7809	32.2923	30.3927	127.2696	144.3655
Total CO_2 Emissions from Fuel Combustion	1412.4933	391.3760	210.1948	391.1004	361.5198

In 1990, 78.0 percent of CO_2 emissions originated from 1A4b 'Residential' source category resulted from solid fuels combustion, 10.9 percent from liquid fuels combustion and 11.1 percent from gaseous fuels combustion (Table 2-9). By 2005, the share of solid and liquid fuels in the structure of total CO_2 emissions originated from the 1A4b 'Residential' decreased up to 15.4 percent, respectively 10.0 percent of the total, while the share of natural gases increased up to 74.7 percent of the total.

Table 2-9: CO_2 Emissions from 1A4b 'Residential' Source Category in the Republic of Moldova for selected years, Gg

	1990	1995	2000	2004	2005
Solid Fuels Combustion	3437.1256	181.7013	125.5597	176.4252	204.0864
Liquid Fuels Combustion	482.3247	34.8582	87.5968	135.0756	132.1707
Gaseous Fuels Combustion	488.1833	440.6947	419.1538	909.5026	991.1831
Total CO_2 Emissions from Fuel Combustion	4407.6336	657.2541	632.3103	1221.0034	1327.4402

The reduction of CO_2 emissions between 1990 and 2005 is most frequently associated with a drastic drop in liquid and solid fuel consumption, as well as with the fuel switching, from more to less GHG intensity fuels (the share of solid and liquid fuels decreased significantly, while the share of natural gases increased more than significantly, by circa 7 times).

Agriculture, Forestry and Fishing (2005 GHG emissions, 184.38 Gg CO_2 eq.)

Emissions covered by this sub-sector preponderantly result from the combustion of fuel for heating of premises, greenhouses, water pumping for irrigation, etc., as well as from mobile combustion for operating agricultural machinery. Overall, the 1.A4.c 'Agriculture / Forestry / Fishing' category accounted for 2.4 percent of the total sectoral GHG emission in 2005 (5.7 percent in 1990) and exhibited a decrease of 90.6 percent: from 1956.39 Gg CO_2 eq. in 1990, to 184.38 Gg CO_2 eq. in 2005. Between 2004 and 2005, respective emissions decreased by 15.0 percent (Table 2-7).

In 1990, 91.6 percent of CO_2 emissions originated from 1A4c 'Agriculture / Forestry / Fishing' source category resulted from mobile liquid fuel combustion, 5.5 percent from stationary liquid fuel combustion, 2.7 percent from solid fuel combustion and 0.2 percent from gaseous fuel combustion (Table 2-10). In 2005, no CO_2 emissions were registered from solid fuels combustion and stationary combustion of liquid fuels. The share of CO_2 emissions resulted from mobile liquid fuel combustion increased up to 96.9 percent, the rest of 3.1 percent, respectively from the natural gases (Table 2-10). The reduction of CO_2 emissions between 1990 and 2005 is most frequently associated with a drastic drop in total fuel consumption, as well as with the fuel switching, from more to less GHG intensity fuels, in particular of liquid fuel consumption (Residual Fuel Oil, NGL, Diesel Oil, Kerosene).

Table 2-10: CO_2 Emissions from 1A4c 'Agriculture / Forestry / Fishing' Source Category in the Republic of Moldova for selected years, Gg

	1990	1995	2000	2004	2005
Solid Fuel Combustion	53.0345	8.5207	0.0000	0.0000	0.0000
Stationary Liquid Fuel Combustion	106.6372	3.1508	12.6032	0.0000	0.0000
Mobile Liquid Fuel Combustion	1778.8921	696.2703	220.9502	202.4670	177.6497
Gaseous Fuel Combustion	3.7991	9.4977	9.4977	13.2968	5.6986
Total CO_2 Emissions from Fuel Combustion	1942.3629	717.4395	243.0511	215.7638	183.3484

Other (2005 GHG emissions,118.52 Gg CO_2 eq.)

Emissions from 'Other' sub-sector include the combustion of fossil fuels for other works and needs in energy sector, inclusive the military transport. Overall, this sub-sector was responsible for 0.4 per cent of Energy Sector's total GHG emissions for 2005 (1.0 percent in 1990). Between 1990 through 2005 emissions from this source category decreased by 23.5 percent: from 154.90 Gg CO_2 eq. in 1990, to 118.52 Gg CO_2 eq. in 2005. Between 2004 and 2005 respective emissions decreased by 3.6 percent (Table 2-3).

In 1990, 52.6 percent from the total CO_2 emissions within 1A5 'Other' originated from liquid fuel combustion, 29.6 percent from solid fuel combustion and 18.2 percent from gaseous fuel combustion (Table 2-11). By 2005, the share of liquid fuels (Residual Fuel Oil, Diesel Oil, Gasoline, Kerosene, Liquefied Gases, Other Oil Products) in the structure of CO_2 emissions covered by the source category 1A5 'Other' reached 91.4 percent of the total, the share of other types of fuel decreasing significantly: the share of solid fuels (Anthracite, Bituminous Coal, Lignite) accounted for as much as 2.1 percent only and 6.4 percent the share of natural gases. The reduction of CO_2 emissions between 1990 and 2005 is most frequently associated with considerable reduction in liquid fuel consumption (Residual Fuel Oil and Diesel Oil) and solid fuel (Anthracite and Coking Coal). The reduction of CO_2 emissions between 1990 and 2005 is most frequently associated with a drastic drop in total fuel consumption (Anthracite, Coking Coal and Natural Gases).

Table 2-11: CO_2 emissions from 1A5 'Other' Sub-sector in the Republic of Moldova for selected years, Gg

	1990	1995	2000	2004	2005
Solid Fuels Combustion	45.1353	24.4293	9.6757	4.9321	2.5255
Liquid Fuels Combustion	81.0989	145.9833	41.5776	111.9394	107.9239
Gaseous Fuels Combustion	28.0373	2.2605	0.0000	5.6986	7.5982
Total CO_2 Emissions from Fuel Combustion	154.2715	172.6731	51.2533	122.5701	118.0475

Fugitive Emissions from Oil and Natural Gases (2005 GHG emissions, 653.90 Gg CO_2 eq.)

As stated above, fugitive emissions from fossil fuels are the intentional or unintentional releases of GHGs from the production, processing, transmission, storage, and deliver of fossil fuels. In the Republic of Moldova fugitive emissions originated basically from activities related to the oil and natural gas industry. Overall, the category 1.B.2 'Fugitive Emissions from Oil and Natural Gases' was responsible for 8.5 per cent of Energy Sector's total GHG emissions for 2005 (2.0 percent in 1990). Between 1990 through 2005 emissions from this source category decreased by 4.3 percent: from 682.93 Gg CO_2 eq. in 1990, to 653.90 Gg CO_2 eq. in 2005 (Table 2-3).

2.3.2 Industrial Processes Sector

The Industrial Processes Sector includes GHG emissions that are direct by-products of processes, including mineral production, chemical industry, metal production, food and beverage production and consumption of halocarbons and SF_6. In 2005 GHG emissions from the Industrial Processes Sector accounted for 4.9 percent of the total national GHG emissions (3.1 percent in 1990). Between 1990 and 2005, total sectoral GHG emissions decreased by 56.9 percent: from 1348.75 Gg CO_2 eq. in 1990, to 581.90 Gg CO_2 eq. in 2005 (Table 2-12, Figure 2-11). However, between 2004 and 2005, respective emissions increased by 21.3 percent, in particular as a result of cement production growth.

Table 2-12: GHG Emissions from Industrial Processes by Category for selected years

SOURCES BY CATEGORIES	1990	1995	2000	2004	2005
	Gg CO_2 eq				
2. Industrial Processes	1348.7472	380.6453	325.6035	479.5229	581.9002
A. Mineral Products	1257.9118	302.7174	217.9316	327.9019	416.8448
1. Cement Production	988.2518	252.3529	175.5925	288.9106	373.2628
2. Lime Production	149.2228	28.3399	11.0292	2.2643	6.6467
6. Asphalt Production	0.3156	0.0957	0.0084	0.0114	0.0168
7a. Glass Production	59.4234	8.1300	19.3617	19.0404	20.8035
7b. Mineral Wool Production	8.0816	0.5721	0.0848	0.0000	0.0000
7c. Bricks Production	52.6166	13.2268	11.8549	17.6752	16.1150
C. Metal Production	71.1959	65.9755	91.2183	101.7723	105.2857
1. Steel Production	71.1959	65.9755	91.2183	101.7723	105.2857
D. Other	19.6395	11.9524	12.2455	36.4980	40.7669
2. Food and Drink	19.6395	11.9524	12.2455	36.4980	40.7669
F. Consumption of Halocarbons and SF_6	NO, NE	NO, NE	4.2080	13.3506	19.0028
1. Refrigeration and Air Conditioning Equipment	NO, NE	NO, NE	4.2080	13.0716	18.7185
4. Aerosols	NO, NE	NO, NE	0.0000	0.0007	0.0004
8. Electrical Equipment	NO, NE	NO, NE	NO, NE	0.2782	0.2839

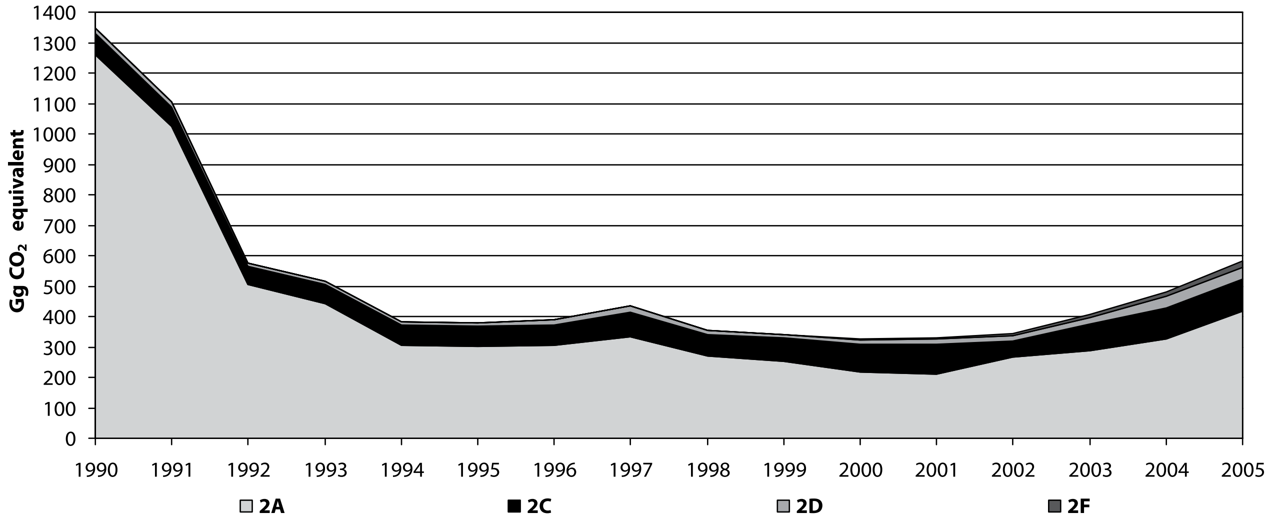

Figure 2-11: GHG Emissions from Industrial Processes by Category in the Republic of Moldova, 1990-2005

The largest source of emission in 2005 was category 2A 'Mineral Products' (Cement, Lime, Asphalt, Glass, Bricks, Mineral Wool), accounting for 71.6 percent of the total sectoral GHG emissions in 2005 (93.3 percent in 1990). Other relevant sources in 2005 were represented by categories 2C 'Metal Production' (Iron and Steel) accounting for 18.1 percent from the total (5.3 percent in 1990), 2D 'Other Production' (Food and Drink) - 7.0 percent from the total (1.5 percent in 1990) and 2F 'Consumption of HFCs and SF_6' (Refrigeration and Air Conditioning Equipment, Aerosols, Electric Equipment) - 3.3 percent of the total sectoral GHG emissions (Figure 2-12).

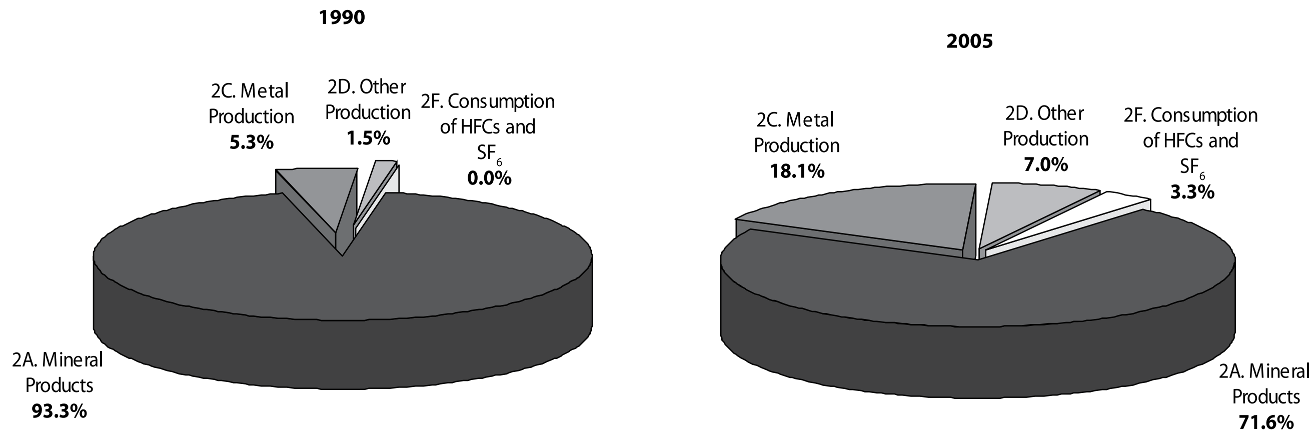

Figure 2-12: Breakdown of Industrial Processes' GHG Emissions by Category in the Republic of Moldova in 1990 and 2005

In 1990, 78.6 percent from the GHG emissions originated from the largest source of emissions within the Industrial Processes Sector, which is the Category 2A 'Mineral Products' resulted from 2A1 'Cement Production', 11.9 percent from 2A2 'Lime Production', 4.7 percent from 2A7a 'Glass Production', 4.2 percent from 2A7c 'Brick Production', 0.6 percent from 2A7b 'Mineral Wool Production' and 0.03 percent from 2A6 'Asphalt Production'. By 2005, the share of 2A1 'Cement Production' and 2A7a 'Glass Production' somewhat increased, while the share of other sources under this category decreased significantly (Figure 2-13).

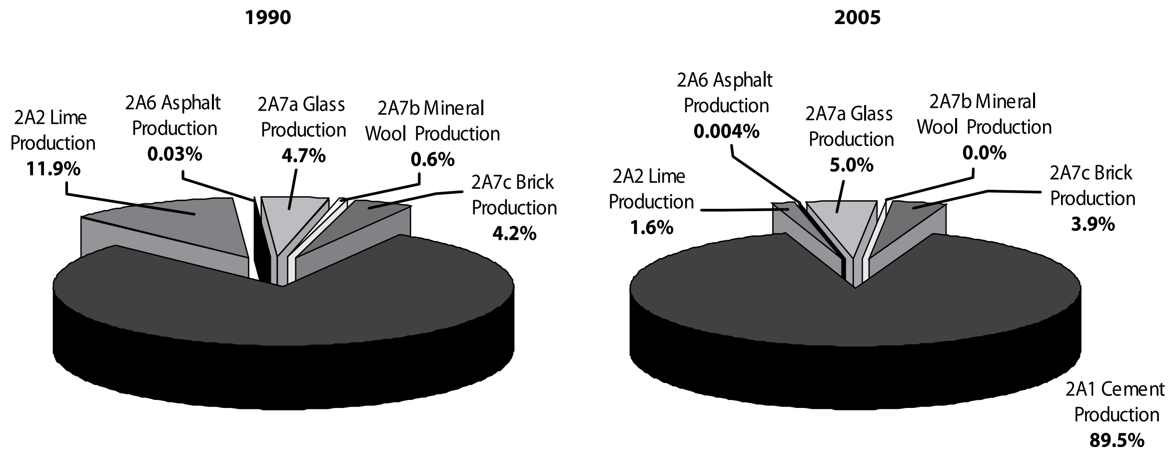

Figure 2-13: Breakdown of the Category 2A 'Mineral Production' GHG Emissions by Source in the Republic of Moldova in 1990 and 2005

2.3.3 Solvents and Other Products Use Sector

In the RM Solvents and Other Products Use Sector is a modest source and includes emissions of non-methane volatile organic compounds (NMVOC), also considered as a CO_2 emissions source - as the majority of solvents are obtained from fossil fuels, as well as N_2O emissions from use of N_2O for anaesthesia. In 2005, the respective sector accounted for as little as circa 0.4 percent of the total national GHG emissions (0.2 percent in 1990).

Between 1990 and 2005, the total GHG emissions covered by this sector decreased by 25.3 percent: from 65.62 Gg CO_2 eq. in 1990, to 49.00 Gg CO_2 eq. in 2005 (Table 2-13). However, between 2004 and 2005, respective emissions increased in the RM by 2.5 percent, in particular as a result of increased use of household products.

Table 2-13: GHG Emissions from Solvents and Other Products Use by Category for selected years

SOURCE CATEGORIES	1990	1995	2000	2004	2005
	Gg CO_2 eq				
3. Solvents and Other Products Use	65.6245	28.0645	33.0638	47.8176	49.0022
3.A Paint Application	30.1849	1.9381	6.7433	18.7906	17.9812
3.B Degreasing and Dry Cleaning	1.9978	0.2212	0.3363	1.2258	1.2401
3.C Chemical Products, Manufacture and Processing	0.5470	0.0281	0.0960	0.2163	0.2931
3.D Other	32.8948	25.8773	25.8882	27.5849	29.4878
3.D.1 Adhesives Use	5.8905	0.9343	1.5481	3.4019	3.9807
3.D.2 Graphic Arts (Ink)	0.5408	0.0563	0.0866	0.2371	0.3428
3.D.3 Seed Oil Extraction and Seed Drying	1.9745	0.4946	0.2207	1.8399	1.8791
3.D.4 Household Products	24.4686	24.3917	24.0192	22.0905	23.2664
3.D.5 Use of N_2O for Anaesthesia	0.0205	0.0003	0.0136	0.0155	0.0189

The largest source of emission in 2005 was 3D 'Other', accounting for 60.2 percent of the total per sector at the level of 2005 (50.1 percent in 1990). Other relevant source categories are represented by 3A 'Paint Application' accounting for 36.7 percent of the total sectoral GHG emissions in 2005 (46.0 percent in 1990), 3B 'Degreasing and Dry Cleaning' - 2.5 percent of the total sectoral emissions (3.0 percent in 1990) and 3C 'Chemical Products, Manufacture and Processing' - 0.6 percent of the total sectoral emissions (0.8 percent in 1990) (Figure 2-14).

In 2005, 78.9 percent from the GHG emissions originated from the largest source of emissions within the Solvents and Other Product Use Sector, which is the Category 3D 'Other', resulted from 3D4 'Households Products' (74.4 percent in 1990), 13.5 percent from 3D1 'Adhesive Use' (17.9 percent in 1990), 6.4 percent from 3D3 'Seed Oil Extraction and Seed Drying' (6.0 percent in 1990), 1.2 percent from 3D2 'Graphic Arts' (Ink) (1.6 percent in 1990) and 0.1 percent from 3D5 'Use of N_2O for Anaesthesia' (0.1 percent in 1990) (Figure 2-15).

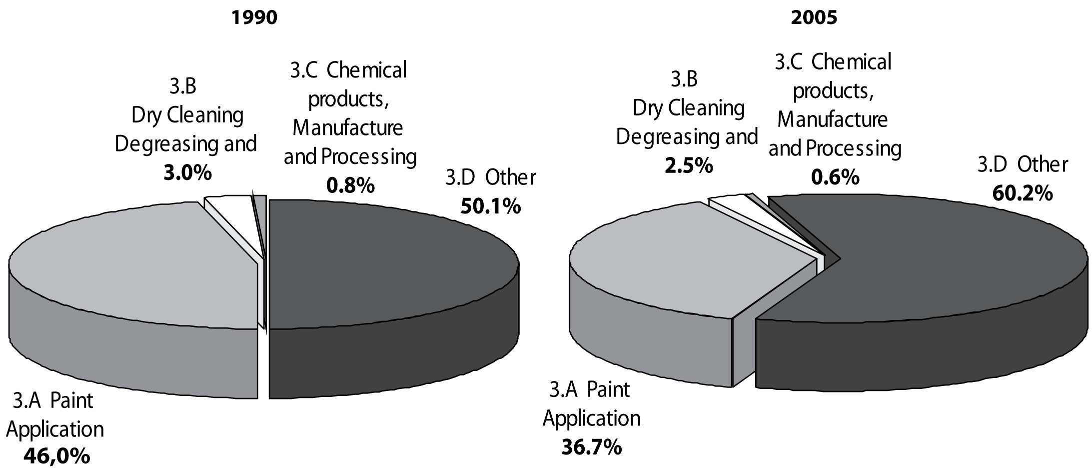

Figure 2-14: Breakdown of Solvents and Other Products Use GHG Emissions by Category in the Republic of Moldova in 1990 and 2005

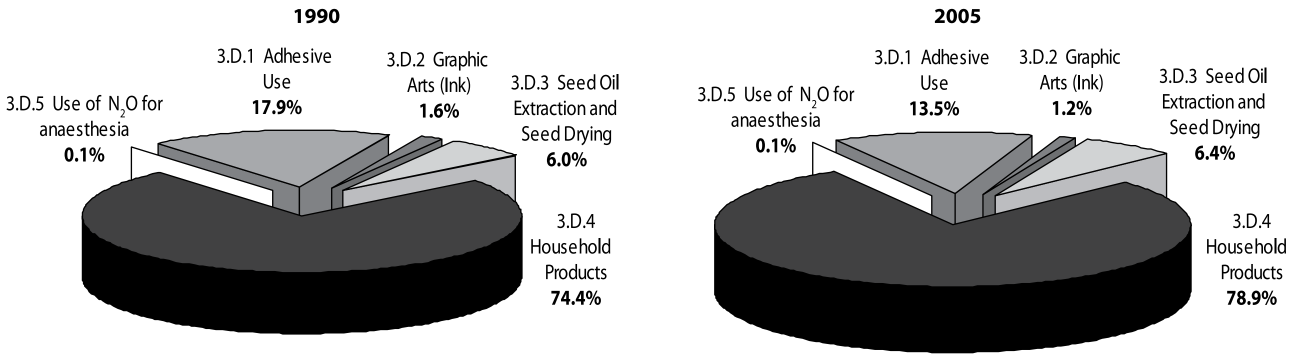

Figure 2-15: Breakdown of the Category 3D 'Other' GHG Emissions by Source in the Republic of Moldova in 1990 and 2005

2.3.4 Agriculture Sector

The processes that produce GHG emissions in the Agriculture Sector are enteric fermentation by domestic animals, manure management, fertilizer application and crop production (direct, indirect soil emissions and animal manure on pastures).

Emissions in this sector were analysed based upon the following two main categories: (1) livestock emissions consist of enteric fermentation from domestic animals (i.e., digestive processes that release CH_4) and manure management (with release CH_4 and N_2O); (2) agriculture soils consist of direct N_2O emissions from synthetic nitrogen fertilizers, animal manure applied to cropland, crop residue decomposition, tillage practices, indirect N_2O emissions from volatilization and leaching of fertilizer, manure and crop residue nitrogen, and N_2O emission from manure on pasture, range and paddock.

In 2005, Agriculture Sector accounted for circa 17.9 percent of the total national GHG emissions (12.4 percent in 1990). Between 1990 and 2005 total GHG emissions originated from this sector decreased by circa 60.0 percent: from 5323.92 Gg CO_2 eq. in 1990, to 2127.79 Gg CO_2 eq. in 2005 (Table 2-14, Figure 2-16), in particular, due to a sharp drop in such indicators as: domestic livestock and poultry population, amounts of synthetic nitrogen and organic fertilizers applied to soils, amounts of agricultural crop residues returned to soils, carbon losses from mineral soils and change of tillage practices.

Table 2-14: GHG Emissions from Agriculture Sector by Category for selected years

SOURCE CATEGORIES	1990	1995	2000	2004	2005
	Gg CO_2 eq				
4. Agriculture	5323.92	3386.18	2214.74	2210.72	2127.79
A. Enteric Fermentation	1903.41	1384.63	903.06	843.96	792.86
B. Manure Management	1701.94	1088.95	665.22	665.77	635.68
D. Agricultural soils	1718.57	912.60	646.46	700.99	699.25

Between 2004 and 2005, direct greenhouse gas emissions covered by Sector 4 Agriculture decreased by circa 3.8 percent.

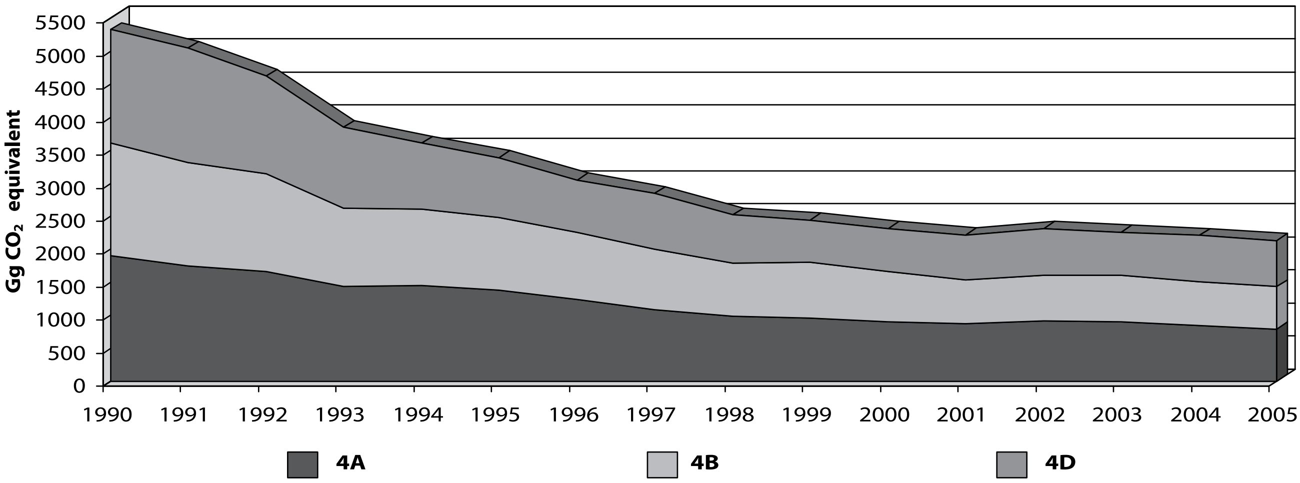

Figure 2-16: GHG emissions from Agriculture in the Republic of Moldova, 1990-2005

The largest source of emission in 2005 was category 4A 'Enteric Fermentation', accounting for circa 37.3 percent of the total per sector (35.8 percent in 1990) (Figure 2-17). Other relevant sources are represented by Categories 4D 'Agricultural Soils', accounting for 32.9 percent of the total (32.3 percent in 1990) and 4B 'Manure Management', accounting for 29.9 percent of the total (32.0 percent in 1990).

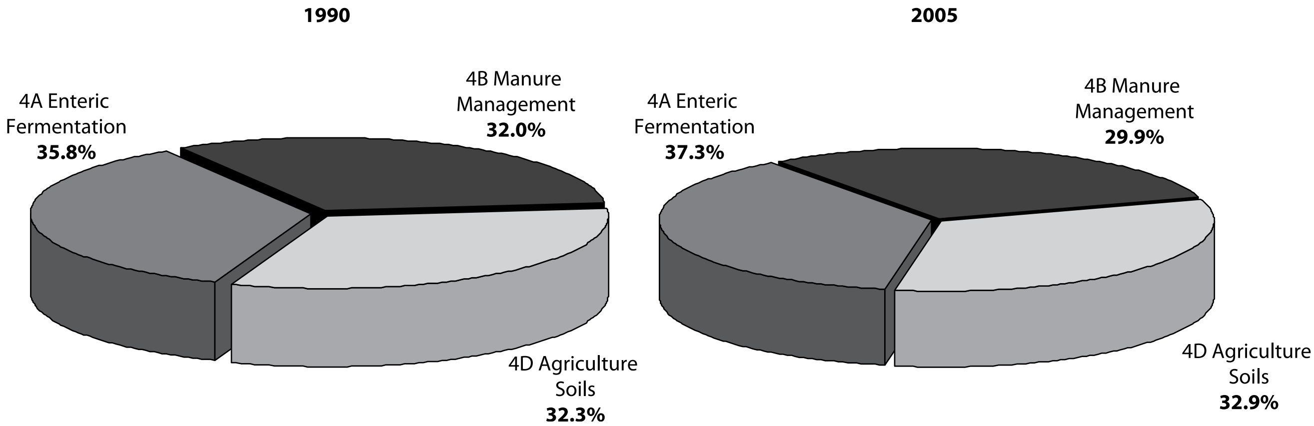

Figure 2-17: Breakdown of Agriculture GHG Emissions by Category in the Republic of Moldova in 1990 and 2005

As the RM does not cultivate rice and there are no savannas, no GHG emissions origin from the Categories 4C 'Cultivation of Rice' and 4E 'Prescribed Burning of Savannas'. GHG emissions originated from the Category 4F 'Field Burning of Agricultural Residues' were reported under LULUCF Sector (Category 5B 'Cropland').

2.3.5 Land Use, Land-Use Change and Forestry Sector

Land Use, Land-Use Change and Forestry Sector reports GHG fluxes between the atmosphere and Republic of Moldova's managed lands, as well as those associated with land-use changes.

In the Republic of Moldova, LULUCF Sector is a source of net carbon sinks. Between the 1990 and 2005, net sinks tended towards lower values, decreasing by circa 17.5 percent: from -1673.2 Gg CO_2 in 1990, to -1381.1 Gg CO_2 in 2005, due to changes in forest management (authorized increased amounts of harvested wood, substantial increase of illegal logging, increased conversion of forestlands into croplands, etc.), as well as gradual increase of CO_2 emissions from croplands due to smaller amounts of organic fertilizers and smaller amounts of agricultural residues returned to soils, and as a consequence, a significant decrease of basic crops yields by circa 2-3 times.

However, between 2004 and 2005, net CO_2 sinks from LULUCF increased by 4.7 percent, in particular due to extension of forest vegetation areas (Table 2-15, Figure 2-18).

Table 2-15: CO_2 Emissions and Sinks in LULUCF by Category for selected years

SOURCE CATEGORIES	1990	1995	2000	2004	2005
	Gg CO_2				
5. LULUCF	-1673.1984	-755.9972	-1353.1508	-1319.0407	-1381.0626
A. Forest Land	-2197.1526	-1620.7880	-2140.3153	-2183.4198	-2246.2034
B. Cropland	1310.4542	1484.3328	1612.6925	1691.5351	1684.5968
C. Grassland	-786.5000	-619.5420	-825.5280	-827.1560	-819.4560

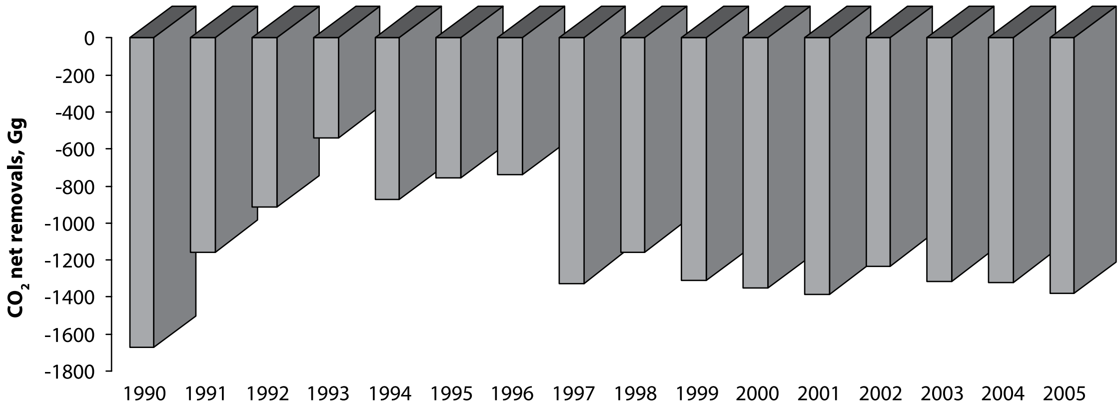

Figure 2-18: CO_2 net removals in Land Use, Land-Use Change and Forestry, 1990-2005

The largest source of carbon removal under LULUCF is forest vegetation (5A 'Forest Land') accounting for 69 percent of the total. Another relevant source is grasslands (5C 'Grassland'), accounting for 24 percent of the total. Contribution of perennial plantations (5B 'Cropland') is as small as 7 percent of the total, in particular due to gradual reduction of respective areas. Between 1995 and 2005, contribution of forest ecosystems (5A 'Forest Land') to the GHG removals under LULUCF is continuously increasing (Figure 2-19), in particular, due to extension of forest vegetation areas.

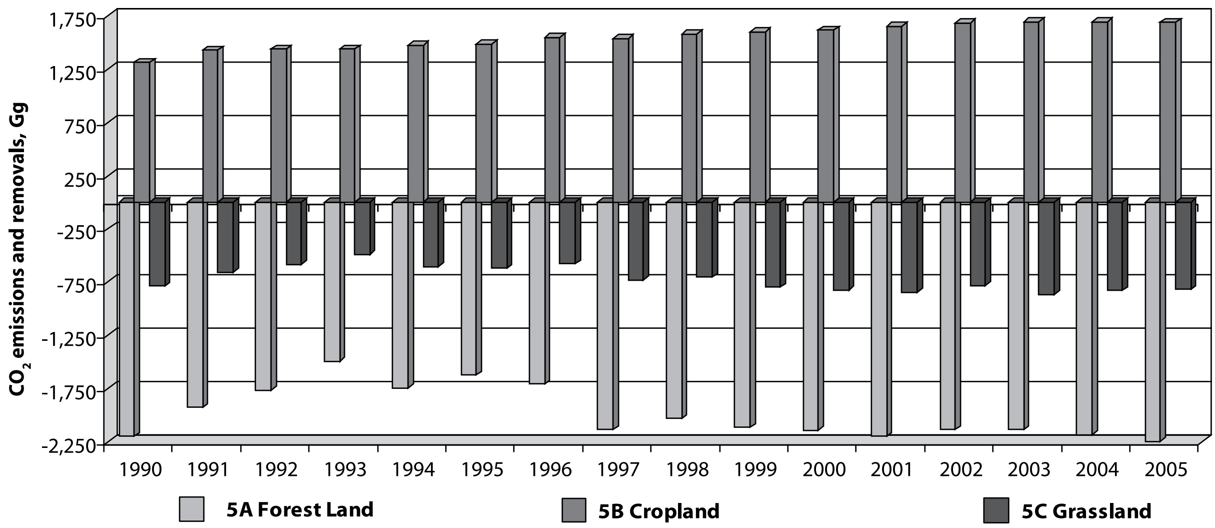

Figure 2-19: Selected Emissions and Removals in LULUCF in the RM, 1990-2005

LULUCF is also a source of non-CO_2 (CH_4 and N_2O) direct GHG emissions, resulting from wood fires (5A 'Forest Land') and field burning of agriculture residues (5B 'Cropland'). Between 1990 and 2005, non-CO_2 direct GHG emissions tended to lower values, decreasing by circa 89.5 percent: from 3.29 Gg CO_2 eq. in 1990 to 0.35 Gg CO_2 eq. in 2005. Between 2004 and 2005, non-CO_2 emissions from LULUCF reduced by circa 9.0 percent. The evolution of these emissions was determined both by the efficiency of forestlands protection measures against wood fires and combating illegal burning of stubble fields, and evolution of climate conditions over the respective period in the RM.

2.3.6 Waste Sector

Waste Sector is an important source of GHG emissions in the Republic of Moldova: CH_4 emissions from 'Solid Waste Disposal on Land' (Category 6A) and 'Wastewater Handling' (Category 6B), as well as N_2O emissions from 'Human Sewage' (Category 6B).

In 2005, Waste Sector accounted for 11.8 percent of the total national direct GHG emissions (3.8 percent in 1990). In the time series 1990 through 2005, total GHG emissions from this sector decreased by 14.0 percent: from 1627.34 Gg CO_2 eq. in 1990, to 1399.96 Gg CO_2 eq. in 2005 (Table 2-16).

Reduction of GHG emissions from by Waste Sector is explained, in particular by the economic decline that occurred in the Republic of Moldova during the period under review, by a significant drop in the wellbeing of population, and respectively, capacity to generate waste (Table 2-17).

Table 2-16: GHG Emissions from Waste Sector by Category for selected years

SOURCE CATEGORIES	1990	1995	2000	2004	2005
	Gg CO_2 eq				
6. Waste	1627.3364	1827.5652	1731.2751	1452.0512	1399.9575
A. Solid Waste Disposal on Land	1321.1268	1616.5821	1536.4167	1254.5064	1186.2060
B. Wastewater Handling	306.2096	210.9831	194.8584	197.5448	213.7515

Between 2004 and 2005, GHG emissions from Waste Sector decreased by 3.6 percent (Figure 2-20).

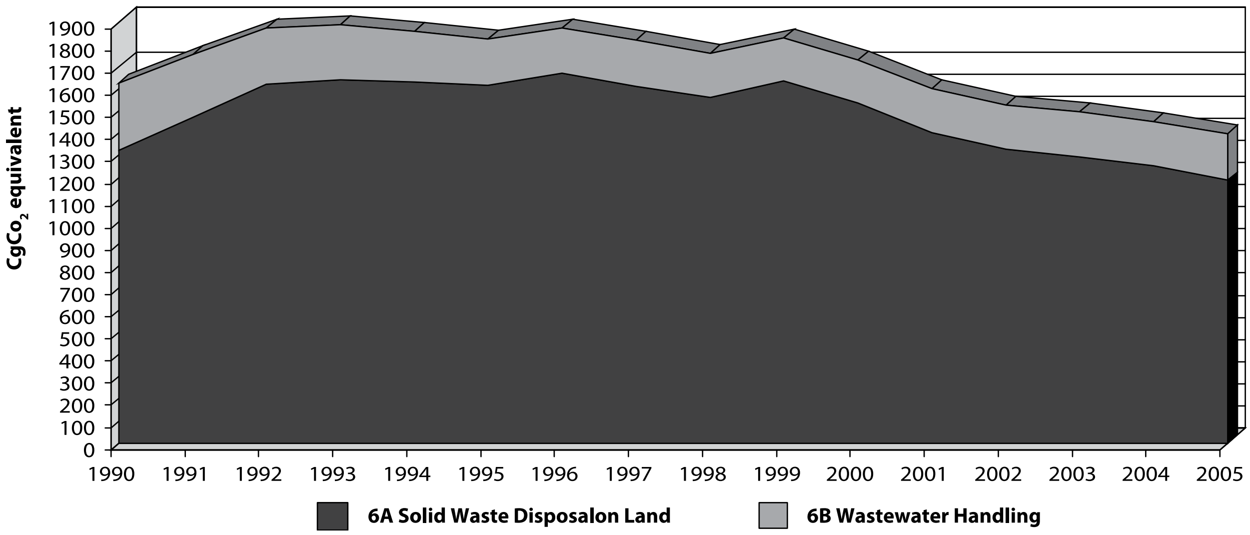

Figure 2-20: National Waste Sector GHG Emission Trends, 1990-2005

Table 2-17: Per Capita GHG Emission Trend for Waste in the Republic of Moldova, 1990-2005

	1990	1991	1992	1993	1994	1995	1996	1997
MSW, kg/capita/day	0.85	0.86	0.85	0.48	0.46	0.43	0.44	0.42
Total Waste, kg/capita/day	1.28	1.30	1.30	0.84	0.80	0.76	0.78	0.74
	1998	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**
MSW, kg/capita/day	0.42	0.40	0.38	0.37	0.38	0.38	0.43	0.42
Total Waste, kg/capita/day	0.75	0.71	0.72	0.70	0.72	0.72	0.80	0.79

Note: the indicators in the table were developed based on data on the amount of MSD and industrial waste eliminated at the SWDS in the RM between 1990 and 2005 (please see Chapter 8 'Waste Sector').

In 2005 the largest source of GHG emissions within the Waste Sector was Category 6A 'Solid Waste Disposal on Land', accounting for circa 84.7 percent of the total per sector (81.2 percent in 1990) (Figure 2-21).

During the period under review per capita GHG emissions from Waste Sector decreased by 9.5 percent, from 373 kg CO_2 eq. per capita in 1990, to 338 kg CO_2 eq. per capita in 2005 (Figure 2-22).

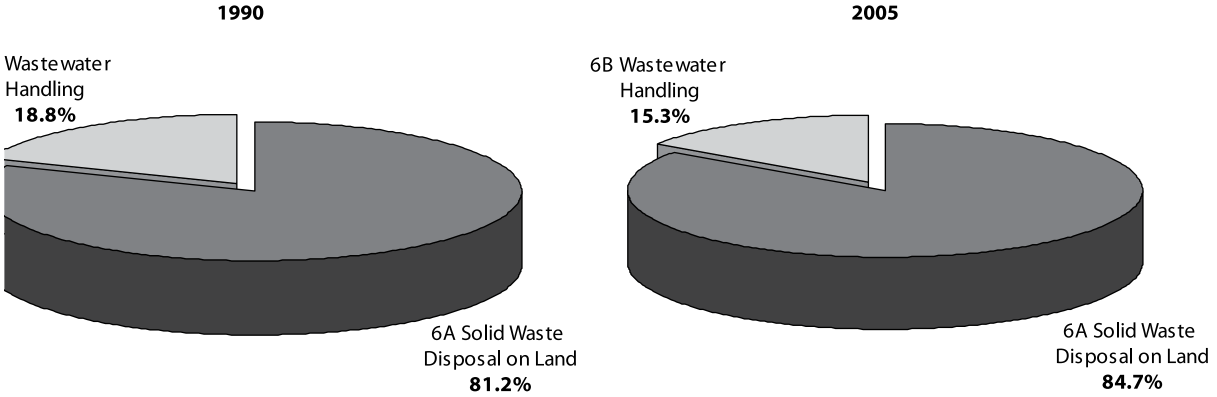

Figure 2-21: Breakdown of Waste GHG Emissions by Category in the Republic of Moldova in 1990 and 2005

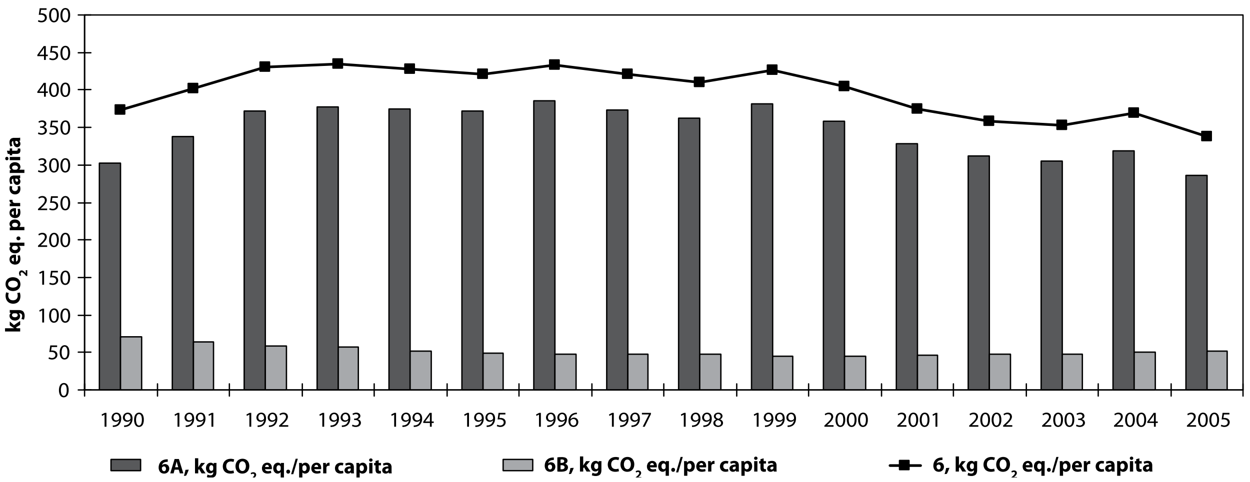

Figure 2-22: Per Capita GHG Emissions Trend for Waste, 1990-2005

2.4 Emission Trends for Ozone and Aerosol Precursors

The reporting requirements of the UNFCCC request that information be provided on indirect greenhouse gases, which include carbon monoxide (CO), nitrogen oxides (NO_x), non-methane volatile organic compounds (NMVOC) and sulphur dioxide (SO_2). These gases do not have a direct global warming effect, but indirectly affect terrestrial radiation absorption by influencing the formation and destruction of tropospheric and stratospheric ozone, or, in the case of SO_2, by affecting the absorption characteristics of the atmosphere. Additionally, some of these gases may react with other chemical compounds in the atmosphere to form compounds that are greenhouse gases. These gases are produced when carbon-containing fuels are combusted incompletely (CO); are created by lightning, fires, fossil fuel combustion, and in the stratosphere (NO_x); emitted from transportation, industrial processes and consumption of organic solvents (NMVOC); emitted from coal combustion for power generation and the metals industry (SO_2).

In 1990-2005, NO_x emissions decreased by 77.1 percent: from 137.74 Gg in 1990 to 31.58 Gg in 2005; CO emissions decreased by 73.1 percent: from 429.05 Gg in 1990, to 115.22 Gg in 2005; NMVOC emissions decreased by 59.0 percent: from 103.12 Gg in 1990 to 42.25 Gg in 2005, while SO_2 emissions deceased by 96.0 percent: from 294.97 Gg in 1990, to 11.79 Gg in 2005 (Table 2-18).

Table 2-18: Ozone and Aerosol Precursors Emission Trends in the RM in 1990-2005, Gg

	1990	1991	1992	1993	1994	1995	1996	1997
NO_x	137.7408	119.3428	80.2690	63.4771	54.0902	47.1408	44.4726	39.9567
CO	429.0537	371.6038	190.4780	155.4473	141.2932	139.2113	136.9144	131.5095
NMVOC	103.1150	90.6729	54.1789	44.0071	39.3583	39.8312	38.6704	38.0953
SO_2	294.9678	256.2761	170.1090	145.6472	102.5218	60.8743	58.8716	33.8937
	1998	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**
NO_x	32.8847	23.7914	22.0042	25.3798	27.1859	29.9830	31.1675	31.5802
CO	116.0268	79.5244	75.5600	78.9760	95.1302	110.2302	112.6899	115.2218
NMVOC	34.4315	25.6009	26.7160	28.2556	33.9985	36.9111	40.9736	42.2495
SO_2	26.9145	13.9877	9.8661	9.4254	10.4569	12.9969	11.1841	11.7886

In 2005, the source categories of NO_x having the biggest share in the total nitrogen oxides emissions in the Republic of Moldova were: 1A3 'Transport' (16.08 Gg or 50.9 percent of the total), 1A1 'Energy Industries' (8.00 Gg or 15.3 percent of the total), 1A2 'Manufacturing Industries and Constructions' (4.83 Gg or 3.4 percent of the total) and 2A 'Mineral Products' (0.97 Gg or 3.1 percent of the total) (Figure 2-23).

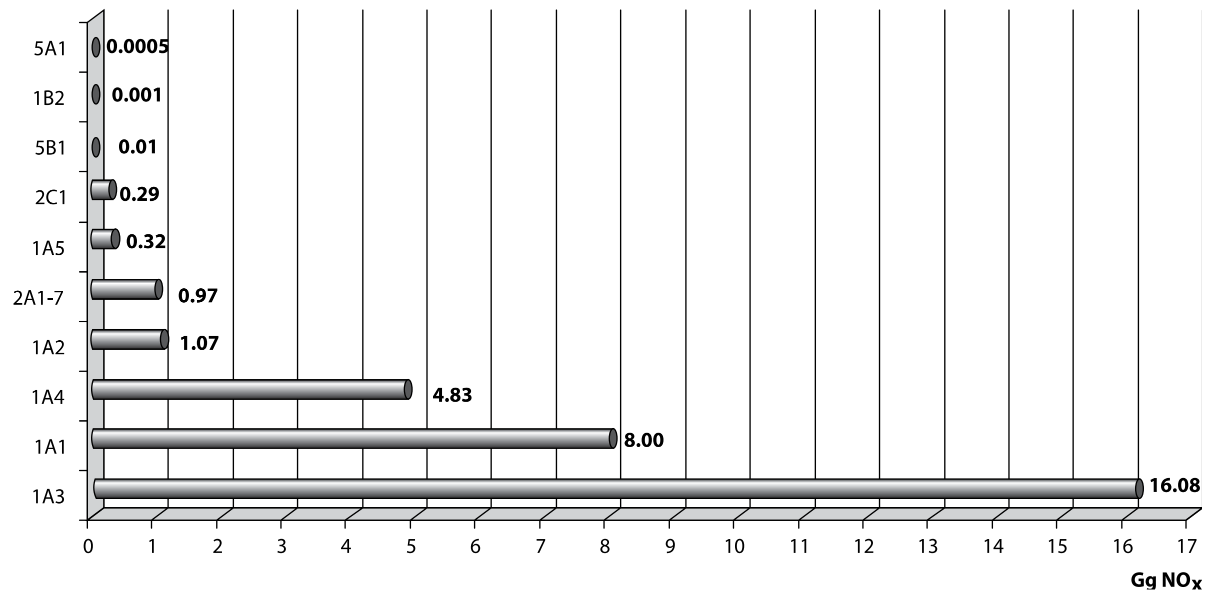

Figure 2-23: 2005 Source Categories of NO_x in the Republic of Moldova

In 2005, the source categories of CO having the biggest share in the total carbon monoxide emissions in the Republic of Moldova were: 1A3 'Transport' (87.32 Gg or 75.8 percent of the total), 1A4 'Other Sectors' (24.36 Gg or 21.1 percent of the total), 2C1 'Steel Production' (1.47 Gg or 1.3 percent of the total) and 1A1 'Energy Industries' (1.19 Gg or 1.0 percent of the total) (Figure 2-24).

In 2005, the source categories of NMVOC having the biggest share in the total non-methane volatile organic compounds emissions in the Republic of Moldova were: 1A3 'Transport' (16.49 Gg or 39.0 percent of the total), 3A-D 'Solvents and Other Products Use' (15.72 Gg or 37.2 percent of the total), 2D2 'Other Production' (foods and beverages) (4.46 Gg or 10.6 percent of the total), 1A4 'Other Sectors' (2.93 Gg or 6.9 percent of the total), 1B2 'Fugitive Emissions From Oil and Natural Gas' (1.18 Gg or 2.8 percent of the total) and 2A 'Mineral Products' (1.04 Gg or 2.5 percent of the total) (Figure 2-25).

In 2005, the source categories of SO_2 having the biggest share in the total sulphur dioxide emissions in the Republic of Moldova were: 1A4 'Other Sectors' (6.14 Gg or 52.1 percent of the total), 1A3 'Transport' (2.15 Gg or 18.2 percent of the total), 1A5 'Other' (Other Needs and Works in Energy Sector) (1.17 Gg or 9.9 percent of the total), 1A1 'Energy Industries' (1.16 Gg or 9.8 percent of the total), 2A 'Mineral Products' (0.57 Gg or 4.8 percent of the total), 1A2 'Manufacturing Industries and Constructions' (0.46 Gg or 3,9 percent of the total) and 2C1 'Steel Production' (0.14 Gg or 1.2 percent of the total) (Figure 2-26).

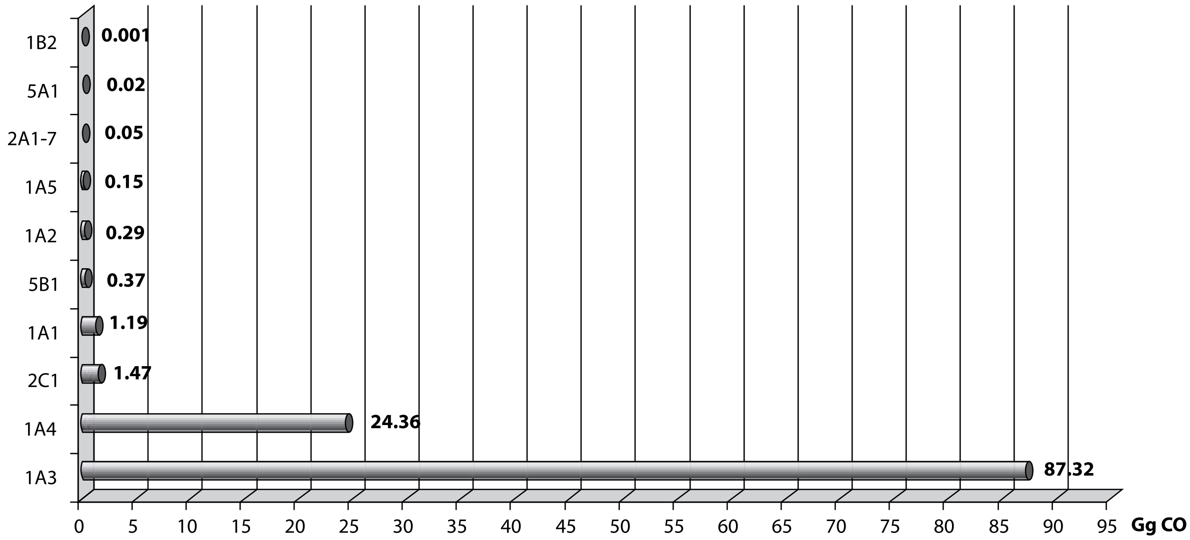

Figure 2-24: 2005 Source Categories of CO in the Republic of Moldova

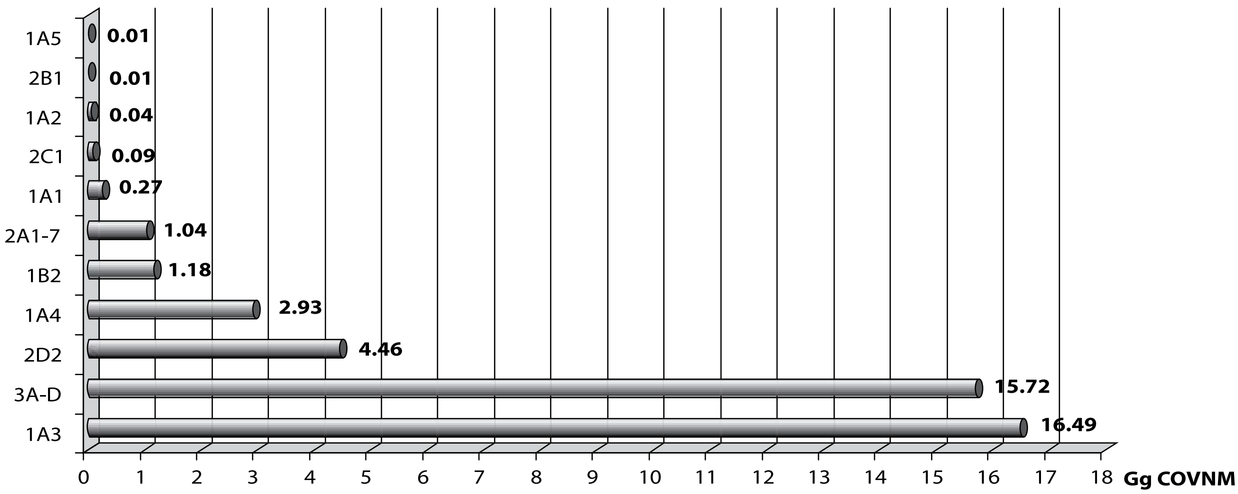

Figure 2-25: 2005 Source Categories of NMVOC in the Republic of Moldova

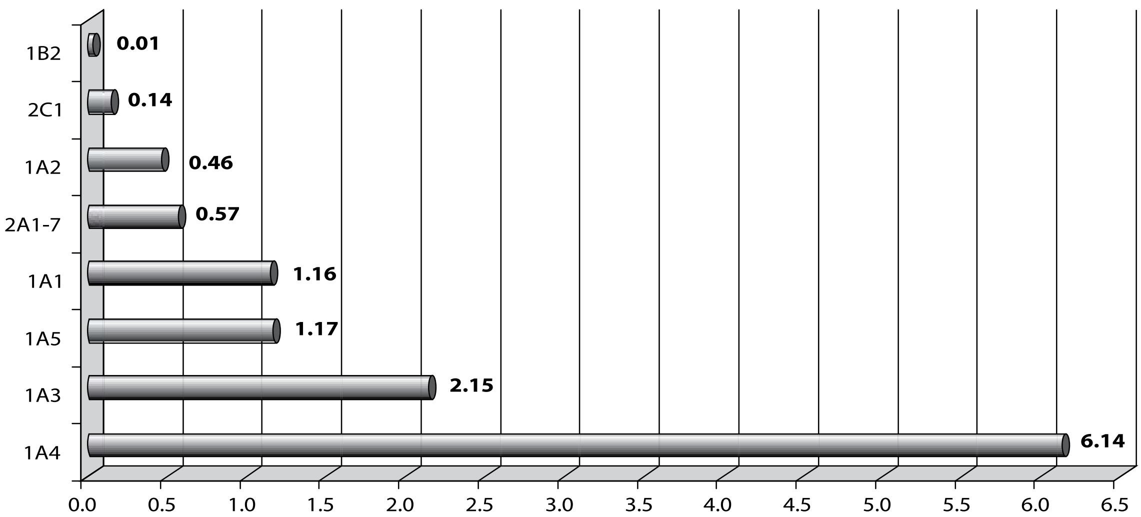

Figure 2-26: 2005 Source Categories of SO_2 in the Republic of Moldova

3. ENERGY SECTOR

3.1 Overview

Energy Sector includes emissions resulting from electricity and heat production activities, and fuel combustion for energy generation purposes. Methodological guidance used includes the Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories (IPCC, 1997), Good Practice Guidance (IPCC, 2000), 2006 IPCC Guidelines for National Greenhouse Gas Inventories (IPCC, 2006) and other guidelines developed under the United Nations Framework Convention on Climate Change (UNFCCC, 2005a, 2005b).

Under the Republic of Moldova's GHG Inventory, the Energy Sector covers GHG emissions generated by the following source categories:

1. Energy Sector

1A. Fuel Combustion Activities

1A1. Energy Industries

1A2. Manufacturing Industries and Constructions

1A3. Transport

1A4. Other Sectors (Commercial/Institutional, Residential and Agricultural/Forestry/Fishing)

1A5. Other

1B. Fugitive emissions

1B2. Oil and Natural Gas

Memo items

International Bunkers

CO_2 Emissions from Biomass

A brief overview, methodological issues and data sources, key categories, uncertainties and times-series consistency, QA/QC and verification, recalculations made and planned improvements are described for each source category in this sector. GHG emissions in the Energy Sector result from fuel combustion for power generation (electricity and heat), transportation needs, industrial production, as well as from fuel combustion in the commercial/institutional, residential and agriculture/forestry/fishing sectors, and for other needs and works in energy sector, including military transport.

3.1.1 Summary of Emission Trends

In 2005, Energy Sector accounted for circa 65.0 percent of total national direct GHG emissions (without LULUCF), being the most important source of GHG emissions at the national level.

Energy Sector was also a relevant source of CH_4 and N_2O emissions, accounting for circa 24.0 percent and, respectively 3.2 percent of total methane and nitrous oxide emissions registered at the national level.

Between 1990 and 2005, the GHG emissions from the Energy Sector tended to lower values, decreasing by 77.6 percent: from 34520.39 Gg CO_2 eq. in 1990 to 7724.81 Gg CO_2 eq. in 2005 (Table 3-1, Figure 3-1), in principal because of the economic decline in the Republic of Moldova in the respective period.

Practically all source categories under the Energy Sector in the Republic of Moldova revealed a GHG emission decreasing trend (Table 3-2):

- 1A1 'Energy Industries' decreased by 84.6 percent: from 19393.29 Gg CO_2 eq. (1990) to 2989.77 Gg CO_2 eq. (2005);
- 1A2 'Manufacturing Industry and Construction' decreased by 81.9 percent: from 2195.89 Gg CO_2 eq. (1990) to 396.99 Gg CO_2 eq. (2005);
- 1A3 'Transport' decreased by 59.2 percent: from 4055,61 Gg CO_2 eq. (1990) to 1654.52 Gg CO_2 eq. (2005);
- 1A4 'Other Sectors' decreased by 76.2 percent: from 8037.78 Gg CO_2 eq. (1990) to 1654.52 Gg CO_2 eq. (2005);
- 1A5 'Other' decreased by 23.5 percent: from 154.90 Gg CO_2 eq. (1990) to118.52 Gg CO_2 eq. (2005).
- 1B2 'Fugitive Emissions from Oil and Natural Gas' decreased by 4.3 percent: from 682.93 Gg CO_2 eq. (1990) to 653.90 Gg CO_2 eq. (2005).

Table 3-1: GHG Emissions from Energy Sector in the Republic of Moldova, 1990-2005

	1990	1991	1992	1993	1994	1995	1996	1997
Energy, Gg CO_2 eq.	34520.39	30220.38	21384.24	16475.22	13975.19	11135.71	11430.27	9526.58
	1998	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**
Energy, Gg CO_2 eq.	7938.33	6184.74	5437.82	6639.87	6738.33	7328.40	7490.74	7724.81

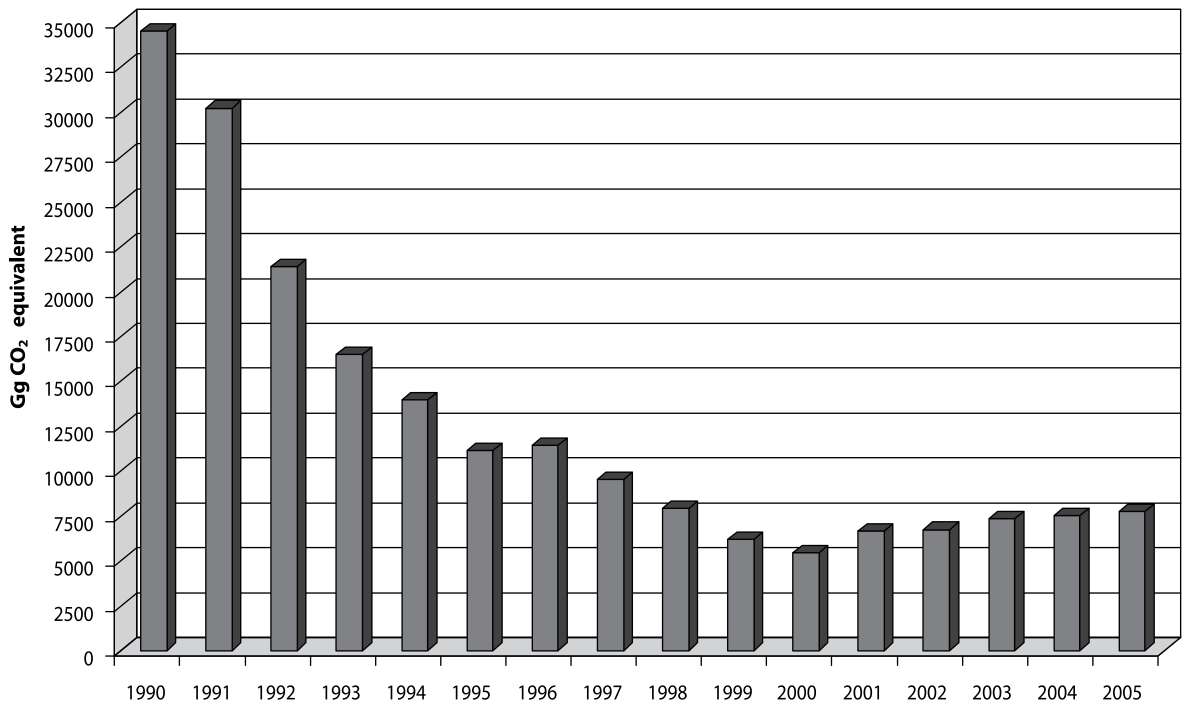

Figure 3-1: GHG Emissions from Energy Sector in the Republic of Moldova, 1990-2005

Table 3-2: GHG Emissions from the Energy Sector by Category in the Republic of Moldova within 1990-2005, Gg CO_2 eq.

	1990	1991	1992	1993	1994	1995	1996	1997
1A1	19393.29	17414.42	13049.34	11373.20	9520.36	6931.76	7057.97	5370.04
1A2	2195.89	1690.89	965.34	541.78	286.20	316.65	261.86	299.44
1A3	4055.61	3662.64	2054.33	1513.52	1317.33	1328.52	1298.13	1321.21
1A4	8037.78	6507.40	4494.19	2338.14	2203.37	1829.47	2062.55	1901.70
1A5	154.90	304.08	240.86	187.28	146.23	173.32	145.42	136.07
1B2	682.93	640.95	580.19	521.29	501.71	555.98	604.33	498.12
	1998	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**
1A1	4427.55	3318.36	2653.71	3416.58	3048.93	2927.52	2944.22	2989.77
1A2	259.78	237.33	258.17	286.11	284.99	301.38	319.80	396.99
1A3	1153.33	784.87	848.27	926.43	1157.96	1451.78	1621.59	1654.52
1A4	1538.61	1322.54	1122.76	1447.33	1639.70	1956.66	1864.60	1911.11
1A5	92.83	56.56	51.51	63.29	64.52	117.73	123.00	118.52
1B2	466.22	465.08	503.40	500.13	542.24	573.33	617.53	653.90

Within the Energy Sector, the source category with the largest specific weight in the national GHG emissions is 1A1 'Energy Industries' with a share varying over the review period, from 69.0 percent (1993) to 38.7 percent (2005). Other major emissions sources within the Energy Sector are represented by 1A4 'Other Sectors', with a share varying from 14.2 percent (1993) to 26.7 percent (2003), 1A3 'Transport', with a share varying from 9.2 percent (1993) to 21.7 percent (2004), and 1B2 'Fugitive Emissions from Oil and Natural Gas', with a share varying from 2.0 percent (1990) to 9.3 percent (2000) (Table 3-3, Figure 3-3).

The share of 'Stationary Fuel Combustion' (included source categories 1A1, 1A2 and 1A4) within the total GHG emissions originated from the sub-sector 1A 'Fuel Combustion Activities' under the Energy Sector, decreased significantly in the Republic of Moldova over the period: from 87.6 percent of the total in 1990 to 74.9 percent in 2005. At the same time, the share of 'Mobile Fuel Combustion' (include source categories 1A3 and 1A5) within the total GHG emissions originated from the respective sub-sector under the Energy Sector, increased from 12.4 percent of the total in 1990 to 25.1 percent in 2005 (Table 3-4, Figure 3-4).

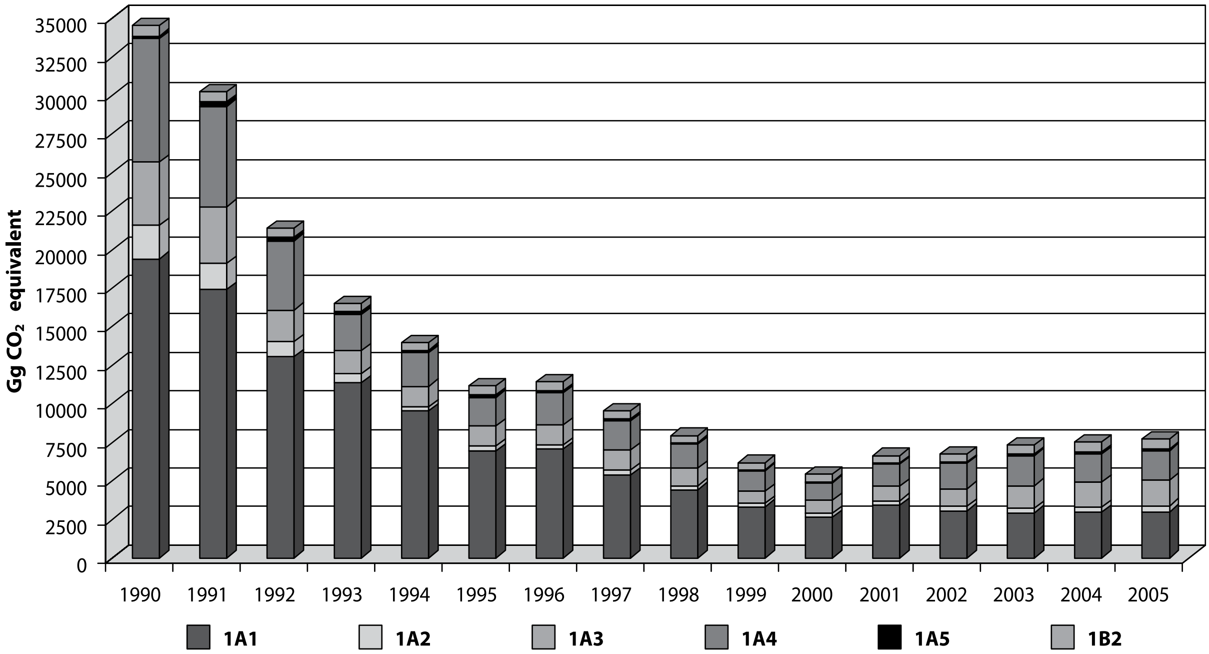

Figure 3-2: GHG Emissions from the Energy Sector by Category in the Republic of Moldova within 1990-2005, Gg CO_2 eq.

Table 3-3: Breakdown of the Republic of Moldova's Energy Sector GHG Emissions by Category within 1990-2005, %

	1990	1991	1992	1993	1994	1995	1996	1997
1A1	56.18	57.62	61.02	69.03	68.12	62.25	61.75	56.37
1A2	6.36	5.60	4.51	3.29	2.05	2.84	2.29	3.14
1A3	11.75	12.12	9.61	9.19	9.43	11.93	11.36	13.87
1A4	23.28	21.53	21.02	14.19	15.77	16.43	18.04	19.96
1A5	0.45	1.01	1.13	1.14	1.05	1.56	1.27	1.43
1B2	1.98	2.12	2.71	3.16	3.59	4.99	5.29	5.23
	1998	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**
1A1	55.77	53.65	48.80	51.46	45.25	39.95	39.30	38.70
1A2	3.27	3.84	4.75	4.31	4.23	4.11	4.27	5.14
1A3	14.53	12.69	15.60	13.95	17.18	19.81	21.65	21.42
1A4	19.38	21.38	20.65	21.80	24.33	26.70	24.89	24.74
1A5	1.17	0.91	0.95	0.95	0.96	1.61	1.64	1.53
1B2	5.87	7.52	9.26	7.53	8.05	7.82	8.24	8.46

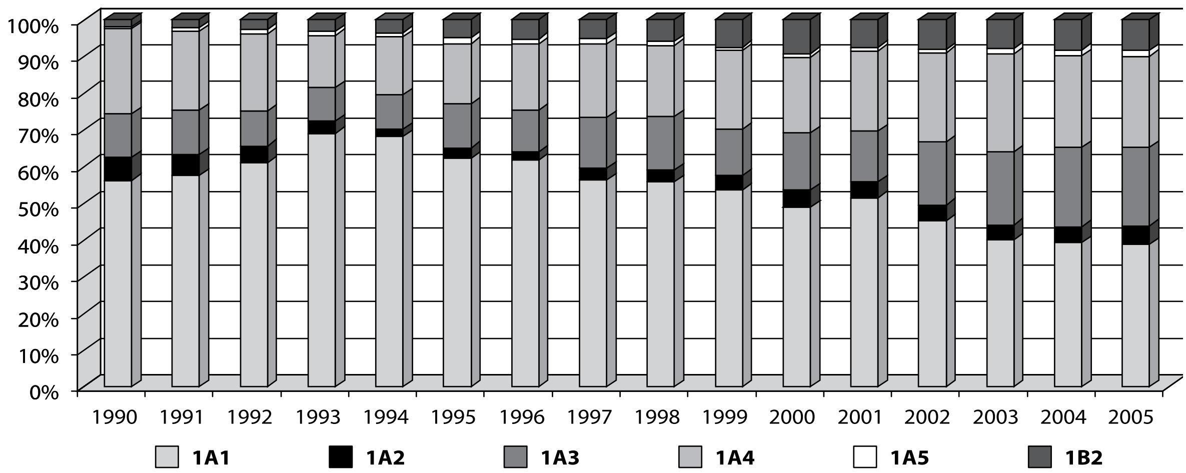

Figure 3-3: Breakdown of the Republic of Moldova's Energy Sector GHG Emissions by Category within 1990-2005, %

Table 3-4: GHG Emissions from the Fuel Combustion Activities Sub-sector in the Republic of Moldova within 1990-2005, in Gg CO_2 eq. and percent from the total

	1990	1991	1992	1993	1994	1995	1996	1997
Stationary combustion	29626.96	25612.70	18508.87	14253.12	12009.93	9077.88	9382.38	7571.18
% from the total	87.6	86.6	89.0	89.3	89.1	85.8	86.7	83.9
Mobile combustion	4210.50	3966.73	2295.18	1700.80	1463.55	1501.84	1443.55	1457.28
% from the total	12.4	13.4	11.0	10.7	10.9	14.2	13.3	16.1
Sub-sector 1A, total	33837.46	29579.43	20804.05	15953.93	13473.49	10579.72	10825.94	9028.46
	1998	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**
Stationary combustion	6225.94	4878.23	4034.64	5150.02	4973.61	5185.56	5128.62	5297.88
% from the total	83.3	85.3	81.8	83.9	80.3	76.8	74.6	74.9
Mobile combustion	1246.17	841.43	899.78	989.72	1222.48	1569.51	1744.59	1773.04
% from the total	16.7	14.7	18.2	16.1	19.7	23.2	25.4	25.1
Sub-sector 1A, total	7472.10	5719.66	4934.43	6139.74	6196.09	6755.07	6873.21	7070.91

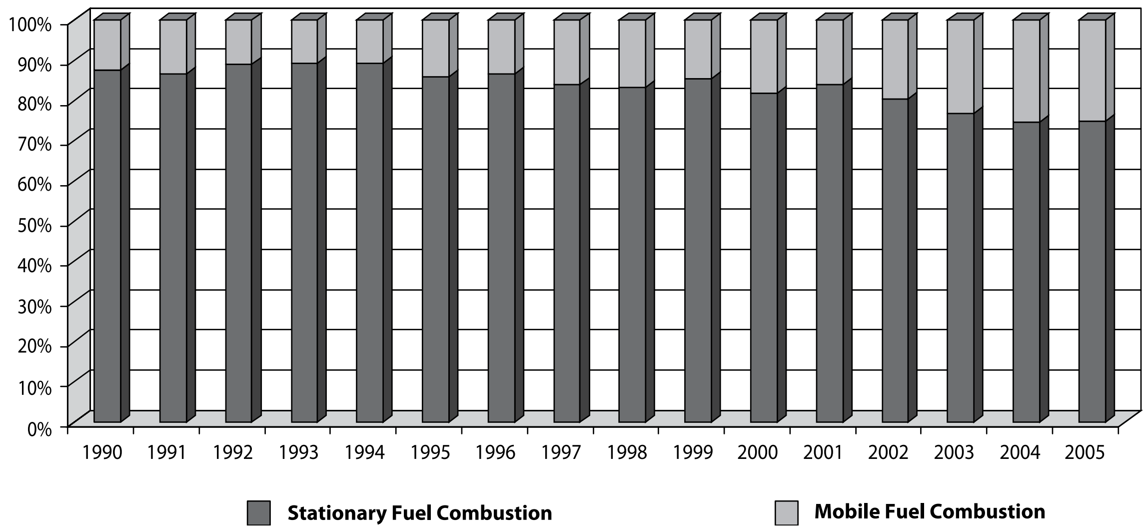

Figure 3-4: Breakdown of the Fuel Combustion Activities Sub-sector's GHG Emissions in the Republic of Moldova within 1990-2005, %

The share of fugitive emissions from the sub-sector 1B 'Fugitive Emissions', in particular from the category 1B2 'Fugitive Emissions from Oil and Natural Gas', in the structure of the total GHG emissions originated from the Energy Sector, tended to grow from a minimum of 2.0 percent in 1990 to maximum of 9.3 percent in 2000. At the same time, the share of GHG emissions originated from the sub-sector 1A 'Fuel Combustion Activities' somewhat decreased: from 98.0 percent in 1990 to 91.5 percent in 2005 (Table 3-5, Figure 3-5).

Table 3-5: GHG Emissions from the 1A 'Fuel Combustion Activities' and 1B 'Fugitive Emissions from Fuels' Sub-sectors in the RM within 1990-2005, in Gg CO_2 eq. and percent from the Total Sectoral GHG Emissions

	1990	1991	1992	1993	1994	1995	1996	1997
1A	33837.46	29579.43	20804.05	15953.93	13473.49	10579.72	10825.94	9028.46
% from the total	98.0	97.9	97.3	96.8	96.4	95.0	94.7	94.8
1B	682.93	640.95	580.19	521.29	501.71	555.98	604.33	498.12
% from the total	2.0	2.1	2.7	3.2	3.6	5.0	5.3	5.2
Total	34520.39	30220.38	21384.24	16475.22	13975.19	11135.71	11430.27	9526.58
	1998	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**
1A	7472.10	5719.66	4934.43	6139.74	6196.09	6755.07	6873.21	7070.91
% from the total	94.1	92.5	90.7	92.5	92.0	92.2	91.8	91.5
1B	466.22	465.08	503.40	500.13	542.24	573.33	617.53	653.90
% from the total	5.9	7.5	9.3	7.5	8.0	7.8	8.2	8.5
Total	7938.33	6184.74	5437.82	6639.87	6738.33	7328.40	7490.74	7724.81

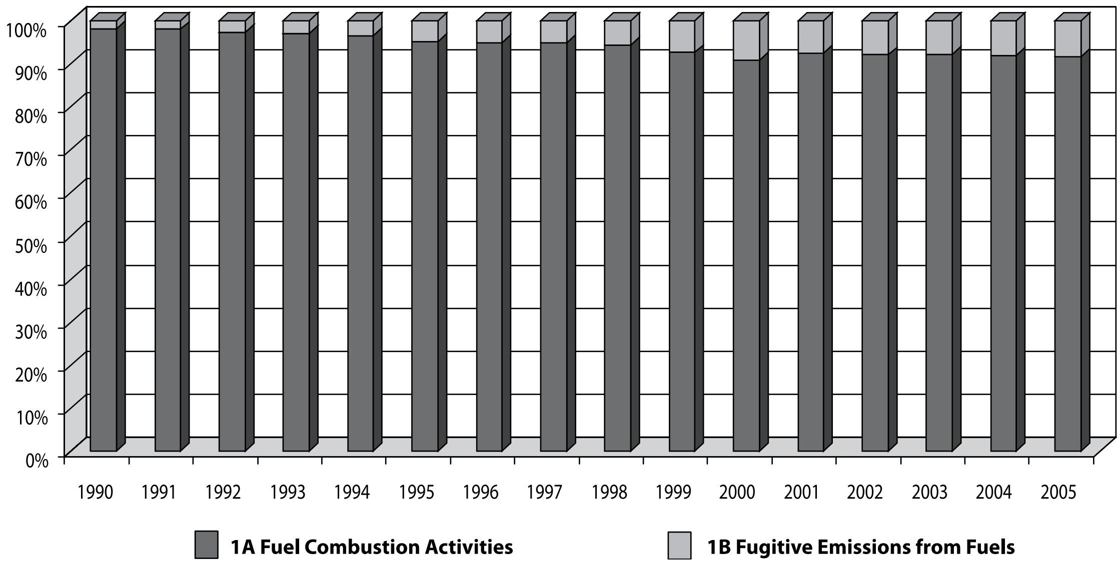

Figure 3-5: Breakdown of the Republic of Moldova's Energy Sector GHG Emissions by Sub-sector within 1990-2005, %

Table 3-6: GHG Emissions from the Energy Sector by Gas in the Republic of Moldova within 1990-2005

	GHG Emissions, CO_2 equivalent				Share in the Total Sectoral Emissions, %			
	CO_2	CH_4	N_2O	Total	CO_2	CH_4	N_2O	Total
1990	33365.55	963.25	191.59	34520.39	96.65	2.79	0.56	100.0
1991	29193.09	860.19	167.10	30220.38	96.60	2.85	0.55	100.0
1992	20587.39	687.44	109.41	21384.24	96.27	3.21	0.51	100.0
1993	15776.07	608.22	90.93	16475.22	95.76	3.69	0.55	100.0
1994	13304.34	590.49	80.36	13975.19	95.20	4.23	0.58	100.0
1995	10456.76	617.56	61.38	11135.71	93.90	5.55	0.55	100.0
1996	10688.36	682.94	58.97	11430.27	93.51	5.97	0.52	100.0
1997	8932.24	546.39	47.95	9526.58	93.76	5.74	0.50	100.0
1998	7389.14	506.59	42.59	7938.33	93.08	6.38	0.54	100.0
1999	5655.74	501.12	27.87	6184.74	91.45	8.10	0.45	100.0
2000	4870.83	538.35	28.65	5437.82	89.57	9.90	0.53	100.0
2001	6074.55	531.87	33.45	6639.87	91.49	8.01	0.50	100.0
2002	6118.17	581.91	38.25	6738.33	90.80	8.64	0.57	100.0
2003	6664.84	618.11	45.45	7328.40	90.95	8.43	0.62	100.0
2004	6790.71	655.43	44.60	7490.74	90.65	8.75	0.60	100.0
2005	6986.14	693.35	45.32	7724.81	90.44	8.98	0.59	100.0

The CO_2 has the largest share in the structure of total GHG emissions originated from the Energy Sector, varying over the reference period, from the minimum of 89.57 percent in 2000, to a maximum of 96.65 percent in 1990. Other GHGs had smaller contribution: CH_4, between 2.79 percent in 1990 and 9.90 percent in 2000; while N_2O respectively, between the minimum of 0.45 percent in 1999 and a maximum of 0.62 percent in 2003 (Table 3-6).

The non-CO_2 emissions originated from the Energy Sector also significantly decreased between 1990 and 2005: CH_4 emissions decreased by 28.0 percent, N_2O emissions by 76.3 percent, NO_x by 77.5 percent, CO by 73.2 percent, NMVOC by 70.9 percent and SO_2 by 96.2 percent (Table 3-7).

3.1.2 Key Categories

The results of key source assessment (including LULUCF) carried out following a Tier 1 approach (IPCC, 2000), are provided in Chapter 1.5, as well as in the Annex 1. Table 3-8 provides information on identified key categories (by level and trend) under the Energy Sector of the Republic of Moldova.

Table 3-7: Non-CO_2 Emissions from the Energy Sector in the RM within 1990-2005, Gg

GHG	1990	1991	1992	1993	1994	1995	1996	1997
CH_4	45.8690	40.9613	32.7354	28.9628	28.1184	29.4076	32.5208	26.0185
N_2O	0.6180	0.5390	0.3529	0.2933	0.2592	0.1980	0.1902	0.1547
NO_x	134.6595	116.4861	78.3833	61.6055	52.9312	46.1500	43.5677	38.8713
CO	423.1362	366.4809	186.1429	149.7682	137.2315	134.8160	133.1780	125.5585
NMVOC	71.9509	63.4604	32.6833	25.0331	22.9155	23.1543	22.4609	22.2158
SO_2	293.0068	254.5103	169.0262	144.5701	101.8663	60.3516	58.3902	33.3266
GHG	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**
CH_4	24.1235	23.8628	25.6355	25.3272	27.7102	29.4339	31.2109	33.0165
N_2O	0.1374	0.0899	0.0924	0.1079	0.1234	0.1466	0.1439	0.1462
NO_x	31.9402	22.9060	20.9849	24.3746	26.2110	28.9496	30.0491	30.3018
CO	110.7788	74.5434	72.8803	75.6838	93.9662	108.8955	110.9883	113.3175
NMVOC	19.3845	12.7405	12.5882	13.2321	16.4127	19.0557	20.3923	20.9266
SO_2	26.4155	13.5331	9.3075	8.8862	9.9173	12.4319	10.5421	11.0858

Table 3-8: Key Categories Identified under the Energy Sector of the Republic of Moldova

IPCC Category	GHG	Source category	Key source
1.A	CO_2	CO_2 Emissions from Stationary Solid Fuels Combustion	Yes (L, T)
1.A	CO_2	CO_2 Emissions from Stationary Gaseous Fuels Combustion	Yes (L, T)
1.A	CO_2	CO_2 Emissions from Liquid Fuels Combustion	Yes (L, T)
1.A	CH_4	CH_4 Emissions from Stationary Fuels Combustion	No
1.A	N_2O	N_2O Emissions from Stationary Fuels Combustion	No
1.A.3b	CO_2	CO_2 Emissions from Mobile Sources: Road Transport	Yes (L, T)
1.A.3b	CH_4	CH_4 Emissions from Mobile Sources: Road Transport	No
1.A.3b	N_2O	N_2O Emissions from Mobile Sources: Road Transport	No
1.A.3c	CO_2	CO_2 Emissions from Mobile Sources: Railway Transport	Yes (L)
1.A.3c	CH_4	CH_4 Emissions from Mobile Sources: Railway Transport	No
1.A.3c	N_2O	N_2O Emissions from Mobile Sources: Railway Transport	No
1.A.3d	CO_2	CO_2 Emissions from Mobile Sources: Water Borne Transport	No
1.A.3d	CH_4	CH_4 Emissions from Mobile Sources: Water Borne Transport	No
1.A.3d	N_2O	N_2O Emissions from Mobile Sources: Water Borne Transport	No
1.A.4c	CO_2	CO_2 Emissions from Mobile Sources: Agriculture, Forestry, Fishery	Yes (L, T)
1.A.4c	CH_4	CH_4 Emissions from Mobile Sources: Agriculture, Forestry, Fishery	No
1.A.4c	N_2O	N_2O Emissions from Mobile Sources: Agriculture, Forestry, Fishery	No
1.A.5	CO_2	CO_2 Emissions from Mobile Sources: Other Works And Needs	Yes (L, T)
1.A.5	CH_4	CH_4 Emissions from Mobile Sources: Other Works And Needs	No
1.A.5	N_2O	N_2O Emissions from Mobile Sources: Other Works and Needs	No
1.B.2	CO_2	CO_2 Fugitive Emissions from Oil and Natural Gas	No
1.B.2	CH_4	CH_4 Fugitive Emissions from Oil and Natural Gas	Yes (L, T)
1.B.2	N_2O	N_2O Fugitive Emissions from Oil and Natural Gas	No
Memo Items	CO_2	CO_2 Emissions from Biomass	Yes (L, T)
Memo Items	CO_2	CO_2 Emissions from International Aviation	No

3.1.3 Methodological Issues and Data Sources

Under the Energy Sector there were estimated GHG emissions originated from 5 source categories under sub-sector 1A (1A1, 1A2, 1A3, 1A4 and 1A5), 1 source category under subsector 1B (1B2) and 2 source categories under Memo Items (International Bunkers: Aviation and CO_2 Emissions from Biomass). GHG emissions originated from the Energy Sector of the RM were estimated following a Tier 1 methodological approach, for all source categories, except 'International Bunkers: Aviation', for which was applied a Tier 2 methodology (Table 3-9).

Table 3-9: Summary of Methods and Emission Factors Used to Estimate GHG Emissions from the Energy Sector of the Republic of Moldova

IPCC Categories	Source category	Method	EF
1.A.1	Energy Industries	T1	D, CS
1.A.2	Manufacturing Industries and Constructions	T1	D, CS
1.A.3	Transport	T1	D, CS
1.A.4	Other Sectors (Commercial, Institutional, Residential, Agriculture, etc.)	T1	D, CS
1.A.5	Other (Other Needs and Works in Energy & Military Transport)	T1	D, CS
1.B.2	Fugitive Emissions from Oil and Natural Gas	T1	D
Memo Items	International Bunkers: Aviation	T2	D, CS
Memo Items	CO_2 Emissions from Biomass	T1	D, CS

Abbreviations: T1 – Tier 1; T2 – Tier 2; EF – emission factors; D – default values of emission factors ; CS – country specific.

The basic equations used to estimate GHG emissions under the Energy Sector are described below (CO_2 and SO_2 emissions estimation methodologies are described as well in the Annex 3-1):

CO_2 Emissions = Σ (Fuel Consumption $_j$ • Conversion Factor (TJ/unit) • Carbon Emission Factor $_j$ (t C/TJ) – Carbon Stored • Oxidation Fraction $_j$ • 44/12) and

Non-CO_2 Emissions = Σ (Fuel Consumption $_j$ • Emission Factor $_j$)

Where: j – type of fuel.

Practically all fuels consumed at the national level are imported (coal - from Ukraine, Russian Federation, Kazakhstan; natural gas – from Russian Federation; oil products – from Romania, Ukraine, Russian Federation, Belarus, Lithuania etc.). Since 1997, oil and natural gas exploration works were initiated in the South of the RM, however, the extracted amounts are yet insignificant.

The main source of reference for AD used for estimating GHG emissions under the Energy Sector is the National Bureau of Statistics (NBS), through its annual publication – Energy Balances of the Republic of Moldova (see Annex 2). Additional AD were provided by central public authorities: Ministry of Transport and Roads (MTR), Ministry of Agriculture and Food Industry (MAFI), Ministry of Defence (MoD), Ministry of Information Development (MID), Customs Service (CS), Civil Aviation State Administration (CASA), as well as by some enterprises: “Moldavian Railways” State Enterprises and “MOLDOVAGAZ” J.S.C., as response to the requests coming from the Ministry of Environment and Natural Resource (MENR), the national entity responsible for development the national GHG inventory. The Energy Balance for 1990 year ensured geographical coverage of the whole country, while the Energy Balances for the time series from 1993 through 2005 covered only the territory on the right bank of the Dniester River (in the 1991-1992 years the Energy Balances were not published in the Republic of Moldova). The AD regarding fuel consumption on the territory situated on left bank of the Dniester River is available partially in the Statistical Yearbooks of the Administrative-Territorial Unites on the Left Bank of the Dniester River (ATULBD).

The estimation of GHG emissions for the FNC of the RM to the UNFCCC was based on default values of “Net Calorific Values”, while the current inventory relied on country specific Net Calorific Values (Table 3-10). In conformity with recommendations in the IPCC 2006 Guidelines, the value of oxidation fraction was assumed as being 1 for all types of fuel (in the FNC, it was 0.99 for liquid fuels, 0.98 – for solid fuels and 0.995 – for gaseous fuels).

3.1.4 Uncertainties and Time-Series Consistency

The uncertainty analysis of the GHG emissions from the Energy Sector (by source categories) is described in detail in the respective sub-chapters (3.2-3.9) of the NIR, as well as in the Annex 7-3.1. Combined uncertainties as a percentage of total direct sectoral emissions were estimated at circa ±16.9 percent (±5.6 percent for CO_2, ±188.1 percent for CH_4 and ±30.4 percent for N_2O). The uncertainties introduced in trend in sectoral emissions were estimated at ±3.1 percent (±1.4 percent for CO_2, ±34.3 percent for CH_4 and ±4.3 percent for N_2O).

In view of ensuring time-series consistency of the results, the same approach was used for the entire period under review, in conformity with the recommendations included in the Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories (IPCC, 2000).

3.1.5 QA/QC and Verification

Standard verification and quality control forms and checklists by individual source categories were filled in for each source category under the Energy Sector, following the Tier 1 and Tier 2 approaches (see in Annex 6). Also, the AD and methods used for estimating GHG emissions under the Energy Sector were documented and archived both in hard copies and electronically. To identify the data entry, as well GHG emissions estimation related errors there were applied AD and EFs verifications and quality control procedures. Inventory quality assurance activities for the Energy Sector were supported by an expert representing the Institute of Energy of the ASM. Following the recommendations included into the Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories (IPCC, 2000), GHG emissions under the Energy Sector were estimated based on AD and EFs from official sources of reference.

3.1.6 Recalculations

GHG emission recalculations under the Energy Sector are due to the availability of an updated set of activity data (Energy Balances, Statistical Yearbooks of the RM and of the ATULBD, and other relevant sources), as well as due to updated methodologies available in the 2006 IPCC Guidelines, which has replaced the methodologies contained into the Revised 1996 IPCC Guidelines (IPCC, 1997) used under the FNC (2000).

In comparison with the results included into the FNC, the performed recalculation resulted in increased GHG emission values for the 1998-1998 time periods, varying from a minimum of 5.2 percent in 1998, up to maximum of 27.1 percent in 1990 (Table 3-11). The results of recalculations performed at the category level are presented in the respective sub-chapters (3.2-3.9) of the NIR.

Table 3-10: Emission Factors and Other Relevant Parameters Used to Estimate GHG Emissions from the Energy Sector of the Republic of Moldova

Fuel type	Net Calorific Value (country specific), TJ/kt		Net Calorific Value, TJ/kt		Emission factors, t C/TJ		Fraction of carbon oxidized	
	Ranges according to the NBS	Value used	IPCC, 1997	IPCC, 2006	IPCC, 1997	IPCC, 2006	IPCC, 1997	IPCC, 2006
Coal	15.40 - 29.13		18.58				0.98	1
Anthracite	22.83 - 29.13		18.58	26.7	26.8	26.8	0.98	1
Brown Coal, including :	6.31 - 15.37		14.65	11.9	27.6	27.6	0.98	1
Donetsk	25.70	25.70			26.8		0.98	1
Kuznetsk	25.44	25.44			26.8		0.98	1
Ukraine	6.31 - 11.68	11.68			27.6		0.98	1
Kansk-Acinsk	15.14	15.14			25.8		0.98	1
Brown Coal Briquettes	17.75	17.75		20.7	25.8	26.6	0.98	1
Coking Coal	26.41 - 29.05	26.41	18.58	28.2	25.8	25.8	0.98	1
Diesel Oil	42.54	42.54	43.33	43.0	20.2	20.2	0.99	1
Fuel for Oven	42.54	42.54			21.1		0.99	1
Residual Fuel Oil	39.02 - 40.20	40.20	40.19	40.4	21.1	21.1	0.99	1
Fuel for Engines	41.96	41.96			20.0		0.99	1
including Jet Engines	43.13				19.5		0.99	1
Aviation Gasoline	43.72	43.72	44.80	44.3	18.9	19.1	0.99	1
Gasoline	43.72	43.72	44.80	44.3	18.9	18.9	0.99	1
Kerosene	43.13	43.13	44.75	43.8	19.6	19.6	0.99	1
Lubricants	42.19	42.19	40.19	40.2	20.0	20.0	0.99	1
Bitumen	39.61	39.61	40.19	40.2	22.0	22.0	0.99	1
Other Oil Products	40.19	40.19	40.19	40.2	20.0	20.0	0.99	1
Natural Gas	33.15 - 34.03	33.86	33.70	48.0	15.3	15.3	0.995	1
Liquefied Petroleum Gases (LPG)	46.06	46.06	47.31	47.3	17.2	17.2	0.99	1
Fuel Wood	12.32	12.32	15	15.6	29.9	30.5	0.98	1
Agricultural Residues	14.67	14.67	15.2		29.9		0.98	1

Source: Instructions for Compiling the Statistical Report No.1-EB "Energy Balance", approved through Order No. 106 from 16.09.2003 of the Department of Statistics and Sociology of the Republic of Moldova.

Table 3-11: Recalculated GHG Emissions under the Energy Sector for the 1990-1998, Gg CO_2 equivalent

	1990	1991	1992	1993	1994	1995	1996	1997	1998
FNC	27149.5	24552.5	19369.6	14234.1	12203.3	9431.3	10023.1	9014.8	7544.9
SNC	34520.4	30220.4	21384.2	16475.2	13975.2	11135.7	11430.3	9526.6	7938.3
Difference, %	27.1	23.1	10.4	15.7	14.5	18.1	14.0	5.7	5.2

Abbreviations: FNC – First National Communication; SNC – Second National Communication.

3.1.7 Assessment of Completeness

Under the current inventory cycle within the Energy Sector there were estimated GHG emissions originated from 8 source categories (Table 3-12). As no coal extraction exist in the Republic of Moldova, there were registered no GHG emissions from the category 1B1 'Fugitive Emissions from Coal Extraction'.

3.1.8 Planned Improvements

Planned improvements at source categories level within the Energy Sector are described in more detail in sub-chapters 3.2-3.9 of this report.

Table 3-12: Assessment of Completeness under the Energy Sector in the RM

Category IPCC	Source category	CO_2	CH_4	N_2O
1.A.1	Energy Industries	X	X	X
1.A.2	Manufacturing Industry and Constructions	X	X	X
1.A.3	Transport	X	X	X
1.A.4	Other Sectors (Commercial, Institutional, Residential, Agriculture, etc.)	X	X	X
1.A.5	Other (Other Works And Needs in Energy & Military Transport)	X	X	X
1.B.1	Fugitive Emissions from Coal Extraction	NO	NO	NO
1.B.2	Fugitive Emissions from Oil and Natural Gas	X	X	X
Memo Items	International Bunkers	X	X	X
Memo Items	CO_2 Emissions from Biomass	X	X	X

Abbreviations: X – Source Categories Included in Republic of Moldova's GHG Inventory; NO – Not Occurring.

3.2 Energy Industries (Category 1A1)

Energy Industry plays an important role in national economy, accounting for 2.1 percent of the Gross Domestic Product (NBS, 2006). Over 1990-2006, a stable number of specialists were involved in the Energy Sector (around 26 thousands) or approximately 2 percent of active population of country. As 1st of January 2006, the Energy Industry of the RM included 43 enterprises, of which 26 publicly owned, 12 were private, 2 with mixed ownership (public and private ownership), and 3 – with foreign capital (NBS, 2006).

3.2.1 Source Category Description

The emission sources monitored in the Republic of Moldova under the category 1A1 'Energy Industries' are as following: 1A1ai 'Public Electricity Generation'; 1A1aii 'Public Combined Heat and Power Generation'; and 1A1aiii 'Public Heat Plants'.

In 2005, category 1A1 'Energy Industries' accounted for 25.2 percent of the total national GHG emissions (without LULUCF). Between 1990 and 2005, direct GHG emissions from category 1A1 'Energy Industries' tended to reveal lower values in the Republic of Moldova, decreasing by 84.6 percent: from 19393.29 Gg CO_2 eq. in 1990, to 2989.77 Gg CO_2 eq. in 2005 (Table 3-13, Figure 3-6).

1A1ai. Public Electricity Generation

Electricity generation sources are placed both on the right and left bank of Dniester (see in *Technological Needs and Development Priorities, Report elaborated under the UNFCCC*, MECDT/UNDP Moldova, 2002). On the left bank of the Dniester (ATULBD), in Dnestrovsk it is placed the Moldovan Thermal Power Plant (MTPP), which is the biggest electricity generation source in the RM, with an installed capacity of 2520 MW (12 energy units). Lately, the MTPP has not been working at its full capacity, electricity being produced only by 2-4 operating units. Currently the MTPP operates on natural gases however it is designed to use also coal and residual fuel oil. Due to lack of official information on fuel consumption for electricity generation at MTPP for the 1999-2005 time periods, the needed activity data was generated indirectly, based on information on the amount of electricity produced.

Table 3-13: Direct GHG Emissions from 1A1 'Energy Industries' Source Category in the Republic of Moldova within 1990-2005, Gg CO_2 equivalent

Years	CO_2	CH_4	N_2O	Total	Years	CO_2	CH_4	N_2O	Total
1990	19332.77	9.29	51.23	19393.29	1998	4420.00	1.86	5.69	4427.55
1991	17361.21	8.03	45.18	17414.42	1999	3314.44	1.39	2.53	3318.36
1992	13009.22	5.94	34.18	13049.34	2000	2650.86	1.07	1.77	2653.71
1993	11336.56	5.32	31.32	11373.20	2001	3412.97	1.38	2.22	3416.58
1994	9489.74	3.80	26.83	9520.36	2002	3045.60	1.26	2.07	3048.93
1995	6913.62	2.76	15.39	6931.76	2003	2924.36	1.20	1.96	2927.52
1996	7040.69	2.80	14.48	7057.97	2004	2940.95	1.24	2.03	2944.22
1997	5360.38	2.22	7.44	5370.04	2005	2986.57	1.23	1.98	2989.77

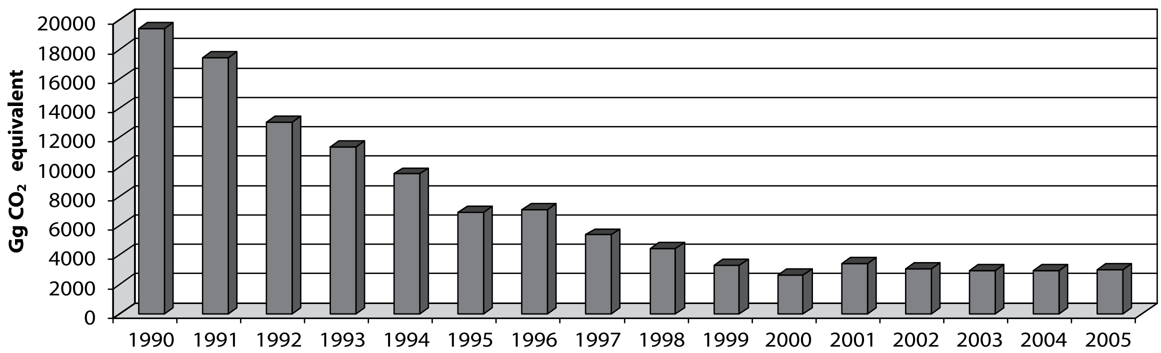

Figure 3-6: GHG Emissions from 1A1 'Energy Industries' Source Category in the Republic of Moldova, 1990-2005

1A1aii. Public Combined Heat and Power Generation

At the moment, on the right bank of the Dniester there are three Combined Heat and Power Plants (CHP): in Chisinau, the CHP-1 with an installed capacity of 62 MW and the CHP-2, with an installed capacity of 240 MW; and in Balti: the CHP–North, with an installed capacity of 28.5 MW (see in *Technological Needs and Development Priorities, Report elaborated under the UNFCCC,* MECDT/UNDP Moldova, 2002). All these sources preponderantly use natural gases (the residual fuel oil is used as a reserve fuel). GHG emissions from fossil fuel combustion for public combined heat and power generation were estimated based on activity data available in the Energy Balances of the Republic of Moldova for 1990 and 1993-2005, as well as from other relevant sources, such as data provided by the Ministry of Industry and Infrastructure and/or obtained directly from the CHPs.

1A1aiii. Public Heat Plants

There are many Heat Plants (HPs) in the Republic of Moldova, mainly operating on natural gases and residual fuel oil, less on coal (see in *Technological Needs and Development Priorities, Report elaborated under the UNFCCC,* MECDT/UNDP Moldova, 2002). GHG emissions from fossil fuel combustion for heat generation were estimated based on activity data available in EBs for 1990, 1993-2005, as well as from the Ministry of Industry and Infrastructure and/or from municipal enterprise "Termocom" J.S.C.

3.2.2 Methodological Issues and Data Sources

GHG emissions originated from the 1A1 'Energy Industry' was estimated following a Tier 1 methodology. EFs used for estimating CO_2 and SO_2 emissions are described in Table 3-10 and Annex 3-1. Default EFs values available in the Revised 1996 IPCC Guidelines (IPCC, 1997) and 2006 IPCC Guidelines were used for non-CO_2 emissions estimation (Table 3-14).

Table 3-14: Emission Factors Used for Estimating non-CO_2 Emissions Originated from 1A1 'Energy Industries' Source Category, kg/TJ

GHG	Coal	Natural Gas	Oil Products	Fuel Wood	Other Biomass
CH_4	1	1	3	30	30
N_2O	1.5	0.1	0.6	4	4
NO_x	300	150	200	100	100
CO	20	20	15	1000	1000
NMVOC	5	5	5	50	50

Source: for NO_x, CO and NMVOC: Revised 1996 IPCC Guidelines, Vol. 3, Tab. 1-9, 1-10 and 1-11, Pages 1.37-1.42; for CH_4, N_2O: 2006 IPCC Guidelines, Vol. 2, Chap. 2, Tab. 2.2, Pages 2.16-2.17

As stated above, the AD related to fuel consumption for heat and power generation (Table 3-15) were collected from the Energy Balances of the RM for 1990, 1993-2005 and other relevant sources of information (i.e., from the Ministry of Industry and Infrastructure and from certain energy enterprises, like CHP-1 J.S.C., CHP-2 J.S.C., CHP-North J.S.C. and State Enterprise "Moldelectrica").

Table 3-15: Fuel Consumption for Heat and Power Generation in the RM, 1990-2005

	1990	1991	1992	1993	1994	1995	1996	1997
Other Kerosene, kt	0.00	0.00	0.00	3.20	1.00	0.00	0.00	0.00
Diesel Oil, kt	62.00	50.00	30.00	9.10	8.00	8.00	7.00	5.00
Residual Fuel Oil, kt	2119.00	1715.00	1248.50	1204.80	559.00	335.10	308.60	213.06
Kerosene, kt	0.00	0.00	0.00	0.90	0.00	0.00	0.00	0.00
Anthracite, kt	0.00	0.00	0.00	20.10	7.00	5.00	2.00	1.00
Coking Coal , kt	0.00	0.00	0.00	0.10	0.00	0.00	0.00	0.00
Bituminous Coal, kt	2657.00	2419.00	1868.00	1683.60	1716.60	900.90	826.34	299.87
Lignite, kt	0.00	0.00	0.00	15.80	4.00	2.00	2.00	2.00
Natural Gas, mil.m^3	3239.00	3184.00	2388.00	1804.00	1879.00	1928.40	2138.80	2082.30
Fuel Wood, kt	0.73	0.00	0.00	0.44	0.73	0.73	0.73	0.73
Other Biomass, kt	3.00	0.00	0.00	3.40	10.00	3.00	3.00	2.00
	1998	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**
Diesel Oil, kt	3.00	3.00	4.00	3.00	2.00	3.00	2.00	3.00
Residual Fuel Oil, kt	188.92	99.00	42.00	39.00	30.00	20.00	18.00	16.00
Anthracite, kt	1.00	0.00	0.00	0.00	2.00	2.00	2.00	3.00
Bituminous Coal, kt	198.42	7.00	0.00	0.00	2.00	3.00	4.00	2.00
Lignite, kt	2.00	1.00	1.00	0.00	0.00	0.00	0.00	0.00
Natural Gas, mil.m^3	1758.62	1568.30	1319.50	1727.90	1545.70	1495.32	1507.72	1534.56
Fuel Wood, kt	1.46	0.73	0.00	0.00	0.73	0.73	0.73	0.00
Other Biomass, kt	1.00	1.00	2.00	5.00	8.00	8.00	12.00	9.00

Because of unavailability of official information on fuel consumption at MTPP, the respective data were generated based of information on the amount of produced electricity (the conversion factors used: 360 grams of coal equivalent per 1 kWh of electricity; respectively, 1.154 tones of coal equivalent per 1000 m^3 of natural gases).

3.2.3 Uncertainties and Time-Series Consistency

The inventory uncertainties for 1A1 'Energy Industries' source category are largely dependent on the collection procedures used for the underlying activity data (commercial fuel volumes and properties are generally well-known), as well as on the representativeness of the emission factors for specific fuel properties. Uncertainties associated with EFs used to estimate CO_2 emissions from the 1A1 'Energy Industry' source category, were estimated at ±5 percent, while those pertaining to EFs used to estimate CH_4 and N_2O emissions reach up to ±50 percent. Uncertainties associated with the statistical data regarding fuel consumption for heat and power generation in the RM can be considered relatively low (±5 percent), however, as in case of MTPP it was necessary to generate indirectly (by using conversion factors) the AD related to the fuel consumption for electricity generation for 1999-2005 time periods, it was deemed appropriate to use higher values, up to ±7 percent for general uncertainty on AD for the respective source category. So, uncertainties pertaining to GHG emissions from the 1A1 'Energy Industries' source category were estimated at ±8.60 percent for CO_2 emissions and at ±50.49 percent for CH_4 and N_2O emissions. At the same time, combined uncertainties, presented as a percent of total sectoral emissions were estimated at ±3.1779 percent for CO_2 emissions, ±0.0077 percent for CH_4 emissions, and ±0.0123 percent for N_2O emissions. Uncertainties introduced in trend in sectoral emissions were estimated at ±0.8719 percent for CO_2 emissions, ±0.0014 percent for CH_4 emissions, and ±0.0141 percent for N_2O emissions (see Annex 7-3.1).

In view of ensuring time-series consistency of the obtained results, the same approach was used for the entire period under review, in conformity with the recommendations included in the Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories (IPCC, 2000).

3.2.4 QA/QC and Verification

Standard verification and quality control forms and checklists were filled in for the respective source category under the Energy Sector, following the Tier 1 and Tier 2 approaches (see in Annex 6). Also, the AD and methods used for estimating GHG emissions under the category 1A1 'Energy Industries' were documented and archived both in hard copies and electronically. For identifying the data entry and emission estimation process related errors there were applied verifications and quality control procedures. Verification was focused on correct use of AD obtained from different sources of reference, including the Energy Balances, Statistical Yearbooks of the RM and of the ATULBD, different central administration authorities; obtained directly from certain energy enterprises and from other relevant sources of information (Bicova, 2000; Postolati, Bicova, 2001; Bicova, Ţăranu, Scorpan, 2005); as well as on ensuring correct use of the default emission factors, available in the Revised 1996 IPCC Guidelines (IPCC, 1997), GPG (IPCC, 2000) and 2006 IPCC Guidelines (IPCC, 2006). Inventory quality assurance activities for the Energy Sector, inclusive for the 1A1 'Energy Industries' source category were supported by an expert representing the Institute of Energy of the ASM.

Following the recommendations included into the Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories (IPCC, 2000), GHG emissions originated from the 1A1 'Energy Industries' were estimated based on AD and EFs from official sources of reference.

3.2.5 Recalculations

GHG emission recalculations performed under the 1A1 'Energy Industries' are due to the availability of an updated set of activity data (Energy Balances, Statistical Yearbooks of the RM and of ATULBD, and other relevant sources, such as central administration authorities and certain energy enterprises), also due to updated methodologies available in the 2006 IPCC Guidelines, which has replaced in the Republic of Moldova's inventory the methodologies contained into the Revised 1996 IPCC Guidelines (IPCC, 1997) used under the FNC (2000), as well as due to use of country specific 'Net Caloric Values' replacing the IPCC default NCVs.

In comparison with the results included into the FNC of RM under the UNFCCC, the performed recalculations under the 1A1 'Energy Industries' sources category resulted in increased values of GHG emissions for the 1998-1998 time periods, varying from a minimum of 12.5 percent in 1998, up to a maximum of 47.8 percent in 1990 (Table 3-16).

Between 1990 and 2005, the CO_2 emissions originated from 1A1 'Energy Industries' source category decreased by 84.6 percent. This is explained both by general decrease in fuel consumption, and fuel switching (use of less GHG intensity fuels–natural gases, instead of more GHG intensity fuels – residual fuel oil and coal). Indeed, during the period under review, the consumption of fuels used for power generation underwent essential changes: the share of coal and residual fuel oil significantly decreased, while the share of natural gases had increased.

The non-CO_2 emissions originated from 1A1 'Energy Industries' source category has significantly decreased as well, over the period under review. Between 1990 and 2005, CH_4 emissions decreased by 86.8 percent, N_2O emissions – by 96.1 percent, NO_x – by 85.3 percent, CO – by 75.9 percent, NMVOC – by 79.6 percent, and SO_2 – by 99.4 percent (Table 3-17).

Table 3-16: Comparative Results of CO_2 Emissions Originated from 1A1 'Energy Industries' Included into the FNC and SNC of the RM under the UNFCCC, Gg

	1990	1991	1992	1993	1994	1995	1996	1997
FNC	13117.04	11925.90	10400.52	8796.66	7352.37	5242.07	5777.20	4735.62
SNC	19393.29	17414.42	13049.34	11373.20	9520.36	6931.76	7057.97	5370.04
Difference, %	47.8	46.0	25.5	29.3	29.5	32.2	22.2	13.4
	1998	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**
FNC	3914.62							
SNC	4427.55	3318.36	2653.71	3416.58	3048.93	2927.52	2944.22	2989.77
Difference, %	13.1							

Table 3-17: Non-CO_2 Emissions from the 1A1 'Energy Industries' Source Category in the Republic of Moldova within 1990-2005, Gg

GHG	1990	1991	1992	1993	1994	1995	1996	1997
CH_4	0.4423	0.3826	0.2828	0.2533	0.1808	0.1314	0.1332	0.1057
N_2O	0.1653	0.1457	0.1102	0.1010	0.0865	0.0496	0.0467	0.0240
NO_x	54.2987	48.8473	36.6784	32.0283	27.2991	19.4831	19.7380	14.6387
CO	4.9157	4.4530	3.3396	2.8827	2.6489	2.0275	2.1139	1.7337
NMVOC	1.3281	1.2021	0.8992	0.7709	0.6597	0.5135	0.5338	0.4367
SO_2	203.2514	172.1415	128.3280	121.2726	82.8434	46.0290	42.2225	21.4411
GHG	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**
CH_4	0.0888	0.0663	0.0511	0.0658	0.0601	0.0573	0.0592	0.0584
N_2O	0.0184	0.0082	0.0057	0.0072	0.0067	0.0063	0.0066	0.0064
NO_x	12.0088	8.8462	7.0799	9.1224	8.1521	7.8320	7.8839	7.9998
CO	1.4414	1.1511	0.9510	1.2689	1.1945	1.1555	1.2213	1.1854
NMVOC	0.3635	0.2882	0.2342	0.3047	0.2750	0.2648	0.2693	0.2709
SO_2	17.0883	6.1854	2.5730	2.3780	1.9609	1.3954	1.3138	1.1564

3.2.6 Planned Improvements

The process of monitoring GHG emissions originated from the source category 1A1 'Energy Industries' can be improved significantly once the activity data pertaining to fuel consumption at MTPP and Heat Plants from the ATULBD, are specified. The possibility to collect additional information shall be considered for the next inventory cycle, to reduce uncertainties of the GHG emissions resulting from the respective source category.

3.3 Manufacturing Industries and Construction (Category 1A2)

'Manufacturing Industries' and 'Construction Sector' play a significant role in the national economy, contributing to the GDP growth at a rate of 14.5 percent and, respectively 3.5 percent (NBS, 2006). According to the data of the NBS of RM the 'Manufacturing Industries' and 'Construction Sector' provides jobs to 132 thousand and, respectively 52 thousand persons, or 10.0 percent and, respectively 3.9 percent of employed population of the country (NBS, 2006). As of 1st of January 2006, 'Manufacturing Industry' of the Republic of Moldova included 637 big enterprises.

3.3.1 Source Category Description

GHG emissions from 1A2 'Manufacturing Industries and Construction' include the combustion of fossil fuels by the iron and steel, non-ferrous metals, chemicals, cement, construction, mining and all manufacturing industries (except for emissions from technological processes monitored under Industrial Processes Sector).

In 2005, the category 1A2 'Manufacturing Industries and Construction' accounted for 3.3 percent of the total national GHG emissions (without LULUCF). Between 1990 and 2005, the direct GHG emissions from category 1A2 'Manufacturing Industries and Construction' tended to show lower values, decreasing by 81.9 percent: from 2195.89 Gg CO_2 eq. in 1990 to 396.99 Gg CO_2 eq. in 2005 (Figure 3-7).

CO_2 emissions decreased by 82 percent: from 2188.73 Gg in 1990 to 396.38 Gg in 2005; CH_4 emissions decreased by 89 percent: from 2.00 Gg in 1990, to 0.21 Gg in 2005, and N_2O emissions by circa 92 percent: from 5.16 Gg in 1990 to 0.40 Gg in 2005 (Table 3-18).

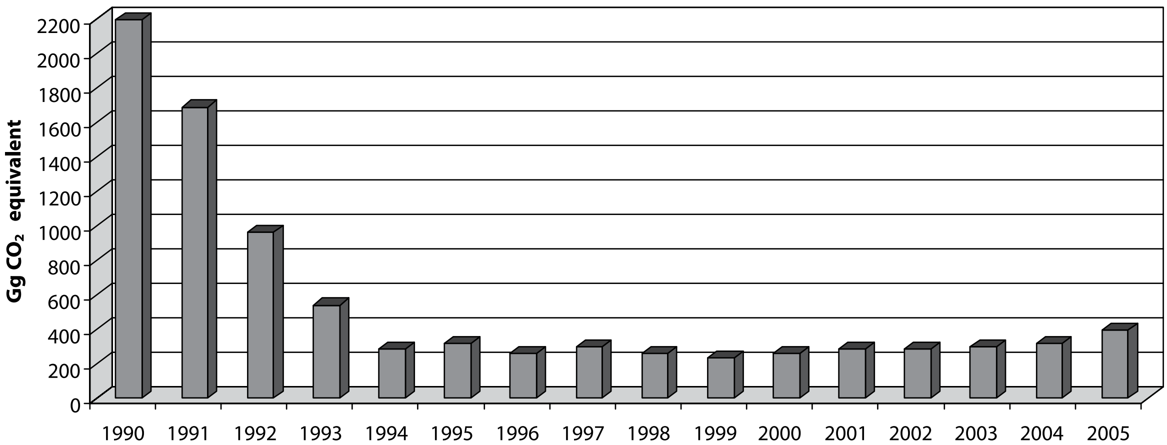

Figure 3-7: GHG Emissions from 1A2 'Manufacturing Industries and Construction' Source Category in the Republic of Moldova, 1990-2005

Table 3-18: Direct GHG Emissions from 1A2 'Manufacturing Industries and Construction' in the Republic of Moldova within 1990-2005, Gg CO_2 equivalent

Years	CO_2	CH_4	N_2O	Total	Years	CO_2	CH_4	N_2O	Total
1990	2188.7285	2.0006	5.1640	2195.8930	1998	259.1851	0.1912	0.4002	259.7766
1991	1684.7939	1.7361	4.3553	1690.8854	1999	236.8620	0.1517	0.3140	237.3277
1992	962.3355	0.8464	2.1564	965.3383	2000	257.7106	0.1548	0.3067	258.1721
1993	539.8762	0.5604	1.3457	541.7823	2001	285.4794	0.1976	0.4331	286.1100
1994	285.2936	0.2753	0.6344	286.2033	2002	284.5227	0.1608	0.3042	284.9876
1995	315.7781	0.2702	0.6051	316.6535	2003	300.9019	0.1659	0.3137	301.3815
1996	261.0795	0.2391	0.5420	261.8606	2004	319.2672	0.1832	0.3524	319.8028
1997	298.6884	0.2384	0.5175	299.4442	2005	396.3804	0.2149	0.3990	396.9942

3.3.2 Methodological Issues and Data Sources

GHG emissions originated from the 1A2 'Manufacturing Industries and Construction' source category was estimated following a Tier 1 methodology. EFs used for estimating CO_2 and SO_2 emissions are described in Table 3-10 and Annex 3-1. Default values of EFs available in the Revised 1996 IPCC Guidelines (IPCC, 1997) and 2006 IPCC Guidelines (Table 3-19) were used for non-CO_2 emissions estimation.

Table 3-19: Emission Factors Used for Estimating Non-CO_2 Emissions Originated from 1A2 'Manufacturing Industries and Construction' Source Category, kg/TJ

GHG	Coal	Natural Gas	Oil Products	Fuel Wood	Other Biomass
CH_4	10	1	3	30	30
N_2O	1.5	0.1	0.6	4	4
NOx	300	150	200	100	100
CO	150	30	10	2 000	4 000
NMVOC	20	5	5	50	50

Source: for NO_x, CO and NMVOC: Revised 1996 IPCC Guidelines, Vol. 3, Tab. 1-9, 1-10 and 1-11, Pages 1.37-1.42; for CH_4, N_2O: IPCC 2006 Guidelines, Vol. 2, Chap. 2, Tab. 2.3, Pages 2.18 – 2.19

Activity data pertaining to fuel consumption in 'Manufacturing Industries and Constructions' (Table 3-20) were collected both from Energy Balances of the RM for 1990, 1993-2005, as well as other relevant sources of information, such as Ministry of Industry and Infrastructure and National Bureau of Statistics. To be noted that fuel consumption in 'Manufacturing Industries and Constructions' decreased significantly over the period under review in the RM, and certain types of fuel (i.e., LPG, coking coal and coal) are not used any more within the respective sub-sector.

3.3.3 Uncertainties and Time-Series Consistency

The primary uncertainties related factors pertain to methodology, emission factors used to estimate GHG emissions covered by the source category 1A2 'Manufacturing Industries and Construction', and quality of activity data available.

The uncertainties for the 1A2 'Manufacturing Industries and Construction' source category are largely dependent on the collection procedures used for the underlying AD (commercial fuel volumes and properties are generally well-known), as well as on the representativeness of the EFs for specific fuel properties. Uncertainties associated with EFs used to estimate CO_2 emissions from the 1A2 'Manufacturing Industries and Construction' source category, were estimated at ±5 percent, while those pertaining to EFs used to estimate CH_4 and N_2O emissions reach up to ±50 percent. Uncertainties associated with statistical data regarding fuel consumption within the 'Manufacturing Industries and Construction Sector' in the RM can be considered relatively

Table 3-20: Fuel Consumption under the 1A2 'Manufacturing Industries and Construction' Source Category in the RM, 1990-2005

	1990	1991	1992	1993	1994	1995	1996	1997
Gasoline, kt	13.0	8.1	1.0	0.6	1.0	1.0	1.0	1.0
Diesel Oil, kt	99.0	75.0	35.0	21.0	19.0	19.0	17.0	16.0
Kerosene, kt	15.0	0.0	0.0	4.6	1.0	0.0	0.0	0.0
Residual Fuel Oil, kt	350.0	261.0	155.5	65.7	13.0	11.0	10.0	7.0
Liquefied Petroleum Gas, kt	0.0	0.0	0.0	0.4	0.0	0.0	0.0	0.0
Anthracite, kt	42.0	42.0	0.0	4.0	0.0	1.0	1.0	1.0
Coking Coal, kt	39.0	33.0	24.0	16.8	12.0	13.0	14.0	12.0
Other types of Coal, kt	0.0	0.0	0.0	8.3	8.0	4.0	2.0	2.0
Brown Coal , kt	1.0	1.0	0.0	2.9	2.0	1.0	0.0	0.0
Gaseous Coke, kt	0.0	32.0	25.0	0.0	0.0	0.0	0.0	0.0
Natural Gas, mil. m^3	262.0	204.0	148.0	93.0	67.0	91.0	69.0	98.0
	1998	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**
Gasoline, kt	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Diesel Oil, kt	8.0	11.0	8.0	8.0	7.0	6.0	7.0	7.0
Residual Fuel Oil, kt	7.0	3.0	3.0	4.0	1.0	4.0	5.0	4.0
Liquefied Petroleum Gas, kt	0.0	0.0	0.0	12.0	0.0	0.0	0.0	0.0
Anthracite, kt	3.0	1.0	1.0	1.0	1.0	1.0	5.0	6.0
Coking Coal, kt	9.0	7.0	6.0	8.0	7.0	5.0	2.0	0.0
Other types of Coal, kt	1.0	0.0	1.0	1.0	0.0	0.0	0.0	2.0
Brown Coal, kt	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Natural Gas, mil. m^3	94.0	91.0	107.0	99.0	126.0	134.0	139.0	180.0

low (±5 percent). Uncertainties pertaining to GHG emissions from the 1A2 'Manufacturing Industries and Construction' source category were estimated at ±7.07 percent for CO_2 emissions, and at ±50.25 percent for CH_4 and N_2O emissions. At the same time, combined uncertainties, presented as a percent of total sectoral emissions were estimated at 0.3467 percent for CO_2 emissions, 0.0013 percent for CH_4 emissions, and 0.0025 percent for N_2O. Uncertainties introduced in trend in sectoral emissions were estimated at ±0.0817 percent for CO_2 emissions, at ±0.0004 percent for CH_4 emissions, and at ±0.0011 percent for N_2O emissions (see Annex 7-3.1). In view of ensuring time-series consistency of the obtained results, the same approach was used for the entire period under review, in conformity with the recommendations included in the Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories (IPCC, 2000).

3.3.4 QA/QC and Verification

Standard verification and quality control forms and checklists were filled in for the respective source category under the Energy Sector, following the Tier 1 and Tier 2 approaches (see in Annex 6). Also, the AD and methods used for estimating GHG emissions under the category 1A2 'Manufacturing Industries and Construction' were documented and archived both in hard copies and electronically. For identifying the data entry and emission estimation process related errors there were applied verifications and quality control procedures. Verification was focused on correct use of AD obtained from different sources of reference (i.e., Energy Balances, Statistical Yearbooks of the RM, Ministry of Industry and Infrastructure and National Bureau of Statistics), as well as on ensuring correct use of the default emission factors available in the Revised 1996 IPCC Guidelines (IPCC, 1997), GPG (IPCC, 2000) and 2006 IPCC Guidelines (IPCC, 2006). Inventory QA activities for the Energy Sector, inclusive for the 1A2 'Manufacturing Industries and Construction' source category, were supported by an expert representing the Institute of Energy of the ASM.

Following the recommendations included into the Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories (IPCC, 2000), GHG emissions originated from the 1A2 'Manufacturing Industries and Construction' were estimated based on AD and EFs from official sources of reference.

3.3.5 Recalculations

GHG emission recalculations performed under the 1A2 'Manufacturing Industries and Construction' are due to the availability of an updated set of activity data (Energy Balances, Statistical Yearbooks of the RM and other relevant sources, such as central administration authorities), also due to updated methodologies available in the 2006 IPCC Guidelines, which has replaced the methodologies contained into the Revised 1996 IPCC Guidelines (IPCC, 1997) used under the FNC (2000), as well as due to use of country specific NCVs replacing the default NCVs available into the Revised 1996 IPCC Guidelines (IPCC, 1997).

In comparison with the results included into the FNC, the performed recalculations under the 1A2 'Manufacturing Industries and Construction' sources category resulted in increased values of GHG emissions for the 1998-1998, varying from a minimum 6.1 percent in 1998, up to maximum 39.0 percent in 1990. Between 1990 and 2005, the CO_2 emissions originated from 1A2 'Manufacturing Industries and Construction' source category decreased by 81.9 percent (Table 3-21).

Table 3-21: Comparative Results of CO_2 Emissions from 1A2 'Manufacturing Industries and Construction' Included into the FNC and SNC of the RM under the UNFCCC, Gg

	1990	1991	1992	1993	1994	1995	1996	1997
FNC	1770.27	1328.03	864.35	444.35	213.22	244.89	187.78	244.35
SNC	2188.73	1684.79	962.34	539.88	285.29	315.78	261.08	298.69
Difference, %	23.6	26.9	11.3	21.5	33.8	28.9	39.0	22.2
	1998	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**
FNC	244.35							
SNC	259.19	236.86	257.71	285.48	284.52	300.90	319.27	396.38
Difference , %	6.1							

Non-CO_2 emissions originated from 1A2 'Manufacturing Industries and Construction' source category has significantly decreased over the same period. Between 1990 and 2005, CH_4 emissions decreased by 89.3 percent, N_2O emissions – by 92.3 percent, NO_x – by 81.8 percent, CO – by 79.0 percent, NMVOC – by 80.5 percent, and SO_2 – by 98.1 percent (Table 3-22).

Table 3-22: Non-CO_2 Emissions from the 1A2 'Manufacturing Industries and Construction' Source Category in the Republic of Moldova within 1990-2005, Gg

GHG	1990	1991	1992	1993	1994	1995	1996	1997
CH_4	0.0953	0.0827	0.0403	0.0267	0.0131	0.0129	0.0114	0.0114
N_2O	0.0167	0.0141	0.0070	0.0043	0.0020	0.0020	0.0017	0.0017
NO_x	5.8887	4.6748	2.6619	1.4796	0.7908	0.8694	0.7217	0.8205
CO	1.4012	1.3740	0.4088	0.6719	0.2992	0.2497	0.2207	0.2406
NMVOC	0.1954	0.1698	0.0879	0.0576	0.0312	0.0333	0.0283	0.0313
SO_2	24.1072	19.1446	10.8429	5.0323	1.5249	1.3217	1.2002	0.9572
GHG	1998	1999	2000	2001	2002	2003	2004	2005
CH_4	0.0091	0.0072	0.0074	0.0094	0.0077	0.0079	0.0087	0.0102
N_2O	0.0013	0.0010	0.0010	0.0014	0.0010	0.0010	0.0011	0.0013
NO_x	0.7091	0.6440	0.6994	0.7932	0.7716	0.8129	0.8625	1.0698
CO	0.1905	0.1479	0.1627	0.1685	0.1809	0.1999	0.2500	0.2949
NMVOC	0.0270	0.0230	0.0251	0.0277	0.0277	0.0288	0.0308	0.0381
SO_2	0.8653	0.4769	0.4589	0.6479	0.3329	0.4528	0.5484	0.4599

3.3.6 Planned Improvements

The process of monitoring GHG emissions originated from the source category 1A2 'Manufacturing Industries and Construction' can be improved significantly once the activity data pertaining to fuel consumption on the ATULBD are specified.

The possibility to collect additional information shall be considered for the next inventory cycle, to reduce uncertainties of the GHG emissions resulting from the respective source category.

3.4 Transport (Category 1A3)

Transport Sector plays a significant role in the national economy of the Republic of Moldova, its current contribution to the Gross Domestic Product being circa 12.1 percent (NBS, 2006), and is permanently increasing (from 4.8 percent in 1990, to 12.1 percent in 2005). According the National Bureau of Statistic of the Republic of Moldova the Transport Sector provides jobs to 71 thousand persons, or to 5.4 percent of the employed population of the country (NBS, 2006).

3.4.1 Source Category Description

The 1A3 'Transport' category includes greenhouse gases generated by the following emissions sources: 1A3a 'Civil Aviation', 1A3b 'Road Transportation', 1A3c 'Railways', 1A3d 'Navigation' and 1A3e 'Other' (Pipeline Transport).

1A3a Domestic Aviation

In conformity with information provided by the Civil Aviation State Administration (CASA), no domestic flights were made in the Republic of Moldova over 2000-2005 years.

As statistical data on the number of domestic flights made in the time series 1990 through 1999 and amount of fuel consumed for this type of flights over the period under review is lacking, it was assumed that GHG emissions covered by this source category are insignificant and were not included in the current inventory cycle.

Table 3-23: Air Transport Means Existing in the RM by the end of the year, Units

	1996	1997	1998	1999	2000
Civil aircrafts for passenger transportation	40	40	32	20	26
Civil aircrafts for goods transportation	9	6	6	5	6
Total aircrafts available	49	46	38	25	32
	2001	2002	2003	2004	2005
Civil aircrafts for passenger transportation	21	19	19	20	32
Civil aircrafts for goods transportation	6	7	9	8	7
Total aircrafts available	27	26	28	28	39

Source: Statistical Yearbooks of the RM for 2004 (page 562) and 2006 (page 407).

1A3b Road Transportation

Length of communication lines in exploitation by the end of 2005 was 9.5 thousand km with a public roads density of 310.6 km per 1000 km^2 (Table 3-24).

Table 3-24: Length and Density of Road Communication Lines by the end of the year in the Republic of Moldova, 1990-2005

	1990	1991	1992	1993	1994	1995	1996	1997
Public roads, km	10300	10300	9300	9200	9200	9400	9400	9400
National roads, km	5000	5000	2800	2800	2800	2800	2800	2800
Local roads, km	5300	5300	6600	6600	6600	6600	6600	6600
Public roads density, km/1000 km^2	304.0	305.1	314.0	310.4	310.5	309.5	309.7	309.9
	1998	1999	2000	2001	2002	2003	2004	2005
Public roads, km	9402	9401	9378	9433	9461	9462	9464	9467
National roads, km	2814	2813	2812	3328	3324	3325	3326	3329
Local roads, km	6587	6587	6566	6105	6137	6137	6138	6138
Public roads density, km/1000 km^2	309.9	308.4	307.7	309.5	310.4	310.4	310.4	310.6

Source: Statistical Yearbooks of the RM for 1994 (page 319), 1999 (page 382) and 2006 (page 405).

In the Republic of Moldova road transportation is represented by a wide range of transport means: cars, buses and minibuses, trucks, special destination vehicles (ambulances, hook-and-ladder trucks, mobile cranes and other) (Table 3-25).

Table 3-25: Road Transportation Means Existent by the end of the year in the RM, units

	1990	1991	1992	1993	1994	1995	1996	1997
Trucks	76909	77941	61595	63235	62171	59888	57138	56924
Buses and Minibuses	11305	11226	8924	9101	9139	9181	9798	11169
Cars	208984	218059	166259	166440	169387	165941	173618	205973
Special Destination Vehicles	20328	19632	16155	15241	15228	14589	13668	12677
	1998	1999	2000	2001	2002	2003	2004	2005
Trucks	57404	52430	46351	45809	46277	46905	47171	49285
Buses and Minibuses	12917	13582	12769	14703	15777	15723	13407	14554
Cars	222769	232278	238380	256459	268882	265841	280075	290090
Special Destination Vehicles	11860	10305	8979	8497	8061	7555	7521	7497

Source: Statistical Yearbooks of the RM for 1994 (page 325), 1999 (page 390) and 2006 (page 407)

To be noted that during the period under review the number of 'special destination vehicles' and 'trucks' decreased significantly, by 63.1 percent and 35.9 percent respectively, in turn, the number of 'cars', 'buses and minibuses' increased by 38.8 percent, and respectively 28.7 percent.

The main types of fuels consumed by road transport are Gasoline, Diesel Oil, Liquefied Petroleum Gases (LPG) and Liquefied Natural Gases (LNG). The data used for estimating GHG emissions from road transport were collected from the National Bureau of Statistics, Ministry of Transport and Roads, Ministry of Agriculture and Food Industry, Ministry of Defence, Ministry of Intern Affaire and Custom Service.

1A3c Railways

The length of railways of general use in the RM by the end of 2005 was 1.1 thousand km (Table 3-26).

The railway transport in the RM is assured by Diesel Locomotives (over 350 HP), Manoeuvring Locomotives, Diesel Trains, Cargo and Passenger Trains (Table 3-27).

To be noted that during the period under review the rolling stock has reduced significantly: Diesel Locomotives (-69.1 percent); Manoeuvring Locomotives (-59.7 percent); Diesel Trains (-54.5 percent); Freight Wagons (-44.4 percent); Passenger Coaches (-9.5 percent).

Table 3-26: Length and Density of Railways by the end of the year in the Republic of Moldova, 1990-2005

	1990	1991	1992	1993	1994	1995	1996	1997
Railways, km	1150	1150	1150	1150	1150	1150	1150	1140
Railways density, km per 1000 km^2	34.1	34.1	34.2	34.2	34.2	34.2	34.1	34.1
	1998	1999	2000	2001	2002	2003	2004	2005
Railways, km	1137	1140	1139	1121	1120	1111	1075	1139
Railways density, km per 1000 km^2	33.6	33.7	33.7	33.1	33.1	32.8	31.8	33.7

Source: Statistical Yearbooks of the RM for 1994 (page 319), 1999 (page 382) and 2006 (page 405).

Table 3-27: Railway Transport Means Existent by the end of the year in the RM, units

	1990	1995	1996	1997	1998	1999
Diesel Locomotives	324	113	103	97	82	78
Manoeuvring locomotives	139	114	100	75	72	50
Diesel Trains (Sections)	44	29	28	26	26	24
Freight Wagons	14960	14097	13316	12838	12233	11010
Passenger Coaches	486	482	480	470	458	461
	2000	**2001**	**2002**	**2003**	**2004**	**2005**
Diesel Locomotives	76	78	89	100	95	100
Manoeuvring locomotives	42	44	48	54	50	56
Diesel Trains (Sections)	22	22	22	22	18	20
Freight Wagons	10577	10033	9303	8723	8492	8318
Passenger Coaches	460	440	460	452	452	440

Source: Statistical Yearbooks of the RM for 1999 (page 390) and 2006 (page 407); Official Letters from "Moldavian Railways" State Enterprise No. 94/T from 26th of March 1999; No. H-4/993 from 17th December 2003; and No. H tex/338 from 19th of September 2006

The main type of fuel used in railways was Diesel Oil. Other types of fuels, such as: Coal, Residual Fuel Oil, Gasoline, Natural Gas and Lubricants are also used for auxiliary needs. The data used for estimating GHG emissions from railway transport were collected from the National Bureau of Statistics (AD are available in the Energy Balances and Statistical Yearbooks of the RM), as well as directly from the "Moldavian Railways" State Enterprise.

1A3d Navigation

The current length of navigable waterways of pubic use in the Republic of Moldova is around 558 km. The number of river transport means used in the RM for both passenger and cargo transportation on Danube, Dniester and Pruth, especially in the warm season, is relatively small (Table 3-28).

The main type of fuel used by the river transport means in the RM is Diesel Oil. For inventory purposes (estimation of GHG emissions originated from the navigation in the Republic of Moldova) there was used the activity data provided by the National Bureau of Statistics and the Ministry of Transport and Roads.

1A3e Pipeline Transport

The Republic of Moldova has a developed natural gas transportation and distribution network (see in *Energy Strategies and Policies, European Union and the Republic of Moldova. Arion, 2004*) (Table 3-29).

Only a small portion of the natural gases delivered towards the RM are consumed locally, including Transnistrian region (ATULBD), the largest part being transited towards the Balkans countries (Romania, Bulgaria, Turkey, Greece, Macedonia, Serbia) (Table 3-30). The main source of reference for activity data used in the current inventory cycle is "MOLDOVAGAZ" J.S.C.

Table 3-28: River Transport Means Existent by the end of the year in the RM, units

	1990	1991	1992	1993	1994	1995	1996	1997
Goods Self-Propelled Ships	14	9	5	5	5	5	5	4
Goods Non-Self-Propelled Ships	72	67	67	67	20	20	15	15
Towboats, Stamps & Stamp-Towboats	49	48	47	47	12	12	11	11
Passenger Self-Propelled Ships	36	37	32	32	3	3	3	4
Other Types of Ship, including Maritime	0	0	0	0	0	0	0	0
	1998	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**
Goods Self-Propelled Ships	4	3	-	-	-	-	-	-
Goods Non-Self-Propelled Ships	13	11	9	8	9	13	13	15
Towboats, Stamps & Stamp-Towboats	11	10	9	8	10	13	13	15
Passenger Self-Propelled Ships	10	8	4	2	4	8	9	9
Other Types of Ship, including Maritime	0	0	0	2	2	5	7	9

Source: Statistical Yearbooks of the RM for 1999 (page 390) and 2006 (page 407); Official Letter from the Ministry of Transport and Communications of the RM No.03-5-2/2-32 as of 31.03.1999; Official Letter from the Ministry of Transport and Roads of the RM No. 04-01-3/754 as of 2.10.2006

Table 3-29: Natural Gas Transportation and Distribution Networks, situation as of 1st of January 2006

Type of network	Pipelines diameter (mm)	Pipelines length (km)	Pressure (kg f/cm^2)	Year of construction
Main gas pipelines	530-1220	593.57	55-75	1966-1993
Connected gas pipelines	up to 530	714.09	55	1966-2005
Natural gas distribution networks	up to 700	12465.05	0.05-12	1966-2005

Table 3-30: Amount of Natural Gas Transited towards the Balkans and Sold in the Republic of Moldova over the time-series from 1990 through 2005, million m^3

	1990	1991	1992	1993	1994	1995	1996	1997
Natural gas transited across the RM	NA	NA	NA	NA	18265	20909	22396	16934
Natural gas sold in the RM	3814	3843	3377	2960	2861	2791	3222	3492
	1998	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**
Natural gas transited across the RM	16021	16790	19170	18524	21032	22132	23625	25017
Natural gas sold in the RM	3169	2702	2361	2642	2328	2512	2567	2716

Note: NA - Not Available; **Source:** Official Letter from "MOLDOVAGAZ" J.S.C., No. 06-1253 from 27.09.2006

To be noted that GHG emissions from military transport are monitored under the category 1A5 'Other', while those from the 'International Bunkers' (Aviation), under the 'Memo Items'.

In 2005, the 'Transport' sub-sector accounted for 13.9 percent of the total national GHG emissions (without LULUCF), being an important source of GHG emissions. The 1A3 'Transport' source category also represented a relevant source of CH_4 and N_2O emissions, accounting for 0.3 percent and respectively, 2.6 percent of the total national CH_4 and N_2O emissions.

In 1990-2005, the total GHG emissions from the 1A3 'Transport' source category have decreased by 59.2 percent (Table 3-31, Figure 3-8).

Table 3-31: Direct GHG Emissions from 1A3 'Transport' in the Republic of Moldova within 1990-2005, Gg CO_2 equivalent

Years	CO_2	CH_4	N_2O	Total	Years	CO_2	CH_4	N_2O	Total
1990	3926.6606	25.0364	103.9092	4055.6062	1998	1118.4626	6.6317	28.2395	1153.3338
1991	3548.3245	22.8474	91.4708	3662.6428	1999	763.1569	3.9126	17.8000	784.8695
1992	1986.1727	11.4076	56.7452	2054.3256	2000	824.4456	3.9788	19.8456	848.2701
1993	1463.2667	7.4019	42.8543	1513.5229	2001	897.8487	4.3227	24.2628	926.4341
1994	1271.1186	6.8492	39.3587	1317.3265	2002	1124.1042	5.5482	28.3094	1157.9617
1995	1288.2094	7.1937	33.1153	1328.5183	2003	1410.1533	6.6442	34.9816	1451.7792
1996	1260.1985	6.8506	31.0852	1298.1343	2004	1578.2557	8.0603	35.2711	1621.5871
1997	1281.9413	7.7819	31.4857	1321.2089	2005	1610.9493	7.5024	36.0651	1654.5168

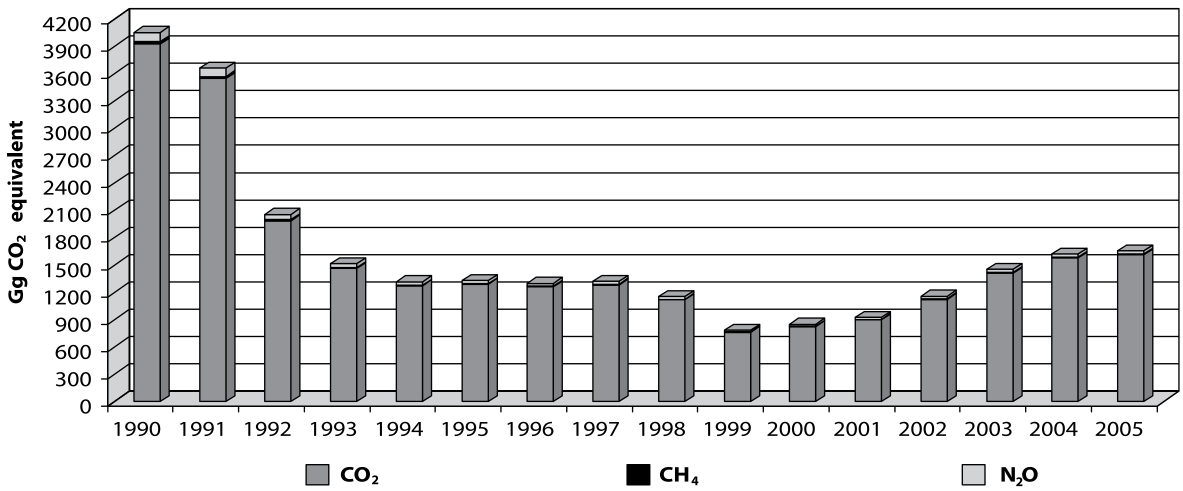

Figure 3-8: GHG Emissions from 1A3 'Transport' Source Category in the Republic of Moldova, 1990-2005

The decreasing trend in GHG emissions is characteristic to all emission sources covered by the category 1A3 'Transport': 1A3b – 56.7 percent; 1A3c – 74.6 percent; 1A3d – 98.2 percent; 1A3e – 60.4 percent (Table 3-32, Figure 3-9).

The emissions source having the largest share in the total GHG emissions under category 1A3 'Transport' is 1A3b 'Road Transportation', with a share that varied over the period from 75.7 percent in 1994 to 90.0 percent in 2005 (Table 3-33).

Other major emissions sources are represented by 1A3c 'Railways', with a share varying between 7.8 percent in 2005 and 17.6 percent in 1994, respectively 1A3e 'Pipeline Transport', with a share varying between 1.2 percent in 1993 and 9.1 percent in 1996 (Figure 3-10).

Table 3-32: GHG Emissions from the Category 1A3 'Transport' by Source in the Republic of Moldova within 1990-2005, Gg CO_2 eq.

	1990	1991	1992	1993	1994	1995	1996	1997
1A3b	3438.2863	3153.6808	1695.9873	1268.3490	997.2772	1083.0985	1030.4014	1131.2767
1A3c	507.0418	432.7382	301.1449	226.3196	232.4823	161.6583	149.7637	140.3307
1A3d	19.0998	0.2419	0.2069	0.2388	0.1878	0.1815	0.1974	0.2133
1A3e	91.1782	75.9818	56.9864	18.6156	87.3791	83.5800	117.7719	49.3882
	1998	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**
1A3b	974.3548	655.2108	734.6764	795.4022	1000.2856	1279.3215	1457.2197	1489.0584
1A3c	131.3567	76.2486	82.9941	115.4854	125.0209	149.3894	126.0804	129.0329
1A3d	0.1337	0.2228	0.2069	0.3502	0.3629	0.2738	0.2961	0.3343
1A3e	47.4887	53.1873	30.3927	15.1964	32.2923	22.7946	37.9909	36.0914

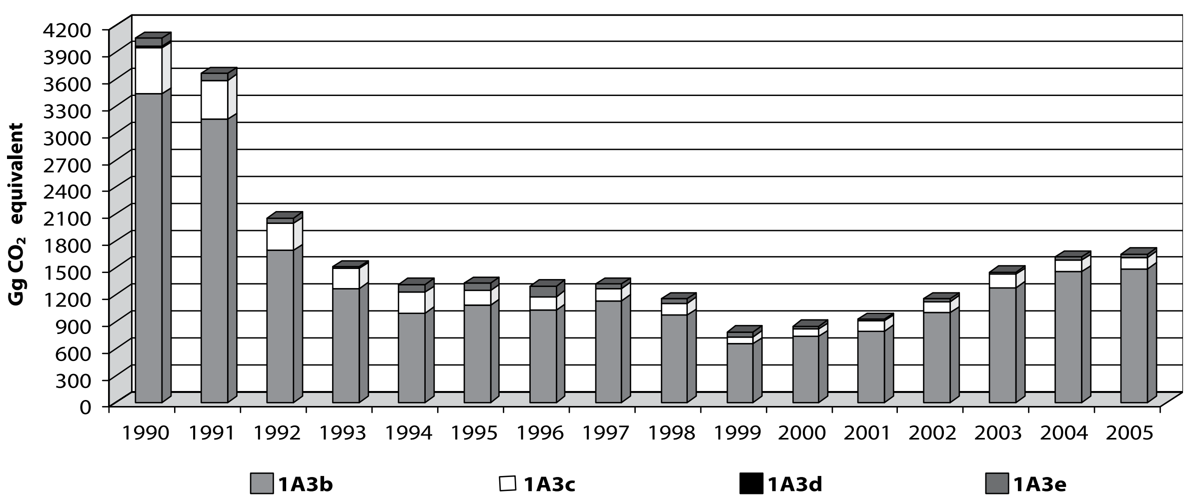

Figure 3-9: GHG Emissions from the Category 1A3 'Transport' by Source in the Republic of Moldova within 1990-2005

Table 3-33: Breakdown of the Category 1A3 'Transport' GHG Emissions by Source within 1990-2005, %

	1990	1991	1992	1993	1994	1995	1996	1997
1A3b	84.78	86.10	82.56	83.80	75.70	81.53	79.38	85.62
1A3c	12.50	11.81	14.66	14.95	17.65	12.17	11.54	10.62
1A3d	0.47	0.01	0.01	0.02	0.01	0.01	0.02	0.02
1A3e	2.25	2.07	2.77	1.23	6.63	6.29	9.07	3.74
	1998	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**
1A3b	84.48	83.48	86.61	85.86	86.38	88.12	89.86	90.00
1A3c	11.39	9.71	9.78	12.47	10.80	10.29	7.78	7.80
1A3d	0.01	0.03	0.02	0.04	0.03	0.02	0.02	0.02
1A3e	4.12	6.78	3.58	1.64	2.79	1.57	2.34	2.18

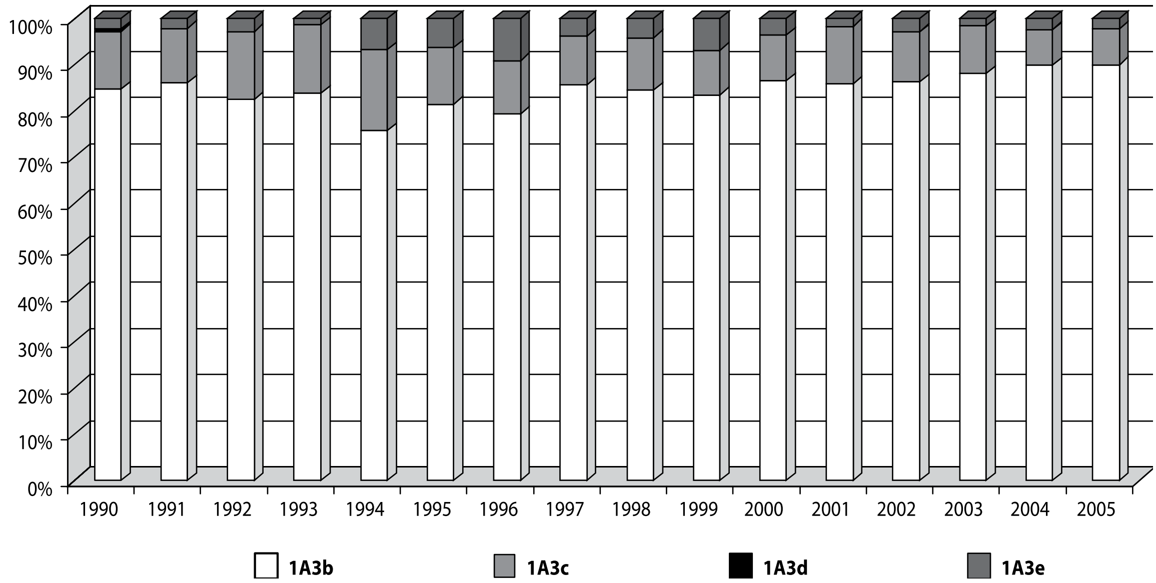

Figure 3-10. Breakdown of the Category 1A3 'Transport' GHG Emissions by Source within 1990-2005, %

3.4.2 Methodological Issues and Data Sources

1A3b Road Transportation

GHG emissions from the 1A3b 'Road Transportation' source category were estimated following a Tier 1 methodological approach (based on AD on fuel consumption and default values of EFs). It was not possible yet to use Tier 2 and Tier 3 methods because of lack of activity data on total vehicle km travelled disaggregated for each vehicle type (for the moment the vehicle km travelled are kept only for some vehicle types included into the State Register of Transport).

EFs used to estimate CO_2 and SO_2 emissions are described in Table 3-10 and in the Annex 3-1. Default EFs values available in the Revised 1996 IPCC Guidelines (IPCC, 1997) and 2006 IPCC Guidelines (Table 3-34) were used for non-CO_2 emissions estimation.

Table 3-34: Emission Factors Used for Estimating Non-CO_2 Emissions Originated from 1A3b 'Road Transportation', kg/TJ

Type of fuel	CH_4	N_2O	NOx	CO	NMVOC
Gasoline	33	3.2	600	8000	1500
Diesel Oil	3.9	3.9	800	1000	200
Natural Gas	92	3	600	400	5

Source: for NO_x, CO and NMVOC: Revised 1996 IPCC Guidelines, Vol. 3, Tab. 1-9, 1-10 and 1-11, Pages 1.37-1.42; for CH_4, N_2O: 2006 IPCC Guidelines, Vol. 2, Chap. 3, Tab. 3.2.2, Page 3.21.

Activity data pertaining to fuel consumption for 1A3b 'Road Transportation' (mainly: Gasoline, Diesel Oil, Liquefied Petroleum Gases and Liquefied Natural Gases) were collected from the Energy Balances of the RM for 1990 and 1993-2005 years, as well as from other relevant sources, including central public authorities and enterprises (Ministry of Transport and Roads, Ministry of Agriculture and Food Industry, Ministry of Defence, Custom Service, National Bureau of Statistics, "MOLDOVAGAZ" J.S.C.).

Activity data pertaining to Diesel Oil consumption for 1A3b 'Road Transportation' (Table 3-35) are available in Energy Balances of the RM (Chapter S.2.1. 'Consumed as Fuel or Energy', Columns: 'for transport operation', 'for agriculture' and 'sold to population'). In order to estimate the total quantity of Diesel Oil consumed by the transport means in the RM, there were summed up the amount of Diesel Oil used for 'transport operation', 'sold to population', and 10 percent of the amount of Diesel Oil used in 'agriculture' to ensure transportation on highways and national roads (the respective value was identified upon consultation with specialists from the Ministry of Agriculture and Food Industry), the remaining 90 percent were reallocated under the 1A4cii 'Agriculture/Forestry/Fishing' (Off-road Vehicles and Other Machinery), as being consumed to ensure operation of Off-road Vehicles and Other Machinery in the agriculture sector.

A similar approach was used to deduce AD pertaining to the Gasoline consumption within 1A3b 'Road Transportation', for which there were summed up the total amount of Gasoline used for 'transport operation' and 'sold to population' available into the Energy Balances of the RM (Table 3-36).

Activity data pertaining to consumption of Liquefied Petroleum Gases and Liquefied Natural Gases under the 1A3b 'Road Transportation' in the RM were provided by "MOLDOVAGAZ" J.S.C. (Table 3-37).

Table 3-35: Diesel Oil Consumption under the 1A3b 'Road Transportation' in the RM within 1990-2005 period, kt

	1990	1991	1992	1993	1994	1995	1996	1997
For transport operation	245.4	233.0	165.0	150.6	78.1	93.2	81.5	70.2
For agriculture	61.0	44.0	27.0	21.8	21.2	20.0	15.7	14.6
Sold to population	2.0	2.0	2.0	1.0	5.0	7.0	15.0	28.0
Total consumption	308.4	279.0	194.0	173.5	104.3	120.2	112.2	112.8
	1998	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**
For transport operation	55.8	46.3	50.4	46.2	82.5	126.0	124.0	132.0
For agriculture	10.7	7.1	5.7	5.5	7.3	6.9	6.2	5.6
Sold to population	32.0	29.0	52.0	67.0	56.0	68.0	111.0	107.0
Total consumption	98.5	82.4	108.1	118.7	145.8	200.9	241.2	244.6

Table 3-36: Gasoline Consumption under the 1A3b 'Road Transportation' in the RM within 1990-2005 period, kt

	1990	1991	1992	1993	1994	1995	1996	1997
For transport operation	655.0	600.0	275.2	209.8	159.0	143.0	135.0	112.0
Sold to population	117.0	107.0	58.0	6.7	47.0	75.0	73.0	127.0
Total consumption	772.0	707.0	333.2	216.5	206.0	218.0	208.0	239.0
	1998	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**
For transport operation	93.0	56.0	50.0	55.0	80.0	99.0	71.0	69.0
Sold to population	110.0	61.0	66.0	70.0	82.0	92.0	137.0	146.0
Total consumption	203.0	117.0	116.0	125.0	162.0	191.0	208.0	215.0

Table 3-37: Liquefied Petroleum Gases and Liquefied Natural Gases Consumption under the 1A3b 'Road Transportation' in the RM, 1990-2005

Type of fuel	1990	1991	1992	1993	1994	1995	1996	1997
Liquefied Petroleum Gases, kt	13.0	17.3	10.4	8.4	6.0	4.0	4.0	5.0
Liquefied Natural Gases, mil. m^3	8.2	7.7	4.9	11.8	7.3	6.8	9.4	10.5
Type of fuel	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**
Liquefied petroleum gases, kt	4.0	5.0	6.0	4.0	5.0	6.0	5.0	5.0
Liquefied natural gases, mil. m^3	10.9	10.8	12.3	12.7	13.7	13.0	12.0	12.0

Source: Official Letters from "MOLDOVAGAZ" J.S.C. No. 604 from 01.04.1999, No. 02-541 from 28.05.2001, No. 02-156 from 06.02.2004 and No. 06-1253 from 27.09.2006

1A3c Railways

GHG emissions from the 1A3c 'Railways' source category were estimated following a Tier 1 methodological approach (based on AD on fuel consumption and default EFs values). EFs used to estimate CO_2 emissions are described in Table 3-10. Default EFs values available in the Revised 1996 IPCC Guidelines (IPCC, 1997) and 2006 IPCC Guidelines (Table 3-38, Annex 3-1) were used for non-CO_2 emissions estimation.

Table 3-38 Emission Factors Used for Estimating Non-CO_2 Emissions Originated from 1A3c 'Railways', kg/TJ

Type of fuel	CH_4	N_2O	NOx	CO	NMVOC
Diesel Oil	4.15	28.6	1200	1000	200
Coal	2	1.5	300	150	20

Source: for NO_x, CO and NMVOC: Revised 1996 IPCC Guidelines 1996, Vol. 3, Tab. 1-9, 1-10 and 1-11, Pages 1.37-1.42; for CH_4, N_2O: 2006 IPCC Guidelines, Vol. 2, Chap. 3, Tab. 3.4.1, Page 3.43.

Activity data pertaining to fuel consumption used to ensure railway transport operation (mainly Diesel Oil) were collected from the Energy Balances of the RM for 1990 and 1993-2005, as well as obtained directly from "Moldavian Railways" State Enterprise.

Certain discrepancies were identified between data pertaining to the fuel consumption used to ensure the railway transport operation from Energy Balance of the RM and data provided by the "Moldavian Railways" State Enterprise. As a consequence, for estimating the GHG emissions originated from the 1A3c 'Railways' source category, there were used activity data provided by the "Moldavian Railways" State Enterprise, as being more credible (Table 3-39).

1A3d Navigation

GHG emissions from the 1A3d 'Navigation' were estimated following a Tier 1 methodological approach (based on AD on fuel consumption and default EFs values). EFs used to estimate CO_2 and SO_2 emissions are described also in Table 3-10 and Annex 3-1. Default EFs values available in the Revised 1996 IPCC Guidelines (IPCC, 1997) and 2006 IPCC Guidelines were used for non-CO_2 emissions estimation (Table 3-40).

Table 3-39: Diesel Oil Consumption under the 1A3c 'Railways' in the RM within 1990-2005 period, kt

Type of fuel	1990	1991	1992	1993	1994	1995	1996	1997
Diesel Oil	143.55	122.53	85.27	64.08	65.83	45.77	42.41	39.74
Type of fuel	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**
Diesel Oil	37.19	21.59	26.36	29.57	36.69	42.30	35.70	36.54

Source: Official Letters from "Moldavian Railways" State Enterprise No. 94/T from 26th of March 1999; No. H-4/993 from 17th of December 2003, and No. H tex/338 from 19th of September 2006

Table 3-40 Emission Factors Used for Estimating Non-CO_2 Emissions Originated from 1A3d 'Navigation', kg/TJ

Type of fuel	CH_4	N_2O	NOx	CO	NMVOC
Diesel Oil	7	2	1500	1000	200

Source: for NO_x, CO and NMVOC: Revised 1996 IPCC Guidelines, Vol. 3, Tab. 1-9, 1-10 and 1-11, Pages 1.37-1.42; for CH_4, N_2O: 2006 IPCC Guidelines, Vol. 2, Chap. 3, Tab. 3.5.3, Page 3.50.

To be noted that Energy Balances of the RM do not contain data on fuel consumption used to ensure water borne transport operation (except the Energy Balance for 1990 year). The reason for that is the insignificant quantity of fuel consumed to ensure operation of this type of transport in the RM. As a consequence, for estimating the GHG emissions originated from the 1A3d 'Navigation', for the rest of the period (1991-2005) there were used AD (Table 3-41) obtained from the Ministry of Transport and Roads of the RM.

1A3e Pipeline Transportation

GHG emissions from the 1A3e 'Pipeline Transportation' source category were estimated following a Tier 1 methodological approach (based on AD on fuel consumption and default EFs values). The EFs used to estimate CO_2 emissions was already described in Table 3-10. AD pertaining to natural gas consumed to ensure pipeline transportation was collected from the Energy Balances of the RM (see Chapter S.2.3. 'Consumed as Fuel or Energy for Transport Operations', Section 'Pipeline Transport') (Table 3-42).

Table 3-41: Diesel Oil Consumption under the 1A3d 'Navigation' in the RM within 1990-2005 period, kt

Type of fuel	1990	1991	1992	1993	1994	1995	1996	1997
Diesel oil	6.000	0.076	0.065	0.075	0.059	0.057	0.062	0.067
Type of fuel	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**
Diesel oil	0.042	0.070	0.065	0.029	0.105	0.086	0.093	0.105

Source: Official Letter from the Ministry of Transport and Communications No. 03-5-2/2-32 from 31st of March 1999; Official Letter from the Ministry of Transport and Roads No. 04-01-3/754 from 2nd of October 2006

Table 3-42: Natural Gas Consumption under the 1A3e "Pipeline Transportation' in the RM within 1990-2005, mil.m^3

Type of fuel	1990	1991	1992	1993	1994	1995	1996	1997
Natural Gas	48.0	40.0	30.0	9.8	46.0	44.0	62.0	26.0
Type of fuel	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**
Natural Gas	25.0	28.0	16.0	8.0	17.0	12.0	20.0	19.0

3.4.3 Uncertainties and Time-Series Consistency

The primary uncertainties related factors pertain to methodology, emission factors used to estimate GHG emissions covered by the 1A3 'Transport' source category, and the quality of activity data available.

The uncertainties for the 1A3 'Transport' source category are largely dependent on the collection procedures used for the underlying activity data (commercial fuel volumes and properties are generally well-known), as well as on the representativeness of the emission factors for specific fuel properties. Uncertainties associated with EFs used to estimate CO_2 emissions from the 1A3 'Transport' source category, were estimated at ±5 percent, while those pertaining to EFs used to estimate CH_4 and N_2O emissions reach up to ±50 percent.

Uncertainties associated with statistical data regarding fuel consumption within the Transport Sector in the RM can be considered relatively low (±5 percent) for 1A3c 'Railways' and 1A3e 'Pipeline Transportation' source categories, and moderate (±10 percent) for 1A3b 'Road Transportation' and 1A3d 'Navigation' source categories.

Inventory uncertainties related to GHG emissions within the category 1A3 'Transport' were estimated at ±11.18 percent for CO_2 emissions from 1A3b 'Road Transportation' and 1A3d 'Navigation', respectively at ±7.07 percent for CO_2 emissions from 1A3c 'Railways' and 1A3e 'Pipeline Transportation'; while the inventory uncertainties related to CH_4 and N_2O emissions, have been estimated at ±50.99 percent for 1A3b 'Road Transportation' and 1A3d 'Navigation', respectively at ±50.25 percent for 1A3c 'Railways' and 1A3e 'Pipeline Transportation'. At the same time, combined uncertainties, presented as a percent of total sectoral emissions were estimated for CO_2 emissions: at ±2.0183 percent for 1A3b 'Road Transportation'; ±0.1007 percent for 1A3c 'Railways'; ±0.0005 percent for 1A3d 'Navigation' and ±0.0316 percent for 1A3e 'Pipeline Transportation'; for CH_4 emissions: at ±0.0465 percent for 1A3b 'Road Transportation', ±0.0008 percent for 1A3c 'Railways' and ±0.000005 percent for 1A3d 'Navigation'; while for N_2O emissions: at ±0.1405 percent for 1A3b 'Road Transportation', ±0.0856 percent for 1A3c 'Railways', and ±0.000002 percent for 1A3d 'Navigation' (Annex 7-3.1).

In view of ensuring time-series consistency of the obtained results, the same approach was used for the entire period under review, in conformity with the recommendations included in the Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories (IPCC, 2000).

3.4.4 QA/QC and Verification

Standard verification and QC forms and checklists were filled in for the respective source category under the Energy Sector, following the Tier 1 and Tier 2 approaches (see in Annex 6). Also, the AD and methods used for estimating GHG emissions under the category 1A3 'Transport' were documented and archived both in hard copies and electronically. For identifying the data entry and emission estimation process related errors there were applied verifications and quality control procedures. Verification was focused on correct use of AD obtained from different sources of reference (i.e., Energy Balances, Statistical Yearbooks of the RM, Ministry of Transport and Roads, Ministry of Agriculture and Food Industry, Ministry of Defence, Ministry of Intern Affaire, Civil Aviation Stat Administration, Custom Service, National Bureau of Statistics, "Moldavian Railways" State Enterprise, "MOLDOVAGAZ" J.S.C.), as well as on ensuring correct use of the default EFs available in the Revised 1996 IPCC Guidelines (IPCC, 1997), GPG (IPCC, 2000) and 2006 IPCC Guidelines (IPCC, 2006). Inventory QA activities for the Energy Sector, inclusive for the 1A3 'Transport' source category were supported by an expert representing the Institute of Energy of the ASM.

Following the recommendations included into the Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories (IPCC, 2000), GHG emissions originated from the 1A3 'Transport' were estimated based on AD and EFs from official sources of reference.

3.4.5 Recalculations

GHG emission recalculations performed under the 1A3 'Transport' are due to the availability of an updated set of activity data related to fuel consumption for road transportation, railways, navigation and pipeline transportation (i.e., Energy Balances, Statistical Yearbooks of the RM, Ministry of Transport and Roads, Ministry of Agriculture and Food Industry, Ministry of Defence, Ministry of Intern Affaire, Civil Aviation Stat Administration, Custom Service, National Bureau of Statistics, "Moldavian Railways" State Enterprise, "MOLDOVAGAZ" J.S.C.), also due to updated methodologies available in the 2006 IPCC Guidelines, which has replaced the methodologies contained into the Revised 1996 IPCC Guidelines (IPCC, 1997) used under the FNC (2000), due to use of country specific NCVs replacing the default NCVs available into the Revised 1996 IPCC Guidelines (IPCC, 1997), as well as a result of reallocation of a certain amount of Diesel Oil used for transport needs from 1A3b 'Road Transportation' into the 1A4cii 'Agriculture/Forestry/Fishing' (Off-road Vehicles and Other Machinery).

In comparison with the results included into the FNC, the performed recalculations under the 1A3 'Transport' sources category resulted in decreased values of GHG emissions for the 1998-1998, varying from a minimum 24.9 percent in 1990, to a maximum of 39.6 percent in 1992. Between 1990 and 2005, the CO_2 emissions originated from 1A3 'Transport' source category decreased by 59.0 percent (Table 3-43).

Table 3-43: Comparative Results of CO_2 Emissions from 1A3 'Transport' Included into the FNC and SNC of the RM under the UNFCCC, Gg

	1990	1991	1992	1993	1994	1995	1996	1997
FNC	5227.1397	5152.1759	3288.4709	2264.5900	1897.7151	2026.5603	1815.9903	1917.8573
SNC	3926.6606	3548.3245	1986.1727	1463.2667	1271.1186	1288.2094	1260.1985	1291.9412
Difference, %	-24.9	-31.1	-39.6	-35.4	-33.0	-36.4	-30.6	-32.6
	1998	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**
FNC	1545.4056							
SNC	1118.4626	763.1589	824.4456	897.8487	1124.1042	1410.1533	1578.2557	1610.9493
Difference, %	-27.6							

As compared to values included in the FNC of the RM under the UNFCCC, the changes described above resulted in a reduction of CO_2 emissions from 1A3b 'Road Transportation', which varied from a minimum of 29.6 percent in 1990, to a maximum of 45.1 percent in 1992 (Table 3-44). Between 1990 and 2005, the CO_2 emissions originated from 1A3b 'Road Transportation' decreased by 56.6 percent.

The update of activity data and the change of estimation methodology resulted in an insignificant increase of CO_2 emissions from 1A3c 'Railways' (Table 3-45). Between 1990 and 2005, the CO_2 emissions originated from 1A3c 'Railways' decreased by 74.6 percent.

As compared to values included in the FNC of the RM under the UNFCCC, the changes described above entailed insignificant variation of CO_2 emissions from 1A3d 'Navigation' (Table 3-46). Between 1990 and 2005, the CO_2 emissions originated from 1A3d 'Navigation' decreased by 98.3 percent.

Table 3-44: Comparative Results of CO_2 Emissions from 1A3b 'Road Transportation' Included into the FNC and SNC of the RM under the UNFCCC, Gg

	1990	1991	1992	1993	1994	1995	1996	1997
FNC	4776.9234	4767.8414	3022.0080	2063.4716	1691.1712	1882.8921	1682.8638	1793.0876
SNC	3364.2178	3086.0330	1660.3132	1242.5024	976.1429	1060.2252	1008.6187	1107.1451
Difference, %	-29.6	-35.3	-45.1	-39.8	-42.3	-43.7	-40.1	-38.3
	1998	1999	2000	2001	2002	2003	2004	2005
FNC	1428.6807							
SNC	953.6509	641.7234	719.8043	779.2747	979.9145	1253.8092	1427.4884	1459.4096
Difference, %	-33.2							

Table 3-45: Comparative Results of CO_2 Emissions from 1A3c 'Railways' Included into the FNC and SNC of the RM under the UNFCCC, Gg

	1990	1991	1992	1993	1994	1995	1996	1997
FNC	449.9748	384.0963	267.2947	200.8801	206.3564	143.4871	132.9295	124.5568
SNC	452.3598	386.0702	268.6684	201.9125	207.4106	144.2245	133.6127	125.1969
Difference, %	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
	1998	1999	2000	2001	2002	2003	2004	2005
FNC	116.5915							
SNC	117.1907	68.0257	74.0437	103.031	111.5382	133.2787	112.4834	115.1175
Difference, %	0.5							

Table 3-46: Comparative Results of CO_2 Emissions from 1A3d 'Navigation' Included into the FNC and SNC of the RM under the UNFCCC, Gg

	1990	1991	1992	1993	1994	1995	1996	1997
FNC	18.7157	0.2382	0.2065	0.2383	0.1875	0.1811	0.197	0.2129
SNC	18.9048	0.2395	0.2048	0.2363	0.1859	0.1796	0.1953	0.2111
Difference, %	1.01	0.55	-0.82	-0.84	-0.85	-0.83	-0.86	-0.85
	1998	1999	2000	2001	2002	2003	2004	2005
FNC	0.1334							
SNC	0.1323	0.2206	0.2048	0.3466	0.3592	0.2710	0.2930	0.3308
Difference, %	-0.82							

CO_2 emissions from the source category 1A3e 'Pipeline Transportation' were not assessed in the FNC of the RM under the UNFCCC, the respective emissions being estimated only during the current inventory cycle. Between 1990 and 2005, the CO_2 emissions originated from 1A3e 'Pipeline Transportation' decreased by 60.4 percent (Table 3-47).

Non-CO_2 emissions originated from 1A3 'Transport' has significantly decreased over the same period. Between 1990 and 2005, CH_4 emissions decreased by 70.0 percent, N_2O emissions – by 65.3 percent, NO_x – by 58.4 percent, CO – by 69.8 percent, NMVOC – by 69.7 percent, and SO_2 – by 50.9 percent (Table 3-48).

Table 3-47: CO_2 Emissions from 1A3e 'Pipeline Transportation' Included into the SNC of the RM under the UNFCCC, Gg

	1990	1991	1992	1993	1994	1995	1996	1997
1A3e	91.1782	75.9818	56.9864	18.6156	87.3791	83.58	117.7719	49.3882
	1998	1999	2000	2001	2002	2003	2004	2005
1A3e	47.4887	53.1873	30.3927	15.1964	32.2923	22.7946	37.9909	36.0914

Table 3-48: Non-CO_2 Emissions from the 1A3 'Transport' in the Republic of Moldova within 1990-2005, Gg

GHG	1990	1991	1992	1993	1994	1995	1996	1997
CH_4	1.1921	1.0880	0.5432	0.3525	0.3262	0.3426	0.3262	0.3706
N_2O	0.3352	0.2951	0.1830	0.1382	0.1270	0.1068	0.1003	0.1016
NO_x	38.6268	34.4576	19.7994	15.0985	12.4665	12.2869	11.6357	12.3542
CO	289.6096	264.4692	128.4896	85.9911	79.3899	83.4016	79.4585	90.2265
NMVOC	54.5258	49.7832	24.2288	16.2216	14.9588	15.7099	14.9584	16.9737
SO_2	4.3700	3.9274	2.4049	1.8949	1.4527	1.4489	1.3385	1.4095
GHG	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**
CH_4	0.3158	0.1863	0.1895	0.2058	0.2642	0.3164	0.3838	0.3573
N_2O	0.0911	0.0574	0.0640	0.0783	0.0913	0.1128	0.1138	0.1163
NO_x	10.7981	7.2014	8.1773	9.2534	11.3034	14.2763	15.7369	16.0797
CO	76.9210	45.4970	46.3416	50.3374	64.5591	77.3296	84.6959	87.3249
NMVOC	14.4691	8.5604	8.7298	9.4886	12.1688	14.5979	15.9993	16.4945
SO_2	1.2361	0.8729	1.0309	1.1639	1.4196	1.8777	2.1080	2.1474

3.4.6 Planned Improvements

The process of monitoring GHG emissions originated from the source category 1A3 'Transport' can be improved significantly once the activity data pertaining to fuel consumption for transportation need on the ATULBD are specified.

The possibility to collect additional information shall be considered for the next inventory cycle, to reduce uncertainties of the GHG emissions resulting from the respective source category.

3.5 Other Sectors (Category 1A4)

3.5.1 Source Category Description

The 1A4 'Other Sectors' category includes greenhouse gases generated by the following emission sources: 1A4a 'Commercial / Institutional'; 1A4b 'Residential'; 1A4c 'Agriculture / Forestry / Fishing'.

1A4a Commercial/Institutional

'Commercial Sector' holds a significant position in the national economy of the RM, its contribution to GDP currently being around 10.6 percent, which over 1990-2005 time period varied from a minimum of 7.1 percent in 1990, to a maximum of 15.3 percent in 1999.

According to the data of the NBS (2006), over 183 thousand persons or 13.9 percent of employed population of the country are involved in the Commercial Sector. As of 1st of January 2006, there were 8350 commercial units in the RM (Table 3-49).

Table 3-49: Number of Commercial Units in the RM, 1990-2005

	1990	1991	1992	1993	1994	1995	1996	1997
Commercial Units	11267	11069	8781	8926	7928	7770	7802	7759
Shops	8874	8908	7279	7379	6785	6434	6432	6315
Booths	2393	2161	1502	1547	1143	1336	1370	1444
Total Commercial Area, thous. m^2	840.0	853.1	708.6	685.7	643.4	622.7	621.2	578.9
on average per one shop, m^2	94.6	95.8	97.3	92.9	94.8	79.8	79.6	91.7
	1998	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**
Commercial Units	7499	6501	6549	5858	6960	7158	7718	8350
Shops	6068	5299	5316	4788	5792	5791	6220	6662
Booths	1431	1202	1233	1070	1168	1367	1498	1688
Total Commercial Area, thous. m^2	546.9	469.4	438.0	399.2	442.7	444.0	485.7	521.1
on average per one shop, m^2	90.1	88.6	82.3	83.4	76.4	76.7	78.1	78.2

Source: Statistical Yearbooks of the RM for 1994 (page 351), 1999 (page 456), 2006 (page 474)

The Institutional Sector includes education and research, health care, culture and sports, post and telecommunication institutions (Table 3-50).

Commercial and institutional premises are preponderantly heated with natural gas, as well as with Coal, Residual Fuel Oil, Diesel Oil, Oven Fuel, Liquefied Petroleum Gases, Fuel Wood, Wood Waste and Agricultural Residues.

Table 3-50: Number of Institutional Premises in the RM, 1990-2005

	1990	1991	1992	1993	1994	1995	1996	1997
Preschool institutions	2336	2306	1940	1877	1774	1680	1596	1497
Non-school educational institutions	830	826	686	613	562	534	516	495
Primary, secondary and high schools	1635	1654	1482	1488	1504	1515	1530	1536
Colleges	50	53	44	48	47	50	51	53
Universities and institutes	9	13	14	17	18	20	24	28
R&D Institutions	95	93	91	84	81	85	89	93
Hospitals	334	335	342	339	334	335	325	294
Ambulatories and out-patient clinics	586	588	594	616	599	612	601	581
Sanitary-epidemiological institutions	55	55	55	55	54	53	53	53
Emergency stations	66	67	70	69	69	68	70	71
Children Homes	5	5	4	4	4	4	4	4
Orphanages	7	7	2	3	3	3	3	3
Boarding schools	6	6	2	2	2	7	7	7
Tuberculosis sanatoriums	8	7	6	6	6	5	5	5
Public libraries	2079	2037	1730	1627	1594	1602	1583	1562
Cinemas	1791	1582	1172	960	784	671	628	666
Museums	79	79	66	66	66	65	65	67
Theatres	10	13	12	13	13	13	13	13
Cultural institutions	1790	1725	1487	1385	1335	1305	1268	1284
Sports facilities	8789	9873	7254	6888	6659	6486	6007	5468
Post and telecommunication offices	1395	1398	1395	1417	1394	1406	1406	1373
	1998	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**
Preschool institutions	1399	1201	1135	1128	1192	1246	1269	1295
Non-school educational institutions	481	448	427	407	409	417	419	418
Primary, secondary and high schools	1556	1565	1573	1584	1587	1583	1577	1558
Colleges	56	57	60	67	63	60	56	51
Universities and institutes	38	43	47	47	45	40	35	35
R&D Institutions	88	85	83	81	76	79	86	88
Hospitals	276	150	132	110	110	111	118	116
Ambulatories and out-patient clinics	625	473	571	545	562	577	636	654
Sanitary-epidemiological institutions	53	47	50	40	40	40	40	40
Emergency stations	70	89	105	107	114	122	122	127
Children Homes	4	4	4	3	3	3	3	3
Orphanages	3	3	3	3	3	3	3	3
Boarding schools	7	6	6	6	6	6	6	6
Tuberculosis sanatoriums	5	5	5	3	2	2	2	2
Public libraries	1551	1439	1419	1378	1372	1380	1386	1389
Cinemas	512	353	104	115	70	71	77	57
Museums	68	70	70	71	73	76	82	83
Theatres	13	13	13	14	15	15	15	15
Cultural institutions	1277	1256	1245	1244	1245	1227	1221	1223
Sports facilities	5614	4766	4842	4926	4947	4609	4764	4808
Post and telecommunication offices	1222	1176	1174	1176	1177	1178	1176	1171

Source: Statistical Yearbooks of the RM for 1994 (pages 135-358), 1999 (pages 74-473) and 2006 (pages 156-419).

1A4b. Residential

As of 1st of January 2006 the population of the RM was circa 4147.3 thousand people. The dwelling stock at that time was around 77.1 million m² (Table 3-51).

To be noted that around 82 percent of living space is connected to natural gas supply systems (NBS, 2006). Besides natural gas, living space is heated with Coal, Residual Fuel Oil, Biomass, while Natural Gases, Liquefied Petroleum Gases and Biomass are preponderantly used for cooking.

Table 3-51: Dwelling Stock in the Republic of Moldova, 1990-2005

	1990	1991	1992	1993	1994	1995	1996	1997
Total dwelling stock, mil. m²	77.9	79.1	66.9	68.7	70.2	71.8	72.2	73.2
on average per person, m²	17.8	18.2	18.2	19.0	19.5	19.9	20.1	20.0
of which share of living space connected to natural gas, %	NA	NA	NA	NA	NA	NA	NA	81.3
Urban dwelling stock, mil. m²	29.5	30.1	23.5	23.9	24.9	26.0	26.1	26.6
on average per person, m²	14.2	14.7	14.9	15.3	16.0	16.9	17.0	17.3
of which share of living space connected to natural gas, %	NA	NA	NA	NA	NA	NA	NA	89.0
Rural dwelling stock, mil. m²	48.4	49.0	43.4	44.8	45.3	45.8	46.1	46.6
on average per person, m²	21.1	21.3	20.7	21.8	22.1	22.2	22.4	22.0
of which share of living space connected to natural gas, %	NA	NA	NA	NA	NA	NA	NA	77.3
	1998	1999	2000	2001	2002	2003	2004	2005
Total dwelling stock, mil. m²	74.5	75.4	75.6	75.9	76.2	76.8	76.8	77.1
on average per person, m²	20.4	20.7	20.8	20.9	21.0	21.3	21.3	21.4
of which share of living space connected to natural gas, %	82.9	81.9	82.6	83.2	83.3	84.4	85.1	85.4
Urban dwelling stock, mil. m²	27.1	27.9	28.1	28.4	28.5	28.5	28.4	28.6
on average per person, m²	17.7	18.2	18.8	18.9	19.0	19.1	19.1	19.2
of which share of living space connected to natural gas, %	90.4	90.0	91.0	91.2	91.1	91.4	91.8	92.1
Rural dwelling stock, mil. m²	47.4	47.5	47.5	47.5	47.7	48.3	48.4	48.5
on average per person, m²	22.4	22.4	22.3	22.3	22.5	22.9	22.9	23.0
of which share of living space connected to natural gas, %	79.1	77.7	78.2	78.9	79.4	80.7	81.6	81.8

Note: NA – 'Not Available'. **Source:** SY of the RM for 1994 (pag. 312-314), 1999 (pag. 214-216), 2006 (pag. 149-152).

1A4c. Agriculture/Forestry/Fishing

Agriculture, hunting, forestry and fishery play an important role in the national economy of the RM, contributing around 14.2 percent to GDP (NBS, 2006), however it tends to show lower values, the maximal value of 41.7 percent being registered in 1990. According the NBS (2006) more than 537 thousand persons or 40.7 percent of employed population is involved in agriculture. Diesel Oil, Natural Gases, Liquefied Petroleum Gases and Biomass are the most used fuels within the respective sectors.

1A4. Other Sectors

In 2005, the 'Other Sectors' sub-sector accounted for 16.1 percent of din total national GHG emissions (without LULUCF), being an important source of GHG emissions. Between the 1990-2005 time period, the total GHG emissions originated from the 1A4 'Other Sectors' source category tended to lower values, decreasing by 76.2 percent (Table 3-52, Figure 3-11).

Table 3-52: Direct GHG Emissions from 1A4 'Other Sectors' in the Republic of Moldova within 1990-2005, Gg CO_2 equivalent

Years	CO_2	CH_4	N_2O	Total	Years	CO_2	CH_4	N_2O	Total
1990	7762.4898	244.4965	30.7925	8037.7787	1998	1497.9511	32.7038	7.9510	1538.6060
1991	6294.8303	187.2196	25.3485	6507.3984	1999	1284.0173	31.5386	6.9815	1322.5374
1992	4388.8608	89.5760	15.7540	4494.1909	2000	1085.5561	30.6961	6.5116	1122.7638
1993	2249.3719	73.9626	14.8054	2338.1399	2001	1414.2708	26.7957	6.2645	1447.3310
1994	2112.0567	78.1965	13.1158	2203.3690	2002	1598.7738	33.6370	7.2891	1639.6999
1995	1766.0697	51.6789	11.7168	1829.4654	2003	1911.0517	37.7795	7.8281	1956.6592
1996	1981.0872	69.0932	12.3685	2062.5488	2004	1827.8676	30.1650	6.5631	1864.5957
1997	1854.6157	39.0457	8.0397	1901.7010	2005	1872.3084	32.2659	6.5339	1911.1082

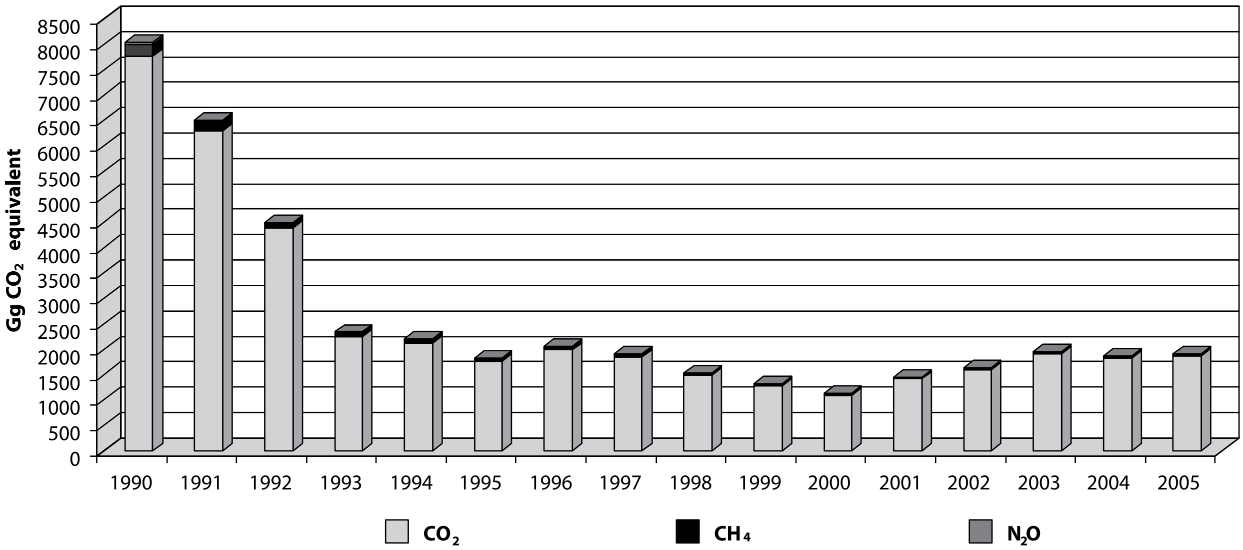

Figure 3-11: GHG Emissions from Category 1A4 'Other Sectors' in the Republic of Moldova, 1990-2005

The decreasing trend in GHG emissions is characteristic to all sources under the category 1A4 'Other Sectors' (Figure 3-12).

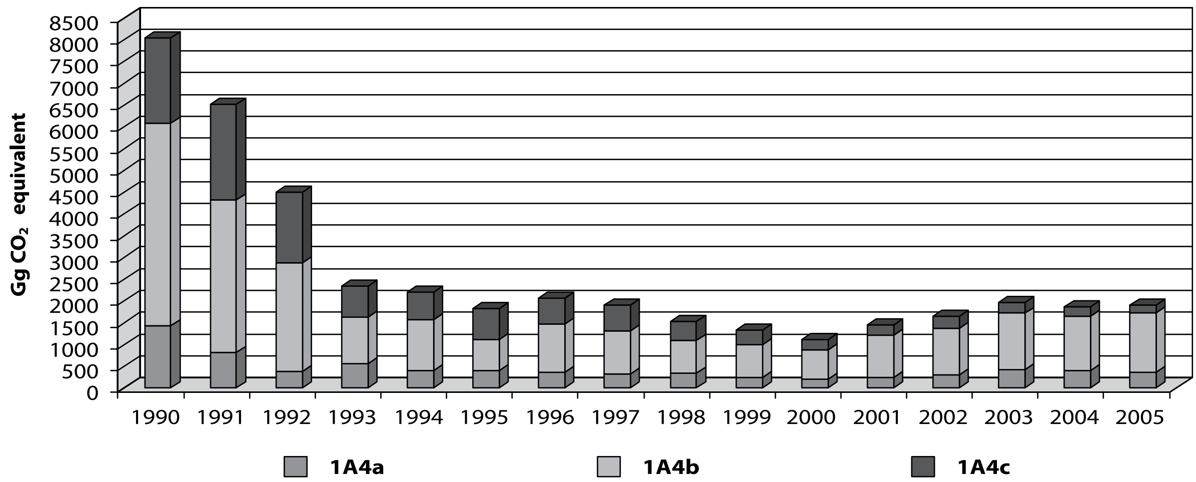

Figure 3-12: GHG Emissions from the Category 1A4 'Other Sectors' by Source in the Republic of Moldova, 1990-2005

Between 1990 and 2005 GHG emissions originated from 1A4a 'Commercial/Institutional' have decreased by 74.3 percent: from 1424.07 Gg CO_2 eq. in 1990 to 365.32 Gg CO_2 eq. in 2005; those originated from 1A4b 'Residential' have decreased by 70.8 percent: from 4657.32 Gg CO_2 eq. in 1990 to 1361.41 Gg CO_2 eq. in 2005 and GHG emissions from 1A4c 'Agriculture/Forestry/Fishing' have decreased by 90.6 percent: from 1956.39 Gg CO_2 eq. in 1990 to 184.38 Gg CO_2 eq. in 2005 (Table 3-53).

Table 3-53: GHG Emissions from the Category 1A4 'Other Sectors' by Source in the Republic of Moldova within 1990-2005, Gg CO_2 eq.

	1990	1991	1992	1993	1994	1995	1996	1997
1A4a	1424.0685	808.9106	380.6989	569.3391	403.6435	395.0255	365.6557	326.1969
1A4b	4657.3239	3511.6971	2489.8212	1060.5292	1164.6211	712.4244	1110.3887	988.5814
1A4c	1956.3862	2186.7907	1623.6708	708.2716	635.1044	722.0155	586.5043	586.9228
	1998	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**
1A4a	334.8629	250.4380	212.3073	236.2975	295.3774	414.3496	395.2562	365.3157
1A4b	755.8429	754.2248	666.0628	973.8224	1082.2735	1303.6011	1252.3923	1361.4120
1A4c	447.9002	317.8746	244.3937	237.2111	262.0489	238.7086	216.9473	184.3805

The emissions source having the largest share in the total GHG emissions under category 1A4 'Other Sectors' is 1A4b 'Residential', with a share that varied over the period from the minimum of 38.9 percent in 1995 to a maximum of 71.2 percent in 2005 (Table 3-54).

Other major emissions sources are represented by 1A4a 'Commercial/Institutional', with a share varying between 8.5 percent in 1992 and 24.4 percent in 1993, respectively 1A4c 'Agriculture/Forestry/Fishing', with a share varying between 9.6 percent in 2005 and 39.5 percent in 1995 (Figure 3-13).

Table 3-54: Breakdown of the Category 1A4 'Other Sectors' GHG Emissions by Source within 1990-2005, %

	1990	1991	1992	1993	1994	1995	1996	1997
1A4a	17.7	12.4	8.5	24.4	18.3	21.6	17.7	17.2
1A4b	57.9	54.0	55.4	45.4	52.9	38.9	53.8	52.0
1A4c	24.3	33.6	36.1	30.3	28.8	39.5	28.4	30.9
	1998	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**
1A4a	21.8	18.9	18.9	16.3	18.0	21.2	21.2	19.1
1A4b	49.1	57.0	59.3	67.3	66.0	66.6	67.2	71.2
1A4c	29.1	24.0	21.8	16.4	16.0	12.2	11.6	9.6

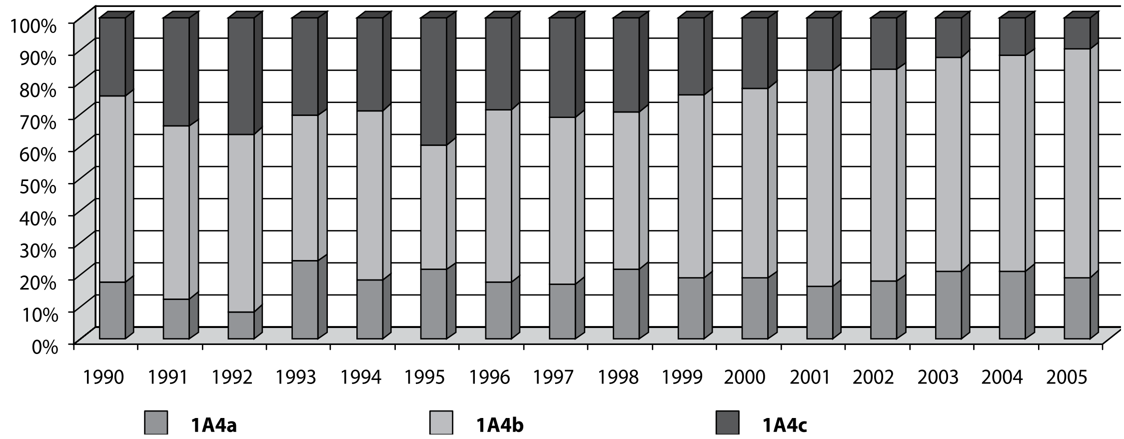

Figure 3-13. Breakdown of the Category 1A4 'Other Sectors' GHG Emissions by Source within 1990-2005, %

3.5.2 Methodological Issues and Data Sources

1A4a Commercial/Institutional

GHG emissions originated from the 1A4a 'Commercial/Institutional' source category were estimated following a Tier 1 methodology. EFs used for estimating CO_2 and SO_2 emissions are described in Table 3-10 and Annex 3-1. Default values of EFs available in the Revised 1996 IPCC Guidelines (IPCC, 1997) and 2006 IPCC Guidelines (Table 3-55) were used for non-CO_2 emissions estimation.

Activity data related to fuel consumption in commercial and institutional sectors (Table 3-56) are available in the Energy Balances of the RM (see Chapter S.2.1 'Consumed as Fuel or Energy', in columns: "for Commerce" and "for Communal Services").

Table 3-55: Emission Factors Used for Estimating Non-CO_2 Emissions Originated from 1A4a 'Commercial/Institutional' Source Category, kg/TJ

Type of fuel	CH_4	N_2O	NOx	CO	NMVOC
Coal	10	1.5	100	2000	200
Natural Gas	5	0.1	50	50	5
Oil Products	10	0.6	100	20	5
Fuel Wood	300	4	100	5000	600
Other Biomass	300	4	100	5000	600

Source: for NO_x, CO and NMVOC: Revised 1996 IPCC Guidelines, Vol. 3, Tab. 1-9, 1-10 and 1-11, Pages 1.37-1.42; for CH_4, N_2O: 2006 IPCC Guidelines, Vol. 2, Chap. 2, Tab. 2.5, Pages 2.22 - 2.23

Table 3-56: Fuel Consumption under the 1A4a 'Commercial/Institutional' Source Category in the RM, 1990-2005

	1990	1991	1992	1993	1994	1995	1996	1997
Other Kerosene, kt	1.0	0.0	0.0	1.1	0.0	0.0	0.0	0.0
Diesel Oil, kt	32.0	25.0	15.0	4.9	3.0	2.0	2.0	2.0
Residual Fuel Oil, kt	21.0	33.0	40.0	12.6	6.0	6.0	5.0	1.0
Kerosene, kt	6.0	4.7	10.6	1.0	2.8	1.0	1.0	2.4
Anthracite, kt	452.0	178.0	0.0	61.7	27.0	17.0	18.0	15.0
Other Bituminous Coal, kt	2.0	31.4	31.6	97.8	94.0	108.0	91.0	87.0
Lignite, kt	1.0	1.0	0.0	41.0	30.0	24.0	26.0	15.0
Natural Gas, mil. m^3	42.0	42.0	51.3	33.8	18.0	17.0	22.0	22.0
	1998	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**
Diesel Oil, kt	2.0	4.0	4.0	6.0	2.0	1.0	3.0	1.0
Residual Fuel Oil, kt	1.0	1.0	1.0	2.0	1.0	1.0	1.0	0.0
Kerosene, kt	1.3	2.6	4.6	3.2	3.2	1.0	1.0	1.0
Anthracite, kt	13.0	13.0	25.0	11.0	27.0	70.0	69.0	55.0
Other Bituminous Coal, kt	98.0	65.0	34.0	52.0	50.0	46.0	32.0	30.0
Lignite, kt	13.0	6.0	5.0	4.0	3.0	1.0	0.0	0.0
Natural Gases, mil. m^3	18.0	15.0	16.0	22.0	43.0	58.0	67.0	76.0

1A4b Residential

GHG emissions originated from the 1A4b 'Residential' source category were estimated following a Tier 1 methodology. EFs used for estimating CO_2 and SO_2 emissions are described in Table 3-10 and Annex 3-1. Default values of EFs available in the Revised 1996 IPCC Guidelines (IPCC, 1997) and 2006 IPCC Guidelines (Table 3-57) were used for non-CO_2 emissions estimation.

Activity data related to fuel consumption in residential sector (Table 3-58) are available in the Energy Balances of the RM (see Chapter S.2.1 'Consumed as Fuel or Energy', in column: "Sold to Population"), as well as in the Statistical Yearbooks of the ATULBD.

Table 3-57: Emission Factors Used for Estimating Non-CO_2 Emissions Originated from 1A4b 'Residential' Source Category, kg/TJ

Type of fuel	CH_4	N_2O	NOx	CO	NMVOC
Coal	300	1.5	100	2000	200
Natural gas	5	0.1	50	50	50
Oil products	10	0.6	100	20	5
Fuel wood	300	4	100	5000	600
Other biomass	300	4	100	5000	600

Source: for NO_x, CO and NMVOC: Revised 1996 IPCC Guidelines, Vol. 3, Tab. 1-9, 1-10 and 1-11, Pages 1.37-1.42; for CH_4, N_2O: 2006 IPCC Guidelines, Vol. 2, Chap. 2, Tab. 2.5, Pages 2.22-2.23

Table 3-58: Fuel Consumption under the 1A4b 'Residential' Source Category in the RM, 1990-2005

	1990	1991	1992	1993	1994	1995	1996	1997
Other Kerosene, kt	10.0	0.0	0.0	0.6	0.0	0.0	0.0	0.0
Diesel oil, kt	28.0	202.0	13.0	0.3	0.0	0.0	0.0	0.0
Residual fuel oil, kt	0.0	26.5	191.9	0.0	1.0	0.0	0.0	0.0
Kerosene, kt	125.0	0.0	18.8	28.6	12.0	12.0	15.0	20.0
Anthracite, kt	1264.0	200.0	0.0	93.6	136.0	51.0	60.0	70.0
Other bituminous coal, kt	30.0	384.9	155.7	61.8	118.0	21.0	132.0	38.0
Lignite, kt	164.0	441.0	0.0	16.9	3.0	2.0	2.0	3.0
Natural gas, mil. m^3	257.0	311.0	704.5	258.3	217.0	232.0	274.6	325.5
	1998	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**
Diesel oil, kt	0.0	2.0	1.0	0.0	0.0	0.0	0.0	0.0
Residual fuel oil, kt	0.0	0.0	1.0	0.0	0.0	0.0	0.0	0.0
Kerosene, kt	20.0	25.0	28.0	27.3	42.4	42.5	46.5	45.5
Anthracite, kt	17.0	37.0	44.0	28.0	57.0	87.0	67.0	77.0
Other bituminous coal, kt	24.0	13.0	6.0	0.0	1.0	4.0	3.0	4.0
Lignite, kt	0.0	1.0	0.0	1.0	0.0	0.0	0.0	0.0
Natural gas, mil. m^3	296.1	271.2	220.7	417.7	408.7	480.6	478.8	521.8

1A4c Agriculture/Forestry/Fishing

GHG emissions originated from the 1A4c 'Agriculture/Forestry/Fishing' source category were estimated following a Tier 1 methodology. EFs used for estimating CO_2 and SO_2 emissions are described in Table 3-10 and Annex 3-1. Default values of EFs available in the Revised 1996 IPCC Guidelines (IPCC, 1997) and 2006 IPCC Guidelines (Table 3-59) were used for non-CO_2 emissions estimation.

Activity data related to fuel consumption in agriculture, forestry and fishery (Table 3-60) are available in the Energy Balances of the RM (see Chapter S.2.1 'Consumed as Fuel or Energy', in column: "for agriculture"), as well as in the Statistical Yearbooks of the ATULBD.

Table 3-59: Emission Factors Used for Estimating Non-CO_2 Emissions Originated from 1A4c 'Agriculture/Forestry/Fishing' Source Category, kg/TJ

Type of fuel	CH_4	N_2O	NOx		CO		NMVOC	
			Stationary	Mobile	Stationary	Mobile	Stationary	Mobile
Coal	300	1.5	100		2000		200	
Natural Gas	5	0.1	50	1000	50	400	5	5
Oil Products	10	0.6	100	1200	20	1000	5	200
Fuel Wood	300	4	100		5000		600	
Other Biomass	300	4	100		5000		600	

Source: for NO_x, CO and NMVOC – Revised 1996 IPCC Guidelines, Vol. 3, Tables 1-9, 1-10 and 1-11, pages 1.37-1.42; for CH_4, N_2O –IPCC 2006 Guidelines, vol. 2, chap. 2, tab. 2.5, pages 2.22-2.23.

Table 3-60: Fuel Consumption under the 1A4c 'Agriculture/Forestry/Fishing' Source Category in the RM, 1990-2005

	1990	1991	1992	1993	1994	1995	1996	1997
Gasoline, kt	7.0	6.4	3.8	1.3	2.0	11.7	11.1	11.9
Other Kerosene, kt	9.0	0.0	0.0	5.7	1.0	0.0	0.0	0.0
Diesel Oil (Stationary), kt	27.0	9.6	4.8	6.3	1.0	1.0	3.0	2.0
Diesel Oil (Mobile), kt	549.0	396.0	243.0	196.3	190.8	209.7	165.1	163.2
Residual Fuel Oil, kt	6.0	25.0	17.0	5.0	0.0	0.0	0.0	1.0
Kerosene, kt	1.0	79.5	56.3	0.3	0.0	0.0	0.0	0.0
Anthracite, kt	21.0	0.0	0.0	3.8	2.0	1.0	1.0	1.0
Other Bituminous Coal, kt	0.0	153.7	150.7	4.8	3.0	2.0	3.0	1.0
Lignite, kt	0.0	0.0	0.0	1.4	1.0	1.0	0.0	0.0
Natural Gas, mil. m^3	2.0	84.3	108.3	2.0	2.0	5.0	5.0	10.0
	1998	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**
Gasoline, kt	7.8	4.1	2.8	2.7	1.2	1.3	0.8	0.6
Diesel Oil (Stationary), kt	6.0	6.0	4.0	5.0	1.0	1.0	0.0	0.0
Diesel Oil (Mobile), kt	120.8	86.6	67.5	65.4	78.1	70.7	63.5	55.8
Other Bituminous Coal, kt	2.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0
Natural Gas, mil. m^3	9.0	5.0	5.0	3.0	4.0	4.0	7.0	3.0

To be noted that the amount of Diesel Oil included in the Energy Balances of the RM, as being consumed for different works and needs in agriculture (see Chapter S.2.1 'Consumed as Fuel or Energy', column "for agriculture") was split as follows: 10 percent were allocated to the category 1A3b 'Road Transportation' for on-road transportation (on highways and national roads), the remaining 90 percent being reallocated under the category 1A4c 'Agriculture/Forestry/Fishing' (Off-road Vehicles and Other Machinery). Information for other types of fuels consumed under this category was presented according the Energy Balances of the RM for respective years.

3.5.3 Uncertainties and Time-Series Consistency

The primary uncertainties related factors pertain to methodology, emission factors used to estimate GHG emissions covered by the 1A4 'Other Sectors' source category, and the quality of activity data available.

The uncertainties for the category 'Other Sectors' are largely dependent on the collection procedures used for the underlying activity data (commercial fuel volumes and properties are generally well-known), as well as on the representativeness of the emission factors for specific fuel properties. Uncertainties associated with EFs used to estimate CO_2 emissions from the 1A4 ‘Other Sectors’ source category, were estimated at ±5 percent, while those related to EFs used to estimate CH_4 and N_2O emissions reach up to ±50 percent.

Uncertainties associated with statistical data regarding fuel consumption within the category ‘Other Sectors’ in the RM can be considered relatively low (±5 percent) for 1A4a ‘Institutional/Commercial’ and 1A4c ’Agriculture/Forestry/Fishing’ source categories, and moderate (±10 percent) for 1A4b ‘Residential’ source category.

Inventory uncertainties related to GHG emissions within the category 1A4 ‘Other Sectors’ were estimated at ±11.18 percent for CO_2 emissions from 1A4b ‘Residential’ and, respectively at ±7.07 percent for CO_2 emissions from 1A4a ‘Institutional/Commercial’ and 1A4c ’Agriculture/Forestry/Fishing’; while the inventory uncertainties related to CH_4 and N_2O emissions, have been estimated at ±50.99 percent for 1A4b ‘Residential’ and, respectively at ±50.25 percent for 1A4a ‘Institutional/Commercial’ and 1A4c ’Agriculture/Forestry/Fishing’ source categories.

At the same time, combined uncertainties, presented as a percent of total sectoral emissions were estimated for CO_2 emissions: at ±0.3162 percent for 1A4a ‘Institutional / Commercial’; ±1.8358 percent for 1A4b ‘Residential’; ±0.1604 percent for 1A4c ’Agriculture/Forestry/Fishing’; for CH_4 emissions: at ±0.0147 percent for 1A4a ‘Institutional/Commercial’, ±0.1850 percent for 1A4b ‘Residential’ and ±0.0036 percent for 1A4c ’Agriculture/Forestry/Fishing’; while for N_2O emissions: at ±0.0089 percent for 1A4a ‘Institutional/Commercial’, ±0.0293 percent for 1A4b ‘Residential’, and ±0.0029 percent for 1A4c ’Agriculture/Forestry/Fishing’ (Annex 7-3.1).

In view of ensuring time-series consistency of the obtained results, the same approach was used for the entire period under review, in conformity with the recommendations included in the Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories (IPCC, 2000).

3.5.4 QA/QC and Verification

Standard verification and quality control forms and checklists were filled in for the respective source category under the Energy Sector, following the Tier 1 and Tier 2 approaches (see in Annex 6). Also, the AD and methods used for estimating GHG emissions under the category 1A4 ‘Other Sectors’ were documented and archived both in hard copies and electronically. For identifying the data entry and emission estimation process related errors there were applied verifications and quality control procedures. Verification was focused on correct use of AD obtained from different sources of reference (i.e., Energy Balances, Statistical Yearbooks of the RM and of the ATULBD, Ministry of Transport and Roads, Ministry of Agriculture and Food Industry, Custom Service, National Bureau of Statistics), as well as on ensuring correct use of the default emission factors available in the Revised 1996 IPCC Guidelines (IPCC, 1997), GPG (IPCC, 2000) and 2006 IPCC Guidelines (IPCC, 2006). Inventory quality assurance activities for the Energy Sector, inclusive for the 1A4 ‘Other Sectors’ source category were supported by an expert representing the Institute of Energy of the ASM.

Following the recommendations included into the Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories (IPCC, 2000), GHG emissions originated from the 1A4 ‘Other Sectors’ were estimated based on AD and EFs from official sources of reference.

3.5.5 Recalculations

GHG emission recalculations performed under the 1A4 ‘Other Sectors’ are due to the availability of an updated set of activity data related to fuel consumption for heating premises of commercial, institutional, residential, agricultural, forestry and fishery sectors, also for heating greenhouses, pumps operation, for irrigation systems and off-road vehicles and other machinery operation, including reallocation of a certain amount of Diesel Oil used for transport needs from 1A3b ‘Road Transportation’ into the 1A4cii ‘Agriculture /Forestry/Fishing’ (Off-road Vehicles and Other Machinery), based on information available into the Energy Balances, Statistical Yearbooks of the RM and ATULBD, and that offered by the Ministry of Transport and Roads, Ministry of Agriculture and Food Industry, Custom Service, National Bureau of Statistics), also due to updated methodologies available in the 2006 IPCC Guidelines, which has replaced the methodologies contained into the Revised 1996 IPCC Guidelines (IPCC, 1997) used under the FNC (2000), due to use of country specific NCVs replacing the default NCVs available into the Revised 1996 IPCC Guidelines (IPCC, 1997).

In comparison with the results included into the FNC, the performed recalculations under the 1A4 ‘Other Sectors’ resulted in increased values of CO_2 emissions for the 1998-1998 time period, varying from a minimum 12.3 percent in 1993, to a maximum of 45.1 percent in 1995. Between 1990 and 2005, the CO_2 emissions originated from 1A4 ‘Other Sectors’ source category decreased by 76.2 percent (Table 3-61).

Table 3-61: Comparative Results of CO_2 Emissions from 1A4 'Other Sectors' Included into the FNC and SNC of the RM under the UNFCCC, Gg

	1990	1991	1992	1993	1994	1995	1996	1997
FNC	5713.69	5009.60	3824.77	2082.82	1836.14	1260.67	1520.67	1532.11
SNC	8037.78	6507.40	4494.19	2338.14	2203.37	1829.47	2062.55	1901.70
Difference, %	40.7	29.9	17.5	12.3	20.0	45.1	35.6	24.1
	1998	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**
FNC	1200.82							
SNC	1538.61	1322.54	1122.76	1447.33	1639.70	1956.66	1864.60	1911.11
Difference, %	28.1							

As compared to values included in the FNC of the RM under the UNFCCC, the changes described above (updating activity data and changing the estimation method) resulted in increased values of CO_2 emissions from 1A4a 'Commercial/Institutional', which varied from a minimum of 277.1 percent in 1998, to a maximum of 1166.5 percent in 1990 (Table 3-62). Between 1990 and 2005, the CO_2 emissions originated from 1A4a 'Commercial/Institutional' decreased by 74.3 percent.

Table 3-62: Comparative Results of CO_2 Emissions from 1A4a 'Commercial / Institutional' Included into the FNC and SNC of the RM under the UNFCCC, Gg

	1990	1991	1992	1993	1994	1995	1996	1997
FNC	112.4428	89.1005	74.8560	57.5215	56.2349	54.6037	55.1205	54.9482
SNC	1424.0685	808.9106	380.6989	569.3391	403.6435	395.0255	365.6557	326.1969
Difference, %	1166.5	807.9	408.6	889.8	617.8	623.4	563.4	493.6
	1998	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**
FNC	88.8083							
SNC	334.8629	250.4380	212.3073	236.2975	295.3774	414.3496	395.2562	365.3157
Difference, %	277.1							

As compared to values included in the FNC of the RM under the UNFCCC, the changes described above (updating activity data and changing the estimation methodology) resulted in variation of CO_2 emissions originated from 1A4b 'Residential' over period under review, from a maximum reduction of circa 26.1 percent in 1993, to a maximum increase of 5.4 percent in 1996 (Table 3-63). Between 1990 and 2005, the CO_2 emissions originated from 1A4b 'Residential' decreased by 70.8 percent.

Table 3-63: Comparative Results of CO_2 Emissions from 1A4b 'Residential' Included into the FNC and SNC of the RM under the UNFCCC, Gg

	1990	1991	1992	1993	1994	1995	1996	1997
FNC	4792.8924	4057.7167	3069.4583	1434.7375	1343.6304	815.2531	1053.8177	978.8749
SNC	4657.3239	3511.6971	2489.8212	1060.5292	1164.6211	712.4244	1110.3887	988.5814
Difference, %	-2.8	-13.5	-18.9	-26.1	-13.3	-12.6	5.4	1.0
	1998	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**
FNC	937.8571							
SNC	755.8429	754.2248	666.0628	973.8224	1082.2735	1303.6011	1252.3923	1361.4120
Difference, %	-19.4							

In comparison with values included in the FNC, the changes described above resulted in higher values for CO_2 emissions originated from the 1A4c 'Agriculture/Forestry/Fishing', source category, which varied from a minimum of 19.9 percent in 1993, up to a maximum of 198.7 percent in 1991 (except an insignificant increase registered in 1998) (Table 3-64). Between 1990 and 2005, the CO_2 emissions originated from 1A4c Agriculture/Forestry/Fishing' decreased by 90.6 percent.

Non-CO_2 emissions originated from 1A4 'Other Sectors' has significantly decreased over the same period. Between 1990 and 2005, CH_4 emissions decreased by 86.8 percent, N_2O emissions – by 78.8 percent, NO_x – by 86.3 percent, CO – by 80.8 percent, NMVOC – by 80.9 percent, and SO_2 – by 89.9 percent (Table 3-65).

Table 3-64: Comparative Results of CO_2 Emissions from 1A4c 'Agriculture / Forestry / Fishing' Included into the FNC and SNC of the RM under the UNFCCC, Gg

	1990	1991	1992	1993	1994	1995	1996	1997
FNC	807.8334	732.0729	679.9251	590.5102	436.1672	390.7012	433.2549	476.6253
SNC	1956.3862	2186.7907	1623.6708	708.2716	635.1044	722.0155	586.5043	586.9228
Difference, %	142.2	198.7	138.8	19.9	45.6	84.8	35.4	23.1
	1998	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**
FNC	448.1696							
SNC	447.9002	317.8746	244.3937	237.2111	262.0489	238.7086	216.9473	184.3805
Difference, %	-0.1							

Table 3-65: Non-CO_2 Emissions from the 1A4 'Other Sectors' in the Republic of Moldova within 1990-2005, Gg

GHG	1990	1991	1992	1993	1994	1995	1996	1997
CH_4	11.6427	8.9152	4.2655	3.5220	3.7236	2.4609	3.2902	1.8593
N_2O	0.0993	0.0818	0.0508	0.0478	0.0423	0.0378	0.0399	0.0259
NO_x	35.4060	27.7087	18.6192	12.4659	11.9701	13.0293	11.0627	10.6761
CO	127.0250	96.1384	53.8737	60.0628	54.7840	48.9299	51.1579	33.1438
NMVOC	15.3004	11.7409	6.9587	7.5191	6.8245	6.4033	6.4083	4.3402
SO_2	60.5137	56.4259	26.7322	15.0889	14.8890	9.8040	12.4329	8.5640
GHG	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**
CH_4	1.5573	1.5018	1.4617	1.2760	1.6018	1.7990	1.4364	1.5365
N_2O	0.0256	0.0225	0.0210	0.0202	0.0235	0.0253	0.0212	0.0211
NO_x	8.1631	6.0485	4.8791	5.0166	5.7931	5.7075	5.2373	4.8350
CO	32.1244	27.4683	25.3142	23.7341	27.8599	30.0633	24.6065	24.3582
NMVOC	4.1229	3.4649	3.1599	2.9750	3.4641	3.6270	2.9835	2.9300
SO_2	6.7794	5.6902	5.0210	4.4348	5.7988	7.6583	6.3854	6.1395

3.5.6 Planned Improvements

The process of monitoring GHG emissions originated from the source category 1A4 'Other Sectors' can be improved significantly once the activity data pertaining to fuel consumption used for heating premises of commercial, institutional, residential, agricultural, forestry and fishery sectors, also for heating greenhouses, pumps operation, for irrigation systems and off-road vehicles and other machinery operation within the ATULBD are specified.

The possibility to collect additional information shall be considered for the next inventory cycle, to reduce uncertainties of the GHG emissions resulting from the respective source category.

3.6 Other (Category 1A5)

3.6.1 Source Category Description

The 1A5 'Other' source category includes GHG emissions from fuels combustion for other works and needs within the energy sector, including military transport (see the Energy Balances of the RM, Chapter S.2.1 'Consumed as Fuel or Energy', in column: "for other works and needs").

To be noted as well that the respective source category includes the total amount of lubricants consumed at the national level. Also, within the Worksheet 1-2, Sheets 15 of 16 'Other' (Not Elsewhere Specified) of the IPCC Sectoral Reporting Tables, the consumption of "Oven Fuel" was reported together with that of "Diesel Oil".

In 2005, the category 1A5 'Other' accounted for 1.0 percent of the total national GHG emissions (without LULUCF).

In 2005, GHG emissions originated from the 1A5 'Other' (other works and needs within the energy sector) source category tended to show lower values in comparison with the reference year (1990), decreasing by 23.5 percent: from 154.90 Gg CO_2 equivalent in 1990 to 118.52 Gg CO_2 equivalent in 2005 (Figure 3-14).

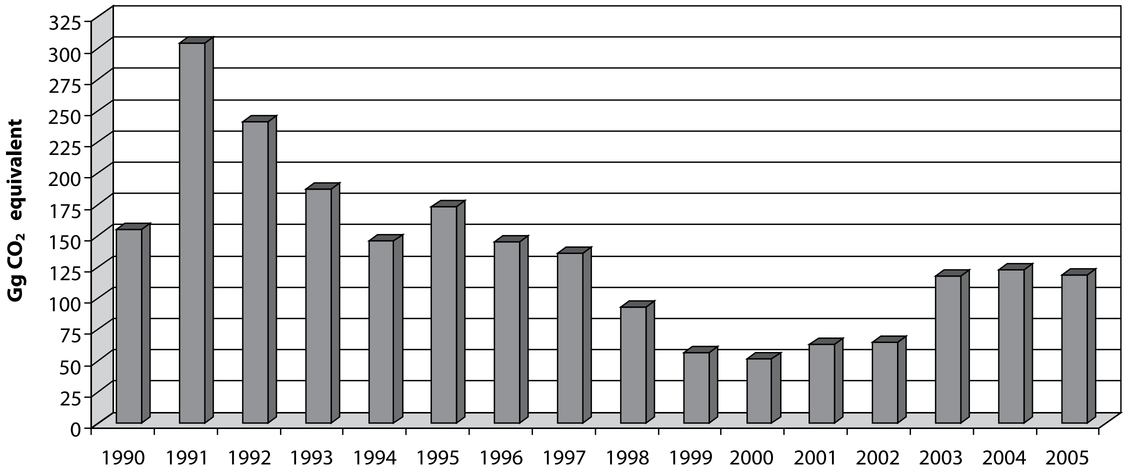

Figure 3-14: GHG Emissions from 1A5 'Other' Source Category in the Republic of Moldova, 1990-2005

Between 1990 and 2005, CO_2 emissions originated from 1A5 'Other' source category have decreased by 23.5 percent: from 154.27 Gg in 1990 to 118.05 Gg in 2005; CH_4 emissions have decreased by 4.1 percent: from 0.1350 Gg CO_2 equivalent in 1990 to 0.1295 Gg CO_2 equivalent in 2005, while the N_2O decreased by 30.2 percent: from 0.4911 Gg CO_2 equivalent in 1990 to 0.3426 Gg CO_2 equivalent in 2005 (Table 3-66).

Table 3-66: Direct GHG Emissions from 1A5 'Other' in the Republic of Moldova within 1990-2005, Gg CO_2 equivalent

Years	CO_2	CH_4	N_2O	Total	Years	CO_2	CH_4	N_2O	Total
1990	154.2715	0.1350	0.4911	154.8976	1998	92.4763	0.0487	0.3072	92.8322
1991	303.3231	0.0098	0.7506	304.0835	1999	56.2421	0.0703	0.2480	56.5604
1992	240.2766	0.0000	0.5806	240.8572	2000	51.2533	0.0495	0.2091	51.5118
1993	186.5611	0.1124	0.6080	187.2816	2001	62.9575	0.0643	0.2678	63.2896
1994	145.7325	0.0691	0.4245	146.2261	2002	64.1625	0.0810	0.2746	64.5181
1995	172.6731	0.0913	0.5585	173.3229	2003	117.3137	0.0544	0.3626	117.7306
1996	144.8332	0.0908	0.4944	145.4184	2004	122.5701	0.0540	0.3789	123.0030
1997	135.5091	0.0877	0.4732	136.0699	2005	118.0475	0.1295	0.3426	118.5196

3.6.2 Methodological Issues and Data Sources

GHG emissions originated from the 1A5 'Other' source category was estimated following a Tier 1 methodology. EFs used for estimating CO_2 and SO_2 emissions are described in Table 3-10 and Annex 3-1. Default values of EFs available in the Revised 1996 IPCC Guidelines (IPCC, 1997) and 2006 IPCC Guidelines (Table 3-67) were used for non-CO_2 emissions estimation.

Activity data pertaining to the fuel consumption under other works and needs in energy sector (1A5 'Other') (Table 3-68) were collected basically from the Energy Balances of the RM for 1990 and 1993-2005, as well as from other relevant sources of information, such as Ministry of Defence and National Bureau of Statistics.

Table 3-67: Emission Factors Used for Estimating Non-CO_2 Emissions Originated from 1A5 'Other' Source Category, kg/TJ

GHG	Coal	Natural Gas	Oil Products	Fuel Wood	Other Biomass
CH_4	10	1	3	30	30
N_2O	1.5	0.1	0.6	4	4
NOx	300	150	200	100	100
CO	150	30	10	2 000	4 000
NMVOC	20	5	5	50	50

Source: for NO_x, CO and NMVOC: Revised 1996 IPCC Guidelines, Vol. 3, Tables 1-9, 1-10 and1-11, Pages 1.37-1.42; for CH_4, N_2O: 2006 IPCC Guidelines, Vol. 2, Chap. 2, Tab. 2.3, Pages 2.18 – 2.19.

Table 3-68: Fuel Consumption under the 1A5 'Other' Source Category in the Republic of Moldova, 1990-2005

	1990	1991	1992	1993	1994	1995	1996	1997
Gasoline	4.00	2.50	2.20	0.90	2.00	2.00	0.00	1.00
Kerosene	1.00	0.00	0.00	26.30	1.00	0.00	0.00	0.00
Diesel Oil	19.00	15.00	10.00	6.80	2.00	3.00	5.00	2.00
Residual Fuel Oil	1.00	6.80	8.65	8.10	12.00	21.00	11.00	8.00
Liquefied Petroleum Gas	1.00	0.00	0.00	2.70	1.00	3.20	3.60	1.00
Bitumen	0.00	34.30	34.00	0.00	0.00	0.00	0.00	0.00
Lubricants	0.00	36.00	21.00	0.00	17.00	18.07	17.12	16.57
Other Oil Products	0.00	0.00	0.00	1.00	1.00	0.00	2.00	9.00
Anthracite	16.00	0.00	0.00	1.90	2.00	3.00	2.00	2.00
Bituminous Coal	0.00	0.00	0.00	13.60	5.00	5.00	6.00	4.00
Lignite	4.00	4.00	0.00	5.90	4.00	4.00	5.00	5.00
Natural Gas	14.80	0.00	0.00	0.30	6.70	1.20	0.00	0.00
Fuel Wood	3.70	0.00	0.00	1.00	2.20	3.70	2.20	4.40
Other Biomass	0.00	0.00	0.00	0.80	0.00	1.00	2.00	1.00
	1998	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**
Gasoline	2.00	0.00	0.00	2.00	0.00	1.00	0.00	0.00
Kerosene	0.00	1.00	0.00	0.00	0.00	1.00	1.00	1.00
Diesel Oil	5.00	0.00	2.00	2.00	2.00	2.00	5.00	3.00
Residual Fuel Oil	2.00	1.00	0.00	0.00	1.00	1.00	0.00	1.00
Liquefied Petroleum Gas	1.00	1.00	1.00	4.00	1.54	1.00	0.00	2.00
Bitumen	0.00	0.00	0.00	0.00	0.00	12.00	17.00	16.00
Lubricants	12.19	9.13	7.61	7.76	7.62	11.40	11.32	10.22
Other Oil Products	4.00	0.00	3.00	1.00	1.00	3.00	1.00	1.00
Anthracite	0.00	6.00	0.00	0.00	1.00	0.00	1.00	1.00
Bituminous Coal	3.00	4.00	3.00	5.00	8.00	5.00	1.00	0.00
Lignite	4.00	2.00	2.00	0.00	0.00	0.00	0.00	0.00
Natural Gas	0.00	2.00	0.00	0.00	1.00	2.00	3.00	4.00
Fuel Wood	2.90	0.70	3.70	3.70	2.90	2.19	2.92	2.92
Other Biomass	0.00	4.00	0.00	1.00	1.00	1.00	2.00	1.00

3.6.3 Uncertainties and Time-Series Consistency

The primary uncertainties related factors pertain to methodology, emission factors used to estimate GHG emissions covered by the source category 1A5 'Other', and quality of activity data available.

The uncertainties for the 1A5 'Other' source category are largely dependent on the collection procedures used for the underlying activity data (commercial fuel volumes and properties are generally well-known), as well as on the representativeness of the emission factors for specific fuel properties. Uncertainties associated with EFs used to estimate CO_2 emissions from the 1A5 'Other' source category, were estimated at ±5 percent, while those pertaining to EFs used to estimate CH_4 and N_2O emissions reach up to ±50 percent.

Uncertainties associated with statistical data regarding fuel consumption under other works and needs in the energy sector of the RM could be considered relatively low (±5 percent). Uncertainties pertaining to GHG emissions from the 1A5 'Other' source category were estimated at ±7.07 percent for CO_2 emissions, and at ±50.25 percent for CH_4 and N_2O emissions.

At the same time, combined uncertainties, presented as a percent of total sectoral emissions were estimated at ±0.1032 percent for CO_2 emissions, ±0.0008 percent for CH_4 emissions, and ±0.0021 percent for N_2O. Uncertainties introduced in trend in sectoral emissions were estimated at ±0.0266 percent for CO_2 emissions, at ±0.0001 percent for CH_4 emissions, and at ±0.0003 percent for N_2O emissions (see Annex 7-3.1).

In view of ensuring time-series consistency of the obtained results, the same approach was used for the entire period under review, in conformity with the recommendations included in the Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories (IPCC, 2000).

3.6.4 QA/QC and Verification

Standard verification and quality control forms and check-lists were filled in for the respective source category under the Energy Sector, following the Tier 1 and Tier 2 approaches (see in Annex 6). Also, the AD and methods used for estimating GHG emissions under the category 1A5 'Other' were documented and archived both in hard copies and electronically. For identifying the data entry and emission estimation process related errors there were applied verifications and quality control procedures. Verification was focused on correct use of AD obtained from different sources of reference (i.e., Energy Balances, Ministry of Defence and National Bureau of Statistics), as well as on ensuring correct use of the default emission factors available in the Revised 1996 IPCC Guidelines (IPCC, 1997), GPG (IPCC, 2000) and 2006 IPCC Guidelines (IPCC, 2006). Inventory quality assurance activities for the Energy Sector, inclusive for the 1A5 'Other' source category were supported by an expert representing the Institute of Energy of the ASM.

Following the recommendations included into the Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories (IPCC, 2000), GHG emissions originated from the 1A5 'Other' were estimated based on AD and EFs from official sources of reference.

3.6.5 Recalculations

GHG emission recalculations performed under the 1A5 'Other' are due to the availability of an updated set of activity data (Energy Balances of the RM and other relevant sources, such as Ministry of Defence and National Bureau of Statistics), also due to updated methodologies available in the 2006 IPCC Guidelines, which has replaced the methodologies contained into the Revised 1996 IPCC Guidelines (IPCC, 1997) used under the FNC (2000), as well as due to use of country specific NCVs replacing the default NCVs available into the Revised 1996 IPCC Guidelines (IPCC, 1997).

Table 3-69: Comparative Results of CO_2 Emissions from 1A5 'Other' Included into the FNC and SNC of the RM under the UNFCCC, Gg

	1990	1991	1992	1993	1994	1995	1996	1997
FNC	17.5314	14.7565	9.5784	9.2510	10.7493	8.1763	12.7461	8.3598
SNC	154.8976	304.0835	240.8572	187.2816	146.2261	173.3229	145.4184	136.0699
Difference, %	783.5	1960.7	2414.6	1924.4	1260.3	2019.8	1040.9	1527.7
	1998	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**
FNC	7.9043							
SNC	92.8322	56.5604	51.5118	63.2896	64.5181	117.7306	123.0030	118.5196
Difference, %	1074.5							

In comparison with the results included into the FNC, the performed recalculations under the 1A5 'Other' sources category resulted in increased values of GHG emissions for the 1998-1998, varying from a minimum 783.5 percent in 1990, up to maximum 2324.2 percent in 1992. Between 1990 and 2005, the CO_2 emissions originated from 1A5 'Other' source category decreased by 23.5 percent (Table 3-69).

Non-CO_2 emissions originated from 1A5 'Other' source category has also decreased over the same period. Between 1990 and 2005, CH_4 emissions decreased by 4.1 percent, N_2O emissions – by 30.2 percent, NO_x – by 27.9 percent, CO – by 17.3 percent, NMVOC – by 44.5 percent, and SO_2 – by 52.7 percent (Table 3-70).

Table 3-70: Non-CO_2 Emissions from the 1A5 'Other' Source Category in the Republic of Moldova within 1990-2005, Gg

GHG	1990	1991	1992	1993	1994	1995	1996	1997
CH_4	0.0064	0.0005	0.0000	0.0054	0.0033	0.0043	0.0043	0.0042
N_2O	0.0016	0.0024	0.0019	0.0020	0.0014	0.0018	0.0016	0.0015
NO_x	0.4393	0.7977	0.6244	0.5331	0.4045	0.4813	0.4095	0.3818
CO	0.1847	0.0462	0.0312	0.1598	0.1096	0.2073	0.2271	0.2139
NMVOC	0.0195	0.0205	0.0156	0.0203	0.0145	0.0181	0.0162	0.0154
SO_2	0.7646	2.8710	0.7182	1.2813	1.1562	1.7481	1.1762	0.9549
GHG	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**
CH_4	0.0023	0.0033	0.0024	0.0031	0.0039	0.0026	0.0026	0.0062
N_2O	0.0010	0.0008	0.0007	0.0009	0.0009	0.0012	0.0012	0.0011
NO_x	0.2611	0.1660	0.1492	0.1890	0.1907	0.3209	0.3285	0.3166
CO	0.1016	0.2791	0.1108	0.1749	0.1717	0.1472	0.2146	0.1527
NMVOC	0.0098	0.0090	0.0071	0.0091	0.0101	0.0117	0.0121	0.0108
SO_2	0.4463	0.3077	0.2237	0.2616	0.4051	1.0477	0.1865	1.1677

3.6.6 Planned Improvements

The process of monitoring GHG emissions originated from the source category 1A5 'Other' can be improved significantly once the activity data pertaining to fuel consumption on the ATULBD are specified. The possibility to collect additional information shall be considered for the next inventory cycle, to reduce uncertainties of the GHG emissions resulting from the respective source category.

3.7 Fugitive Emissions from Oil and Natural Gas (Category 1B2)

The most used type of fuel in the Republic of Moldova is natural gases. This type of fuel has been used in the RM since 1966, being 100 percent imported from Russian Federation through the gas pipeline system. The main operator on the natural gas market in the country is the Moldovan-Russian joint venture "MOLDOVAGAZ".

The infrastructure of the 'Natural Gas Sector' currently includes: high and medium pressure main gas pipelines (circa 593.6 km), high and medium pressure connection gas pipelines – circa 714 km, medium and low pressure gas distribution pipelines – circa 12465 km, 5 transported gas compression and metering stations and 65 gas distribution stations (of which 9 were put into operation in 2005-2007). Two main gas pipelines systems cross the territory of the Republic of Moldova, in the North: the Ananiev – Cernauti –Bogorodciani gas pipeline (transit capacity: 8.7 B. m^3/year); in the South: Sebelinka – Dneproppetrovsk – Krivoi Rog – Ismail and Razdelnaia – Ismail gas pipeline (total transit capacity: 15.8 B. m^3/year) and Ananiev – Tiraspol – Ismail gas pipeline (transit capacity: 20.0 B. m^3/year). The total capacity of the gas transit system towards the Balkans is around 43 B. m^3/year, however it is currently used at a capacity of only circa 25 B. m^3/year. Connection gas pipelines and gas distribution stations situated on the territory of the RM allow deliver around 9 B. m^3/year to the consumers in the RM, while real consumption at present is around 2.5-3.0 B. m^3/year. The RM has its own natural gas and oil resources, however quite modest. The natural gas reserves are concentrated in the settlement Victorovca, Cantemir district (the estimated amount is circa 346 million m^3), while oil reserves are in Valeni, Cahul district (the estimated amount is circa 2-3 million tones). On July 6, 1995 the Government of the Republic of Moldova has entered into a concession agreement with an American company 'Redeco' LTD to research and exploit natural gas and oil resources in the Republic of Moldova. The works started in 1997, at 8 oil wells that were drilled at 1 km depth, however, with no palpable results. The amount of gas captured from the reserves at Victorovca was around 3 thousand m^3/day, or circa 1 mln. m^3 per year. The amount of oil extracted in Valeni, was also insignificant (10 tones in 2002, 600 tones in 2003). Since 2003, the Redeco LTD business was joined by AS Petrol of the RM, which by 2004 managed to increase extraction up to 14 thousand tones of oil per year (according to information provided by the Institute of Ecology and Geography of the ASM (2004), the specific density of the oil extracted in Valeni being 941 kg/m^3). The extracted petrol is refined at Comrat refinery which has a capacity of 30 thousand tones per year, and was set into exploitation on July 15, 2005. By the end of 2006, 'Valiexchimp' LTD Company became the main partner of 'Redeco' LTD group. By the end of 2007, 'Valiexchimp' LTD founded a joint venture with the Irish 'Island Oil&Gaz plc', starting together a joint investment program in oil and natural gas extraction and refining, estimated at 12 million euro, including 44 oil wells drilling on the oil fields in Valeni and Victorovca, construction of 9 km of gas pipelines to connect the oil fields in Victorovca to 'MOLDOVAGAZ' J.S.C. network, and upgrading the oil refinery in Comrat, to make it possible to initiate production of bitumen and asphalt for road construction. On October 10th, 2007 the Government accepted 'Redeco' LTD 's leasing concession to 'Valiexchimp' LTD on all rights and obligations under the Concession Agreement for development and exploitation of oil and natural gas reserves in the Republic of Moldova as of July 6th, 1995. However, the rights and obligations of Valiexchimp LTD do not include prospecting and exploitation of oil and natural gas resources in the Republic of Moldova.

LPG are used in the RM starting 1946, and are currently sold to settlements not connected to gas networks (specific density of LPG is 584 kg/m^3). LPG is refined and supplied to consumers through filling stations having a total storing capacity of 6.9 thousand m^3.

3.7.1 Source Category Description

The 1B2b 'Fugitive Emissions from Oil and Natural Gas' category includes the GHG emissions originated from oil and natural gas distribution systems, except distribution systems of energy resources which are burnt as fuel. Distribution systems include the entire infrastructure needed to produce, collect, process, refine and distribute oil products and natural gases. Oil and natural gas systems comprise all infrastructure required to produce, collect, process or refine and deliver natural gas and petroleum products to final consumers market. The system begins at the well head, or oil and gas source, and ends at the final sales point to the consumer. The sources of fugitive emissions on oil and gas systems include equipment leaks, evaporation and flashing losses, venting, flaring, incineration and accidental releases (e.g., pipeline dig-ins, well blow-outs and spills).

In 2005, the source category 1B2 'Fugitive Emissions from Oil and Natural Gas' accounted for 5.5 percent of total national greenhouse gas emissions (except the LULUCF).

Over the period under review, GHG emissions covered by the 1B2 'Fugitive Emissions from Oil and Natural Gas' category tended to show lower values, decreasing by 4.3 percent: from 682.93 Gg CO_2 eq. in 1990 up to 653.90 Gg CO_2 eq. in 2005 (Table 3-71, Figure 3-15).

CO_2 emissions increased by 195.0 percent: from 0.6377 Gg in 1990, up to 1.8809 Gg in 2005; CH_4 emissions decreased by 4.3 percent: from 32.4902 Gg in 1990 to 31.0480 Gg in 2005, while N_2O emissions increased by circa 2950.4 percent: from 5.50E-07 Gg in 1990, up to 1.68E-05 Gg in 2005.

Table 3-71: Direct GHG Emissions from 1B2 'Fugitive Emissions from Oil and Natural Gas' in the Republic of Moldova within 1990-2005, Gg CO_2 equivalent

Years	CO_2	CH_4	N_2O	Total	Years	CO_2	CH_4	N_2O	Total
1990	0.6377	682.2942	0.000171	682.9320	1998	1.0691	465.1532	0.001479	466.2238
1991	0.6140	640.3404	0.000149	640.9545	1999	1.0225	464.0533	0.001463	465.0773
1992	0.5175	579.6756	0.000087	580.1931	2000	1.0007	502.3930	0.001455	503.3952
1993	0.4316	520.8630	0.000037	521.2946	2001	1.0231	499.1097	0.001455	500.1342
1994	0.4052	501.2999	0.000016	501.7051	2002	1.0096	541.2252	0.001454	542.2362
1995	0.4158	555.5660	0.000016	555.9818	2003	1.0657	572.2646	0.001601	573.3318
1996	0.4680	603.8655	0.000018	604.3335	2004	1.8042	615.7242	0.004954	617.5333
1997	1.1056	497.0149	0.001473	498.1220	2005	1.8809	652.0090	0.005201	653.8950

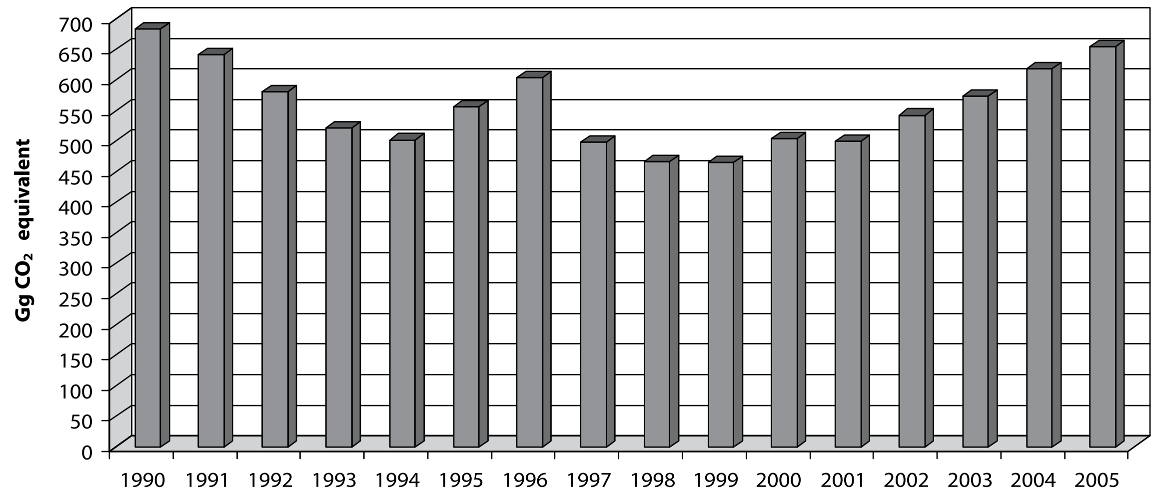

Figure 3-15: GHG Emissions from 1B2 'Fugitive Emissions from Oil and Natural Gas' Source Category in the Republic of Moldova, 1990-2005

3.7.2 Methodological Issues and Data Sources

GHG emissions originated from the 1B2 'Fugitive Emissions from Oil and Natural Gas' category were estimated following a Tier 1 methodology (IPCC, 2006). Fugitive emissions of CH_4, CO_2, NMVOC and N_2O were monitored. The basic equations used to estimate GHG emissions under this category are:

$$E_{gas,\ industry\ segment} = A_{industry\ segment} \bullet EF_{gas,\ industry\ segment}$$

$$E_{gas} = \Sigma E_{gas,\ industry\ segment}$$

Where:

$E_{gas,\ industry\ segment}$ = annual emissions (Gg);

$A_{industry\ segment}$ = activity data for the respective industry segment;

$EF_{gas,\ industry\ segment}$ = emission factor (Gg/activity unit).

Activity data related to amounts of natural gas transited across the Republic of Moldova, as well as data on amounts of natural gas and liquefied petroleum gas sold in the Republic of Moldova were provided by the S.A. MOLDOVA-GAZ (Table 3-72).

Average default emission factors values available in the 2006 IPCC Guidelines were used to estimate GHG emissions (Table 3-73).

Table 3-72: Consumption of Natural Gases and Liquefied Petroleum Gases in the Republic of Moldova in the time series from 1990 through 2005, million m[3] and kt

	1990	1991	1992	1993	1994	1995	1996	1997
Natural Gas Transited across the RM	25000	23000	21000	19000	18265	20909	22396	16934
Imported Natural Gas	3844	3873	3435	3093	3012	3005	3489	3676
Technological Losses	30	30	58	133	151	214	267	184
Natural Gas Sold	3814	3843	3377	2960	2861	2791	3222	3492
on the right bank of the Dniester	NA	NA	NA	1729	1558	1770	1883	1729
on the left bank of the Dniester	NA	NA	NA	1132	1233	1452	1609	1132
Liquefied Petroleum Gas sold, kt	145.9	128.0	75.4	30.9	14.5	14.1	15.7	19.3
	1998	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**
Natural Gas Transited across the RM	16021	16790	19170	18524	21032	22132	23625	25017
Imported Natural Gas	3333	2857	2478	2732	2420	2615	2687	2819
Technological Losses	164	155	117	90	92	103	120	103
Natural Gas Sold	3169	2702	2361	2642	2328	2512	2567	2716
on the right bank of the Dniester	1700	1221	920	1057	1052	1132	1143	1316
on the left bank of the Dniester	1469	1481	1441	1585	1276	1380	1424	1400
Liquefied Petroleum Gas sold, kt	19.8	10.2	3.4	3.1	2.9	2.1	2.8	1.7

Note: NA – Not Available; **Source:** Official Letter from S.A. MOLDOVAGAZ No. 06-1253 from 27.09.2006.

Table 3-73: Default EFs Values Used to Estimate GHG Emissions Originated from the 1B2 'Fugitive Emissions from Oil and Natural Gas' Source Category

Category	IPCC Code	CH_4	CO_2	NMVOC	N_2O	UM
		Ranges and average EFs values used				
Well drilling	1B2a	33-560 296.5	100-1700 900	0.87-15.0 7.935	-	kg/well/year
Well testing	1B2a	51-850 450.5	9000-150000 79500	12-200 106	0.068-1.1 0.584	kg/well/year
Well servicing	1B2a	110-1800 955	1.9-32.0 17.0	17-2800 1408.5	-	kg/well/year
Fugitives from oil production	1B2a	2-60000 30000	0.1-4300 2150	1.8-75000 37500.9	-	$kg/10^3m^3$/ year
Fugitives from natural gas	1B2b	380-24000 12190	14-180 97	91-1200 645.5	-	$kg/10^6m^3$/ year
Fugitives from natural gas transportation	1B2b	166-1100 633	0.88-2.00 1.44	7.0-16.0 11.5	-	$kg/10^6m^3$/ year
Fugitives from natural gas distribution	1B2b	1100-2500 1800	51-140 95.5	16-36 26	-	$kg/10^6m^3$/ year
Fugitives from liquefied petroleum gas transportation	1B2b	-	430	-	0.0022	$kg/10^3m^3$/ year
Flaring at natural gas production	1B2c	0.76-1.00 0.88	1200-1600 1400	0.62-0.85 0.74	0.021-0.029 0.025	$kg/10^6m^3$/ year
Ventilation at natural gas transportation	1B2c	44-740 392	3.1-7.3 5.2	4.6-11.0 7.8	-	$kg/10^6m^3$/ year
Ventilation at oil extraction	1B2c	720-990 855	95-130 112.5	430-590 510	-	$kg/10^3m^3$/ year
Flaring at oil production	1B2c	25-34 30	41000-56000 48500	21-29 25	0.64-0.88 0.76	$kg/10^3m^3$/ year
Oil transportation in tanks	1B2c	25	2.3	250	-	$kg/10^3m^3$/ year

Source: 2006 IPCC Guidelines, Vol. 2, Chap. 4, Tab. 4.2.5, Pages 4.59-4.67.

Lately the coverage of population under the gas supply network has been showing an increasing trend: the length of natural gas distribution networks increased by 6.7 times over the 1990-2005 time periods (Table 3-74).

Table 3-74: Length of Natural Gas Distribution Networks (status as of 01.01.2006)

	1990	1991	1992	1993	1994	1995	1996	1997
Total networks length, km	1873.4	2868.0	2040.6	2227.6	2597.3	4305.8	4696.0	5490.4
	1998	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**
Total networks length, km	6427.3	7137.7	7470.9	7926.2	8627.9	9509.2	10835.1	12465.0

Source: Statistical Yearbooks of the RM for 1994 (page 315), 1999 (page 218) and 2006 (page 154).

In conformity with Gasification Program of the RM until 2010, it is planned to extend the main gas pipelines network (by 186 km), connection pipelines (by 365 km), interurban pipelines (by 6265 km), with 20 natural gas distribution plants and 7 metering stations. The Program comprises three phases: (i) gasification of district towns (accomplished by the end of 2004); (ii) assembling pipelines at the border of all settlements (will be finalized at the end of 2009); (iii) gasification of all final consumers (to be finalized at the end of 2010). In 2000 year natural gas was supplied to 175 settlements, in 2001 year – to 26, in 2002 year – to 28, in 2003 year – to 68, in 2004 year – to 120, in 2005 year – to 143, in 2006 year – to 113 and in 2007 year – to 80 settlements. So, by 01.12.2007, of 1528 settlements existing in the country 787 settlements, or 52 percent, were gasified.

3.7.3 Uncertainties and Time-Series Consistency

The primary uncertainties related factors pertain to methodology, emission factors used to estimate GHG emissions covered by the source category 1B2 'Fugitive Emissions from Oil and Natural Gas', and quality of activity data available.

Uncertainties associated with emission factors used to estimate GHG emissions (CO_2, CH_4, NMVOC and N_2O) originated from the 1B2 'Fugitive Emissions from Oil and Natural Gas' source category were estimated at circa ±200 percent. Uncertainties related to activity data pertaining to fuel consumption is relatively low (±5 percent). So, the uncertainties related to GHG emissions covered by the 1B2 'Fugitive Emissions from Oil and Natural Gas' source category were estimated at ±200.06 percent.

The combined uncertainties presented as a percent of total sectoral emissions were estimated at ±0.0465 percent for CO_2 emissions, ±16.1349 percent for CH_4 and ±0.0001 percent for N_2O emissions. Uncertainties introduced in trend in sectoral emissions were estimated at ±0.0099 percent for CO_2 emissions, at ±2.8304 percent for CH_4 emissions, and at ±0.00003 percent for N_2O emissions (see Annex 7-3.1).

In view of ensuring time-series consistency of the obtained results, the same approach was used for the entire period under review, in conformity with the recommendations included in the Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories (IPCC, 2000).

3.7.4 QA/QC and Verification

Standard verification and quality control forms and checklists were filled in for the respective source category under the Energy Sector, following the Tier 1 and Tier 2 approaches (see in Annex 6). Also, the AD and methods used for estimating GHG emissions under the category 1B2 'Fugitive Emissions from Oil and Natural Gas' were documented and archived both in hard copies and electronically. For identifying the data entry and emission estimation process related errors there were applied verifications and quality control procedures. Verification was focused on correct use of AD obtained from different sources of reference (i.e., "MOLDOVAGAZ" J.S.C. and National Bureau of Statistics), as well as on ensuring correct use of the default emission factors available in the 2006 IPCC Guidelines (IPCC, 2006). Inventory QA activity for the Energy Sector, inclusive for the 1B2 'Fugitive Emissions from Oil and Natural Gas', was supported by an expert representing the Institute of Energy of the ASM.

Following the recommendations included into the Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories (IPCC, 2000), GHG emissions originated from the 1B2 'Fugitive Emissions from Oil and Natural Gas' were estimated based on AD and EFs from official sources of reference.

3.7.5 Recalculations

GHG emission recalculations performed under the 1B2 'Fugitive Emissions from Oil and Natural Gas' are due to the availability of an updated set of activity data pertaining to the amounts of natural gas transited the territory of the RM towards the Balkan countries, as well as activity data pertaining to amounts of natural gas sold in the RM ("MOLDOVA-GAZ" J.S.C. and National Bureau of Statistics), also due to updated methodologies available in the 2006 IPCC Guidelines, which has replaced the methodologies contained into the Revised 1996 IPCC Guidelines (IPCC, 1997) used under the FNC (2000).

In comparison with the results included into the FNC, the performed recalculations under the 1B2 'Fugitive Emissions from Oil and Natural Gas' sources category resulted in variation of the GHG emissions values for the 1998-1998, from a maximum reduction by 36.7 percent in 1990 to a maximum increase by 5.1 percent in 1995. Between 1990 and 2005, the GHG emissions originated from 1B2 'Fugitive Emissions from Oil and Natural Gas' source category decreased by 4.3 percent (Table 3-75).

Table 3-75: Comparative Results of GHG Emissions from 1B2 Source Category Included into the FNC and SNC of the RM under the UNFCCC, Gg CO_2 eq.

	1990	1991	1992	1993	1994	1995	1996	1997
FNC	1079.44	925.37	814.59	501.35	648.84	529.18	590.33	588.00
SNC	682.93	640.95	580.19	521.29	501.71	555.98	604.33	498.12
Difference, %	-36.7	-30.7	-28.8	4.0	-22.7	5.1	2.4	-15.3
	1998	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**
FNC	500.51							
SNC	466.22	465.08	503.40	500.13	542.24	573.33	617.53	653.90
Difference, %	-6.9							

Over the period under review the GHG emissions originated from the source category 1B2 'Fugitive Emissions from Oil and Natural Gas' increased significantly: the N_2O emissions increased by 2950.4 percent, while the NMVOC emissions by 103.3 percent (Table 3-76). As an exception, CH_4 emissions decreased by 4.4 percent over the respective period (1990-2005), first of all due to smaller amount of natural gases being transported and distributed on the territory of the Republic of Moldova.

Table 3-76: Non-CO_2 Emissions from the 1B2 'Fugitive Emissions from Oil and Natural Gas' Source Category in the Republic of Moldova within 1990-2005, Gg

GHG	1990	1991	1992	1993	1994	1995	1996	1997
CH_4	32.4902	30.4924	27.6036	24.8030	23.8714	26.4552	28.7555	23.6674
N_2O	5.50E-07	4.80E-07	2.80E-07	1.20E-07	5.00E-08	5.30E-08	5.90E-08	4.75E-06
NMVOC	0.5817	0.5438	0.4931	0.4437	0.4269	0.4761	0.5160	0.4183
GHG	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**
CH_4	22.1502	22.0978	23.9238	23.7671	25.7726	27.2507	29.3202	31.0480
N_2O	4.77E-06	4.72E-06	4.69E-06	4.69E-06	4.69E-06	5.17E-06	1.60E-05	1.68E-05
NMVOC	0.3923	0.3950	0.4321	0.4269	0.4672	0.5255	1.0973	1.1823

3.7.6 Planned Improvements

The process of monitoring GHG emissions originated from the source category 1B2 'Fugitive Emissions from Oil and Natural Gas' can be improved significantly once a more advanced, Tier 2 or Tier 3 methodology is followed, and default EFs values are replaced by country specific values.

The possibility to work more closely with the national operator in natural gas sector "MOLDOVAGAZ" J.S.C. shall be considered for the next inventory cycle, to collect additional information that can be used to reduce the inventory uncertainties resulted from the 1B2 'Fugitive Emissions from Oil and Natural Gas' source category.

3.8 International Bunkers: Aviation (Memo Items)

3.8.1 Source Category Description

GHG emissions from International Bunkers: Aviation (Memo Items) comes from the combustion of jet fuel used in the international air transport. In the Republic of Moldova, international air transport includes jet propelled aircrafts using jet kerosene.

The largest share in total emissions from international aviation is covered by CO_2 (70 percent), less than 30 percent of total emissions by water vapours and as little as circa 1 percent by other gases (NO_x, CO, NMVOC and SO_2). Methane and nitrous oxide emissions are insignificant (it is considered that modern engines emit little or no CH_4, in particular, during the cruise cycle) (IPCC, 2006). Operations of aircraft are divided into two phases: (i) *Landing/Take-Off (LTO)* occurring at altitudes lower than 914 meters and (ii) *Cruise* (C), occurring at altitudes higher than 914 meters. Generally, about 10 percent of all type aircraft emissions are produced during airport ground level operations and during the LTO (landing/take-off) phase of the flight, while the bulk of aircraft emissions (90 percent) occur at higher altitudes. For NMVOC and CO, the split is closer to 30 percent for LTO phase of the flight and 70 percent for cruise phase of the flight.

Between the 1990 and 2005, GHG emissions covered from the 'International Bunkers: Aviation' (Memo Items) decreased by 70.7 percent: from 220.43 Gg CO_2 eq. in 1990 to 64.64 Gg CO_2 eq. in 2005 (Figure 3-16, Table 3-77).

CO_2 emissions decreased by 70.6 percent: from 217.37 Gg in 1990 to 63.96 Gg in 2005; CH_4 emissions: by 97.7 percent: from 0.90 Gg in the baseline year to 0.02 Gg in 2005, while N_2O emissions: by 69.4 percent: from 2.16 Gg in 1990 to 0.66 Gg in 2005.

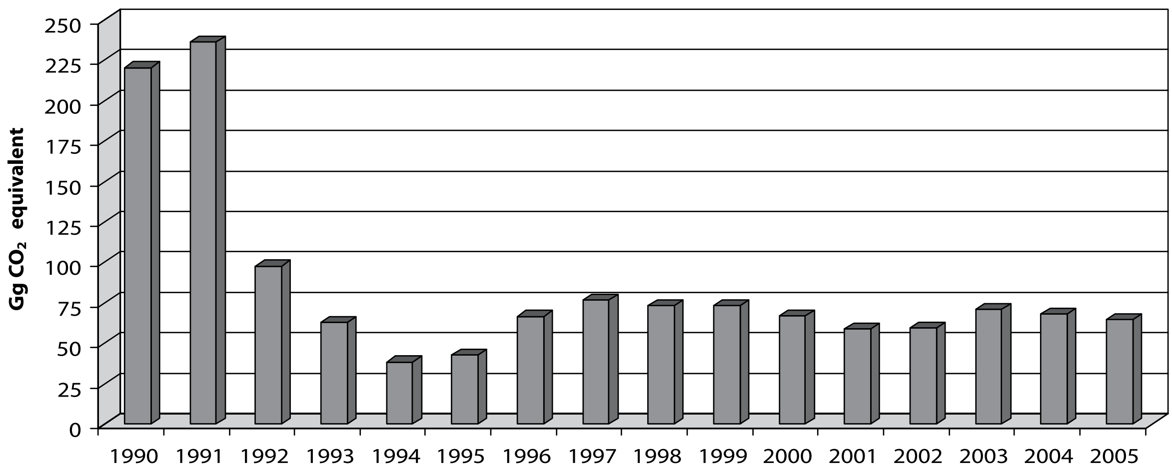

Figure 3-16: GHG Emissions from 'International Bunkers: Aviation' (Memo Items) in the Republic of Moldova, 1990-2005

Table 3-77: Direct GHG Emissions from 'International Bunkers: Aviation' (Memo Items) in the Republic of Moldova within 1990-2005, Gg CO_2 equivalent

Years	CO_2	CH_4	N_2O	Total	Years	CO_2	CH_4	N_2O	Total
1990	217.3668	0.9036	2.1560	220.4264	1998	72.4974	0.0976	0.7274	73.3224
1991	232.8115	1.0222	2.3076	236.1412	1999	72.4938	0.0920	0.6694	73.2552
1992	96.2635	0.3964	0.9551	97.6150	2000	66.1989	0.0851	0.6663	66.9503
1993	62.0927	0.2083	0.6162	62.9173	2001	58.1538	0.0668	0.5895	58.8101
1994	37.8235	0.1218	0.3755	38.3208	2002	58.6473	0.0623	0.5953	59.3049
1995	41.9185	0.1267	0.4161	42.4613	2003	70.0426	0.0511	0.7093	70.8030
1996	65.8650	0.1007	0.6555	66.6212	2004	67.2294	0.0375	0.6865	67.9534
1997	75.6443	0.1148	0.7567	76.5157	2005	63.9592	0.0203	0.6589	64.6384

3.8.2 Methodological Issues and Data Sources

GHG emissions from the International Bunkers: Aviation (Memo Items) was estimated using a Tier 2 methodological approach. Unlike Tier 1 methodology requiring only activity data on fuel consumption and default EFs values, the Tier 2 methodology can be applied only on the availability of activity data on the number of flights by each type of aircraft used in the international air transport, and the amount of fuels used for LTO and Cruise phases of the flights.

The basic equations used to estimate emissions are as follows:
Total Emissions = LTO Emissions + Cruise Emissions
Where:

LTO Emissions = Number of LTOs • Emission Factor $_{LTO}$

LTO Fuel Consumption = Number of LTOs • Fuel Consumption per LTO

Cruise Emissions = (Total Fuel Consumption – LTO Fuel Consumption) • Emission Factor $_{Cruise}$

Emission factors available in the Revised 1996 IPCC Guidelines (IPCC, 1997), as well as in 2006 IPCC Guidelines were used to estimate GHG emissions originated from this source category (Table 3-78 and 3-79).

Table 3-78: Default Emission Factors Available in the Revised 1996 IPCC Guidelines, Used to Estimate GHG Emissions from International Aviation

	CO_2	CH_4	N_2O	NO_X	CO	NMVOC	SO_2
New aircraft types: LTO (kg/LTO)	7900	1.5	0.2	41	50	15	2.5
Old aircraft types: LTO (kg/LTO)	7560	7	0.2	23.6	101	66	2.4
All aircraft types: cruise phase of flight (kg/t)	3150	0	0.1	17	5	2.7	1.0

Source: Revised 1996 IPCC Guidelines, Vol. 3, Table 1-52, Page 1.98

Thus, to estimate emissions from cruise phase of the flight, mostly emission factors available in the Revised 1996 IPCC Guidelines (IPCC, 1997) were used, while for LTO phase of the flight as well as for NO_x there were used the EFs values available in the 2006 IPCC Guidelines.

To be noted that the 2006 IPCC Guidelines does not cover emission factors for all types of aircraft used in the Republic of Moldova within the international air transport. So for some of them it was necessary to use emission factors specific to other similar group aircrafts (jet or turbo prop aircrafts), taking into account the engine type used.

Table 3-79: Default Emission Factors Available in the 2006 IPCC Guidelines, Used to Estimate GHG Emissions from International Bunkers: Aviation (Memo Items)

Aircraft used in the RM	Consumption tons per LTO	CO_2, kg/LTO	CH_4, kg/LTO	N_2O, kg/LTO	NO_x		CO, kg/LTO	NMVOC, kg/LTO	SO_2, kg/LTO
					LTO, Kg/LTO	Cruise, kg/tons			
TU-154-B	2.23	7030	11.90	0.20	14.33	9.10	143.05	107.13	2.22
TU-134	0.93	2930	1.80	0.10	8.68	8.50	27.98	16.19	0.93
IL-76	2.31	7300	7.40	0.20	31.64	15.70	103.33	66.56	2.31
IAK-42	0.91	2880	0.25	0.10	10.66	15.60	10.22	2.27	0.91
A320	0.77	2440	0.06	0.10	9.01	12.90	6.19	0.51	0.77
B707	1.86	5890	9.75	0.20	10.96	5.90	92.37	87.81	1.86
B737-100/200	0.87	2740	0.45	0.10	6.74	8.70	16.04	4.06	0.87
B747-100	3.21	10140	4.84	0.30	49.17	15.50	114.59	43.59	3.21
B757-300	1.46	4630	0.01	0.10	17.85	9.80	11.62	0.10	1.46
L-410	2.31	7300	7.40	0.20	31.64	15.70	103.33	66.56	2.31
MD-83	1.01	3180	0.19	0.10	11.97	12.40	6.46	1.69	1.01
RJ-RJ85	0.60	1910	0.13	0.10	4.34	15.60	11.21	1.21	0.60
BAE-146	0.57	1800	0.14	0.10	4.07	8.40	11.18	1.27	0.57
CRJ-100ER	0.33	1060	0.06	0.03	2.27	8.00	6.70	0.56	0.33
ERJ-145	0.31	990	0.06	0.03	2.69	7.90	6.18	0.50	0.31
F-100/70/28	0.76	2390	0.14	0.10	5.75	8.40	13.84	1.29	0.76
BAC-561RC	0.80	2520	0.15	0.10	7.40	12.00	13.07	1.36	0.80
ATR-42	0.20	620	0.03	0.02	1.82	14.20	2.33	0.26	0.20
SF-340B	0.68	2160	0.14	0.10	5.63	8.00	8.88	1.23	0.68
Saab 2000	0.60	1890	0.03	0.10	5.58	9.50	8.42	0.28	0.60
LEAR-35	0.34	1070	0.33	0.03	0.74	7.20	34.07	3.01	0.34

Over the period under review the aircraft park used in the Republic of Moldova for international air transport has essentially changed its structure (Table 3-80). Before 1995, mostly aircrafts produced in the former CIS region were used (TU-154, TU-134, IL-76, IL-18, YAK-40, YAK-42, AN-12, AN-24, AN-26, AN-32, AN-72 etc.), but by 2005 the share of these aircrafts in international air transport in the Republic of Moldova decreased to 21.5 percent, the rest 78.5 percent being represented by aircrafts produced in other regions of the world, such as: Airbus A-320 (27.1 percent from the total), Saab 2000 (25.8 percent), Embraer EMB-120 (18.8 percent), Canadair Regional Jet CRJ-200 (8.2 percent), Boeing 737-300 (7.1 percent), British Aerospace BAE-146 (5.8 percent), Avions de Transport Règional ATR-42 (4.6 percent), Saab Fairchild SF-340B (1.5 percent) etc.

Table 3-80: Number of International Flights made by Aircrafts from the RM, 1990-2005

	1990	1991	1992	1993	1994	1995	1996	1997
Flights with aircrafts from CIS	17758	19020	7864	4495	2738	2809	3585	4142
Flights with other aircrafts	0	0	0	0	0	20	34	576
Total flights performed	17758	19020	7864	4495	2738	2829	3619	4718
	1998	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**
Flights with aircrafts from CIS	3999	3751	3791	2878	3086	2167	1397	1197
Flights with other aircrafts	872	877	971	2054	2119	2583	3981	4368
Total flights performed	4871	4628	4762	4932	5205	4750	5378	5565

Source: Civil Aviation State Administration of the Republic of Moldova, Official Letter No. 3978 from 02.10.2006

AD related to the consumption of fuel for international aviation was provided by the Civil Aviation State Administration (CASA). There were revealed certain discrepancies between data on aviation kerosene consumption for international aviation included in the Energy Balances of the RM for 1990 and 1993-2005 and data provided by the CASA (for some years the difference is of magnitude 2) (Table 3-81). Under such circumstances, in order to estimate GHG emissions from 'International Bunkers: Aviation' (Memo Items), it was decided to use data provided by the CASA, as deemed to be more precise.

Table 3-81: Aviation Kerosene Consumption for International Aviation in the Republic of Moldova within 1990-2005, kt

	1990	1991	1992	1993	1994	1995	1996	1997
Data available in the EBs	69.000	NA	NA	19.700	11.000	11.000	18.000	21.000
Data provided by CASA	68.960	73.860	30.540	19.700	12.000	13.300	20.900	24.000
Difference, %	-0.1	NA	NA	0.0	9.1	20.9	16.1	14.3
	1998	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**
Data available in the EBs	17.000	20.000	20.000	16.000	19.000	11.000	11.000	12.000
Data provided by CASA	23.000	23.000	21.000	18.444	18.599	22.219	21.325	20.286
Difference, %	35.3	15.0	5.0	15.3	-2.1	102.0	93.9	69.1

3.8.3 Uncertainties and Time-Series Consistency

The primary uncertainties related factors pertain to methodology, emission factors used to estimate GHG emissions covered by the 'International Bunkers: Aviation' (Memo Items), and quality of activity data available.

Uncertainties associated with EFs used to estimate CO_2 emissions from the 'International Bunkers: Aviation' (Memo Items), were estimated at ±5 percent, those pertaining to EFs used to estimate CH_4 emissions reach up to ±75 percent, while those related to EFs used to estimate N_2O emissions reach up to ±100 percent. Uncertainties associated with statistical data regarding aviation kerosene consumption and number of flights made by aircrafts of the Republic of Moldova is deemed to be relatively low (±10 percent). Uncertainties pertaining to GHG emissions from the 'International Bunkers: Aviation' (Memo Items) were estimated at ±11.18 percent for CO_2 emissions, ±75.66 percent for CH_4 emissions and ±100.50 percent for N_2O. At the same time, combined uncertainties, presented as a percent of total sectoral emissions were estimated at 0.0885 percent for CO_2 emissions, 0.0002 percent for CH_4 emissions, and 0.0082 percent for N_2O. Uncertainties introduced in trend in sectoral emissions were estimated at ±0.0260 percent for CO_2 emissions, at ±0.0004 percent for CH_4 emissions, and at ±0.0005 percent for N_2O emissions (see Annex 7-3.1).

In view of ensuring time-series consistency of the obtained results, the same approach was used for the entire period under review, in conformity with the recommendations included in the Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories (IPCC, 2000).

3.8.4 QA/QC and Verification

Standard verification and quality control forms and checklists were filled in for the respective source category, following the Tier 1 and Tier 2 approaches (see in Annex 6). Also, the AD and methods used for estimating GHG emissions under the category 'International Bunkers: Aviation' (Memo Items) were documented and archived both in hard copies and electronically. For identifying the data entry and emission estimation process related errors there were applied verifications and quality control procedures. Verification was focused on correct use of AD obtained from different sources of reference (i.e., Energy Balances, Statistical Yearbooks of the RM, Civil Aviation State Administration and National Bureau of Statistics), as well as on ensuring correct use of the default emission factors available in the Revised 1996 IPCC Guidelines (IPCC, 1997), GPG (IPCC, 2000) and 2006 IPCC Guidelines (IPCC, 2006). Inventory QA activities for the Energy Sector, inclusive for the 'International Bunkers: Aviation' (Memo Items), were supported by an expert representing the Institute of Energy of the ASM.

Following the recommendations included into the Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories (IPCC, 2000), GHG emissions originated from the 'International Bunkers: Aviation' (Memo Items) were estimated based on AD and EFs from official sources of reference.

3.8.5 Recalculations

GHG emission recalculations performed under the 'International Bunkers: Aviation' (Memo Items) are due to the availability of an updated set of activity data on aviation kerosene consumption and number of flights made by the aircrafts of the RM (Statistical Yearbooks of the RM, Energy Balances, and other relevant sources, such as Civil Aviation State Administration), also due to updated methodologies available in the 2006 IPCC Guidelines, which has complemented the methodologies contained into the Revised 1996 IPCC Guidelines (IPCC, 1997) used under the FNC (2000), as well as due to use of higher tier methodologies (Tier 2 instead of Tier 1).

In comparison with the results included into the FNC for the 1998-1998, the performed recalculations under the 'International Bunkers: Aviation' (Memo Items) resulted in GHG emission variation values, varying from an insignificant reduction by 0.2 percent within 1990-1991 time period, to a maximum increase by 89.7 percent in 1996 (Table 3-82). Between 1990 and 2005, the GHG emissions originated from 'International Bunkers: Aviation' (Memo Items) decreased by 70.7 percent.

Non-CO_2 emissions originated from 'International Bunkers: Aviation' (Memo Items) has significantly decreased over the same period. Between 1990 and 2005, CH_4 emissions decreased by 97.7 percent, N_2O emissions – by 69.4 percent, NO_x – by 71.7 percent, CO – by 84.8 percent, NMVOC – by 89.7 percent, and SO_2 – by 70.6 percent (Table 3-83).

3.8.6 Planned Improvements

The process of monitoring GHG emissions originated from the 'International Bunkers: Aviation' (Memo Items) can be improved significantly once the country specific emission factors by types of aircrafts used in the Republic of Moldova for international air transport (both in landing/take off and cruise phases of the flights) are updated.

Table 3-82: Comparative Results of GHG Emissions from 'International Bunkers: Aviation' Included into the FNC and SNC of the RM under the UNFCCC, Gg

	1990	1991	1992	1993	1994	1995	1996	1997
FNC	217.7849	233.2508	94.6891	61.5479	37.8756	34.7193	34.7193	64.3886
SNC	217.3668	232.8115	96.2635	62.0927	37.8235	41.9185	65.8650	75.6443
Difference, %	-0.2	-0.2	1.7	0.9	-0.1	20.7	89.7	17.5
	1998	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**
FNC	64.0730							
SNC	72.4974	72.4938	66.1989	58.1538	58.6473	70.0426	67.2294	63.9592
Difference, %	13.1							

Table 3-83: Non-CO_2 Emissions from the 'International Bunkers: Aviation' (Memo Items) in the Republic of Moldova within 1990-2005, Gg

GHG	1990	1991	1992	1993	1994	1995	1996	1997
CH_4	0.0430	0.0487	0.0189	0.0099	0.0058	0.0060	0.0048	0.0055
N_2O	0.0070	0.0074	0.0031	0.0020	0.0012	0.0013	0.0021	0.0024
NO_x	0.7949	0.8447	0.3512	0.2331	0.1433	0.1573	0.2556	0.2921
CO	0.8733	0.9641	0.3847	0.2215	0.1323	0.1413	0.1687	0.1965
NMVOC	0.5202	0.5792	0.2288	0.1293	0.0766	0.0820	0.0901	0.1020
SO_2	0.0689	0.0738	0.0305	0.0197	0.0120	0.0133	0.0209	0.0240

GHG	1998	1999	2000	2001	2002	2003	2004	2005
CH_4	0.0046	0.0044	0.0041	0.0032	0.0030	0.0024	0.0018	0.0010
N_2O	0.0023	0.0022	0.0021	0.0019	0.0019	0.0023	0.0022	0.0021
NO_x	0.2802	0.2641	0.2528	0.1997	0.2072	0.2336	0.2272	0.2247
CO	0.1828	0.1693	0.1657	0.1447	0.1443	0.1552	0.1469	0.1331
NMVOC	0.0919	0.0862	0.0818	0.0683	0.0661	0.0725	0.0639	0.0537
SO_2	0.0230	0.0213	0.0210	0.0177	0.0186	0.0222	0.0213	0.0203

3.9 CO_2 Emissions from Biomass (Memo Items)

3.9.1 Source Category Description

Under Memo Items there are also monitories the CO_2 emissions from biomass. In conformity with recommendations provided in the Revised 1996 IPCC Guidelines (IPCC, 1997), GHG emissions from biomass shall be estimated under each individual source category of the Energy Sector: non-CO_2 emissions shall be reported under the respective source category, while CO_2 emissions shall be reported separately, under 'Memo Items', being not included into the national totals.

The Energy Balances of the RM keep account of the following type of biomass: fuel wood (data are provided in thousand m^3: expressing wood in cubic meters is accomplished by multiplying the number of cubic meters by conversion factor 0.73); wood waste (data are provided in thousand tones of coal equivalent: the conversion factors for one metric tone of fuel into one tone of coal equivalent are: for bark – 0.42, shavings – 0.05, saw dust – 0.36 and wood processing waste – 0.12); agricultural crop residues (data are provided in thousand tones of coal equivalent: the conversion factors for one metric tone of fuel into one tone of coal equivalent are: for straw, seed shells – 0.5, for maize cobs – 0.33). The main consumer of biomass in the RM is the residential sector.

Between 1990 and 2005, the CO_2 emissions from Biomass (Memo Items) in the Republic of Moldova showed a raising trend, increasing by circa 39.9 percent: from 210,83 Gg in 1990 up to 295.04 Gg in 2005 (Figure 3-17).

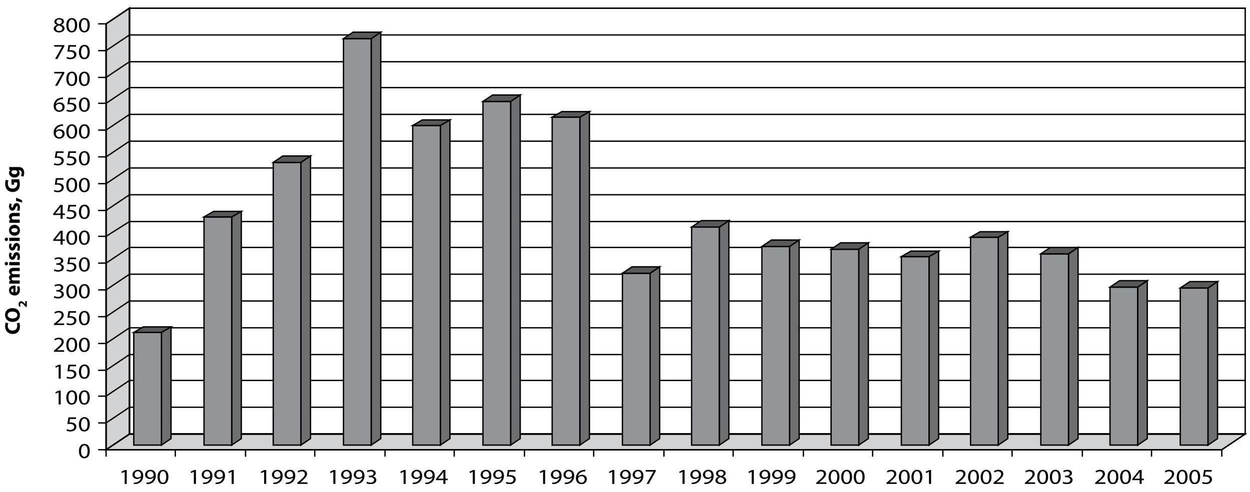

Figure 3-17: CO_2 Emissions from Biomass (Memo Items) in the Republic of Moldova, 1990-2005

3.9.2 Methodological Issues and Data Sources

CO_2 emissions from biomass were estimated following a Tier 1 methodological approach, available in the Revised 1996 IPCC Guidelines (IPCC, 1997), Vol.3, Chap. 1.4.3; as well as in the 2006 IPCC Guidelines, Vol.2, Chap. 2.3.3.4 (IPCC, 2006).

The basic equations used to estimate CO_2 emissions from biomass are:

CO_2 Emissions (Wood) = fuel consumption (thousand m^3) • conversion factor in natural units (t/m^3) • conversion factor in energy units (TJ/kt) • carbon emission factor (tC/TJ) –carbon stored • fraction oxidized • 44/12

CO_2 emissions (Agricultural Waste) = fuel consumption (thousand t.c.e.) • conversion factor in natural units (t/t.c.e.) • conversion factor in energy units (TJ/kt) • carbon emission factor (t C/TJ) –carbon stored • fraction oxidized • 44/12

Where: 1 m^3 fuel wood – 0.73 t; 1 tone of agricultural residues – 0.50 t.c.e.; 1 t.c.e. – 2 t of agricultural residues; 1 kt of fuel wood – 12.32 TJ; 1 kt of agricultural residues – 14.67 TJ; Fuel Wood Carbon EF – 30.5 t C/TJ; Agricultural Residues Carbon EF – 27.3 t C/TJ.

Activity data pertaining to biomass consumption in such sectors of national economy as energy, industry, commercial/institutional, residential, agriculture/forestry/fishing, and other needs and works in energy sector have been collected from the Energy Balances of the RM for 1990 and for 1993-2005 (no EB were compiled in 1991 and 1992) (Table 3-84).

Table 3-84: Biomass Consumption in the RM within 1990-2005, kt

	1990						
	1A1	**1A2**	**1A4a**	**1A4b**	**1A4c**	**1A5**	**1A**
Fuel wood	0.73	10.95	27.01	89.64	2.92	3.65	134.90
Agricultural crop residues	3.00	6.00	0	8.00	0	0	17.00
	1991						
	1A1	**1A2**	**1A4a**	**1A4b**	**1A4c**	**1A5**	**1A**
Fuel wood	-	-	-	293.1	-	-	293.1
Agricultural crop residues	-	-	-	-	-	-	-
	1992						
	1A1	**1A2**	**1A4a**	**1A4b**	**1A4c**	**1A5**	**1A**
Fuel wood	-	-	-	385.51	-	-	385.51
Agricultural crop residues	-	-	-	-	-	-	-
	1993						
	1A1	**1A2**	**1A4a**	**1A4b**	**1A4c**	**1A5**	**1A**
Fuel wood	0.44	6.13	10.22	514.87	0.80	0.95	533.41
Agricultural crop residues	3.40	4.60	0.40	10.00	0.20	0.80	19.40
	1994						
	1A1	**1A2**	**1A4a**	**1A4b**	**1A4c**	**1A5**	**1A**
Fuel wood	0.73	0.73	9.49	392.81	1.46	2.19	407.41
Agricultural crop residues	10.00	2.00	0	14.00	0	0	26.00
	1995						
	1A1	**1A2**	**1A4a**	**1A4b**	**1A4c**	**1A5**	**1A**
Fuel wood	0.73	2.92	11.68	435.66	2.19	3.65	456.83
Agricultural crop residues	3.00	0	0	7.00	0	1.00	11.00
	1996						
	1A1	**1A2**	**1A4a**	**1A4b**	**1A4c**	**1A5**	**1A**
Fuel wood	0.73	2.92	16.06	407.27	1.46	2.19	430.63
Agricultural crop residues	3.00	0	1.00	15.00	0	2.00	15.00
	1997						
	1A1	**1A2**	**1A4a**	**1A4b**	**1A4c**	**1A5**	**1A**
Fuel wood	0.73	2.92	11.68	199.00	1.46	4.38	220.17
Agricultural crop residues	2.00	0	0	10.00	0	1.00	13.00
	1998						
	1A1	**1A2**	**1A4a**	**1A4b**	**1A4c**	**1A5**	**1A**
Fuel wood	1.46	1.46	12.41	269.81	1.46	2.92	289.52
Agricultural crop residues	1.00	0	0	6.00	0	0	7.00
	1999						
	1A1	**1A2**	**1A4a**	**1A4b**	**1A4c**	**1A5**	**1A**
Fuel wood	0.73	0.73	7.30	243.16	1.46	0.73	254.11
Agricultural crop residues	1.00	0	0	11.00	0	4.00	16.00

	2000						
	1A1	1A2	1A4a	1A4b	1A4c	1A5	1A
Fuel wood	0	0.73	8.78	232.85	0.763	3.615	246.74
Agricultural crop residues	2.00	0	0	17.00	0	0	19.00
	2001						
	1A1	1A2	1A4a	1A4b	1A4c	1A5	1A
Fuel wood	0	0.73	11.68	211.04	1.46	3.65	228.56
Agricultural crop residues	5.00	0	0	20.00	0	1.00	26.00
	2002						
	1A1	1A2	1A4a	1A4b	1A4c	1A5	1A
Fuel wood	0.73	0.73	14.60	234.55	1.46	2.92	254.99
Agricultural crop residues	8.00	0	0	17.00	0	1.00	26.00
	2003						
	1A1	1A2	1A4a	1A4b	1A4c	1A5	1A
Fuel wood	0.73	1.46	37.23	183.96	1.46	2.19	227.03
Agricultural crop residues	8	0	5	18	0	1	32
	2004						
	1A1	1A2	1A4a	1A4b	1A4c	1A5	1A
Fuel wood	0.73	0.73	21.9	156.22	0.73	2.92	182.5
Agricultural crop residues	12.00	1	0	15.00	0	1.00	32
	2005						
	1A1	1A2	1A4a	1A4b	1A4c	1A5	1A
Fuel wood	0	0.73	19.71	159.14	0.73	2.92	183.23
Agricultural crop residues	9.00	1	1	17.00	0	1.00	29

3.9.3 Uncertainties and Time-Series Consistency

The primary uncertainties related factors pertain to methodology, emission factors used to estimate CO_2 emissions from biomass, and quality of activity data available.

Uncertainties associated with emission factors used to estimate CO_2 emissions from biomass (Memo Items) were estimated at ±20 percent. Uncertainties associated with statistical data regarding biomass consumption in the RM are quite high (±75 percent), inclusive due to incomplete monitoring of biomass consumption within the residential sector, in particular in rural areas of the country. Uncertainties pertaining to CO_2 emissions from biomass (Memo Items) were estimated at ±77.62 percent. At the same time, combined uncertainties, presented as a percent of total sectoral emissions were estimated at 2.8327 percent. Uncertainties introduced in trend in sectoral emissions were estimated at ±0.5799 percent (see Annex 7-3.1).

In view of ensuring time-series consistency of the obtained results, the same approach was used for the entire period under review, in conformity with the recommendations included in the Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories (IPCC, 2000).

3.9.4 QA/QC and Verification

Standard verification and quality control forms and checklists were filled in for the respective source category under the Energy Sector, following the Tier 1 and Tier 2 approaches (see in Annex 6). Also, the AD and methods used for estimating CO_2 emissions from biomass (Memo Items) were documented and archived both in hard copies and electronically. For identifying the data entry and emission estimation process related errors there were applied verifications and quality control procedures. Verification was focused on correct use of AD obtained from different sources of reference, as well as on ensuring correct use of the default emission factors available in the Revised 1996 IPCC Guidelines (IPCC, 1997), GPG (IPCC, 2000) and 2006 IPCC Guidelines (IPCC, 2006). Inventory QA activities for the Energy Sector, inclusive for the CO_2 emissions from biomass (Memo Items), were supported by an expert representing the Institute of Energy of the ASM.

Following the recommendations included into the Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories (IPCC, 2000), CO_2 emissions from biomass (Memo Items) were estimated based on AD and EFs from official sources of reference.

3.9.5 Recalculations

The estimates of CO_2 emissions from biomass (Memo Items) for the 1990-1998 time period were recalculated, in particular as a result of completing and updating the activity data pertaining to biomass consumption in RM; due to use of country specific conversion factors (from natural units into energy units) and NCVs (i.e., within the SNC there were used the values of 12.32 TJ/kt for fuel wood and 14.67 TJ/kt for agricultural residues, replacing the default NCVs used in the FNC, 13.92 TJ/thousand m^3 for fuel wood), as well as by changing the carbon oxidation factor (in FNC – 0.98, in the SNC – 1.0).

In comparison with the results included into the FNC, the performed recalculations under the CO_2 emissions from biomass (Memo Items) resulted in variations values of CO_2 emission estimates for the 1998-1998, varying from a maximal reduction by 50.3 percent in 1990, to a maximal increase by 97.7 percent in 1993. Between 1990 and 2005, the CO_2 emissions from biomass increased by 39.9 percent (Table 3-85).

3.9.6 Planned Improvements

The process of monitoring CO_2 emissions from biomass can be improved significantly once the activity data pertaining to fuel consumption on the ATULBD are specified. The possibility to collect additional information shall be considered for the next inventory cycle, to reduce uncertainties of the CO_2 emissions resulting from biomass burning in the RM.

Table 3-85: Comparative Results of CO_2 Emissions from Biomass (Memo Items) Included into the FNC and SNC of the RM under the UNFCCC, Gg

	1990	1991	1992	1993	1994	1995	1996	1997
FNC	424.4774	422.6033	385.1218	386.0589	378.5626	391.6811	412.2959	412.2959
SNC	210.8274	427.7268	531.1505	763.4134	599.5042	645.5674	615.3433	322.4374
Difference, %	-50.3	1.2	37.9	97.7	58.4	64.8	49.2	-21.8
	1998	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**
FNC	412.2959							
SNC	409.1761	373.6048	367.8560	353.0871	389.5020	359.7899	296.5059	295.0374
Difference, %	-0.8							

4. INDUSTRIAL PROCESSES SECTOR

Industry is an important part of the national economy. In 2006, its contribution to GDP formation was 14.4 percent. The largest share among branches covered by this sector is held by the 'Processing Industry' – 12.1 percent of the total, 'Electricity, Heat, Natural Gases and Water' account for 1.8 percent and 'Extraction Industry' – for 0.5 percent.

According to the NBS (2006), Industry Sector involves more than 12.8 percent of active population. This sector contains more than 15 750 economical agents, which is circa 12.5 percent of the total number per country. Small enterprises account for circa 19 percent of the total number of economical agents within the industry. The sector includes 683 big enterprises, of which 7.6 percent are public ownership, 66.5 percent - private ownership, 10.4 percent - mixed (public and private) ownership (no foreign capital), 3.6 percent - foreign capital and 11.9 percent joint ventures (NBS, 2006).

Industry Sector structure covers 97 types of activity, grouped as follows: Group 1 – industries based on local raw materials, which maintained their traditional markets: food industry (winemaking, canned food, juices, sugar); manufacturing of other products of non-metal minerals (cement, plaster stone, lime, ceramics production); cosmetics and perfumery; manufacturing of wooden elements for construction, manufacturing of wooden packaging; waste and recyclable materials recovery; Group 2 – industries preponderantly based on imported raw materials and have a potential market which however, needs upgrading and fast restructuring: light industry (textiles, knit-wear, leather goods); machinery manufacturing (pumping machines, medical equipment, engineering-and-electrical goods, agricultural machinery and equipment; Group 3 – industries based on imported raw materials and parts having low competitiveness: furniture, chemical products, including pharmaceuticals; paper and carton; plastics; finished metal goods; Group 4 – science-intensive enterprises, requiring special restructuring programs, as well as investment attraction programs: information technologies and instrument making engineering. The largest share among all industries is held by enterprises of the first group, in particular, processing enterprises accounting for more than 50 percent of the total industrial output.

4.1 Overview

Industrial Processes Sector includes greenhouse gas emissions generated directly from non-energy[2] industrial activities. Methodological guidance used includes the Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories (IPCC, 1997), Good Practice Guidance (IPCC, 2000), 2006 IPCC Guidelines for National Greenhouse Gas Inventories (IPCC, 2006), European Emissions Inventory Guidebook (CORINAIR, 1996, 1999, 2005) and other relevant guidelines (UNFCCC, 2005).

The source categories covered by this sector are: 2A 'Mineral Products' (cement, lime, asphalt, glass, mineral wool, bricks), 2B 'Chemical Industry' (polyethylene, synthetic resins and detergents), 2C 'Metal Production' (iron and steel), 2D 'Other Production' (food products: bread, confectionary, sugar, meat, butter, fodder; alcoholic beverages: wine, sparkling wine, divin (cognac), brandy, liqueur and beer) and 2F 'Consumption of Halocarbons and Sulphur Hexafluoride' incorporated in refrigeration and air conditioning equipment, fire extinguishes, aerosols, blown foams, electric equipment etc.

As no halocarbons and sulphur hexafluorides are produced in the RM, respectively, there were registered no direct greenhouse gas emissions from the source category 2E 'Production of Halocarbons and Sulphur Hexafluoride'.

A brief overview, methodological issues and data sources, key categories, uncertainties and times-series consistency, QA/QC and verification, recalculations made and planned improvements are described for each source category in this sector.

4.1.1 Summary of Emission Trends

In 2005, Industrial Processes Sector accounted for circa 4.9 percent of total national greenhouse gas direct emissions (without LULUCF), being a relevant source of GHG emissions in the Republic of Moldova.

This sector represented an important source of CO_2 national emissions (7.1 percent of national total) and the only source of HFCs (Hydrofluorocarbons) emissions, which are direct greenhouse gas with a significant potential for global warming ($GWP_{100\ years}$ variation for these gases is between 140 and 11700) and a relevant atmospheric persistence (vary between 1.5 and 264 years).

[2] GHG emissions from fossil fuel combustion for production of energy used for industrial activities are estimated in Energy Sector.

Between 1990 and 2005, the total GHG emissions originated from the Industrial Processes Sector tended to lower values (Table 4-1, Figure 4-1), decreasing by circa 56.9 percent, from 1348.75 Gg CO_2 eq. in 1990 to 581.90 Gg CO_2 eq. in 2005, in principal due to reduced industrial output, in particular, mineral products: cement (by 66 percent), lime (by 95 percent), glass for recipients (by 76 percent), bricks (by 71 percent), asphalt (by 95 percent) etc.

In 1990, CO_2, CH_4 and N_2O emissions accounted for circa 98.9 percent, 1.0 percent and respectively 0.1 percent of the total GHG emissions from the Industrial Processes Sector. In 2005, the largest share in the total GHG emissions covered by Industrial Processes Sector was held by CO_2 (93.0 percent), CH_4 (3.4 percent) and HFC (3.2 percent), the share of other direct greenhouse gases (N_2O and SF_6) being absolutely insignificant.

Table 4-1: GHG Emissions from Industrial Processes Sector by Gas in the Republic of Moldova, 1990-2005

Year	CO_2	CH_4	N_2O	HFC	SF_6	Total
	CO_2 equivalent					
1990	1334.1247	13.5239	1.0986	0.0000	0.0000	1348.7472
1991	1090.8625	11.7348	0.9536	0.0000	0.0000	1103.5509
1992	563.4552	11.3869	0.9265	0.0000	0.0000	575.7686
1993	504.3335	11.5911	0.9448	0.0000	0.0000	516.8694
1994	369.1497	12.0086	0.9813	0.0000	0.0000	382.1396
1995	367.1749	12.4524	1.0180	0.0000	0.0000	380.6453
1996	376.0921	12.6812	1.0371	0.0000	0.0000	389.8105
1997	418.3766	15.3333	1.2565	0.0000	0.0000	434.9664
1998	340.0224	13.5822	1.1131	0.0000	0.0000	354.7176
1999	322.9788	15.0499	1.2339	0.0000	0.0000	339.2626
2000	302.8214	17.1665	1.4076	4.2080	0.0000	325.6035
2001	305.9360	18.2831	1.4991	5.4113	0.0000	331.1295
2002	326.0406	9.7041	0.7955	7.5630	0.0000	344.1033
2003	379.8911	16.7524	1.3735	10.0184	0.0057	408.0411
2004	445.4484	19.1534	1.5704	13.0724	0.2782	479.5229
2005	541.4561	19.8167	1.6246	18.7189	0.2839	581.9002
1990-2005,%	-59.4	46.5	47.9	344.8	4849.4	-56.9

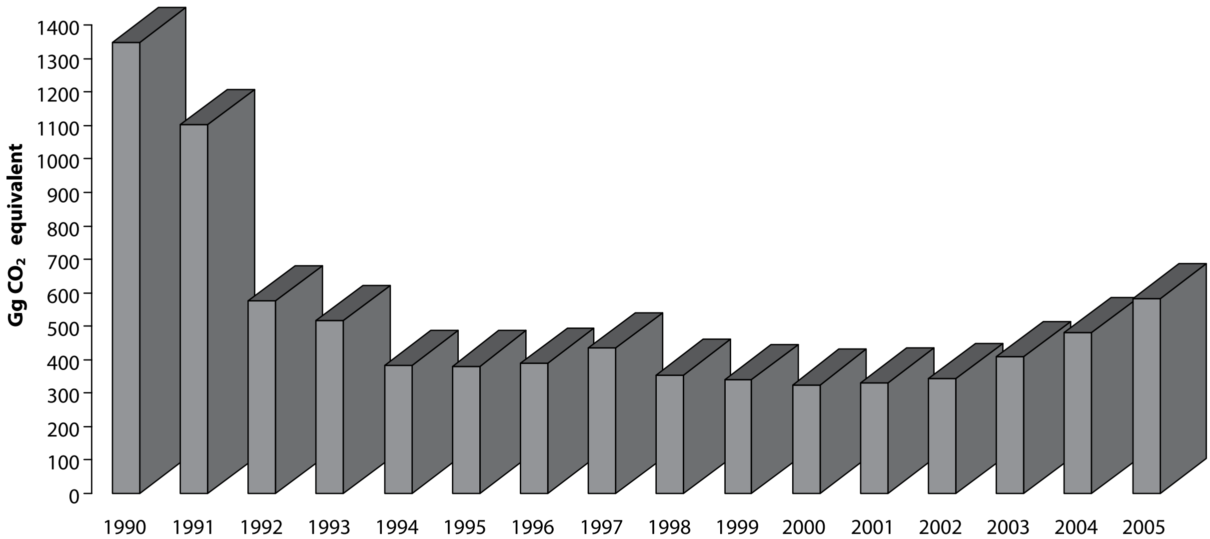

Figure 4-1: GHG Emissions from Industrial Processes Sector in the Republic of Moldova, 1990-2005

From Tables 4-2 and 4-3 one can notice that in the times series from 1990 through 2005 categories 2A Mineral Products and 2C Metal Production were the major source of greenhouse gas direct emissions under Industrial Processes Sector of the Republic of Moldova, with a share varying between 63.8-93.3 percent and respectively 5.3-29.3 percent of the total.

Table 4-2: GHG Emissions from the Industrial Processes Sector by Category in the Republic of Moldova within 1990-2005, Gg CO_2 eq.

Year	2A	2C	2D	2F	Total
	CO_2 equivalent				
1990	1257.9118	71.1959	19.6395	0.0000	1348.7472
1991	1024.4570	61.8019	17.2921	0.0000	1103.5509
1992	504.2851	60.0430	11.4405	0.0000	575.7686
1993	443.2077	61.2263	12.4354	0.0000	516.8694
1994	306.9845	63.5949	11.5602	0.0000	382.1396
1995	302.7174	65.9755	11.9524	0.0000	380.6453
1996	305.5530	67.2110	17.0465	0.0000	389.8105
1997	331.5877	81.4303	21.9484	0.0000	434.9664
1998	268.5845	72.1352	13.9979	0.0000	354.7176
1999	250.9564	79.9649	8.3413	0.0000	339.2626
2000	217.9316	91.2183	12.2455	4.2080	325.6035
2001	211.1681	97.1485	17.4015	5.4113	331.1295
2002	268.0543	51.5558	16.9302	7.5630	344.1033
2003	287.2804	89.0128	21.7239	10.0241	408.0411
2004	327.9019	101.7723	36.4980	13.3506	479.5229
2005	416.8448	105.2857	40.7669	19.0028	581.9002
1990-2005,%	-66.9	47.9	107.6	351.6	-56.9

To be noted that the specific weight of categories 2D 'Other Production' (in particular, 2D2 'Food and Drink') and 2F 'Consumption of Halocarbons and Sulphur Hexafluoride' (in particular, 2F1 'Refrigeration and Air Conditioning Equipment') in the total direct greenhouse gas emissions covered by the Industrial Processes Sector, tends to increase lately (Table 4-3).

4.1.2 Key Categories

The results of key source assessment (including LULUCF) carried out following a Tier 1 approach (IPCC, 2000), are provided in Chapter 1.5, as well as in the Annex 1. Table 4-4 provides information on identified key categories (by level and trend) under the Industrial Processes Sector of the Republic of Moldova.

4.1.3 Methodological Issues

Emissions covered by source categories 2A 'Mineral Products', 2C 'Iron and Steel Production' and 2D 'Other Production', 2F 'Consumption of HFCs and SF_6' were estimated using both, the Tier 1 methodological approach and default EFs values, as well as the Tier 2 methodological approach and country specific emission factors, in particular for the key source. A summary description of methods used to estimate emissions by source categories is provided in Table 4-5, while a more detailed description is available in the respective sub-chapters of this report (4.2-4.6).

Table 4-3: Breakdown of the Republic of Moldova's Industrial Processes Sector GHG Emissions by Category within 1990-2005, %

Year	2A	2C	2D	2F	Total
1990	93.3	5.3	1.5	0.0	100.0
1991	92.8	5.6	1.6	0.0	100.0
1992	87.6	10.4	2.0	0.0	100.0
1993	85.7	11.8	2.4	0.0	100.0
1994	80.3	16.6	3.0	0.0	100.0
1995	79.5	17.3	3.1	0.0	100.0
1996	78.4	17.2	4.4	0.0	100.0
1997	76.2	18.7	5.0	0.0	100.0
1998	75.7	20.3	3.9	0.0	100.0
1999	74.0	23.6	2.5	0.0	100.0
2000	66.9	28.0	3.8	1.3	100.0
2001	63.8	29.3	5.3	1.6	100.0
2002	77.9	15.0	4.9	2.2	100.0
2003	70.4	21.8	5.3	2.5	100.0
2004	68.4	21.2	7.6	2.8	100.0
2005	71.6	18.1	7.0	3.3	100.0
1990-2005,%	-23.2	242.8	381.1	152.7	0.0

Table 4-4: Key Categories Identified under the Industrial Processes Sector of the Republic of Moldova

IPCC Category	GHG	Source category	Key source
2A1	CO_2	Cement Production	Yes (L, T)
2A2	CO_2	Lime Production	No
2A6	CO_2	Road Paving with Asphalt	No
2A6	CH_4	Road Paving with Asphalt	No
2A7	CO_2	Glass Production	No
2A7	CO_2	Mineral Wool Production	No
2A7	CO_2	Brick Production	No
2C1	CO_2	Iron and Steel Production	No
2C1	CH_4	Iron and Steel Production	No
2C1	N_2O	Iron and Steel Production	No
2D2	CO_2	Food and Drink	No
2F1	HFC	Refrigeration and Air Conditioning Equipment	No
2F4	HFC	Aerosols	No
2F8	SF_6	Electrical Equipment	No

Table 4-5: Summary of Methods and Emission Factors Used to Estimate GHG Emissions from the Industrial Processes Sector of the Republic of Moldova

IPCC Category	Source category	CO_2		CH_4		N_2O	
		Method	EF	Method	EF	Method	EF
2A	Mineral Products	T2, T1	CS, D	NA	NA	NA	NA
2C	Iron and Steel Production	T1	D	T1	D	T1	D
2D	Other Production	T2, T1	CS, D	NA	NA	NA	NA
2F	Consumption of HFCs and SF_6	NA	NA	NA	NA	NA	NA
IPCC Category	**Source category**	**HFC**		**PFC**		**SF_6**	
		Method	EF	Method	EF	Method	EF
2A	Mineral Products	NA	NA	NA	NA	NA	NA
2C	Iron and Steel Production	NA	NA	NA	NA	NA	NA
2D	Other Production	NA	NA	NA	NA	NA	NA
2F	Consumption of HFCs and SF_6	T2, T1	D	NO	NO	T2, T1	D

Abbreviations: T1 –Tier 1; T2 –Tier 2; CS –Country Specific; D –Default; NA – Not Applicable; NO – Not Occurring.

4.1.4 Uncertainties and Time-Series Consistency

The uncertainty analysis of the GHG emissions from the Industrial Processes Sector (by source categories) is described in detail in the respective sub-chapters (4.2-4.6) of the NIR, as well as in the Annex 7-3.2. Combined uncertainties as a percentage of total direct sectoral emissions were estimated at circa ±9.7 percent (±8.5 percent for CO_2, ±150.0 percent for CH_4, ±300.0 percent for N_2O and ±70.7 percent for HFCs). The uncertainties introduced in trend in sectoral emissions were estimated at ±4.6 percent (±4.2 percent for CO_2, ±10.9 percent for CH_4, ±10.5 percent for N_2O and ±314.5 percent for HFCs).

In view of ensuring time-series consistency of the results, the same approach was used for the entire period under review, in conformity with the recommendations included in the Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories (IPCC, 2000).

4.1.5 QA/QC and Verification

Standard verification and quality control forms and checklists by individual source categories were filled in for each source category under the Industrial Processes Sector, following the Tier 1 and Tier 2 approaches (see in Annex 6). Also, the AD and methods used for estimating GHG emissions under the Industrial Processes Sector were documented and archived both in hard copies and electronically. To identify the data entry, as well GHG emissions estimation related errors there were applied AD and EFs verifications and quality control procedures. Inventory quality assurance activities for the Industrial Processes Sector were supported by an expert representing the Technical University of Moldova (TUM). Following the recommendations included into the Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories (IPCC, 2000), GHG emissions under the Industrial Processes Sector were estimated based on AD and EFs from official sources of reference.

4.1.6 Recalculations

GHG emission recalculations under the Industrial Processes Sector are due to the availability of an updated set of activity data (Statistical Yearbooks of the RM and of the ATULBD, other relevant publications, such as the Steel Statistical Yearbooks, published by the International Iron and Steel Institute), as well as due to updated methodologies and EFs (in particular, for 2A1 'Cement Production', 2A2 'Lime Production', 2A7 'Glass Production', 2C1 'Iron and Steel Production', 2D2 'Food and Drink', 2F1 'Refrigeration and Air Conditioning Equipment', etc.) available in the Good Practice Guidance (IPCC, 2000), European Emissions Inventory Guidebook (CORINAIR, 1996, 1999, 2005) and 2006 IPCC Guidelines for National Greenhouse Gas Inventories (IPCC, 2006), which have replaced the methodologies contained into the Revised 1996 IPCC Guidelines (IPCC, 1997) used under the FNC of the RM under the UNFCCC (2000).

In comparison with the results included into the FNC, the performed recalculation resulted in decreased GHG emission values for the 1998-1998 time periods, varying from a minimum of 42.4 percent in 1993, up to maximum of 71.1 percent in 1998 (Table 4-6). The results of recalculations performed at the category level are presented in the respective sub-chapters (4.2-4.6) of the NIR.

Table 4-6: Recalculated GHG Emissions under the Industrial Processes Sector for the 1990-1998, Gg CO_2 equivalent

	1990	1991	1992	1993	1994	1995	1996	1997	1998
FNC	2538.5	2107.7	1157.8	896.9	689.2	692.3	858.3	1056.2	1227.9
SNC	1348.7	1103.6	575.8	516.9	382.1	380.6	389.8	435.0	354.7
Difference, %	-46.9	-47.6	-50.3	-42.4	-44.5	-45.0	-54.6	-58.8	-71.1

Abbreviations: FNC – First National Communication; SNC - Second National Communication.

4.1.7 Assessment of Completeness

The current inventory covers greenhouse gas emissions from 5 source categories under the Republic of Moldova's Industrial Processes Sector (Table 4-7).

Table 4-7: Assessment of Completeness under the Industrial Processes Sector in the Republic of Moldova

IPCC Category	Source category	CO_2	CH_4	N_2O	HFC	PFC	SF_6
2A	Mineral Products	X	NO	NO	NO	NO	NO
2B	Chemical Industry	X	NE	NO	NO	NO	NO
2C	Metal Production	X	X	X	NO	NO	NO
2D	Other Production	X	NO	NO	NO	NO	NO
2E	Production of HFCs and SF_6	NO	NO	NO	NO	NO	NO
2F	Consumption of HFCs and SF_6	NO	NO	NO	X	NE	X

Abbreviations: X – source categories included in the inventory; NO – Not Occurring; NE –Not Estimated.

As no HFCs and SF_6 are produced in the RM, there were registered no such emissions under the category 2E 'Production of HFCs and SF_6'. So far the use of PFC (i.e., CF_4; C_2F_6; C_3F_8; C_4F_{10}; c-C_4F_8; C_5F_{12}; C_6F_{14}) was not reported in the RM, respectively no such emissions have been included within the inventory under the Industrial Processes Sector.

4.1.8 Planned Improvements

Planned improvements at the source categories level within the Industrial Processes Sector are described in detail in respective sub-chapters (4.2-4.6) of this report.

4.2 Mineral Products (Category 2A)

4.2.1 Source Category Description

Category 2A 'Mineral Products' includes GHG emissions from the following sources: 2A1 'Cement Production', 2A2 'Lime Production', 2A3 'Limestone and Dolomite Use', 2A4 'Soda Ash Production and Use', 2A5 'Asphalt Roofing', 2A6 'Road Paving with Asphalt' and 2A7 'Other' (Glass Production, Mineral Wool Production and Bricks Production). No GHG emissions were registered in the Republic of Moldova from categories 2A4 'Soda Ash Production and Use' and 2A5 'Asphalt Roofing'; the respective emission sources being reported as 'Not Occurring' (NO). Also, as statistic data on limestone and dolomite use is not available, GHG emissions from this source category were reported as 'Not Estimated' (NE).

Over the period under review (1990-2005), the direct greenhouse gas emissions originated from the source category 2A 'Mineral Products' decreased by 66.9 percent, from 1257.91 Gg CO_2 eq. in 1990 to 416.84 Gg CO_2 eq. in 2005 (Figure 4-2).

Ozone and Aerosol Precursors Emissions (NO_x, CO, NMVOC and SO_2) covered by the respective source category (Figure 4-3) demonstrated the same decreasing trend. Between 1990 and 2005, NO_x emissions decreased by 65.0 percent, from 2.78 Gg to 0.97 Gg; CO emissions by 96.3 percent, from 1.31 Gg to 0.05 Gg; NMVOC emissions by 61.3 percent, from 2.69 Gg to 1.04 Gg; while SO_2 emissions by 69.7 percent, from 1.87 to 0.57 Gg.

2A1. 'Cement Production'

CO_2 is generated in the process of clinker production, an intermediary product used to produce cement. $CaCO_3$ from limestone, chalk or other calcium rich materials, as well as $MgCO_3$ from dolomite, is heated at high temperatures in a kiln, to form the lime (CaO) and/or dolomite lime (CaO • MgO) and carbon dioxide (CO_2) in a process called "calcination".

$CaCO_3$ (limestone) + heat → CaO (lime) + CO_2

$CaMg(CO_3)_2$ (dolomite) + heat → CaO • MgO (dolomite lime) + $2CO_2$

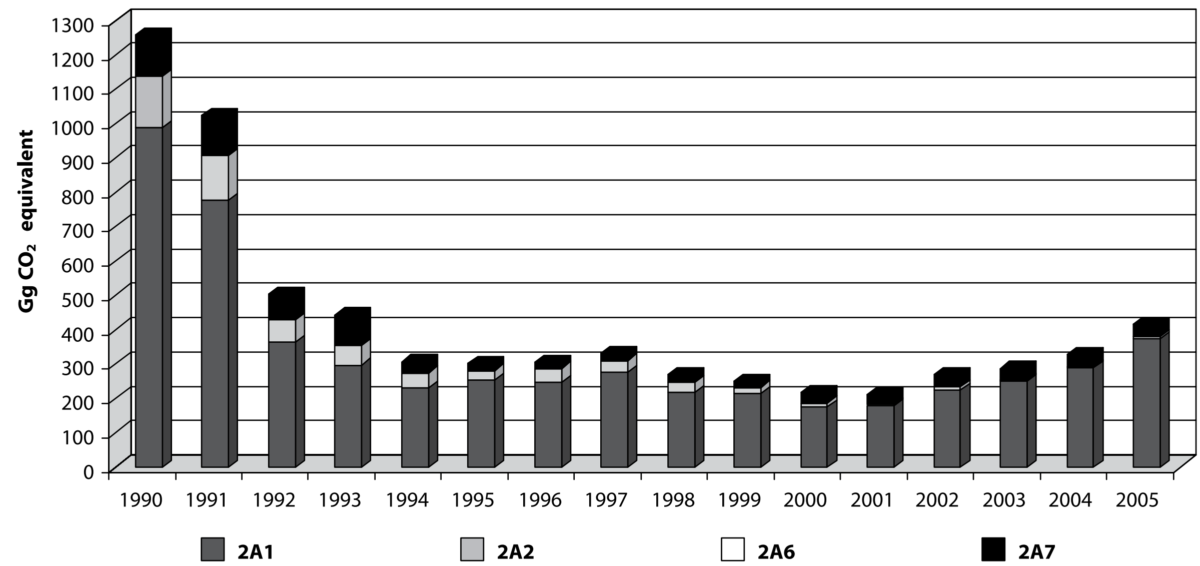

Figure 4-2: GHG Emissions from the Category 2A 'Mineral Products' by Source in the Republic of Moldova within 1990-2005

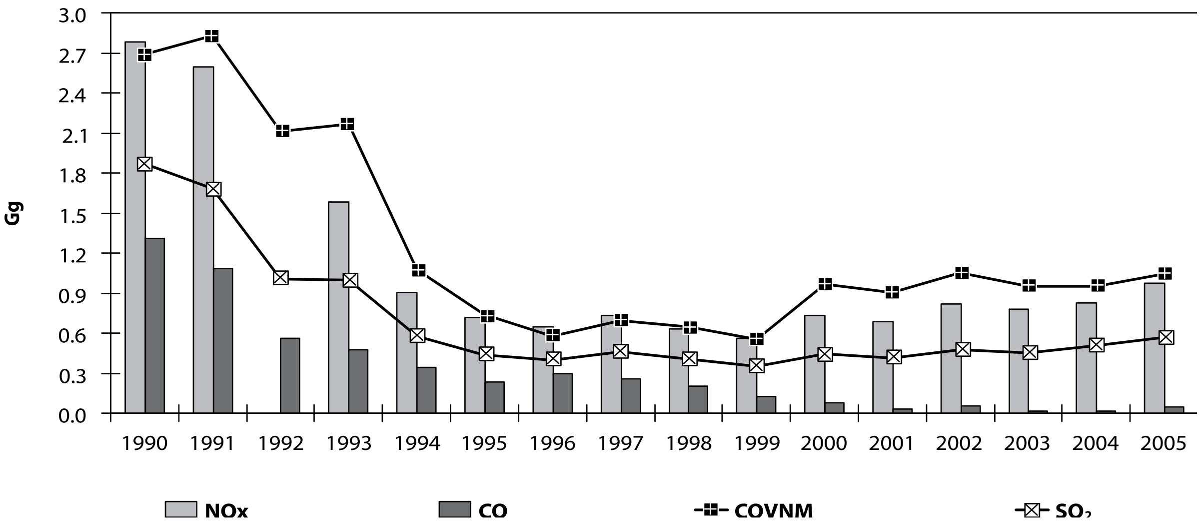

Figure 4-3: Ozone and Aerosol Precursors Emissions from the Category 2A 'Mineral Products' by Gas in the Republic of Moldova within 1990-2005

Lime and/or dolomite lime is then combined with silicon containing materials (SiO_2), aluminium (Al_2O_3) and iron oxide (Fe_2O_3) to produce clinker (grayish-black pellets about the size of 12 mm-diameter marbles). The clinker is then removed from the kiln, chilled and pulverized, and added to gypsum to obtain 'Portland Cement'. At present, all cement produced in the Republic of Moldova is of 'Portland' type, in which, in conformity with ORTECH (1994), CaO content varies between 60-67 percent, and MgO content is around 2 percent.

At present, there are two cement producing plants operating in the RM: Lafarge Cement J.S.C. in Rezina and Cement and Slate Combined Works in Ribnita (ATULBD). CO_2 emissions from cement production are directly proportionate to CaO fraction from the clinker used in its production (Annex 3-2). To be noted that GHG emissions resulting from combustion of fossil fuels used to produce heat which induces reaction in the oven, are covered by the Energy Sector and are not discussed in this chapter.

2A2. 'Lime Production'

Lime (CaO) is formed by heating the limestone to decompose the carbonates. This reaction takes place at higher temperatures, usually in a rotating kiln, and CO_2 is emitted in the process of calcination. Primary limestone (calcite) is processed from the rock mined in the quarry to produce caustic lime (quicklime) using the above mentioned reaction (see *Cement Production*). Dolomite limestone can also be heated at high temperatures to obtain dolomite lime, consequently, produce CO_2 emissions as a result of the chemical reaction described above.

2A6. 'Road Paving with Asphalt'

Asphalt is composed of a compact aggregate and bonding material. In highly industrialized countries, typically around 80-90 percent of the produced asphalt is used for road paving, the rest is used as roofing asphalt (US EPA, 2004). There are several types of road paving asphalt, 80 percent of the produced asphalt is hot mix asphalt (HMA type), the rest is liquefied asphalt (CORINAIR, 2005). Pollutant gases (NMVOC, CO, CH_4 and CO_2) are emitted from Asphalt Producing Plants (stationary or mobile), during road paving, as well as from the road pavement itself.

2A7a. 'Other' [Glass Production]

GHG emissions originated from production of different types of glass (flat window glass, glass for recipients, glassware, special glass, etc.), are covered under this source category. Glass is produced from a raw material mix containing silicon (SiO_2), sodium (Na_2O), lime (CaO) or other carbonates ($CaCO_3$, $CaMg(CO_3)_2$, Na_2CO_3, $BaCO_3$, K_2CO_3, $SrCO_3$ etc.), with small admixture of aluminium (Al_2O_3) and alkaline substances, plus other minor ingredients. Glass production process allows for a small quality of recycled glass to be used (its share can vary between 10-80 percent of the total raw material used). The melting process for glass of different types is similar. Glass production process implies the following phases: selection and preparation of the raw material; melting, moulding, hardening, quenching and finishing. The main polluting emissions from this process are SO_2, NO_x, NMVOC and CO_2. The amount of SO_2 emissions during the glass production process is mostly determined by the amount of melted dose of sulphur and its absorption capacity, by the access of air and combustion temperature. The principal mechanisms of NO_x formation are related to fuel combustion and emission of NO_x, as well as emission resulting from use of nitrates in the raw material for some types of glass. CO_2 emissions come from lime calcinations and other carbonates at high temperatures.

2A7b. 'Other' [Mineral Wool Production]

Products produced of mineral fibres are composed of inorganic fibres produced from melting of silicate and, depending on their use, contain different bonding agents and additives (a mix of minerals and coke heated until it melts and can be wriggled in fibres; the fibres are treated with resin to form a product resembling cotton wool). The principal pollutants generated during the process of melting and wriggling, as well as during the finishing of mineral wool are: SO_2, CO and CO_2.

2A7c. 'Other' [Brick Production]

Brick production involves mining, extraction, processing and refining the raw material (clay) with such additives as kaolin or lime stone, moulding, cutting, drying and kilning of the final product. The principal pollutants resulting from calcination of carbonates at high temperatures in the process of brick production are CO_2 and SO_2.

4.2.2 Methodological Issues and Data Sources

2A1. 'Cement Production'

Following the GPG (IPCC, 2000) recommendations, it was considered the possibility to replace the Tier 1 methodology (IPCC, 1997) used to estimate the GHG emissions from cement production within the FNC of the RM under the UNFCCC, with a Tier 2 methodology (IPCC, 2000), based on activity data on clinker production and country specific emission factors.

CO_2 emission factor is the product of the fraction of quicklime (CaO) and/or dolomitic quicklime (CaO•MgO) used in the cement clinker and a constant reflecting the mass of CO_2 released per unit of quicklime and/or dolomitic quicklime (molecular weight ratio of CO_2/CaO is 0.785, while that of CO_2/MgO is 1.092).

Since clinker is mixed with gypsum, which contains no lime per unit, to make cement, clinker has a higher lime percentage than finished cement: the average clinker lime percentage has been estimated to be 64.6 per cent (IPCC, 1997); the average cement lime percentage has been estimated to be 63.5 per cent (IPCC, 1997); also clinker contains around 2 percent of MgO (see Annex VII to the Decision of the European Commission 29/01/2004).

$FE_{clinker}$ = Content CaO (0.646) • stoichiometric ratio CO_2/CaO (0.785) + Content MgO (0.02) • stoichiometric ratio CO_2/MgO (1.092)

FE_{cement} = Content CaO (0.635) • stoichiometric ratio CO_2/CaO (0,785) + Content MgO (0.02) • stoichiometric ratio CO_2/MgO (1.092)

Thus, in the current inventory cycle, CO_2emissions from cement/clinker production were estimated following a Tier 2 methodological approach (IPCC, 2000).

CO_2 emissions = $EF_{clinker}$ • Clinker Production • CKD Correction Factor

This approach assumes that all the CaO and MgO is from a carbonate source (e.g., $CaCO_3$ in limestone and $CaMg(CO_3)_2$ in dolomite). If data on non-carbonate sources are available, a decrease should be made to the emission factor ($EF_{clinker}$).

The *good practice* was followed in the RM to correct for the CO_2 contained in non-recycled calcined Cement Kiln Dust (that is largely a mix of calcined and uncalcined raw materials and clinker), because this CO_2 will not be accounted for the clinker produced.

To be mentioned, that practically all cement kilns produce Cement Kiln Dust (CKD), its quantity depending of plant technologies. In general, the amount of CKD produced can vary from about 1.5 percent for a modern plant to about 8 percent of the weight of clinker production for a plant losing a lot of highly calcinated CKD (IPCC, 2000).

CKD can be directly recycled, or it may be recovered via electrostatic precipitation or filtration from the exhaust stacks. The recovered CKD may be recycled to the kiln as a raw material, used for other purposes, or transferred to a landfill. Any CKD not recycled to the kiln is lost to the cement system in terms of CO_2 emissions.

The IPCC default CKD correction factor (IPCC, 2000) was used in the Republic of Moldova (i.e., 2 percent were add to the CO_2 calculated for clinker).

Country specific $EF_{clinker}$ values were estimated based on information obtained directly from the producer on the CaO and MgO fractions in the produced clinker (Table 4-8), stoichiometrical reports on CO_2/CaO and CO_2/MgO and default CKD correction factor values.

Table 4-8: Country Specific Emission Factors used to estimate CO_2 emissions from Clinker Production in the Republic of Moldova, 1988-2006

	1988	1990	1991	1992	1993	1994
CaO fraction in clinker	0.6576	0.6576	0.6576	0.6576	0.6566	0.6566
MgO fraction in clinker	0.0200	0.0200	0.0200	0.0200	0.0200	0.0200
EF (without CKD), t CO_2/t clinker	0.5381	0.5381	0.5381	0.5381	0.5373	0.5373
EF (with CKD), t CO_2/t clinker	0.5488	0.5488	0.5488	0.5488	0.5480	0.5480
	1995	**1996**	**1997**	**1998**	**1999**	**2000**
CaO fraction in clinker	0.6577	0.6577	0.6577	0.6577	0.6577	0.6569
MgO fraction in clinker	0.0200	0.0200	0.0200	0.0200	0.0200	0.0200
E F (without CKD), t CO_2/t clinker	0.5381	0.5381	0.5381	0.5381	0.5381	0.5375
EF (with CKD), t CO_2/t clinker	0.5489	0.5489	0.5489	0.5489	0.5489	0.5483
	2001	**2002**	**2003**	**2004**	**2005**	**2006**
CaO fraction in clinker	0.6599	0.6602	0.6618	0.6586	0.6591	0.6605
MgO fraction in clinker	0.0200	0.0200	0.0200	0.0200	0.0200	0.0200
EF (without CKD), t CO_2/t clinker	0.5399	0.5401	0.5414	0.5388	0.5392	0.5403
EF (with CKD), t CO_2/t clinker	0.5507	0.5509	0.5522	0.5496	0.5500	0.5511

For comparison, below are presented the default EFs values (IPCC, 1997) used to estimate GHG emissions from cement/clinker production (Table 4-9).

Table 4-9: Default Emission Factors used to estimate GHG emissions from 2A1 'Cement Production'

Source	Process description	CO_2 [1]	NO_x [2]	SO_2 [1]
		kg / t		
Mineral Products	Clinker Production (CaO fraction = 0.646)	507.1	0.6	
	Clinker Production (CaO fraction = 0.646, CKD = 2%)	517.3		
	Cement production (CaO fraction = 0.635)	498.5		0.3

Source: [1] Revised 1996 IPCC Guidelines (IPCC, 1997), Vol. 3, Page 2.6; [2] EMEP CORINAIR Atmospheric Emissions Inventory Guidebook, 3rd edition, December 2000, B3311-11and B3311-12, ic 030311.

As information on clinker production is not available in the Statistical Yearbooks of the RM, following the good practice (IPCC, 2000), there were inferred from activity data on cement production. To be noted that the Statistical Yearbooks of the RM contain aggregated activity data on cement production in the RM (both, right and left banks of the Dniester) only for the 1990-1992 time period.

Information on cement production was received directly from the main producer in the RM, which is Lafarge Cement J.S.C. in Rezina, while activity data on cement production at Cement and Slate Combined Works in Ribnita were obtained from the Statistical Yearbooks of the ATULBD (Table 4-10).

Table 4-10: Activity Data on Cement Production in the Republic of Moldova within 1988-2005 time series, kt

	1988	1990	1991	1992	1993	1994
Rezina	1150.00	1101.00	820.00	100.00	100.00	40.00
Ribnita	1211.20	1187.00	980.00	710.00	570.00	490.00
Total: RM	2361.20	2288.00	1800.00	810.00	670.00	530.00

	1995	1996	1997	1998	1999	2000
Rezina	48.80	40.00	121.80	74.00	50.02	221.93
Ribnita	470.00	454.00	490.00	419.00	412.00	210.00
Total: RM	518.80	494.00	611.80	493.00	462.02	431.93
	2001	**2002**	**2003**	**2004**	**2005**	**1990-2005, %**
Rezina	158.09	259.40	255.40	430.57	628.80	-42.9
Ribnita	244.00	198.00	229.00	237.00	144.00	-87.9
Total: RM	402.09	457.40	484.40	667.57	772.80	-66.2

Source: Statistical Yearbooks of the Republic of Moldova for 1988 (page 227), 1994 (page 286), 1999 (page 302), 2003 (page 392), 2004 (page 442), 2005 (page 322), 2006 (page 312), Statistical Yearbooks of ATULBD for 1998 (page 176), 2000 (page 99), 2002 (page 103), 2005 (page 94), 2006 (page 93).

The information on clinker production at Lafarge Cement J.S.C. in Rezina was also provided by the producer (Table 4-11). As activity data on Cement and Slate Combined Works in Ribnita are lacking, there were inferred from activity data on cement production, by using the equation below.

Estimated Clinker Production = Cement Production • Clinker Fraction – Imported Clinker + Exported Clinker

Table 4-11: Activity Data on Clinker Production in the Republic of Moldova within 1988-2005 time series, kt

	1988	1990	1991	1992	1993	1994
Rezina	904.94	866.70	645.26	105.10	93.60	34.10
Ribnita	953.09	934.05	771.16	558.70	448.53	385.58
Total: RM	1858.03	1800.75	1416.42	663.80	542.13	419.68
	1995	**1996**	**1997**	**1998**	**1999**	**2000**
Rezina	89.90	94.10	114.60	68.10	66.10	155.00
Ribnita	369.84	357.25	385.58	329.71	324.20	165.25
Total: RM	459.74	451.35	500.18	397.81	390.30	320.25
	2001	**2002**	**2003**	**2004**	**2005**	**1990-2005, %**
Rezina	129.90	251.00	272.47	339.18	565.35	-34.8
Ribnita	192.00	155.81	180.20	186.50	113.31	-87.9
Total: RM	321.90	406.81	452.67	525.67	678.66	-62.3

In conformity with the technological documentation for Portland type cement production, in order to produce one tone of cement, cement plants in the RM use approximately 786.9 kg of clinker (see also Annex 3-2). The respective value was used to estimate the amount of clinker produced at Cement and Slate Integrated Works in Ribnita (ATULBD).

2A2. 'Lime Production'

The mass of CO_2 produced per unit of lime manufactured was estimated from the molecular weights and the lime content of products (ORTECH, 1991). On the basis of calcination reaction, one mole of carbon dioxide is formed for each mole of quicklime produced from burning calcium carbonate, and two moles of CO_2 is formed for each mole of dolomitic quicklime. This principle was used to develop emission factors estimated on the basis of equations below.

$EF_{quicklime}$ = Stoichiometric Ratio (CO_2/CaO) (0.785) • CaO Content

$EF_{dolomitic\ quicklime}$ = Stoichiometric Ratio (CO_2/CaO•MgO) (0.913) • (CaO•MgO) Content

To be noted that there are three types of lime: high-calcium lime (CaO + impurities); dolomitic lime (CaO•MgO + impurities); hydraulic lime (CaO + calcium silicates), that is a substance between lime and cement (the first two types have different stoichiometric ratios, and the third has a reduced content of CaO). Taking the types of lime into account allow improve emissions estimates. As in the RM does not exist statistic information on lime production by type, following the good practice (IPCC, 2000), the AD on lime production was disaggregated for the breakdown of lime types according the default values for high-calcium/dolomitic lime (85 percent–high calcium lime/15 percent–dolomitic lime), the proportion of hydraulic lime being assumed zero (IPCC, 2000). The basic parameters used for calculation CO_2 emission from lime production are presented in Table 4-12.

The emission factors values for other greenhouse gases originated from 2A2 'Lime Production' are available in the EMEP CORINAIR Guidelines (1996) (Table 4-13).

Table 4-12: Basic Parameters for Calculation of Emission Factors for Lime Production

Type of lime	Stoichio-metric Ratio (1)	Range of CaO Content (%)	Range of MgO Content (%)	Default values for CaO/CaO·MgO content (2)	Default EF, t CO_2/t lime (1) · (2)
High-calcium lime	0.785	93-98	0.3-2.5	0.95	0.75
Dolomitic lime	0.913	55-57	38-41	0.85	0.77
Hydraulic lime	0.785	65-92		0.75	0.59

Source: GPG (IPCC, 2000), Chap. 3.1.2 'Lime Production', Tab. 3.4, Page 3.22.

Table 4-13: Default Emission Factors for Lime Production

Source	Process description	NO_x	CO	SO_2
		kg / t		
Mineral Products	Limestone Calcination	1.4	5.0	1.0

Source: EMEP CORINAIR Guidelines, 3rd edition, February 15, 1996, B3312-5, ic030312, Lime.

Statistical Yearbooks of the RM contain aggregated activity data on lime production for the period until 1992. For the time series from 1993 through 2005, activity data on lime production are available separately for the right and left bank of Dniester, the Statistical Yearbooks of the RM and ATULBD, serving as official sources of reference (Table 4-14).

Table 4-14: Activity Data on Lime Production in the Republic of Moldova within 1988-2005 time series, kt

	1988	1990	1991	1992	1993	1994
RM: right bank of Dniester	167.70	134.30	100.00	32.80	30.00	15.90
RM: left bank of Dniester	100.00	90.00	78.60	55.00	48.00	45.00
RM: total	267.70	204.30	178.60	87.80	78.00	60.90
	1995	**1996**	**1997**	**1998**	**1999**	**2000**
RM: right bank of Dniester	10.80	19.90	9.70	12.70	5.20	3.10
RM: left bank of Dniester	28.00	34.00	39.00	26.00	19.00	12.00
RM: total	38.80	53.90	48.70	38.70	24.20	15.10
	2001	**2002**	**2003**	**2004**	**2005**	**1990-2005, %**
RM: right bank of Dniester	3.30	3.30	2.90	2.10	2.10	-98.4
RM: left bank of Dniester	2.00	8.00	0.40	1.00	7.00	-92.2
RM: total	5.30	11.30	3.30	3.10	9.10	-95.5

Source: Statistical Yearbooks of the RM for 1988 (page 228), 1994 (page 286), 1999 (page 302), 2003 (page 392), 2006 (page 312), Statistical Yearbooks of the ATULBD for 1998 (page 176), 2000 (page 99), 2002 (page 103), 2006 (page 93).

Because the produced amount of hydrated lime (by means of slaking, lime is disaggregated into hydrated lime, that is $Ca(OH)_2$ or $Ca(OH)_2 \cdot Mg(OH)_2$), following the good practice (IPCC, 2000), this value was inferred from activity data on total amount of lime produced in the RM, by multiplying it by a correction factor - the default value being 0.97 (IPCC, 2000). At the same time the amount of high-calcium lime and dolomitic lime was inferred from activity data on the amount of slaking lime, by using the default value for high calcium/dolomitic lime 85/15 (Table 4-15).

Table 4-15: Activity Data on Slack (Hydrated) Lime Production in the Republic of Moldova within the 1988-2005 time series, kt

Category	1988	1990	1991	1992	1993	1994
High calcium lime	220.72	168.45	147.26	72.39	64.31	50.21
Dolomitic lime	38.95	29.73	25.99	12.77	11.35	8.86
Total lime produced	259.67	198.17	173.24	85.17	75.66	59.07
Category	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**
High calcium lime	31.99	44.44	40.15	31.91	19.95	12.45
Dolomitic lime	5.65	7.84	7.09	5.63	3.52	2.20
Total lime produced	37.64	52.28	47.24	37.54	23.47	14.65
Category	**2001**	**2002**	**2003**	**2004**	**2005**	**1990-2005, %**
High calcium lime	4.37	9.32	2.72	2.56	7.50	-95.5
Dolomitic lime	0.77	1.64	0.48	0.45	1.32	-95.5
Total lime produced	5.14	10.96	3.20	3.01	8.83	-95.5

CO_2 emissions were estimated following a Tier 1 methodological approach, by multiplying the emission factors mentioned above to annual activity data on hydrated lime production, taking into account the type of produced lime.

Emissions $CO_2 = P_i \bullet FE_{lime, i}$

Where:

P_i = production of lime of type *i* (tones);

$FE_{var, i}$ = emission factor for lime of type *i* (0.75 t CO_2/t high-calcium lime and 0.77 t CO_2/t dolomitic lime).

This approach was preferred to the one available in the Revised 1996 IPCC Guidelines (IPCC, 1997), which admitted the use of emission factors that do not take into account CaO and CaO•MgO content in lime (circa 95 percent for CaO and circa 85 percent for CaO•MgO), what entailed excessive increase of default EF values: 0.785 t CO_2 per tone of high calcium and 0.913 t CO_2 per tone of dolomitic lime (assuming that CaO and CaO•MgO content in lime is 100 percent).

2A6. 'Road Paving with Asphalt'

Methodological issues related to estimating GHG emissions from road paving with asphalt are addressed in the Atmospheric Emissions Inventory Guidebook (CORINAIR, 2005), as well as in 2006 IPCC Guidelines for National Greenhouse Gas Inventories (IPCC, 2006).

GHG emissions covered by this source category were estimated following a Tier 1 methodological approach. Default EFs values for NMVOC, CO and CH_4 are presented in Table 4-16, while the annual activity data on asphalt production (there were provided by the Ministry of Transport and Roads of the RM), respectively in the Table 4-17.

Table 4-16: Emission Factors Used to Estimate GHG Emissions from Road Paving with Asphalt

Source	Description	CH_4	CO	NMVOC	C content in NMVOC
		g / t			Fraction C
Mineral products	Production of hot mix asphalts	5	75	15	0.4
	Production of liquefied asphalts	100000	NA	100000	0.5
	Production of roofing asphalt	NO	10000	50	0.8

Source: EMEP CORINAIR Atmospheric Emissions Inventory Guidebook, 3rd edition, February 15, 1996, B4611-6, pr040611, Road paving with asphalt; 2006 IPCC Guidelines for National Greenhouse Gas Inventories (IPCC, 2006), vol. 3, Chapter 5.

GHG emissions (NMVOC, CH_4 and CO) were estimated by using the following equation:

GHG Emissions $= \Sigma P_i \bullet EF_{asphalt, i}$

Where:

GHG emissions = emissions of NMVOC, CO and CH_4;

P_i = production of asphalt by type *i* (tones);

$EF_{asphalt, i}$ = asphalt emission factor by type *i*.

Table 4-17: Activity Data on Asphalt Production in the RM within the 1990-2005 time series, kt

Years	AD	Years	AD
1990	1220.3	1998	92.3
1991	1014.8	1999	40.3
1992	853.0	2000	32.6
1993	678.0	2001	40.8
1994	410.0	2002	35.7
1995	370.0	2003	41.0
1996	335.0	2004	44.0
1997	113.7	2005	65.0

Source: Data on asphalt production were provided by the Ministry of Transport and Roads through the Official Letters No. 03-5-2/2-32 from 31.03.1999, No. 04-02-3/101 from 18.02.2004 and No. 04-01-3/754 from 02.10.2006

Based on default values of carbon content in the NMVOC, the indirect CO_2 emissions covered by this source category were estimated as well.

Emissions $CO_2 = \Sigma$ *(NMVOC • Fraction C • 44/12) + (CO • 44/28) + (*CH_4 *• 44/16)*

Where:

NMVOC, CO, CH_4 and CO_2 emissions =GHG emissions;

C fraction = carbon fraction in the NMVOC;

[44/12] = stoichiometric ratio of carbon content in CO_2 and NMVOC;

[44/28] = stoichiometric ratio of carbon content in CO_2 and CO;

[44/16] = stoichiometric ratio of carbon content in CO_2 and CH_4

2A7a. 'Other' [Glass Production]

Methodological issues related to estimating GHG emissions from glass production are addressed in the 2006 IPCC Guidelines for National Greenhouse Gas Inventories. CO_2 emissions from this source category were estimated following a Tier 1 methodological approach, by multiplying activity data on glass production to a default emission factor. To be noted, that for the time being it was not possible to use a Tier 2 methodological approach, first of all due to lack of activity data on the quantity of glass melted in different production processes (see default EFs values in the Table 4-18).

Table 4-18: Default Emission Factors and Cullet Ratios for Different Glass Types

Glass Type	CO_2 FE, t CO_2/t glass	Cullet Ratio (Typical Range), %
Float	0.21	10-25
Container (Flint)	0.21	30-60
Container (Green/Amber)	0.21	30-80
Fiberglass (E-glass)	0.19	0-15
Fiberglass (Insulation)	0.25	10-50
Speciality (TV Panel)	0.18	20-75
Speciality (TV Funnel)	0.13	20-70
Speciality (Tableware)	0.10	20-60
Speciality (Lab/Pharma)	0.03	30-75
Speciality (Lighting)	0.20	40-70

Emissions $CO_2 = P_{glass} \bullet EF_{glass} \bullet (1 - CR)$
Where:
P_{glass} = mass of glass produced (tones)
EF_{glass} = default emission factor (0.20 t CO_2 /t glass);
CR = cullet ratio, represent the fraction of recycled glass (the range is within 10-80 percent, assuming the default value of 50 percent)[3].

For other GHG there were used EFs available in the third edition of EMEP CORINAIR Inventory Guidebook and in the Revised 1996 IPCC Guidelines (Table 4-19).

Table 4-19: EF Used to Estimate GHG Emissions from Glass Production

Source	Process description	NO_x	SO_2	NMVOC
		kg / t		
Mineral products	Flat glass production	4.6	3.0	4.5
	Production of glass for recipients	2.4	1.2	

Source: EMEP CORINAIR Atmospheric Emissions Inventory Guidebook, 3rd edition, June 2005, B3314-20-23 for flat glass production and B3314-24-27 for production of glass for recipients, ic030314, Glass production (EFs for NO_x and SO_2); Revised 1996 IPCC Guidelines (IPCC, 1997), vol. 3, sub-chap. 2.7.3, page 2.14 (EF for NMVOC).

There are four glass factories in the Republic of Moldova: two in Chisinau, one in Floreşti and one in Tiraspol (ATULBD). Activity data on flat glass production are available in Statistical Yearbooks of the Republic of Moldova, however, for the times series from 1985 through 1992 only (no such production was registered further in the RM) (Table 4-20). The conversion coefficient used to covert the activity data from squire metres into metric mass units was 0.005 t per 1 m^2.

Table 4-20: Activity Data on Flat Glass Production in the RM, 1985-1992

Category	1985	1986	1987	1988	1990	1991	1992
Flat glass, thousand m^2	94.0	124.0	118.0	265.0	226.0	287.0	184.0

Source: Statistic Yearbooks of the RM for 1988 (page 228) and 1994 (page 287).

The activity data on container glass production for winemaking industry (expressed in conventional standard 75 cl wine bottle[4]), manufactured at the glass factories on the right bank of Dniester, are available for the whole period under review (Table 4-21).

Table 4-21: Activity Data on Container Glass Production for Winemaking Industry in the RM, 1988-2005

	1988	1990	1991	1992	1993	1994
75 cl standard wine bottles, M pieces	191.1	166.0	153.0	139.0	138.0	133.0
	1995	**1996**	**1997**	**1998**	**1999**	**2000**
75 cl standard wine bottles, M pieces	184.0	165.0	172.2	189.1	125.2	260.0
	2001	**2002**	**2003**	**2004**	**2005**	**1990-2005, %**
75 cl standard wine bottles, M pieces	228.3	296.1	281.4	308.0	353.1	112.7

Source: Statistical Yearbooks of the RM for 1988 (page 228), 1994 (page 287), 1999 (page 303), 2003 (page 393), 2004 (page 443), 2005 (pages 321-322), 2006 (page 312).

In terms of glass packaging for canned products industry (expressed in 0.5 litres[5] equivalent standard glass jars), the Statistical Yearbooks of the RM contain aggregated activity data for the time period until 1992 only. For the time period from 1993 through 2005 data on production of glass packaging for canned products industry are available separately for the right and left bank of Dniester, the Statistical Yearbooks of the RM and of the ATULBD serving as official sources of reference (Table 4-22).

Table 4-22: Activity Data on Production Glass Packaging for Canned Products Industry in the RM within 1988-2005 time periods, million standard glass jars, 0.5 litres equivalent

	1988	1990	1991	1992	1993	1994
RM: right bank of Dniester	147.4	223.0	246.0	187.0	249.0	153.0
RM: left bank of Dniester	425.0	435.0	448.0	330.0	284.0	111.0
RM: total	572.4	658.0	694.0	517.0	533.0	264.0
	1995	**1996**	**1997**	**1998**	**1999**	**2000**
RM: right bank of Dniester	87.0	40.0	86.4	84.2	104.6	156.2
RM: left bank of Dniester	89.5	72.0	81.9	52.0	19.0	56.0
RM: total	176.5	112.0	168.3	120.3	149.4	212.2
	2001	**2002**	**2003**	**2004**	**2005**	**1990-2005, %**
RM: right bank of Dniester	148.8	137.4	107.4	98.9	103.5	-53.6
RM: left bank of Dniester	69.0	77.0	69.0	45.0	33.0	-92.4
RM: total	217.8	214.4	176.4	143.9	136.5	-79.3

Source: Statistical Yearbooks of the RM for 1988 (page 228), 1994 (page 287), 1999 (page 303), 2003 (page 393), 2004 (page 443), 2005 (page 321-322), 2006 (page 312), Statistical Yearbooks of the ATULBD for 1998 (page 180), 2000 (page 100), 2002 (page 104), 2005 (page 94) and 2006 (page 93).

[3]Country specific values of the cullet ratios (CR) and emission factors (EF) were inferred based on the information provided by the Glass Factory in Chisinau for the 1990-2006 time series (Annex 3-2). These values have a substantial variation over time: for *flat glass*, in 1988-1992 time series, CR–10%, EF –180 kg CO_2/t glass; for *container glass*, in the time series from 1990 through 1993, CR-50%, EF - 100 kg CO_2/t glass; in the time series from 1994 through 1999, CR-75%, EF - 50 kg CO_2/t glass; in the time series from 2000 through 2006, CR-55%, EF - 90 kg CO_2/t glass.

[4]To convert the activity data in metric mass units (tones), a conversion coefficient of 0.5 kg per standard 75 cl wine bottle was used.

[5]To convert the activity data in metric mass units (tones), a conversion coefficient of 0.4 kg per one conventional 0.5 liters jar was used.

2A7b. 'Other' [Mineral Wool Production]

Methodological issues regarding estimation of GHG emissions from mineral wool production are addressed in the EMEP CORINAIR Inventory Guidelines (Table 4-23).

Table 4-23: EFs Used to Estimate GHG Emissions from Mineral Wool Production

Source	Process description	CO_2	CO	SO_2
		kg gas / t of product		
Mineral products	Mineral wool production	115	3.2	1.5

Source: EMEP CORINAIR Atmospheric Emissions Inventory Guidebook, 3rd edition, June 2005, B3318-7, ic030318, Mineral Wool.

Activity data regarding mineral wool production (expressed in thousand m^3) are available in the Statistical Yearbooks of the RM and of the ATULBD [6] (Table 4-24). In conformity with the information provided by the National Bureau of Statistics, starting 2001 no mineral wool is produced in the RM. On the left bank of Dniester production of mineral wool stopped in 2002.

Table 4-24: Activity Data Regarding Mineral Wool Production in the RM within 1988-2002 time periods, thousand m^3

	1988	1990	1991	1992	1993	1994	1995
RM: right bank of the Dniester	172.9	124.5	110.7	66.3	55.7	14.8	29.5
RM: left bank of the Dniester	450.0	437.7	244.0	110.2	50.2	25.5	10.3
RM: total	622.9	562.2	354.7	176.5	105.9	40.3	39.8
	1996	**1997**	**1998**	**1999**	**2000**	**2002**	**1990–2002, %**
RM: right bank of the Dniester	21.0	21.1	13.5	8.9	5.9	0.0	-100.0
RM: left bank of the Dniester	0.0	5.9	6.0	4.0	0.0	1.0	-99.8
RM: total	21.0	27.0	19.5	12.9	5.9	1.0	-99.8

Source: Statistical Yearbooks of the RM for 1988 (page 228), 1994 (page 286), 1999 (page 303) and 2003 (page 392), Statistical Yearbooks of the ATULBD for 1998 (page 177), 2000 (page 99), 2002 (page 103) and 2006 (page 93).

2A7c. 'Other' [Bricks Production]

Methodological issues regarding estimation of GHG emissions from bricks production are addressed in 2006 IPCC Guidelines for National Greenhouse Gas Inventories (IPCC, 2006). In the bricks production process CO_2 emissions result from calcination of carbonates contained in clay, as well as in other additives used in the technological process. Similarly to cement and lime production processes, carbonates are heated in kilns at high temperatures and emit carbon dioxide. CO_2 emissions can be estimated by multiplying annual activity data on the amount of carbonates used in production process (different types of clay) by a specific EF, taking into account the content of CaO and MgO in the carbonates used.

Emissions $CO_2 = M_c \bullet FE_{c,}$

Where:

M_c = mass of carbonate consumed (tones of clay)

EF_c = emission factor for carbonates calcination (t CO_2 /t clay).

In carbonates calcination reaction each mole of CaO and respectively, MgO forms one mole of CO_2. This principle was used for developing country specific values of emission factors.

EF = Stoichiometric Ratio (CO_2/CaO) • Content of CaO in Clay + Stoichiometric Ratio (CO_2/MgO) • Content of MgO in Clay

To be noted, that in the RM the content of CaO in clay varies between 8 and 9 percent, while content of MgO, respectively between 3 and 4 percent [7]. The values of emission factors used to estimate CO_2 emissions from brick production (see also in Annex 3-2) was determined based on information provided by the producers (Table 4-25).

Table 4-25: Country Specific Emission Factors Used to Estimate CO_2 Emissions from Bricks Production in the Republic of Moldova, 1988-2006

	1988	1990	1991	1992	1993	1994
Content of CaO in clay	0.0844	0.0844	0.0844	0.0844	0.0844	0.0844
Content of MgO in clay	0.0303	0.0303	0.0303	0.0303	0.0303	0.0303
EF, t CO_2/t clay used	0.0993	0.0993	0.0993	0.0993	0.0993	0.0993
	1995	**1996**	**1997**	**1998**	**1999**	**2000**
Content of CaO in clay	0.0844	0.0822	0.0822	0.0822	0.0822	0.0822
Content of MgO in clay	0.0303	0.0303	0.0321	0.0321	0.0321	0.0321
EF, t CO_2/t clay used	0.0993	0.0976	0.0996	0.0996	0.0996	0.0996
	2001	**2002**	**2003**	**2004**	**2005**	**2006**
Content of CaO in clay	0.0822	0.0822	0.0822	0.0822	0.0822	0.0822
Content of MgO in clay	0.0321	0.0357	0.0357	0.0357	0.0357	0.0357
EF, t CO_2/t clay used	0.0996	0.1035	0.1035	0.1035	0.1035	0.1035

SO_2 emission factors from brick production are available in the third edition of the EMEP CORINAIR Inventory Guidebook (Table 4-26).

[6] To convert the activity data in metric mass units (tones), a conversion coefficient of 0.125 t per 1 m^3 of mineral wool was used.

[7] In conformity with information provided by producers, the average content of CaO in clay extracted in Purcel quarry is circa 8.44%, and in Micauti and Pruncul quarries – 8.22%; the average content of MgO in clay extracted in Purcel quarry is 3.03%, and in Micauti and Pruncul quarries – 3.57% (see also Annex 3-2).

Table 4-26: EF Used to Estimate SO_2 Emissions from Brick Production

Source	Description	SO_2, kg / t
Mineral Products	Red Brick Production Yellow Brick Production White Brick Production	0.175 0.040 0.600

Source: EMEP CORINAIR, Atmospheric Emissions Inventory Guidebook 3rd edition, February 15, 1996, B3319-5, ic030319, Bricks.

Statistical Yearbooks of the RM contain aggregated activity data regarding bricks production (preponderantly red bricks) for the time series until 1992 only. For the time series from 1993 through 2005 official data are available separately for right and left banks of Dniester (Table 4-27).

Table 4-27: Activity Data on Bricks Production in the Republic of Moldova in the time series from 1988 through 2005, million pieces

	1988	1990	1991	1992	1993	1994
RM: right bank of the Dniester	190.2	190.5	174.5	83.2	149.7	64.3
RM: left bank of the Dniester	50.0	45.0	43.0	35.0	27.0	25.0
RM: total	240.2	235.5	217.5	118.2	176.7	89.3
	1995	**1996**	**1997**	**1998**	**1999**	**2000**
RM: right bank of the Dniester	39.2	37.2	47.7	48.6	44.8	39.9
RM: left bank of the Dniester	20.0	16.0	12.0	7.0	12.0	13.0
RM: total	59.2	53.2	59.7	64.8	56.8	52.9
	2001	**2002**	**2003**	**2004**	**2005**	**1990-2005. %**
RM: right bank of the Dniester	38.1	45.8	52.2	54.9	51.2	-73.1
RM: left bank of the Dniester	15.0	17.0	16.0	21.0	18.0	-60.0
RM: total	53.1	62.8	68.2	75.9	69.2	-70.6

Source: Statistical Yearbooks of the RM for 1988 (page 228), 1994 (page 287), 1999 (page 303), 2005 (page 322), Statistical Yearbooks of the ATULBD for 1998 (page 177), 2000 (page 99), 2002 (page 103), 2006 (page 93).

The amount of clay needed to produce one brick (on average circa 2.25 kg clay per one brick) was inferred from the information found in specialty literature (Cashkaev, Sheitan, 1978) (in Russian), as well as from information provided directly from MACON J.S.C. (the biggest bricks producer in the Republic of Moldova) on the amount of clay used in bricks production in the time series from 1990 through 2006 (see also in Annex 3-2). This coefficient was used to estimate the amount of clay used in bricks production countrywide (Table 4-28).

Table 4-28: Activity Data on the Amount of Clay Used in Bricks Production in the Republic of Moldova, 1988-2005

	1988	1990	1991	1992	1993	1994
Clay used, kt	540.45	529.88	489.38	265.95	397.58	200.93
	1995	**1996**	**1997**	**1998**	**1999**	**2000**
Clay used, kt	133.20	119.70	134.33	145.80	127.80	119.03
	2001	**2002**	**2003**	**2004**	**2005**	**1990-2005, %**
Clay used, kt	119.48	141.30	153.45	170.78	155.70	-70.6

4.2.3 Uncertainties and Time-Series Consistency

2A1 'Cement Production'

The uncertainty of the CaO and MgO fractions in clinker is low (±2 percent), the same is the uncertainty of emission factor. The activity data related uncertainties were also estimated as being moderate: in the case of AD provided by the Lafarge Cement J.S.C. uncertainties account for ±5 percent, while in the case of Cement and Slake Integrated Works in Ribnita, uncertainties reach up to ±15 percent; thus, the average AD uncertainties were accepted as being ±10 percent.

Uncertainties pertaining to CO_2 emissions from the 2A1 'Cement Production' source category were estimated at ±10.20 percent. At the same time, combined uncertainties, presented as a percent of total sectoral emissions were estimated at ±6.54 percent. Uncertainties introduced in trend in sectoral emissions were estimated at ±3.91 percent (see Annex 7-3.2).

In view of ensuring time-series consistency of the obtained results, the same approach was used for the entire period under review, in conformity with the recommendations included in the Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories (IPCC, 2000).

2A2 'Lime Production'

Uncertainty of the average CaO fraction in lime was estimated at circa 4-8 percent. The stoichiometric ratio is an exact figure, so the uncertainties on the emission factor are around ±2 percent. Uncertainties related to activity data on lime production in the RM are ±10 percent. The correction factor used for hydrated lime adds another ±5 percent to general uncertainties.

Uncertainties pertaining to CO_2 emissions from the 2A2 'Lime Production' source category were estimated at ±15.13 percent. At the same time, combined uncertainties, presented as a percent of total sectoral emissions were estimated at ±0.17 percent. Uncertainties introduced in trend in sectoral emissions were estimated at ±0.14 percent (see Annex 7-3.2).

In view of ensuring time-series consistency of the obtained results, the same approach was used for the entire period under review, in conformity with the recommendations included in the Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories (IPCC, 2000).

2A6 'Road Paving with Asphalt'

Uncertainty of the GHG emissions from road paving with asphalt was estimated as being very high, depending on precision of activity data and detailed information on the technological process used. At the same time the uncertainty associated with carbon content in NMVOC is relatively small (±10 percent). It was assumed that uncertainty related to emission factors is ±100 percent for CO_2 emissions and ±200 percent for CH_4. Uncertainty of the activity data on asphalt production in the RM are quite high (±50 percent), especially taking into account that a certain amount of asphalt is produced by the mobile plants; this fact does not guarantee very accurate statistical data. It should be noted that respective activity data are not reported to the NBS of the RM, this information being available at the Ministry of Transport and Roads of the RM only.

Uncertainties pertaining to GHG emissions from the 2A6 'Road Paving with Asphalt' source category were estimated at ±111.80 percent for CO_2 emissions and at ±206.16 percent for CH_4 emissions. At the same time, combined uncertainties, presented as a percent of total sectoral emissions were estimated at ±0.0019 percent for CO_2 emissions and at ±0.0024 percent for CH_4 emissions. Uncertainties introduced in trend in sectoral emissions were estimated at ±0.0053 percent for CO_2 emissions and at ±0.0072 percent for CH_4 emissions (see Annex 7-3.2).

In view of ensuring time-series consistency of the obtained results, the same approach was used for the entire period under review, in conformity with the recommendations included in the Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories (IPCC, 2000).

2A7a 'Other' [Glass Production]

Uncertainties related to default emission factors (EFs) and cullet ratios (CR) used to calculate CO_2 emissions from glass production are medium (±50 percent). Uncertainty of activity data on glass production are relatively reduced (±10 percent). However, because activity data were converted (from squire meters or conventional standard wine bottles into metric mass units), additional uncertainties were added (±10 percent).

Uncertainties pertaining to CO_2 emissions from the 2A7a 'Glass Production' source category were estimated at ±53.85 percent. At the same time, combined uncertainties, presented as a percent of total sectoral emissions were estimated at ±1.93 percent. Uncertainties introduced in trend in sectoral emissions were estimated at ±0.47 percent (see Annex 7-3.2).

In view of ensuring time-series consistency of the obtained results, the same approach was used for the entire period under review, in conformity with the recommendations included in the Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories (IPCC, 2000).

2A7b 'Other' [Mineral Wool Production]

Uncertainties related to default emission factors used to calculate CO_2 emissions from mineral wool production were considered moderate (±30 percent). Uncertainty of activity data on mineral wool production are relatively reduced (±10 percent). However, because activity data were converted (from cubic meters into metric mass units), additional uncertainties were added (±10 percent).

Uncertainties pertaining to CO_2 emissions from the 2A7b 'Mineral Wool Production' source category were estimated at ±36.06 percent. At the same time, combined uncertainties, presented as a percent of total sectoral emissions and the uncertainties introduced in trend in sectoral emissions were insignificant (see Annex 7-3.2).

In view of ensuring time-series consistency of the obtained results, the same approach was used for the entire period under review, in conformity with the recommendations included in the Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories (IPCC, 2000).

2A7c 'Other' [Bricks Production]

The uncertainty of the average CaO and MgO fractions in carbonates used for bricks production is relatively low (±2 percent). The stoichiometric ratio is an exact number, so the uncertainty of the emission factor is ±5 percent. Uncertainties related to activity data on bricks production are ±10 percent. However, because activity data were converted (from millions of manufactured bricks into metric mass units), additional uncertainties were added (±10 percent).

Uncertainties pertaining to CO_2 emissions from the 2A7c 'Bricks Production' source category were estimated at ±20.62 percent. At the same time, combined uncertainties, presented as a percent of total sectoral emissions were estimated at ±0.57 percent. Uncertainties introduced in trend in sectoral emissions were estimated at ±0.34 percent (see Annex 7-3.2).

In view of ensuring time series consistency of results, the same approach was used for the entire period under review, in conformity with good practices applied in the GHG emissions inventory (IPCC, 2000).

4.2.4 QA/QC and Verification

Standard verification and quality control forms and check-lists were filled in for the respective source category under the Industrial Processes Sector, following the Tier 1 and Tier 2 approaches (see in Annex 6). Also, the AD and methods used for estimating GHG emissions under the category 2A 'Mineral Products' were documented and archived both in hard copies and electronically. For identifying the data entry and emission estimation process related errors there were applied verifications and quality control procedures. Verification was focused on correct use of AD obtained from different sources of reference (i.e., Statistical Yearbooks of the RM and ATULBD, Ministry of Transport and Roads, National Bureau of Statistics, and other sources [Ţăranu, Filatov, 2000; Ţăranu et al., 2005; Ţăranu, Brega, Scorpan, 2007; Ţăranu et. al., 2007]), especially in case of converting AD into mass units compatible with GHG emissions estimation methods; as well as on ensuring correct use of the default emission factors available in the Revised 1996 IPCC Guidelines (IPCC, 1997), GPG (IPCC, 2000), 2006 IPCC Guidelines (IPCC, 2006) and EMEP CORINAIR Atmospheric Emissions Inventory Guidebook (CORINAIR, 1996, 1999, 2005) and comparing the results obtained by using different estimating methodologies (Tier 1 and Tier 2), by explaining the identified discrepancies, etc. Inventory quality assurance activities for the Industrial Processes Sector, inclusive for the 2A 'Mineral Products', were supported by an expert representing the Technical University of Moldova (TUM).

Following the recommendations included into the Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories (IPCC, 2000), GHG emissions originated from the 2A 'Mineral Products' were estimated based on AD and EFs from official sources of reference.

4.2.5 Recalculations

2A1. 'Cement Production'

In comparison with the results included in the FNC of the RM under the UNFCCC (2000), CO_2 emissions from cement production were recalculated for the 1990-1998 time series (for the Republic of Moldova the 1990 is the reference year under the UNFCCC, while emissions for 1988 year are presented here for comparison purposes), because the Tier 1 estimation methodology, based on activity data on cement production and use of another country specific EF[8], was replaced by a Tier 2 methodological approach, activity data on clinker production, annual information on CaO content in clinker and use of default correction factor (CKD).

The results included into the FNC of the RM for the time series from 1992 through 1998 refer to the right bank of Dniester only (there were used AD available for the Cement Plant in Rezina), while at present these refer to the whole territory of the country.

In comparison with the previously obtained results for the 1988-1991 time periods, the above mentioned changes resulted in a circa 16 percent decrease of CO_2 emissions. For the 1992 through 1998 time series, the changes made with the aim to complete the activity data with information available from the Cement and Slake Integrated Works in Ribnita (ATULBD), resulted in a substantial increase of CO_2 emissions from the 2A1 'Cement Production' source category (Table 4-29).

[8] A country specific emission factor (INMACON, 1999) was used for the category 2A1 'Cement Production' within the FNC of the RM under the UNFCCC (2000); $EF_{cement} = 0.785 \cdot 0.655 = 0.5142$ t CO_2/t cement.

Table 4-29: Comparative Results of CO_2 Emissions from 2A1 'Cement Production' Included into the FNC and SNC of the RM under the UNFCCC, Gg

	1988	1990	1991	1992	1993	1994
FNC	1214.1290	1182.6600	925.5600	51.4200	51.4200	20.5680
SNC	1019.6859	988.2518	777.3313	364.2929	297.0889	229.9852
Difference, %	-16.0	-16.4	-16.0	608.5	477.8	1018.2
	1995	**1996**	**1997**	**1998**	**1999**	**2000**
FNC	25.1958	20.5680	62.6296	38.0508		
SNC	252.3529	247.7474	274.5494	218.3585	214.2372	175.5925
Difference, %	901.6	1104.5	338.4	473.9		
	2001	**2002**	**2003**	**2004**	**2005**	**1990-2005, %**
FNC						
SNC	177.2723	224.1095	249.9639	288.9106	373.2628	-62.2
Difference, %						

For the period 1999-2005, CO_2 emissions resulting from clinker production were estimated for the first time. The results allow assert that within the 1990-2005 time series CO_2 emissions from 2A1 'Cement Production' source category decreased by circa 62.2 percent.

In terms of non-CO_2 emissions, under the FNC there were estimated only the SO_2 emissions. Though the same emission factor (0.3 kg SO_2/t cement) was used under the SNC, the respective emissions were recalculated due to the availability of a new set of AD. NO_x emissions were estimated for the first time, by using an emission factor based on clinker production data (0.6 kg NO_x/t clinker). Between 1990 and 2005, NO_x emissions decreased by 62.3 percent, while SO_2 emissions by 66.2 percent (Table 4-30).

Table 4-30: Non-CO_2 Emissions from the 2A1 'Cement Production' Source Category in the Republic of Moldova within 1988-2005, Gg

GHG	1988	1990	1991	1992	1993	1994
NO_x	1.1148	1.0805	0.8499	0.3983	0.3253	0.2518
SO_2	0.7084	0.6864	0.5400	0.2430	0.2010	0.1590
GHG	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**
NO_x	0.2758	0.2708	0.3001	0.2387	0.2342	0.1921
SO_2	0.1556	0.1482	0.1835	0.1479	0.1386	0.1296
GHG	**2001**	**2002**	**2003**	**2004**	**2005**	**1990-2005, %**
NO_x	0.1931	0.2441	0.2716	0.3154	0.4072	-62.3
SO_2	0.1206	0.1372	0.1453	0.2003	0.2318	-66.2

2A2. 'Lime Production'

CO_2 emissions from lime production were recalculated for the 1990-1998 time series (for the Republic of Moldova the 1990 is the reference year under the UNFCCC, while emissions for 1988 year are presented here for comparison purposes), as a result of implementation of good practices (IPCC, 2000) and emissions estimations methods improvement: CO_2 emissions from 2A2 "Lime Production' were estimated by taking into account both activity data on quicklime and dolomite lime as well as on hydrated lime production (by applying a correction factor of 0.97). The respective approach allowed calculate CO_2 emissions originated from different types of lime produced in the RM. In the FNC of the RM under the UNFCCC the emission factor used (0.785 t CO_2/t lime) have not taken into account the purity of lime (the default EF correspond to 100 percent of CaO in lime, according the stoichiometric ration, while this can lead to an overestimation of emissions, since the CaO content may be less than 100 percent); these been solved within the current inventory cycle (the emissions factors used: 0.750 t CO_2/t of quicklime and 0.770 t CO_2/t of dolomite lime, have been adjusted to account for the CaO and CaO•MgO contents).

The results included into the FNC of the RM for the time series from 1992 through 1998 refer to the right bank of Dniester only (there were used AD available for the right bank of Dniester), while at present these refer to the whole territory of the country.

In comparison with the previously obtained results for the 1988-1991 time periods, the above mentioned changes resulted in a circa 7 percent decrease of CO_2 emissions. For the 1992 through 1998 time series, the changes made with the aim to complete the activity data with information available from the left bank of Dniester (ATULBD), resulted in a substantial increase of CO_2 emissions from the 2A2 'Lime Production' source category (Table 4-31).

For the period 1999-2005, CO_2 emissions resulting from lime production were estimated for the first time. The results allow assert that within the 1990-2005 time series CO_2 emissions from 2A2 'Lime Production' source category decreased by circa 95.5 percent.

Table 4-31: Comparative Results of CO_2 Emissions from 2A2 'Lime Production' Included into the FNC and SNC of the RM under the UNFCCC, Gg

	1988	1990	1991	1992	1993	1994
FNC	210.1445	160.3755	140.2010	25.7480	23.5500	12.4815
SNC	195.5308	149.2228	130.4512	64.1300	56.9720	44.4820
Difference, %	-7.0	-7.0	-7.0	149.1	141.9	256.4
	1995	**1996**	**1997**	**1998**	**1999**	**2000**
FNC	8.4780	15.6215	7.6145	9.9695		
SNC	28.3399	39.3691	35.5710	28.2669	17.6759	11.0292
Difference, %	234.3	152.0	367.2	183.5		
	2001	**2002**	**2003**	**2004**	**2005**	**1990-2005, %**
FNC						
CND	3.8712	8.2536	2.4104	2.2643	6.6467	-95.5
Difference, %						

Table 4-32: Non-CO_2 Emissions from the 2A2 'Lime Production' Source Category in the Republic of Moldova within 1988-2005, Gg

GHG	1988	1990	1991	1992	1993	1994
NO_x	0.3635	0.2774	0.2425	0.1192	0.1059	0.0827
CO	1.2983	0.9909	0.8662	0.4258	0.3783	0.2954
SO_2	0.2597	0.1982	0.1732	0.0852	0.0757	0.0591
GHG	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**
NO_x	0.0527	0.0732	0.0661	0.0526	0.0329	0.0205
CO	0.1882	0.2614	0.2362	0.1877	0.1174	0.0732
SO_2	0.0376	0.0523	0.0472	0.0375	0.0235	0.0146
GHG	**2001**	**2002**	**2003**	**2004**	**2005**	**1990-2005, %**
NO_x	0.0072	0.0153	0.0045	0.0042	0.0124	-95.5
CO	0.0257	0.0548	0.0160	0.0150	0.0441	-95.5
SO_2	0.0051	0.0110	0.0032	0.0030	0.0088	-95.5

The non-CO_2 emissions resulting from lime production were estimated for the first time. Between 1990 and 2005, the respective emissions decreased by 95.5 percent (Table 4-32), the situation being explained by a significant decrease in the lime production in the Republic of Moldova.

2A6. 'Road Paving with Asphalt'

CO and NMVOC emissions from 2A6 'Road paving with asphalt' were recalculated for the 1990-1998 time series because of change of the estimation methodology, while the indirect CO_2 and CH_4 emissions were estimated for the first time.

In comparison with GHG emission estimation values included into the FNC of the RM under the UNFCCC, the new methodological approach resulted in 35 percent decrease of NMVOC emissions and 115 percent increase of CO emissions from the 2A6 'Road Paving with Asphalt'.

For the period 1999-2005, GHG emissions resulting from road paving with asphalt were estimated for the first time. The results allow assert that within the 1990-2005 time series GHG emissions from 2A6 'Road Paving with Asphalt' source category decreased by 94.7 percent (Table 4-33).

2A7a. 'Other' [Glass Production]

GHG emissions from glass production were recalculated for the period from 1990 through 1998 (for the RM the 1990 is the reference year under the UNFCCC, while emissions for 1988 year are presented here for comparison purposes), due to use a new calculation methodology - for CO_2 emissions it was used the methodology available in the 2006 IPCC Guidelines for National Greenhouse Gas Inventories (IPCC, 2006), for non-CO_2 emissions (NO_x, NMVOC and SO_2), respectively the methods available in the 3rd edition of the EMEP CORINAIR Atmospheric Emissions Inventory Guidebook (CORINAIR, 2005), which replaced the method available in the 1st edition of the EMEP CORINAIR Atmospheric Emissions Inventory Guidebook (CORINAIR, 1995), used in the FNC of the RM under UNFCCC (2000).

Table 4-33: GHG Emissions from the 2A6 'Road Paving with Asphalt' Source Category in the Republic of Moldova within 1990-2005, Gg

Year	CO_2	CH_4	CO	NMVOC
1990	0.1874	0.0061	0.0915	0.0183
1991	0.1559	0.0051	0.0761	0.0152
1992	0.1310	0.0043	0.0640	0.0128
1993	0.1041	0.0034	0.0509	0.0102
1994	0.0630	0.0021	0.0308	0.0062
1995	0.0568	0.0019	0.0278	0.0056
1996	0.0516	0.0017	0.0252	0.0050
1997	0.0175	0.0006	0.0085	0.0017
1998	0.0142	0.0005	0.0069	0.0014
1999	0.0062	0.0002	0.0030	0.0006
2000	0.0050	0.0002	0.0024	0.0005
2001	0.0063	0.0002	0.0031	0.0006
2002	0.0055	0.0002	0.0027	0.0005
2003	0.0063	0.0002	0.0031	0.0006
2004	0.0068	0.0002	0.0033	0.0007
2005	0.0100	0.0003	0.0049	0.0010

The results included into the FNC of the RM under the UNFCCC for the 1992-1998 time series refer to the right bank of Dniester only, while the present inventory covers the whole country's territory. In comparison with values included into the FNC, the changes made resulted in an essential increase of the non-CO_2 emissions from glass production (CO_2 emissions from glass production were not estimated into the FNC of the RM).

For the period 1999-2005, CO_2 emissions resulting from glass production were estimated for the first time. The results allow assert that within the 1990-2005 time series, the CO_2 emissions from 2A7a 'Other' [Glass Production] source category decreased by circa 65 percent, while the non-CO_2 emissions, respectively by circa 61 percent (Table 4-34)

2A7b. 'Other' [Mineral Wool Production]

GHG emissions from mineral wool production[9] were recalculated for the period from 1990 through 1998 (for the RM the 1990 is the reference year under the UNFCCC, while emissions for 1988 year are presented here for comparison purposes), first of all due to updated set of activity data being available in the Statistical Yearbooks of the RM and ATULBD (to be noted that since 2002 no mineral wool is produced in the RM).

[9]The methodology used to estimate GHG emissions from mineral wool production (CORINAIR, 1996) under the SNC is the same with that used under the FNC of the RM under the UNFCCC.

Table 4-34: GHG Emissions from the 2A7a 'Other' [Glass Production] Source Category in the Republic of Moldova within 1988-2005, Gg

GHG	1988	1990	1991	1992	1993	1994
CO_2	32.6895	59.4234	62.7183	46.6956	47.9700	11.8800
NO_x	0.7849	1.4265	1.5056	1.1210	1.1513	0.5702
NMVOC	1.4663	2.6700	2.8172	2.0980	2.1587	1.0692
SO_2	0.3934	0.7140	0.7538	0.5611	0.5756	0.2851
GHG	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**
CO_2	8.1300	6.3650	7.6710	7.1332	6.1186	19.3617
NO_x	0.3902	0.3055	0.3682	0.3424	0.2937	0.5163
NMVOC	0.7317	0.5729	0.6904	0.6420	0.5507	0.9681
SO_2	0.1951	0.1528	0.1841	0.1712	0.1468	0.2582
GHG	**2001**	**2002**	**2003**	**2004**	**2005**	**1990-2005, %**
CO_2	18.1143	21.0429	19.0134	19.0404	20.8035	-65.0
NO_x	0.4830	0.5611	0.5070	0.5077	0.5548	-61.1
NMVOC	0.9057	1.0521	0.9507	0.9520	1.0402	-61.0
SO_2	0.2415	0.2806	0.2535	0.2539	0.2774	-61.2

In comparison with the previously obtained results for the 1988-1991 time periods, the above mentioned changes resulted in an insignificant variation of the CO_2 emissions from mineral wool production. For the 1992 through 1998 time series, the changes made with the aim to complete the activity data with information available from the Statistical Yearbooks of the ATULBD, resulted in a substantial increase of CO_2 emissions from the 2A7b 'Other' [Mineral Wool Production] source category.

For the period 1999-2002, CO_2 emissions resulting from mineral wool production were estimated for the first time. The results allow assert that within the 1990-2002 time series CO_2 emissions from 2A7b 'Other' [Mineral Wool Production] source category decreased by circa 99.8 percent (Table 4-35).

Table 4-35: Comparative Results of CO_2 Emissions from 2A7b 'Other' [Mineral Wool Production] Included into the FNC and SNC of the RM under the UNFCCC, Gg

	1988	1990	1991	1992	1993	1994	1995
FNC	8.9700	8.1535	5.0945	0.9545	0.8050	0.2070	0.4255
SNC	8.9542	8.0816	5.0988	2.5372	1.5223	0.5793	0.5721
Difference, %	-0.18	-0.88	0.08	165.81	89.11	179.86	34.46
	1996	**1997**	**1998**	**1999**	**2000**	**2002**	**1990–2002, %**
FNC	0.2990	0.3036	0.0978				
SNC	0.3019	0.3881	0.2803	0.1854	0.0848	0.0144	-99.8
Difference, %	0.96	27.84	186.62				

The non-CO_2 emissions resulting from mineral wool production were estimated for the first time. Between 1990 and 2002, the respective emissions decreased by 99.8 percent (Table 4-36), the situation being explained by a sharp decrease in the mineral wool production in the Republic of Moldova over the respective period of time.

Table 4-36: Non-CO_2 Emissions from the 2A7b 'Other' [Mineral Wool Production] Source Category in the Republic of Moldova within 1988-2002, Gg

	1988	1990	1991	1992	1993	1994	1995
CO	0.2492	0.2249	0.1419	0.0706	0.0424	0.0161	0.0159
SO_2	0.1168	0.1054	0.0665	0.0331	0.0199	0.0076	0.0075
	1996	**1997**	**1998**	**1999**	**2000**	**2002**	**1990–2002, %**
CO	0.0084	0.0108	0.0078	0.0052	0.0024	0.0004	-99.8
SO_2	0.0039	0.0051	0.0037	0.0024	0.0011	0.0002	-99.8

2A7c. 'Other' [Bricks Production]

CO_2 emissions from bricks production were calculated for the 1988-2005 time series for the first time. It was used the estimation methodology available in the 2006 IPCC Guidelines for National GHG Inventories (IPCC, 2006). The results allow assert that within the 1990-2005 time series CO_2 emissions from 2A7c 'Other' [Bricks Production] source category decreased by circa 69.4 percent (Table 4-37).

SO_2 emissions from bricks production were recalculated for the period from 1990 through 1998 (for the RM the 1990 is the reference year under the UNFCCC, while emissions for 1988 year are presented here for comparison purposes), due to use of another emission factor (0.175 kg/t) available in the 3rd edition of the EMEP CORINAIR Inventory Guidebook (CORINAIR, 2005), replacing the previously used value (0.350 kg/t), available in the first edition of EMEP CORINAIR Inventory Guidebook (CORINAIR, 1995).

Table 4-37: GHG Emissions from the 2A7c 'Other' [Bricks Production] Source Category in the Republic of Moldova within 1988-2005, Gg

	1988	1990	1991	1992	1993	1994
CO_2	53.6667	52.6166	48.5949	26.4088	39.4792	19.9519
SO_2	0.1681	0.1649	0.1523	0.0827	0.1258	0.0625
	1995	**1996**	**1997**	**1998**	**1999**	**2000**
CO_2	13.2268	11.6827	13.3788	14.5217	12.7289	11.8549
SO_2	0.0414	0.0372	0.0418	0.0454	0.0398	0.0370
	2001	**2002**	**2003**	**2004**	**2005**	**1990-2005, %**
CO_2	11.8997	14.6246	15.8821	17.6752	16.1150	-69.4
SO_2	0.0372	0.0440	0.0477	0.0531	0.0484	-70.6

In comparison with the previously obtained results, the above mentioned changes resulted in a 50 percent decrease of SO_2 emissions originated from the 2A7c 'Other' [Bricks Production] source category. For the period 1999-2005, SO_2 emissions from bricks production were estimated for the first time. The results allow assert that within the 1990-2005 time series SO_2 emissions from 2A7c 'Other' [Brick Production] source category decreased by circa 70.6 percent.

4.2.6 Planned Improvements

Possible improvements under the 2A 'Mineral Products' source category might be possible under the consideration the possibility to collect activity data needed to estimate CO_2 emissions from the 2A3 'Limestone and Dolomite Use' source category (i.e., used for refining sugar, for iron and steel production, in construction sector and in agriculture). Activities aiming at précising the activity data used to estimate GHG emissions from emissions sources under the 2A 'Mineral Products' category, are also planned as future improvements.

4.3 Chemical Industry (Category 2B)

4.3.1 Source Category Description

The 2B 'Chemical Industry' category comprises the following emission sources: 2B1 'Ammonia Production', 2B2 'Nitric Acid Production', 2B3 'Adipic Acid Production', 2B4 'Carbide Production' and 2B5 'Other'. No emissions were registered in the RM under the categories 2B1-2B4. Within the 2B5 'Other' in the RM are monitored the NMVOC emissions from the following sources: 2B5a 'Polyethylene Production', 2B5b 'Acrylonitrile Butadiene Styrene Resins Production' and 2B5c 'Detergents Production'.

Between 1990 and 2005, the NMVOC emissions from the 2B 'Chemical Industry' category decreased by 97.8 percent: from 0.3657 Gg in 1990, to 0.0081 Gg in 2005 (Figure 4-4).

2B5a. 'Other' [Polyethylene Production]

Three types of polyethylene are produced: low density polyethylene (LDPE), linear low density polyethylene (LLDPE) and high density polyethylene (HDPE). Polyethylene is a polymer of ethylene and has the general empirical formula $(-CH_2CH_2-)n$. The manufacturing process used depends upon the type of polymer produced. LDPE is a tough waxy polymer, with approximately 2 percent branching between polymer chains and has a density of about 0.92t/m^3. LDPE is generally produced by high pressure and high temperature catalytic polymerization of ethylene in a tubular or autoclave reactor. LLDPE is a crystalline polymer with no chain branching and a density comparable to that of LDPE. A low pressure method is generally used in which ethylene

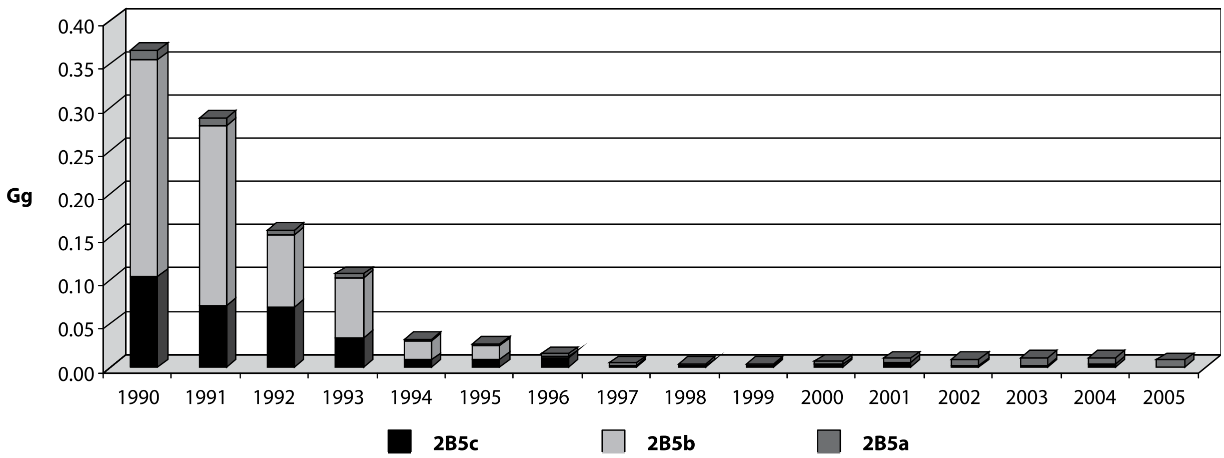

Figure 4-4: NMVOC Emissions from the Category 2B 'Chemical Industry' by Source in the Republic of Moldova within 1990-2005

and a co-monomer such as butane or hexane is catalytically polymerized. HDPE is a crystalline polymer with no chain branching and a density of about 0.96t/m[3]. HDPE is produced by low pressure polymerization of ethylene in a reactor containing a liquid hydrocarbon diluent and in the presence of Ziegler catalysts. The polymer produces slurry as it forms and is filtered from the solvent. The major emissions to air are NMVOC - un-reacted monomer (i.e. ethylene), some partially reacted monomer (alkenes and alkane) together with small amounts of additives. NMVOCs are emitted primarily through leakages, and may be production time dependent rather than production dependent. Control techniques are primarily through replacement of leaking valves etc, and regular maintenance.

2B5b. 'Other' [Acrylonitrile Butadiene Styrene Resins (ABS) Production]

Acrylonitrile butadiene styrene (ABS) is a combination of a graft copolymer and a polymer mixture (graft copolymer - a polymer with a 'backbone' of one type of monomer and with 'ribs' of copolymers of two other monomers). ABS can be produced in three ways: (1) emulsion polymerization: it is a two step process; in the first step a rubber latex is made, usually in a batch process; in the second step, which can be operated as batch and continuous, styrene and acrylonitrile are polymerized in the rubber latex solution to form an ABS latex; the ABS polymer is recovered through coagulation of the ABS latex by adding a destabilizing agent; the resulting slurry is filtered or centrifuged to recover the ABS resin; the ABS resin is then dried; (2) mass polymerization: two or more continuous flow reactors are used in this process; rubber is dissolved in the monomers, being styrene and Acrylonitrile; during the reaction the dissolved rubber is replaced by the styrene acrylonitrile copolymer (SAN) and forms discrete rubber particles; part of the SAN is grafted on the rubber particles, while another part is occluded in the particles; the reaction mixture contains several additives, e.g. initiator, chain-transfer agents, these are needed in the polymerization; the product is devolatilized ro remove unreacted monomer, which are recycled to the reactor, and then pelletized; (3) mass suspension: this batch process starts with a mass polymerization which is stopped at a monomer conversion of 15 - 30 percent; then a suspension reaction completes the polymerization; for this reaction the mixture of polymer and monomer is suspended in water using a suspending agent and then the polymerization is continued; unreacted monomers are stripped, then the product is centrifuged and dried.

NMVOC emissions of acrylonitrile butadiene styrene resins plants can be subdivided as follows: leakage losses from appendages, pumps, and other leakage; flaring, disruptions; losses due to storage and handling; combustion emissions; other process emissions. The losses due to leakage can be limited by use of certain types of seals and application of double seals near pumps.

2B5c. 'Other' [Detergents Production]

The term "synthetic detergent products" applies broadly to cleaning and laundering compounds containing surface-active compounds along with other ingredients. Until the early 1970s, almost all laundry detergents sold were heavy-duty powders. Liquid detergents that utilized sodium citrate and sodium silicate were introduced in 1980-s of the XX century. The liquids offered superior performance and solubility. Introduction of super concentrated powder detergents lead to an increase in spray drying operations at some facilities. Manufacturers are currently developing more biodegradable surfactants from natural oils.

The manufacture of spray-dried detergent has 3 main processing steps: (1) slurry preparation, (2) spray drying, and (3) granule handling. The 3 major components of detergent are surfactants (to remove dirt and other unwanted materials), builders (to treat the water to improve surfactant performance), and additives to improve cleaning performance. Additives may include bleaches, bleach activators, antistatic agents, fabric softeners, optical brighteners, anti re-deposition agents, and fillers.

The formulation of slurry for detergent granules requires the intimate mixing of various liquid, powdered, and granulated materials. Detergent slurry is produced by blending liquid surfactant with powdered and liquid materials (builders and other additives) in a closed mixing tank called a soap crutcher. Premixing of various minor ingredients is performed in a variety of equipment prior to charging to the crutcher or final mixer. Liquid surfactant used in making the detergent slurry is produced by the sulfonation of either a linear alkylate or a fatty acid, which is then neutralized with a caustic solution containing sodium hydroxide (NaOH). The blended slurry is held in a surge vessel for continuous pumping to a spray dryer. The slurry is atomized by spraying through nozzles rather than by centrifugal action. The slurry is sprayed at high pressure into a vertical drying tower. The detergent granules are conveyed mechanically or by air from the tower to a mixer to incorporate additional dry or liquid ingredients, and finally to packaging and storage.

The exhaust air from detergent spray drying towers contains 2 types of air contaminants: (1) fine detergent particles and (2) organics vaporized in the higher temperature zones of the tower. Dust emissions are generated at scale hoppers, mixers, and crutchers during the batching and mixing of fine dry ingredients to form slurry. Conveying, mixing, and packaging of detergent granules can also cause dust emissions. Pneumatic conveying of fine materials causes dust emissions when conveying air is separated from bulk solids.

For this process, fabric filters are generally used, not only to reduce or to eliminate dust emissions, but also to recover raw materials. The dust emissions principally consist of detergent compounds, although some of the particles are uncombined phosphates, sulfates, and other mineral compounds.

Dry cyclones and cyclonic impingement scrubbers are the primary collection equipment employed to capture the detergent dust in the spray dryer exhaust for return to processing. Dry cyclones are used in parallel or in series to collect this particulate matter (PM) and recycle it back to the crutcher. The dry cyclone separators can remove 90 percent or more by weight of the detergent product fines from the exhaust air. Cyclonic impinged scrubbers are used in parallel to collect the particulate from a scrubbing slurry and to recycle it to the crutcher. Secondary collection equipment is used to collect fine particulates that escape from primary devices. For example, cyclonic impingement scrubbers are often followed by mist eliminators. Several types of scrubbers can be used following the cyclone collectors. Venturi scrubbers have been used but are being replaced with packed bed scrubbers. Packed bed scrubbers are usually followed by wet-pipe-type electrostatic precipitators built immediately above the packed bed in the same vessel. Fabric filters have been used after cyclones but have limited applicability, especially on efficient spray dryers, due to condensing water vapour and organic aerosols binding the fabric filter.

NMVOC originate primarily from the surfactants included in the slurry. A method for controlling emissions would be to remove offending organic compounds from the slurry.

4.3.2 Methodological Issues and Data Sources

2B5a. 'Other' [Polyethylene Production]

Methodological issues for calculation the NMVOC emissions from polyethylene production are addressed in the EMEP CORINAIR Inventory Guidebook (1996). The methodology used relied on the use of an emission factor for each type of polyethylene production (Table 4-38) combined with activity data from Statistical Yearbooks of the Republic of Moldova and of the ATULBD (Table 4-39).

Table 4-38: EF Used to Estimate NMVOC Emissions from Polyethylene Production

Source	Description	NMVOC, kg / t
Other Chemical Production	Polyethylene manufacture at new plants	2
	Polyethylene manufacture at old plants	10
	LDPE manufacture	2-3
	LLDPE manufacture	2
	HDPE manufacture	5.0-6.4

Source: EMEP CORINAIR Atmospheric Emissions Inventory Guidebook, 3rd edition, February 15, 1996, B456-1 up to B456-3, pr040506, Polyethylene Production.

As the share of different types of polyethylene in total production of this product in the RM is unknown, it was not possible to use EF specific for each type of polyethylene (an EF of 2 kg NMVOC per tone of polyethylene was used, practically all polyethylene producing plants in the RM were re-equipped).

Table 4-39: Activity Data on Polyethylene Production in the Republic of Moldova within 1988-2005 time series, kt

	1988	1990	1991	1992	1993	1994
RM: right bank of the Dniester	5.300	3.519	3.100	1.715	1.601	0.878
RM: left bank of the Dniester	1.800	1.681	1.300	0.900	0.700	0.300
RM: total	7.100	5.200	4.400	2.615	2.301	1.178
	1995	**1996**	**1997**	**1998**	**1999**	**2000**
RM: right bank of the Dniester	0.717	1.552	1.168	1.170	0.683	1.689
RM: left bank of the Dniester	0.012	0.296	0.031	0.040	0.035	0.034
RM: total	0.729	1.848	1.199	1.210	0.718	1.723
	2001	**2002**	**2003**	**2004**	**2005**	**1990-2005, %**
RM: right bank of the Dniester	2.050	3.324	4.225	3.595	3.759	6.8
RM: left bank of the Dniester	0.041	0.024	0.011	0.002	0.001	-99.9
RM: total	2.091	3.348	4.236	3.597	3.760	-27.7

Source: Statistical Yearbooks of the RM for 1988 (page 232), 1994 (page 284), 1999 (page 302), 2003 (page 391), the Official Letter from the National Bureau of Statistics No. 02-10/115 from 06.10.2006 (comprises activity data covering the period 1992 through 2005); Statistical Yearbooks of the ATULBD for 1998 (page 176), 2000 (page 99), 2002 (page 103), 2005 (page 94) and 2006 (page 93).

2B5b. 'Other' [Acrylonitrile Butadiene Styrene Resins (ABS) Production]

Methodological issues for calculating the NMVOC emissions from synthetic resins (Acrylonitrile Butadiene Styrene) production are addressed in the EMEP CORINAIR Inventory Guidebook (1996). The methodology used relied on the use of a specific emission factor (Table 4-40) combined with activity data from the national statistics (Table 4-41). In conformity with the information provided by the NBS, starting 1997 there is no production of acrylonitrile butadiene styrene (ABS) resins in the RM.

Table 4-40: Emission Factor Used to Estimate NMVOC Emissions from Acrylonitrile Butadiene Styrene Resins (ABS) Production

Source	Description	NMVOC emissions, kg / t
Other chemicals production	Production of ABS resins	1.4 – 27.2

Source: EMEP CORINAIR Atmospheric Emissions Inventory Guidebook, 3rd edition, February 15, 1996, B4515, pr040515, Production of ABS resins.

As it is not known what technology was used for acrylonitrile butadiene styrene resins production in the RM over the period under review, and the range for the emission factors is large (between 1.4 and 27.2 kg of NMVOC/t of product), it has been decided to use an average value, of 14.3 kg NMVOC per tone of product.

Table 4-41: Activity Data on Acrylonitrile Butadiene Styrene Resins (ABS) Production in the Republic of Moldova, 1985-1996

	1985	1986	1987	1988	1990	1991
RM: production of ABS resins, kt	15.900	16.200	16.000	16.300	17.500	14.600
	1992	**1993**	**1994**	**1995**	**1996**	**1990-1996, %**
RM: production of ABS resins, kt	5.839	4.792	1.510	1.104	0.040	-99.8

Source: Statistical Yearbooks of the RM for 1988 (page 226), 1994 (page 284) and the Official Letter from the National Bureau of Statistics No. 02-10/115 from 06.10.2006 (comprises activity data covering the period 1992 through 1996).

2B5c. 'Other' [Detergents Production]

Methodological issues for calculating the NMVOC emissions from detergents production are addressed in the US EPA's publications. The methodology used relied on the use of an emission factor specific for the detergents production technology used in the RM (Table 4-42), combined with activity data from the national statistics.

Table 4-42: EF Used to Estimate NMVOC Emissions from Detergents Production

Source	Description	Control device	NMVOC kg / t
Other Chemicals Production	Detergents Production	Uncontrolled	45
		Cyclone	7
		Cyclone with spray chamber	3.5
		Cyclone with packed scrubber	2.5
		Cyclone with venture scrubber	1.5
		Cyclone with wet scrubber	0.544
		Cyclone with wet scrubber/ electrostatic precipitation	0.023
		Cyclone with packed bed/ electrostatic precipitation	0.470
		Fabric filter	0.540

Sources: EPA-450/4-90-003, EPA, USA, Research Triangle Park, NC, March 1990; Emission Test Report, Procter and Gamble, Augusta, GA Georgia Department of Natural Resources, Atlanta, GA, July 1988; A.J. Buonicore and W.T. Davis, Eds., Air Pollution Engineering Manual, Van Nostrand Reinhold, New York, NY, 1992.

As in the RM the control devices used in detergents production are of cyclone type, the value of the NMVOC emission factor was assumed as being 7 kg per tone of detergent produced.

Table 4-43: Activity Data on Detergents Production in the RM, 1988-2005

	1988	1990	1991	1992	1993	1994
RM: detergents production, kt	13.4000	15.0000	10.1000	9.8780	4.9370	1.2000
	1995	**1996**	**1997**	**1998**	**1999**	**2000**
RM: detergents production, kt	1.3540	1.5870	0.3390	0.1820	0.2700	0.4060
	2001	**2002**	**2003**	**2004**	**2005**	**1990-2005, %**
RM: detergents production, kt	0.8220	0.2830	0.2700	0.4929	0.0846	-99.4

Source: Statistical Yearbooks of the RM for 1988 (page 233), 1994 (page 291), 1999 (page 306), 2003 (page 395), 2005 (page 321) and 2006 (page 311).

4.3.3 Uncertainties and Time-Series Consistency

The primary uncertainties related factors pertain to methodology, emission factors used to estimate NMVOC emissions covered by the 2B 'Chemical Industry' category, and quality of activity data available. Uncertainty of the default emission factors values were considered as being high (±100 percent), while those of activity data respectively, moderate (±10 percent).

In view of ensuring time-series consistency of the obtained results, the same approach was used for the entire period under review, in conformity with the recommendations included in the Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories (IPCC, 2000).

4.3.4 QA/QC and Verification

Standard verification and quality control forms and checklists were filled in for the respective category under the Industrial Processes Sector, following the Tier 1 and Tier 2 approaches (see in Annex 6). Also, the AD and methods used for estimating GHG emissions under the category 2B 'Chemical Industry' were documented and archived both in hard copies and electronically. For identifying the data entry and emission estimation process related errors there were applied verifications and quality control procedures. Verification was focused on correct use of AD obtained from different sources of reference (i.e., Statistical Yearbooks of the RM and ATLBD, National Bureau of Statistics, and other sources [Dobrova, Ţăranu, 2000b]), as well as on ensuring correct use of the default emission factors available in the EMEP CORINAIR Atmospheric Emissions Inventory Guidebook (CORINAIR, 1996) and US EPA publications (1990). Inventory quality assurance activities for the Industrial Processes Sector, inclusive for the 2B 'Chemical Industry', were supported by an expert representing the Technical University of Moldova (TUM).

Following the recommendations included into the Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories (IPCC, 2000), GHG emissions originated from the 2B 'Chemical Industry' were estimated based on AD and EFs from official sources of reference.

4.3.5 Recalculations

Total NMVOC emissions from the 2B5 'Other' source category were recalculated for the 1990-1998 time series (for the Republic of Moldova the 1990 is the reference year under the UNFCCC, while emissions for 1988 year are presented here for comparison purposes), inclusively due to including new emission sources. Within the FNC of the RM under the UNFCCC, there were included only NMVOC emissions from detergents production (the same estimation methodology, emission factor and activity data set was used under the current inventory cycle), while under the SNC of the RM under the UNFCCC there were included as well the NMVOC emissions from polyethylene production and ABS synthetic resins production. The obtained results show that between 1990 and 2005, the total NMVOC emissions from 2B5 'Other' decreased by 97.8 percent (Table 4-44).

Table 4-44: NMVOC Emissions from the 2B5 'Other' Source Category in the Republic of Moldova within the 1988-2005 time series, Gg

	1988	1990	1991	1992	1993	1994
2B5a Polyethylene	0.0142	0.0104	0.0088	0.0052	0.0046	0.0024
2B5b ABS Synthetic Resins	0.2331	0.2503	0.2088	0.0835	0.0685	0.0216
2B5c Detergents	0.0938	0.1050	0.0707	0.0691	0.0346	0.0084
2B5 Total: Other Chemical Products	0.3411	0.3657	0.2883	0.1579	0.1077	0.0323
	1995	1996	1997	1998	1999	2000
2B5a Polyethylene	0.0015	0.0037	0.0024	0.0024	0.0014	0.0034
2B5b ABS Synthetic Resins	0.0158	0.0006	0.0000	0.0000	0.0000	0.0000
2B5c Detergents	0.0095	0.0111	0.0024	0.0013	0.0019	0.0028
2B5 Total: Other Chemical Products	0.0267	0.0154	0.0048	0.0037	0.0033	0.0063
	2001	2002	2003	2004	2005	1990-2005, %
2B5a Polyethylene	0.0042	0.0067	0.0085	0.0072	0.0075	-27.7
2B5b ABS Synthetic Resins	0.0000	0.0000	0.0000	0.0000	0.0000	-100.0
2B5c Detergents	0.0058	0.0020	0.0019	0.0035	0.0006	-99.4
2B5 Total: Other Chemical Products	0.0099	0.0087	0.0104	0.0106	0.0081	-97.8

4.3.6 Planed Improvements

Further improvements under the 2B 'Chemical Industry' category might be possible by considering the possibility to update the activity data set used to estimate GHG emissions from 2B5 'Other' source category.

4.4 Metal Production (Category 2C)

4.4.1 Source Category Description

The 2C 'Metal Production' category covers GHG emissions from the following sources: 2C1 'Iron and Steel Production', 2C2 'Ferroalloys Production', 2C3 'Aluminium Production', 2C4 'SF_6 used in Aluminium and Magnesium Foundries', and 2C5 'Other'. At the moment, the 2C1 'Iron and Steel Production' is the only source category relevant for the RM in terms of GHG emissions under the category 2C 'Metal Production'.

Iron and steel production can occur at primary integrated facilities by reducing the iron ore with metallurgical coke, at secondary facilities, in particular, by melting the recycled steel scrap using electrical energy imparted to the charge through carbon electrodes.

Primary facilities are: open hearth furnaces (OHFs) accounting for circa 4 percent of the world iron and steel production, and basic oxygen steelmaking furnaces (BOFs), accounting for circa 63 percent of the world iron and steel production. The metallurgical coke used in furnaces and ovens is oxidized to CO_2 and then emitted into the atmosphere (a certain amount of carbon is retained in iron). Secondary steelmaking most often occurs in electric arc furnaces (EAFs) accounting for circa 33 percent of the world iron and steel production.

To be noted that the technology used in the RM for steel production is exclusively EAF. Electric arc furnaces are equipped with carbon electrodes (can also be made of graphite or Soderberg mix). Through carbon electrodes electricity is added to the scrap in the furnace, thus raising the temperature to 1700 °C. Lime, anthracite and pig-iron are then added. Depending on the desired quality of the steel, chromium, manganese, molybdenum or vanadium compounds can be added (CORINAIR, 2005). CO_2 emissions from steel production in electric arc furnaces are determined by carbon losses in electrodes. When electrodes are placed above the melted metal, the electric arc oxidizes the carbon to CO or CO_2. Sometimes, electrodes are immersed in the melted metal to increase carbon concentration in steel, thus contributing to additional CO_2 emissions.

The direct greenhouse gas emissions from the 2C1 'Iron and Steel Production' source category tended to increase over the period under review in the Republic of Moldova (Figure 4-5), except for the 1998 and 2002 years, when the emissions have decreased due to regional economic crisis in 1998, and change of ownership at Metal Integrated Works in Ribnita (ATULBD).

Between 1990 and 2005 time series, the GHG emissions from the source category 2C1 'Iron and Steel Production' increased in the Republic of Moldova by 47.9 percent, from 71.20 Gg CO_2 eq. in 1990 up to 105.29 Gg CO_2 eq. in 2005.

The indirect greenhouse gas emissions (NO_x, CO, NMVOC) and SO_2 covered by the respective source category also tended to increase (Figure 4-6).

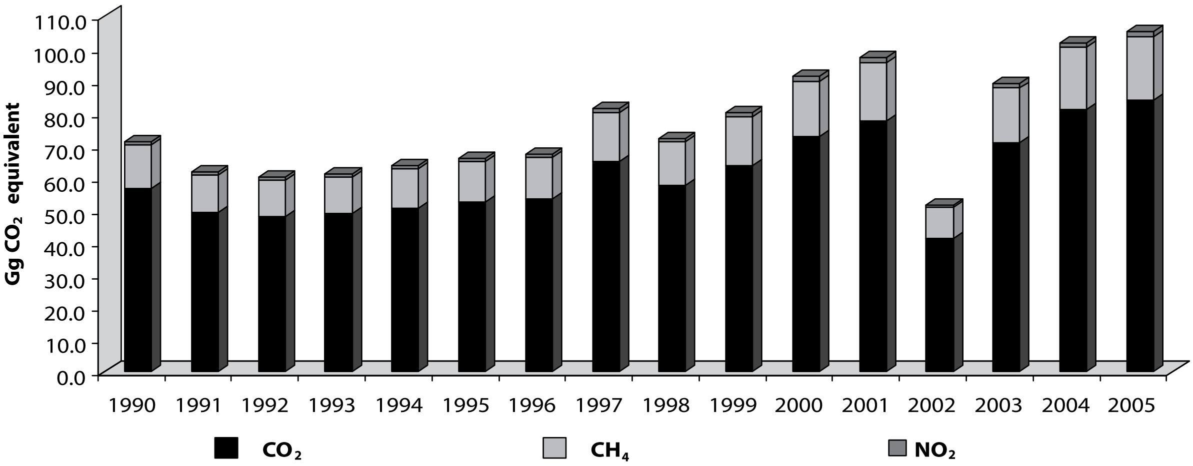

Figure 4-5: GHG Emissions from the Category 2C 'Metal Production' by Gas in the Republic of Moldova within 1990-2005

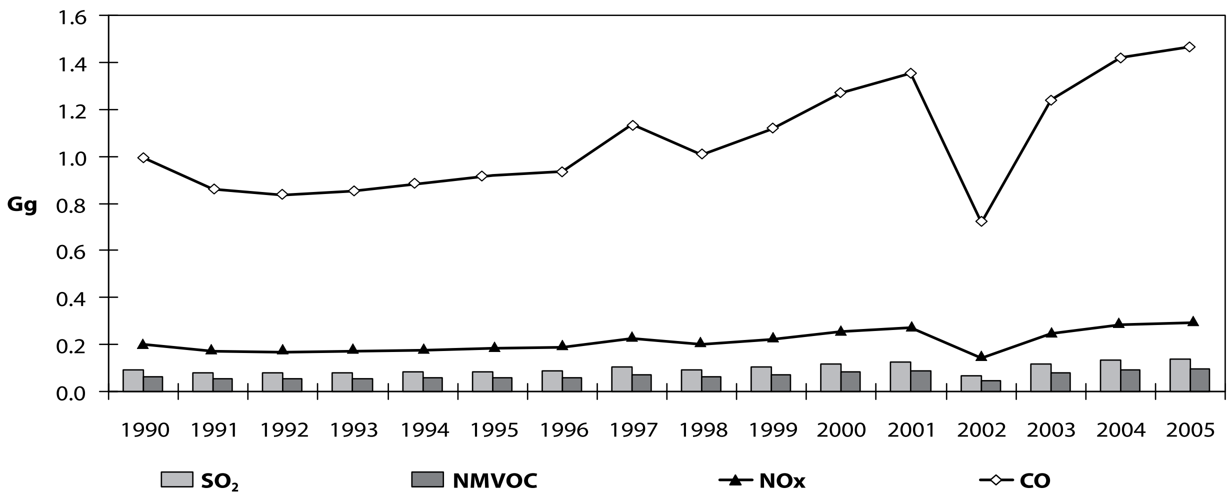

Figure 4-6: Ozone and Aerosol Precursors Emissions from the Category 2C 'Metal Production' by Gas in the Republic of Moldova within 1990-2005

4.4.2 Methodological Issues and Data Sources

CO_2 emissions from steel production were estimated by using a Tier 1 methodology implying use of default emission factor value (Table 4-45) combined with activity data on steel production, available in the Statistical Yearbooks of the RM and of the ATULBD (Table 4-47), based on equation below.

$Emissions\ CO_2=(BOF \bullet EF_{BOF})+(EAF \bullet EF_{EAF})+(OHF \bullet EF_{EAF})+(IP \bullet EF_{IP})$

Where:

BOF = quantity of BOF crude steel produced, tones

EAF = quantity of EAF crude steel produced, tones

OHF = quantity of OHF crude steel produced, tones

IP = quantity of pig iron production not converted to steel, tones

EF = emission factors specific for different steel production technologies.

Table 4-45: Default CO_2 Emission Factors for Iron and Steel Production

Steel Production Technology	EF, tone CO_2 per tone of steel produced
Basic Oxygen Furnace (BOF)	1.46
Electric Arc Furnace (EAF)	0.08
Open Hearth Furnace (OHF)	1.72

Source: IPCC 2006 Guidelines for National Greenhouse Gas Inventories, Volume 3, Chapter 4, Tab. 4.1, Page 4.25.

The emission factors used to calculate non-CO_2 emissions from steel production in EAF rely on default values available in EMEP CORINAIR Atmospheric Emissions Inventory Guidebook (CORINAIR, 1999), and other relevant sources (Table 4-46).

Table 4-46: Default Emission Factors Used to Estimate Non-CO_2 Emissions from Steel Production in Electric Arc Furnace (EAF)

Source	Description	CH_4	N_2O	NO_x	CO	NMVOC	SO_2
		g / t					
EAF Steel Production	Steel Production [1]		5			90	130
	Steel Production [2]	900		280	1400		

Source: [1] EMEP CORINAIR Atmospheric Emissions Inventory Guidebook, September 1999, B427-1, pr040207, EAF Steel Production; [2] Handbook on specific indicators of pollutant atmospheric emissions for some industries – main sources of atmospheric pollution (Saint-Petersburg, 2001) *(in Russian)*.

To be noted that by now it was not possible to use the Tier 2 methodological approach, first of all due to lack of activity data on the amount of reduction agents used (it was not possible to get the information from the producer - Metal Integrated Works from Ribnita, on the left bank of Dniester). For the time series 1995 through 2005 there were available also activity data from the Steel Statistical Yearbooks, published by the International Institute of Iron and Steel (<http://www.worldsteel.org>)[10].

Table 4-47: Activity Data on Steel Production within 1988-2005 time series, kt

	1988	1990	1991	1992	1993	1994
RM: right bank of the Dniester	0.4	0.4	0.4	0.3	0.3	0.3
RM: left bank of the Dniester	712.7	708.4	614.9	597.4	609.2	632.8
RM: total	713.1	708.8	615.3	597.7	609.5	633.1
	1995	**1996**	**1997**	**1998**	**1999**	**2000**
RM: right bank of the Dniester	0.3	0.2	0.3	0.1	0.1	0.1
RM: left bank of the Dniester	656.5	668.9	810.4	718.0	796.0	908.0
RM: total	656.8	669.1	810.7	718.1	796.1	908.1
	2001	**2002**	**2003**	**2004**	**2005**	**1990-2005, %**
RM: right bank of the Dniester	0.1	0.2	0.1	0.2	0.1	-62.1
RM: left bank of the Dniester	967.0	513.0	886.0	1013.0	1048.0	47.9
RM: total	967.1	513.2	886.1	1013.2	1048.1	47.9

Source: Statistical Yearbooks of the RM for 1988 (page 221), 1999 (page 302), 2003 (page 391), 2004 (page 441), Statistical Yearbooks of the ATULBD for 1998 (page 178), 2000 (page 99), 2002 (page 103), 2006 (page 93).

4.4.3 Uncertainties and Time-Series Consistency

The primary uncertainties related factors pertain to methodology, emission factors used to estimate GHG emissions covered by the 2C 'Metal Production' category, and quality of activity data available. Uncertainties associated with EFs used to estimate CO_2 emissions from the 2C1 'Iron and Steel Production' source category, were estimated at ±25 percent for CO_2 emissions, ±150 percent for CH_4 emissions and ±300 percent for N_2O emissions. Uncertainties associated with statistical data on iron and steel production in the RM can be considered relatively low (±5 percent).

Uncertainties pertaining to GHG emissions from the 2C1 'Iron and Steel Production' source category were estimated at ±25.50 percent for CO_2 emissions, ±150.08 percent for CH_4 and ±300.04 percent for N_2O emissions. At the same

[10] The activity data on steel production published in the Statistical Yearbooks of the ATULBD are consistent with the data from the available within the Steel Statistical Yearbooks only for the period 1998 through 2001, while for other years there are slight differences: 656.5 kt versus 663 kt in 1995; 668.9 kt versus 646 kt in 1996; 810.4 kt versus 811 kt in 1997; 513 kt versus 514 kt in 2002; 886 kt versus 850 kt in 2003, 1013 kt versus 1012 kt in 2004, 1048 kt versus 1016 kt in 2005.

time, combined uncertainties, presented as a percent of total sectoral emissions were estimated at ±3.67 percent for CO_2 emissions, ±5.11 percent for CH_4 emissions, and ±0.84 percent for N_2O. Uncertainties introduced in trend in sectoral emissions were estimated at ±1.18 percent for CO_2 emissions, at ±1.56 percent for CH_4 emissions, and at ±0.26 percent for N_2O emissions (see Annex 7-3.2).

In view of ensuring time-series consistency of the obtained results, the same approach was used for the entire period under review, in conformity with the recommendations included in the Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories (IPCC, 2000).

4.4.4 QA/QC and Verification

Standard verification and quality control forms and checklists were filled in for the respective category under the Industrial Processes Sector, following the Tier 1 and Tier 2 approaches (see in Annex 6). Also, the AD and methods used for estimating GHG emissions under the category 2C 'Metal Production' were documented and archived both in hard copies and electronically. For identifying the data entry and emission estimation process related errors there were applied verifications and quality control procedures. Verification was focused on correct use of AD obtained from different sources of reference (i.e., Statistical Yearbooks of the RM and ATULBD, Steel Statistical Yearbook published by the International Institute of Iron and Steel and other sources [Ţăranu, Galitchii, 2000; Ţăranu et al., 2005]), as well as on ensuring correct use of the default emission factors available in the Revised 1996 IPCC Guidelines (IPCC, 1997), GPG (IPCC, 2000), 2006 IPCC Guidelines (IPCC, 2006) and EMEP CORINAIR Atmospheric Emissions Inventory Guidebook (CORINAIR, 1999). Inventory quality assurance activities for the Industrial Processes Sector, inclusive for the 2C 'Metal Production', were supported by an expert representing the Technical University of Moldova (TUM).

Following the recommendations included into the Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories (IPCC, 2000), GHG emissions originated from the 2C 'Metal Production' were estimated based on AD and EFs from official sources of reference.

4.4.5 Recalculations

CO_2 emissions from the 2C1 'Iron and Steel Production' source category were recalculated for the 1990 through 1998 time series (for the Republic of Moldova the 1990 is the reference year under the UNFCCC, while emissions for 1988 year are presented here for comparison purposes) as a result of change the estimation methodology: based on AD on steel production technology (EAF) and use of default emission factor available in the 2006 IPCC Guidelines (0.08 t CO_2/t steel), that replaced the methodology available in the Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories and the default emission factor used for the integrated facility (coke plus iron and steel production) (1.6 t CO_2/t iron or steel), used within the FNC of the RM under the UNFCCC (2000), as well as due to use of a new set of activity data[11] available into the Statistical Yearbooks of the RM and ATULBD.

In comparison with emissions estimates included into the FNC of the RM, the changes performed resulted in a significant decrease of CO_2 emissions from iron and steel production, which varied over the period under review between -91.8 percent in 1995 and -95.4 percent in 1992 (Table 4-48).

[11]In the FNC of the RM, activity data for the period from 1990 through 1994 were taken from the Statistical Yearbook of the RM for 1994 year, activity data for the period 1995 through 1997 were extrapolated, while those for 1998 year were provided by the producer (Integrated Metal Works in Ribnita).

Table 4-48: Comparative Results of CO_2 Emissions from 2C1 'Iron and Steel Production' Included into the FNC and SNC of the RM under the UNFCCC, Gg

	1988	1990	1991	1992	1993	1994
FNC	1140.9600	1139.0400	996.8000	1045.4400	796.6400	637.6000
SNC	57.0480	56.7016	49.2200	47.8192	48.7616	50.6480
Difference, %	-95.0	-95.0	-95.1	-95.4	-93.9	-92.1
	1995	**1996**	**1997**	**1998**	**1999**	**2000**
FNC	640.0000	800.0000	960.0000	1149.2640		
SNC	52.5439	53.5279	64.8524	57.4496	63.6854	72.6478
Difference, %	-91.8	-93.3	-93.2	-95.0		
	2001	**2002**	**2003**	**2004**	**2005**	**1990-2005, %**
FNC						
SNC	77.3706	41.0598	70.8912	81.0531	83.8512	47.9
Difference, %						

For the period 1999-2005, CO_2 emissions resulting from iron and steel production were estimated for the first time. The results allow assert that within the 1990-2005 time series CO_2 emissions from 2C1 'Iron and Steel Production' source category increased by 47.9 percent.

The non-CO_2 (CH_4, N_2O, NO_x, CO, NMVOC and SO_2) emissions from the 2C1 'Iron and Steel Production' source category, were recalculated as well, in particular due to change the emissions factors: in the FNC of RM there were used EFs available in the Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories, while in the SNC of the RM respectively, the EFs available in the EMEP CORINAIR Atmospheric Emissions Inventory Guidebook (CORINAIR, 1999) and other relevant sources (Handbook on specific indicators of pollutant atmospheric emissions for some industries – main sources of atmospheric pollution (Saint-Petersburg, 2001).

For the period 1999-2002, non-CO_2 emissions resulting from iron and steel production were estimated for the first time. The results allow assert that within the 1990-2005 time series non-CO_2 emissions from 2C1 'Iron and Steel Production' source category increased by circa 47.9 percent (Table 4-49).

4.4.6 Planned Improvements

Further improvements under the 2C 'Metal Production' category might be possible under the consideration the possibility to collect the activity data on the amount of reduction agents used at the Metal Integrated Works in Ribnita (ATULBD), that will allow using a higher Tier methodology for estimating the GHG emissions from 2C1 'Iron and Steel Production' source category.

Table 4-49: Non-CO_2 Emissions from the 2C1 'Iron and Steel Production' Source Category in the Republic of Moldova within 1988-2005, Gg

GHG	1988	1990	1991	1992	1993	1994
CH_4	0.6418	0.6379	0.5537	0.5380	0.5486	0.5698
NO_2	0.0036	0.0035	0.0031	0.0030	0.0030	0.0032
NO_x	0.1997	0.1985	0.1723	0.1674	0.1707	0.1773
CO	0.9983	0.9923	0.8614	0.8368	0.8533	0.8863
NMVOC	0.0642	0.0638	0.0554	0.0538	0.0549	0.0570
SO_2	0.0927	0.0921	0.0800	0.0777	0.0792	0.0823
GHG	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**
CH_4	0.5911	0.6022	0.7296	0.6463	0.7165	0.8173
NO_2	0.0033	0.0033	0.0041	0.0036	0.0040	0.0045
NO_x	0.1839	0.1873	0.2270	0.2011	0.2229	0.2543
CO	0.9195	0.9367	1.1349	1.0054	1.1145	1.2713
NMVOC	0.0591	0.0602	0.0730	0.0646	0.0716	0.0817
SO_2	0.0854	0.0870	0.1054	0.0934	0.1035	0.1181
GHG	**2001**	**2002**	**2003**	**2004**	**2005**	**1990-2005, %**
CH_4	0.8704	0.4619	0.7975	0.9118	0.9433	47.9
NO_2	0.0048	0.0026	0.0044	0.0051	0.0052	47.9
NO_x	0.2708	0.1437	0.2481	0.2837	0.2935	47.9
CO	1.3540	0.7185	1.2406	1.4184	1.4674	47.9
NMVOC	0.0870	0.0462	0.0798	0.0912	0.0943	47.9
SO_2	0.1257	0.0667	0.1152	0.1317	0.1363	47.9

4.5 Other Production (Category 2D)

4.5.1 Source Category Description

Category 2D 'Other Production' covers greenhouse gas emissions generated from the following sources: 2D1 'Pulp and Paper' and 2D2 'Food and Drink'. As no pulp and paper production is registered in the RM, respectively no GHG emissions are reported for this category (Not Occurring).

The NMVOC and CO_2 emissions are monitored under the 2D2 'Food and Drink' source category. Activity data needed to estimate NMVOC and CO_2 emissions originated from this source category are available in the Statistical Yearbooks of the RM and those of the ATULBD. NMVOC emissions from the 2D2 'Food and Drink' source category have decreased by 36.3 percent over the period under review in the RM: from 7.00 Gg in 1990 to la 4.46 Gg in 2005, while CO_2 emissions increased by 107.6 percent: from 19.64 Gg in 1990, to 40.77 Gg in 2005 (Figure 4-7).

In the base year around 85 percent of the total NMVOC emissions from the 2D2 'Food and Drink' source category were generated by the 2D2a 'Bread Making and Other Food'. By 2005 the share of this category in the total NMVOC emissions covered by the 2D2 'Food and Drink' source category decreased practically twofold (to 44 percent of the total), for the rest being responsible the 2D2b 'Alcoholic Beverages' (Figure 4-8).

4.5.2 Methodological Issues and Data Sources

2D2a 'Bread Making and Other Food'

Methodological issues pertaining to calculation of the NMVOC emissions from bread making and other food are addressed in the EMEP CORINAIR Atmospheric Emissions Inventory Guidebook (CORINAIR, 1996). The esti-

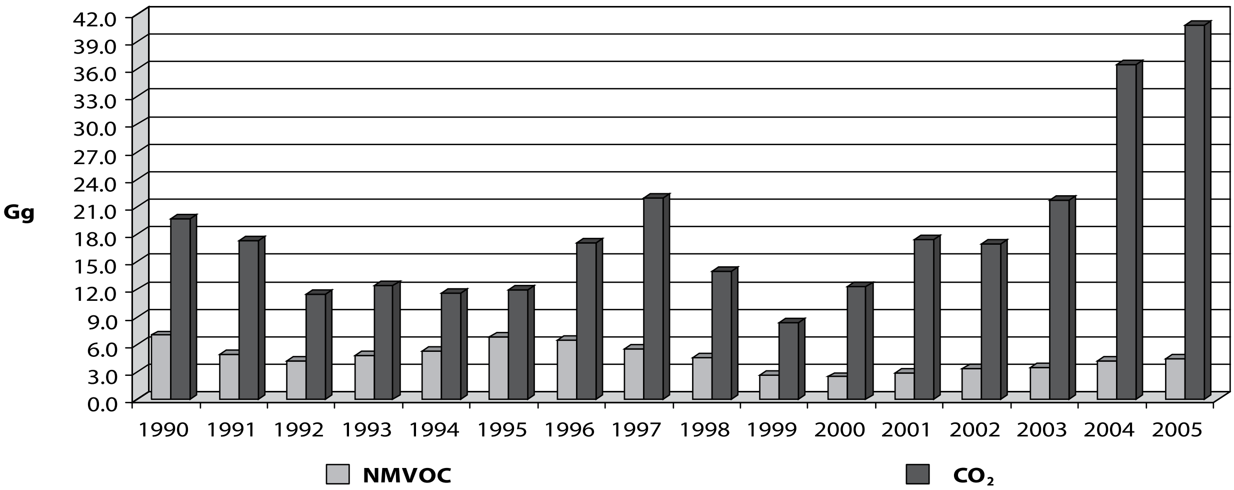

Figure 4-7: GHG Emissions from the Category 2D 'Other Production' by Gas in the Republic of Moldova within 1990-2005

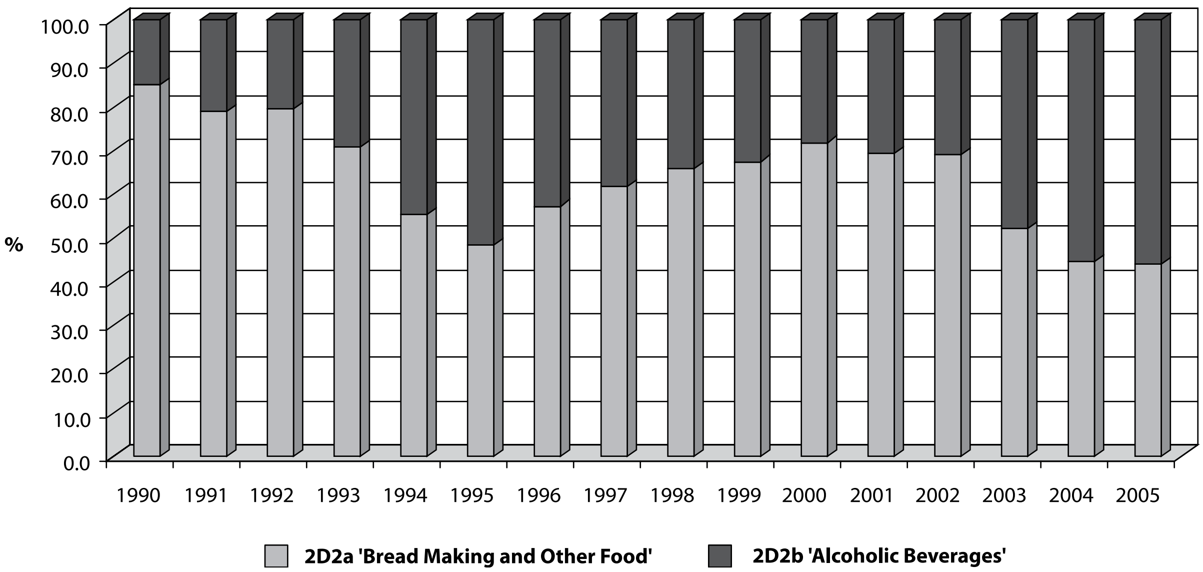

Figure 4-8: Breakdown of the Category 2D2 'Food and Drink' GHG Emissions by Source within 1990-2005, %

mation method used implies multiplication of default EF values (Table 4-50) by activity data on bread making and other food available in the national statistics (Table 4-51).

Table 4-50: Default Emission Factors Used to Estimate NMVOC Emissions from Bread Making and Other Food

Source	Bread Making and Other Food	NMVOC, kg / t
Bread Making and Other Food	Meat, Fish and Poultry	0.3
	Sugar	10
	Margarine and Solid Cooking Fats	10
	Cakes, Biscuits and Breakfast Cereals	1
	White Bread	4.5
	Rye Bread	3
	Animal Feed	1

Source: EMEP CORINAIR Atmospheric Emissions Inventory Guidebook, 3rd edition, February, 15, 1996, B465-5, pr040605, Bread Making and Other Food.

The information available in the Statistical Yearbooks of the ATULBD was summed to the statistical data available in the Statistical Yearbooks of the RM, which contained aggregated data on bread making and other food for the whole country only for the period until 1992. For the time series from 1993 through 2005, statistical data on bread making and other food manufacturing[12] are available separately for the right and left bank of Dniester.

2D2b 'Alcoholic Beverages'

Methodological issues related to calculation of NMVOC emissions from production of alcoholic beverages are addressed in the Atmospheric Emissions Inventory Guidebook (CORINAIR, 1996). The estimation method is based

[12]Statistical data on animal feed are available in reference sources starting 1997, for the previous years the data are extrapolated.

on multiplying default values of emission factors (Table 4-52) by activity data on production of alcoholic beverages available in national statistics (Table 4-54).

Table 4-51: Activity Data on Bread Making and Other Food in the Republic of Moldova over the period from 1988 through 2005, kt

	1988	1990	1991	1992	1993	1994
Meat, fish and poultry	338.7	257.9	218.5	136.0	105.7	81.1
Sugar	374.0	435.8	236.9	192.2	209.0	166.7
Margarine and solid cooking fats	28.7	27.0	21.8	16.7	11.0	9.6
Cakes, biscuits and breakfast cereals	21.4	24.3	23.5	9.7	7.9	3.0
Bread	211.0	208.0	203.0	200.0	196.0	194.1
Animal feed	298.0	290.0	278.0	269.0	258.0	247.0
	1995	**1996**	**1997**	**1998**	**1999**	**2000**
Meat, fish and poultry	58.4	52.6	50.8	27.3	25.7	13.4
Sugar	218.7	264.5	213.3	194.5	100.5	105.4
Margarine and solid cooking fats	6.8	4.7	3.0	2.9	2.4	2.8
Cakes, biscuits and breakfast cereals	3.2	3.6	4.4	8.1	7.2	7.4
Bread	179.4	173.8	221.9	180.2	147.0	138.1
Animal feed	239.0	232.0	229.3	218.7	107.7	58.1
	2001	**2002**	**2003**	**2004**	**2005**	**1990–2005, %**
Meat, fish and poultry	7.4	11.3	14.9	18.5	15.2	-94.1
Sugar	132.6	167.6	107.1	110.9	133.5	-69.4
Margarine and solid cooking fats	3.4	2.7	2.9	3.8	3.6	-86.7
Cakes, biscuits and breakfast cereals	11.7	14.8	17.0	16.9	17.9	-26.5
Bread	133.3	130.8	144.7	145.9	123.2	-40.8
Animal feed	29.8	39.0	25.7	41.8	14.5	-95.0

Source: Statistical Yearbooks of the RM for 1988 (page 272), 1994 (pages 289-290), 1999 (pages 304-305), 2003 (pages 393-394), 2004 (pages 443-444), 2005 (pages 319-320), 2006 (pages 309-310), Statistical Bulletin January –December 2006 (page 27); Statistical Yearbooks of the ATULBD for 1998 (page 177), 2000 (page 100), 2002 (page 104), 2006 (page 93).

CO_2 emissions from the alcoholic beverages production process were estimated based on emission factors identified in specialty literature with reference to the process of alcoholic fermentation, a biochemical process transforming glucose[13] in ethylic alcohol and carbon dioxide (see equation below).

$$C_6H_{12}O_6 \rightarrow 2C_2H_5OH + 2CO_2$$
$$1g \quad 0{,}511g \quad 0{,}489g$$

Country specific information on the content of glucose (expressed in °brix[14]) in the alcoholic beverages from the RM was used to estimate EF values [15] (Table 4-53).

Table 4-52: Default Emission Factors Used to Calculate NMVOC Emissions from Alcoholic Beverages

Source	Alcoholic beverages	NMVOC, kg/hl	CO_2, kg/hl
Alcoholic Beverages	Red Wine	0.08	10.8
	White Wine	0.035	9.6
	Sparkling Wine	0.035	10.2
	Beer	0.035	2.5
	Spirits (unspecified)	15.0	-
	Grain Whisky	7.5	-
	Brandy	3.5	-

Source: for NMVOC: EMEP CORINAIR Atmospheric Emissions Inventory Guidebook, 3rd edition, February 15, 1996, B466-5, pr040606, Alcoholic beverages; for CO_2, the estimation methodology is based on 'CO_2 from beer' (Pablo Päster, 2007).

Table 4-53: Information on Glucose Content in Some Alcoholic Beverages Produced in the Republic of Moldova

Alcoholic beverage	Glucose, °brix	Alcoholic beverage	Glucose, °brix
White table wine	14.0-18.0	Red table wine	17.0-18.0
White fine wine	19.0-21.0	Red fine wine	19.0-21.5
White semidry wine	22	Red semidry wine	22
White medium sweet wine	23.0-25.5	Red medium sweet wine	23.0-25.5
White sweet wine	26	Red sweet wine	26
Sparkling wine	17.0-21.0	Beer	5.0-15.0

Statistical Yearbooks of the RM contain aggregated activity data on alcoholic beverages production for the time period until 1992. Data on alcoholic beverages production for the 1993-2005 time periods are available separately for the right and left banks of Dniester.

The information available in the Statistical Yearbooks of the ATULBD was summed up with statistical data on alcoholic beverages production on the right bank of Dniester (Table 4-54). As at the time of inventory compilation there were no statistic data on the share of different types of wine in the total production reported in the RM, the breakdown in percent of different types of red and white wines was inferred

[13]The molecular weight of one molecule of glucose ($C_6H_{12}O_6$) is 180.16 g/mole. In the process of fermentation, yeast converts one molecule of glucose into 2 molecules of ethanol (C_2H_5OH) having a molecular mass of 51.07 g/mole, and 2 molecules of carbon dioxide (CO_2) with a molecular mass of 44.01 g/mole. So, the glucose CO_2 conversion factor is circa 48.9% (44.01·2)/180.16=0.489).

[14]Brix – measure unit, representing the ratio between the content of glucose in solution and mass of the solution itself (for example: 20 g of glucose in 100 g of wine will have a value of 20 brix).

[15]Emission factors were calculated taking into account the contents of glucose in the juice, and the fact that produced carbon dioxide reduces the volume of the solution. For example, the value of emission factor for a beer containing 5 g glucose per 100 g beer can be calculated in the following way: 1) [(44.01*2)/180.16]*5=2.44 g CO_2 per 100 g beer, and 2) [2.44/(100-2.44)*100] = 2.50 g CO_2 per 100 g beer.

based on expert judgement[16] (for the 1988-2000 period), as well as based on survey data covering 10 winemaking enterprises[17] from the RM (for the 2001-2006 period).

4.5.3 Uncertainties and Time-Series Consistency

The primary uncertainties related factors pertain to methodology, EFs used to estimate GHG emissions covered by the 2D2 'Food and Drink' source category, and the quality of activity data available. Uncertainties related to the default EFs used to estimate the NMVOC emissions may be a factor of 2 (CORINAIR, 1996). At the same time, uncertainties related to emission factors used to estimate CO_2 emissions from alcoholic beverages are considered as being moderate (±20 percent). Uncertainties related to activity data on food and drink production in the RM are quite low (±10 percent). So, uncertainties pertaining to CO_2 emissions from the 2D2b 'Alcoholic Beverages' were estimated at ±22.36 percent. At the same time, combined uncertainties, presented as a percent of total sectoral emissions were estimated at ±1.57 percent. Uncertainties introduced in trend in sectoral emissions were estimated at ±0.67 percent (see Annex 7-3.2).

In view of ensuring time-series consistency of the obtained results, the same approach was used for the entire period under review, in conformity with the recommendations included in the Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories (IPCC, 2000).

[16]According the expert judgment, the share of white and red wines in the total wine production in the RM varied as follows: from 1988 to 1991: 35/65; from 1992 to 1994: 40/60; and from 1995 to 2000: 45/55.

[17]The survey results, covering 10 winemaking enterprises revealed that the share of white and red wines in the total wine production in the RM varied as follows: in the 2001 year: 50/50; in the 2002 year: 55/45; in the 2003 year: 60/40; in the 2004 year: 45/55; in the 2005 year: 45/55 and in the 2006 year: 40/60.

Table 4-54: Activity Data on Alcoholic Beverages Production in the Republic of Moldova, 1988-2005

	1988	1990	1991	1992	1993	1994
Wine, thousand dal	11.3	16.3	14.3	9.2	10.3	9.8
Sparkling Wine, thousand dal	728.0	804.0	783.0	854.0	888.0	742.0
Brandy, thousand dal	1102.0	1394.0	1402.0	750.0	740.0	793.0
Vodka and Liqueurs, thousand dal	444.0	559.0	556.0	676.0	1394.0	2647.0
Beer, million dal	6.5	7.6	6.6	4.3	3.6	2.8
	1995	**1996**	**1997**	**1998**	**1999**	**2000**
Wine, thousand dal	10.0	14.6	19.4	12.4	6.9	10.9
Sparkling Wine, thousand dal	948.0	1419.0	1345.0	519.0	675.0	416.0
Brandy, thousand dal	1027.0	457.0	586.0	497.0	486.0	717.7
Vodka and Liqueurs, thousand dal	4127.0	3358.0	2370.0	1741.0	870.0	489.0
Beer, million dal	3.0	2.6	2.6	3.0	2.2	2.6
	2001	**2002**	**2003**	**2004**	**2005**	**1990–2005, %**
Wine, thousand dal	15.6	14.9	19.3	32.9	36.7	125.3
Sparkling Wine, thousand dal	584.3	613.0	738.5	938.3	1117.7	39.0
Brandy, thousand dal	955.6	1038.1	1361.1	1428.0	1710.8	22.7
Vodka and Liqueurs, thousand dal	594.0	779.0	1398.0	2129.0	2198.0	293.2
Beer, million dal	3.4	4.6	6.0	7.0	7.8	2.3

Source: Statistical Yearbooks of the RM for 1988 (page 274), 1994 (pages 289-290), 1999 (pages 304-305), 2003 (pages 393-394), 2004 (pages 444-445), 2006 (page 310); Statistical Bulletin for January-December 2006 (page 27); Official Letter from the National Bureau of Statistics No. 02-10/115 from 06.10.2006 (covering the period 1992-2005); Statistical Yearbooks of the ATULBD for 1998 (pages 177, 184), 2000 (page 100), 2002 (page 104), 2006 (page 93).

4.5.4 QA/QC and Verification

Standard verification and quality control forms and checklists were filled in for the respective source category under the Industrial Processes Sector, following the Tier 1 and Tier 2 approaches (see in Annex 6). Also, the AD and methods used for estimating GHG emissions under the category 2D2 'Food and Drink' were documented and archived both in hard copies and electronically. For identifying the data entry and emission estimation process related errors there were applied verifications and quality control procedures. Verification was focused on correct use of AD obtained from different sources of reference (i.e., Statistical Yearbooks of the RM and ATULBD, National Bureau of Statistics, and other sources [Dobrova, Ţăranu, 2000a]), especially in case of converting AD into mass units compatible with GHG emissions estimation methods; as well as on ensuring correct use of the default emission factors available in the Revised 1996 IPCC Guidelines (IPCC, 1997) and EMEP CORINAIR Atmospheric Emissions Inventory Guidebook (CORINAIR, 1996). Inventory quality assurance activities for the Industrial Processes Sector, inclusive for the 2D2 'Food and Drink', were supported by an expert representing the Technical University of Moldova (TUM).

Following the recommendations included into the Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories (IPCC, 2000), GHG emissions originated from the 2D2 'Food and Drink' were estimated based on AD and EFs from official sources of reference.

4.5.5 Recalculations

NMVOC emissions from the 2D2 'Food and Drink' source category were recalculated for the period 1990-1998 (for the Republic of Moldova the 1990 is the reference year under the UNFCCC, while emissions for 1988 year are presented here for comparison purposes), in particular due to completion and updating activity data on bread making and other food and alcoholic beverages based on new editions of the Statistical Yearbooks of the RM and ATULBD, as well as due to use new emission factors available in the EMEP CORINAIR Inventory Guidebook (CORINAIR, 1996).

2D2a 'Bread Making and Other Food"

In comparison with values included in the FNC of the RM under the UNFCCC, the changes made (completing and updating the activity data set, adding a new emission source (animal feed), and use a new EF for bread (4.5 kg/t instead of 8 kg/t), resulted in an increased NMVOC emission estimates, which varied from a minimum of 3.37 percent in 1990, to a maximum of 14.78 percent in 1995 (Table 4-55).

Table 4-55: Comparative Results of NMVOC Emissions from 2D2a 'Bread Making and Other Food' Included into the FNC and SNC of the RM under the UNFCCC, Gg

	1988	1990	1991	1992	1993	1994
FNC	5.1900	5.7617	3.6761	3.1235	3.1793	2.5957
SNC	5.3975	5.9557	3.8676	3.3085	3.3796	2.9109
Difference , %	4.00	3.37	5.21	5.92	6.30	12.14
	1995	**1996**	**1997**	**1998**	**1999**	**2000**
FNC	2.8944	3.5080	3.0110	2.8316		
SNC	3.3222	3.7256	3.4101	3.0198	1.8129	1.7734
Difference , %	14.78	6.20	13.25	6.65		
	2001	**2002**	**2003**	**2004**	**2005**	**1990-2005, %**
FNC						
SNC	2.0032	2.3490	1.7980	1.8682	1.9620	-67.1
Difference , %						

For the period 1999-2005, NMVOC emissions from bread making and other food were estimated for the first time. The results indicate that over the period 1990 through 2005, NMVOC emissions from bread making and other food decreased by 67.1 percent, first of all due to a significant reduction of the processing industry's outputs over the period under review.

2D2b 'Alcoholic Beverages'

In comparison with values included in the FNC of the RM under the UNFCCC, the changes made (completing and updating activity data set, use a new emission factor for brandies and liqueurs (7.5 kg/hl instead of 15 kg/hl) resulted in smaller values of NMVOC emission estimates from alcoholic beverages, varying from a minimum of -5.4 percent in 1993, to a maximum of -37.1 percent in 1992 (Table 4-56).

For the period 1999-2005, NMVOC emissions from alcoholic beverages were estimated for the first time. The results indicate that over the period 1990 through 2005, NMVOC emissions from alcoholic beverages increased by circa 139.9 percent, which is explained by a substantial growth of winemaking industry's output in the Republic of Moldova over the period under review.

Table 4-56: Comparative Results of NMVOC Emissions from 2D2b 'Alcoholic Beverages' Included into the FNC and SNC of the RM under the UNFCCC, Gg

	1988	1990	1991	1992	1993	1994
FNC	1.1707	1.4898	1.4684	1.3692	1.7917	3.0030
SNC	0.8166	1.0413	1.0254	0.8446	1.3841	2.3360
Difference, %	-28.45	-28.14	-28.39	-37.03	-5.41	-10.94
	1995	**1996**	**1997**	**1998**	**1999**	**2000**
FNC	4.3345	3.0597	2.5520	2.3128		
SNC	3.5282	2.7795	2.1125	1.5661	0.8740	0.6935
Difference, %	-18.04	-7.98	-15.45	-31.10		
	2001	**2002**	**2003**	**2004**	**2005**	**1990-2005, %**
FNC						
SNC	0.8837	1.0485	1.6508	2.3210	2.4979	139.9
Difference, %						

CO_2 emissions from the process of alcoholic fermentation in wines, sparkling wines and beer production, were estimated for the first time. The results allow assert that within the 1990-2005 time series, CO_2 emissions from 2D2 'Alcoholic Beverages' increased by 107.6 percent (Table 4-57), this being explained through increasing trends of wine production in the Republic of Moldova.

Table 4-57: CO_2 Emissions from 2D2b 'Alcoholic Beverages' in the RM, 1990-2005

	1988	1990	1991	1992	1993	1994
CO_2, Gg	14.0970	19.6395	17.2921	11.4405	12.4354	11.5602
	1995	**1996**	**1997**	**1998**	**1999**	**2000**
CO_2, Gg	11.9524	17.0465	21.9484	13.9979	8.3413	12.2455
	2001	**2002**	**2003**	**2004**	**2005**	**1990-2005, %**
CO_2, Gg	17.3916	16.9302	21.7239	36.4980	40.7669	107.6

4.5.6 Planned Improvements

For the next inventory cycle it is planned to carry out activities aimed at collecting and updating activity data used to estimate NMVOC emissions from the 2D2 'Food and Drink' source category in the Republic of Moldova. Also, it will be considered the opportunity to improve the methodology and country specific emission factors used to estimate CO_2 emissions from the respective source category.

4.6 Consumption of HFCs and SF_6 (Category 2F)

4.6.1 Source Category Description

The group of halocarbons comprises partially fluorinated hydrocarbons (HFC-23; HFC-32; HFC-41; HFC-43-10mee; HFC-125; HFC-134; HFC-134a; HFC-143, HFC-143a; HFC-152a; HFC-227ea; HFC-236fa; HFC-245ca) and perfluorinated hydrocarbons (perfluoromethane – CF_4, perfluoroethane – C_2F_6, pefluoropropane – C_3F_8, perfluorobutane – C_4F_{10}, perfluorociclobutane – c-C_4F_8, perfluoropentan – C_5F_{12}, perfluorohexan – C_6F_{14}) (Table 4-58).

Table 4-58: Global Warming Potentials and Atmospheric Lifetimes

GHG	Chemical formula	100-year GWP	Atmospheric lifetime, years
Hydrofluorocarbons (HFC)			
HFC-23	CHF_3	11700	264
HFC-32	CH_2F_3	650	5,6
HFC-41	CH_3F	150	3,7
HFC-43-10mee	$C_5H_2F_{10}$	1300	17,1
HFC-125	C_2HF_5	2800	32,6
HFC-134	$C_2H_2F_4$ (CHF_2CHF_2)	1000	10,6
HFC-134a	$C_2H_2F_2$ (CH_2FCF_3)	1300	14,6
HFC-143	$C_2H_3F_3$ (CHF_2CH_2F)	300	1,5
HFC-143a	$C_2H_3F_3$ (CF_3CH_3)	3800	3,8
HFC-152a	$C_2H_4F_2$ (CH_3CHF_2)	140	48,3
HFC-227ea	C_3HF_7	2900	36,5
HFC-236fa	$C_3H_2F_6$	6300	209
HFC-245ca	$C_3H_3F_5$	560	6,6
Perfluorocarbons (PFC)			
Perfluoromethane	CF_4	6500	50000
Perfluoroethane	C_2F_6	9200	10000
Perfluoropropane	C_3F_8	7000	2600
Perfluorobutan	C_4F_{10}	7000	2600
Perfluorociclobutan	c-C_4F_8	8700	3200
Perfluoropentan	C_5F_{12}	7500	4100
Perfluorohexan	C_6F_{14}	7400	3200
Sulphur Hexafluoride (SF_6)			
Sulphur Hexafluoride	SF_6	23900	3200

Source: IPCC (1996a), 1995 Summary for Policy Makers - A Report of Working Group I of the Intergovernmental Panel on Climate Change.

Globally, wide scale production of halocarbons started in 1991, as alternative substances to chlorofluorocarbons (CFC), ozone layer depleting substances (ODS). According the Montreal Protocol, the countries Parties to this treaty committed to phase out the import and consumption of chemical substances that deplete the ozone layer, with further complete elimination starting 2008 (because halocarbons do not contain atoms of chlorine, they do not have any impact on ozone layer).

The 2F 'Consumption of HFCs and SF_6' source category includes GHG emissions from the following sources: 2F1 'Refrigeration and Air Conditioning Equipment', 2F2 'Foam Blowing', 2F3 'Fire Extinguishes', 2F4 'Aerosols', 2F5 'Solvents', 2F6 'Other Applications with ODS', 2F7 'Semiconductors Production', 2F8 'Electrical Equipment' and 2F9 'Other'.

Under the current inventory cycle the RM monitored emissions generated by the consumption of HFCs and SF_6 from source categories 2F1 'Refrigeration and Air Conditioning Equipment', 2F4 'Aerosols' and 2F8 'Electrical Equipment'. Emissions from other sources were reported as 'Not Estimated' (NE) due to lack of activity data.

The process of collecting activity data on consumption of halocarbones and sulphur hexafluoride is extremely difficult in the Republic of Moldova. The primary difficulty is due to the fact that import, export, re-export and circulation of halocarbons and equipments charged with halocarbons on the market is not regulated at the national level (like, for example, the ODS).

Import of halocarbons in bulk, as well as products and equipments charged with halocarbons does not require a license and/or environmental authorisation, being allowed to practically any legal entity or individual. Another difficulty is that halocarbons may be imported both in "standard" packaging of 10-15 kg, and in small containers (300-500 g), which can be imported practically by any individual.

In these circumstances, GHGs under the source category 2F 'Consumption of HFCs and SF_6' were estimated based on data on import and consumption of halocarbons provided by the National Bureau of Statistics, Customs Service, the Republican Association of Refrigeration Technicians and based on Annual Reports submitted by enterprises to the Ozone Office besides the Ministry of Environment and Natural Resources: in 2007 there were 10 enterprises licensed to import, export, re-export, transit and placing ODS and equipments containing ODS on the market, including alternative substances (HFC).

It should be noted that the Republic of Moldova does not produce halocarbons and SF_6, and until year 2000 these substances had a relatively narrow use, being imported in insignificant amounts. So, in the Republic of Moldova the year of 2000 is considered to be a reference year for emissions originated from consumption of halocarbons and sulphur hexafluoride.

2F1. 'Refrigeration and Air Conditioning Equipment'

Refrigeration equipment (household refrigerators and freezers; other stationary refrigeration and air conditioning equipment, including: cold storage warehouses, retail food refrigeration, industrial process refrigeration, commercial and industrial appliances such as vending machines, ice machines, dehumidifiers, and water coolers, refrigerated transport including trucks with refrigerated compartments, commercial and residential air conditioning including chillers, heat pumps, window air conditioners, centralized air conditioners) and mobile air conditioners used to cool the passenger compartment of automobiles, trucks and buses are a primary source of HFCs emissions in the RM.

Since 1996 (in conformity with Montreal Protocol) the developed countries are not supposed to produce CFC and equipments using CFC, the RM uses R-22 and R-600a refrigerants as transit substances, and R-134a, R-404a, R-407c, R-408a, R-507a, R-410a as alternative refrigerants to chlorofluorocarbons (Table 4-59).

Table 4-59: Composition of Refrigerants Preponderantly Used in the Republic of Moldova

Commercial Name	Sector of Use	Composition
R-134a	Transport refrigerant	HFC-134a (100%)
R-404a	Commercial refrigerant	HFC-125 (44%)/HFC-143a (52%)/HFC-134a (4%)
R-407a	Commercial refrigerant	HFC-32 (20%)/HFC-125 (40%)/HFC-134a (40%)
R-407b	Commercial refrigerant	HFC-32 (10%)/HFC-125 (70%)/HFC-134a (20%)
R-407c	Commercial refrigerant	HFC-32 (23%)/HFC-125 (25%)/HFC-134a (52%)
R-407d	Transport refrigerant	HFC-32 (15%)/HFC-125 (15%)/HFC-134a (70%)
R-408a	Commercial refrigerant	HCFC-22 (47%)/HFC-143a (46%)/HFC-125 (7%)
R-410a	Transport refrigerant	HFC-32 (50%)/HFC-125 (50%)
R-507a	Transport refrigerant	HFC-125 (50%)/HFC-143a (50%)

The breakdown of refrigerants used in the Republic of Moldova in different types of refrigeration and air conditioning equipment varied in different years (Table 4-60).

2F2. 'Foam Blowing'

Since 1996 hydrofluorocarbons have been also used to replace CFC and HCFC used in foam blowing (closed and opened cell foams), used in insulation, cushioning and packaging. The basic components for production of these foams are: HFC-245f, HFC-365mfc, HFC-134a, and HFC-152a. There is no foam blowing production in the Republic of Moldova, while imported foams are preponderantly opened cell foams (emissions generated by opened cell foams have a longer time lag). It was not possible to estimate the emissions under this source category (NE) for the current inventory cycle due to unavailability of activity data.

Table 4-60: Breakdown of Different Refrigerants Incorporated in Refrigeration and Air Conditioning Equipment Imported in the RM within 2000-2006 time series, percent

Refrigeration equipment	Refrigerant	2000	2001	2002	2003	2004	2005	2006
Refrigerators	R-22	25	10	0	0	0	0	0
	R-134a	75	90	85	85	85	85	80
	R-600a	0	0	15	15	15	15	20
Ice machines	R-134a	45	45	50	40	35	40	45
	R-404a	55	55	50	60	65	60	55
AC window units	R-134a	90	90	85	85	80	80	75
	R-407c	10	10	15	15	20	20	25
Air Conditioning Equipment	R-22	80	60	40	20	20	20	20
	R-404a	15	30	45	60	55	50	50
	R-407c	5	10	15	20	25	30	30

Source: Customs Service of the RM, Official Letter No. 07/2-1269 from 22.10.2007

2F3. 'Fire Extinguishers'

There are two types of fire extinguishers: total fixed flooding fire extinguishing systems and portable streaming fire extinguishers. Halon based extinguishers (halon-1211 or bromoclorodifluoromethane; halon-1301 or bromotrifluoromethane and halon-2402 or dibromotetrafluoroethane) tend to be replaced by HFC based extinguishers (HFC-227-ea and HFC-236fa).

According with the information received from the Civil Protection and Emergency Situations Service of the Ministry of Intern Affaire (Official Letter No. 19/5-393 from 04.04.2008), only carbon dioxide is used in total flooding fixed fire extinguishing systems as extinctor agent, (halon and HFC based stationary and portable extinguishing systems are not available).

Table 4-61: Import of Carbon Dioxide Based Portable Fire Extinguishers in the Republic of Moldova, 2000-2007

	2000	2001	2002	2003	2004	2005	2006	2007
Portable fire extinguishers, units	7572	4178	9247	13806	20913	18494	26666	41232

Source: Customs Service of the RM, Official Letter No. 07/2-612 from 04.04.2008

2F4. 'Aerosols'

In most aerosol products HFC or CFC are used as propellants (in insignificant quantities). Gases from aerosols are usually released shortly after production, on average 1-2 years after sale. During use of aerosols, 100 per cent of the chemical is emitted (US EPA, 1992). Most frequently, HFC-134a is used as propellant (less frequently: HFC-227ea and HFC-152a).

In the Republic of Moldova, aerosols containing chemical substances included in Annex A, Group I of the Montreal Protocol (including CFC-12) can not be imported, exported, re-exported, transited and put into circulation on the market. The interdiction does not extend on medical care goods: pharmaceutical aerosols in the form of sprays used in treatment of chronic lung obstructions, cardiac conditions and treatment substances that can be used as aerosols only; as well as goods needed to ensure public order (special products manufactured at commission and used by the Ministry of Intern Affaire of the RM or other organizations entitled to ensure public order, and used in cases stipulated by legislation).

2F8. 'Electrical Equipment'

Sulphur Hexafluoride (SF_6) is mostly used as an insulation medium in high tension electrical equipment including gas insulated switchgear, chemical lasers and circuit breakers. To find out in what way SF_6 is used in the RM, enterprises subordinated to the Ministry of Industry and Infrastructure (including 'Moldelectrica' J.S.C.), Ministry of Health and the Academy of Science of Moldova were surveyed.

The survey of the abovementioned organizations revealed the following: (1) no activity data is available on application of SF_6 in gas insulated chemical lasers at the Academy of Science and Ministry of Health for the time period from 1990 through 2005; (2) SF_6 is used in two high tension circuit breakers of GL311F1 type (330 kW substation in Balti) within the 'Moldelectrica' J.S.C. enterprise subordinated to the Ministry of Industry and Infrastructure.

Over the period from 1990 through 2005 no perfluorocarbons (PFCs) represented by CF_4; C_2F_6; C_3F_8; C_4F_{10}; c-C_4F_8; C_5F_{12}; C_6F_{14} use was reported in the Republic of Moldova.

Total potential direct greenhouse gas emissions covered by the source category 2F 'Consumption of Halocarbons and Sulphur Hexafluoride' increased by circa 326.4 percent in the RM, from 30.82 Gg CO_2 eq. in 2000 up to 131.42 Gg CO_2 eq. in 2005. At the same time current total direct GHG covered by the source category 2F 'Consumption of Halocarbons and Sulphur Hexafluoride' increased by 351.6 percent over the period 2000 through 2005, from 4.21 Gg CO_2 eq. in 2000 up to 19.01 Gg CO_2 eq. in 2005. Share of SF_6 emissions in the total GHG emissions generated from the source category 2F 'Consumption of Halocarbons and Sulphur Hexafluoride' is insignificant, such emissions being reported in the RM since 2003 only (Table 4-62).

Table 4-62: GHG Emissions from the 2F 'Consumption of Halocarbons and Sulphur Hexafluoride' Source Category in the RM within 2000-2005 time series, Gg CO_2 eq.

Year	HFC		SF_6		Total	
	Potential	Actual	Potential	Actual	Potential	Actual
2000	30.8178	4.2080	0.0000	0.0000	30.8178	4.2080
2001	40.0039	5.4113	0.0000	0.0000	40.0039	5.4113
2002	56.1985	7.5630	0.0000	0.0000	56.1985	7.5630
2003	72.8019	10.0184	0.2868	0.0057	73.0887	10.0241
2004	95.9306	13.0724	0.2868	0.2782	96.2174	13.3506
2005	130.8470	18.7189	0.5736	0.2839	131.4206	19.0028
2000-2005,%	324.6	344.8	100.0	4850.0	326.4	351.6

4.6.2 Methodological Issues and Data Sources

2F1. 'Refrigeration and Air Conditioning Equipment'

Refrigeration equipment (refrigerators, ice machines, AC window units) and air conditioning equipment (stationary and mobile air conditioners) are a primary source of HFC emissions in the Republic of Moldova.

Greenhouse gas emissions generated from consumption of halocarbons in 2F1 'Refrigeration and Air Conditioning Equipment' source category were estimated using both Tier 1b (potential emissions), and Tier 2 estimation method (actual emissions).

Potential emissions equal to the amount of virgin chemical substances consumed in the country minus the amount of chemical substances recovered to be destroyed or exported within one calendar year.

Potential Emissions = Production + Imports (Bulk Chemicals + Chemical Contained in Products) – Exports (Bulk Chemicals + Chemical Contained in Products) – Destruction

If not destroyed, over time the entire amount of chemical substances consumed is emitted in the atmosphere, so that in the long run (for example, 50 years) potential emissions become equal to actual emissions. However, it should be noted that this approach overlooks accumulation of possible leakages of chemical substances from different products and equipments, entailing estimation uncertainties, in particular, for shorter periods of time (for example, 10-15 years). Because such an accumulation is a dominant process, potential emissions will be much more overestimated than the actual emissions.

The Tier 2 estimation method (bottom-up approach) is based on estimation of HFC emissions from assembly, operation, and disposal of equipment.

Total Emissions = Assembly Emissions + Operation Emissions + Disposal Emissions

Where:

- Assembly Emissions include the emissions associated with product manufacturing, even if the products are eventually exported;
- Operation Emissions include annual leakage from equipment stock in use as well as servicing emissions; this calculation should include all equipment units in the country, regardless of where they were manufactured;
- Disposal Emissions include the amount of refrigerant released from scrapped systems; as with operation emissions, they should include all equipment units in the country where they were scraped, regardless of where they were manufactured; to be noted that refrigeration and air conditioning equipment based on ODS substituents started to be imported in the Republic of Moldova preponderantly since 2000, so it is relatively new and in good technical condition.

The estimation process implies three consecutive stages using the equations below.

Assembly Emissions = (Total HFC and PFC Charged in year t) • (k /100)

Where:

k = Emission factor that represents the percentage of initial charge that is released during assembly

Operation Emissions = (Amount of HFC and PFC Stock in year t) • (x /100)

Where:

x = Emission factor that represents the annual leak rate as a percentage of total charge; since different types of refrigeration equipment will leak at different rates, data were disaggregate into homogeneous classes in order to develop values of x specific to different types of equipment.

Disposal Emissions = (HFC and PFC Charged in year t – n) • (y /100) • (1 – z /100) – (Amount of Intentional Destruction)

Where:

y = Percentage of the initial charge remaining in the equipment at the time of disposal;

z = Recovery efficiency at the time of disposal (if any chemical is recycled during disposal, the percentage should be subtracted from the total, while if there is no recycling, this term will be zero).

A). Stationary Refrigeration and Air Conditioning Equipment

The information about the average charge for each type of equipment is based on data provided by the Customs Service of the RM, Republican Association of Refrigeration Technicians and annual reports submitted by companies to the Climate Change Office by the Ministry of Environment and Natural Resources (Table 4-63). Default values were used for other parameters and factors (IPCC, 2000).

Activity data used to estimate HFC emissions from consumption of hydrofluorocarbons charged into refrigeration and air conditioning equipment (stationary air conditioning equipment) are provided below (Table 4-64).

The information on the composition of refrigerants preponderantly used in the RM (Table 4-59), the share of refrigerants charged into the refrigeration and air conditioning equipment imported in the country over the period from 2000 through 2005 (Table 4-60), the average charge of equipment with refrigerant (Table 4-63) and statistical data on import of refrigeration and air conditioning equipment (the respective equipment is not produced in the RM) was used to estimate the total amount of HFC imported in the country (on average circa 0.6 percent of assembly emissions were subtracted from the total charge of equipment with refrigerant) (Table 4-65).

Table 4-63: Estimates for Charge, Lifetime and Emission Factors for Stationary Refrigeration Equipment in the Republic of Moldova

Equipment Type	Charge, kg (Ei_{charge})	Lifetimes, years (n)	Emission factor, % of initial charge/year		% of Initial Charge Remaining at Disposal (y)	End-of-Life Emissions (Recovery Efficiency) (z)
			Initial Emissions (k)	Lifetime Emissions (x)		
Domestic refrigeration	0.15	15	0.6	0.3	95	0
Ice machines	1.00	15	0.6	5.0	90	0
AC window units	1.50	20	0.6	10.0	60	0
Air conditioning equipment	1.20	12	0.6	5.0	60	0

Table 4-64: Activity Data on Refrigeration and Air Conditioning Equipment Imported in the Republic of Moldova over the period from 2000 through 2005, units

Equipment	2000	2001	2002	2003	2004	2005	2000-2005, %
Domestic Refrigerators	12092	20400	30606	42528	52278	70412	482.3
Ice Machines	900	1682	2750	3016	3151	4231	370.1
AC Window Units	2017	2673	4275	3408	3725	4003	98.5
Stationary Air Conditioning Equipment	1677	826	2079	5778	6276	9221	449.9

Source: Customs Service of the RM, Official Letter No. 07/2-1269 from 22.10.2007

Table 4-65: Activity Data on Imported HFC Charged into Refrigeration and Air Conditioning Equipment in the RM over the period from 2000 through 2005, tones

	2000	2001	2002	2003	2004	2005	2000-2005, %
HFC-32	0.0927	0.1150	0.3073	0.4953	0.6901	1.0397	1021.2
HFC-125	0.4132	0.6252	1.2908	2.6381	3.0445	4.2610	931.3
HFC-134a	4.8264	7.5235	11.8818	13.6638	15.1306	19.2093	298.0
HFC-143a	0.4144	0.6357	1.2988	3.1043	3.2190	4.1970	912.9
Total HFCs	5.7467	8.8995	14.7787	19.9015	22.0841	28.7070	399.5

B). Mobile Air Conditioning Equipment

Default values were used for average charge with Freon (mainly, HFC-134a) of mobile sources of air conditioning equipment (passenger cars, trucks, buses, minibuses and refrigeration vehicles), as well as for other parameters and emission factors (IPCC, 2000) (Table 4-66).

Table 4-66: Estimates for Charge, Lifetime and Emission Factors for Mobile Air Conditioning and Transport Refrigeration Equipment in the Republic of Moldova

Equipment Type	Charge, kg (Ei_{charge})	Lifetimes, years (n)	Emission factor, % of initial charge/year		% of Initial Charge Remaining at Disposal (y)	End-of-Life Emissions (Recovery Efficiency) (z)
			Initial Emissions (k)	Initial Emissions (k)		
Passenger Cars	0.80	12	0.5	15	40	0
Buses	1.20	12	0.5	15	40	0
Trucks	1.20	12	0.5	15	40	0
Refrigerators	8.00	9	0.6	15	40	0

Estimation of the amount of HFC used in mobile air conditioning equipment was based on information on the total number of transportation means units registered in the Republic of Moldova, in conformity with data recorded in the State Transport Register (Table 4-67), as well as the share of transportation means produced after 1995 (Table 4-68), when Freon R-134a started to be widely used in mobile air conditioning equipment.

Table 4-67: Number of Transport Units Registered in the RM,
According with Data Recorded in the State Transport Register (standing for the end of the calendar year)

	2000	2001	2002	2003	2004	2005	2000-2005, %
Passenger Cars	188219	208676	231147	264083	286474	312196	65.9
Buses	3910	4240	4549	4917	5387	5901	50.9
Minibuses	9987	10561	11284	12163	12610	12818	28.3
Trucks	47942	55524	64381	73661	82006	91756	91.4
Refrigeration Vehicles	1464	1636	1933	2262	2562	2764	88.8

Source: Ministry of Information Development of the RM, Official Letter No. 01/987 from 24.04.2008

As any statistical data on the number of transportation units equipped with air conditioning are absent in the RM, this data was inferred from the assumption that all vehicles manufactured from 1995 onwards contain HFC-134a. Based on information on the average Freon charge (HFC-134a) of air conditioning equipment in mobile sources (Table 4-64), information on total number of transportation units registered in the RM in conformity with data recorded in the State Transport Register (Table 4-67) and information on the share of vehicles manufactured from 1995 onwards (equipped with air conditioning equipment) (Table 4-68) was used to estimate the total amount of HFC-134a charged into the air conditioning equipment used in transportation units in the RM (Table 4-69) (on average 0.5 percent of assembly emissions were subtracted from the total charge of Freon reported by manufacturing countries).

Table 4-68: Share of Transportation Units Manufactured from 1995 Onwards,
According with Data Recorded in the State Transport Register of the RM (by the end of calendar year)

	2000	2001	2002	2003	2004	2005	2000-2005, %
Passenger Cars	6.1	6.8	7.7	9.3	11.3	15.4	154.9
Buses	3.1	2.9	3.1	3.9	5.9	7.5	145.7
Minibuses	4.9	5.1	5.9	7.2	8.1	8.8	80.4
Trucks	3.4	4.2	5.5	7.7	10.0	13.7	296.6
Refrigeration Vehicles	5.2	6.4	8.8	12.9	17.3	21.4	311.9

Source: Ministry of Information Development of the RM, Official Letter No. 01/987 from 24.04.2008

Table 4-69: Activity Data on the Amount of HFC-134a Charged into the Air Conditioning Equipment
of Transportation Units over the time period from 2000 through 2005, tones

	2000	2001	2002	2003	2004	2005	2000-2005, %
Passenger Cars	1.9725	2.7522	4.2387	6.7568	9.8099	14.9728	659.1
Buses	0.1433	0.1457	0.1684	0.2304	0.3797	0.5313	270.8
Minibuses	0.5803	0.6376	0.7892	1.0471	1.2262	1.3433	131.5
Trucks	9.0800	11.2913	14.2006	19.5545	25.7084	38.3887	322.8
Refrigeration vehicles	0.6044	0.8350	1.3598	2.3220	3.5148	4.6996	677.6
Total	12.3804	15.6617	20.7567	29.9109	40.6390	59.9357	384.1

C). Import of Hydrofluorcarbons in Bulk

The information about import of HFC in bulk (Table 4-70) was provided by businesses licensed to import freons and freons containing equipment. At the time of inventory compilation, this information was available only for the time period from 2003 through 2005, and the activity data for the time period from 2000 through 2002 was extrapolated based on modelling using the regression type trend through the exponential and polynomial equations.

Table 4-70: Activity Data on Import of HFC in Bulk in the Republic of Moldova over the time series from 2000 through 2005, tones

	2000	2001	2002	2003	2004	2005	2000-2005, %
HFC-32	0.0945	0.1065	0.1303	0.1655	0.2425	0.3408	260.6
HFC-125	0.5098	0.6188	0.7430	0.9241	1.2004	1.4808	190.5
HFC-134a	1.5900	1.8240	2.2840	2.4563	5.9447	6.2930	295.8
HFC-143a	0.5315	0.6610	0.7930	0.9724	1.2442	1.4019	163.8
Total HFCs	2.7258	3.2103	3.9503	4.5183	8.6319	9.5164	249.1

2F4. 'Aerosols' (Metered Dose Aerosols)

HFC emissions from consumption of aerosol (in particular – metered dose aerosols, where HFC-134a is used as propellant) were estimated using a Tier 2 estimation methodology. It is considered that during the use of aerosols, 100 percent of the chemical is emitted into the atmosphere (US EPA, 1992). These emissions occur within 1-2 years after sales and should be estimated using the equation below.

Emissions of HFCs in year t = [(Quantity of HFC and PFC Contained in Aerosol Products Sold in year t) • (EF)] + [(Quantity of HFC and PFC Contained in Aerosol Products Sold in year (t – 1)] • (1 – EF)]

The activity data on the amount of medicamentary substances imported in the RM (metered dose inhalers used in asthma and chronicle pulmonary diseases treatment, including tuberculosis) were provided by the Ministry of Health of the RM (Table 4-71).

Table 4-71: Import of Metered Dose Inhalers within the 2003-2007 time series, flacons

Pharmaceutical product	Propellant	2003	2004	2005	2006	2007
Metered dose inhalers, flacons	CFC	82098	37611	33106	5350	63668
	HFC-134a	3014	12080	17993	108800	75651
	DPI	-	-	-	-	570

Source: Ministry of Health of the Republic of Moldova, Official Letters No. 0701/319 from 07.03.2003 and No. 01-02/153 from 24.01.2007.

To be noted that metered dose inhalers are not produced in the Republic of Moldova and these substances are imported preponderantly from Ukraine and more recently, from Russian Federation and China. Over the time period from 2003-2007, the total amount of metered dose inhalers imported in the RM increased from circa 85 thousand flacons in 2003 to circa 140 thousand bottles in 2007. At the same time the share of CFC based metered dose inhalers was continuously decreasing, from 96.5 percent in 2003 to 45.5 percent in 2007, while the share of HFC based metered dose inhalers tended to increase, from 3.5 percent in 2003, to 54.1 percent in 2007 (Table 4-72).

Table 4-72: Share of Different Types of Imported Metered Dose Inhalers within 2003-2007 time series, percent

	2003	2004	2005	2006	2007
Chlorfluorcarbons (CFC) Based Metered Dose Inhalers	96.5	75.7	64.8	4.7	45.5
Hydrofluorcarbons (HFC) Based Metered Dose Inhalers	3.5	24.3	35.2	95.3	54.1
Dry Powder Metered Dose Inhalers (DPI)	0	0	0	0	0.4

Based on activity data above the amount of HFC contained in metered dose aerosols (where HFC-134a is used s propellant) was estimated. Because at the time of inventory compilation, this information was available only for the time period from 2003 through 2007, the activity data for the time period from 2000 through 2002 was extrapolated based on modelling using regression type trend (using an exponential equation). To be noted that the total amount of HFC imported in the RM with metered dose aerosols is absolutely insignificant, and varied between 0.15 and 1.75 grams annually over the time period from 2000 through 2005 (Table 4-73).

Table 4-73: Activity Data on HFC Incorporated in Metered Dose Aerosols Imported in the Republic of Moldova in the time period from 2000 through 2005, kg

	2000	2001	2002	2003	2004	2005	2000-2005, %
HFCs	1.546E-04	2.012E-04	2.998E-04	3.014E-04	1.178E-03	1.750E-03	1031.7

2F8. 'Electrical Equipment'

SF_6 emissions from use of sulphur hexafluoride as insulation medium in high tension electrical circuit breakers were estimated based on Tier 2b estimation methodology using default emission factors (IPCC, 2000), based on the equation below.

Emissions of SF_6 in year t = (2 % of the Total Charge of SF_6 Contained in the Existing Stock of Equipment of Operation in year t) + (95 % of the Nameplate Capacity of SF_6 in Retiring Equipment)

According to technical characteristics of the two high-tension electrical circuit breakers of GL311F1 type currently in use at the 330 kW sub-station in Balti, the SF_6 charge in each case is 12 kg (the first was put into operation in 2003, and the second in 2005). In conformity with the manufacturer's Technical Log the first repairs with demonstration shall take place after 25 years of operation.

4.6.3 Uncertainties and Time-Series Consistency

The primary uncertainties related factors pertain to methodology, emission factors used to estimate GHG emissions from the 2F 'Consumption of HFCs and SF_6' source category, and quality of activity data available.

Uncertainties associated with default emission factors used to estimate HFC and SF_6 emissions covered by this source category reach up to ±50 percent. Uncertainties associated with activity data on import of halocarbons (in stock and incorporated in different types of equipment) are high (±50 percent), while those associated with activity data on import of metered dose aerosols and SF_6 are lower (±10 percent).

Combined uncertainties related to HFC emissions covered by the source category 2F1 'Refrigeration and Air Conditioning Equipment' are considered high (±70.71 percent), while uncertainties associated with HFC emissions from the 2F4 'Aerosols' source category and those related to SF_6 emissions from the 2F8 'Electrical Equipment' source category are considered medium (±50.99 percent).

At the same time, combined uncertainties, presented as a percent of total sectoral emissions were estimated at ±2.27 percent for HFC emissions from the 2F1 'Refrigeration and Air Conditioning Equipment' source category and ±0.02 percent for SF_6 emissions from the 2F8 'Electrical Equipment'. Uncertainties introduced in trend in sectoral emissions were estimated at ±1.20 percent for HFC emissions from the 2F1 'Refrigeration and Air Conditioning Equipment' source category and ±0.01 percent for SF_6 emissions from the 2F8 'Electrical Equipment' (see Annex 7-3.2).

In view of ensuring time-series consistency of the obtained results, the same approach was used for the entire period under review, in conformity with the recommendations included in the Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories (IPCC, 2000).

4.6.4 QA/QC and Verification

Standard verification and quality control forms and checklists were filled in for the respective category under the Industrial Processes Sector, following the Tier 1 and Tier 2 approaches (see in Annex 6).

Also, the AD and methods used for estimating GHG emissions under the category 2F 'Consumption of HFCs and SF_6' were documented and archived both in hard copies and electronically. For identifying the data entry and emission estimation process related errors there were applied verifications and quality control procedures. Verification was focused on correct use of AD obtained from different sources of reference (i.e., National Bureau of Statistics, Customs Service, Ministry of Health, Ministry of Information Development, Republican Association of Refrigeration Technicians and Annual Reports submitted by businesses to the Ozone Office by the Ministry of Environment and Natural Resources), as well as on ensuring correct use of the default emission factors available in the Revised 1996 IPCC Guidelines (IPCC, 1997) and GPG (IPCC, 2000).

Inventory quality assurance activities for the Industrial Processes Sector, inclusive for the 2F 'Consumption of Halocarbons and Sulphur Hexafluoride', were supported by an expert representing the Technical University of Moldova (TUM).

4.6.5 Recalculations

Potential and current GHG emissions from the 2F 'Consumption of Halocarbons and Sulphur Hexafluoride' source category were estimated for the first time under the current inventory cycle.

The obtained results demonstrate that over the period under review the potential F-gas emissions in the RM increased by 326.4 percent (Table 4-74), while the current F-gas emissions increased by 351.6 percent (Table 4-75).

Table 4-74: Potential F-gas Emissions from the 2F 'Consumption of Halocarbons and Sulphur Hexafluoride' Source Category in the RM within 2000-2005 time series, Gg

GHG	GWP	2000	2001	2002	2003	2004	2005	2000-2005, %
2F1 'Refrigeration and Air Conditioning Equipment'								
HFC-32, t	650	0.1872	0.2101	0.3065	0.3628	0.4576	0.6062	223.8
HFC-125, t	2800	0.9230	1.1851	1.7173	2.1943	2.5507	3.3132	259.0
HFC-134a, t	1300	18.8596	24.5504	34.1919	44.1492	60.0819	83.0545	340.4
HFC-143a, t	3800	0.9459	1.2194	1.7741	2.3758	2.7328	3.4751	267.4
2F1, Gg CO_2 eq.		30.8178	40.0039	56.1985	72.8019	95.9306	130.8470	324.6
2F4 'Aerosols'								
HFC-134a, t	1300	1.5E-07	2.0E-07	3.0E-07	3.0E-07	1.2E-06	1.7E-06	1031.7
2F4, t CO_2 eq.		2.0E-07	2.6E-07	3.9E-07	3.9E-07	1.5E-06	2.3E-06	1031.5
2F8 'Electrical Equipment'								
SF_6, t	23900	0.0000	0.0000	0.0000	0.0120	0.0120	0.0240	100.0
2F8, Gg CO_2 eq.		0.0000	0.0000	0.0000	0.2868	0.2868	0.5736	100.0
2F 'Consumption of Halocarbons and SF_6'								
Total, Gg CO_2 eq.		30.8178	40.0039	56.1985	73.0887	96.2174	131.4206	326.4

Table 4-75: Actual F-gas Emissions from the 2F 'Consumption of Halocarbons and Sulphur Hexafluoride' Source Category in the RM within the 2000-2005 time series, Gg

GHG	GWP	2000	2001	2002	2003	2004	2005	2000-2005, %
2F1 'Refrigeration and Air Conditioning Equipment'								
HFC-32, t	650	0.0124	0.0150	0.0247	0.0239	0.0260	0.0305	146.0
HFC-125, t	2800	0.0396	0.0557	0.0943	0.1144	0.1218	0.1619	308.8
HFC-134a, t	1300	3.0451	3.8942	5.3571	7.1089	9.4207	13.5366	344.5
HFC-143a, t	3800	0.0343	0.0482	0.0839	0.1160	0.1229	0.1705	397.1
2F1, Gg CO_2 eq.		4.2080	5.4113	7.5630	10.0184	13.0716	18.7185	344.8
2F4 'Aerosols'								
HFC-134a, t	1300	7.7E-06	2.5E-06	5.1E-06	3.8E-05	5.7E-04	3.0E-04	3752.2
2F4, t CO_2 eq.		1.0E-05	3.2E-06	6.7E-06	4.9E-05	7.5E-04	3.9E-04	3752.2
2F8 'Electrical Equipment'								
SF_6, t	23900	0.0000	0.0000	0.0000	0.0002	0.0116	0.0119	4850.0
2F8, Gg CO_2 eq.		0.0000	0.0000	0.0000	0.0057	0.2782	0.2839	4880.7
2F 'Consumption of Halocarbons and SF_6'								
Total, Gg CO_2 eq.		4.2080	5.4113	7.5630	10.0241	13.3506	19.0028	351.6

4.6.6 Planned Improvements

Activities focused on updating data used to estimate GHG emissions from the 2F 'Consumption of Halocarbons and Sulphur Hexafluoride' source category in the Republic of Moldova are planned for the next inventory cycle.

5. SOLVENTS AND OTHER PRODUCT USE SECTOR

5.1 Overview

Solvents and Other Products Use Sector includes emissions of non-methane volatile organic compounds (NMVOC) which are also regarded as CO_2 emissions source, because the majority of solvents are obtained from fossil fuels. Most solvents are part of the final product (e.g., paints) and will sooner or later evaporate. In most countries this process is an important source of NMVOC emissions. On a European scale its contribution is approximately one quarter of the total national anthropogenic NMVOC emissions (in different countries, NMVOC emissions from this sector account for 15-40 percent of total national NMVOC emissions). This sector also includes nitrous oxide emissions from the use of N_2O in medicine (in particular, in anaesthesia). The entire quantity of N_2O used in anaesthesia is considered emitted in atmosphere.

5.1.1 Summary of Emission Trends

In 2005, Solvents and Other Products Use Sector accounted for 0.4 percent of total national GHG in the RM (without LULUCF). To be noted that this sector is a major source of national NMVOC emissions, accounting for 37.2 percent of the total.

In the time series 1990 through 2005, total GHG emissions originated from Solvents and Other Products Use Sector tended to decrease: from 65.62 Gg CO_2 eq. in 1990 to 49.00 Gg CO_2 eq. in 2005 (Figure 5-1, Table 5-1), in principal due to reduced consumption of solvents at national level.

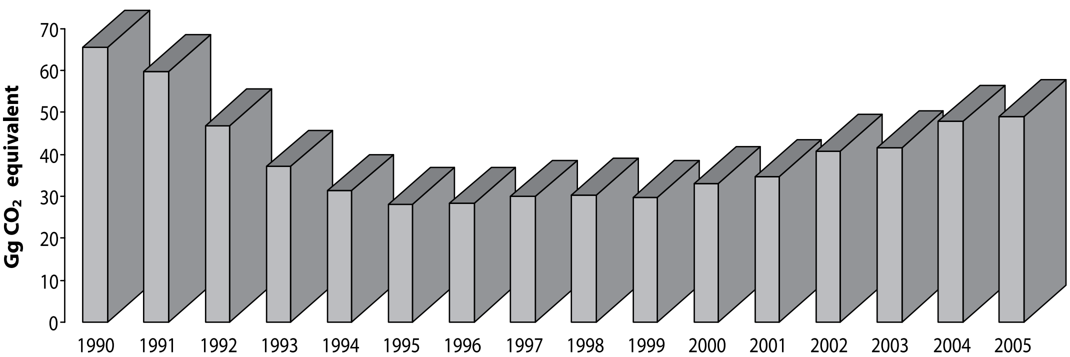

Figure 5-1: GHG Emissions from Solvents and Other Products Use Sector in the Republic of Moldova, 1990-2005

Table 5-1: Direct GHG Emissions from the Solvents and Other Products Use Sector by Category in the Republic of Moldova within 1988-2005, Gg CO_2 eq.

Categories	1988	1990	1991	1992	1993	1994
3. Total	61.6431	65.6245	59.6810	46.8844	37.0661	31.2861
3.A Paint Application	26.6475	30.1849	25.4710	16.9684	8.8535	4.0115
3.B Degreasing and Dry Cleaning	1.8388	1.9978	1.6207	1.1812	0.7106	0.4737
3.C Chemical Products, Manufacture and Processing	0.5096	0.5470	0.4114	0.2010	0.1075	0.0468
3.D Other	32.6472	32.8948	32.1780	28.5338	27.3944	26.7541
3.D.1 Adhesive Use	5.7970	5.8905	5.3295	3.0855	2.1505	1.4025
3.D.2 Graphic Arts (Inks)	0.5267	0.5408	0.4861	0.3785	0.2178	0.1102
3.D.3 Seed Oil Extraction and Seed Drying	1.9694	1.9745	1.8504	0.5998	0.6164	0.8073
3.D.4 Household Products	24.3339	24.4686	24.4949	24.4546	24.3912	24.4186
3.D.5 Use of N_2O in Anaesthesia	0.0202	0.0205	0.0171	0.0155	0.0186	0.0155

Categories	1995	1996	1997	1998	1999	2000
3. Total	28.0646	28.2112	29.8819	30.3874	29.7698	33.0638
3.A Paint Application	1.9381	2.1367	2.9577	2.9907	2.9340	6.7433
3.B Degreasing and Dry Cleaning	0.2212	0.6586	0.9322	0.3456	0.9534	0.3363
3.C Chemical Products, Manufacture and Processing	0.0281	0.0234	0.0238	0.0173	0.0315	0.0960
3.D Other	25.8773	25.3926	25.9682	27.0338	25.8509	25.8882
3.D.1 Adhesive Use	0.9343	0.6304	1.3157	2.5357	1.4971	1.5481
3.D.2 Graphic Arts (Inks)	0.0563	0.0772	0.0829	0.0791	0.0600	0.0866
3.D.3 Seed Oil Extraction and Seed Drying	0.4946	0.3684	0.3335	0.2681	0.1967	0.2207
3.D.4 Household Products	24.3917	24.3160	24.2352	24.1494	24.0837	24.0192
3.D.5 Use of N_2O in Anaesthesia	0.0003	0.0006	0.0009	0.0016	0.0133	0.0136
Categories	**2001**	**2002**	**2003**	**2004**	**2005**	**1990–2005, %**
3. Total	34.7125	40.7827	41.6691	47.8175	49.0021	-25.3
3.A Paint Application	7.6785	12.4334	12.4890	18.7906	17.9812	-40.4
3.B Degreasing and Dry Cleaning	0.5977	1.1938	2.2818	1.2258	1.2401	-37.9
3.C Chemical Products, Manufacture and Processing	0.1342	0.1914	0.1610	0.2163	0.2931	-46.4
3.D Other	26.3022	26.9640	26.7374	27.5849	29.4878	-10.4
3.D.1 Adhesive Use	1.7721	2.3023	1.5027	3.4019	3.9807	-32.4
3.D.2 Graphic Arts (Inks)	0.1372	0.1556	0.1821	0.2371	0.3428	-36.6
3.D.3 Seed Oil Extraction and Seed Drying	0.4565	0.6629	1.2441	1.8399	1.8791	-4.8
3.D.4 Household Products	23.9227	23.8296	23.7948	22.0905	23.2664	-4.9
3.D.5 Use of N_2O in Anaesthesia	0.0136	0.0136	0.0136	0.0155	0.0189	-7.6

Categories 3A 'Paint Application' (36.7 percent of the total) and 3D 'Other', in particularly: 3D4 'Household Products' (47.5 percent of the total), 3D1 'Adhesives Use' (8.1 percent of the total) were the major sources of direct GHG emissions originated from Solvents and Other Products Use Sector in the time series 1990 through 2005.

Table 5-2: NMVOC Emissions from the Solvents and Other Products Use Sector by Category in the Republic of Moldova within 1988-2005, Gg

Categories	1988	1990	1991	1992	1993	1994
3. Total	19.7721	21.0494	19.1435	15.0382	11.8869	10.0333
3.A Paint Application	8.5500	9.6850	8.1725	5.4444	2.8407	1.2871
3.B Degreasing and Dry Cleaning	0.5900	0.6410	0.5200	0.3790	0.2280	0.1520
3.C Chemical Products, Manufacture and Processing	0.1635	0.1755	0.1320	0.0645	0.0345	0.0150
3.D Other	10.4686	10.5479	10.3190	9.1503	8.7837	8.5792
3.D.1 Adhesive Use	1.8600	1.8900	1.7100	0.9900	0.6900	0.4500
3.D.2 Graphic Arts (Inks)	0.1690	0.1735	0.1560	0.1214	0.0699	0.0354
3.D.3 Seed Oil Extraction and Seed Drying	0.6319	0.6335	0.5937	0.1925	0.1978	0.2590
3.D.4 Household Products	7.8077	7.8509	7.8593	7.8464	7.8260	7.8349
Categories	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**
3. Total	9.0046	9.0515	9.5875	9.7495	9.5475	10.6043
3.A Paint Application	0.6218	0.6856	0.9490	0.9596	0.9414	2.1636
3.B Degreasing and Dry Cleaning	0.0710	0.2113	0.2991	0.1109	0.3059	0.1079
3.C Chemical Products, Manufacture and Processing	0.0090	0.0075	0.0076	0.0056	0.0101	0.0308
3.D Other	8.3028	8.1471	8.3317	8.6734	8.2901	8.3020
3.D.1 Adhesive Use	0.2998	0.2023	0.4222	0.8136	0.4804	0.4967
3.D.2 Graphic Arts (Inks)	0.0181	0.0248	0.0266	0.0254	0.0192	0.0278
3.D.3 Seed Oil Extraction and Seed Drying	0.1587	0.1182	0.1070	0.0860	0.0631	0.0708
3.D.4 Household Products	7.8262	7.8019	7.7760	7.7485	7.7274	7.7067

Categories	2001	2002	2003	2004	2005	1990–2005, %
3. Total	11.1333	13.0810	13.3654	15.3375	15.7165	-25.3
3.A Paint Application	2.4637	3.9894	4.0072	6.0291	5.7694	-40.4
3.B Degreasing and Dry Cleaning	0.1918	0.3831	0.7321	0.3933	0.3979	-37.9
3.C Chemical Products, Manufacture and Processing	0.0431	0.0614	0.0516	0.0694	0.0940	-46.4
3.D Other	8.4348	8.6472	8.5745	8.8458	9.4553	-10.4
3.D.1 Adhesive Use	0.5686	0.7387	0.4821	1.0915	1.2772	-32.4
3.D.2 Graphic Arts (Inks)	0.0440	0.0499	0.0584	0.0761	0.1100	-36.6
3.D.3 Seed Oil Extraction and Seed Drying	0.1465	0.2127	0.3992	0.5904	0.6029	-4.8
3.D.4 Household Products	7.6757	7.6459	7.6347	7.0879	7.4651	-4.9

To be noted that the share of the 3D5 'Use of N_2O in Anaesthesia' source category in the total direct GHG emissions originated from the Solvents and Other Products Use Sector over the entire period under review was insignificant (maximum 0.05 percent of the total).

The NMVOC emissions from the Solvents and Other Products Use Sector decreased significantly from 1990 through 2005: from 21.05 Gg in 1990 to 15.72 Gg in 2005 (Table 5-2). Between 1990 and 2005 time series, the 3A 'Paint Application' and 3D 'Other' source categories were the major sources of NMVOC emissions covered by this sector.

5.1.2 Key Categories

The results of key source assessment (including LULUCF) carried out following a Tier 1 approach (IPCC, 2000), are provided in Chapter 1.5, as well as in the Annex 1. No key categories (by level and trend) were identified under Solvents and Other Products Use Sector in the Republic of Moldova (Table 5-3).

Table 5-3: Results of Key Sources Analysis for Solvents and Other Products Use Sector

IPCC Category	GHG	Source Categories	Key sources
3.A	CO_2	Paint Application	No
3.B	CO_2	Degreasing and Dry Cleaning	No
3.C	CO_2	Chemical Products, Manufacture and Processing	No
3.D	CO_2	Other	No
3.D	N_2O	Other (use of N_2O in Anaesthesia)	No

5.1.3 Methodological Issues

All source categories covered by Solvents and Other Products Use Sector were estimated based on the CORINAIR estimation methodology (EMEP CORINAIR Atmospheric Emissions Inventory Guidebook, 1999) and default emission factors (Table 5-4).

Table 5-4: GHG Emissions Estimation Methodologies Used to Evaluate Emissions from Solvents and Other Products Use Sector

IPCC Category	Source Categories	Emissions de GHG	
		Methodology	Emission Factors
3.A	Paint Application	CORINAIR	D
3.B	Degreasing and Dry Cleaning	CORINAIR	D
3.C	Chemical Products, Manufacture and Processing	CORINAIR	D
3.D.1	Adhesive Use	CORINAIR	D
3.D.2	Graphic Arts (Inks)	CORINAIR	D
3.D.3	Seed Oil Extraction and Seed Drying	CORINAIR	D
3.D.4	Household Products	CORINAIR	D
3.D.5	Use of N_2O in Anaesthesia	CORINAIR	D

Abbreviations: D – default emission factors.

The CORINAIR Inventory Guidebook provides information on how to convert the SNAP nomenclature classification of source categories into the Intergovernmental Panel on Climate Change's nomenclature classification (IPCC, 1997) (Table 5-5).

Table 5-5: Converting the SNAP CORINAIR Nomenclature into the IPCC Nomenclature

SNAP	Solvents and Other Products Use	IPCC	Solvents and Other Products Use
0601	Paint Application	3A	Paint Application
0602	Degreasing and Dry Cleaning	3B	Degreasing and Dry Cleaning
0603	Chemical Products, Manufacture and Processing	3C	Chemical Products, Manufacture and Processing
0604	Other Uses of Solvents	3D	Other
0605	Use of N_2O	3D	Other

In general, the GHG emissions (NMVOC, CO_2 and N_2O) reported under Solvents and Other Products Use Sector is emitted in the process of manufacturing, using and storage solvents. Estimating emissions from Solvent and Other Product Use Sector can be done following two basic ways: (1) either by estimating the amount of pure solvents consumed or (2) by estimating the amount of solvent containing products consumed (taking account of their solvent content).

Table 5-6: Default NMVOC Emission Factors for Some Source Categories under the 'Solvents and Other Products Use' Sector, in kg NMVOC/per capita/year

Country	Years	Paint Application	Industrial Degreasing	Ink Use	Adhesives Use	Household Products	Total
Australia	1990	3.7	1.6	0.80		1.3	11.0
Australia	1990	5.0	1.6				9.9
Austria	1987	5.3		0.60	1.45		
Austria	1990						17.1
Canada	1985	4.8					12.7
Canada	1990	4.8					17.1
Canada	1995	6.5					22.8
Czech Republic	1988						14.6
Finland	1991	5.55					9.6
Finland	1985	3.7		1.8		0.7	12.3
France	1986	4.8	2.7	0.4	0.17	0.27	10.4
Germany	'84-'86	6.8	0.84	0.47	0.26	1.1	18.8
Italy	1983	4.5	2.0	1.5	1.1	2	12.9
Japan	1981	6.4	0.75	0.60	1.0	0.8	10.4
Netherlands	1989	6.6	0.74	1.15	0.29		15.3
Netherlands	1990	5.05	0.85	1.2	0.20	1.6	
Netherlands	1992	4.5					10.0
Netherlands	1976	4.6	0.40	0.76		1.5	11.3
Norway	1992		0.73	0.99	0.05	1.75	15.1
Norway	'88-'92	4.5					7.5
Norway	1989	2.5-5.0		0.36			10.1
Poland	1990	4.45					
Slovak Republic	1993	6.2	1.3			1.6	9.0
Slovak Republic	1988	3.6	0.64			1.6	5.8
Sweden	1990	4.7	1.4	0.82		2.6	12.1
Switzerland	1988						22.1
Great Britain	'91-'92	4.8	0.81	0.68	1.02	3.3	13.7
Great Britain	1985						11.4
USA	1989						17.5
USA	1990	8.6	2.8	1.3	1.3	1.5	21.3
USA	1990	9.5	2.7	2.5			22.9
USA	1990	7.6	2.7	1.3	2.7	3.9	21.6
Western Europe	1988						15.2
Western Europe	1990	5.3	1.0	0.86	0.84	1.1	14.4
Europe (average)	> 1990	4.5±0.4	0.85±0.30	0.65±0.25	0.6±0.45	1.8±0.45	12.0±3.4

Source: EMEP/CORINAIR Guidebook, September 1, 1999, Activity 060000, su060000, B600-5.

The first approach implies an inventory of the most relevant categories of solvents used in the country, at least those together representing more than 90 percent of the total NMVOC emission. It is assumed that the total amount of solvents used in the country shall be equal to the total amount of national GHG emissions. In case of the second approach, the inventory covers all source categories identified under this sector (SNAP CORINAIR defines the categories 0601-0604).

GHG emissions covered by these source categories can be estimated based on information collected at the national level on total consumption of solvents, or by using default emission factors for the average values of per capita in the European countries (Table 5-6) multiplied by the number of population in the respective country (this approach shall be applied only in cases when no AD on total consumption of solvents and other products is available on the national level). A more detailed description of estimation methodologies and emission factors used in this inventory cycle is available in the respective sub-chapters of the report (5.2-5.5).

5.1.4 Uncertainties and Time-Series Consistency

The uncertainty analysis of the GHG emissions from the Solvents and Other Product Use Sector (by source categories) is described in detail in the respective sub-chapters (5.2-5.5) of the NIR, as well as in the Annex 7-3.3. Combined uncertainties as a percentage of total direct sectoral emissions were estimated at circa ±97.45 percent (±97.49 percent for CO_2, and ±14.1 percent for N_2O). The uncertainties introduced in trend in sectoral emissions were estimated at ±18.12 percent (±18.13 percent for CO_2 and ±13.07 percent for N_2O).

In view of ensuring time-series consistency of the results, the same approach was used for the entire period under review, in conformity with the recommendations included in the Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories (IPCC, 2000).

5.1.5 QA/QC and Verification

Standard verification and quality control forms and checklists by individual source categories were filled in for each source category under the Solvents and Other Product Use Sector, following the Tier 1 and Tier 2 approaches (see in Annex 6). Also, the AD and methods used for estimating GHG emissions under the Solvents and Other Product Use Sector were documented and archived both in hard copies and electronically. To identify the data entry, as well GHG emissions estimation related errors there were applied AD and EFs verifications and quality control procedures. Inventory quality assurance activities for the Solvents and Other Product Use Sector were supported by an expert representing the Technical University of Moldova (TUM).

Following the recommendations included into the Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories (IPCC, 2000), GHG emissions under the Solvents and Other Product Use Sector were estimated based on AD and EFs from official sources of reference.

5.1.6 Recalculations

GHG emission recalculations under the Solvents and Other Product Use Sector are due to new, updated set of activity data becoming available, and as a result of changing the estimation methods with the ones available in the 3rd edition of the EMEP CORINAIR Inventory Guidebook, replacing those available in the 1st edition, that have been used in the FNC of the RM under the UNFCCC).

Table 5-7: Recalculated GHG Emissions under the 'Solvent and Other Product Use' Sector for the 1990-1998 time series

	1990	1991	1992	1993	1994	1995	1996	1997	1998
FNC, Gg CO_2 eq.	5.19	4.64	4.81	4.78	4.48	4.84	5.33	4.63	4.78
SNC, Gg CO_2 eq.	65.62	59.68	46.88	37.07	31.29	28.06	28.21	29.88	30.39
Difference, %	1165.6	1187.0	874.1	674.8	597.6	479.3	429.1	544.9	535.3
FNC, Gg NMVOC	40.23	40.10	40.09	39.98	39.93	40.00	40.05	39.69	39.60
SNC, Gg NMVOC	21.05	19.14	15.04	11.89	10.03	9.00	9.05	9.59	9.75
Difference, %	-47.7	-52.3	-62.5	-70.3	-74.9	-77.5	-77.4	-75.8	-75.4

Abbreviations: FNC – First National Communication; SNC – Second National Communication.

In comparison with the results included into the FNC of the RM under the UNFCCC (2000), the performed recalculation resulted in a significant increased of the direct GHG emissions for the 1998-1998 time series, varying from a minimum of 429 percent in 1996, up to a maximum of 1187 percent in 1991; and in a reduction of NMVOC emissions, which varied from a minimum of 47.7 percent in 1990, to a maximum of 77.5 percent in 1995 (Table 5-7). The results of recalculations performed at the category level are presented in the respective sub-chapters (5.2-5.5) of the NIR.

5.1.7 Assessment of Completeness

The current inventory covers greenhouse gas emissions from 8 source categories under the Republic of Moldova's Solvents and Other Products Use Sector (Table 5-8).

Table 5-8: Assessment of Completeness under the 'Solvents and Other Product Use' Sector in the Republic of Moldova

IPCC Category	Source Category	CO_2	N_2O	NMVOC
3.A	Paint Application	X	NO	X
3.B	Degreasing and Dry Cleaning	X	NO	X
3.C	Chemical Products, Manufacture and Processing	X	NO	X
3.D.1	Adhesive Use	X	NO	X
3.D.2	Graphic Arts (Inks)	X	NO	X
3.D.3	Seed Oil Extraction and Seed Drying	X	NO	X
3.D.4	Household Products	X	NO	X
3.D.5	Use of N_2O in Anaesthesia	NO	X	NO

Abbreviations: X – source categories included in the inventory; NO–Not Occurring.

5.1.8 Planned Improvements

Planned improvements at the source categories level within the Solvents and Other Product Use Sector are described in detail in respective sub-chapters (5.2-5.5) of this report.

5.2 Paint Application (Category 3A)

5.2.1 Source Category Description

Under the 3A 'Paint Application' source category there were reported NMVOC emissions from industrial and domestic paint application. Industrial paint application implies use of paints for painting vehicles, boats, aircrafts, carriages, machines, equipments, bridges, metal tanks, other objects made of metal, food cans, wood and wooden materials, other applications in constructions and residential sector. To be noted that there is no evident difference in paint application in construction and building sectors in the RM.

5.2.2 Methodological Issues and Data Sources

The methodology used to estimate NMVOC emissions from paint application is represented by the following formula:

NMVOC Emissions = PA • EF

Where:

NMVOC emissions = emissions resulting from paint application, kt/year;

PA = amount of paint applied, kt/year;

EF = emission factor (contents of solvent in paint), percent.

According to the available methodology (CORINAIR, 1999), the contents of solvents in different types of paint vary depending on the technology used to produce it. So, for conventional solvent paint (solvent-borne), the content of organic solvents vary between 40-70 percent (on average 55 percent), while for alternative paints (waterborne), the content of organic solvents is under 20 percent (on average 10 percent). For most activities involving paint application, no veridical statistics is available for activity data. Under such circumstances, the total consumption of varnishes and paints was estimated taking into account internal production and statistical data on import and export of such substances in the RM.

$$Consumption_{paint} = Production_{paints} + Import_{paints} - Export_{paints}$$

Where:

$Consumption_{paints}$ = total consumption of paints, kt/year;

$Production_{paints}$ = produced amount of paints, kt/year;

$Import_{paints}$ = imported amount of paints, kt/year;

$Export_{paints}$ = exported amount of paints, kt/an.

Statistical Yearbooks of the RM contain aggregated data on total production of varnishes and paints in the country (Table 5-9). The National Bureau of Statistics also provide disaggregated activity data on production of different types of varnishes and paints, such as: enamel paint, solvents and de-rusting agents for varnishes and paints, hydro emulsified paints (waterborne paints), fluid oil based paints, siccative oil, etc.

The Customs Service represents a primary source of information on varnishes and paints import-export operations by enterprises and organizations on the territory of the RM (Table 5-10).

Table 5-9: Activity Data on Production of Varnishes and Paints in the RM in the time series 1988-2005, thousand tones

	1988	1990	1991	1992	1993	1994
Production of conventional solvent paints	7.900	10.100	8.250	5.526	2.722	1.164
Production of waterborne paints	3.000	1.600	0.550	0.451	0.386	0.069
Total paints production	10.900	11.700	8.800	5.977	3.108	1.233
	1995	**1996**	**1997**	**1998**	**1999**	**2000**
Production of conventional solvent paints	0.699	0.670	0.451	0.350	0.674	2.025
Production of waterborne paints	0.062	0.036	0.058	0.020	0.000	0.029
Total paints production	0.761	0.706	0.509	0.370	0.674	2.054
	2001	**2002**	**2003**	**2004**	**2005**	**1990-2005, %**
Production of conventional solvent paints	2.713	3.399	2.428	3.872	4.608	-54.4
Production of waterborne paints	0.169	0.716	1.026	1.264	1.661	3.8
Total paints production	2.882	4.115	3.454	5.136	6.269	-46.4

Source: National Bureau of Statistics of the Republic of Moldova in the Official Letter No. 06-06/12 from 23.06.2006 (for the period 1992-2004) and Statistical Yearbooks for 1988, 1994 and 2006 years (for 1988-1991 period and 2005 year).

Table 5-10: Activity Data on Import of Varnishes and Paints in the RM in the time series from 1988 through 2005, thousand tones

	1988	1990	1991	1992	1993	1994
Imports of conventional solvent paints	7.000	7.100	6.400	4.200	2.300	1.100
Imports of waterborne paints	0.550	0.650	0.600	0.500	0.400	0.350
Total paints import	7.550	7.750	7.000	4.700	2.700	1.450
	1995	**1996**	**1997**	**1998**	**1999**	**2000**
Imports of conventional solvent paints	0.375	0.517	1.203	1.310	0.934	1.797
Imports of waterborne paints	0.247	0.290	0.338	0.444	0.572	0.587
Total paints import	0.622	0.807	1.540	1.755	1.506	2.384
	2001	**2002**	**2003**	**2004**	**2005**	**1990–2005, %**
Imports of conventional solvent paints	1.616	3.658	4.150	6.809	5.546	-21.9
Imports of waterborne paints	0.660	0.368	2.862	0.285	0.189	-70.9
Total paints import	2.276	4.025	7.013	7.094	5.735	-26.0

Source: National Bureau of Statistics of the Republic of Moldova in the Official Letter No. 07-21/121 from 20.06.2006 (for the period 1995-2005); for the period from 1988 through 1994 activity data were extrapolated.

Table 5-11: Activity Data on Consumption of Varnishes and Paints in the RM in the time series from 1988 through 2005, thousand tones

	1988	1990	1991	1992	1993	1994
Consumption of conventional solvent paints	14.900	17.200	14.650	9.726	5.022	2.264
Consumption of waterborne paints	3.550	2.250	1.150	0.951	0.786	0.419
Total paints consumption	18.450	19.450	15.800	10.677	5.808	2.683
	1995	**1996**	**1997**	**1998**	**1999**	**2000**
Consumption of conventional solvent paints	1.074	1.187	1.654	1.660	1.608	3.822
Consumption of waterborne paints	0.309	0.326	0.396	0.464	0.572	0.616
Total paints consumption	1.384	1.513	2.049	2.125	2.180	4.438
	2001	**2002**	**2003**	**2004**	**2005**	**1990–2005, %**
Consumption of conventional solvent paints	4.329	7.056	6.579	10.680	10.153	-41.0
Consumption of waterborne paints	0.829	1.084	3.888	1.549	1.850	-17.8
Total paints consumption	5.158	8.140	10.467	12.229	12.004	-38.3

Source: Statistical Yearbooks for 1988, 1994, 1999, 2003 and 2006 years; National Bureau of Statistics, Official Letters No. 06-06/12 from 23.06.2006 and No. 07-21/121 from 20.06.2006

CO_2 emissions were estimated assuming that the content of carbon in NMVOC emissions accounts for 85 percent. Further, by oxidizing this carbon is converted in carbon dioxide in the atmosphere (it is assumed that all solvents from varnishes and paints are of fossil origin). CO_2 emissions from paint application were estimated using the following formula:

CO_2 *emissions = NMVOC • 0.85 • 44/12*

Where:

CO_2 emissions = carbon dioxide emissions resulting from paint application, kt/yr;

0.85 = carbon fraction in NMVOC;

44/12 = stoichiometric ratio of carbon in CO_2 and NMVOC.

5.2.3 Uncertainties and Time-Series Consistency

Uncertainties related to the AD on production, import and export of paints in the RM, as well as those related to carbon content in NMVOC are considered to be moderate (±20 percent). At the same time, uncertainties related to content of solvents in different types of paints are considerable. Uncertainties related to content of organic solvents in paints dissolved in conventional solvent medium are estimated to be at around ±50 percent, while uncertainties related to content of organic solvents in alternative paints, inclusive in waterborne medium, reach to around ±200 percent.

So, combined uncertainties related to GHG emissions from the 3A 'Paint Application' source category can be considered medium for emissions from application of conventional solvent paints (±53.85 percent), and high for emissions from application of waterborne paints (±201.00 percent).

At the same time, combined uncertainties, presented as a percent of total sectoral emissions were estimated at ±19.13 percent for CO_2 emissions from conventional solvent paints, and at ±2.37 percent for CO_2 emissions from waterborne paints. Uncertainties introduced in trend in sectoral emissions were estimated at ±8.28 percent for CO_2 emissions from conventional solvent paints and at ±0.30 percent for CO_2 emissions from waterborne paints (see Annex 7-3.3).

In view of ensuring time-series consistency of the obtained results, the same approach was used for the entire period under review, in conformity with the recommendations included in the Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories (IPCC, 2000).

5.2.4 QA/QC and Verification

Standard verification and quality control forms and checklists were filled in for the respective category under the Solvents and Other Product Use Sector, following the Tier 1 and Tier 2 approaches (see in Annex 6). Also, the AD and methods used for estimating GHG emissions under the category 3A 'Paint Application' were documented and archived both in hard copies and electronically. For identifying the data entry and emission estimation process related errors there were applied verifications and quality control procedures. Verification was focused on correct use of AD obtained from different sources of reference (i.e., National Bureau of Statistics, Customs Service), as well as on ensuring correct use of the default emission factors available in the EMEP CORINAIR Atmospheric Emissions Inventory Guidebook (CORINAIR, 1999). Inventory quality assurance activities for the Solvents and Other Product Use Sector, inclusive for the 3A 'Paint Application', were supported by an expert representing the Technical University of Moldova (TUM).

Following the recommendations included into the Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories (IPCC, 2000), GHG emissions originated from the 3A 'Paint Application' were estimated based on AD and EFs from official sources of reference.

5.2.5 Recalculations

GHG emissions from the source category 3.A 'Paint Application' were recalculated for the period 1990 through 1998 (year 1990 is reference year under the UNFCCC, while emissions for 1988 are cited here for comparison purposes only), in particular, due to employing a new estimation methodology: in SNC – based on activity data on the total consumption of varnishes and paints; while in the FNC – by using default per capita emission factors (CORINAIR, 1996) for the Western Europe countries (Table 5-6), combined with activity data on the number of population in the Republic of Moldova.

In comparison with results recorded in the FNC, the changes made in the process of compiling the current inventory resulted in significantly decreased NMVOC emissions over the period 1990 through 1998, which varied from a minimum of -58.10 percent in 1990, to a maximum of -97.30 percent in 1995 (Table 5-12).

Table 5-12: Comparative Results of NMVOC Emissions from 3A 'Paint Application' Included into the FNC and SNC of the RM under the UNFCCC, Gg

	1988	1990	1991	1992	1993	1994
FNC	22.9893	23.1165	23.1414	23.1032	23.0433	23.0693
SNC	8.5500	9.6850	8.1725	5.4444	2.8407	1.2871
Difference, %	-62.81	-58.10	-64.68	-76.43	-87.67	-94.42
	1995	**1996**	**1997**	**1998**	**1999**	**2000**
FNC	23.0439	22.9723	22.8960	22.8149		
SNC	0.6218	0.6856	0.9490	0.9596	0.9414	2.1636
Difference, %	-97.30	-97.02	-95.86	-95.79		
	2001	**2002**	**2003**	**2004**	**2005**	**1990-2005, %**
FNC						
SNC	2.4637	3.9893	4.0072	6.0291	5.7694	-40.4
Difference, %						

CO_2 emissions from the 3A 'Paint Application' source category (Table 5-13) were not estimated under the FNC. For the 1999-2005 time series, the GHG emissions resulting from paint application were estimated for the first time. The results allow assert that over the period 1990 through 2005, the GHG emissions resulting from paint application decreased by 40.4 percent (Tables 5-12 and 5-13).

Table 5-13: CO_2 Emissions from 3A 'Paint Application' Source Category in the Republic of Moldova in the time series 1988 through 2005, Gg

Years	CO_2 Emissions, Gg	Years	CO_2 Emissions, Gg
1988	26.6475	1998	2.9907
1990	30.1849	1999	2.9340
1991	25.4710	2000	6.7433
1992	16.9684	2001	7.6785
1993	8.8535	2002	12.4334
1994	4.0115	2003	12.4890
1995	1.9381	2004	18.7906
1996	2.1367	2005	17.9812
1997	2.9577	1990-2005, %	-40.4

5.2.6 Planned Improvements

Activities aimed at updating activity data used to estimate GHG emissions from 3A 'Paint Application' in the Republic of Moldova are planned for the next inventory cycle.

5.3 Degreasing and Dry Cleaning (Category 3B)

5.3.1 Source Category Description

Under the 3B 'Degreasing and Dry Cleaning' source category there were reported NMVOC emissions from the solvents used for cleaning and degreasing surfaces, dry cleaning of clothes and textiles, degreasing of leather and metal.

Chlorinated solvents, including methylene chloride, tetrachloroethylene, trichloroethylene, 1,1,1-trichloroehane, perchloroethylene, dichloromethane, cichloromethane and xylenes are widely used in degreasing in the industrial sector (cleaning metal surfaces), for degreasing in vaporized solvent and dry cleaning (clean clothes and other textiles).

The main technologies used in degreasing in the industrial sector are: (1) cold cleaners, that is mainly applied in maintenance and manufacturing; they are batch loaded, non-boiling solvent degreasers, providing the simplest method of metal cleaning; cleaners for maintenance use petroleum solvents, while production cleaners use more specialized solvents; cold cleaner operations include spraying, brushing, flushing, and immersion phases; emissions occur by waste solvent evaporation, solvent carryout, solvent batch evaporation, spray evaporation and agitation; (2) open-top vapour system - open-top vapour degreasers are batch loaded degreasers where the cleaning effect is achieved by condensation of hot solvent vapour on colder object parts; vapour degreasers only use halogenated hydrocarbons as solvents; vapour degreasers are usually equipped with a water separator which allows the solvent to flow back into the degreaser; the use of good housekeeping can greatly effect the size of the emissions; sources of emissions are solvent carry-out, exhaust systems, and waste solvent evaporation.

The main technologies used for dry cleaning are: (1) open-circuit machines - deodorisation of the clothes take place with venting of drying air to atmosphere; (2) closed-circuit machines - solvent is condensed from drying air inside the machine and there is no general venting; emissions arise from evaporative losses of solvent, primarily from the final drying of the clothes, known as deodorisation; emission may also arise from disposal of wastes from the process.

In general, solvents used are recovered and recycled, in particular, if new equipment is used, however, fugitive emissions occur especially in old, open-circuit machines where deodorization of the clothes take place with venting of drying air to atmosphere.

It should be mentioned that chemical degreasing is also used in leather industry – the skins need to be degreased because of the high content of grease. Chlorinated solvents are usually used for this purpose.

5.3.2 Methodological Issues and Data Sources

The methodology used to estimate NMVOC emissions from dry cleaning and degreasing is represented by the following formula:

NMVOC Emissions = DCD • EF

Where:

NMVOC emissions = generated from dry cleaning and degreasing activities, kt/yr;

DCD = amount of solvents used in dry cleaning and degreasing, kt/yr;

EF = emission factor (content of solvent in substances used), percent

According the available methodology (CORINAIR, 1999), the content of organic solvents in substances used in degreasing and dry cleaning and is assumed to be 100 percent.

For most activities involving use of organic solvents for dry cleaning and degreasing in the RM there are no veridical statistic data. Under such circumstances, the total consumption of solvents used in dry cleaning and degreasing (Table 5-14) was estimated based on information on import of solvents in the RM (internal production of solvents is insignificant, also it was assumed that such substances are not re-exported).

$$Consumption_{solvents} = Production_{solvents} + Import_{solvents} - Export_{solvents}$$

Where:

$Consumption_{solvents}$ = total consumption of solvents in the RM, kt/yr;

$Production_{solvents}$ = quantity of solvents produced in the country, kt/yr;

$Import_{solvents}$ = quantity of solvents imported in the country, kt/yr;

$Export_{solvents}$ = quantity of solvents exported from the country, kt/yr.

Table 5-14: Activity Data on Consumption of Solvents Used in Dry Cleaning and Degreasing in the Republic of Moldova in the time series from 1988 through 2005

	1988	1990	1991	1992	1993	1994
Aromatic Hydrocarbons, kt	0.1300	0.1400	0.1200	0.0700	0.0150	0.0100
Halogenated Hydrocarbons, kt	0.0150	0.0160	0.0150	0.0140	0.0130	0.0120
Alcohols, kt	0.0650	0.0750	0.0550	0.0450	0.0400	0.0350
Ketone, kt	0.1200	0.1300	0.1000	0.0900	0.0600	0.0400
Esters, kt	0.1000	0.1100	0.0800	0.0600	0.0500	0.0450
Glycolic/Acetate Ethers, kt	0.1600	0.1700	0.1500	0.1000	0.0500	0.0100
Total solvents, kt	0.5900	0.6410	0.5200	0.3790	0.2280	0.1520
	1995	**1996**	**1997**	**1998**	**1999**	**2000**
Aromatic Hydrocarbons, kt	0.0000	0.0170	0.0260	0.0000	0.0004	0.0027
Halogenated Hydrocarbons, kt	0.0150	0.0133	0.0245	0.0035	0.1190	0.0165
Alcohols, kt	0.0000	0.0005	0.0000	0.0050	0.0039	0.0074
Ketone, kt	0.0208	0.0617	0.1231	0.0334	0.0543	0.0344
Esters, kt	0.0309	0.0786	0.0657	0.0350	0.0676	0.0000
Glycolic/Acetate Ethers, kt	0.0043	0.0402	0.0598	0.0340	0.0607	0.0469
Total solvents, kt	0.0710	0.2113	0.2991	0.1109	0.3059	0.1079
	2001	**2002**	**2003**	**2004**	**2005**	**1990-2005, %**
Aromatic Hydrocarbons, kt	0.0202	0.0002	0.4844	0.1049	0.1090	-22.2
Halogenated Hydrocarbons, kt	0.0012	0.0399	0.0015	0.0262	0.0100	-37.8
Alcohols, kt	0.0727	0.0457	0.0383	0.0438	0.0446	-40.5
Ketone, kt	0.0041	0.1302	0.0921	0.0967	0.0976	-24.9
Esters, kt	0.0000	0.0000	0.0000	0.0000	0.0000	-100.0
Glycolic/Acetate Ethers, kt	0.0937	0.1670	0.1158	0.1216	0.1368	-19.5
Total solvents, kt	0.1918	0.3831	0.7321	0.3933	0.3979	-37.9

Source: Statistical Yearbooks for 1988 and 1994 years; National Bureau of Statistics of the Republic of Moldova, Official Letters No. 06-06/12 from 23.06.2006 and No. 07-21/121 from 20.06.2006

Customs Service is a primary source of information on solvents import-export operations (including aromatic hydrocarbons – benzen, toluen, xylene isomers mix for other uses; halogenated hydrocarbons – tetrachlorocarbon, tetrachloroethylene; alcohols – methylic alcohol, propylic alcohol, isopropylic alcohol and n-butylic alcohol; ketones - acetone, butanone, cycloxenanone and methylcyclohexanone; esters – ethylacetate, n-butylacetate, other esters of acetic acid; glycolic eters – methylacetate, pentylacetate, isopentylacetates acetat glycerol; acetate eters – p-tolyl acetate, fenylpropyl acetates, benzyl acetate, rodinyl acetate, santalyl acetate, fenylethane acetates -1,2-diol etc.) by enterprises and organizations working on the territory of the country; the respective information being submitted to the NBS for generalization.

CO_2 emissions were estimated on assumption that carbon content in NMVOC is 85 percent. Further, by oxidizing, this carbon converts into CO_2 in atmosphere (it is assumed that all solvents are of fossil origin). CO_2 emissions from degreasing and dry cleaning were estimated on the basis of the following formula:

CO_2 *Emissions = NMVOC • 0.85 • 44/12*

Where:

CO_2 emissions = carbon dioxide emissions from degreasing and dry cleaning, kt/yr;

0.85 = carbon content in NMVOC;

44/12 =stoichiometric ratio of carbon content in CO_2 and NMVOC.

5.3.3 Uncertainties and Time-Series Consistencies

Uncertainties related to activity data on production, import and export of solvents in the RM and those related to content of organic solvents (100 percent of solvent consumed) in substances used in dry cleaning and degreasing are deemed to be low (±10 percent), while uncertainties related to the amount of organic solvents evaporated in atmosphere in the process of dry cleaning and degreasing are deemed to be moderate (±30 percent).

So, combined uncertainties associated with GHG emissions from the 3B 'Degreasing and Dry Cleaning' source category may be considered moderate (±31.62 percent). At the same time, combined uncertainties, presented as a percent of total sectoral emissions were estimated at ±0.80 percent. Uncertainties introduced in trend in sectoral emissions were estimated at ±0.29 percent (Annex 7-3.3).

In view of ensuring time-series consistency of the obtained results, the same approach was used for the entire period under review, in conformity with the recommendations included in the Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories (IPCC, 2000).

5.3.4 QA/QC and Verification

Standard verification and quality control forms and checklists were filled in for the respective category under the Solvents and Other Product Use Sector, following the Tier 1 and Tier 2 approaches (Annex 6).

Also, the AD and methods used for estimating GHG emissions under the category 3B 'Degreasing and Dry Cleaning' were documented and archived both in hard copies and electronically.

For identifying the data entry and emission estimation process related errors there were applied verifications and quality control procedures. Verification was focused on correct use of AD obtained from different sources of reference (i.e., National Bureau of Statistics, Customs Service), as well as on ensuring correct use of the default emission factors available in the EMEP CORINAIR Atmospheric Emissions Inventory Guidebook (CORINAIR, 1999). Inventory quality assurance activities for the Solvents and Other Product Use Sector, inclusive for the 3B 'Degreasing and Dry Cleaning', were supported by an expert representing the Technical University of Moldova (TUM).

Following the recommendations included into the Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories (IPCC, 2000), GHG emissions originated from the 3B 'Degreasing and Dry Cleaning' were estimated based on AD and EFs from official sources of reference.

5.3.5 Recalculations

GHG emissions from the source category 3.B 'Degreasing and Dry Cleaning' were recalculated for the period 1990 through 1998 (year 1990 is reference year under the UNFCCC, while emissions for 1988 are cited here for comparison purposes only), in particular, due to employing a new estimation methodology: in SNC – based on activity data on the total consumption of varnishes and paints; while in the FNC – by using default emission factors (CORINAIR, 1996) for the Western Europe countries (Table 5-6), combined with activity data on the number of population in the Republic of Moldova.

In comparison with results recorded in the FNC, the changes made in the process of compiling the current inventory resulted in significantly decreased NMVOC emissions over the period 1990 through 1998, which varied from a minimum of -85.30 percent in 1990, to a maximum of -98.37 percent in 1995 (Table 5-15).

Table 5-15: Comparative Results of NMVOC Emissions from 3B 'Degreasing and Dry Cleaning' included into the FNC and SNC of the RM under the UNFCCC, Gg

	1988	**1990**	**1991**	**1992**	**1993**	**1994**
FNC	4.3376	4.3616	4.3663	4.3591	4.3478	4.3527
SNC	0.5900	0.6410	0.5200	0.3790	0.2280	0.1520
Difference, %	-86.40	-85.30	-88.09	-91.31	-94.76	-96.51
	1995	**1996**	**1997**	**1998**	**1999**	**2000**
FNC	4.3479	4.3344	4.3200	4.3047		
SNC	0.0710	0.2113	0.2991	0.1109	0.3059	0.1079
Difference, %	-98.37	-95.13	-93.08	-97.42		
	2001	**2002**	**2003**	**2004**	**2005**	**1990-2005, %**
FNC						
SNC	0.1918	0.3831	0.7321	0.3933	0.3979	-37.9
Difference, %						

CO_2 emissions from the 3B 'Degreasing and Dry Cleaning' source category (Table 5-16) were not estimated under the FNC. For the 1999-2005 time series, the GHG emissions resulting from degreasing and dry cleaning were estimated for the first time.

The results allow assert that over the period 1990 through 2005, the GHG emissions resulting from degreasing and dry cleaning decreased by 37.9 percent in the Republic of Moldova (Tables 5-15 and 5-16).

Table 5-16: CO_2 Emissions from 3B 'Degreasing and Dry Cleaning' Source Category in the Republic of Moldova, 1988-2005

Years	CO_2 Emissions, Gg	Years	CO_2 Emissions, Gg
1988	1.8388	1998	0.3456
1990	1.9978	1999	0.9534
1991	1.6207	2000	0.3363
1992	1.1812	2001	0.5977
1993	0.7106	2002	1.1938
1994	0.4737	2003	2.2818
1995	0.2212	2004	1.2258
1996	0.6586	2005	1.2401
1997	0.9322	1990-2005, %	-37.9

5.3.6 Planned Improvements

Activities aimed at updating activity data used to estimate GHG emissions from 3B 'Degreasing and Dry Cleaning' in the RM are planned for the next inventory cycle.

5.4 Chemical Products, Manufacture and Processing (Category 3C)

5.4.1 Source Category Description

Under the 3C 'Chemical Products, Manufacture and Processing' source category there were reported NMVOC emissions from manufacture and processing of different chemical products.

Manufacture of chemical products, including household products, includes production of paints and varnishes, inks, glues and other adhesive materials, leather, paper and textile items. Leather items are tanned with substances derived from polymers dispersed or dissolved in water medium, though other products based on polymers dispersed or dissolved in non-water medium were widely used for this purpose in the past. Tanning of leather items is aimed at conferring additional protection and improve their appearance (more intense colour or gloss). The process of textiles finishing includes treatment of textiles with different chemical substances. Manufacturing of tires and other rubber goods (hoses, belts, sports equipment, etc.) involves use of solvents. Also, solvents are used in cleaning of rubber items, as well as for improving adhesion in the process of gluing the rubber items.

This category also includes NMVOC emissions from the application and subsequent discharge of organic compounds as blowing agents for creating plastic foams (Polyurethane and Polystyrene Foam Processing). These blowing agents need to be liquids which are characterised by a low boiling point. By application of external heat (Polystyrene) or due to the reaction heat (Polyurethane) the liquid evaporates and helps create the foam, without taking part in the reaction. Emissions are from the release of these blowing agents during foaming, or subsequently by long-term release over several years, and are strictly evaporative[18]. Polyurethane and Polystyrene are used in building construction, for heat insulation, and for packaging material.

5.4.2 Methodological Issues and Data Sources

The methodology used to estimate NMVOC emissions from manufacture and processing of chemical products is represented by the following formula:

NMVOC emissions = (CPM • EF) / 10^3

Where:

NMVOC emissions = from manufacture and processing of chemical products, kt/yr;

CPM = amount of Chemical Products Manufactured, kt/year;

EF = Emission Factors, kg gas/t product (see Table 5-17).

Table 5-17: Emission Factors Used to Calculate NMVOC Emissions from the 3C 'Chemical Products, Manufacture and Processing' Source Category

Source	EF, kg NMVOC/ tones product	Reference
Paints Manufacturing	15	US EPA (1983)
Inks Manufacturing	60	US EPA (1983)
Glues Manufacturing	20	CORINAIR (1996)

Statistical Yearbooks of the RM provide activity data on manufacturing of different industrial commodities, including: leather items, textiles, leather footwear, as well as data on tires and other rubber products manufacturing (Table 5-18).

It was not possible to estimate NMVOC emissions from manufacturing and processing of some industrial commodities due to lack of conversion factors compatible with the estimation methodology (i.e., from m^2, dm^2, pairs and pieces in tones). Under such circumstances, only NMVOC emissions from varnishes and paints manufacturing were estimated within the current inventory cycle.

CO_2 emissions were estimated assuming that the content of carbon in NMVOC emissions accounts for 85 percent. Further, by oxidizing this carbon is converted in carbon dioxide in the atmosphere (it is assumed that all solvents from chemical products produced and processed, are of fossil origin). CO_2 emissions were estimated using the following formula:

CO_2 emissions = NMVOC • 0.85 • 44/12

Where:

CO_2 emissions = carbon dioxide emissions resulting from paint application, kt/yr;

0.85 = carbon fraction in NMVOC;

44/12 = stoichiometric ratio of carbon in CO_2 and NMVOC.

[18]Content of orgaic solvents in organic compounds used in foam creation (Polyurethane and Polystyrene) vary between 15-25% (the default value being circa 23%). Source: CORINAIR Guidebook, 1996, activities 060303-060304, B633-4.

Table 5-18: Activity Data on Manufacturing Industrial Commodities in the Republic of Moldova in the time series from 1988 through 2005

Category	1988	1990	1991	1992	1993	1994
Linoleum, mil. m^2	3.60	3.50	2.40	0.10	0.15	0.20
Refurbished tyres, thous. pieces	98.10	75.30	73.10	40.10	1.50	4.50
Man-made leather, mil. m^2	5.84	6.10	4.50	3.20	2.30	0.60
Coarse leather goods, mil. dm^2	67.00	62.70	57.70	15.10	9.10	3.90
Box calf leather, mil. dm^2	179.00	167.70	167.60	128.20	87.30	26.00
Varnishes and paints, thous. tones	10.90	11.70	8.80	5.98	3.11	1.23
Footwear, mil. pairs	22.40	23.20	20.80	6.90	4.90	2.30
Fabrics, mil. m^2	211.00	244.20	228.10	9.30	2.60	0.50
Carpets and mats, mil. m^2	5.52	5.40	4.20	2.80	2.60	1.70
Hosiery, mil. pairs	40.60	44.40	37.10	26.80	19.40	6.80
Knitwear, mil. pieces	66.90	66.10	52.30	25.40	18.70	5.20
Category	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**
Linoleum, mil. m^2	0.25	0.29	0.37	0.18	0.14	0.18
Refurbished tyres, thous. pieces	6.60	8.00	9.80	7.10	10.20	7.00
Man-made leather, mil. m^2	0.31	0.18	0.32	0.10	0.02	0.02
Coarse leather goods, mil. dm^2	6.70	7.70	7.60	7.90	2.60	1.80
Box calf leather, mil. dm^2	20.40	25.30	30.50	13.50	5.70	6.10
Varnishes and paints, thous. tones	0.76	0.71	0.51	0.37	0.67	2.05
Footwear, mil. pairs	1.50	1.40	1.10	0.79	0.85	1.11
Fabrics, mil. m^2	0.60	0.70	0.60	0.22	0.13	0.12
Carpets and mats, mil. m^2	0.98	1.01	0.83	0.69	0.55	0.53
Hosiery, mil. pairs	2.77	2.41	0.96	0.60	0.54	0.82
Knitwear, mil. pieces	3.60	4.50	3.00	3.40	3.40	6.90
Category	**2001**	**2002**	**2003**	**2004**	**2005**	**1990–2005, %**
Linoleum, mil. m^2	0.09	0.00	0.00	0.00	0.00	-100.00
Refurbished tyres, thous. pieces	9.20	4.60	6.00	0.00	0.00	-100.00
Man-made leather, mil. m^2	0.01	0.00	0.00	0.00	0.00	-100.00
Coarse leather goods, mil. dm^2	1.70	0.60	0.30	0.00	0.00	-100.00
Box calf leather, mil. dm^2	8.50	19.30	6.00	0.00	0.00	-100.00
Varnishes and paints, thous. tones	2.87	4.10	3.44	5.14	6.27	-46.41
Footwear, mil. pairs	1.24	1.93	2.74	2.99	3.65	-84.27
Fabrics, mil. m^2	0.08	0.19	0.16	0.10	0.11	-99.95
Carpets and mats, mil. m^2	1.18	2.44	3.54	4.47	4.42	-18.15
Hosiery, mil. pairs	1.22	0.93	1.14	0.99	0.90	-97.97
Knitwear, mil. pieces	10.20	11.90	11.40	18.30	16.30	-75.34

Source: Statistical Yearbooks for 1988, 1994, 1999, 2003 and 2006; National Bureau of Statistics of the Republic of Moldova, Official Letter No. 06-06/12 from 23.06.2006

5.4.3 Uncertainties and Time-Series Consistency

Uncertainties related to activity data on varnishes and paints production in the RM and those related to carbon contents in NMVOC are deemed to be relatively low (±10 percent), while uncertainties related to the emission factors are deemed to be medium (±50 percent). So, combined uncertainties associated with GHG emissions from the 3C 'Chemical Products, Manufacture and Processing' source category may be considered medium (±50.99 percent). At the same time, combined uncertainties, presented as a percent of total sectoral emissions were estimated at ±0.30 percent. Uncertainties introduced in trend in sectoral emissions were estimated at ±0.11 percent (Annex 7-3.3).

In view of ensuring time-series consistency of the obtained results, the same approach was used for the entire period under review, in conformity with the recommendations included in the Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories (IPCC, 2000).

5.4.4 QA/QC and Verification

Standard verification and quality control forms and checklists were filled in for the respective category under the Solvents and Other Product Use Sector, following the Tier 1 and Tier 2 approaches (Annex 6). Also, the AD and methods used for estimating GHG emissions under the category 3C 'Chemical Products, Manufacture and Processing' were documented and archived both in hard copies and electronically. For identifying the data entry and emission estimation process related errors there were applied verifications and quality control procedures. Verification was focused on correct use of AD obtained from different sources of reference (i.e., National Bureau of Statistics, Customs Service), as well as on ensuring correct use of the default emission factors available in the EMEP CORINAIR Atmospheric Emissions Inventory Guidebook (CORINAIR, 1999) and US EPA publications (US EPA, 1983). Inventory quality assurance activities for the Solvents and Other Product Use Sector, inclusive for the 3C 'Chemical Products, Manufacture and Processing', were supported by an expert representing the Technical University of Moldova (TUM).

Following the recommendations included into the Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories (IPCC, 2000), GHG emissions originated from the 3C 'Chemical Products, Manufacture and Processing' were estimated based on AD and EFs from official sources of reference.

5.4.5 Recalculations

GHG emissions from the source category 3.C 'Chemical Products, Manufacture and Processing' were recalculated for the period 1990 through 1998 (year 1990 is reference year under the UNFCCC, while emissions for 1988 are cited here for comparison purposes only), in particular, due to employing a new emission factor (in SNC - 15 kg NMVOC per tone of product; while in the FNC – 500 kg NMVOC per tone of product[19]). In comparison with results recorded in the FNC, the changes made in the process of compiling the current inventory resulted in significantly decreased (by 97 per cent) NMVOC emissions over the period 1990 through 1998 (Table 5-19).

CO_2 emissions from the 3C 'Chemical Products, Manufacture and Processing' source category (Table 5-20) were not estimated within the FNC of the Republic of Moldova under the UNFCCC (2000). For the 1999-2005 time series, the GHG emissions resulting from chemical products, manufacture and processing were estimated for the first time.

[19]In the FNC of the RM under the UNFCCC, the NMVOC emissions from production of varnishes and paints were included in the Industrial Processes Sector.

Table 5-19: Comparative Results of NMVOC Emissions from 3C 'Chemical Products, Manufacture and Processing' Included into the FNC and SNC of the RM under the UNFCCC, Gg

	1988	1990	1991	1992	1993	1994
FNC	5.4500	5.8500	4.4000	2.1500	1.1500	0.5000
SNC	0.1635	0.1755	0.1320	0.0645	0.0345	0.0150
Difference, %	-97.00	-97.00	-97.00	-97.00	-97.00	-97.00
	1995	**1996**	**1997**	**1998**	**1999**	**2000**
FNC	0.3000	0.2500	0.2545	0.1850		
SNC	0.0090	0.0075	0.0076	0.0056	0.0101	0.0308
Difference, %	-97.00	-97.00	-97.00	-97.00		
	2001	**2002**	**2003**	**2004**	**2005**	**1990-2005, %**
FNC						
SNC	0.0431	0.0614	0.0516	0.0694	0.0940	-46.4
Difference, %						

Table 5-20: CO_2 Emissions from 3C 'Chemical Products, Manufacture and Processing' Source Category in the Republic of Moldova, 1988-2005

Years	CO_2 Emissions, Gg	Years	CO_2 Emissions, Gg
1988	0.5096	1998	0.0173
1990	0.5470	1999	0.0315
1991	0.4114	2000	0.0960
1992	0.2010	2001	0.1342
1993	0.1075	2002	0.1914
1994	0.0468	2003	0.1610
1995	0.0281	2004	0.2163
1996	0.0234	2005	0.2931
1997	0.0238	1990-2005, %	-46.4

The results allow assert that over the period 1990 through 2005, the GHG emissions resulting from 3C 'Chemical Products, Manufacture and Processing' source category decreased by 46.4 percent (Tables 5-19 and 5-20).

5.4.6 Planned Improvements

Activities aimed at updating AD used to estimate GHG emissions from 3C 'Chemical Products, Manufacture and Processing' in the Republic of Moldova are planned for the next inventory cycle.

5.5 Other (Category 3D)

5.5.1 Source Category Description

Under the 3D 'Other' source category there were reported NMVOC and CO_2 emissions from use of solvents in printing industry, use of glues and other adhesives, seed oil extraction and seed drying, and other domestic uses of solvents.

There are various techniques of printing paper (offset: cold set web offset, heat set web offset, sheet fed offset; rotagravure; flexography; letterpress and screen printing) involving different types of inks, including solvent-based inks. A bigger quantity of solvents is found in inks used for printing of paper and packaging cardboard by rotogravure and rotogravure techniques. Printing of magazines also involves use of inks with high proportion of solvents. Usually, the process of offset printing (newspapers, magazines and other publications) involves use of paste type inks. Hydrocarbons contained in such inks are absorbed in the printing substratum at high temperatures. The offset printing may also involve solvents in "damp solutions", used to ensure a more exact reproduction of the image. High quality colour printing, such as reproduction of art works and imprinting on textiles, may involve both solvent-based inks and water based inks.

The process of paper colouring involves both use of solvents in the process of wall paper manufacturing, and colouring other types of products made of paper.

Solvent-based adhesives are widely used in a variety of industries, such as construction, footwear manufacturing, abrasives and furniture manufacturing.

Seed oil extraction from oilseeds involves use of hexane; the solvent can be recovered and reused.

Solvents are also used in impregnation and conservation of wood, though consumption of these types of solvents decreased substantially in the past decade, in particular, due to wider use of creosote which does not contain organic solvents.

Chemical substances used in agriculture may be solid, as well as liquid; some of these substances are diluted in organic solvents which when used, are emitted in the atmosphere.

Aerosols manufacturing process involves use of organic chemical substances as propellants, as well as solvents; non-aerosol household use products (air fresheners, nail polishes, nail polish removers, styling aids, shoe waxes and polishes, screen cleaners, grease removers, etc.), can also contain a certain quantity of solvents; other use of solvents are reported in pharmaceuticals and cosmetics.

The 3D 'Other' source category includes also the nitrous oxide emissions from the use of N_2O in anaesthesia.

Liquid molecular nitrogen – produced by distillation from liquefied air, usually represented by the quasi-formula N_2(l), as well as the gaseous molecular nitrogen known as N_2, obtained by heating and evaporation of liquid nitrogen, are also widely used in the Republic of Moldova. So, in food industry the molecular nitrogen is used for freezing and transportation of food products, for keeping the packaged food fresh, used as an alternative to CO_2 for pressurizing some types of canned beer, frothing in fats and mayonnaise production and in ebullition – for volumizing or changing the texture of bread. Liquefied molecular nitrogen is widely used in science and for demonstration in education: in studying cryogenesis, for cryogenesis of bodies, reproductive cells and samples of biologic materials; in dermatology, for eliminating possible cancerous excrescences; as a chiller for sensitive sensors and low frequency amplifiers; as a cooler for overcharged central processing unit, for graphical processing unit, or other hardware component, etc. It is assumed that after being used, the whole amount of the molecular nitrogen is emitted in atmosphere, where N_2 is relatively non-reactive. However, being subjected to electrical discharges and ultraviolet radiation the molecular nitrogen can oxidize and form nitrogen oxide.

5.5.2 Methodological Issues and Data Sources

The methodology used to estimate NMVOC emissions from other use of solvents (adhesives use, in printing industry and graphic arts, seed oil extraction and seed drying, household products) is represented by the formula below.

NMVOC Emissions = (OSU • EF) / 10^3

Where:

NMVOC Emissions = from other uses of solvents, kt/yr;

OSU = amount of Other Solvents Used, kt/yr;

EF = Emission Factors, kg NMVOC/tone of product (see Table 5-21).

Table 5-21: Emission Factors Used to Estimate NMVOC Emissions from the 3D 'Other' Source Category

Source of emissions	FE, kg NMVOC/ tone product	Reference
Cold Set Web Offset Printing	54	Passant (1993)
Heat Set Web Offset Printing	182	Passant (1993)
Rotogravure Printing	425	Passant (1993)
Rotogravure Packaging	1296	Passant (1993)
Flexography Packaging	800	Passant (1993)
Use of glues and other adhesives	600	CORINAIR (1996)
Seed Oil Extraction	6.00	Munday (1990)
Seed Drying	1.31	US EPA (1985)

3D1 'Adhesives Use' & 3D2 'Graphic Arts' (Inks)

For most activities involving use of solvents in the Republic of Moldova there are no sources of veridical statistic data. Under such circumstances, the consumption of glues and other products used as adhesives, as well as the consumption of inks (Table 5-22) was estimated based of available information on imports of such substances in the RM.

There is no ink production in the country, while internal production of adhesives is insignificant, it is also assumed that such substances are not re-exported. The Customs Service is the primary source for information on import-export operations with inks, glues and products used as adhesives by enterprises and organizations in the country, as the respective service provides the aggregated information to the NBS of the RM.

Table 5-22: Activity Data on Adhesives and Inks Use in the Republic of Moldova in the time series from 1988 through 2005, thousand tones

	1988	1990	1991	1992	1993	1994
Glues and Adhesives Used	3.1000	3.1500	2.8500	1.6500	1.1500	0.7500
Printing Inks Used	0.3900	0.4000	0.3600	0.2800	0.1600	0.0800
Writing and Drawing Inks Used	0.0600	0.0650	0.0550	0.0450	0.0350	0.0250
Total Inks Used	0.4500	0.4650	0.4150	0.3250	0.1950	0.1050
	1995	**1996**	**1997**	**1998**	**1999**	**2000**
Glues and Adhesives Used	0.4996	0.3371	0.7036	1.3560	0.8006	0.8278
Printing Inks Used	0.0404	0.0572	0.0613	0.0590	0.0450	0.0646
Writing and Drawing Inks Used	0.0166	0.0083	0.0099	0.0054	0.0021	0.0059
Total Inks Used	0.0570	0.0655	0.0712	0.0644	0.0471	0.0705
	2001	**2002**	**2003**	**2004**	**2005**	**1990-2005, %**
Glues and Adhesives Used	0.9476	1.2312	0.8036	1.8192	2.1287	-32.4
Printing Inks Used	0.1026	0.1164	0.1357	0.1770	0.2534	-36.6
Writing and Drawing Inks Used	0.0082	0.0083	0.0143	0.0160	0.0425	-34.6
Total Inks Used	0.1107	0.1247	0.1500	0.1929	0.2959	-36.4

Source: National Bureau of Statistics Official Letter No. 07-21/121 from 20.06.2006 (for 1995-2005); for 1988-1994 period activity data were extrapolated.

3D3 'Seed Oil Extraction and Seed Drying'

The extraction of oil from oil seeds is performed either mechanically or through the use of solvents, or both. Where solvent is used, it is generally recovered and cleaned for reuse. The seed may be subject to solvent treatment many times before the oil is extracted. The remaining seed residue is then dried and may be used as an animal feed.

Hexane has become a preferred solvent for extraction. In extracting oil from seeds, the cleaned and prepared seeds are washed several times in warm solvent. The remaining seeds residue is treated with steam to capture the solvent and oil remains in it. The oil is separated from the oil-enriched wash solvent and from the steamed out solvent. The solvent is recovered and re-used. The oil is further refined.

Statistic data on quantities of oil extracted at the relevant enterprises in the Republic of Moldova were used to estimate NMVOC emissions. In conformity with the information received from the Ministry of Agriculture and Food Industry, there are more than 45 enterprises specialized in oil production, the biggest being 'Floarea-Soarelui' J.S.C. in Balti.

Current technologies used in the Republic of Moldova in seed oil extraction by use of solvents allow obtain around 450 kg of oil per one tone of seeds. This particular conversion factor was used to estimate the quantity of seeds consumed for oil extraction (Table 5-23).

Table 5-23: Activity Data on Oil Production and Quantity of Seeds Consumed for Oil Extraction in the RM in the time series from 1988 through 2005, thousand tones

	1988	1990	1991	1992	1993	1994
Total oil produced	124.90	125.60	117.90	38.22	39.27	51.44
Refined oil obtained by extraction	38.90	39.00	36.55	11.85	12.17	15.95
Quantity of seeds consumed for oil extraction	86.44	86.67	81.22	26.33	27.05	35.44
	1995	**1996**	**1997**	**1998**	**1999**	**2000**
Total oil produced	31.52	23.47	19.27	18.15	17.46	22.54
Refined oil obtained by extraction	9.77	7.28	6.59	5.30	3.89	4.36
Quantity of seeds consumed for oil extraction	21.71	16.17	14.64	11.77	8.64	9.69
	2001	**2002**	**2003**	**2004**	**2005**	**1990-2005, %**
Total oil produced	37.69	51.73	72.75	92.43	77.29	-38.5
Refined oil obtained by extraction	9.02	13.09	24.57	36.34	37.12	-4.8
Quantity of seeds consumed for oil extraction	20.04	29.10	54.61	80.76	82.48	-4.8

Source: Statistical Yearbooks for years 1994, 1999, 2003 and 2006; National Bureau of Statistics, Official Letter No. 06-06/12 from 23.06.2006

3D4 'Household Products'

As veridical statistic data on quantities of household products containing solvents are not available, NMVOC emissions from domestic solvent use (ex. use of cosmetics and toiletries, household chemicals, car care products, etc.) were estimated in conformity with the formula below:

NMVOC Emissions = (P • EF)/ 10^6

Where:

NMVOC emissions = from domestic use of solvents, kt/yr;

P = number of population in the country, inhabitants/yr (see Table 5-24);

EF = emission factor, kg NMVOC/per capita/yr, default EF value is 1.8 kg NMVOC/per capita/yr and represent a European average.

Table 5-24: Population of the Republic of Moldova in the time series from 1988 through 2005, inhabitants

Years	Population, inhabitants	Years	Population, inhabitants
1988	4337600	1998	4304700
1990	4361600	1999	4293000
1991	4366300	2000	4281500
1992	4359100	2001	4264300
1993	4347800	2002	4247700
1994	4352700	2003	4241500
1995	4347900	2004	3937700
1996	4334400	2005	4147300
1997	4320000	1990-2005, %	-4,9

CO_2 emissions were estimated assuming that the content of carbon in NMVOC emissions accounts for 85 percent. Further, by oxidizing this carbon is converted in carbon dioxide in the atmosphere (it is assumed that all solvents from domestic solvent use are of fossil origin). CO_2 emissions from domestic solvent use were estimated using the following formula:

CO_2 emissions = NMVOC • 0.85 • 44/12

Where:

CO_2 emissions = CO_2 emissions resulting from domestic solvent use, kt/yr;

0.85 = carbon fraction in NMVOC;

44/12 = stoichiometric ratio of carbon in CO_2 and NMVOC.

3D5 'Use of N_2O in Anaesthesia'

Estimation of nitrous oxide emissions from use of N_2O in anaesthesia was based on activity data provided by the Ministry of Health of the Republic of Moldova (Official Letter No. 01-9/2513 from 09.11.2007, as a response to the Official Letter No. 01-07/1608 from 15.10.2007 of the Ministry of Environment and Natural Resources) (Table 5-25). In conformity with currently accepted methodology (CORINAIR, 1999), the whole amount of N_2O used in anaesthesia is deemed to be emitted into the atmosphere.

Table 5-25: Amount of Nitrous Oxide Used in Anaesthesia in the Republic of Moldova in the time series from 1990 through 2006

Years	N_2O, kg	Years	N_2O, kg
1990	66	1999	43
1991	55	2000	44
1992	50	2001	44
1993	60	2002	44
1994	50	2003	44
1995	1	2004	50
1996	2	2005	61
1997	3	2006	59
1998	5	1990-2006, %	-10.6

N_2O emissions from use of molecular nitrogen in food industry and in education for demonstrations were not estimated due to unavailability of an estimation methodology. With status of additional information, below are available the data provided by the 'Mezon' J.S.C., subordinated to the Ministry of Industry and Infrastructure (the only enterprise producing nitrogen in the RM) on production and selling liquefied molecular nitrogen to food processing enterprises and to the Academy of Science of Moldova (Table 5-26).

Table 5-26: Amount of liquefied molecular nitrogen produced and sold to food processing enterprises and to the ASM, 1990-2006

Years	N_2, tonnes	Years	N_2, tonnes
1990	65.680	1999	3.210
1991	169.024	2000	4.137
1992	142.439	2001	6.083
1993	101.752	2002	6.288
1994	9.801	2003	7.130
1995	10.935	2004	8.958
1996	6.555	2005	7.589
1997	5.417	2006	7.650
1998	2.703	1990-2006, %	-88.4

5.5.3 Uncertainties and Time-Series Consistency

Uncertainties related to the AD on consumption of glues, other products used as adhesives in the RM and uncertainties related to seed oil extraction are considered to be moderate (±20 percent). Uncertainties related to use of N_2O in anaesthesia and number of population in the RM are considered to be low (±10 percent), while uncertainties related to default emission factors for the 'Adhesives Use', 'Graphic Arts (Inks)', 'Seed Oil Extraction and Seed Drying' sources are high (±100 percent), and in case of the 'Household Products' source can reach a factor of two. So, combined uncertainties related to GHG emissions from the 3D 'Other' source category can be considered low for those from the 'Use of N_2O in Anaesthesia' (±14.14 percent), high for emissions from 'Adhesives Use', 'Graphic Arts (Inks)' and 'Seed Oil Extraction and Seed Drying' (±101.98 percent) and very high for 'Household Products' (±200.25 percent). At the same time, combined uncertainties, presented as a percent of total sectoral emissions were estimated at ±0.005 percent for N_2O emissions from 'Use of N_2O in Anaesthesia', ±8.28 percent for CO_2 emissions from 'Adhesives Use', ±0.71 percent for CO_2 emissions from 'Graphic Arts (Inks)', ±3.91 percent for CO_2 emissions from 'Seed Oil Extraction and Seed Drying', ±95.08 percent for CO_2 emissions from 'Household Products'. Uncertainties introduced in trend in sectoral emissions were estimated at ±0.004 percent for N_2O emissions from 'Use of N_2O in Anaesthesia', ±1.83 percent for CO_2 emissions from 'Adhesives Use', ±0.17 percent for CO_2 emissions from 'Graphic Arts (Inks)', ±1.02 percent for CO_2 emissions from 'Seed Oil Extraction and Seed Drying', ±15.98 percent for CO_2 emissions from 'Household Products' (see Annex 7-3.3).

In view of ensuring time-series consistency of the obtained results, the same approach was used for the entire period under review, in conformity with the recommendations included in the Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories (IPCC, 2000).

5.5.4 QA/QC and Verification

Standard verification and quality control forms and checklists were filled in for the respective category under the Solvents and Other Product Use Sector, following the Tier 1 and Tier 2 approaches (see in Annex 6). Also, the AD and methods used for estimating GHG emissions under the category 3D 'Other' were documented and archived both in hard copies and electronically. For identifying the data entry and emission estimation process related errors there were applied verifications and quality control procedures. Verification was focused on correct use of AD obtained from different sources of reference (i.e., National Bureau of Statistics, Customs Service), as well as on ensuring correct use of the default emission factors available in the publications of US EPA (1983), Munday (1990), Passant (1993), as well as in the EMEP CORINAIR Atmospheric Emissions Inventory Guidebook (CORINAIR, 1999). Inventory quality assurance activities for the Solvents and Other Product Use Sector, inclusive for the 3D 'Other', were supported by an expert representing the Technical University of Moldova (TUM).

Following the recommendations included into the Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories (IPCC, 2000), GHG emissions originated from the 3D 'Other' were estimated based on AD and EFs from official sources of reference.

5.5.5 Recalculations

3D1 'Adhesives Use'

GHG emissions from the source category 3.D1 'Adhesives Use' were recalculated for the period 1990 through 1998 (year 1990 is reference year under the UNFCCC, while emissions for 1988 are cited here for comparison purposes only), in particular, due to employing a new estimation methodology: in SNC – based on activity data on use of glues and other adhesives; while in the FNC – by using default per capita emission factors (CORINAIR, 1996) for the Western Europe countries (Table 5-6), combined with activity data on the number of population in the RM. In comparison with results recorded in the FNC, the changes made in the process of compiling the current inventory resulted in decreased NMVOC emissions over the period 1990 through 1998, which varied from a minimum of -48.41 percent in 1990, to a maximum of -94.44 percent in 1996 (Table 5-27).

Table 5-27: Comparative Results of NMVOC Emissions from 3D1 'Adhesives Use' Included into the FNC and SNC of the RM under the UNFCCC, Gg

	1988	1990	1991	1992	1993	1994
FNC	3.6436	3.6637	3.6677	3.6616	3.6522	3.6563
SNC	1.8600	1.8900	1.7100	0.9900	0.6900	0.4500
Difference, %	-48.95	-48.41	-53.38	-72.96	-81.11	-87.69
	1995	**1996**	**1997**	**1998**	**1999**	**2000**
FNC	3.6522	3.6409	3.6288	3.6159		
SNC	0.2998	0.2023	0.4222	0.8136	0.4804	0.4967
Difference, %	-91.79	-94.44	-88.37	-77.50		
	2001	**2002**	**2003**	**2004**	**2005**	**1990-2005, %**
FNC						
SNC	0.5686	0.7387	0.4821	1.0915	1.2772	-32.4
Difference, %						

CO_2 emissions from the 3D1 'Adhesives Use' (Table 5-28) were not estimated under the FNC of the RM under the UNFCCC.

For the 1999-2005 time series, the GHG emissions resulting from adhesive use were estimated for the first time. The results (Tables 5-27 and 5-28) allow assert that over the period 1990 through 2005, the GHG emissions resulting from adhesives use decreased by 32.4 percent.

Table 5-28: CO_2 Emissions Resulting from 3D1 'Adhesives Use' in the Republic of Moldova in the time series from 1988 through 2005

Years	CO_2 Emissions, Gg	Years	CO_2 Emissions, Gg
1988	5.7970	1998	2.5357
1990	5.8905	1999	1.4971
1991	5.3295	2000	1.5481
1992	3.0855	2001	1.7721
1993	2.1505	2002	2.3023
1994	1.4025	2003	1.5027
1995	0.9343	2004	3.4019
1996	0.6304	2005	3.9807
1997	1.3157	1990-2005, %	-32.4

3D2 'Graphic Arts' (Inks)

GHG emissions from the source category 3D2 'Graphic Arts' (Inks) were recalculated for the period 1990 through 1998 (year 1990 is reference year under the UNFCCC, while emissions for 1988 are cited here for comparison purposes only), in particular, due to employing a new estimation methodology: in SNC – based on activity data on use of inks; while in the FNC – by using default per capita emission factors (CORINAIR, 1996) for the Western Europe countries (Table 5-6), combined with activity data on the number of population in the RM.

In comparison with results recorded in the FNC, the changes made in the process of compiling the current inventory resulted in decreased NMVOC emissions over the period 1990 through 1998, which varied from a minimum of -95.37 percent in 1990, to a maximum of -99.52 percent in 1995 (Table 5-29).

Table 5-29: Comparative Results of NMVOC Emissions from 3D2 'Graphic Arts' (Inks) Included into the FNC and SNC of the RM under the UNFCCC, Gg

	1988	1990	1991	1992	1993	1994
FNC	3.7303	3.7510	3.7550	3.7488	3.7391	3.7433
SNC	0.1690	0.1735	0.1560	0.1214	0.0699	0.0354
Difference, %	-95.47	-95.37	-95.85	-96.76	-98.13	-99.06
	1995	**1996**	**1997**	**1998**	**1999**	**2000**
	3.7392	3.7276	3.7152	3.7020		
SNC	0.0181	0.0248	0.0266	0.0254	0.0192	0.0278
Difference, %	-99.52	-99.34	-99.28	-99.31		
	2001	**2002**	**2003**	**2004**	**2005**	**1990-2005, %**
FNC						
SNC	0.0440	0.0499	0.0584	0.0761	0.1100	-36.6
Difference, %						

CO_2 emissions from the 3D2 'Graphic Arts' (Inks) (Table 5-30) were not estimated under the FNC of the RM under the UNFCCC. For the 1999-2005 time series, the GHG emissions resulting from inks use were estimated for the first time. The results (Tables 5-29 and 5-30) allow assert that over the period 1990 through 2005, the GHG emissions resulting from inks use decreased by 36.6 percent.

Table 5-30: CO_2 Emissions Resulting from 3D2 'Graphic Arts' (Inks) in the Republic of Moldova in the time series from 1988 through 2005

Years	CO_2 Emissions, Gg	Years	CO_2 Emissions, Gg
1988	0.5267	1998	0.0791
1990	0.5408	1999	0.0600
1991	0.4861	2000	0.0866
1992	0.3785	2001	0.1372
1993	0.2178	2002	0.1556
1994	0.1102	2003	0.1821
1995	0.0563	2004	0.2371
1996	0.0772	2005	0.3428
1997	0.0829	1990-2005, %	-36.6

3D3 'Seed Oil Extraction and Seed Drying'

GHG emissions from the source category 3D3 'Seed Oil Extraction and Seed Drying' were recalculated for the period 1990 through 1998 (year 1990 is reference year under the UNFCCC, while emissions for 1988 are cited here for comparison purposes only), in particular, due to availability of updated activity data: the estimations performed within the FNC of the RM under the UNFCCC relied on departmental activity data, while current inventory is based on information provided by the NBS of the RM; as well as due to change the emission factors: under the FNC there were used the value of 2.16 kg NMVOC per tone of seeds, while current inventory relied on a CORINAIR default emission factors of 6 kg NMVOC per tone of seeds (for oil extraction) and of 1.31 kg NMVOC per tone of seeds (for seed drying).

In comparison with results recorded in the FNC, the changes made in the process of compiling the current inventory resulted in significantly variation of NMVOC (Table 5-31) and CO_2 emissions (Table 5-32), which varied from a maximal decrease by circa 80.2 percent in 1996, to a maximum increase by 61.7 percent in 1991.

For the 1999-2005 time series, the GHG emissions resulting from 3D3 'Seed Oil Extraction and Seed Drying' were estimated for the first time. The results allow assert that over the period 1990 through 2005, the GHG emissions resulting from seed oil extraction and seed drying decreased by 4.8 percent (Tables 5-31 and 5-32).

Table 5-31: Comparative Results of NMVOC Emissions from 3D3 'Seed Oil Extraction and Seed Drying' Included into the FNC and SNC of the RM under the UNFCCC, Gg

	1988	1990	1991	1992	1993	1994
FNC	0.5400	0.5443	0.3672	0.4255	0.4190	0.3218
SNC	0.6319	0.6335	0.5937	0.1925	0.1978	0.2590
Difference, %	17.02	16.39	61.69	-54.77	-52.81	-19.51
	1995	**1996**	**1997**	**1998**	**1999**	**2000**
FNC	0.4385	0.5983	0.3780	0.4298		
SNC	0.1587	0.1182	0.1070	0.0860	0.0631	0.0708
Difference, %	-63.81	-80.24	-71.69	-79.99		
	2001	**2002**	**2003**	**2004**	**2005**	**1990-2005, %**
FNC						
SNC	0.1465	0.2127	0.3992	0.5904	0.6029	-4.8
Difference, %						

Table 5-32: Comparative Results of CO_2 Emissions from 3D3 'Seed Oil Extraction and Seed Drying' Included into the FNC and SNC of the RM under the UNFCCC, Gg

	1988	1990	1991	1992	1993	1994
FNC	1.6825	1.6960	1.1441	1.3258	1.3056	1.0028
SNC	1.9694	1.9745	1.8504	0.5998	0.6164	0.8073
Difference, %	17.05	16.42	61.74	-54.76	-52.79	-19.49
	1995	**1996**	**1997**	**1998**	**1999**	**2000**
FNC	1.3662	1.8642	1.1778	1.3393		
SNC	0.4946	0.3684	0.3335	0.2681	0.1967	0.2207
Difference, %	-63.80	-80.24	-71.68	-79.98		
	2001	**2002**	**2003**	**2004**	**2005**	**1990-2005, %**
FNC						
SNC	0.4565	0.6629	1.2441	1.8399	1.8791	-4.8
Difference, %						

3D4 'Household Products'

GHG emissions from the 3D4 'Household Products' (including those contained in air fresheners, deodorants, nail polishes, nail polish removers, styling aids, insecticides, shoe waxes and polishes, screen cleaners, grease removers and other household products) were recalculated for the period 1990 through 1998 (year 1990 is reference year under the UNFCCC, while emissions for 1988 are cited here for comparison purposes only), in particular, due to use a new emission factor: under the current inventory cycle there was used the CORINAIR default that is an average European emission factor (1.8 kg NMVOC/per capita/year), while in the FNC of the RM under the UNFCCC (2000) there was used a CORINAIR default value specific for Western European countries (Table 5-6), combined with activity data on the number of population in the RM.

In comparison with results recorded in the FNC, the changes made resulted in a significant increase (by 64 percent) of the GHG emissions for the 1990-1998 period (Table 5-33).

Table 5-33: Comparative Results of NMVOC Emissions from 3D4 'Household Products' Included into the FNC and SNC of the RM under the UNFCCC, Gg

	1988	1990	1991	1992	1993	1994
FNC	4.7714	4.7978	4.8029	4.7950	4.7826	4.7880
SNC	7.8077	7.8509	7.8593	7.8464	7.8260	7.8349
Difference, %	63.6	63.6	63.6	63.6	63.6	63.6
	1995	**1996**	**1997**	**1998**	**1999**	**2000**
FNC	4.7827	4.7678	4.7520	4.7352		
SNC	7.8262	7.8019	7.7760	7.7485	7.7274	7.7067
Difference, %	63.6	63.6	63.6	63.6		
	2001	**2002**	**2003**	**2004**	**2005**	**1990-2005, %**
FNC						
SNC	7.6757	7.6459	7.6347	7.0879	7.4651	-4.9
Difference, %						

For the 1999-2005 time series, the GHG emissions resulting from 3D4 'Household Products' were estimated for the first time. The results allow assert that over the period 1990 through 2005, the GHG emissions resulting from household products decreased by 4.9 percent (Tables 5-33 and 5-34).

Table 5-34: Comparative Results of CO_2 Emissions from 3D4 'Household Products' Included into the FNC and SNC of the RM under the UNFCCC, Gg

	1988	1990	1991	1992	1993	1994
FNC	3.4701	3.4893	3.4930	3.4873	3.4782	3.4822
SNC	24.3339	24.4686	24.4949	24.4546	24.3912	24.4186
Difference, %	601.3	601.3	601.3	601.3	601.3	601.3
	1995	**1996**	**1997**	**1998**	**1999**	**2000**
FNC	3.4783	3.4675	3.4560	3.4438		
SNC	24.3917	24.3160	24.2352	24.1494	24.0837	24.0192
Difference, %	601.3	601.3	601.3	601.3		
	2001	**2002**	**2003**	**2004**	**2005**	**1990-2005, %**
FNC						
SNC	23.9227	23.8296	23.7948	22.0905	23.2664	-4.9
Difference, %						

3D5 'Use of N_2O in Anaesthesia'

N_2O emissions from the 3D5 'Use of N_2O in Anaesthesia' were not recalculated as under the FNC of the RM under UNFCCC the respective emissions were not estimated. For the 1990-2005 time series, the N_2O emissions resulting from

3D5 'Use of N_2O in Anaesthesia' were estimated for the first time.

The results allow assert that over the period 1990 through 2006, the respective emissions decreased by 10.6 percent (Table 5-35), in particular, due to smaller quantity of N_2O used in health care facilities in the Republic of Moldova.

Table 5-35: Nitrous Oxide Emissions from Use of N_2O in Anaesthesia in the Republic of Moldova in the time series from 1990 through 2006, Gg

Years	N_2O Emissions, Gg	Years	N_2O Emissions, Gg
1990	0.000066	1999	0.000043
1991	0.000055	2000	0.000044
1992	0.000050	2001	0.000044
1993	0.000060	2002	0.000044
1994	0.000050	2003	0.000044
1995	0.000001	2004	0.000050
1996	0.000002	2005	0.000061
1997	0.000003	2006	0.000059
1998	0.000005	1990-2006, %	-10.6

5.5.6 Planned Improvements

Activities aimed at updating activity data used to estimate GHG emissions from 3D 'Other' in the Republic of Moldova are planned for the next inventory cycle.

6. AGRICULTURE SECTOR

Agriculture plays a significant role in the national economy of the RM, contributing with 15-25 percent to its Gross Domestic Product formation (within the last ten years). Combined with the Food Processing Industry, the Agriculture Sector contributes with 27-35 percent to GDP creation and almost with 65 percent to the total exports. Under the Agriculture Sector the plant production account for a relatively big share – 67.3 percent, while animal breeding account for 32.7 percent (NBS, 2006).

According the National Bureau of Statistics of the Republic of Moldova, more than 33.6 percent of active population are employed in agriculture (NBS, 2006). The overwhelming majority of agricultural workers represent small and medium agricultural production enterprises.

As of January 1, 2006, the following business entities were active in the Agriculture Sector of the Republic of Moldova: (a) 147 production cooperatives with a total area of 132.2 thousand ha (8.6 percent of the total area of agricultural lands); (b) 1291 limited liability companies with a area of de 632.3 thousand ha (41.2 percent), of which land owned by the founders – 128.2 thousand ha (8.4 percent); (c) 378 070 peasant farms with an area of 563.1 thousand ha (36.7 percent); (d) 221 individual businesses with an area of 10.1 thousand ha (0.66 percent); (e) other forms of businesses with an area of 196.8 thousand ha (12.84 percent). The average surface of a production cooperative is approximately 899 ha, of a limited liability company - 489 ha, of a peasant farm – 1.5 ha; total leased lands – 567.1 thousand ha.

As of January 1, 2007 the total area of the country was 3384.6 thousand ha, including 2511.8 thousand ha (74.2 percent) – agricultural lands; of which 1820.1 thousand ha (53.8 percent) – arable lands; 301.8 thousand ha (8.9 percent) – perennial plantations; 364.2 thousand ha (10.8 percent) – hayfields and pastures; 25.7 thousand ha (0.7 percent) – derelict lands; 450.9 thousand ha (13.3 percent) – forests and lands with forest vegetation; 96.3 thousand ha (2.9 percent) – rivers, lakes, water basins and marshes, and 325.6 thousand ha (9.6 percent) – other lands. The area of publicly owned agricultural lands is 667.3 thousand ha (26.6 percent), while privately owned agricultural lands account for 1844.5 thousand ha (73.4 percent).

6.1 Overview

The principal sources covered by Agriculture Sector in the Republic of Moldova include methane emissions from animal breeding, in particular from 4A 'Enteric Fermentation' category, 4B 'Manure Management' category, and nitrous oxide emissions from 4B 'Manure Management' category, as well as 4D 'Agricultural Soils' category. As the Republic of Moldova does not cultivate rice and there are no savannas, no greenhouse gas emissions covered by the categories 4C 'Rice Cultivation' and 4E 'Prescribed Burning of Savannas' were reported. GHG emissions covered by the source category 4F 'Field Burning of Agricultural Residues' were reported under Land Use, Land-Use Change and Forestry Sector (i.e., under the 5B 'Cropland' category), following the recommendations set forth in the Good Practice Guidance for Land Use, Land-Use Change and Forestry (IPCC, 2003).

A brief overview, methodological issues and data sources, key categories, uncertainties and times-series consistency, QA/QC and verification, recalculations made and planned improvements are described for each source category in this sector.

6.1.1 Summary of Emission Trends

In 2005, Agriculture Sector accounted for 17.9 percent of total national greenhouse gas direct emissions (without LULUCF), being the second major source of GHG emissions after the Energy Sector. To be noted that Agriculture Sector was a major source of CH_4 and N_2O emissions, accounting for 29.9 percent and respectively 90.0 percent of total emissions reported at national level.

Between 1990 and 2005, the total GHG emissions originated from the Agriculture Sector tended to lower values, decreasing by 60 percent, from 5323.92 Gg in 1990 to 2127.79 Gg in 2005 (Table 6-1), in particular, due to decreasing values of such indicators as: number of domestic livestock and poultry, amount of synthetic and organic nitrogen fertilizers applied to soils, quantities of agricultural crop residues returned to soil and carbon losses from land use change and soil management practices.

In 1990, CH_4 and N_2O emissions accounted for 43 percent and respectively 57 percent of total GHG emissions originated from the Agriculture Sector. By 2005, the share of CH_4emissions decreased to 40.6 percent, while that of N_2O emissions increased up to 59.4 percent.

Over the time period under review, total GHG emissions from the Agriculture Sector decreased by 60 percent (Figure 6-1), while CH_4 and N_2O emissions decreased respectively, by 62.3 percent and 58.3 percent (Table 6-2).

Table 6-1: GHG Emissions from Agriculture Sector by Gas in the Republic of Moldova within the 1990-2005 time series, Gg CO_2 equivalent

	1990	1991	1992	1993	1994	1995	1996	1997
CH_4	2291.02	2061.44	1950.14	1647.66	1652.33	1545.40	1383.51	1207.65
N_2O	3032.90	2973.89	2664.99	2192.12	1947.42	1840.78	1662.96	1631.57
Total	5323.92	5035.34	4615.13	3839.78	3599.75	3386.18	3046.47	2839.22
	1998	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**
CH_4	1089.44	1078.55	1000.60	955.41	993.49	977.24	918.90	863.44
N_2O	1428.87	1359.48	1311.58	1262.01	1320.42	1277.60	1291.82	1264.35
Total	2518.31	2438.03	2312.19	2217.42	2313.91	2254.84	2210.72	2127.79

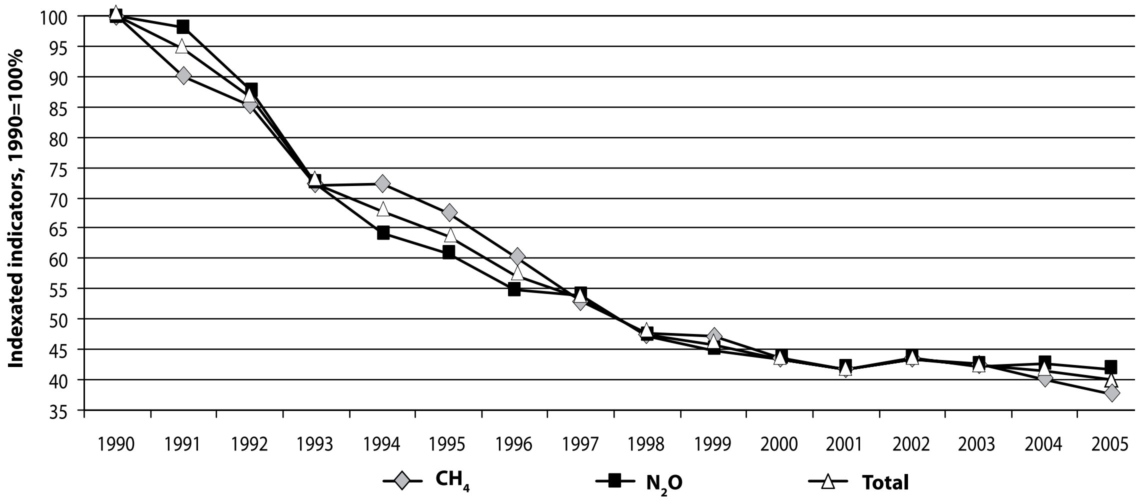

Figure 6-1: Trends in GHG Emissions from Agriculture Sector of the RM, 1990-2005

Table 6-2: Methane and Nitrous Oxide Emissions from Agriculture Sector by Category in the Republic of Moldova within the 1990-2005 time series, Gg

Year	CH_4 emissions, Gg		Total	N_2O emissions, Gg		Total
	4A	4B		4B	4D	
1990	90.6384	18.4577	109.0961	4.2398	5.5438	9.7835
1991	83.3580	14.8059	98.1639	4.0151	5.5781	9.5932
1992	78.9349	13.9289	92.8638	3.8520	4.7448	8.5968
1993	68.1893	10.2705	78.4598	3.1485	3.9229	7.0714
1994	68.9186	9.7638	78.6824	3.0700	3.2120	6.2820
1995	65.9346	7.6557	73.5903	2.9941	2.9439	5.9380
1996	58.8935	6.9880	65.8815	2.7946	2.5698	5.3644
1997	51.3233	6.1837	57.5070	2.5712	2.6919	5.2631
1998	46.8051	5.0729	51.8780	2.2749	2.3344	4.6092
1999	45.8021	5.5576	51.3597	2.3282	2.0572	4.3854
2000	43.0030	4.6448	47.6478	2.1456	2.0854	4.2309
2001	41.6103	3.8854	45.4956	1.8860	2.1850	4.0710
2002	43.4618	3.8472	47.3090	1.9553	2.3041	4.2594
2003	42.6594	3.8759	46.5353	2.0237	2.0976	4.1213
2004	40.1884	3.5686	43.7569	1.9059	2.2613	4.1672
2005	37.7552	3.3608	41.1160	1.8229	2.2556	4.0786
1990-2005, %	-58.3	-81.8	-62.3	-57.0	-59.3	-58.3

Table 6-3: Breakdown of the Republic of Moldova's Agriculture Sector Methane and Nitrous Oxide Emissions by Category within 1990-2005, %

Year	CH_4, % of the total		Total	N_2O, % of the total		Total
	4A	4B		4B	4D	
1990	83.1	16.9	100.0	43.3	56.7	100.0
1991	84.9	15.1	100.0	41.9	58.1	100.0
1992	85.0	15.0	100.0	44.8	55.2	100.0
1993	86.9	13.1	100.0	44.5	55.5	100.0
1994	87.6	12.4	100.0	48.9	51.1	100.0
1995	89.6	10.4	100.0	50.4	49.6	100.0
1996	89.4	10.6	100.0	52.1	47.9	100.0
1997	89.2	10.8	100.0	48.9	51.1	100.0
1998	90.2	9.8	100.0	49.4	50.6	100.0
1999	89.2	10.8	100.0	53.1	46.9	100.0
2000	90.3	9.7	100.0	50.7	49.3	100.0
2001	91.5	8.5	100.0	46.3	53.7	100.0
2002	91.9	8.1	100.0	45.9	54.1	100.0
2003	91.7	8.3	100.0	49.1	50.9	100.0
2004	91.8	8.2	100.0	45.7	54.3	100.0
2005	91.8	8.2	100.0	44.7	55.3	100.0
1990-2005, %	10.5	-51.7	0.0	3.1	-2.4	0.0

The 4A 'Enteric Fermentation' source category was the largest source of CH_4 emissions in the time segment from 1990 through 2005 (with a share varying between 83-92 percent of the total), while 4D 'Agricultural Soils' and 4B 'Manure Management' source categories respectively, were the most relevant sources of N_2O emissions (with a share varying between 47-58 percent and respectively, 42-53 percent from the total).

6.1.2 Key Categories

The results of key source assessment (including LULUCF) carried out following a Tier 1 approach (IPCC, 2000), are provided in Chapter 1.5, as well as in the Annex 1. Table 6-4 provides information on identified key categories (by level and trend) under the Agriculture Sector of the Republic of Moldova.

Table 6-4: Key Categories Identified under the Agriculture Sector of the RM

IPCC Category	GHG	Source Category	Key source
4A	CH_4	CH_4 emissions from enteric fermentation	Yes (L, T)
4B	CH_4	CH_4 emissions from manure management	No
4B	N_2O	Direct N_2O emissions from manure management	Yes (L, T)
4B	N_2O	Indirect N_2O emissions from manure management	No
4D	N_2O	Direct N_2O emissions from agricultural soils	Yes (L, T)
4D	N_2O	Indirect N_2O emissions from agricultural soils	Yes (L, T)

6.1.3 Methodological Issues

Emissions covered by source categories 4A 'Enteric Fermentation', 4B 'Manure Management' and 4D 'Agriculture Soils' were estimated using both, the Tier 1 methodological approach and default EFs values, as well as the Tier 2 methodological approach and country specific emission factors, in particular for the key sources. A summary description of methods used to estimate emissions by source categories is provided in Table 6-5, while a more detailed description is available in the respective sub-chapters of this report (6.2-6.4).

Table 6-5: Summary of Methods and Emission Factors Used to Estimate GHG Emissions from the Agriculture Sector of the Republic of Moldova

IPCC Category	Source Category	CH_4		N_2O	
		Method	EF	Method	EF
4A	Enteric Fermentation	T2, T1	CS, D		
4B	Manure management	T2, T1	CS, D	T2, T1	CS, D
4D	Agricultural soils			T1	CS, D

Abbreviations: T1 – Tier 1 method; T2 – Tier 2 method; CS – country specific; D – default use; EF– emission factors.

6.1.4 Uncertainties and Time-Series Consistency

The uncertainty analysis of the GHG emissions from the Agriculture Sector (by source categories) is described in detail in the respective sub-chapters (6.2-6.4) of the NIR, as well as in the Annex 7-3.4.

Combined uncertainties as a percentage of total direct sectoral emissions were estimated at ±15.8 percent (inclusive, ±15.9 percent for CH_4 and ±24.3 percent for N_2O). The uncertainties introduced in trend in sectoral emissions were estimated at ±3.7 percent (inclusive, ±3.9 percent for CH_4 and ±5.8 percent for N_2O).

In view of ensuring time-series consistency of the results, the same approach was used for the entire period under review, in conformity with the recommendations included in the Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories (IPCC, 2000).

6.1.5 QA/QC an d Verification

Standard verification and quality control forms and checklists by individual source categories were filled in for each source category under the Agriculture Sector, following the Tier 1 and Tier 2 approaches (see in Annex 6).

Also, the AD and methods used for estimating GHG emissions under the Agriculture Sector were documented and archived both in hard copies and electronically. To identify the data entry, as well GHG emissions estimation related errors there were applied AD and EFs verifications and quality control procedures. Inventory quality assurance activities for the Agriculture Sector were supported by two experts representing the Agribusiness and Rural Development Management Institute, as well as the Institute of Pedology, Agrochemistry and Soil Protection "N. Dimo".

Following the recommendations included into the Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories (IPCC, 2000), GHG emissions under the Agriculture Sector were estimated based on AD and EFs from official sources of reference.

6.1.6 Recalculations

GHG emission recalculations under the Agriculture Sector are due to the availability of an updated set of activity data (Statistical Yearbooks of the RM and of the ATULBD, other relevant publications pertaining to agriculture sector), as well as due to updated methodologies and EFs available in the Good Practice Guidance (IPCC, 2000) and 2006 IPCC Guidelines for National Greenhouse Gas Inventories (IPCC, 2006), which have replaced the methodologies contained into the Revised 1996 IPCC Guidelines (IPCC, 1997) used within the FNC of the RM under the UNFCCC (2000).

In comparison with the results included into the FNC, the performed recalculation resulted in increased GHG emission values for the 1990-1998 time periods, varying from a minimum of 80.4 percent in 1993, up to maximum of 101.3 percent in 1997 (Table 6-6). The results of recalculations performed at the category level are presented in the respective sub-chapters (6.2-6.4) of the NIR.

Table 6-6: Recalculated GHG Emissions under the Agriculture Sector for the 1990-1998, Gg CO_2 equivalent

	1990	1991	1992	1993	1994	1995	1996	1997	1998
FNC	2811.1	2710.2	2487.1	2128.9	1953.3	1821.8	1641.2	1410.1	1345.1
SNC	5323.9	5035.3	4615.1	3839.8	3599.8	3386.2	3046.5	2839.2	2518.3
Difference,%	89.4	85.8	85.6	80.4	84.3	85.9	85.6	101.3	87.2

Abbreviations: FNC – First National Communication; SNC – Second National Communication.

6.1.7 Assessment of Completeness

The current inventory covers greenhouse gas emissions from 3 source categories (4A 'Enteric Fermentation', 4B 'Manure Management' and 4D 'Agricultural Soils') under the Republic of Moldova's Agriculture Sector.

Table 6-7: Assessment of Completeness under the Agriculture Sector in the RM

IPCC Category	Source Category	CH_4	N_2O
4A	Enteric Fermentation	X	NO
4B	Manure Management	X	X
4C	Rice Cultivation	NO	NO
4D	Agricultural Soils	NE	X
4E	Prescribed Burning of Savannas	NO	NO
4F	Field Burning of Agricultural Residues	IE	IE

Abbreviations: X – source categories included in the inventory; NO–Not Occurring; NE – Not Estimated; IE –Included Elsewhere.

As in the RM there are no savannas and rice is not cultivated, respectively no GHG emissions have been registered from the 4C 'Rice Cultivation' and 4E 'Prescribed Burning of Savannas' source categories. GHG emissions from the 4F 'Field Burning of Agricultural Residues' source category were reported under LULUCF Sector (5B 'Cropland' source category). CH_4 emissions from 4D 'Agricultural Soils' source category were not estimated due to lack of estimation methodology.

6.1.8 Planned Improvements

Planned improvements at the source categories level within the Agriculture Sector are described in detail in respective sub-chapters (6.2-6.4) of this report.

6.2 Enteric Fermentation (Category 4A)

6.2.1 Source Category Description

A considerable amount of methane is produced in herbivores in the process of enteric fermentation, a digestive process by which carbohydrates are broken down by micro-organisms into simple molecules for absorption into the bloodstream where CH_4 is formed as a by-product. The methane is further released by eructation and exhalation. A portion of methane is later released through flatulence. Ruminant livestock (e.g., cattle, sheep and goats) are major sources of methane with moderate amounts produced from non-ruminant livestock (e.g., pigs, horses, asses and mules). However, ruminant livestock account for a larger share of total CH_4 resulting from this source category. The amount of methane that is released depends on a number of factors, such as the type of digestive tract, age, and weight of the animal, and the quality and quantity of the feed intake.

6.2.2 Methodological Issues and Data Sources

Estimation of methane emissions covered by the 4A 'Enteric Fermentation' source category involved three basic steps: (1) divide the livestock population into subgroups and characterize each subgroup (see basic information on the livestock and poultry groups within the Republic of Moldova in the Annex 3-4); (2) estimate emission factors for each subgroup, in kilograms of CH_4/animal/year (it is good practice to use country specific factors for each individual subgroup); (3) multiply the subgroup emission factors by the subgroup populations to estimate subgroup emissions, and sum across the subgroups to estimate total CH_4 emissions from the 4A 'Enteric Fermentation' category.

It was possible to carry out these steps for different levels of details and complexity, following two methodological approaches (Tier 1 and Tier 2). While following the Tier 1 methodology, CH_4 emissions from the source category 4A

'Enteric Fermentation' were estimated on the basis of equations 10.19 and 10.20 from 2006 IPCC Guidelines:

Total $CH_{4\ enteric} = \sum_i E_i\ [EF_{(T)} \bullet (N_{(T)} / 10^6)]$
Where:
Total $CH_{4\ enteric}$ = total CH_4 emissions from Enteric Fermentation, Gg CH_4/yr;
E_i = is the emissions for the *i* livestock categories and subcategories;
$EF_{(T)}$ = emission factor for the defined livestock population, kg CH_4/head/yr;
$N_{(T)}$ = the number of head of livestock species /category T in the country;
T = species/category of livestock..

The Tier 1 methodology is a simplified approach based on use of default EFs (Table 6-8) multiplied by national AD on the animal population data (Table 6-9).

Table 6-8: Default EF for Western Europe (WE) and Eastern Europe (EE) used to estimate CH_4 emissions from 4A 'Enteric Fermentation' Source Category

Categories	EF, kg CH_4/head/yr		Comments
	WE	EE	
Dairy cows	109	89	Average Milk Production: WE – 6000 kg/head/yr , EE – 2550 kg/ head/yr
Other cattle	57	58	Beef cows, including young cattle
Sheep	8	5	Live weight ♂ - 65 and ♀ - 45 kg
Goats	5	5	Average live weight - 40 kg
Horses	18	18	Average live weight - 550 kg
Asses and mules	10	10	Average live weight - 245 kg
Swine	1.5	1	Average live weight -50 kg, breeding -180 kg

Table 6-9: Animal Population Data in the RM within 1980-2006, thousand heads

	1980	1985	1986	1987	1988	1989	1990	1991
Cattle	1150	1254	1259	1214	1162	1131	1112	1061
Dairy Cows	446	472	471	439	419	412	402	395
Other Cattle	704	782	788	775	743	719	710	666
Sheep and goats	1226	1258	1253	1253	1258	1303	1338	1282
Sheep	1207	1238	1232	1230	1233	1272	1306	1245
Goats	19	20	21	23	25	31	32	37
Horses	51	50	49	49	48	47	46	47
Asses and mules	2	2	2	2	2	2	2	2
Swine	2079	1947	1962	1892	1703	1871	2045	1850
Rabbits	300	290	280	270	260	250	249	250
Poultry	17232	21989	22631	20927	21485	22828	25003	24625
	1992	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**
Cattle	1000	870	884	832	729	646	549	532
Dairy Cows	397	368	402	402	381	356	324	318
Other Cattle	603	502	481	430	348	290	225	214
Sheep and goats	1289	1331	1437	1502	1423	1372	1235	1147
Sheep	1239	1253	1362	1411	1328	1274	1139	1051
Goats	49	78	75	91	95	98	96	96
Horses	48	51	57	58	61	63	65	69
Asses and mules	2	2	2	2	2	2	2	2
Swine	1753	1311	1085	1047	1014	950	797	928
Rabbits	251	260	280	237	209	190	177	186
Poultry	23716	13678	12808	13449	13745	12365	12364	13046
	2000	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**1980-2006, %**
Cattle	482	445	454	455	409	360	337	-70.7
Dairy Cows	307	298	300	305	277	249	233	-47.8
Other Cattle	175	147	153	150	132	111	104	-85.2
Sheep and goats	1055	962	972	978	958	960	954	-22.2
Sheep	953	851	857	849	835	838	832	-31.1
Goats	102	111	115	129	124	121	122	542.4
Horses	72	76	82	83	82	76	72	40.9
Asses and mules	2	2	2	2	2	2	2	0.0
Swine	751	493	489	550	477	422	490	-76.4
Rabbits	183	161	191	191	206	239	283	-5.6
Poultry	13730	13625	14731	15535	16196	17884	22593	31.1

Sources: Agriculture of Moldova, 2004 (pages 61-62); Farming on Auxiliary Household Plots and at Peasant Farms in the RM in 2003 (page 28), 2004 (page 56) and 2005 (page 52); Statistical Yearbook of the RM for 2006 (page 357); Statistical Yearbook of the ATULBD for 1998 (page 224), 2000 (page 114), 2002 (page 118), 2006 (page 109).

The Tier 2 methodology is a more complex approach requiring country specific data on the animal population (including distribution by species/categories), maintenance requirements and feeding conditions for typical livestock under each species/categories (in particular, for cattle and sheep, which have a larger share in the total methane emissions from the 4A 'Enteric Fermentation' source category).

Divide livestock population into subgroups. It is *good practice* to choose the appropriate method for estimating emissions from enteric fermentation according country specific information for specific livestock categories. The livestock population should be divided first into subgroups (ex., dairy cows, other mature cattle and young cattle). At the moment, the Statistical Yearbooks of the RM and those of the AT-ULBD, feature the following groups: (i) total cattle and (ii) of which dairy cows. The Eastern European countries default values used for cattle weighted population (other than dairy cows) are as follows: *30 percent of the total population* – mature females, *22 percent of the total population* – mature males and calves, and *48 percent of the total population* – young cattle (*2006 IPCC Guidelines, Volume 3, Chapter 10, Table 10A-2, Page 10.73).* To estimate these data, the total cattle population of the RM was distributed according with the respective default values (Table 6-10).

Table 6-10: Cattle Population Data in the Republic of Moldova and its Distribution by Subgroups in the period from 1980 through 2006, thousand heads

Categories	1980	1985	1986	1987	1988	1989	1990	1991
Dairy cows	446.0	472.0	471.0	439.0	419.0	412.0	402.0	395.0
Other cattle	704.0	782.0	788.0	775.0	743.0	719.0	710.0	666.0
Mature females	211.2	234.6	236.4	232.5	222.9	215.7	213.0	199.8
Mature males	154.9	172.0	173.4	170.5	163.5	158.2	156.2	146.5
Young cattle	337.9	375.4	378.2	372.0	356.6	345.1	340.8	319.7
Categories	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**
Dairy cows	397.0	368.0	402.4	402.2	381.2	356.0	324.1	318.3
Other cattle	603.5	502.0	481.1	430.0	348.1	290.3	225.2	214.0
Mature females	181.0	150.6	144.3	129.0	104.4	87.1	67.6	64.2
Mature males	132.8	110.4	105.8	94.6	76.6	63.9	49.6	47.1
Young cattle	289.7	241.0	230.9	206.4	167.1	139.3	108.1	102.7
Categories	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**1980-2006, %**
Dairy cows	307.0	298.4	300.3	304.5	277.5	249.2	233.0	-47.8
Other cattle	175.5	147.1	153.3	150.1	131.8	110.6	104.1	-85.2
Mature females	52.6	44.1	46.0	45.0	39.6	33.2	31.2	-85.2
Mature males	38.6	32.4	33.7	33.0	29.0	24.3	22.9	-85.2
Young cattle	84.2	70.6	73.6	72.1	63.3	53.1	49.9	-85.2

In terms of distribution of the sheep and goat population into subgroups, it is known that the share of breeding livestock in local species of sheep and goats in the RM is as follows: breeding males – 3 percent, mature females – 75 percent and the rest of 22 percent – young growing lambs (Bucataru et al., 2003).

At the same time, based on information provided by the National Bureau of Statistics in its recent publications (Agricultural Activity of Households and Farms in the Republic of Moldova, Results of Statistical Surveys), it has been revealed that the percentage of females that give birth in a year in the breeding structure over the past ten years in sheep was circa 80 percent and in goats, respectively circa 75 percent. So, to distribute the total population of sheep and goats by sub-categories, activity data from statistical sources were extrapolated for the whole period under review and distributed as follows – sheep: mature rams – 3 percent, mature ewes – 80 percent, growing lambs – 17 percent (Table 6-11); goats: breeding males – 3 percent, mature females – 75 percent and growing kids – 22 percent (Table 6-12).

Average daily feed intake per day. As mentioned above, for each representative animal categories defined, is required the information on average daily feed intake (MJ) per day and/or kg per day of dry matter. As generally, data on average daily feed intake are not available in statistical sources, particularly for grazing livestock, it was necessary to infer this information indirectly. The following general data were collected for each representative animal category: weight of a typical animal in the category (kg), average weight gain per day (g), feeding situation (confined, grazing, pasture conditions), average daily milk production (kg), milk fat content (%), percentage of females that give birth in a year (%) average annual wool production per sheep (kg), number of offspring produced per year (units), and feed digestibility (%).

Table 6-11: Sheep Population Data in the Republic of Moldova and its Distribution by Subgroups in the period from 1980 through 2006, thousand heads

Categories	1980	1985	1986	1987	1988	1989	1990	1991
Sheep	1207.0	1238.0	1232.0	1230.0	1233.0	1272.0	1306.0	1245.0
Mature rams	36.2	37.1	37.0	36.9	37.0	38.2	39.2	37.4
Mature ewes	965.6	990.4	985.6	984.0	986.4	1017.6	1044.8	996.0
Growing lambs	205.2	210.5	209.4	209.1	209.6	216.2	222.0	211.7
Categories	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**
Sheep	1239.3	1253.0	1362.2	1410.7	1327.9	1274.0	1138.9	1050.7
Mature rams	37.2	37.6	40.9	42.3	39.8	38.2	34.2	31.5
Mature ewes	991.4	1002.4	1089.8	1128.5	1062.3	1019.2	911.1	840.5
Growing lambs	210.7	213.0	231.6	239.8	225.7	216.6	193.6	178.6
Categories	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**1980-2006, %**
Sheep	953.2	850.7	857.0	849.1	834.7	838.3	831.7	-31.1
Mature rams	28.6	25.5	25.7	25.5	25.0	25.1	25.0	-31.1
Mature ewes	762.5	680.5	685.6	679.3	667.8	670.6	665.4	-31.1
Growing lambs	162.0	144.6	145.7	144.4	141.9	142.5	141.4	-31.1

Table 6-12: Goats Population Data in the Republic of Moldova and its Distribution by Subgroups in the period from 1980 through 2006, thousand heads

Categories	1980	1985	1986	1987	1988	1989	1990	1991
Goats	19.0	20.0	21.0	23.0	25.0	31.0	32.0	37.0
Breeding males	0.6	0.6	0.6	0.7	0.8	0.9	1.0	1.1
Mature females	14.4	15.2	16.0	17.5	19.0	23.6	24.3	28.1
Growing kids	3.6	3.8	4.0	4.4	4.8	5.9	6.1	7.0
Categories	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**
Goats	49.5	78.0	74.9	91.1	95.0	98.0	96.1	96.1
Breeding males	1.5	2.3	2.2	2.7	2.9	2.9	2.9	2.9
Mature females	37.6	59.3	56.9	69.3	72.2	74.4	73.0	73.1
Growing kids	9.4	14.8	14.2	17.3	18.1	18.6	18.3	18.3
Categories	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**1980-2006, %**
Goats	102.4	111.4	114.6	129.2	123.6	121.3	122.1	542.4
Breeding males	3.1	3.3	3.4	3.9	3.7	3.6	3.7	542.4
Mature females	77.8	84.7	87.1	98.2	94.0	92.2	92.8	542.4
Growing kids	19.4	21.2	21.8	24.6	23.5	23.0	23.2	542.4

Weight (W) and Mature Weight (MW) in cattle. The information on the weight of the most prevalent breeds of cattle in the RM (Steppe Red and Spotted Black), in dynamics (by age), is presented in below (Table 6-13)[20]. To be noted, that at present most of animals are not pure blood, but rather different half-breeds obtained by crossbreeding (Bucataru, Rodionov, 1999). So, the productivity indicators for half-breeds have average values.

Weight (W) of animals in sheep and goats. To calculate country specific emission factors for sheep and goats it was necessary to collect data on animals weight at different stages of their ontogenesis: at birth, at weaning, at one year of age and at slaughtering, if it occurs before the age of one year. According with data from the specialty literature, the weight of sheep and goats at birth in the RM is circa 2-4 kg, the lambs are weaned at 3-4 months when they reach 18-23 kg, while kids at 2-3 months when they reach 13-15 kg. Growing lambs not meant for breeding are fed intensely until the age of 6-7 months when they reach the weight of 30-35 kg, and then slaughtered (Bucataru, Radionov, Varban, 2003). Other relevant information on the weight of sheep and goats in the RM is provided in Annex 3-4.

Average daily weight gain per day (WG) [21]*, g/day.* The information on daily actual weight gain reported in RM within 1970-2005 period for cattle and swine is presented in Table 6-14.

[20]Default values used for Eastern European countries: 550 kg for dairy cows, 600 kg for males and 230 kg for young cattle (*IPCC 2006 Guidelines, Volume 4, Cchapter 10, Tables 10A-1 and 10A-2, Pages 10.72-10.73).*

[21]Default values are as follows: *WG* = 0 kg per day for dairy cows and adult males (>5 years), and *WG* = 0.4 kg per day for young cattle (*IPCC 2006 Guidelines, Vol. 4, Chap.10, Tab. 10A.2).*

Table 6-13: Weight of the most Prevalent Cattle Breeds in the RM

Breed	Sex	Weight in dynamics by months, kg														
		At birth	6	7	8	9	10	12	15	18	24	30	36	48	60	72
Steppe Red	♀	30	150	170	190	205	220	250	295	340	400	425	450	490	520	520
	♂	30	170	195	220	240	260	300	375	445	525	590	650	750	800	800
Spotted Black	♀	35	165	180	200	220	240	270	320	375	430	455	480	520	550	550
	♂	35	180	205	250	255	280	330	405	480	575	640	750	820	880	880

Table 6-14: Average Daily Weight Gain Characteristic for Cattle and Swine in the RM in the time series from 1970 through 2005

Indicator	Category	1970	1975	1980	1985	1990	1991	1992
Daily weight gain, g	cattle	500	473	375	531	515	427	348
	swine	415	346	299	433	304	262	165
Indicator	**Category**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**
Daily weight gain, g	cattle	230	243	223	203	181	230	192
	swine	115	118	148	171	189	222	117
Indicator	**Category**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**1970 - 2005, %**
Daily weight gain, g	cattle	217	260	287	262	275	321	-35.8
	swine	107	134	147	136	166	187	-54.9

Source: Agriculture of the Moldova, 2004 (page 103) and Statistical Yearbook of the RM for 2006 (page 362).

Average Annual Milk Production per One Cow. In the past 25 years, the average productivity of milking cows in the Republic of Moldova varied between the maximum of 10.9 kg of milk per day over the period between 1989 through 1990 and a minimum of 4.6 kg of milk per day in 1997, though the potential of local breeds is much higher (Annex 3-4). Table 6-15 shows that the average milking productivity featured over the period 1993 though 2004 is much lower than the one reported earlier (in particular, between 1975-1992), comparable with milking productivity reported in the '60-'70 of the past century when the cattle stock in the RM was preponderantly represented by Red Estonian (8 percent), Simmental (35.6-37.4 percent) and Steppe Red (48.1-53.4 percent) (Bucataru, Cosman, Holban, 2006).

Table 6-15: Average Annual Milk Production per one Cow in the Republic of Moldova in the time series from 1985 through 2005, kg/head/yr

Indicator	1985	1990	1991	1992	1993	1994	1995	1996	1997
Average annual milk production at agricultural enterprises in the RM	3420	3975	3394	3026	2413	2245	2207	2051	1687
Average annual milk production at enterprises with public ownership	3421	3927	3239	2993	2316	2098	2114	2086	1855
Average annual milk production at enterprises with private ownership	3418	4210	3442	3035	2442	2284	2227	2046	1665
Indicator	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**1985-2005, %**
Average annual milk production at agricultural enterprises in the RM	2001	2036	2179	2447	2710	2493	2561	3018	-11.8
Average annual milk production at enterprises with public ownership	2341	2387	2423	2878	3173	2818	2850	3921	14.6
Average annual milk production at enterprises with private ownership	1966	1996	2154	2417	2676	2467	2533	2938	-14.0

Source: Statistical Yearbooks for years 1995 (pages 307-308), 1996 (page 346), 1999 (page 348) and 2006 (page 362).

Since 1970, the breed Spotted Black started to be massively imported in the country. A program to crossbreed all public stock with this breed, considered to be one of the most productive in the world, was developed. As a consequence, over the following 30 years absorption crossbreeding was carried out for Simmental, Estonian Red and Steppe Red breeds with Spotted Black breed. Holstein breed was also intensely used to improve the breed, in particular in 1980' – 1990' of the past century. So, developing an immense stock of half-breeds of different generations and a good organization of foddering allowed obtain a national average daily milk yield of 10.9 kg per head, by 1990 in the RM (Table 6-16).

Table 6-16: Average Daily Milk Production per one Cow
in the Republic of Moldova in the time series from 1985 through 2005, kg/head/day

Indicator	1985	1990	1991	1992	1993	1994	1995	1996	1997
Average annual milk production at agricultural enterprises in the RM	9.4	10.9	9.3	8.3	6.6	6.2	6.0	5.6	4.6
Average annual milk production at enterprises with public ownership	9.4	10.8	8.9	8.2	6.3	5.7	5.8	5.7	5.1
Average annual milk production at enterprises with private ownership	9.4	11.5	9.4	8.3	6.7	6.3	6.1	5.6	4.6
Indicator	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**1985-2005, %**
Average annual milk production at agricultural enterprises in the RM	5.5	5.6	6.0	6.7	7.4	6.8	7.0	8.3	-11.8
Average annual milk production at enterprises with public ownership	6.4	6.5	6.6	7.9	8.7	7.7	7.8	10.7	14.6
Average annual milk production at enterprises with private ownership	5.4	5.5	5.9	6.6	7.3	6.8	6.9	8.0	-14.0

Source: Statistical Yearbooks for years 1995 (pages 307-308), 1996 (page 346), 1999 (page 348) and 2006 (page 362).

Further, once the big collective farms collapsed and the livestock concentrated in private sector (at present, circa 94 percent of total cattle of the RM is in the private sector, see Table 6-17), the average productivity of milking cows decreased a lot, in particular as a consequence of poor organization of foddering and inappropriate animal feeding and maintenance conditions in the private sector.

To be noted that milk yield greatly depends on the content of protein in the animal diet. The optimal level of protein is circa 12-18 percent of the dry matter in the feed intake. At a 20 percent deficit of protein in the feed intake the milk yield decreases by 30 percent, and at a 30 percent deficit of protein, milking productivity drops by up to 50 percent.

In the recent years the protein deficit in the cattle diet in the RM exceeds 20 percent (Bucataru, Cosman, Holban, 2006), being the main reason of poor productivity indicators, in particular during the period from 1996 through 2000. Over the period 2001 through 2005, the average productivity of milking cows in the RM tended to grow, in particular, at public owned agricultural enterprises: for example, in 2005 the average productivity was reported to be 3921 kg of milk per cow; unlike the private sector where this indicator featured only 2938 kg of milk per cow (NBS, 2006).

Average annual milk production per one sheep and goat. Milk yield from sheep and goats in the RM varies in different breeds (Bucataru, Radionov, Urzica, 2002; Bucataru, Rodionov, Varban, 2003). For example, the potential average milk yield of a Karakul breed sheep is 60-80 kg of milk per year with a fat content of 7-8 percent, and Tsigae breed reaches a productivity of 75-120 kg of milk per year with a fat content of 6.5-7.0 percent, while in local goats the milking potential is 224-324 kg of milk per year with an average fat content of 4.7 percent (see Annex 3-4). Table 6-18 provide statistical data on the average production of milk in sheep and goats at the farms in the RM in the time series from 1990 through 2006.

Table 6-17: Breakdown of Total Livestock and Poultry Population by Types of Farming Entities
in the RM in the time series from 1986 through 2006, percent

Categories	1986	1990	1991	1992	1993	1994	1995	1996	1997
Agricultural enterprises									
Cattle	81.5	81.8	77.2	71.3	62.1	54.0	46.7	43.8	37.0
of which, cows	74.2	74.9	69.5	62.0	52.6	43.1	35.7	33.0	26.6
Swine	90.3	81.0	77.5	71.0	61.7	54.7	52.5	55.2	52.1
Sheep and goats	42.1	35.9	31.3	27.3	21.3	17.4	15.4	14.6	11.7
of which, sheep	42.9	36.9	32.6	28.7	22.5	18.6	16.6	15.6	12.6
Horses	98.0	85.1	75.5	64.7	54.5	47.5	42.6	42.1	35.6
Poultry	56.6	53.5	51.9	36.4	24.7	23.6	23.1	19.4	16.9
Households and farms									
Cattle	18.5	18.1	22.8	28.7	37.9	46.0	53.3	56.2	63.0
of which, cows	25.8	25.1	30.5	38.0	47.4	56.9	64.3	67.0	73.4
Swine	9.6	19.0	22.5	29.0	38.3	45.3	44.1	44.8	47.9
Sheep and goats	57.8	64.1	68.7	72.7	78.7	82.6	84.6	85.4	88.3
of which, sheep	57.1	63.1	67.4	71.3	77.5	81.4	83.4	84.4	87.4
Horses	2.0	14.9	24.5	35.3	45.5	52.5	57.4	57.9	64.4
Poultry	43.4	46.5	48.1	63.6	75.3	76.4	76.9	80.6	83.1

Categories	1998	1999	2000	2001	2002	2003	2004	2005	2006
Agricultural enterprises									
Cattle	26.8	20.9	13.0	9.4	7.9	7.8	6.7	6.0	6.4
of which, cows	18.6	14.3	8.4	5.6	5.1	4.3	3.9	3.5	3.7
Swine	40.2	36.9	19.6	9.2	11.1	14.6	9.2	8.5	10.0
Sheep and goats	9.4	8.1	5.9	4.9	5.0	5.0	4.6	4.0	4.1
of which, sheep	10.2	8.9	6.6	5.5	5.5	5.7	5.1	4.6	4.5
Horses	29.5	21.9	11.9	8.5	6.5	6.4	5.1	4.1	4.3
Poultry	14.9	12.9	9.8	9.6	12.6	10.9	9.5	11.3	11.7
Households and farms									
Cattle	73.2	79.1	87.0	90.6	92.1	92.2	93.3	94.0	93.6
of which, cows	81.4	85.7	91.6	94.4	94.9	95.7	96.1	96.5	96.3
Swine	59.8	63.1	80.4	90.8	88.9	85.4	90.8	91.5	90.0
Sheep and goats	90.6	91.9	94.1	95.1	95.0	95.0	95.4	96.0	95.9
of which, sheep	89.8	91.1	93.4	94.5	94.5	94.3	94.9	95.4	95.5
Horses	70.5	78.1	88.1	91.5	93.5	93.6	94.9	95.9	95.7
Poultry	85.1	87.1	90.2	90.4	87.4	89.1	90.5	88.7	88.3

Table 6-18: Average Milk Production in Sheep and Goats at the Farms in the Republic of Moldova in the time series from 1990 through 2006, kg/head/yr

Indicators	1990	1995	1996	1997	1998	1999	2000
Average milk yield from a sheep	15.9	16.1	18.2	16.2	18.9	20.0	20.0
Average milk yield from a goat	62	127	131	145	125	106	57
Indicators	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**1990-2006, %**
Average milk yield from a sheep	20	24	26	27	32	30	88.7
Average milk yield from a goat	57	59	58	65	112	106	71.0

Source: Agriculture of Moldova, 2004 (page 136), Agriculture Activity of Households and Farms in the Republic of Moldova (Results of the Statistical Survey), in 2006 (page 51).

Average Wool Production per Sheep. The default value used is 4 kg/year (*IPCC, 2000*). According the statistical data, in the RM the value of this indicator varied over the period from 1960 through 2006 between 1.9 and 2.7 kg of wool collected per year from one sheep (Table 6-19). Local goats can yield 1-2 kilograms of wool per year.

Table 6-19: Average Wool Production from Sheep at the Farms in the Republic of Moldova in the time series from 1960 through 2006, kg/head/yr

Indicator	1960	1970	1975	1980	1985	1988	1990	1991
Amount of wool sheared	1.9	2.3	2.2	2.2	2.3	2.4	2.3	2.3
Indicator	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**
Amount of wool sheared	2.1	2.0	2.1	2.1	2.2	2.7	2.2	2.3
Indicator	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**1960-2006, %**
Amount of wool sheared	2.30	2.50	2.49	2.50	2.49	2.54	2.68	41.1

Source: Statistical Yearbooks for 1988 year (page 270), Agriculture of Moldova, 2004 (page 75 and 136), Agriculture Activity of Households and Farms in the Republic of Moldova (Results of the Statistical Survey), in 2006 (page 51).

Climate Conditions. Feeding situation of animals is greatly dependent on climate conditions, in particular, on average annual temperature in areas where livestock is bred. In conformity with the 2006 IPCC Guidelines, the data on the average annual temperature in areas with animal population have to be used as follows: areas with average annual temperatures <15^{0}C are defined as cold climate areas; areas with average annual temperatures between 15^{0}C and 25^{0}C inclusively are defined as moderate climate areas, and areas with average annual temperatures >25^{0}C are defined as warm climate areas. In conformity with data on the average annual temperature in Celsius degrees available in the Statistical Yearbooks, the RM refers to Eastern European countries with cold climate (Table 6-20).

Table 6-20: Average Annual Temperature in Different Regions of the RM in the time series from 1985 through 2005, in ^{0}C

Geographic areas	1985	1986	1987	1988	1989	1990	1991
North	6.5	7.9	6.5	7.5	9.3	9.5	8.0
Centre	8.0	9.6	8.1	9.0	10.9	11.3	9.4
South	8.2	9.7	8.5	9.3	10.9	11.4	9.3
Geographic areas	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**
North	8.5	7.8	9.5	8.4	7.1	7.7	8.2
Centre	10.1	9.4	11.3	10.0	9.1	9.4	10.3
South	10.2	9.3	11.3	10.0	9.1	9.1	10.1
Geographic areas	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**
North	9.2	9.7	8.8	9.5	8.6	9.0	8.7
Centre	11.0	11.2	10.3	10.8	9.8	10.3	10.5
South	10.9	11.2	10.4	11.0	10.3	10.9	10.8

Source: Statistical Yearbooks of the RM for years 1991 (page 207), 1994 (page 31), 1999 (page 13) and 2006 (page 15).

Percent of females that give birth in a year (%). The default values for the Eastern European countries were as follows: 80 percent for dairy cows and 67 percent for other cattle (*2006 IPCC Guidelines, Volume 4, Chapter 10, Tables 10A.1-2, Pages 10.73-10.74*).

Table 6-21 below provide statistical data on live products produced by 100 females at publicly owned agricultural enterprises in the RM over the period from 1970 through 2005.

Table 6-21: Live Products Produced by 100 Females at Publicly Owned Agricultural Enterprises in the Republic of Moldova, 1970-2005

Indicators	1970	1975	1980	1985	1990	1991	1992
Calves from cows	91	91	90	90	87	80	79
Pigs from sows	1461	1987	1993	1366	1342	1317	1569
Lambs from sheep giving birth	93	92	85	94	91	84	80
Indicators	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**
Calves from cows	75	72	66	65	58	61	55
Pigs from sows	1223	989	983	1019	892	1123	772
Lambs from sheep giving birth	79	78	76	75	73	75	68
Indicators	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**1970-2005, %**
Calves from cows	58	65	69	63	71	76	-16.5
Pigs from sows	434	869	967	558	946	1218	-16.6
Lambs from sheep giving birth	71	79	81	75	79	81	-12.9

Source: Agriculture of Moldova, 2004 (page 105).

To be noted, that the birth rate of some local breeds of sheep and goats is much higher than the officially reported one: featuring circa 115 lambs per 100 Karakul breed female sheep giving birth; circa 120 lambs per 100 Tigae breed female sheep giving birth; and circa 165 kids per 100 local female goats giving birth (see Annex 3-4).

Feed Digestibility (DE%). The portion of gross energy (GE) in the feed not excreted in the faeces is known as digestible feed. That percentage of feed that is not digested represents the percent of dry matter intake that will be excreted as faeces (50-60 percent for crop by-products and range lands, 60-75 percent for good pastures, good preserved forages, and grain supplemented forage-based diets and 75-85 percent for grain-based diets fed in feedlots).

In the RM fodder use effectiveness, or digestibility indicator varies in cattle from 59.3 to 85.8 per cent of dry nutritive matter, from 38.8 to 74.4 percent of crude cellulose and from 58.8 to 78.4 percent of crude protein. The value of this indicator varied over the years, so before 1991, when the livestock maintenance conditions, foddering and feeding situation were optimal, the DE value was admitted 67 percent; for 1992 and 2005, DE = 66 percent, and for the period 1993 through 2004 the average value of DE for cattle, as well as for sheep and goats was accepted at the level of 65 percent, typical for animals on a preponderantly pastures based diet (IPCC 2006 Guidelines, Vol. 4, Chapter 10, Table 10.2, Page 10.14).

Gross Energy (GE). Animal performance and diet data were collected from Statistical Yearbooks and other relevant specialty publications to estimate feed intake, which is the amount of energy (MJ/day) an animal needs for maintenance and for activities such as growth, lactation, and pregnancy. The Good Practice Guidance (IPCC, 2000) and 2006 IPCC Guidelines (IPCC, 2006) provide equations (Table 6-22) that were used to calculate the average amount of gross energy required for animal maintenance and other relevant vital activities.

Table 6-22: Summary of Equations Used to Estimate Daily Gross Energy Intake for Cattle, Sheep and Goats

Metabolic Function	Equations for cattle		Equations for sheep and goats	
	IPCC, 2000	IPCC, 2006	IPCC, 2000	IPCC, 2006
Maintenance (NE_m)	4.1	10.3	4.1	10.3
Activity (NE_a)	4.2a	10.4	4.2b	10.5
Growth (NE_g)	4.3a	10.6	4.3b	10.7
Weight loss ($NE_{mobilised}$)	4.4a and 4.4b	NA	NA	NA
Lactation (NE_l)	4.5a	10.8	4.5b and 4.5c	10.9 and 10.10
Draft Power (NE_w)	4.6	10.11	NA	NA
Wool Production (NE_{wool})	NA	NA	4.7	10.12
Pregnancy (NE_p)	4.8	10.13	4.8	10.13
REM {NE_{ma}/DE}	4.9	10.14	4.9	10.14
REG {NE_{ga}/DE}	4.10	10.15	4.10	10.15
Gross Energy *(GE)*	4.11	10.16	4.11	10.16

Net energy for maintenance (NE_m). Net energy required for maintenance, which is the amount of energy needed to keep the animal in equilibrium where body energy is neither gained nor lost. NE_m was calculated on the basis of Equation 10.3 in IPCC 2006 Guidelines.

$$NE_m = Cf_i \cdot (Weight)^{0,75}$$

Where:

NE_m = net energy required by the animal for maintenance, MJ day

Cf_i = a coefficient which varies for each animal category, default values being used as follows: Cf_i = 0.386 for lactating cows, Cf_i = 0.370 for breeding bulls, Cf_i = 0.322 for other cattle, Cf_i = 0.236 for sheep and goats to 1 year[22] and Cf_i = 0.217 for animals older than 1 year[23] (IPCC 2006 Guidelines, Volume 4, Chapter 10, Table 10.4, Page 10.16), MJ/kg day;

Weight = live-weight of animal, kg.

Net energy for animal activity (NE_a). NE_a is the net energy for activity, or the energy needed for animals to obtain their food, water and shelter. NE_a for cattle was calculated in conformity with Equation 10.4, while for sheep and goats in conformity with Equation 10.5 in IPCC 2006 Guidelines.

$$NE_a = C_a \cdot NE_m$$

Where:

NE_a = net energy for animal (cattle) activity, MJ/day;

C_a = coefficient corresponding to animal's feeding situation, default values used are as follows: C_a = 0, cattle is confined to a small area (i.e., tethered, pen, barn) with the result that they expend very little or no energy to acquire feed; C_a = 0.17, cattle is confined in areas with sufficient forage requiring modest energy expense to acquire feed; C_a = 0.36, cattle graze in open range land or hilly terrain and expend significant energy to acquire feed (2006 IPCC Guidelines, Volume 4, Chapter 10, Table 10.5, Page 10.17); keeping account that the grazing period for cattle in the RM is generally circa 180 days (April–November), and the confinement period is respectively circa 185 days (December–March) (Andries, Rusu, Donos, Constantinov, 2005), the average weighted value for C_a coefficient for conditions of the RM is C_a = 0.086;

NE_m = net energy required by the animal for maintenance, MJ/day;

$$NE_a = C_a \cdot Weight$$

Where:

NE_a = net energy for animal (sheep and goats) activity, MJ/day;

C_a = coefficient corresponding to animal's feeding situation, default values used are as follows: C_a = 0.009, when animals are confined due to pregnancy in final trimester, C_a = 0.0107, when animals walk up to 1000 metres per day and expend very little energy to acquire feed, C_a = 0.024, when animals walk up to 5,000 metres per day and expend significant energy to acquire feed and C_a = 0.0067, when animals are housed for fattening (IPCC 2006 Guidelines, Volume 4, Chapter 10, Table 10.5, Page 10.17), MJ/kg day; keeping account that the grazing period for sheep and goats in the RM is generally circa 180 days (April–November) and the confinement period is respectively circa 185 days (December–March) (Andries, Rusu, Donos, Constantinov, 2005), the weighted average values for C_a coefficient for conditions of the RM is C_a = 0.0151 for mature rams and housed fattening lambs and respectively 0.0155 for housed ewes;

Weight = live-weight of animal, kg.

Net energy for growth: (NE_g) is the net energy needed for growth (i.e., weight gain). NE_a for cattle was calculated on the basis of Equation 10.6, and for sheep and goats - Equation 10.7 in the 2006 IPCC Guidelines.

$$NE_g = 22.02 \cdot (BW / C \cdot MW)^{0,75} \cdot WG^{1,097}$$

Where:

NE_g = net energy needed for cattle growth, MJ/day;

BW = the average live body weight (BW) of cattle in the population, kg;

C = a coefficient with a value of 0.8 for females, 1.0 for castrates and 1.2 for bulls (2006 IPCC Guidelines, Volume 4, Chapter 10, Page 10.17);

MW = the mature live body weight of an adult female in moderate body condition, kg;

WG = the average daily weight gain of the animals in the population, kg/day.

$$NE_g = \{WG_{lamb} \cdot [a + 0.5b\ (BW_i + BW_f)]\} / (365\ days/yr)$$

Where:

NE_g = net energy needed for growth (sheep and goats), MJ/day;

WG_{lamb} = the average weight gain (BW_f-BW_i), kg/year;

BW_i = the average live body weight at weaning, kg;

BW_f = the average live bodyweight at one year old or at slaughter (live-weight) if slaughtered prior to 1 year of age, kg;

a, b = constants; a = 2.5 and b = 0.35 for intact males; a = 4.4 and b = 0.32 for castrates; a = 2.1 and b = 0.45 for females (2006 IPCC Guidelines, Volume 4, Chapter 10, Table 10.6, Page 10.18).

Net energy for lactation: (NE_l) is the net energy for lactation. For cattle the net energy for lactation was calculated in conformity with Equation 10.8, based on information on the

[22]This coefficient shall be increased by 15% for intact males (non-castrates).

[23]This coefficient shall be increased by 15% for intact males (non-castrates).

amount of milk produced and its fat content, and for sheep it was calculated in conformity with Equation 10.7 in the 2006 IPCC Guidelines.

$NE_l = Milk \cdot (1.47+0.40 \cdot Fat)$

Where:

NE_l = net energy for lactation (cattle), MJ/day;

Milk = amount of milk produced, kg of milk /day;

Fat = fat content of milk (cattle), percent by weight.

For sheep and goats NE_l may be calculated using two possible methods. The first method is used when the amount of milk produced is known (Equation 10.9 in the 2006 IPCC Guidelines), and the second method is used when the amount of milk produced is not known (Equation 10.10 in the 2006 IPCC Guidelines).

$NE_l = Milk \cdot EV_{milk}$

Where:

NE_l = net energy for lactation (sheep and goats), MJ/day;

Milk = amount of milk produced, kg of milk/day;

EV_{milk} = the net energy required to produce 1 kg of milk; a default value of 4.6 MJ/kg can be used, which corresponds to a milk fat content of 7 percent by weight.

$NE_l = [(5 \cdot WG_{lamb})/365\ day/year] \cdot EV_{milk}$

Where:

NE_l = net energy for lactation (sheep and goats), MJ/day;

WG_{lamb} = the weight gain (BWf – BWi), kg;

EV_{milk} = the net energy required to produce 1 kg of milk; a default value of 4.6 MJ/kg can be used, which corresponds to a milk fat content of 7 percent by weight.

Net energy for work: (NE_{work}) is the net energy for work. It is believed that one hour of typical work of draft animals (cattle) require circa 10 percent of the net daily energy for maintenance (NE_m). NE_{work} shall be calculated in conformity with Equation 10.11 in the IPCC 2006 Guidelines.

$NE_{work} = 0.10 \cdot NE_m \cdot Hours$

Where:

NE_{work} = net energy for work (cattle), MJ/days;

NE_m = net energy required by the animal for maintenance (from Equation 10.3), MJ/day;

Hours = number of hours of work per day, the default value used is zero (2006 IPCC Guidelines, Volume 4, Chapter 10, Table 10A-2, Page 10.73).

Net energy for wool production: (NE_{wool}) is the average daily net energy required for sheep to produce a year of wool. The NE_{wool} was calculated in conformity with Equation 10.12 from 2006 IPCC Guidelines.

$NE_{wool} = (EV_{wool} \cdot Production_{wool}) / 365$

Where:

NE_{wool} = net energy required to produce wool, (sheep and goats), MJ /day;

EV_{wool} = the energy value of each kg of wool produced, MJ/kg, the default value used is 24 MJ/kg;

$Production_{wool}$ = annual wool production per sheep, kg.

*Net energy for pregnancy***:** (NE_p) is the energy required for pregnancy[24] and shall be calculated in conformity with Equation 10.13 in 2006 IPCC Guidelines. For cattle, the total energy requirement for pregnancy for a 281-day gestation period averaged over an entire year is calculated as 10 percent of NE_m. For sheep, the NE_p requirement is similarly estimated for the 144-154-days gestation period, although the percentage varies with the number of lambs born[25]: for single birth $C_{pregnancy}$ = 0,077; double birth (twins) $C_{pregnancy}$ = 0.126; triple birth or more (triplets) $C_{pregnancy}$ = 0.150 (2006 IPCC Guidelines, Volume 4, Chapter 10, Table 10.7, Page 10.20).

$NE_p = C_{pregnancy} \cdot NE_m$

Where:

NE_p = net energy required for pregnancy, MJ/day;

$C_{pregnancy}$ = pregnancy coefficient;

NE_m = net energy required by the animal for maintenance (Equation 10.3), MJ/day.

Ratio of net energy available in diet for maintenance to digestible energy consumed (REM). REM was calculated in conformity with Equation 10.14 in the IPCC 2006 Guidelines.

$REM = [1.123-(4.092 \cdot 10^{-3} \cdot DE\%)+[1.126 \cdot 10^{-5} \cdot (DE\%)^2]-(25.4/DE\%)]$

Where:

REM = ratio of net energy available in diet for maintenance to digestible energy consumed;

DE = digestible energy expressed as a percentage of gross energy.

Ratio of net energy available for growth in a diet to digestible energy consumed (REG). REG was calculated in conformity with Equation 10.15 in the IPCC 2006 Guidelines.

[24] To be noted that NEp estimate must be weighted by the portion of the mature females that actually go through gestation in a year. For example, if 75% of the mature females in the animal category give birth in a year, then in order to calculate GE, the NEp value should be multiplied by 75%.

[25] Taking into account the average fertility of local sheep breeds, it was possible to calculate the average value of $C_{pregnancy}$ characteristic to these breeds: $C_{pregnancy}$ = 0.084 for Karakul breed sheep, $C_{pregnancy}$ = 0.087 for Tsigaie breed sheep, and $C_{pregnancy}$ = 0.108 for local goats.

REG = [1.164 – (5.160 • 10⁻³ • DE%) + (1.308 • 10⁻⁵ • (DE%)²) – (37.4/DE%)]

$$REG = [1.164 - (5.160 \cdot 10^{-3} \cdot DE\%) + (1.308 \cdot 10^{-5} \cdot (DE\%)^2) - (37.4/DE\%)]$$

Where:

REG = ratio of net energy available for growth in a diet to digestible energy consumed;

DE = digestible energy expressed as a percentage of gross energy.

Gross Energy (GE). Gross energy (GE) was calculated in conformity with Equation 10.16 in the 2006 IPCC Guidelines.

$$GE = \{[(NE_m + NE_a + NE_l + NE_{work} + NE_p) / REM] + [(NE_g) + NE_{wool} / REG]\} / (DE\%/100)$$

Where:

GE = gross energy, MJ/day;

NE_m = net energy required by the animal for maintenance (Equation 10.3), MJ/day

NE_a = net energy for animal activity (Equations 10.4 and 10.5), MJ/day;

NE_l = net energy for lactation (Equations 10.8, 10.9 and 10.10), MJ/day;

NE_{work} = net energy for work (Equation 10.11), MJ/day;

NE_p = net energy required for pregnancy (Equation 10.13), MJ/day;

REM = ratio of net energy available in diet for maintenance to digestible energy consumed (Equation 10.14);

NE_g = net energy needed for growth (Equations 10.6 and 10.7), MJ/day;

NE_{wool} = net energy required to produce wool (Equation 10.12), MJ/day;

REG = ratio of net energy available for growth in a diet to digestible energy consumed (Equation 10.15);

DE = digestible energy expressed as a percentage of gross energy.

GE values calculated for animal categories relevant for the Republic of Moldova are provided in Table 6-23.

Methane Conversion Factor (Y_m). The extent to which feed energy is converted to CH_4 depends on several interacting feed and animal factors. As CH_4 conversion factors are unavailable from country-specific research, default values provided in 2006 IPCC Guidelines were used: Y_m =0.03 for feedlot fed cattle (young animals) and Y_m =0.065 for mature cattle (*IPCC 2006 Guidelines, Volume 4, Chapter 10, Table 10.12, Tables 10A-1 and 10A-2, Pages 10.30, 10.72-10.73*); Y_m = 0.045 for lambs and kids and Y_m = 0.065 for mature rams, ewes and goats (*IPCC 2006 Guidelines, Volume 4, Chapter 10, Table 10.13, Page 10.31*).

Table 6-23: Gross Energy (GE) Values Calculated for Animal Categories in the RM following a Tier 2 Methodology, MJ/head/day

Categories	1989	1990	1991	1992	1993	1994
Dairy cows	243.77	243.52	224.47	219.28	206.51	199.76
Other cattle	147.87	145.42	142.54	139.98	134.89	130.60
heifers	195.70	194.40	193.10	185.70	178.40	168.70
bulls and steers	171.00	170.10	167.70	168.70	164.60	161.10
calves	107.40	103.50	99.40	98.20	94.10	92.80
Sheep	14.78	14.80	14.79	14.81	14.85	14.94
fattening lambs	10.20	10.20	10.20	10.20	10.20	10.20
mature ewes	15.40	15.45	15.47	15.53	15.64	15.23
mature rams	23.17	23.19	23.19	23.12	23.06	23.09
Goats	15.85	16.14	17.00	17.24	17.96	19.15
growing kids	9.20	9.20	9.20	9.20	9.20	9.20
mature females	17.81	18.20	19.34	19.67	20.63	22.21
mature males	15.64	15.66	15.66	15.63	15.63	15.60
Categories	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**
Dairy cows	196.21	191.55	179.33	189.14	190.31	194.89
Other cattle	128.17	125.11	119.10	122.80	124.43	126.48
heifers	166.10	163.40	151.00	159.20	160.50	161.70
bulls and steers	159.30	154.90	150.40	153.10	155.80	157.60
calves	90.20	87.50	84.80	86.20	87.50	90.20
Sheep	15.12	15.29	15.18	15.36	15.34	15.34
fattening lambs	10.20	10.20	10.20	10.20	10.20	10.20
mature ewes	15.97	16.08	15.97	16.16	16.15	16.14
mature rams	23.09	23.06	23.09	23.09	23.06	23.02
Goats	19.92	20.18	21.01	19.82	18.63	15.68
growing kids	9.20	9.20	9.20	9.20	9.20	9.20
mature females	23.24	23.59	24.70	23.10	21.52	17.58
mature males	15.60	15.63	15.63	15.63	15.66	15.66
Categories	**2001**	**2002**	**2003**	**2004**	**2005**	**1989 - 2005, %**
Dairy cows	205.88	213.70	204.67	210.37	219.87	-9.80
Other cattle	128.31	129.51	129.54	132.54	134.71	-8.90
heifers	163.00	164.30	163.00	170.00	172.30	-11.96
bulls and steers	158.40	159.30	158.40	159.80	160.20	-6.32
calves	90.20	94.10	95.40	96.60	99.50	-7.36
Sheep	15.54	15.78	15.78	15.96	16.12	9.06
fattening lambs	10.20	10.20	10.20	10.20	10.20	0.00
mature ewes	16.38	16.67	16.69	16.91	17.11	11.10
mature rams	23.19	23.16	23.09	23.12	23.16	-0.04
Goats	15.77	15.90	15.80	15.91	15.99	0.88
growing kids	9.20	9.20	9.20	9.20	9.20	0.00
mature females	17.70	17.88	17.74	17.90	18.00	1.07
mature males	15.70	15.70	15.70	15.73	15.73	0.58

Methane emission factors (EF). Based on information above, country specific national factors were developed for the 4A 'Enteric Fermentation' source category (for cattle, sheep and goats). The emission factor for each animal category was developed following the Equation 10.21 in the 2006 IPCC Guidelines.

$$EF = [GE \cdot (Y_m/100) \cdot 365/55.65]$$

Where:

EF = emission factor, kg CH_4/head /yr;

GE = gross energy intake, MJ/head/day;

Y_m = methane conversion factor, % of gross energy in feed converted to methane;

55.65 MJ/kg CH_4= the energy content of methane.

Table 6-24 features country specific emission factor for cattle bred in the RM, developed by using a Tier 2 (IPCC, 2006) simplified methodology.

The performed analysis showed that the correlation between the 'annual milk production' and the 'methane emission factors' from enteric fermentation in dairy cows indices is 0.99, indicating an extremely efficient concordance of these two indices (Figure 6-2).

The obtained results are comparable with emission factors values for cattle used by a number of Annex I Parties in national greenhouse gas inventories for the 1990-2005 time series (Table 6-25).

Table 6-24: Country Specific Emission Factors for Enteric Fermentation, Calculated for Cattle Population in the RM following a Tier 2 methodology, kg CH_4/head/yr

Categories	1989	1990	1991	1992	1993	1994
Dairy cows	103.92	103.82	95.70	93.48	88.04	85.16
Other cattle	51.21	50.60	49.82	48.85	47.14	45.45
heifers	83.45	82.90	82.34	79.16	76.04	71.93
bulls and steers	72.88	72.53	71.48	71.93	70.18	68.68
calves	21.12	20.36	19.56	19.33	18.51	18.26
Categories	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**
Dairy cows	83.65	81.66	76.45	80.63	81.14	83.09
Other cattle	44.7	43.69	41.43	42.86	43.4	43.98
heifers	70.81	69.67	64.37	67.86	68.41	68.96
bulls and steers	67.92	66.03	67.11	65.26	66.41	67.17
calves	17.75	17.22	16.69	16.96	17.22	17.75
Categories	**2001**	**2002**	**2003**	**2004**	**2005**	**1989-2005, %**
Dairy cows	87.77	91.11	87.25	89.69	93.74	-9.80
Other cattle	44.48	44.84	44.72	45.86	46.47	-9.26
heifers	69.50	70.04	69.50	72.49	73.48	-11.95
bulls and steers	67.55	67.92	67.55	68.11	68.31	-6.27
calves	18.26	18.51	18.77	19.02	19.58	-7.29

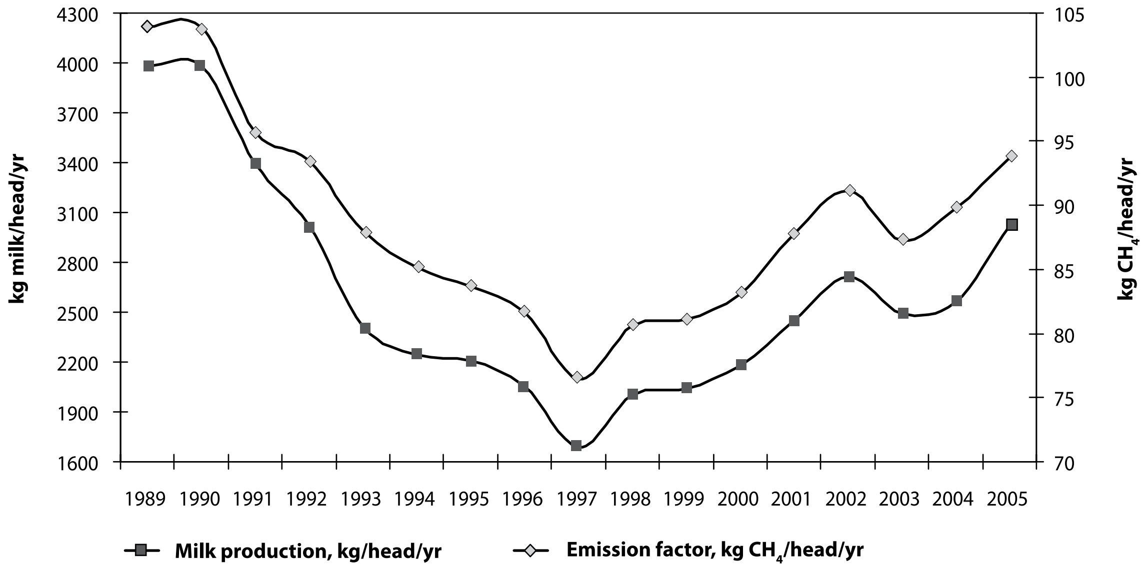

Figure 6-2: Correlation of the Methane Emission Factors from Enteric Fermentation in Dairy Cows with the Annual Milk Production per Cow in the RM, 1989-2005

Table 6-25: Country Specific EFs Used by Different Annex I Parties for National GHG Inventories under the 4A 'Enteric Fermentation' (Cattle), kg CH_4/head/yr

Categories	Ukraine		Russia		Lithuania		Estonia		Poland	
	1990	2005	1990	2005	1990	2005	1990	2005	1990	2005
Dairy cows	106.52	104.27	100.66	101.21	90.68	95.11	98.67	121.45	91.63	93.99
Other cattle	42.96	46.79	48.19	51.08	45.49	43.87	47.75	48.64	41.26	47.37
Categories	**Czech Republic**		**Austria**		**Ireland**		**Portugal**		**Italy**	
	1990	**2005**	**1990**	**2005**	**1990**	**2005**	**1990**	**2005**	**1990**	**2005**
Dairy cows	96.01	114.41	97.64	115.04	102.75	106.78	94.93	118.10	92.78	112.90
Other cattle	44.38	52.70	48.38	56.07	55.31	53.13	50.05	57.94	45.58	46.40

Source: National Inventory Reports, 1990-2005 (2007 year submission) of Ukraine, Russia, Lithuania, Estonia, Poland, Czech Republic, Austria, Ireland, Portugal and Italy.

Table 6-26 features country specific emission factors calculated for sheep and goats in the RM. The obtained results are intermediary to default values characteristic for developing countries (5 kg CH_4/head/year for sheep and goats), and developed countries (8 kg CH_4/head/year for sheep and 5 kg CH_4/ head/year for goats) (IPCC, 2006).

Table 6-26: Country Specific Emission Factors for Enteric Fermentation, Calculated for Sheep and Goat Populations in the RM following a Tier 2 Methodology, kg CH_4/head/yr

Categories	1989	1990	1991	1992	1993	1994
Sheep	6.06	6.08	6.08	6.10	6.14	6.22
fattening lambs	3.00	3.00	3.00	3.00	3.00	3.00
mature ewes	6.58	6.60	6.60	6.62	6.67	6.76
mature rams	9.88	9.90	9.89	9.86	9.83	9.84
Goats	6.49	6.62	6.98	7.09	7.39	7.90
growing kids	2.70	2.70	2.70	2.70	2.70	2.70
mature females	7.59	7.76	8.25	8.39	8.80	9.47
mature males	6.67	6.68	6.68	6.66	6.66	6.65
Categories	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**
Sheep	6.25	6.29	6.24	6.32	6.31	6.31
fattening lambs	3.00	3.00	3.00	3.00	3.00	3.00
mature ewes	6.81	6.86	6.80	6.89	6.88	6.88
mature rams	9.84	9.83	9.84	9.84	9.83	9.82
Goats	8.23	8.34	8.69	8.18	7.68	6.42
growing kids	2.70	2.70	2.70	2.70	2.70	2.70
mature females	9.91	10.06	10.53	9.85	9.17	7.49
mature males	6.65	6.66	6.66	6.66	6.68	6.68
Categories	**2001**	**2002**	**2003**	**2004**	**2005**	**1989-2005, %**
Sheep	6.40	6.49	6.50	6.58	6.64	9.57
fattening lambs	3.00	3.00	3.00	3.00	3.00	0.00
mature ewes	6.98	7.11	7.12	7.21	7.30	10.94
mature rams	9.89	9.87	9.84	9.86	9.87	-0.10
Goats	6.46	6.52	6.47	6.52	6.55	0.92
growing kids	2.70	2.70	2.70	2.70	2.70	0.00
mature females	7.55	7.62	7.56	7.63	7.67	1.05
mature males	6.69	6.69	6.69	6.71	6.71	0.60

The obtained results also fit into the range of country specific emission factors values for these animal categories used by some Annex 1 Parties for national GHG inventories for the period from 1990 through 2005 (Table 6-27).

6.2.3 Uncertainties and Time-Series Consistency

Uncertainties related to estimation of methane emissions from enteric fermentation, in particular depend on the accuracy of the livestock characterisation, and also on the default emission factors used. The uncertainties associated with the total animal population in the Republic of Moldova are higher than it is officially acknowledged (±10 percent for cattle, sheep, goats, horses, swine, and up to ±20 percent for rabbits, asses and mules). It is quite likely that the reported data collected from current statistical reports are erroneous; in particular keeping in mind that seasonal variation in total animal population is not taken into account. To be noted that the accuracy of default emission factors estimated by using a Tier 1 method is around ±30 percent (IPCC, 2006). As this methodology does not rely on country specific values and does not take account of country's livestock characteristics, general uncertainty of results obtained by using this approach could reach up to ±50 percent (IPCC, 2006). In case of Tier 2 methodology uncertainties will depend mostly on how accurately the characteristics of the main animal categories are used and on the extent to which estimation methods and coefficients applied in various equations used to calculate net energy comply with national circumstances. Emission factor estimates using the Tier 2 method are likely to be in the order of ±20 percent (IPCC, 2006). So, combined uncertainties associated with methane emissions from enteric fermentation can be considered moderate for cattle, sheep and goats (±22.36 percent) and medium for other animal categories (±31.62 percent for swine and horses, ±36.06 percent for rabbits, asses and mules). At the same time, combined uncertainties, presented as a percent of total sectoral emissions were estimated at ±6.29 percent for cattle, ±1.23 percent for sheep, ±0.18 percent for goats, ±0.43 percent for horses, ±0.007 percent for asses and

Table 6-27: Country Specific EFs Used by Different Annex I Parties for National GHG Inventories under the 4A 'Enteric Fermentation' (Sheep and Goats), kg CH_4/head/yr

Categories	Portugal		Luxemburg		Netherlands		Belgium		Ireland	
	1990	2005	1990	2005	1990	2005	1990	2005	1990	2005
Sheep	8.33	9.63	7.87	7.87	7.99	8.00	8.30	8.18	6.13	5.84
Goats	7.38	7.60	4.59	4.59	4.94	5.13	8.89	8.57	5.00	5.00
Categories	**Switzerland**		**Finland**		**Denmark**		**Australia**		**New Zeeland**	
	1990	**2005**	**1990**	**2005**	**1990**	**2005**	**1990**	**2005**	**1990**	**2005**
Sheep	9.57	10.44	6.80	8.20	17.17	17.17	6.95	6.76	9.25	11.01
Goats	10.38	10.37	5.00	5.00	13.15	13.15	5.00	5.00	9.00	9.00

Source: National Inventory Reports for the period 1990 through 2005 (2007 year submission) of Portugal, Luxemburg, Netherlands, Belgium, Ireland, Switzerland, Finland, Denmark, Australia and New Zeeland.

mules, ±0.20 percent for swine and ±0.31 percent for rabbits. Uncertainties introduced in trend in sectoral emissions were estimated at ±1.60 percent for cattle, ±0.36 percent for sheep, ±0.07 percent for goats, ±0.15 percent for horses, ±0.003 percent for asses and mules, ±0.08 percent for swine and ±0.11 percent for rabbits (Annex 7-3.4).

In view of ensuring time-series consistency of the obtained results, the same approach was used for the entire period under review, in conformity with the recommendations included in the Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories (IPCC, 2000).

6.2.4 QA/QC and Verification

Standard verification and quality control forms and checklists were filled in for the respective category under the Agriculture Sector, following the Tier 1 and Tier 2 approaches (see in Annex 6). Also, the AD and methods used for estimating GHG emissions under the category 4A 'Enteric Fermentation' were documented and archived both in hard copies and electronically. For identifying the data entry and emission estimation process related errors there were applied verifications and quality control procedures. Verification was focused on correct use of AD obtained from different sources of reference (i.e., Statistical Yearbooks of the RM and ATULBD, National Bureau of Statistics and FAO Database), as well as on ensuring correct use of the default emission factors available in the 2006 IPCC Guidelines for National Greenhouse Gas Inventories. Inventory quality assurance activities for the 4A 'Enteric Fermentation', were supported by an expert representing the Agribusiness and Rural Development Management Institute.

Following the recommendations included into the Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories (IPCC, 2000), CH_4 emissions originated from the 4A 'Enteric Fermentation' were estimated based on AD and EFs from official sources of reference.

6.2.5 Recalculations

Methane emissions from the 4A 'Enteric Fermentation' source category were recalculated for the 1990 through 1998 time series (for the Republic of Moldova the 1990 is the reference year under the UNFCCC, while emissions for 1989 year are presented here for comparison purposes), first of all as a result of change the estimation methodology: a Tier 2 method and country specific EFs (in particular for cattle, sheep and goats) and default EFs (for other animal categories), available in the 2006 IPCC Guidelines, were used within the SNC of the RM under the UNFCCC, that replaced the Tier 1 method and default emission factors available in the Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories, used within the FNC of the RM under the UNFCCC (2000); as well as due to use of a new set of activity data on animal population, available into the Statistical Yearbooks of the RM and ATULBD and other relevant sectoral publications.

As stated above, default emission factors were used for some categories of livestock: 18 kg CH_4/head/year for horses and 10 kg CH_4/head/year for asses and mules (IPCC, 2006). For swine, there was used the default emission factor specific to Western European countries (1.5 kg/head/year), also preferred by other Eastern European countries (ex., by Ukraine, Russia, Lithuania and Estonia). As no default EFs is available in case of rabbits, the Portuguese country specific emission factor (3.63 kg/head/year) was used. In comparison with emissions estimates included into the FNC of the RM, the changes performed resulted in increased methane emissions from 4A 'Enteric Fermentation" over the period 1990 through 1991 and in 1998 year, with a variation from a minimum of 0.3 percent in 1998 to a maximum of 9.1 percent in 1990; and lower values over the period from 1992 through 1997, with a variation from a minimum of -1.7 percent in 1992, to a maximum of -12.4 percent in 1993 (Table 6-28).

Table 6-28: Comparative Results of CH_4 Emissions from 4A 'Enteric Fermentation' Included into the FNC and SNC of the RM under the UNFCCC, Gg

Emissions	1989	1990	1991	1992	1993	1994
FNC	85.4533	83.0570	81.9042	80.2887	77.8135	74.9435
SNC	92.1065	90.6384	83.3580	78.9349	68.1893	68.9186
Difference, %	7.8	9.1	1.8	-1.7	-12.4	-8.0
Emissions	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**
FNC	70.1655	61.9217	53.1035	46.6560		
SNC	65.9346	58.8935	51.3233	46.8051	45.8021	43.0030
Difference, %	-6.0	-4.9	-3.4	0.3		
Emissions	**2001**	**2002**	**2003**	**2004**	**2005**	**1990 - 2005, %**
FNC						
SNC	41.6103	43.4618	42.6594	40.1884	37.7552	-58.3
Difference, %						

For the period 1999-2005, methane emissions resulting from enteric fermentation were estimated for the first time. The results allow assert that within the 1990-2005 time series methane emissions from 4A 'Enteric Fermentation' source category decreased by 58.3 percent, in particular due to reduced animal population, but also due to evolution of the principal productivity indicators in the livestock sector of the Republic of Moldova.

To be noted that over the period under review the share of different livestock categories in the overall methane emissions from the 4A 'Enteric Fermentation' source category has changed significantly. By 2005, the percentage of such categories as 'other cattle' and 'swine' decreased considerable against 1990 level, while the percentage of other categories such as 'dairy cows', 'sheep', 'goats', 'horses', 'asses and mules', 'rabbits', increased considerably against 1990 level (Table 6-29).

Table 6-29: Breakdown of the Methane Emissions from 4A 'Enteric Fermentation' by Livestock Category within 1989-2005, %

Categories	1989	1990	1991	1992	1993	1994
Dairy cows	46.48	46.05	45.35	47.02	47.51	49.72
Other cattle	39.98	39.64	39.80	37.35	34.70	31.73
Sheep	8.37	8.76	9.08	9.58	11.28	12.33
Goats	0.22	0.23	0.31	0.44	0.85	0.86
Horses	0.90	0.92	1.01	1.11	1.36	1.49
Asses and mules	0.02	0.02	0.02	0.02	0.03	0.03
Swine	3.05	3.38	3.33	3.33	2.88	2.36
Rabbits	0.99	1.00	1.09	1.15	1.38	1.47
Categories	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**
Dairy cows	51.03	52.86	53.03	55.83	56.39	59.32
Other cattle	29.15	25.82	23.43	20.62	20.28	17.95
Sheep	13.37	14.18	15.49	15.38	14.48	13.99
Goats	1.14	1.35	1.66	1.68	1.61	1.53
Horses	1.59	1.88	2.22	2.52	2.69	3.01
Asses and mules	0.03	0.04	0.05	0.05	0.04	0.04
Swine	2.38	2.58	2.78	2.56	3.04	2.62
Rabbits	1.31	1.29	1.34	1.37	1.47	1.54

Categories	2001	2002	2003	2004	2005	1990-2005, %
Dairy cows	62.94	62.95	62.28	61.93	61.87	34.4
Other cattle	15.72	15.82	15.74	15.04	13.61	-65.7
Sheep	13.08	12.80	12.94	13.67	14.74	68.3
Goats	1.73	1.72	1.96	2.01	2.10	800.4
Horses	3.29	3.38	3.49	3.67	3.64	295.6
Asses and mules	0.05	0.05	0.05	0.05	0.05	140.1
Swine	1.78	1.69	1.93	1.78	1.68	-50.4
Rabbits	1.41	1.60	1.62	1.86	2.30	130.6

6.2.6 Planned Improvements

As, 'cattle' and 'sheep' animal categories accounting for the largest share in the structure of total methane emissions originated from the 4A 'Enteric Fermentation' source category it is planned to continue activities focused on a further specifying of values for the main indices used to develop the country specific emission factors for respective animal categories following a Tier 2 method, also there are planned certain activities focused on updating the activity data set for the livestock breeding sector of the Republic of Moldova for the whole period under review.

6.3 Manure Management (Category 4B)

The 4B 'Manure Management' source category includes both methane and nitrous oxide emissions. The emissions level depends on the amount of manure treated and handled within manure management systems, properties of manure and type of manure management systems. Usually poorly aerated manure management systems generate great amounts of CH_4 and smaller amount of N_2O; while well aerated systems generate less CH_4 emissions and more N_2O emissions.

6.3.1 Methane Emissions

6.3.1.1 Source Category Description

When manure decomposes anaerobically (in absence of oxygen), methanogenic bacteria produce methane. The main factors affecting production of CH_4 emissions from manure are the amount of manure produced and the share (or percentage) of manure decomposed anaerobically.

On the national level manure production depends on the number of livestock and poultry, and, in particular, on average amount of waste produced per animal per year. The share of manure that decomposes anaerobically depends on how the manure is managed. When manure is stored or treated as a liquid (e.g., in lagoons, ponds, tanks, or pits), it decomposes anaerobically and can produce a significant quantity of CH_4. When manure is handled as a solid (e.g., in stacks or piles) or when it is deposited on pastures and paddocks, it tends to decompose under more aerobic conditions and less CH_4 is produced. To estimate methane emissions from manure management the total animal population was divided in subgroups to better reflect the average amount of waste produced per animal or poultry per year, as well as the way manure is managed. Average emissions rates were calculated for existent animal and poultry categories based on typical manure management systems and country specific emission factors for cattle and swine, as well as based on default emission factors for other livestock and poultry categories.

6.3.1.2 Methodological Issues and Data Sources

While following a Tier 1 methodology, there are required livestock population data by animal species/category (identical to those used to estimate CH_4 emissions from the 4A 'Enteric Fermentation') and climate region or temperature (RM corresponds to countries with cold climate - the average annual temperature being less than 15^0C), in combination with IPCC default emission factors to estimate emissions.

The Tier 2 methodology is a more complex method for estimating CH_4 emissions from manure management and it is used where a particular livestock species/category represents a significant share of a country's emissions (in the RM only for swine and cattle). The respective method requires detailed information on animal characteristics and manure management practices, which is used to develop emission factors specific to the conditions of the country,

The following steps are used to estimate CH_4 emissions from manure management: (1) collect population data from livestock population characterisation; (2) used default values or develop country specific emission factors for each livestock subcategory in terms of kilograms of methane per animal per year; (3) multiply the livestock subcategory emission factors by the subcategory populations to estimate subcategory emissions, and sum across the subcategories to estimate total emissions by primary livestock species; (4) sum emissions from all defined livestock species to determine national emissions.

Equation below shows how to calculate CH_4 emissions from manure management (see Equation 10.22, Chapter 10, Volume 4, 2006 IPCC Guidelines).

$$CH_4\ emissions = \sum_{(T)} [(EF_{(T)} \cdot N_{(T)})/10^6]$$

Where:

CH_4 emissions = CH_4 from manure management, for a defined population, Gg CH_4/yr;

$EF_{(T)}$ =emission factor for the defined livestock population, kg CH_4/head/yr;

$N_{(T)}$ = the number of head of livestock species/category *T* in the country;

T = species/category of livestock.

Methane Emission Factors (EF). In the Republic of Moldova country specific EFs (for cattle and swine) were calculated based on information collected from statistical publications and various scientific research publications. To calculate these coefficients, it was necessary to determine the range in manure volatile solids content per animal (VS, in kg); the maximum methane producing capacity characteristic for certain type of manure (B_0 in m^3 per kg of VS). Additionally, methane conversion factors (MCF) which also account for the influence of climate conditions on CH_4 forming process were identified for each type of manure management system.

Table 6-30: Daily Volatile Solid Excreted (VS) Calculated for 1989-2005 time series, kg dry matter animal/day

Categories	1989	1990	1991	1992	1993	1994
Dairy cows	4.11	4.10	3.78	3.79	3.67	3.55
Other cattle	2.49	2.45	2.40	2.42	2.40	2.32
heifers	3.30	3.28	3.25	3.21	3.17	3.00
bulls and steers	2.88	2.87	2.82	2.92	2.92	2.86
calves	1.81	1.74	1.67	1.70	1.67	1.65
Swine	0.60	0.60	0.59	0.57	0.56	0.54
fattening swine	0.55	0.55	0.54	0.52	0.51	0.49
market swine	0.88	0.87	0.86	0.84	0.82	0.79
Categories	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**
Dairy cows	3.48	3.40	3.18	3.36	3.38	3.46
Other cattle	2.28	2.22	2.11	2.18	2.21	2.25
heifers	2.95	2.90	2.68	2.83	2.85	2.87
bulls and steers	2.83	2.75	2.67	2.72	2.77	2.80
calves	1.60	1.55	1.51	1.53	1.55	1.60
Swine	0.53	0.51	0.50	0.51	0.51	0.52
fattening swine	0.49	0.47	0.46	0.47	0.47	0.47
market swine	0.78	0.75	0.74	0.75	0.76	0.76
Categories	**2001**	**2002**	**2003**	**2004**	**2005**	**1989–2005, %**
Dairy cows	3.66	3.79	3.63	3.74	3.80	-7.4
Other cattle	2.28	2.3	2.3	2.35	2.33	-6.4
heifers	2.89	2.92	2.89	3.02	2.98	-9.6
bulls and steers	2.81	2.83	2.81	2.84	2.77	-3.7
calves	1.65	1.67	1.69	1.72	1.72	-4.8
Swine	0.52	0.53	0.52	0.53	0.53	-11.1
fattening swine	0.48	0.48	0.48	0.48	0.49	-11.2
market swine	0.77	0.77	0.77	0.78	0.78	-10.9

CH_4 emission factors under the 4B 'Manure Management' source category were calculated by using the equation provided below (see Equation 10.23, Chapter 10, Volume 4, 2006 IPCC Guidelines).

$$EF_{(T)} = (VS_{(T)} \cdot 365) \cdot [B_{0(T)} \cdot 0.67\ kg/m^3 \cdot \Sigma_{(S,k)} (MCF_{(S,k)}/100) \cdot MS_{(T,S,k)}]$$

Where:

$EF_{(T)}$ = annual CH_4 emission factor for livestock category *T*, kg CH_4/animal/yr;

$VS_{(T)}$ = daily volatile solid excreted for livestock category *T*, kg dm/animal/day (see Table 6-30);

$B_{0(T)}$ = maximum methane producing capacity for manure produced by livestock category *T*, m^3 CH_4/kg of VS excreted;

0.67 = conversion factor of m^3 CH_4 to kilograms CH_4;

$MCF_{(S,k)}$ = methane conversion factors for each manure management system *S* by climate region *k*, %;

$MS_{(T,S,k)}$ = fraction of livestock category *T*'s manure handled using manure management system *S* in climate region *k*, dimensionless.

Table 6-31: Coefficients and Default Emission Factors Used for Cattle and Swine under the 4B 'Manure Management' source category

Categories	Mass, kg	Diges-tibility , %	Energy, MJ/ day	Daily feed intake, kg	Manure, kg dm / day	VS, kg/day	B_0, m^3 CH_4 / kg VS	EF, kg CH_4 / head / yr
Dairy cows	550	60	207.2	11.2	4.49	4.5	0.24	11
Other cattle	391	60	134.4	7.3	2.91	2.7	0.17	6
Fattening swine	50	75	38.0	2.1	0.51	0.3	0.45	3
Market swine	180	60	38.0	2.1	0.51	0.5	0.45	4

Source: IPCC 2006 Guidelines, Volume 4, Chapter 10, Table 10.14, Page 10.38; Table 10A-4, Page 10.77; Table 10A-5, Page 10.78; Table 10A-7, Page 10.80 and Table 10A-8, Page 10.81.

Volatile Solids Excretion Rate (VS) was calculated in conformity with the equation below (see Equation 10.24, Chapter 10, Volume 4, 2006 IPCC Guidelines)..

$$VS = [GE \cdot (1 - DE\%/100) + (UE \cdot GE)] \cdot [(1 - ASH/18.45)]$$

Where:

VS = volatile solid excretion per day on a dry-organic matter basis, kg VS/day.

GE = gross energy intake, MJ/day; the same values as those used under the 4.A 'Enteric Fermentation' source category;

DE = digestibility of the feed in percent; for cattle the same values were used as under the 4A 'Enteric Fermentation'; for fattening swine, *DE* = 75 percent, while for market swine, accounting for 15 percent of the total population of swine, *DE* = 60 percent;

(UE • GE) = urinary energy expressed as fraction of gross energy (GE); typically, this value is 0.04GE for cattle and 0.02GE for swine;

ASH = the ash content of manure calculated as a fraction of the dry matter feed intake; values used by Austria into its NIR (submission of 2007 year) were used, 11 percent for dairy cows, 11.5 percent for bulls and heifers, and 12 percent for young calves; the default value of 4 percent was used for swine (IPCC, 2006);

18.45 = conversion factor for dietary GE per kg of dry matter; this value is relatively constant across a wide range of forage and grain-based feeds commonly consumed by livestock.

Table 6-32: Coefficients and Default Emission Factors Used Under the 4B 'Manure Management' Source Category (Developed Countries)

Categories	Mass, kg	Digesti-bility, %	Daily feed intake, kg	% Ash (dry basis)	VS, kg VS/ day	B_0, m^3/kg VS	CF CH_4, %	EF, kg CH_4/ head/ yr
Sheep	48.5	60	1.08	8	0.40	0.19	1	0.19
Goats	38.5	60	0.76	8	0.30	0.18	1	0.13
Horses	377	70	5.96	4	2.13	0.30	1	1.56
Asses& Mules	130	70	3.25	4	0.94	0.33	1	0.76
Chickens	1.8	63	-	5	0.02	0.39	1	0.03
Turkeys	6.8	68	-	3	0.07	0.36	1	0.09
Broilers	0.9	68	-	2	0.01	0.36	1	0.02
Ducks	2.7	66	-	2	0.02	0.36	1	0.02

Source: 2006 IPCC Guidelines, Volume 4, Chapter 10, Table 10.15, Page 10.41; Table 10A-9, Pages 10.82-10.83.

The maximum *methane-producing capacity of the manure* (*B_0*) varies by species and diet. As it was not possible to identify country specific values of B_0 expressed in m^3 per kg of VS in specialty literature, there were used default values characteristic for Eastern European countries (Tables 6-31 and 6-32).

Methane Conversion Factors (MCF) values vary by different manure management systems and by annual average temperatures. Because of unavailability of country specific methane conversion factors (MCF), the default values provided in 2006 IPCC Guidelines were used, to replace those proposed in the GPG (IPCC, 2000) and Revised 1996 IPCC Guidelines (IPCC, 1997) (Tables 6-33 and 6-34).

Methane conversion factor (MCF) represents the extent to which maximum methane producing capacity (B_0) is attained. So, measurement of the MCF values should include the following factors: timing of storage/application; length of storage; manure characteristics; determination of the amount of manure left in the storage facility; time and temperature distribution between indoor and outdoor storage; daily temperature fluctuation; seasonal temperature variation, etc. The default values of methane conversion factor for cattle and swine are presented in the Table 6-35, while the percentage of using different manure management systems in Eastern Europe Countries, respectively in the Table 6-36 below.

Table 6-33: Default Values of Methane Conversion Factor for Manure Management Systems non-specified in the Revised 1996 IPCC Guidelines

Additional animal waste management systems		MCF, %	
		IPCC, 2000	IPCC, 2006
Pit storage below animal confinements (cattle and swine): collection and storage of manure with little or no added water typically below a slatted floor in an enclosed animal confinement facility, usually for periods less than one year	< 30 days	0	3
	> 30 days	39	17
Composting - Intensive Windrow: composting in windrows with regular (at least daily) turning for mixing and aeration		0.5	0.5
Composting - Passive Windrow: composting in windrows with infrequent turning for mixing and aeration		0.5	0.5
Poultry manure with litter: similar to cattle and swine deep bedding except usually not combined with a dry lot or pasture; typically used for all poultry breeder flocks and for the production of meat type chickens (broilers) and other fowl		1.5	1.5
Poultry manure without litter: may be similar to open pits in enclosed animal confinement facilities or may be designed and operated to dry the manure as it accumulates; the latter is known as a high-rise manure management system and is a form of passive windrow composting when designed and operated properly		1.5	1.5
Aerobic Treatment: the biological oxidation of manure collected as a liquid with either forced or natural aeration; natural aeration is limited to aerobic and facultative ponds and wetland systems and is due primarily to photosynthesis; hence, these systems typically become anoxic during periods without sunlight		0.1	0

Table 6-34: Default Values of Methane Conversion Factor (MCF) for Manure Management Systems Specified in the IPCC Guidelines

Manure Management Systems		MCF, %		
		IPCC, 1997	IPCC, 2000	IPCC, 2006
Pasture/Range/Paddock: the manure from pasture and range grazing animals is allowed to lie as deposited, and is not managed		1	1	1
Daily Spread: manure is not routinely removed from a confinement facility and is applied to cropland or pasture within 24 hours of excretion		0.1	0.1	0.1
Solid Storage: the storage of manure, typically for a period of several months, in unconfined piles or stacks; manure is able to be stacked due to the presence of a sufficient amount of bedding material or loss of moisture by evaporation		1	1	2
Dry lot: a paved or unpaved open confinement area without any significant vegetative cover where accumulating manure may be removed periodically		1	1	1
Liquid/Slurry: manure is stored as excreted or with minimal addition of water in either tanks or earthen ponds outside the animal housing, usually for periods less than one year	with natural crust cover	10	39	10
	without natural crust cover			17
Anaerobic Lagoon: a type of liquid storage system designed and operated to combine waste stabilization and storage; lagoon supernatant is usually used to remove manure from the associated confinement facilities to the lagoon; anaerobic lagoons are designed with varying lengths of storage (up to a year or greater), depending on the climate region, the volatile solids loading rate, and other operational factors; the water from lagoons may be recycled as flush water or used to irrigate and fertilise fields		90	0-100	66
Pit Storage below animal confinements: collection and storage of manure usually with litter or no added water typically below a slatted floor in an enclosed animal confinement, usually for periods less than one year	< 1 month	5	0	3
	> l month	10	39	17
Anaerobic Digester: the dung and urine in liquid/slurry are collected and anaerobically digested; methane may be burned flared or vented.		5-15	0-100	0-100
Burned for Fuel: the dung and urine are excreted on fields; the sun dried dung cakes are burned for fuel		5-10	10	10

Table 6-35: Manure Management Systems MCFs for Different Animal Categories

Manure Management Systems	MCF for different animal categories, %			
	Revised 1996 IPCC Guidelines		2006 IPCC Guidelines	
	Cattle	Swine	Cattle	Swine
Anaerobic Lagoon	47	19	66	66
Liquid/Slurry	39	39	17	17
Solid Storage	1	1	2	2
Dry lot	1	1	1	1
Pasture/Range/Paddock	1	0	1	0
Pit Storage below animal confinements < 1 month	0	0	0	3
Pit Storage below animal confinements > 1 month	0	39	0	17
Daily Spread	0.1	0.1	0.1	0.1
Anaerobic Digester	0	0	10	10
Burning for fuel	10	0	10	0
Other Systems	1	1	1	1

Source: Revised 1996 IPCC Guidelines (1997), Vol. 3, Tab. B-3, Page 4.43, Tab. B-4 and Tab. B-6; 2006 IPCC Guidelines, Vol. 4, Chap. 10, Tab. 10A-4, 10A-5, Tab. 10A-7 and Tab. 10A-8.

Based on country specific AD (identical to those used for the enteric fermentation), as well as default EFs and coefficients, there were developed country specific CH_4 EFs for 4B 'Manure Management' source category. Following *good practices*, the same estimation methodology was used for the entire period under review.

Table 6-36: Default Manure Management Systems Usage in the Eastern Europe (MS%)

Category	Anaerobic Lagoon	Liquid / Slurry	Solid Storage	Pasture/ Range/ Paddock	Daily Spread	Other
Dairy cows	0	17.5	60	18	2.5	2
Other cattle	0	22.5	44	20	0	13.5
Category	**Anaerobic Lagoon**	**Liquid / Slurry**	**Solid Storage**	**Pits <1 month**	**Pits >1 month**	**Other**
Dairy cows	3	0	42	24.7	24.7	5.7
Other cattle	3	0	42	24.7	24.7	5.7

Source: IPCC 2006 Guidelines, Vol. 4, Chap. 10, Tab. 10A-4, 10A-5, Tab. 10A-7 and Tab. 10A-8.

As significant changes occurred in the livestock breeding sector of the RM in terms of manure management practices (*large scale feedlots for cattle and swine were closed down, most animal population being concentrated currently in private sector; the share of liquid manure management, contributing to a greater extent to generation of CH_4 emissions, decreased; while the share of solid manure management systems, less responsible for generation of CH_4 emissions, increased*), as well as a consequence of non-compliance of actual manure management systems in the RM with the ones described in the 2006 IPCC Guidelines, it was not deemed necessary to use default values in terms of share of different manure management systems (MS%) characteristic to Eastern European countries. So, to calculate CH_4 emissions from the 4B 'Manure Management' source category (for cattle and swine), country specific values were used on the manure management systems usage in the Republic of Moldova (Table 6-37).

Table 6-37: Manure Management Systems Usage (MS%) in the RM, 1989-2005

Animal categories (T) and management systems (S)	1989-1990	1991-1992	1993-1994	1995-1997	1998-1999	2000-2001	2002-2003	2004-2005
	MS $_{(T, S)}$ values							
Dairy cows								
Pasture/Range/ Paddock	12	14	18	22	24	24	24	24
Liquid/Slurry	18	16	12	7	5	3	2	2
Solid Storage	70	70	70	71	71	73	74	74
Other cattle								
Pasture/Range/ Paddock	10	12	16	18	20	21	22	22
Liquid/Slurry	20	18	13	10	7	5	3	2
Solid Storage	70	70	71	72	73	74	75	76
Swine								
Liquid/Slurry	24	22	20	18	16	14	12	10
Solid Storage	76	78	80	82	84	86	88	90

Country specific EFs, calculated following a simplified Tier 2 methodology, are provided below (Table 6-38).

To be noted that country specific CH_4 EFs values for cattle and swine, calculated by following a simplified Tier 2 methodology, can be considered intermediary to the CH_4 EFs values used by a number Annex I Parties under the UNFCCC in their national GHG inventories for the period from 1990 through 2005 (Table 6-39).

Table 6-38: Country Specific Methane EFs for the 4B 'Manure Management', Calculated following a Tier 2 Methodology for Cattle and Swine Population in the RM

Categories	1989	1990	1991	1992	1993	1994
Dairy cows	12.62	12.60	10.12	10.05	8.80	8.51
Other cattle	5.77	5.68	4.90	4.85	4.24	4.11
heifers	7.65	7.60	6.52	6.44	5.62	5.31
bulls and steers	6.69	6.65	5.92	5.86	5.18	5.07
calves	4.17	4.02	3.41	3.39	2.95	2.91
Swine	4.02	3.98	3.43	3.33	3.07	3.20
fattening swine	3.69	3.66	3.15	3.05	2.82	2.93
market swine	5.88	5.84	5.02	4.88	4.51	4.69
Categories	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**
Dairy cows	6.13	5.99	5.60	5.24	5.27	4.88
Other cattle	3.30	3.24	3.07	2.72	2.75	2.59
heifers	4.29	4.22	3.90	3.53	3.56	3.32
bulls and steers	4.11	4.00	3.88	3.39	3.45	3.23
calves	2.32	2.25	2.18	1.90	1.93	1.84
Swine	2.74	2.65	2.60	2.46	2.67	2.49
fattening swine	2.51	2.43	2.39	2.26	2.45	2.29
market swine	4.03	3.90	3.83	3.64	3.93	3.67
Categories	**2001**	**2002**	**2003**	**2004**	**2005**	**1989-2005, %**
Dairy cows	5.16	4.96	4.75	4.88	4.97	-60.6
Other cattle	2.63	2.30	2.30	2.18	2.16	-62.6
heifers	3.35	2.93	2.90	2.80	2.77	-63.8
bulls and steers	3.25	2.84	2.82	2.63	2.57	-61.6
calves	1.89	1.67	1.69	1.58	1.59	-61.9
Swine	2.36	2.34	2.18	2.15	2.17	-46.0
fattening swine	2.17	2.15	2.00	1.97	1.99	-46.1
market swine	3.47	3.42	3.21	3.16	3.19	-45.7

Table 6-39: Country Specific Methane EFs Values Under the 4B "Manure Management' Used by a number Annex I Parties in their National GHG Inventories, kg CH_4/head/yr

Categories	Austria		Germany		Finland		Sweden		Norway	
	1990	2005	1990	2005	1990	2005	1990	2005	1990	2005
Dairy cows	19.45	20.36	14.29	18.92	6.38	13.29	10.20	18.62	14.41	14.41
Other cattle	6.17	7.43	7.72	7.99	2.30	4.42	3.96	6.22	5.60	5.60
Swine	5.78	5.96	2.72	3.01	2.78	3.52	2.09	3.36	2.02	1.99
Categories	Russia		Ukraine		Estonia		Poland		Italy	
	1990	2005	1990	2005	1990	2005	1990	2005	1990	2005
Dairy cows	4.75	4.71	46.38	3.11	7.66	16.33	5.63	9.33	15.04	14.36
Other cattle	2.61	2.67	15.75	1.02	3.37	5.45	1.61	5.88	7.47	7.43
Swine	3.04	3.92	8.59	0.89	5.50	2.28	5.40	6.54	8.11	7.52

Source: National Inventory Reports (submission of 2007 year) of Austria, Germany, Finland, Sweden, Norway, Russian Federation, Ukraine, Estonia, Poland and Italy.

6.3.1.3 Uncertainties and Time-Series Consistency

Uncertainties related to estimation of methane emissions from 4B 'Manure Management' source category, depend on the accuracy of the livestock characterisation, and also on the default emission factors used. The uncertainties associated with the total animal population in the Republic of Moldova are higher than it is officially acknowledged (±10 percent for cattle, sheep, goats, horses, swine, and up to ±20 percent for rabbits, asses and mules). It is quite likely that the reported data collected from current statistical reports are erroneous; in particular keeping in mind that seasonal variation in total animal population is not taken into account. The uncertainty range for the default emission factors estimated by using a Tier 1 method is estimated to be ±30 percent (IPCC, 2006). Improvements achieved by Tier 2 methodologies are estimated to reduce uncertainty ranges in the emission factors to ±20 percent (IPCC, 2006).

Uncertainties related to manure management systems to great extent depend on the characteristic features of the livestock breeding sector and how information on manure management systems is collected in the RM. Because lately the RM uses preponderantly two manure management systems (pasture/range/paddock and solid storage), uncertainties related to manure management systems can be considered relatively small (circa ±10 percent), however, due to the fact that previously (in particular in the period from 1990 through 1996) a wide spectrum of manure management systems was used, the uncertainties on these are considered to be higher (up to ±50 percent).

Combined uncertainties associated with methane emissions from manure management can be considered moderate for cattle and swine (±31.62 percent) and medium for other animal categories (±50.99 percent for sheep, goats, horses and ±53.85 percent for poultry, rabbits, asses and mules). At the same time, combined uncertainties, presented as a percent of total sectoral emissions were estimated at ±0.46 percent for cattle, ±0.08 percent for sheep, ±0.08 percent for goats, ±0.06 percent for horses, ±0.001 percent for asses and mules, ±0.29 percent for swine, ±0.30 percent for poultry and ±0.06 percent for rabbits. Uncertainties introduced in trend in sectoral emissions were estimated at ±0.27 percent for cattle, ±0.02 percent for sheep, ±0.003 percent for goats, ±0.019 percent for horses, ±0.0003 percent for asses and mules, ±0.281 percent for swine, ±0.079 percent for poultry and ±0.018 percent for rabbits (Annex 7-3.4).

In view of ensuring time-series consistency of the obtained results, the same approach was used for the entire period under review, in conformity with the recommendations included in the Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories (IPCC, 2000).

6.3.1.4 QA/QC and Verification

Standard verification and quality control forms and checklists were filled in for the respective category under the Agriculture Sector, following the Tier 1 and Tier 2 approaches (see in Annex 6). Also, the AD and methods used for estimating GHG emissions under the category 4B 'Manure Management' were documented and archived both in hard copies and electronically. For identifying the data entry and emission estimation process related errors there were applied verifications and quality control procedures. Verification was focused on correct use of AD obtained from different sources of reference (i.e., Statistical Yearbooks of the RM and ATLBD, National Bureau of Statistics and FAO Database), as well as on ensuring correct use of the default emission factors available in the 2006 IPCC Guidelines for National Greenhouse Gas Inventories. Inventory quality assurance activities for the 4B 'Manure Management', were supported by an expert representing the Agribusiness and Rural Development Management Institute.

Following the recommendations included into the Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories (IPCC, 2000), CH_4 emissions originated from the 4B 'Manure Management' were estimated based on AD and EFs from official sources of reference.

6.3.1.5 Recalculations

Methane emissions from the 4B 'Manure Management' source category were recalculated for the 1990 through 1998 time series (for the Republic of Moldova the 1990 is the reference year under the UNFCCC, while emissions for 1989 year are presented here for comparison purposes), as a result of change the estimation methodology: a Tier 2 method and country specific EFs (in particular for cattle and swine), and default EFs (for other animal categories), available in the 2006 IPCC Guidelines, were used within the SNC of the RM under the UNFCCC, that replaced the Tier 1 method and default emission factors available in the Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories, used within the FNC of the RM under the UNFCCC (2000); as well as due to use of a new set of activity data on animal population, available into the Statistical Yearbooks of the RM and ATULBD and other relevant sectoral publications.

As stated above, default emission factors were used for some categories of livestock: 0.19 kg CH_4/head/yr for sheep, 0.13 kg CH_4/head/yr for goats, 1.56 kg CH_4/head/yr for horses, 0.76 kg CH_4/head/yr for asses and mules, 0.03 kg CH_4/head/yr for chickens, 0.02 kg CH_4/head/yr for geese and ducks and 0.09 kg CH_4/head/yr for turkeys (IPCC, 2006). As no default EFs is available in case of rabbits, the Portuguese country specific emission factor (0.48 kg/head/year) was used.

In comparison with emissions estimates included into the FNC of the RM, the changes performed resulted in increased methane emissions from 4B 'Manure Management' over the period 1990 through 1992, with a variation from a minimum of 2.1 percent in 1992 to a maximum of 25.9 percent in 1990; and lower values over the period from 1993 through 1998, with a variation from a minimum of -10.56 percent in 1994, to a maximum of -29.8 percent in 1998 (Table 6-40).

For the period 1999-2005, methane emissions resulting from manure management were estimated for the first time. The obtained results allow assert that within the 1990-2005 time series methane emissions from 4B 'Manure Management' source category decreased by 81.8 percent, in particular due to reduced animal population, but also due to changes in the share of animal waste management systems in the livestock breeding sector of the RM.

To be noted that over the period under review the share of different animals in the structure of methane emissions from the 4.B 'Manure Management' source category has changed significantly (Table 6-41).

Table 6-40: Comparative Results of CH_4 Emissions from 4B 'Manure Management' Included into the FNC and SNC of the RM under the UNFCCC, Gg

	1989	1990	1991	1992	1993	1994
FNC	14.7494	14.6611	14.4292	13.6402	12.2952	10.9168
SNC	18.0161	18.4577	14.8059	13.9289	10.2705	9.7638
Difference, %	22.15	25.90	2.61	2.12	-16.47	-10.56
	1995	**1996**	**1997**	**1998**	**1999**	**2000**
FNC	9.9019	8.8304	7.9205	7.2213		
SNC	7.6557	6.9880	6.1837	5.0729	5.5576	4.6448
Difference, %	-22.68	-20.86	-21.93	-29.75		
	2001	**2002**	**2003**	**2004**	**2005**	**1990-2005, %**
FNC						
SNC	3.8854	3.8472	3.8759	3.5686	3.3608	-81.8
Difference, %						

Table 6-41: Breakdown of the Methane Emissions from 4B 'Manure Management' by Livestock and Poultry Category within 1989-2005, %

Categories	1989	1990	1991	1992	1993	1994
Dairy cows	28.86	27.44	27.00	28.64	31.53	35.07
Other cattle	23.03	21.85	22.04	21.01	20.72	20.25
Sheep	1.34	1.34	1.60	1.69	2.32	2.66
Goats	0.02	0.02	0.03	0.05	0.10	0.10
Horses	0.40	0.39	0.50	0.54	0.78	0.91
Asses and mules	0.01	0.01	0.01	0.01	0.02	0.02
Swine	41.75	44.10	42.86	41.91	39.19	35.54
Rabbits	0.67	0.65	0.81	0.86	1.22	1.38
Chickens	2.85	3.05	3.74	3.83	3.00	2.95
Geese	0.28	0.30	0.37	0.37	0.29	0.29
Ducks	0.23	0.24	0.30	0.31	0.24	0.24
Turkeys	0.57	0.61	0.75	0.77	0.60	0.59
Categories	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**
Dairy cows	32.20	32.68	32.24	33.48	30.18	32.25
Other cattle	18.54	16.14	14.41	12.07	10.59	9.79
Sheep	3.50	3.61	3.91	4.27	3.59	3.90
Goats	0.15	0.18	0.21	0.25	0.22	0.29
Horses	1.19	1.37	1.60	2.01	1.92	2.42
Asses and mules	0.02	0.03	0.03	0.03	0.03	0.03
Swine	37.46	38.46	39.93	38.66	44.58	40.28
Rabbits	1.49	1.44	1.47	1.67	1.61	1.89
Chickens	3.95	4.43	4.50	5.48	5.28	6.65
Geese	0.39	0.43	0.44	0.54	0.52	0.65
Ducks	0.32	0.35	0.36	0.44	0.42	0.53
Turkeys	0.79	0.89	0.90	1.10	1.06	1.33

Categories	2001	2002	2003	2004	2005	1990–2005, %
Dairy cows	39.63	38.72	37.32	37.95	36.85	34.3
Other cattle	9.96	9.16	8.91	8.05	7.11	-67.5
Sheep	4.16	4.23	4.16	4.44	4.74	252.5
Goats	0.37	0.39	0.43	0.45	0.47	1981.9
Horses	3.05	3.31	3.32	3.58	3.54	805.1
Asses and mules	0.04	0.04	0.04	0.04	0.05	449.2
Swine	29.93	29.75	30.94	28.71	27.27	-38.2
Rabbits	1.99	2.39	2.36	2.76	3.41	427.6
Chickens	7.89	8.54	8.89	10.24	12.10	297.1
Geese	0.77	0.83	0.92	1.00	1.09	265.6
Ducks	0.63	0.71	0.73	0.82	0.95	288.0
Turkeys	1.58	1.93	1.97	1.94	2.42	297.5

By 2005, the share of such livestock categories as "other cattle" and "swine" decreased significantly in comparison with 1990, while the share of poultry and other livestock categories (dairy cows, sheep, goats, horses, asses and mules, rabbits) increased considerably.

6.3.1.6 Planned Improvements

As, 'cattle' and 'swine' livestock categories accounting for the largest share in the structure of total methane emissions originated from the 4B 'Manure Management' source category it is planned to continue activities focused on a further specifying of values for the main indices used to develop the country specific emission factors for respective animal categories following a Tier 2 method, also there are planned certain activities focused on updating the activity data set for the livestock breeding sector of the Republic of Moldova for the whole period under review.

6.3.2 Nitrous Oxide Emissions

6.3.2.1 Source Category Description

N_2O is produced, directly and indirectly, during the storage and treatment of manure before it is applied to land or otherwise used for feed, fuel, or construction purposes. The term 'manure' is used here collectively to include both dung and urine (i.e., the solids and the liquids) produced by livestock. The N_2O emissions generated by manure in the system 'Pasture, range, and paddock' occur directly and indirectly from the soil, and are therefore reported under the category 'N_2O Emissions from Agriculture Soils', while the emissions associated with the burning of dung for fuel are reported under the Energy Sector (1A 'Fuel Combustion').

Direct N_2O emissions occur via combined nitrification and denitrification of nitrogen contained in the manure. To be noted that nitrification is the aerobic oxidation of ammonia nitrogen (NH_4^+) to nitrate nitrogen (NO_3^-), while nitrites and nitrates are transformed to N_2O and dinitrogen (N_2) during the naturally occurring process of denitrification, that is an anaerobic process: $NO_3^- \rightarrow NO_2^- \rightarrow NO \rightarrow N_2O \rightarrow N_2$.

The direct emission of N_2O from manure during storage and treatment depends on the nitrogen and carbon content of manure, and on the duration of the storage and type of treatment within the animal waste management systems. It is considered that sufficient supply of oxygen to animal waste contributes to direct N_2O emissions. There is general agreement in the scientific literature that the ratio of N_2O to N_2 increases with increasing acidity, nitrate concentration, and reduced moisture. In summary, the production and emission of N_2O from managed manures requires the presence of either nitrites or nitrates in an anaerobic environment preceded by aerobic conditions necessary for the formation of these oxidized forms of nitrogen. In addition, conditions preventing reduction of nitrogen oxide (N_2O) to dinitrogen (N_2), such as a low pH or limited moisture, must be present.

Indirect emissions result from volatile nitrogen losses that occur primarily in the forms of ammonia (NH_3) and (NO_x). The fraction of excreted organic nitrogen that is mineralized to ammonia nitrogen during manure collection and storage depends primarily on time, and to a lesser degree temperature. Simple forms of organic nitrogen such as urea (mammals) and uric acid (poultry) are rapidly mineralized to ammonia nitrogen, which is highly volatile and easily diffused into the surrounding air. Nitrogen losses begin at the point of excretion in houses and other animal production areas (e.g., milk parlours) and continue through on-site management in storage and treatment systems (i.e., manure management systems). Nitrogen is also lost through runoff and leaching into soils from the solid storage of manure at outdoor areas, in feedlots and where animals are grazing in pastures.

Due to significant direct and indirect losses of manure nitrogen in management systems it is important to estimate the remaining amount of animal manure nitrogen available for application to soils or for use in feed, fuel, or construction purposes.

6.3.2.2 Methodological Issues and Data Sources

N_2O emissions from the 4B 'Manure Management' source category were estimated based on a Tier 2 methodology (IPCC, 2006). To estimate direct N_2O emissions from manure management it was necessary to collect information on the total livestock population (identical to those used for the 4.A 'Enteric Fermentation' source category), information on the amount of produced manure per head in a year, as well as information on manure management systems usage in the Republic of Moldova.

The following steps are used to estimate direct N_2O emissions from 4B “Manure Management”: collect livestock population data from the livestock population characterisation; develop the annual average nitrogen excretion rate per head ($Nex_{(T)}$) for each defined livestock species/category T; determine the fraction of total annual nitrogen excretion for each livestock species/category T that is managed in each manure management system *S* ($MS_{(T, S)}$); develop N_2O EFs for each manure management system *S* ($FE_{3\ (S)}$); for each manure management system type S, multiply the emission factor ($FE_{3\ (S)}$) by the total amount of nitrogen managed (from all livestock species/categories) in that system, to estimate N_2O emissions from that manure management system, then sum over all manure management systems.

The calculation of direct N_2O emissions from manure management is based on the following equation (2006 IPCC Guidelines, Volume 4, Chapter 10, Equation 10.25):

$$N_2O_{D(mm)} = [\Sigma_{(S)} [\Sigma_{(T)} (N_{(T)} \cdot Nex_{(T)} \cdot MS_{(T,S)})] \cdot FE_{3(S)}] \cdot 44/28$$

Where:

$N_2O_{D(mm)}$ = direct N_2O emissions from Manure Management in the country (kg N_2O/yr);

$N_{(T)}$ = number of head of livestock species/category *T* in the country;

$Nex_{(T)}$ = annual average N excretion per head of species/category *T* in the country (kg N/animal/yr);

$MS_{(T,S)}$ = fraction of total annual nitrogen excretion for each livestock species / category *T* that is managed in manure management system *S* in the country, dimensionless;

$FE_{3\ (S)}$ = emission factor for direct N_2O emissions from manure management system *S* in the country, (kg N_2O-N/kg N in manure management system *S*);

S = manure management system;

T = species/category of livestock.

44/28 = conversion of $(N_2O\text{-}N)_{(mm)}$ emissions to $N_2O_{(mm)}$ emissions.

The calculation of the average N excretion rates $Nex_{(T)}$ is based on the following equation (2006 IPCC Guidelines, Volume 4, Chapter 10, Equation 10.30):

$$Nex_{(T)} = N_{rate(T)} \cdot (TAM/1000) \cdot 365$$

Where:

$Nex_{(T)}$ = annual N excretion for livestock category *T*, (kg N/animal/yr);

$N_{rate\ (T)}$ = default N excretion rate, kg N (1000 kg animal mass)/day;

$TAM_{(T)}$ = typical animal mass for livestock category *T*, kg/animal/yr.

Based on information on the typical (average) weight of livestock and poultry in the Republic of Moldova and default values of nitrogen excretion rate (kg N/1000 kg of animal mass/yr) characteristic for Eastern European countries, country specific $Nex_{(T)}$ values were calculated (Table 6-42).

To be noted that where organic forms of bedding material (straw, sawdust, chippings, etc.) are used, the additional nitrogen from the bedding should also be considered as part of the managed manure N applied to soils. Based on information from scientific literature, country specific values on average annual N excretion ($N_{ex(T)}$) from manure were calculated following an alternative methodological approach (Table 6-43).

Table 6-42: Average Annual N Excretion and Amount of N in Organic Bedding per Typical Animal, under the ‘Solid Storage’ Manure Management System

Categories	$N_{rate\ (T)}$, kg N/1000 kg /day	TAM, weight, kg	TAM / 1000	$N_{ex\ (T)\ ANIMAL}$, kg N / head/yr	$N_{in\ bedding\ MS}$, kg N / head/yr	$N_{ex\ (T)\ TOTAL}$, kg N / head/yr
Dairy cows	0.35	550	0.5500	70.3	14.0	84.3
Other cattle	0.35	395	0.3950	50.5	8.0	58.5
Sheep	0.90	43	0.0430	14.1	1.0	15.1
Goats	1.28	35	0.0350	16.4	1.0	17.4
Horses	0.30	380	0.3800	41.6	14.0	55.6
Asses and mules	0.30	130	0.1300	14.2	6.0	20.2
Swine	0.74	70	0.0695	18.8	2.0	20.8
Fattening swine	0.55	50	0.0500	10.0	1.6	11.6
Market swine	0.46	180	0.1800	30.2	5.5	35.7
Rabbits	NA	3.0	0.0030	8.1	2.0	10.1
Chicken	0.82	1.8	0.0018	0.5	0.1	0.6
Geese	0.83	4.0	0.0040	1.2	0.1	1.3
Ducks	0.83	3.0	0.0030	0.9	0.1	1.0
Turkeys	0.74	7.0	0.0070	1.9	0.1	2.0

Reference: IPCC 2006 Guidelines, Volume 4, Chapter 10, Table 10.19, Page 10.59.

Table 6-43: Average Annual N Excretion for a Typical Animal, $Nex_{(T)}$ Calculated Based on Country Specific Data

Categories	Solid manure, kg/head /day	Liquid manure, kg/head /day	Straw bedding, kg/ head /day	Total manure with/ without bedding, kg/head/day	N content with / without bedding, kg/tone	$N_{ex(T)}$ with/without bedding kg N/head/yr
Cattle	25.0	12.0	5.0	42.0 / 37.0	5.6 / 4.6	85.8 / 62.1
Sheep	2.5	1.0	0.8	4.3 / 3.5	9.5 / 9.2	14.9 / 11.8
Horses	18.0	5.0	4.0	27.0 / 23.0	6.0 / 5.0	59.1 / 42.0
Swine	2.0	3.5	1.5	7.0 / 5.5	8.2 / 5.7	21.0 / 11.4
Poultry	0.1	0.0	0.1	0.2 / 0.1	16.3 / 22.3	1.2 / 0.8

Reference: Ungureanu, Cerbari et al., 2006; Bucataru, Cosman, Holban, 2006; Raileanu, Jolondcovschi et al., 2006; Andries, Rusu, et al., 2005; Bucataru, Maciuc, 2005; Toncea, 2004.

Although the average annual N excretion values $Nex_{(T)}$ were calculated by different methods, the obtain results are still comparable. As values featured in Table 6-43 are not available for all animal categories, $Nex_{(T)}$ values set forth in Table 6-42 were used to calculate the direct N_2O emissions from manure management in the RM.

Information on manure management systems usage is identical to that used earlier in sub-chapter 6.3.1. To be noted that the actual distribution of manure management systems in the RM does not comply with the default values for Eastern European countries (MS%) available in the Revised 1996 Guidelines (see Volume 3, Table 4-21, Page 4.101), so their use was deemed to be inappropriate.

To estimate direct N_2O emissions from the 4B 'Manure Management' source category there were used country specific information on the manure management systems usage in the RM (for cattle and swine the respective values are set forth in Table 6-37, while for other animal and poultry categories, respectively into the Table 6-44).

Table 6-44: Manure Management Systems (MS%) Usage in the Republic of Moldova for Other Animal Categories

Categories	Liquid Systems	Solid Storage	Pasture, Range and Paddock
Sheep	0	60	40
Goats	0	60	40
Horses, Asses & Mules	0	90	10
Rabbits	0	100	0
Poultry	15	80	5

A *good practice* is to estimate emissions from manure management systems keeping account of duration of the storage and type of treatment. While identifying types of treatment, account should be taken of temperature and aeration. As it was not possible to use country specific EFs, the default values provided into the 2006 IPCC Guidelines were used in the RM (Table 6-45).

A significant portion of the total amount of nitrogen excreted by livestock in different manure management systems (except pasture, range and paddock), is lost before being applied to lands. Therefore, in order to estimate the amount of nitrogen in manure which is applied to managed soils, it is necessary to omit nitrogen losses occurring through volatilization (NH_3, NO_x), as well as runoffs and leaching from the total amount of nitrogen excreted by livestock in different manure management systems.

Indirect N_2O emissions from the source category 4B 'Manure Management' were estimated by using a Tier 1 methodology (IPCC, 2006). Indirect N_2O emissions ($N_2O_{G(mm)}$) from volatilization of N in forms of NH_3 and NO_x were estimated by using the following equation (2006 IPCC Guidelines, Volume 4, Chapter 10, Equations 10.26 and 10.27):

$$N_2O_{G(mm)} = [\, \Sigma_{(S)} [\Sigma_{(T)} (N_{(T)} \cdot Nex_{(T)} \cdot MS_{(T,S)}) \cdot (Frac_{GasMS}/100)_{(T,S)} \,] \cdot FE_4 \cdot 44/28$$

Where:

$N_2O_{G(mm)}$ = indirect N_2O emissions due to volatilization of N from Manure Management in the country (kg N_2O/yr);

$N_{(T)}$ = number of head of livestock species/category *T* in the country;

$Nex_{(T)}$ = annual average N excretion per head of species/category *T* in the country (kg N/animal/yr);

$MS_{(T,S)}$ = fraction of total annual nitrogen excretion for each livestock species/category *T* that is managed in manure management system *S* in the country, dimensionless;

$Frac_{GasMS}$ = percent of managed manure nitrogen for livestock category *T* that volatilizes as NH_3 and NO_x in the manure management system *S*, percent (see in Table 6-46);

FE_4 = emission factor for N_2O emissions from atmospheric deposition of nitrogen on soils and water surfaces, kg N_2O-N/kg NH_3-N+NO_x-N volatilized;

S =manure management system;

T = species/category of livestock.

44/28 = conversion of (N_2O-N)(mm) emissions to N_2O (mm) emissions.

Table 6-45: Default EFs for Direct N_2O Emissions from Manure Management

Manure Management System		FE_3, kg N_2O-N / kg N excreted	Uncertainty ranges of FE_3
Pasture/Range/Paddock: The manure from pasture and range grazing animals is allowed to lie as is, and is not managed. Direct and indirect N_2O emissions associated with the manure deposited on agricultural soils and pasture, range, paddock systems are treated in 'N_2O from agricultural soils'	cattle, swine, poultry	0.020	0.007-0.06
	sheep, goats, horses, asses and mules	0.010	0.003-0.03
Solid Storage: The storage of manure, typically for a period of several months, in unconfined piles or stacks. Manure is able to be stacked due to the presence of a sufficient amount of bedding material or loss of moisture by evaporation		0.005	Factor of 2
Dry lot: A paved or unpaved open confinement area without any significant vegetative cover where accumulating manure may be removed periodically. Dry lots are most typically found in dry climates but also are used in humid climates		0.020	Factor of 2
Liquid/Slurry: Manure is stored as excreted. Liquid may be stored for a long time (months) with some minimal addition of water to facilitate handling and is stored in either tanks or earthen ponds Emissions are considered to be insignificant due to absence of oxidized forms of nitrogen, combined with the low nitrification and denitrification potential in this manure management system	With natural crust cover	0.005	Factor of 2
	Without natural crust cover	0.000	Not applicable
Pit storage below animal confinements: Collection and storage of manure usually with little or no added water typically below a slatted floor in an enclosed animal confinement facility		0.002	Factor of 2
Cattle and swine deep bedding: As manure accumulates, bedding is continually added to absorb moisture over a production cycle and possibly for as long as 6 to 12 months. This manure management system also is known as a bedded pack manure management system and may be combined with a dry lot or pasture	No mixing	0.010	Factor of 2
	Active mixing	0.070	Factor of 2
Composting - In-Vessel: Composting, typically in an enclosed channel, with forced aeration and continuous mixing		0.006	Factor of 2
Composting - Static Pile: Composting in piles with forced aeration but no mixing		0.006	Factor of 2
Composting – Intensive Windrow: Composting in windrows with regular turning for mixing and aeration		0.100	Factor of 2
Composting – Passive Windrow: Composting in windrows with infrequent turning for mixing and aeration		0.010	Factor of 2
Poultry manure with litter: Manure is excreted on floor with bedding, birds walk on manure		0.001	Factor of 2
Poultry manure without bedding: Manure is excreted on floor without bedding, birds do not walk on manure		0.001	Factor of 2
Aerobic treatment: The biological oxidation of manure collected as a liquid with either forced or natural aeration. Natural aeration is limited to aerobic and facultative ponds and wetland systems and is due primarily to photosynthesis. Hence, these systems typically become anoxic during periods without sunlight. Nitrification-denitrification is used widely for the removal of nitrogen in the biological treatment of municipal and industrial wastewaters with negligible N_2O emissions. Limited oxidation may increase emissions compared to forced aeration systems.	Natural aeration systems	0.010	Factor of 2
	Forced aeration systems	0.005	Factor of 2

Indirect N_2O emissions ($N_2O_{\ L(mm)}$) from leaching into soils and/or runoff during solid storage of manure at outdoor areas or in feedlots were estimated by using the following equation (2006 IPCC Guidelines, Volume 4, Chapter 10, Equations 10.28 and 10.29):

$$N_2O_{L(mm)} = [\ \Sigma_{(S)} [\Sigma_{(T)} (N_{(T)} \cdot Nex_{(T)} \cdot MS_{(T,S)}) \cdot (Frac_{\ leach\ MS}/100)_{(T,S)}\ ]\ FE_5 \bullet 44/28$$

Where:

$N_2O_{\ L(mm)}$ = indirect N_2O emissions due to leaching and runoff from manure management in the country (kg N_2O/yr);

$N_{(T)}$ = number of head of livestock species/category *T* in the country;

$Nex_{\ (T)}$ = annual average N excretion per head of species/category *T* in the country (kg N/animal/yr);

$MS_{\ (T,S)}$ = fraction of total annual nitrogen excretion for each livestock species/category *T* that is managed in manure management system *S* in the country, dimensionless;

$Frac_{\ leach\ MS}$ = percent of managed manure nitrogen losses for livestock category *T* due to runoff and leaching during solid and liquid storage of manure (typical range 1-20 percent);

FE_5 = emission factor for N_2O emissions from nitrogen leaching and runoff, kg N_2O-N/kg N leaching/runoff (default: 0.0075 kg N_2O-N/kg N leaching/runoff);

S = manure management system;

T = species/category of livestock;

44/28 = conversion of (N_2O-N) $_{L(mm)}$ emissions to $N_2O_{\ L(mm)}$ emissions.

Table 6-46: Default Values for Nitrogen Loss due to Volatilization of NH_3 and NO_x from Manure Management *S*, percent

Categories	Manure Management System (MMS)	N loss from MMS due to volatilization of N-NH_3 and N-NOx (%) $Frac_{GasMS}$ (Range of $Frac_{GasMS}$)
Dairy Cow	Anaerobic lagoon	35% (20-80)
	Liquid/slurry	40% (15-45)
	Pit storage	28% (10-40)
	Dry lot	20% (10-35)
	Solid storage	30% (10-40)
	Daily spread	7% (5-60)
Other Cattle	Dry lot	30% (20-50)
	Solid storage	45% (10-65)
	Deep bedding	30% (20-40)
Swine	Anaerobic lagoon	40% (25-75)
	Pit storage	25% (15-30)
	Deep bedding	40% (10-60)
	Liquid/slurry	48% (15-60)
	Solid storage	45% (10-65)
Sheep, Goats, Horses, Asses & Mules	Deep bedding	25% (10-30)
	Solid storage	12% (5-20)
Poultry	Poultry without litter	55% (40-70)
	Anaerobic lagoon	40% (25-75)
	Poultry with litter	40% (10-60)

From scientific speciality literature it is known that in drier climates, runoff losses are smaller than in high rainfall areas and have been estimated in the range of 3 to 6 per cent of N excreted (Eghball and Power, 1994). Studies by Biermann et al. (1999) found nitrogen lost in runoff was 5 to 19 percent of N excreted and 10 to 16 percent leached into soil, while other data show relatively low loss of nitrogen through leaching in solid storage (less than 5 percent of N excreted) but greater loss could also occur (Rotz, 2004).

Table 6-47 presents default values for total nitrogen losses from manure management systems. These default values include losses that occur from the point of excretion, including animal housing losses, manure storage losses, and losses from leaching and runoff at the manure storage system where applicable.

There is a high level of variability in the range of total nitrogen losses from manure management systems. The majority of these are due to volatilization losses, primarily ammonia losses that occur rapidly following excretion of the manure. Losses also occur in the form of NO_3, N_2O, and N_2 as well from leaching and runoff that occurs where manure is stored in piles. The values in Table 6-47 reflect average values for typical housing/storage combinations for each animal category.

Table 6-47: Default Values for Total Nitrogen Loss from Manure Management *S*, percent

Animal Categories	Manure Management System (MMS	Total N loss from MMS (%), $Frac_{LossMS}$ (Range of $Frac_{LossMS}$)
Dairy Cow	Anaerobic lagoon	77% (55-99)
	Liquid/slurry	40% (15-45)
	Pit storage	28% (10-40)
	Dry lot	30% (10-35)
	Solid storage	40% (10-65)
	Daily spread	22% (15-60)
Other Cattle	Dry lot	40% (20-50)
	Solid storage	50% (20-70)
	Deep bedding	40% (10-50)
Swine	Anaerobic lagoon	78% (55-99)
	Pit storage	25% (15-30)
	Deep bedding	50% (10-60)
	Liquid/slurry	48% (15-60)
	Solid storage	50% (20-70)
Sheep, Goats, Horses, Asses & Mules	Deep bedding	35% (15-40)
	Solid storage	15% (5-20)
Poultry	Poultry without litter	55% (40-70)
	Anaerobic lagoon	77% (50-99)
	Poultry with litter	50% (20-80)

Following storage or treatment in any system of manure management, nearly all the manure is applied to land. The N_2O emissions that subsequently arise from application of the manure to soil should be reported under the category 4D 'Agricultural Soils'. In estimating N_2O emissions from managed soils, the amount of animal manure nitrogen that is directly applied to soils, or available for use in feed, or construction purposes, should be considered.

A significant proportion of the total nitrogen excreted by animals in managed systems (i.e., all livestock except those in pasture and grazing conditions) is lost prior to final application to managed soils. In order to estimate the amount of animal manure nitrogen that is directly applied to soils it is necessary to reduce the total amount of nitrogen excreted by animals in managed systems by the losses of N through volatilisation (i.e., NH_3, N_2 and NO_x), conversion to N_2O and losses through leaching and runoff.

Where organic forms of bedding material (straw, sawdust, chippings, etc.) are used, the additional nitrogen It should be noted, however, that since mineralization of nitrogen compounds in beddings occurs more slowly compared to manure and the concentration of ammonia fraction in organic beddings is negligible, both volatilisation and leaching losses during storage of bedding are assumed to be zero.

The estimate of managed manure N available for application to managed soils was based on the following equation (2006 IPCC Guidelines, Volume 4, Chapter 10, Equation 10.34):

$N_{MMS\_Avb} = \Sigma_{(S)} \{\Sigma_{(T)} [(N_{(T)} \cdot Nex_{(T)} \cdot MS_{(T, S)}) \cdot (1\text{-}Frac_{leach\ MS} /100)] + [N_{(T)}\ Nex_{(T)}\ N_{bending\ MS}]\}$

Where:

N_{MMS_Avb} = amount of managed manure nitrogen available for application to managed soils or for feed, fuel, or construction purposes, (kg N/yr);

$N_{(T)}$ =number of head of livestock species/category *T* in the country;

$Nex_{(T)}$ = annual average N excretion per animal of species/category *T* in the country (kg N/animal/yr);

$MS_{(T, S)}$ = fraction of total annual nitrogen excretion for each livestock species/category *T* that is managed in manure management system *S* in the country, dimensionless;

$Frac_{Loss\ MS}$ = amount of managed manure nitrogen for livestock category *T* that is lost in the manure management system *S*, percent;

$N_{bedding\ MS}$ = amount of nitrogen from bedding (to be applied for solid storage and deep bedding MMS if known organic bedding usage), kg N/animal/year; limited data from scientific literature indicates the amount of nitrogen contained in organic bedding material applied for dairy cows and heifers is usually around 7 kg N/animal/year, for other cattle is 4 kg N/animal/year, for market and breeding swine is around 0.8 and 5.5 kg N/animal/year, respectively; for deep bedding systems, the amount of N in litter is approximately double these amounts (Webb, 2001; Döhler *et al.*, 2002); cited from 2006 IPCC Guidelines);

S = manure management system;

T = species/category of livestock.

6.3.2.3 Uncertainties and Time-Series Consistency

Uncertainties related to estimation of N_2O emissions from 4B 'Manure Management' source category, depend on the accuracy of the livestock characterisation, and also on the default emission factors used. The uncertainties associated with the total animal population in the Republic of Moldova are higher than it is officially acknowledged (±10 percent for cattle, sheep, goats, horses, swine, and up to ±20 percent for rabbits, asses and mules). It is quite likely that the reported data collected from current statistical reports are erroneous; in particular keeping in mind that seasonal variation in total animal population is not taken into account. Uncertainty ranges for the default N excretion rates are estimated at about ±50 percent. Uncertainties associated with the default emission factors for direct N_2O emissions from manure management are also large (-50 percent to +100 percent). Uncertainties associated with the default emission factors for indirect N_2O emissions from manure management, in particular, uncertainties related to default values for nitrogen loss due to volatilization of NH_3 and NO_x and total nitrogen loss from manure management are very high. The uncertainty associated with default emission factors for nitrogen volatilization and re-deposition (EF_4), as well as for leaching and runoff (EF_5), are also quite high, from -100 percent, to +200 percent.

So, combined uncertainties associated with direct N_2O emissions from manure management can be considered medium for cattle, sheep and swine (±50.99 percent), as well as for poultry (±53.85 percent), and high for other animal categories (±75.66 percent for goats, horses, and respectively ±77.62 percent for rabbits, asses and mules). At the same time, combined uncertainties, presented as a percent of total sectoral emissions were estimated at ±4.04 percent for cattle, ±1.66 percent for sheep, ±0.41 percent for goats, ±0.99 percent for horses, ±0.009 percent for asses and mules, ±1.71 percent for swine, ±2.56 percent for poultry and ±0.69 percent for rabbits. Uncertainties introduced in trend in sectoral emissions were estimated at ±0.48 percent for cattle, ±0.31 percent for sheep, ±0.15 percent for goats, ±0.31 percent for horses, ±0.002 percent for asses and mules, ±0.52 percent for swine, ±0.68 percent for poultry and ±0.19 percent for rabbits (Annex 7-3.4).

Combined uncertainties associated with indirect N_2O emissions from manure management can be considered high for cattle, sheep and swine (±100.50 percent), as well as for poultry (±101.98 percent), and very high for other animal categories (±150.33 percent for goats, horses, and respectively ±151.33 percent for rabbits, asses and mules). At the same time, combined uncertainties, presented as a percent of total sectoral emissions were estimated at ±1.53 percent for cattle, ±0.53 percent for sheep, ±0.13 percent for goats, ±0.32 percent for horses, ±0.003 percent for asses and mules, ±0.81 percent for swine, ±1.24 percent for poultry and ±0.22 percent for rabbits. Uncertainties introduced in trend in sectoral emissions were estimated at ±0.21 percent for cattle, ±0.09 percent for sheep, ±0.05 percent for goats, ±0.10 percent for horses, ±0.001 percent for asses and mules, ±0.31 percent for swine, ±0.25 percent for poultry and ±0.05 percent for rabbits (Annex 7-3.4).

In view of ensuring time-series consistency of the obtained results, the same approach was used for the entire period under review, in conformity with the recommendations included in the Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories (IPCC, 2000).

6.3.2.4 QA/QC and Verification

Standard verification and quality control forms and checklists were filled in for the respective category under the Agriculture Sector, following the Tier 1 and Tier 2 approaches (see in Annex 6). Also, the AD and methods used for estimating N_2O emissions under the category 4B 'Manure Management' were documented and archived both in hard copies and electronically. For identifying the data entry and emission estimation process related errors there were applied verifications and quality control procedures. Verification was focused on correct use of AD obtained from different sources of reference (i.e., Statistical Yearbooks of the RM and ATULBD, National Bureau of Statistics and FAO Database), as well as on ensuring correct use of the default emission factors available in the 2006 IPCC Guidelines for National Greenhouse Gas Inventories. Inventory quality assurance activities for N_2O emissions from manure management were supported by an expert representing the Agribusiness and Rural Development Management Institute.

Following the recommendations included into the Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories (IPCC, 2000), N_2O emissions originated from the 4B 'Manure Management' were estimated based on AD and EFs from official sources of reference.

6.3.2.5 Recalculations

Estimations of N_2O emissions from the category 4B 'Manure Management' were not recalculated as these emissions were not estimated within the FNC of the RM under the UNFCCC (2000). The obtained results allow assert that within the 1990-2005 time series (for the Republic of Moldova the 1990 is the reference year under the UNFCCC, while emissions for 1989 year are presented here for comparison purposes) direct N_2O emissions from 4B 'Manure Management' source category decreased by 55.9 percent (Table 6-48), in particular due to reduced animal population, but also due to changes in the share of animal waste management systems in the livestock breeding sector of the RM. To be noted that at present, circa 94 percent of the total cattle population, 90 percent of the swine population, 96 percent of the total sheep, goats and horses population and 88 percent of poultry population is concentrated in the private sector; thus the share of liquid/slurry manure management systems has become smaller, while the share of the solid storage systems increased.

The N_2O emissions from volatilization of ammonia and nitrogen oxides, as well as N_2O emissions from leaching and runoff of nitrogen, demonstrated that over the period from 1990 through 2005, total indirect N_2O emissions from the 4B 'Manure Management' source category have decreased by 61.6 percent (Table 6-49).

Table 6-50 below presents the total amounts of N generated by all manure management systems, as well as the amounts of N from animal waste available for application to managed soils in the Republic of Moldova, estimated in conformity with the methodology set forth in the IPCC 2006 Guidelines.

Table 6-48: Direct $N_2O_{D(mm)}$ Emissions from the 4B 'Manure Management' Source Category in the Republic of Moldova within 1989-2005 time series, Gg

Emissions	1989	1990	1991	1992	1993	1994
N_2O_D dairy cows	0.6782	0.6617	0.6458	0.6491	0.5935	0.6490
N_2O_D other cattle	0.8559	0.8452	0.7875	0.7136	0.5916	0.5670
N_2O_D sheep	0.3382	0.3472	0.3310	0.3295	0.3332	0.3633
N_2O_D goats	0.0096	0.0099	0.0114	0.0153	0.0241	0.0232
N_2O_D horses	0.0541	0.0545	0.0553	0.0571	0.0605	0.0673
N_2O_D asses and mules	0.0008	0.0008	0.0008	0.0007	0.0008	0.0009
N_2O_D swine	0.9065	0.9908	0.9127	0.8649	0.6584	0.5447
N_2O_D rabbits	0.0636	0.0634	0.0636	0.0639	0.0662	0.0713
N_2O_D chickens	0.2253	0.2468	0.2431	0.2341	0.1350	0.1264
N_2O_D geese	0.0852	0.0934	0.0919	0.0886	0.0511	0.0478
N_2O_D ducks	0.0523	0.0573	0.0564	0.0543	0.0313	0.0293
N_2O_D turkeys	0.0571	0.0625	0.0616	0.0593	0.0342	0.0320
Total $N_2O_{D(mm)}$	3.3268	3.4334	3.2613	3.1303	2.5800	2.5221
Emissions	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**
N_2O_D dairy cows	0.6465	0.6127	0.5722	0.5174	0.5081	0.5002
N_2O_D other cattle	0.5084	0.4116	0.3433	0.2672	0.2539	0.2096
N_2O_D sheep	0.3751	0.3531	0.3387	0.3028	0.2794	0.2534
N_2O_D goats	0.0282	0.0294	0.0303	0.0297	0.0297	0.0317
N_2O_D horses	0.0685	0.0722	0.0746	0.0770	0.0806	0.0847
N_2O_D asses and mules	0.0009	0.0010	0.0010	0.0009	0.0008	0.0007
N_2O_D swine	0.5350	0.5184	0.4853	0.4146	0.4825	0.3973
N_2O_D rabbits	0.0604	0.0533	0.0483	0.0450	0.0473	0.0465
N_2O_D chickens	0.1327	0.1357	0.1220	0.1220	0.1288	0.1355
N_2O_D geese	0.0502	0.0513	0.0462	0.0462	0.0487	0.0513
N_2O_D ducks	0.0308	0.0315	0.0283	0.0283	0.0299	0.0315
N_2O_D turkeys	0.0336	0.0344	0.0309	0.0309	0.0326	0.0343
Total $N_2O_{D(mm)}$	2.4704	2.3046	2.1212	1.8819	1.9223	1.7768
Emissions	**2001**	**2002**	**2003**	**2004**	**2005**	**1990 - 2005, %**
N_2O_D dairy cows	0.4862	0.4943	0.5012	0.4568	0.4102	-38.0
N_2O_D other cattle	0.1757	0.1843	0.1805	0.1600	0.1343	-84.1
N_2O_D sheep	0.2262	0.2279	0.2258	0.2219	0.2229	-35.8
N_2O_D goats	0.0345	0.0354	0.0400	0.0382	0.0375	279.1
N_2O_D horses	0.0894	0.0960	0.0972	0.0965	0.0898	64.8
N_2O_D asses and mules	0.0008	0.0008	0.0008	0.0008	0.0008	0.0
N_2O_D swine	0.2605	0.2630	0.2958	0.2605	0.2308	-76.7
N_2O_D rabbits	0.0411	0.0487	0.0485	0.0523	0.0609	-3.9
N_2O_D chickens	0.1345	0.1441	0.1512	0.1604	0.1784	-27.7
N_2O_D geese	0.0509	0.0541	0.0605	0.0605	0.0621	-33.4
N_2O_D ducks	0.0312	0.0347	0.0361	0.0371	0.0405	-29.4
N_2O_D turkeys	0.0341	0.0413	0.0425	0.0385	0.0452	-27.6
Total $N_2O_{D(mm)}$	1.5650	1.6247	1.6800	1.5835	1.5134	-55.9

Table 6-49: Indirect $N_2O_{IND(mm)}$ Emissions from 4B 'Manure Management' Source Category in the Republic of Moldova within 1989-2005 time series, Gg

Em issions	1989	1990	1991	1992	1993	1994
N_2O_{IND} dairy cows	0.1522	0.1485	0.1425	0.1432	0.1262	0.1380
N_2O_{IND} other cattle	0.1954	0.1930	0.1768	0.1602	0.1268	0.1215
N_2O_{IND} sheep	0.0550	0.0564	0.0538	0.0535	0.0541	0.0590
N_2O_{IND} goats	0.0016	0.0016	0.0019	0.0025	0.0039	0.0038
N_2O_{IND} horses	0.0088	0.0089	0.0090	0.0093	0.0098	0.0109
N_2O_{IND} asses and mules	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
N_2O_{IND} swine	0.2475	0.2705	0.2442	0.2314	0.1727	0.1429
N_2O_{IND} rabbits	0.0103	0.0103	0.0103	0.0104	0.0108	0.0116
N_2O_{IND} chick-ens	0.0592	0.0648	0.0638	0.0615	0.0355	0.0332
N_2O_{IND} geese	0.0202	0.0222	0.0218	0.0210	0.0121	0.0114
N_2O_{IND} ducks	0.0124	0.0136	0.0134	0.0129	0.0074	0.0070
N_2O_{IND} turkeys	0.0150	0.0164	0.0162	0.0156	0.0090	0.0084
Total $N_2O_{IND (mm)}$	0.7778	0.8064	0.7539	0.7216	0.5686	0.5478
Emissions	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**
N_2O_{IND} dairy cows	0.1307	0.1239	0.1157	0.1025	0.1007	0.0969
N_2O_{IND} other cattle	0.1058	0.0856	0.0714	0.0539	0.0512	0.0414
N_2O_{IND} sheep	0.0610	0.0574	0.0550	0.0492	0.0454	0.0412
N_2O_{IND} goats	0.0046	0.0048	0.0049	0.0048	0.0048	0.0051
N_2O_{IND} horses	0.0111	0.0117	0.0121	0.0125	0.0131	0.0138
N_2O_{IND} asses and mules	0.0002	0.0002	0.0002	0.0001	0.0001	0.0001
N_2O_{IND} swine	0.1377	0.1334	0.1249	0.1047	0.1218	0.0984
N_2O_{IND} rabbits	0.0098	0.0087	0.0079	0.0073	0.0077	0.0076
N_2O_{IND} chick-ens	0.0349	0.0356	0.0321	0.0321	0.0338	0.0356
N_2O_{IND} geese	0.0119	0.0122	0.0110	0.0110	0.0116	0.0122
N_2O_{IND} ducks	0.0073	0.0075	0.0067	0.0067	0.0071	0.0075
N_2O_{IND} turkeys	0.0088	0.0090	0.0081	0.0081	0.0086	0.0090
Total $N_2O_{IND (mm)}$	0.5238	0.4900	0.4500	0.3929	0.4059	0.3688

Emissions	2001	2002	2003	2004	2005	1990 - 2005, %
N_2O_{IND} dairy cows	0.0942	0.0947	0.0960	0.0875	0.0786	-47.1
N_2O_{IND} other cattle	0.0347	0.0357	0.0349	0.0306	0.0257	-86.7
N_2O_{IND} sheep	0.0368	0.0370	0.0367	0.0361	0.0362	-35.8
N_2O_{IND} goats	0.0056	0.0058	0.0065	0.0062	0.0061	279.1
N_2O_{IND} horses	0.0145	0.0156	0.0158	0.0157	0.0146	64.8
N_2O_{IND} asses and mules	0.0001	0.0001	0.0001	0.0001	0.0001	0.0
N_2O_{IND} swine	0.0645	0.0640	0.0719	0.0622	0.0551	-79.6
N_2O_{IND} rabbits	0.0067	0.0079	0.0079	0.0085	0.0099	-3.9
N_2O_{IND} chick-ens	0.0353	0.0378	0.0397	0.0421	0.0469	-27.7
N_2O_{IND} geese	0.0121	0.0128	0.0144	0.0144	0.0148	-33.4
N_2O_{IND} ducks	0.0074	0.0082	0.0086	0.0088	0.0096	-29.4
N_2O_{IND} turkeys	0.0089	0.0108	0.0112	0.0101	0.0119	-27.6
Total $N_2O_{IND (mm)}$	0.3209	0.3306	0.3437	0.3224	0.3095	-61.6

To be noted that over the period under review the share of different animals in the structure of total amount of managed manure N available for application to managed soils changed significantly (account of these data is taken in estimating N_2O emissions from managed soils). In comparison with 1990 year, by 2005 the share of certain animal categories as 'other cattle' and 'swine' decreased, while the share of 'other animal' categories increased considerably (Table 6-51).

Table 6-50: Amount of Managed Manure N Available for Application to Managed Soils

	1989	1990	1991	1992	1993	1994
$Nex_{(T)}$, t N/yr	138 450.0	142 548.7	135 170.5	129 902.5	108 430.8	106 891.4
N_{MMS_Avb}, t N/yr	83 234.6	85 381.0	80 379.4	77 179.4	63 292.8	62 430.3
	1995	**1996**	**1997**	**1998**	**1999**	**2000**
$Nex_{(T)}$, t N/yr	104 615.9	97 400.8	89 764.0	79 409.1	80 312.9	73 566.1
N_{MMS_Avb}, t N/yr	59 959.2	55 756.3	51 305.8	45 071.8	45 802.8	42 140.8
	2001	**2002**	**2003**	**2004**	**2005**	**1990-2005, %**
$Nex_{(T)}$, t N/yr	65 292.8	67 170.2	69 200.6	65 030.9	62 118.0	-56.4
N_{MMS_Avb}, t N/yr	37 522.3	38 732.9	39 888.7	37 539.7	35 784.3	-58.1

Table 6-51: Contribution of Different Animal Categories into the Total Amount of Managed Manure N Available for Application to Managed Soils within 1989-2005, %

Categories	1989	1990	1991	1992	1993	1994
Dairy cows	23.2	22.1	22.6	23.7	25.8	28.6
Other cattle	28.4	27.3	26.7	25.2	24.7	24.0
Sheep	9.3	9.3	9.4	9.8	12.1	13.3
Goats	0.3	0.3	0.3	0.4	0.9	0.8
Horses	2.0	2.0	2.2	2.3	3.0	3.4
Asses and mules	0.0	0.0	0.0	0.0	0.0	0.0
Swine	24.1	25.6	24.7	24.4	22.3	18.7
Rabbits	2.2	2.1	2.3	2.4	3.0	3.3
Chickens	6.1	6.5	6.8	6.9	4.8	4.6
Geese	1.9	2.0	2.1	2.1	1.5	1.4
Ducks	1.2	1.3	1.4	1.4	1.0	0.9
Turkeys	1.2	1.3	1.4	1.4	1.0	0.9
Categories	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**
Dairy cows	28.7	29.3	29.7	30.2	29.2	30.8
Other cattle	21.9	19.1	17.3	15.0	14.1	12.4
Sheep	14.4	14.5	15.1	15.4	14.0	13.8
Goats	1.1	1.2	1.3	1.5	1.5	1.7
Horses	3.6	4.1	4.6	5.4	5.5	6.3
Asses and mules	0.1	0.1	0.1	0.1	0.1	0.1
Swine	18.8	19.6	20.0	19.1	21.9	19.3
Rabbits	2.9	2.7	2.7	2.8	2.9	3.1
Chickens	5.0	5.5	5.4	6.1	6.3	7.3
Geese	1.6	1.7	1.7	1.9	2.0	2.3
Ducks	1.0	1.1	1.1	1.2	1.3	1.5
Turkeys	1.0	1.1	1.1	1.2	1.3	1.5
Categories	**2001**	**2002**	**2003**	**2004**	**2005**	**1990-2005, %**
Dairy cows	33.6	32.9	32.4	31.4	29.5	33.7
Other cattle	11.7	11.7	11.2	10.4	9.2	-66.4
Sheep	13.8	13.5	13.0	13.6	14.3	53.2
Goats	2.1	2.1	2.3	2.3	2.4	804.4
Horses	7.5	7.8	7.6	8.1	7.9	293.2
Asses and mules	0.1	0.1	0.1	0.1	0.1	138.6
Swine	14.2	13.7	15.0	13.8	12.8	-49.9
Rabbits	3.1	3.6	3.5	4.0	4.9	129.2
Chickens	8.1	8.4	8.6	9.6	11.3	72.5
Geese	2.5	2.6	2.8	3.0	3.2	58.8
Ducks	1.6	1.7	1.8	1.9	2.2	68.6
Turkeys	1.6	1.9	1.9	1.9	2.3	72.7

6.3.2.6 Planned Improvements

Category 4B 'Manure Management' is a relevant source of N_2O emissions in the Republic of Moldova. Following the *good practices*, the direct N_2O emissions from manure management (key sources in the RM) were estimated by using a simplified Tier 2 methodology (the indirect N_2O emissions were estimated based on a Tier 1 methodology). For the next inventory cycle the possibility to collect additional data, coefficients, parameters and other relevant information, in particular on country specific manure management systems, will be considered, aiming at improving the general inventory quality and for reducing inventory uncertainties.

6.4 Agricultural Soils (Category 4D)

Direct and indirect N_2O emissions are monitored under the 4D 'Agricultural Soils' category. The following nitrogen sources are included in the methodology for estimating direct N_2O emissions from managed soils: synthetic N fertilisers; organic N applied as fertiliser; urine and dung N deposited on pasture, range and paddock by grazing animals; N in crop residues (above-ground and below-ground), including from N-fixing crops and from forages during pasture renewal; N mineralization associated with loss of soil organic matter resulting from change of land use or management of mineral soils; and drainage/management of organic soils.

Direct N_2O emissions from managed soils were estimated by using the following equation (2006 IPCC Guidelines, Volume 4, Chapter 11, Equations 11.1 and 11.2):

$$N_2O_{direct} = N_2O_{(SN)} + N_2O_{(ON)} + N_2O_{(PRP)} + N_2O_{(CR)} + N_2O_{(SOM)}$$

Where:

$N_2O_{(SN)}$ = annual N_2O emissions from the amount of synthetic fertilizer N applied to soils; Gg/yr;

$N_2O_{(ON)}$ = annual N_2O emissions from the amount of animal manure, compost, sewage sludge and other organic N additions applied to soils, Gg/yr;

$N_2O_{(PRP)}$ = annual N_2O emissions from urine and dung inputs to grazed soils, Gg/yr;

$N_2O_{(CR)}$ = annual N_2O emissions from the amount of N in crop residues (above-ground and below-ground), including N-fixing crops and from forages during pasture renewal, returned to soils, Gg/yr;

$N_2O_{(SOM)}$ = annual N_2O emissions from the amount of N in mineral soils that is mineralized, in association with loss of soil organic matter resulting from change of land use or management of mineral soils, Gg/yr.

To be noted, that within the 1990-2005 time series, direct N_2O emissions from 4D 'Agriculture Soils' category decreased by 57.5 percent (Figure 6-3).

The contribution of different emission sources in the structure of total direct N_2O emissions has changed significantly between 1990 and 2005 time series. So, the share of $N_2O_{(SN)}$ and $N_2O_{(ON)}$ emissions has decreased significantly, by 56.8 percent and respectively, by 98.9 percent, while the share of $N_2O_{(CR)}$, $N_2O_{(PRP)}$ and $N_2O_{(SOM)}$ emissions increased by 13.7 percent, 79.7 percent and respectively 149.1 percent (Table 6-52).

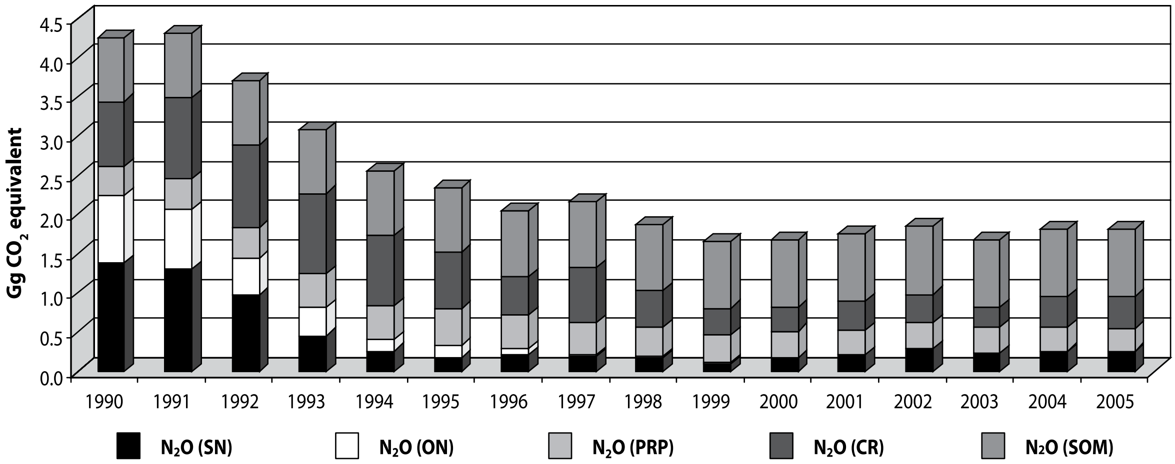

Figure 6-3: Direct N_2O emissions from the 4D 'Agricultural Soils', 1990-2005

Table 6-52: Breakdown of the Direct N_2O Emissions from 4D 'Agriculture Soils' by Source within 1990-2005, %

	1990	1991	1992	1993	1994	1995	1996	1997
N_2O_{SN}	32.4	30.2	26.2	14.6	10.0	7.0	10.1	8.3
N_2O_{ON}	20.1	17.6	12.6	12.0	5.6	6.7	3.9	1.4
N_2O_{PRP}	8.8	9.3	10.5	13.5	16.9	20.3	21.3	18.5
N_2O_{CR}	19.5	24.0	28.5	33.4	35.3	30.5	23.8	32.7
N_2O_{SOM}	19.1	18.9	22.1	26.5	32.3	35.5	40.9	39.1
	1998	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**
N_2O_{SN}	8.5	5.6	9.6	11.4	15.3	13.7	13.9	14.0
N_2O_{ON}	1.1	0.6	0.4	0.5	0.3	0.2	0.2	0.2
N_2O_{PRP}	20.1	21.9	20.3	18.2	17.7	19.7	17.0	15.9
N_2O_{CR}	24.9	20.4	18.5	20.7	19.8	14.8	21.2	22.2
N_2O_{SOM}	45.4	51.5	51.1	49.3	46.9	51.6	47.7	47.6

In addition to the direct emissions of N_2O from managed soils that occur through a direct pathway (i.e., directly from the soils to which N is applied), emissions of N_2O also take place through two indirect pathways: the first is the volatilisation of N as NH_3 and oxides of nitrogen (NO_x), and the deposition of these gases and their products NH_4^+ and NO_3^- onto soils and the surface of lakes and other waters; while the second pathway is leaching and runoff from land of N from synthetic and organic fertiliser additions, crop residue, mineralization of N associated with loss of soil C in mineral and drained/managed organic soils through land-use change or management practices, and urine and dung deposition from grazing animals.

Indirect N_2O emissions from managed soils were estimated by using the following equation (2006 IPCC Guidelines, Volume 4, Chapter 11, Equations 11.09, 11.10 and 11.11):

$$N_2O_{\,indirect} = N_2O_{\,(ATD)} + N_2O_{\,(L)}$$

Where:

$N_2O_{(ATD)}$ = indirect N_2O emissions, produced from atmospheric deposition of nitrogen as ammonia (NH_3), oxides of N (NO_x), and their products NH_4^+ and NH_3^- onto soils and the surface of lakes and other waters; deposition of agriculturally derived NH_3 and NO_x, following the application of synthetic and organic N fertilizers and/or urine and dung deposition from grazing animals;

$N_2O_{(L)}$ = from leaching and runoff from land of N from synthetic and organic fertilizer additions, crop residues returned to soils, mineralization of N associated with loss of soil C in mineral and drained/managed organic soils through land-use change or management practices and urine and dung deposition from grazing animals.

Over the period from 1990 through 2005, indirect N_2O emissions from the 4D 'Agricultural Soils' source category decreased by 65.2 percent (Figure 6-4).

The contribution of emission sources in the structure of total indirect N_2O emissions has changed between 1990 and 2005 time series. So, the share of $N_2O_{(ATD)}$ emissions has decreased by 48.8 percent: from 27.8 percent from the total indirect N_2O emissions to 14.3 percent, while the share of $N_2O_{(L)}$ emissions have increased by 18.8 percent: from 72.2 percent from the total indirect N_2O emissions to 85.7 percent (Table 6-53).

Table 6-53: Breakdown of the Indirect N_2O Emissions from 4D 'Agriculture Soils' by Source within 1990-2005, %

	1990	1991	1992	1993	1994	1995	1996	1997
$N_2O_{(ATD)}$	27.8	26.2	23.1	20.7	16.9	18.2	18.0	14.5
$N_2O_{(L)}$	72.2	73.8	76.9	79.3	83.1	81.8	82.0	85.5
	1998	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**
$N_2O_{(ATD)}$	15.0	14.5	15.0	14.5	15.5	15.9	14.7	14.3
$N_2O_{(L)}$	85.0	85.5	85.0	85.5	84.5	84.1	85.3	85.7

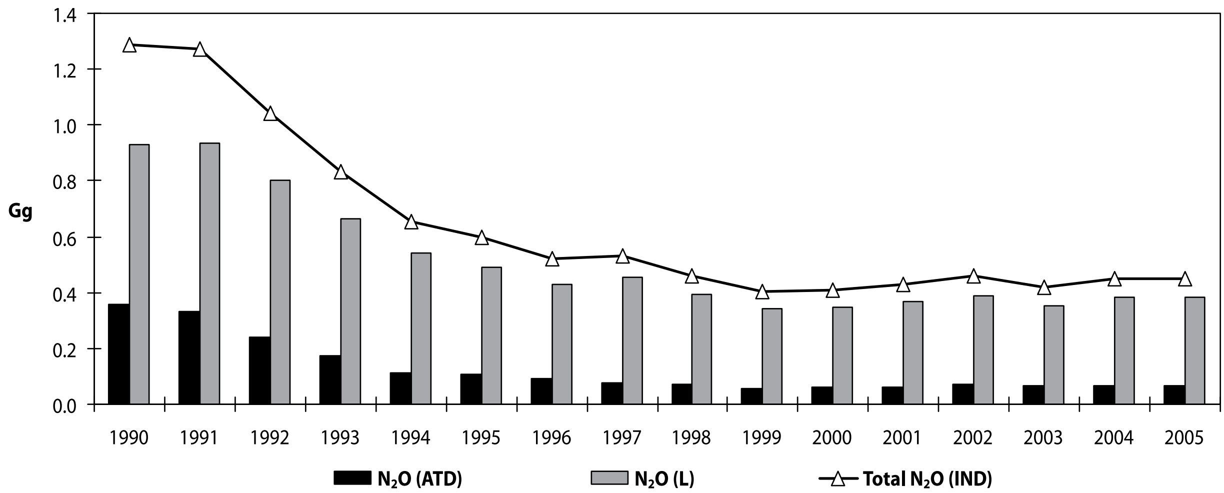

Figure 6-4: Indirect N_2O emissions from the 4D 'Agricultural Soils', 1990-2005

6.4.1 Direct N_2O Emissions from Managed Soils

6.4.1.1 Applied Synthetic Nitrogen Fertilizer

Source Category Description

Considerable amounts of nitrogen are applied to soils with synthetic N fertilizer. Nitrous oxide is produced naturally in soils through the processes of nitrification and denitrification. The amount of emissions from fertilizers consumption depends on a number of factors, such as: the amount and type of N fertilizers applied, crops type, soil type, climate and other environment related conditions. N_2O emissions from synthetic N fertilizer vary a lot over a year.

Methodological Issues and Data Sources

Direct N_2O emissions from applied synthetic fertiliser were estimated by using a Tier 1 methodology (IPCC, 2006). The following equation was used to calculate N_2O emissions:

$$N_2O_{SN} = F_{SN} \cdot EF_1 \cdot 44/28$$

Where:

N_2O_{SN} = N_2O emissions from applied synthetic fertilizer (Gg/yr);

F_{SN} = annual amount of synthetic fertilizer N applied to soils (kg N/yr);

EF_1 = emission factor for N_2O emissions from N inputs; default: 0.01 kg N_2O-N/kg N applied; range: 0.003-0.03 kg N_2O-N/kg N;

[44/28] = stoichiometric ratio of nitrogen content in N_2O-N and N_2O.

Table 6-54 provides a short overview of synthetic N fertilizers, including complex fertilizers most commonly used in the Republic of Moldova.

Table 6-54: Overview of Synthetic N Fertilizers Most Commonly Used in the RM

Type of fertilizer	Chemical formula	Active substance, %	Form	Features
Ammonium nitrate	NH_4NO_3	34.5	White macro crystals or pellets	Physiologically it is faintly acid, may be applied to all crops and all soils. Highly hygroscopic.
Urea (carbamide)	$CO(NH_2)_2$	46	White crystals or pellets	Has a physiologically faintly acid/neutral, low hygroscopic. Highly volatile. Applied to soils, may be used in solutions for foliar fertilization.
Ammophos	$NH_4H_2PO_4$	N: 11-12, P_2O_5: 42-50	Grey pellets	Efficient on chernozems, brown soils, and phosphor deficient soils.
Diammophos	$(NH_4)_2HPO_4$	N: 21, P_2O_5: 53	Grey pellets	Efficient on chernozems, brown soils, and phosphor deficient soils.
Nitroammophos (nitrophoska)	Complex formula	N:P:K 13-19 each	Pellets of different colours	Efficient on all soils and used for all crops.
Diammophos (diammophoska)	Complex formula	N:P:K 10:26:26	Pellets of different colours	Efficient on all soils and used for all crops.

Information on the amounts of applied synthetic N fertilizers (active substance) on managed soils in the RM is available in the Statistical Yearbooks of the RM (for the period until 1992 for the whole territory of the country, and for the period after 1993 - only for the right bank of the Dniester river), and in the Statistical Yearbooks of ATULBD (for the 1993-2005 time series).

Table 6-55 indicates, that in the period from 1988 through 2005 there was a significant decrease (by circa 23 times) of the amounts of synthetic fertilizers used in the agriculture sector of the RM: from about 206 kg active substance per 1 sown hectare in 1988 to circa 20 kg active substance per 1 sown hectare in 2005, while the average consumption of nutrients, in kg of nitrogen per 1 tone of basic yield in most crops is 30-35 kg, and the yield capacity of crops grown in the RM, according to the National Complex Soil Fertility Enhancing Program for 2001-2020, vary between 35-48 quintals/ha in winter wheat, 45-64 quintals/ha in grain maize, 21-35 quintals/ha in sunflower, 268-370 quintals/ha in sugar beets, etc.

Table 6-55: Applied Synthetic Fertilizers in the Republic of Moldova within 1988-2005 time series, thousand tones (active substance)

Indicator	1988	1990	1991	1992	1993	1994
Applied Synthetic N Fertilizer, kt	180.0	87.8	82.7	61.8	28.7	16.2
Total Applied Synthetic Fertilizer, kt	423.0	217.2	191.4	127.6	44.9	20.0
Total Fertilizers Applied, kg/ha	205.9	136.0	124.0	86.0	37.7	27.0
Indicator	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**
Applied Synthetic N Fertilizer, kt	10.5	13.2	11.4	10.2	5.9	10.2
Total Applied Synthetic Fertilizer, kt	12.5	14.3	12.1	20.3	6.1	10.3
Total Fertilizers Applied, kg/ha	7.8	7.6	9.9	12.3	10.3	12.6
Indicator	**2001**	**2002**	**2003**	**2004**	**2005**	**1990-2005, %**
Applied Synthetic N Fertilizer, kt	12.7	18.0	14.6	16.1	16.1	-83.1
Total Applied Synthetic Fertilizer, kt	12.8	18.4	15.4	17.5	18.1	-92.4
Total Fertilizers Applied, kg/ha	12.3	19.4	16.5	18.6	19.7	-84.6

Source: Statistical Yearbooks of the RM for 1988 (page 280), 1994 (page 239), 1999 (page 330), 2003 (page 442), 2004 (page 493), 2005 (page 360) and 2006 (page 352); Statistical Yearbooks of the ATULBD for 1998 (page 230), 2000 (page 107), 2002 (page 111) and 2006 (page 108).

A sharp reduction in fertilizer consumption occurred due to a number of reasons, such as: a drop in import of synthetic fertilizer in the country, lack of financial resources by farmers in certain times of the year, in particular in the context of the breakdown of agriculture during transition to market economy. To be noted that in conformity with the National Complex Soil Fertility Enhancing Program for 2001-2020, it is planned to increase the annual amount of synthetic N fertilizer up to 70-80 thousand tones of nitrogen by 2010, and up to circa 120-130 thousand tones of fertilizer by 2020.

Uncertainties and Time-Series Consistency

Uncertainties related to activity data on applied synthetic N fertilizer in the RM are considered to be low (±10 percent). Uncertainties associated with the default emission factor (EF_1 for F_{SN}) may reach up to ±6 percent. So, combined uncertainties associated with direct N_2O emissions from applied synthetic N fertilizer are considered to be low (±11.66 percent). At the same time, combined uncertainties, presented as a percent of total sectoral emissions were estimated at ±0.43 percent. Uncertainties introduced in trend in sectoral emissions were estimated at ±0.23 percent (see Annex 7-3.4).

In view of ensuring time-series consistency of the obtained results, the same approach was used for the entire period under review, in conformity with the recommendations included in the Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories (IPCC, 2000).

QA/QC and Verification

Standard verification and quality control forms and checklists were filled in for the respective source category under the Agriculture Sector, following the Tier 1 and Tier 2 approaches (see in Annex 6). Also, the AD and methods used for estimating direct N_2O emissions from applied synthetic N fertilizers under the category 4D 'Agriculture Soils' were documented and archived both in hard copies and electronically. For identifying the data entry and emission estimation process related errors there were applied verifications and quality control procedures. Verification was focused on correct use of AD obtained from different sources of reference (i.e., Statistical Yearbooks of the RM and ATULBD); as well as on ensuring correct use of the default emission factors available in the 2006 IPCC Guidelines (IPCC, 2006). Inventory quality assurance activities for the Agriculture Sector, inclusive for the 4D 'Agriculture Soils', were supported by an expert representing the Institute of Pedology, Agrochemistry and Soil Protection "N. Dimo".

Following the recommendations included into the Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories (IPCC, 2000), N_2O emissions originated from the 4D 'Agriculture Soils' were estimated based on AD and EFs from official sources of reference.

Recalculations

In comparison with the results included in the FNC of the RM under the UNFCCC (2000), direct N_2O emissions from applied synthetic fertilisers were recalculated for the 1990-1998 time series (for the RM the 1990 is the reference year under the UNFCCC, while emissions for 1988 year are presented here for comparison purposes), in particular due to becoming available new activity data on synthetic fertilizers consumption in the RM (Statistical Yearbooks of the RM and ATULBD).[26]

The changes made for the period of time from 1990 to 1992 resulted in lower values of direct N_2O emissions from applied synthetic N fertilizer on managed soils in the RM, varying from a minimum of -4.7 percent in 1990 to a maximum of -4.9 percent in 1991 (Table 6-56), which is mostly explained by use of most precise activity data become available lately. The changes made for the period from 1993 through 1998 resulted in increased values of direct N_2O emissions from applied synthetic N fertilizer in the RM, varying from a minimum 1.7 percent in 1996 to a maximum of 80.5 percent in 1994, the increase being explained by taking into account for the first time of activity data available in the Statistical Yearbooks of the ATULBD.

Table 6-56: Comparative Results of Direct $N_2O_{(SN)}$ Emissions from Applied Synthetic N Fertiliser under the 4D 'Agriculture Soils' Category Included into the FNC and SNC of the RM under the UNFCCC, Gg

	1988	1990	1991	1992	1993	1994
FNC	2.9700	1.4473	1.3671	1.0214	0.3143	0.1414
SNC	2.8286	1.3797	1.2996	0.9711	0.4514	0.2552
Difference, %	-4.8	-4.7	-4.9	-4.9	43.6	80.5
	1995	**1996**	**1997**	**1998**	**1999**	**2000**
FNC	0.1509	0.2043	0.1477	0.1069		
SNC	0.1652	0.2077	0.1795	0.1600	0.0929	0.1609
Difference, %	9.5	1.7	21.5	49.8		
	2001	**2002**	**2003**	**2004**	**2005**	**1990-2005, %**
FNC						
SNC	0.1994	0.2823	0.2298	0.2524	0.2530	-81.7
Difference, %						

For the period 1999-2005, direct N_2O emissions from applied synthetic N fertilizer on managed lands in the RM, were estimated for the first time. The results allow assert that within the 1990-2005 time series, direct N_2O emissions from applied synthetic N fertilizer on managed lands under 4D 'Agriculture Soils' source category decreased by circa 81.7 percent.

Planned Improvements

Activities aiming at précising and updating the activity data used to estimate direct N_2O emissions from applied synthetic N fertilisers under the 4D 'Agriculture Soils' category, are planned as future improvements.

6.4.1.2 Applied Organic Nitrogen Fertilizer

Source Category Description

Applied organic nitrogen fertilizer may enhance the processes of nitrification and denitrification, thus contribute to increasing N_2O emissions from managed soils. While calculating emissions covered by this source category, activity data on generation diverse organic matter should be taken into account.

In the RM, the largest share of such organic matter comes from the livestock breeding sector and the food processing industry. However, the livestock breeding sector is still the major provider of organic fertilizer: animal manure, poultry manure, sewage sludge applied to soil, crop residues based composts applied to soil, manure slurry, delluvial soil, alluvium from water basins, as well as other organic amendments (e.g., rendering waste, brewery waste, liquid waste from sugar beet refineries and wineries, etc.).

Methodological Issues and Data Sources

N_2O emissions from applied organic N fertilizer were estimated by using a Tier 1 methodology (2006 IPCC Guidelines, Volume 4, Chapter 11, Equations 11.2 and 11.3):

$$N_2O_{ON} = F_{ON} \cdot EF_1 \cdot 44/28$$

Where:

N_2O_{ON} = N_2O emissions from applied organic N fertilizer (Gg/yr);

$F_{ON} = (F_{AM} + F_{SEW} + F_{COMP} + F_{OOA})$, total annual amount of organic N fertilizer applied to soils other than by grazing animals (kg N/yr);

F_{AM} = annual amount of animal manure N applied to soils (kg N/yr);

F_{SEW} = annual amount of total sewage N that is applied to soils (kg N/yr);

F_{COMP} = annual amount of total compost N applied to soils (kg N/yr);

F_{OOA} = annual amount of other organic amendments used as fertilizer (kg N/yr);

EF_1 = default EF: 0.01 kg N_2O-N/kg N applied (range: 0.003-0.03 kg N_2O-N/kg N);

[44/28] = stoichiometric ratio of nitrogen content in N_2O-N and N_2O.

[26] The EF_1 value and the estimation methodology available in the 2006 IPCC Guidelines is identical with that from the IPCC 1995 Guidelines used within the FNC of the RM under the UNFCCC (2000).

Data on total amount of organic fertilizer (preponderantly, manure with bedding[27]) applied on managed lands are available in the Statistical Yearbooks of the RM and of the ATULBD (Table 6-57).

Table 6-57: Applied Organic Fertilizers in the Republic of Moldova, 1988-2005

Indicator	1988	1990	1991	1992	1993	1994
Applied organic N fertilizer, kt	10800	9700	8600	5300	4200	1620
Applied organic N fertilizer, kg/ha	6000	5600	5100	3400	3934	1097
Indicator	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**
Applied organic N fertilizer, kt	1779.2	905.7	352.9	227.3	122.1	83.3
Applied organic N fertilizer, kg/ha	1232.5	614.5	309.5	250.0	200.0	195.0
Indicator	**2001**	**2002**	**2003**	**2004**	**2005**	**1990-2005, %**
Applied organic N fertilizer, kt	98.2	54.2	47.3	42.2	44.2	-99.5
Applied organic N fertilizer, kg/ha	100.0	85.0	55.0	40.0	45.0	-99.2

Source: Statistical Yearbooks of the RM for 1988 (page 280), 1994 (page 239), 1999 (page 330), 2003 (page 442) and 2006 (page 352); Statistical Yearbooks of the ATULBD for 1998 (page. 230), 2000 (page 107), 2002 (page 111), 2006 (page 108)

The table shows that in the period from 1988 through 2005 there was a significant reduction, by circa 133 times, of the amounts of organic N fertilizers applied per hectare of sown fields: from 6 t/ha in 1988, to 45 kg/ha in 2005, while in conformity with crop rotation structure the need for organic fertilizer, is 10-15 t/ha for a neutral humus balance, and 20-30 t/ha for a positive balance (to fully compensate for the humus losses, an average amount of organic fertilizer of 10 t/ha is needed).

Based on the relevant agriculture expert opinion, the stabilization of humus content in soil on arable lands and horticultural plantations require annual application of circa 20-22 million tones of organic fertilizer, while current resources of organic matter can ensure application of as much as 9-11 million tones of organic fertilizer.

It is considered that the only way to eliminate the 10 million tones deficit of organic fertilizer is to radically change the structure of crops by changing the land use categories, improving crop rotations, and a more comprehensive use of all local sources of organic matter. In conformity with the National Complex Soil Fertility Enhancing Program for 2001-2020, it is planned to increase the amount of applied organic fertilizer up to 5-6 t/ha by 2010, in total by 9-10 million tones annually, and up 10-12 t/ha by 2020, in total by 18-20 million tones annually.

From specialty literature[28] it is known that 1 tone of cattle manure with bedding contain circa 5.6 kg of nitrogen (sheep manure with bedding –9.5 kg of nitrogen, horse manure with bedding – 6.0 of kg nitrogen, swine manure with bedding –8.2 kg of nitrogen, poultry manure with bedding –16.3 kg of nitrogen), 1 tone of slurry – circa 3 kg of nitrogen, and 1 tone of sewage sludge – 20 kg of nitrogen.

To calculate the F_{ON} values, the applied amount of organic fertilizer was multiplied by the conversion factor from bedding manure to nitrogen – 5.6 kg N/t of manure with bedding (Banaru, 2003). The obtained results are presented in the Table 6-58.

Table 6-58: Annual Amount of Organic Nitrogen Applied to Soils in the RM, 1988-2005

Years	F_{ON}, kt	Years	F_{ON}, kt
1988	60.48	1998	1.27
1990	54.32	1999	0.68
1991	48.16	2000	0.47
1992	29.68	2001	0.55
1993	23.52	2002	0.30
1994	9.07	2003	0.26
1995	9.96	2004	0.24
1996	5.07	2005	0.25
1997	1.98	1990-2005, %	-99.5

Uncertainties and Time-Series Consistency

Uncertainties related to activity data on applied organic N fertilizer in the RM are considered to be medium (±50 percent). Uncertainties associated with the default emission factor (EF_1 for F_{ON}) may reach up to ±6 percent. So, combined uncertainties associated with direct N_2O emissions from applied organic N fertilizer are considered to be medium (±50.36 percent). At the same time, combined uncertainties, presented as a percent of total sectoral emissions were estimated at ±0.03 percent. Uncertainties introduced in trend in sectoral emissions were estimated at ±0.12 percent (see Annex 7-3.4).

In view of ensuring time-series consistency of the obtained results, the same approach was used for the entire period under review, in conformity with the recommendations included in the Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories (IPCC, 2000).

[27]In early 1990', the share of animal bedding manure (4-6 kg bedding/animal/day) in Moldova was circa 37.6% of the total amount of animal manure generated in the livestock breeding sector, the share of manure with semi-bedding (1-3 kg bedding/animal/day) was circa 26.7%, and the share of manure without bedding, respectively circa 35.4% (Turcan et al., 1984; Balteanskyi, 1986).

[28]Ungureanu, Cerbari et al., 2006; Bucataru et al., 2006; Raileanu, Jolondcovschi et al., 2006; Andries, Rusu, et al., 2005; Bucataru, Maciuc, 2005; Toncea, 2004; Banaru, 2003.

QA/QC and Verification

Standard verification and quality control forms and checklists were filled in for the respective source category under the Agriculture Sector, following the Tier 1 and Tier 2 approaches (see in Annex 6). Also, the AD and methods used for estimating direct N_2O emissions from applied organic fertilisers under the category 4D 'Agriculture Soils' were documented and archived both in hard copies and electronically. For identifying the data entry and emission estimation process related errors there were applied verifications and quality control procedures. Verification was focused on correct use of AD obtained from different sources of reference (i.e., Statistical Yearbooks of the RM and ATLBD); as well as on ensuring correct use of the default emission factors available in the 2006 IPCC Guidelines (IPCC, 2006). Inventory quality assurance activities for the Agriculture Sector, inclusive for the 4D 'Agriculture Soils', were supported by an expert representing the Institute of Pedology, Agrochemistry and Soil Protection "N. Dimo".

Following the recommendations included into the Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories (IPCC, 2000), N_2O emissions originated from the 4D 'Agriculture Soils' were estimated based on AD and EFs from official sources of reference.

Recalculations

In comparison with the results included in the FNC of the RM under the UNFCCC (2000), direct N_2O emissions from applied organic fertilisers were recalculated for the 1990-1998 time series (for the RM the 1990 is the reference year under the UNFCCC, while emissions for 1988 year are presented here for comparison purposes), in particular due to becoming available new activity data on organic fertilizers consumption in the RM (Statistical Yearbooks of the RM and ATULBD).[29]

The changes made for the period of time from 1990 to 1998 resulted in higher values of direct N_2O emissions from applied organic N fertilizer on managed soils in the RM, varying from a minimum of 16.1 percent in 1990 to a maximum of 76.8 percent in 1993 (Table 6-59), which is mostly explained by use of most precise activity data become available lately, inclusive by taking into account for the first time activity data available in the Statistical Yearbooks of the ATULBD, as well as by using a different conversion factor of manure to nitrogen (in the FNC: 5.0 kg N/t manure, while in the SNC: 5.6 kg N/t manure). For the period 1999-2005, direct N_2O emissions from applied organic N fertilizer on managed lands, were estimated for the first time. The results allow assert that within the 1990-2005 time series, direct N_2O emissions from applied organic N fertilizer on managed lands under 4D 'Agriculture Soils' category decreased by 99.5 percent (Table 6-59).

Table 6-59: Comparative Results of Direct $N_2O_{(ON)}$ Emissions from Applied Organic N Fertiliser under the 4D 'Agriculture Soils' Category Included into the FNC and SNC of the RM under the UNFCCC, Gg

	1988	1990	1991	1992	1993	1994
FNC	0.8171	0.7354	0.5971	0.3504	0.2090	0.0880
SNC	0.9504	0.8536	0.7568	0.4664	0.3696	0.1426
Difference, %	16.31	16.07	26.74	33.09	76.84	62.00
	1995	**1996**	**1997**	**1998**	**1999**	**2000**
FNC	0.1021	0.0566	0.0204	0.0129		
SNC	0.1566	0.0797	0.0311	0.0200	0.0107	0.0073
Difference, %	53.28	40.89	52.02	55.23		
	2001	**2002**	**2003**	**2004**	**2005**	**1990-2005, %**
FNC						
SNC	0.0086	0.0048	0.0042	0.0037	0.0039	-99.5
Difference, %						

The significant decrease in emissions is due to a drastic drop in amount of organic fertilisers applied to soils, in particular, as a result of collapse of the livestock breeding sector during the period of transition to market economy. In early 1990' the collective farms were regularly collecting the manure from big feeding lots and applying it to soil, while private farmers (at present circa 95 percent of the total livestock, the principal source of manure is concentrated in private sector) are more reluctant to do the same due to high transportation costs.

Planned Improvements

Activities aiming at précising and updating the activity data used to estimate direct N_2O emissions from applied organic N fertilisers under the 4D 'Agriculture Soils' category, are planned as future improvements.

6.4.1.3 Urine and Dung Inputs to Grazed Soils

Source Category Description

By the end of 2006, hayfields and pastures occupied circa 370.2 thousand ha (14.7 percent of agricultural lands surface or circa 10.9 percent of the country's area). Worldwide, permanent grasslands, hayfields and pastures generally occupy a surface twice as big as arable lands, in Moldova however this surface is 5 times smaller (Table 6-60).

[29]The EF_1 value and the estimation methodology available in the 2006 IPCC Guidelines is identical with that from in the IPCC 1995 Guidelines used within the FNC of the RM under the UNFCCC (2000).

Table 6-60: Available Lands by Use in the Republic of Moldova, periods from 1991 through 1994 and from 2003 through 2006 (as of January 1), thousand hectares

	1991	1992	1993	1994	...	2003	2004	2005	2006
Total lands	3376.0	3384.3	3384.3	3384.3	...	3384.4	3384.6	3384.6	3384.6
Agricultural lands:	2565.9	2559.7	2557.3	2556.7	...	2533.8	2528.3	2521.6	2518.2
arable land	1736.3	1735.4	1744.5	1758.7	...	1842.6	1845.4	1840.2	1833.2
perennial plantations:	474.8	466.4	448.2	430.7	...	300.8	298.0	297.8	299.0
orchards	224.5	222.9	216.6	208.3	...	137.5	134.8	131.9	131.1
vineyards	215.8	211.8	205.5	202.6	...	152.8	153.0	155.5	157.3
pastures	350.5	355.2	362.0	365.2	...	379.7	374.1	370.8	368.1
hayfields	4.3	2.9	2.6	2.1	...	2.4	2.8	2.7	2.1
fallow lands	0.0	0.0	0.0	0.0	...	8.3	8.0	10.1	15.8
Forests and forest lands	421.7	421.3	420.7	425.3	...	426.6	433.5	439.5	443.3
Rivers, lakes and bogs	88.7	89.5	90.4	92.6	...	97.5	96.3	96.8	96.1
Other lands	299.7	313.8	315.6	310.5	...	326.5	326.5	326.7	327.0

Generally, the surface of land occupied by pastures vary between 0.3 and 300 ha, these being the pastures on the steep slopes, where agricultural machinery can not be used, as well as lowlands with excessive amount of water due to flooding or superficial level of surface waters. In the RM, grazing takes place during 7 months (from March through November), involving a big number of cattle, regardless of weather. Nitrous oxide is produced naturally in soils through the processes of nitrification and denitrification of N inputs from urine and dung N deposited on pasture by grazing animals.

Methodological Issues and Data Sources

N_2O emissions from urine and dung inputs to grazed soils were estimated by using a Tier 1 methodology (2006 IPCC Guidelines, Volume 4, Chapter 11, Equations 11.2 and 11.5):

$$N_2O_{PRP} = F_{PRP} \cdot EF_{3\ (PRP)} \cdot 44/28$$

Where:

N_2O_{PRP} = N_2O emissions from urine and dung inputs to grazed soils;

F_{PRP} = annual amount of urine and dung N deposited by grazing animals on pasture, range and paddock (kg N/yr);

$F_{PRP} = \Sigma_{(s)} [(N_{(T)} \cdot Nex_{(T)}) \cdot MS_{(T, PRP)}]$;

$N_{(T)}$ = number of head of livestock species/category *T* in the country;

$Nex_{(T)}$ = annual average N excretion per animal of species/category *T* in the country (kg N/animal/yr);

$MS_{(T, PRP)}$=fraction of annual amount of urine and dung N deposited by grazing animals on pasture, range and paddock/number of head of livestock species/category *T*;

$EF_{3\ (PRP)}$ = default emission factor values are: 0.02 kg N_2O-N/kg N for cattle, swine and poultry; 0.01 kg N_2O-N/kg N for other animal categories;

[44/28] = stoichiometric ratio of nitrogen content in N_2O-N and N_2O.

To calculate the amount of nitrogen from urine and dung inputs to grazed soils (Table 6-61), activity data on the total population of livestock and poultry from the Statistical Yearbooks of the RM, and of the ATULBD (identical to those used under the source categories 4A 'Enteric Fermentation' and 4B 'Manure Management'), country specific data on nitrogen excretion rate $Nex_{(T)}$ (in kg N/head/yr) and country specific values of the different manure management systems usage in the RM (identical to those used under the 4B 'Manure Management' source category) were used.

Table 6-61: Annual Amount of Urine and Dung Nitrogen Deposited by Grazing Animals on Pasture, Range and Paddock in the Republic of Moldova, 1988-2005

Years	F_{PRP}, kt	Years	F_{PRP}, kt
1988	15.56	1998	15.63
1990	15.87	1999	14.96
1991	16.49	2000	14.01
1992	16.15	2001	13.05
1993	17.12	2002	13.36
1994	17.99	2003	13.50
1995	19.53	2004	12.73
1996	18.05	2005	12.06
1997	16.79	1990-2005, %	-24.0

Uncertainties and Time-Series Consistency

Uncertainties related to activity data on N urine and dung inputs to grazed soils in the RM are considered to be medium (±50 percent). Uncertainties associated with the default emission factor (EF_3 for F_{PRP}) also may reach up to ±50 percent. So, combined uncertainties associated with direct N_2O emissions from N urine and dung inputs to grazed soils are considered to be quite high (±70.71 percent). At the same time, combined uncertainties, presented as a percent of total sectoral emissions were estimated at ±2.96 percent. Uncertainties introduced in trend in sectoral emissions were estimated at ±1.25 percent (see Annex 7-3.4).

In view of ensuring time-series consistency of the obtained results, the same approach was used for the entire period under review, in conformity with the recommendations included in the Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories (IPCC, 2000).

QA/QC and Verification

Standard verification and quality control forms and checklists were filled in for the respective source category under the Agriculture Sector, following the Tier 1 and Tier 2 approaches (see in Annex 6). Also, the AD and methods used for estimating direct N_2O emissions from N urine and dung inputs to grazed soils under the category 4D 'Agriculture Soils' were documented and archived both in hard copies and electronically. For identifying the data entry and emission estimation process related errors there were applied verifications and quality control procedures. Verification was focused on correct use of AD obtained from different sources of reference (i.e., Statistical Yearbooks of the RM and ATULBD); as well as on ensuring correct use of the default emission factors available in the 2006 IPCC Guidelines (IPCC, 2006). Inventory quality assurance activities for the Agriculture Sector, inclusive for the 4D 'Agriculture Soils', were supported by an expert representing the Institute of Pedology, Agrochemistry and Soil Protection "N. Dimo".

Following the recommendations included into the Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories (IPCC, 2000), GHG emissions originated from the 4D 'Agriculture Soils' were estimated based on AD and EFs from official sources of reference.

Recalculations

The direct N_2O emissions from urine and dung inputs to grazed soils were not recalculated, as emissions from this source category were not calculates within the FNC of the RM under the UNFCCC (2000). The obtained results allow assert that within the 1990-2005 time series (for the RM the 1990 is the reference year under the UNFCCC, while emissions for 1988 year are presented here for comparison purposes), direct N_2O emissions from urine and dung inputs to grazed soils under 4D 'Agriculture Soils' source category decreased by circa 23.7 percent (Table 6-62).

The decrease in emissions is due to significant reduction in total population of livestock over the period under review. Despite the fact that the share of this type of manure management system (grazing) increased in comparison to the 1990', it did not have any major impact on the trend of N_2O emissions from urine and dung inputs to grazed soils.

Table 6-62: Direct N_2O Emissions from Urine and Dung Inputs to Grazed Soils in the Republic of Moldova, 1988-2005

Years	N_2O_{PRP}, Gg	Years	N_2O_{PRP}, Gg
1988	0.3741	1998	0.3759
1990	0.3766	1999	0.3626
1991	0.4010	2000	0.3404
1992	0.3893	2001	0.3183
1993	0.4156	2002	0.3269
1994	0.4328	2003	0.3302
1995	0.4756	2004	0.3080
1996	0.4356	2005	0.2874
1997	0.4006	1990-2005, %	-23.7

Planned Improvements

It is planned to undertake activities on obtaining more precise country specific values for nitrogen excretion $Nex_{(T)}$ rates (in kg N/head/year) and manure management systems usage in the Republic of Moldova for the next inventory cycle.

6.4.1.4 Nitrogen in Crop Residues

Source Categories Description

During crop harvesting, a part of the crop, as agricultural residues (above-ground and below-ground), is left in the field to decompose. The nitrogen in crop residues is a relevant source for nitrification and denitrification, contributing to N_2O emissions. Emissions estimation require taking into account both the amount of crop residues burnt in fields to clean the stubble fields for the next agricultural cycle, as well as the amount of crop residues to be removed annually for purposes such as feed, bedding, burned for heating and cooking, etc.

Methodological Issues and Data Sources

N_2O emissions from crop residues were estimated by using a Tier 1 methodology (2006 IPCC Guidelines, Volume 4, Chapter 11, Equations 11.2, 11.6 and 11.7):

$$N_2O_{CR} = F_{CR} \cdot EF_1 \cdot 44/28$$

Where:

F_{CR} = annual amount of N in crop residues (above and below ground), including N-fixing crops, and from forage/pasture renewal, returned to soils annually, kg N/yr;

$$F_{CR} = \Sigma_T [Crop_{(T)} \cdot (Area_{(T)} - Area\ burnt_{(T)} \cdot C_f) \cdot Frac_{Renew (T)} \cdot \{R_{AG (T)} \cdot N_{AG (T)} \cdot (1 - Frac_{Remove (T)}) + R_{BG (T)} \cdot N_{BG (T)}\}],$$

$Crop_{(T)}$ = harvested annual dry matter yield for crop *T* (dm)/ha;

$Crop_{(T)}$ = Yield $Fresh_{(T)}$ x DRY;

Yield $Fresh_{(T)}$ = harvested fresh yield for crop *T*, kg fresh weight/ha;

DRY = dry matter fraction of harvested crop *T*, kg dm/kg of yield;

$Area_{(T)}$ =total annual area harvested of crop *T*, ha/yr;

Area burnt $_{(T)}$ = annual area of crop *T* burnt, ha/yr;
C $_f$ =default combustion factor, for wheat and barley residues has the value of 0.90;
Frac $_{Renew (T)}$ = fraction of total area under crop *T* that is renewed annually; for annual crops: Frac $_{Renew (T)}$ =1, and for perennial crops, Frac $_{Renew (T)}$ =1/X year;
$R_{AG (T)}$ = ratio of above-ground residues dry matter ($AG_{DM(T)}$) to harvested yield for crop *T* ($Crop_{(T)}$), kg dm/kg dm;
$N_{AG (T)}$ = N content of above-ground residues for crop *T*, kg N/kg dm;
$R_{BG (T)}$ =ratio of below-ground residues to harvested yield for crop *T*, kg dm/kg dm;
$N_{BG (T)}$ = N content of below-ground residues for crop *T*, kg N/kg dm;
Frac $_{Remove (T)}$ = fraction of above-ground residues of crop *T* removed annually for purposes such as feed, fuel for heating and cooking, bedding and construction, kg N/kg crop-N;
EF_1= default value of emission factor is 0.01 kg N_2O-N/kg N;
[44/28] = stoichiometric ratio of nitrogen content in N_2O-N and N_2O.

Indices used to estimate N_2O emissions from crop residues returned to soils come from different sources of reference, including the 2006 IPCC Guidelines (Table 6-63).

Table 6-63: Indices Used to Estimate Amount of N in Crop Residues Returned to Soils

Crop	DRY	R_{AG}	N_{AG}	R_{BG}	N_{BG}	$Frac_{BURND}$	$Frac_{REMOVE}$
Wheat	0.89	1.4	0.006	0.55	0.009	0.05	0.80
Barley	0.89	1.2	0.007	0.50	0.014	0.05	0.80
Grain maize	0.87	1.1	0.006	0.48	0.007	0	0.90
Leguminous crops	0.91	2.1	0.016	0.55	0.014	0	0.90
Sun-flower	0.90	2.5	0.006	0.50	0.008	0	0.50
Soybeans	0.91	2.0	0.008	0.55	0.008	0	0.50
Sugar beets	0.22	0.4	0.016	0.10	0.014	0	0.10
Tobacco	0.90	2.6	0.006	0.50	0.008	0	0.10
Potatoes	0.22	0.4	0.019	0.10	0.014	0	0
Legumes	0.15	0.3	0.019	0.10	0.014	0	0
Melons and gourds	0.20	0.3	0.019	0.10	0.014	0	0
Forage crops	0.22	0.4	0.016	0.10	0.014	0	0.10
N-fixing forage crops	0.90	0.3	0.027	0.40	0.022	0	0.90
Non-N-fixing forage crops	0.90	0.3	0.015	0.54	0.012	0	0.90

Source: 2006 IPCC Guidelines: for DM, R_{AG}, N_{AG}, R_{BG} and N_{BG} values; State Ecological Inspectorate annual reports on cases of burning stubble fields: for the Frac $_{Burned}$ values; and expert judgement on management practices used in the agriculture sector of the RM: for the Frac $_{Remove}$ values.

Activity data on areas sown with crops and average yield per ha for the main crops is available in Statistical Yearbooks of the RM and of the administrative territorial units on the left bank of the Dniester river (Tables 6-64 and 6-65).

Table 6-64: Areas Sown with Crops within 1989-2005 time series, thousand hectares

Crops	1989	1990	1991	1992	1993	1994
Winter wheat	281.7	286.5	302.9	282.3	392.4	326.3
Barley	122.9	114.9	139.6	139.6	161.3	173.0
Grain maize	315.9	259.1	312.1	260.2	364.1	293.9
Leguminous crops	83.8	72.4	77.4	71.3	76.9	71.9
Sun flower	129.2	134.0	126.9	131.3	146.6	160.9
Soybeans	37.2	26.7	24.1	16.7	9.1	5.6
Sugar beet	86.0	81.6	79.9	82.6	91.0	91.2
Tobacco	35.5	32.0	32.5	29.8	31.3	28.6
Potatoes	42.2	41.0	46.9	55.5	72.9	64.4
Legumes	79.1	75.0	81.7	77.3	93.7	83.3
Melons and gourds	10.7	9.5	12.2	10.3	8.7	6.1
Root crops	26.3	25.0	20.0	18.0	18.3	16.2
Maize for silo and green fodder	232.0	304.7	462.3	546.1	477.2	521.2
Crops	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**
Winter wheat	394.0	380.9	410.0	405.3	390.4	420.7
Barley	135.1	108.7	129.5	134.0	128.5	124.9
Grain maize	321.3	350.0	450.7	416.7	411.7	454.1
Leguminous crops	53.6	44.6	46.2	58.9	64.8	53.6
Sun flower	163.2	225.1	199.0	234.5	246.0	256.9
Soybeans	3.3	2.3	2.3	6.3	17.0	11.6
Sugar beet	90.4	83.9	76.3	76.4	65.5	66.6
Tobacco	20.1	16.4	17.3	22.0	18.8	23.7
Potatoes	57.1	59.6	62.3	62.0	66.6	65.4
Legumes	72.3	61.4	63.5	58.6	56.3	56.8
Melons and gourds	10.9	9.3	9.6	7.3	8.1	10.1
Root crops	16.1	8.2	6.7	5.4	3.5	2.3
Maize for silo and green fodder	350.3	321.6	209.3	182.9	128.7	102.7
Crops	**2001**	**2002**	**2003**	**2004**	**2005**	**1990-2005, %**
Winter wheat	482.3	500.2	209.2	338.7	428.0	49.4
Barley	114.0	133.7	96.1	140.8	133.5	16.2
Grain maize	483.8	454.7	567.9	604.1	461.0	77.9
Leguminous crops	52.1	59.9	48.3	37.9	42.7	-41.0
Sun flower	234.3	280.7	381.3	293.0	291.0	117.1
Soybeans	9.4	10.2	18.3	28.5	36.2	35.8
Sugar beet	63.1	52.0	39.7	34.9	34.4	-57.9
Tobacco	17.1	9.3	5.6	5.7	4.7	-85.3
Potatoes	42.8	45.1	38.6	34.8	36.6	-10.7
Legumes	66.7	58.3	43.3	37.9	38.5	-48.6
Melons and gourds	9.8	8.8	10.2	8.4	7.1	-25.5
Root crops	1.6	1.2	0.9	0.6	0.4	-98.3
Maize for silo and green fodder	80.4	79.4	94.4	76.4	72.8	-76.1

Source: Statistical Yearbooks of the RM for 1996 (page 324), 1999 (page 328), 2006 (page 341); Statistical Yearbooks of the ATULBD for 1998 (page 218), 2002 (page 113), 2005 (page 101).

Table 6-65: Average Yield per Hectare for the Main Crops in the RM within 1989-2005 time series, quintals/ha

Crops	1989	1990	1991	1992	1993	1994
Winter wheat	40.1	39.4	34.9	32.8	40.0	21.5
Barley	36.2	36.4	29.2	29.2	31.2	28.6
Grain maize	50.2	34.2	48.1	24.4	36.4	23.6
Leguminous crops	17.5	13.4	13.7	17.1	18.8	10.5
Sun flower	21.8	18.8	13.4	15.0	15.0	9.5
Soybeans	13.8	9.0	13.7	4.8	9.9	7.1
Sugar beet	420.0	291.0	283.0	239.0	245.8	175.1
Tobacco	19.0	20.6	20.0	15.1	13.2	11.1
Potatoes	110.0	72.0	62.0	56.0	97.1	71.7
Legumes	152.0	157.0	121.0	102.0	105.7	88.2
Melons and gourds	34.1	36.1	31.2	31.2	35.6	33.1
Root crops	784.0	461.0	398.0	378.0	289.9	277.6
Maize for silo and green fodder	230.0	148.0	142.0	138.0	125.0	121.9
Crops	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**
Winter wheat	32.2	22.1	33.9	28.9	24.1	18.9
Barley	23.5	14.1	25.9	21.2	17.6	12.5
Grain maize	29.1	24.7	40.3	30.5	23.3	21.9
Leguminous crops	10.3	7.2	14.2	12.7	8.1	5.9
Sun flower	14.1	13.7	9.7	8.1	11.7	12.7
Soybeans	8.6	10.3	11.8	9.4	8.1	10.1
Sugar beet	205.7	183.4	224.9	155.6	110.3	133.1
Tobacco	11.5	7.5	12.0	9.2	9.7	7.6
Potatoes	49.6	38.3	50.7	56.3	54.0	47.7
Legumes	71.1	54.0	52.9	85.9	76.3	61.0
Melons and gourds	28.3	28.9	28.7	35.6	37.4	26.2
Root crops	253.4	204.9	304.7	230.2	135.5	106.9
Maize for silo and green fodder	113.3	74.8	162.8	89.7	60.4	65.5
Crops	**2001**	**2002**	**2003**	**2004**	**2005**	**1990-2005, %**
Winter wheat	27.4	24.9	4.5	29.9	26.7	-32.4
Barley	23.8	19.9	6.6	23.4	19.0	-47.8
Grain maize	21.6	21.4	22.0	28.2	26.9	-21.3
Leguminous crops	16.6	8.1	4.3	13.2	15.7	16.8
Sun flower	10.6	11.1	11.0	10.6	11.5	-39.1
Soybeans	10.1	12.3	10.6	14.1	18.1	101.1
Sugar beet	141.8	175.3	96.2	130.5	283.7	-2.5
Tobacco	7.1	10.5	10.2	10.7	13.2	-35.9
Potatoes	69.6	64.6	59.7	134.3	131.2	82.2
Legumes	62.3	51.0	75.5	83.6	109.7	-30.2
Melons and gourds	32.8	31.0	57.8	49.0	68.9	90.7
Root crops	198.7	191.5	136.9	201.9	282.2	-38.8
Maize for silo and green fodder	76.4	92.0	72.8	86.3	111.5	-24.7

Source: Statistical Yearbooks for the RM for 1993 (page 255), 1994 (page 245), 1999 (page 337-338), 2006 (page 348); Statistical Yearbooks of the ATULBD for 1998 (page 221), 2002 (page 117), 2005 (page 104).

Based on information provided in the Table 6-63 and data included into the Tables 6-64 and 6-65, the total amount of nitrogen in crop residues returned to soils, was calculated. The obtained results denote that over the period from 1990 through 2005 (for the RM the 1990 is the reference year under the UNFCCC, while emissions for 1988 year are presented here for comparison purposes), the total amount of nitrogen in crop residues returned to soils decreased by 51.7 percent (Table 6-66).

Table 6-66: Amount of Nitrogen in Crop Residues Returned to Soils, 1989-2005

Years	F_{CR}, kt	Years	F_{CR}, kt
1989	65.73	1998	29.73
1990	52.95	1999	21.44
1991	65.85	2000	19.75
1992	67.15	2001	23.10
1993	65.68	2002	23.22
1994	57.45	2003	15.86
1995	45.47	2004	24.40
1996	31.06	2005	25.57
1997	44.88	1990-2005, %	-51.7

To be noted that implementation of activities aimed at reasonable distribution of soil resources in function of the volume and characteristics of agricultural production, the recommended crop structure will allow to obtain the necessary amount of grain needed to ensure the food safety of population, fodder for the livestock breeding sector, industrial and leguminous crops to meet the needs of population and the processing industry. At the same time this structure will allow to use soil protective crop rotation, contributing to stabilizing the humus balance in soil and soil fertility conservation (Figure 6-5).

Uncertainties and Time-Series Consistency

Uncertainties related to activity data on areas sown with crops and average yield per hectare for the main crops in the RM are considered to be low (±10 percent). Uncertainties related to coefficients used to calculate the amount of nitrogen in agricultural crop residues returned to soils were estimated at circa ±50 percent. Uncertainties related to default emission factor (EF_1 for F_{CR}) may reach up to ±6 percent. So, combined uncertainties associated with direct N_2O emissions from crop residues are considered to be medium (±50.99 percent). At the same time, combined uncertainties, presented as a percent of total sectoral emissions were estimated at ±2.99 percent. Uncertainties introduced in trend in sectoral emissions were estimated at ±0.39 percent (see Annex 7-3.4).

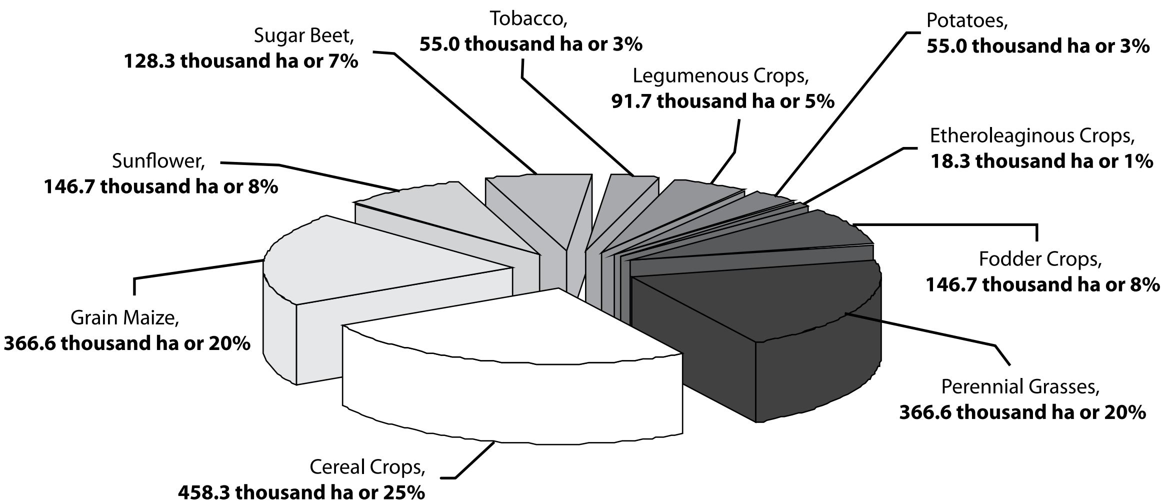

Figure 6-5: Recommended Crops Structure on Agricultural Lands in the RM
(Buza, Parvan, Boian, Cerbari et al., 2007, *Disaster Risks Management in the Republic of Moldova*)

In view of ensuring time-series consistency of the obtained results, the same approach was used for the entire period under review, in conformity with the recommendations included in the Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories (IPCC, 2000).

QA/QC and Verification

Standard verification and quality control forms and checklists were filled in for the respective source category under the Agriculture Sector, following the Tier 1 and Tier 2 approaches (see in Annex 6). Also, the AD and methods used for estimating direct N_2O emissions from crop residues (above and below ground), including N-fixing crops, and from forage/pasture renewal, returned to soils under the category 4D 'Agriculture Soils' were documented and archived both in hard copies and electronically. For identifying the data entry and emission estimation process related errors there were applied verifications and quality control procedures. Verification was focused on correct use of AD obtained from different sources of reference (i.e., Statistical Yearbooks of the RM and ATULBD); as well as on ensuring correct use of the default emission factors available in the 2006 IPCC Guidelines (IPCC, 2006). Inventory quality assurance activities for the Agriculture Sector, inclusive for the 4D 'Agriculture Soils', were supported by an expert representing the Institute of Pedology, Agrochemistry and Soil Protection "N. Dimo".

Following the recommendations included into the Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories (IPCC, 2000), GHG emissions originated from the 4D 'Agriculture Soils' were estimated based on AD and EFs from official sources of reference.

Recalculations

The direct N_2O emissions from crop residues (above and below ground), including N-fixing crops, and from forage/pasture renewal, returned to soils under the category 4D 'Agriculture Soils' were not recalculated, as emissions from this source category were not calculates within the FNC of the RM under the UNFCCC (2000). The obtained results allow assert that within the 1990-2005 time series (for the RM the 1990 is the reference year under the UNFCCC, while emissions for 1989 year are presented here for comparison purposes), N_2O emissions from crop residues decreased by 54 percent (Table 6-67).

Table 6-67: Direct N_2O Emissions from Crop Residues Returned to Soils in the RM, 1989-2005

Years	N_2O_{CR}, Gg	Years	N_2O_{CR}, Gg
1989	1.0329	1998	0.4672
1990	0.8321	1999	0.3369
1991	1.0348	2000	0.3104
1992	1.0552	2001	0.3629
1993	1.0321	2002	0.3649
1994	0.9027	2003	0.2492
1995	0.7145	2004	0.3835
1996	0.4882	2005	0.4018
1997	0.7052	1990-2005, %	-51.7

The decrease in emissions is due to both less area being sown with crops over the period under review (for example, over the period from 1990 through 2005 areas sown with root crops decreased by 98.3 percent, with tobacco - by 85.3 percent, maize for silo and green fodder–by 76.1 percent, sugar beets–by 57.9 percent, legumes–by 48.6 percent, leguminous crops–by 41.0 percent etc.), and lower average yields per hectare (for example, between 1990-2005 the average yield per hectare of barley decreased by 47.8 percent, sunflower – by circa 39.1 percent, root crops – by 38.8 percent, tobacco – by 35.9 percent, winter wheat – by 32.4 percent, legumes – by 30.2 percent, maize for silo and green fodder – by circa 24.7 percent, grain maize – by 21.3 percent etc.).

Despite the fact that over time the areas sown with some crops increased: sunflower (by 117 percent), grain maize (by 78 percent), winter wheat (by 49 percent) and soybeans (by 36 percent), and the there was also an increase in average yield per hectare in other crops, such as soybeans (by 101 percent), melons and gourds (by 91 percent), potatoes (by 82 percent) and leguminous crops (by 17 percent), it did not considerable affect the decreasing trend in N_2O emissions from crop residues returned to soils.

Planned Improvements

Activities aiming at précising and updating the activity data used to estimate direct N_2O emissions from crop residues returned to soils under the 4D 'Agriculture Soils' category, are planned as future improvements.

6.4.1.5 Nitrogen Mineralization Associated with Loss of Soil Carbon

Source Category Description

Land-use change and a variety of management practices may have a significant impact on soil organic C storage. Organic C and N are intimately linked in soil organic matter (humus). Where soil C is lost through oxidation as a result of land-use or management practices change, this loss will be accompanied by a simultaneous mineralization of nitrogen. Where a loss of soil C occurs, this mineralized N is regarded as an additional source of N available for conversion to N_2O.

Methodological Issues and Data Sources

The N_2O emissions from nitrogen mineralization associated with loss of soil carbon as a result of land-use or management change were estimated by using a Tier 1 methodology (2006 IPCC Guidelines, Volume 4, Chapter 11, Equations 11.1, 11.2 and 11.8):

$$N_2O_{SOM} = F_{SOM} \cdot EF_1 \cdot 44/28$$

Where:

N_2O_{SOM} = N_2O emissions from nitrogen mineralization associated with loss of soil carbon (Gg/yr);

F_{SOM} = the net annual amount of N mineralized in mineral soils as a result of loss of soil carbon through change in land use or management (kg N/yr);

$F_{SOM} = \Sigma\ [(\Delta C_{mineral} \cdot 1/R) \cdot 1000]$

R = C:N ratio of the soil organic matter (R = C : N); the IPCC default value of 10 (range from 8 to 15) is used for arable soils; according the national scientific sources (Krupenikov, Gonenko, 1984; Banaru, 2002), R = C:N ratio of the soil organic matter in the Republic of Moldova is 10.7 (range from 10.1 to 11.3);

$\Delta C_{mineral}$ = annual change in carbon stocks in mineral soils, (t C/yr),

$\Delta C_{mineral} = (SOC_0 - SOC_{(0-T)})/D$

T = number of years over a single inventory time period (yrs);

D = time dependence of stock change factors which is the default time period for transition between equilibrium SOC values (commonly 20 years);

SOC_0 = soil organic carbon stock in the last year of an inventory time period (t C/yr);

$SOC_{(0-T)}$ = soil organic C stock at the beginning of the inventory time period (t C/yr);

$SOC = \Sigma\ (SOC_{REF} \cdot F_{LU} \cdot F_{MG} \cdot F_I \cdot A)$

SOC_{REF} =the reference C stock for mineral soils to a default depth of 30 cm (t C/ha);

F_{LU} = stock change factor for land-use systems or sub-system for a particular land-use, dimensionless (the default value used for regions with temperate climate is 0.82);

F_{MG} = stock change for management regime, dimensionless (the default value used for regions with temperate climate, where substantial soil disturbance with full inversion and/or frequent tillage operations are undertaken and at planting time, little of the surface is covered by residues, is 1);

F_I = stock change factor for input of organic matter, dimensionless (the default values used for regions with temperate climate, representative for annual cropping with cereals where all crop residues are returned to the field and/or if residues are removed, then supplemental organic matter (e.g. manure) is added, was assumed to be 1.0 (in the RM it is characteristic for the base year), while in case of low residue return due to removal of residues via collection or burning (in the RM it is characteristic to the last inventory years), was assumed to be around 0.90-0.92);

A = land area of the stratum being estimated (ha/yr);

EF_1 = default 0.01 kg N_2O-N/kg N applied (range: 0.003-0.03 kg N_2O-N/kg N);

[44/28] = stoichiometric ratio between the content of nitrogen in N_2O-N and N_2O.

The following has been taken into account while estimating annual soil carbon losses:

By agricultural practices used on arable lands in the RM as well as soil and climate conditions there is one single agricultural area by land use criteria (the range of soils in the RM is rather homogenous, being preponderantly represented by chernozems);

No significant changes in soil management practices occurred over the time period from 1990 through 2005: as substantial soil disturbance with full inversion is predominant on all arable lands, the default value of the coefficient used for soil management practices or frequent tillage operation, was used ($F_{MG} = 1$);

Since 1990, the amount of carbon removed from arable soils increased essentially, in particular, due to the fact that the amount of organic fertilizer applied to soils, and crop residues returned to soils gradually decreased (also as a consequence of 2-3 times decrease in basic crop yields);

Taking into account the national circumstances and keeping in mind the recommendations set forth in the GPG for LULUCF (IPCC, 2003), there were selected F_I values corresponding to moving over the inventory covered period, from moderate input of organic matter returned in soil (for $SOC_{(0-T)}$, $F_I = 1$) to low input of organic matter returned in soil (for SOC_0, $F_I = 0.9$);

The stocks of organic soil carbon at the beginning of the inventory period were estimated based on default values of F_{LU}, F_{MG}, and F_I, as well as based on a factor identified in the national scientific literature – the results of long term research were taken into account (Ursu, 2000), indicating that in 1990 the content of humus in arable soils in the RM (layer of 0-30 cm) was circa 3 percent or 110 tones humus/ha, respectively, $SOC_{(0-T)}$ = 64 t C/ha (in 1897 the content of humus in the soils in the RM was circa 200 tones humus/ha or 116 t C/ha, in 1950 - circa 150 tones humus/ha or 87 t C/ha, in 1965 - circa 130 tones humus/ha or 75 t C/ha);

The stocks of organic soil carbon in the last year of the inventory (SOC_0) were estimated based on default values of F_{LU}, F_{MG}, and F_I, as well as based on national coefficients of the SOC_0 and $SOC_{(0-T)}$. By 2005, the stocks of organic soil carbon in the Republic of Moldova were circa 57.6 t C/ha, which corresponds to medium annual soil carbon losses of circa 320 kg/ha/yr;

It should be noted that the major part of soils of the RM became managed soils circa 100-150 years ago and over time lost about 25-30 percent of the carbon stock. The direct measurements performed on the leached chernozems in the Northern part of the country showed that over the past 60 years the managed soil lost 37 percent of the carbon stock, and the average annual loss rate is 300 kg C/ha/yr (Soils of Moldova, Volume 1, 1989). The 30-40 years long term experience of the Institute of Pedology, Agrochemistry and Soil Protection "Nicolae Dimo", manly in the soils and climate zones of the country by sub-types of chernozems predominant among other soils, shows that annual soil carbon loss rates are greatly dependant on the zone and sub-type of the chernozems, being circa 325 kg C/ha/yr (Ecopedological Monitoring Bulletin, 7th edition, 2000). The rates with very close values were determined under the oldest long term experiments in the country performed by the State Agrarian University of Moldova in Chetros village, Anenii Noi district, on carbonated chernozems (Zagorcea, 1990). Other researchers identified values between 300-330 kg C/ha/year of carbon losses in currently managed soils (Ungureanu et al., 1997; Andries, 1999; Banaru, 2001).

The Statistical Yearbooks and the General Land Cadastre of the RM provide activity data on areas with arable lands over the period under review from 1990 through 2005 (the 1990 is the reference year under the UNFCCC, while emissions for 1988 year are presented here for comparison purposes) (Table 6-68).

Table 6-68: Arable Lands in the Republic of Moldova, 1988-2005

Years	Arable lands, thousand ha	Years	Arable lands, thousand ha
1988	1796.0	1998	1809.9
1990	1733.6	1999	1813.8
1991	1736.3	2000	1820.7
1992	1744.5	2001	1839.7
1993	1744.7	2002	1842.6
1994	1758.7	2003	1845.4
1995	1774.0	2004	1840.2
1996	1784.8	2005	1833.2
1997	1795.8	1990-2005, %	5.7

Based on information and activity data provided above, there were calculated the annual loss of soil carbon ($\Delta C_{mineral}$) (Table 6-69).

Table 6-69: Annual Loss of Soil Carbon in the Republic of Moldova, 1988-2005

Years	ΔC mineral, kt C/yr	Years	ΔC mineral, kt C/yr
1988	574.36	1998	578.81
1990	554.41	1999	580.05
1991	555.27	2000	582.26
1992	557.89	2001	588.34
1993	557.96	2002	589.26
1994	562.43	2003	590.16
1995	567.33	2004	588.50
1996	570.78	2005	586.26
1997	574.30	1990-2005, %	5.7

The obtained results indicate on certain rhythm of changes in soil carbon stocks over the period under review in the RM equivalent to 320 kg C/ha/yr, ranging from 300 to 330 kg C/ha/yr, which is a value close to results obtained by other authors in the RM (Zagorcea, 1990; Ungureanu et al., 1997; Andries, 1999; Banaru, 2001).

To calculate the values for F_{SOM}, activity data on reported soil carbon losses from arable lands, were divided by C:N ratio of the soil organic matter. As mentioned above, the value of this ratio in soils in the RM is 10.7. The obtained results are provided in Table 6-70.

Table 6-70: The Net Annual Amount of N Mineralized in Mineral Soils as a Result of Loss of Soil Carbon through Change in Land Use or Management in the RM, 1988-2005

Years	N mineralized, F_{SOM}, kt	Years	N mineralized, F_{SOM}, kt
1988	53.68	1998	54.09
1990	51.81	1999	54.21
1991	51.89	2000	54.42
1992	52.14	2001	54.98
1993	52.15	2002	55.07
1994	52.56	2003	55.16
1995	53.02	2004	55.00
1996	53.34	2005	54.79
1997	53.67	1990-2005, %	5.7

Uncertainties and Time-Series Consistency

Uncertainties related to activity data on areas of arable lands in the RM are considered to be low (±10 percent). Uncertainties related to coefficients used to estimate direct N_2O from nitrogen mineralization associated with loss of soil carbon as a result of land-use or management change were estimated at circa ±20 percent, while uncertainties related to default emission factor (EF_1 for F_{SOM}) may reach up to ±6 percent. So, combined uncertainties associated with direct N_2O emissions from nitrogen mineralization associated with loss of soil carbon as a result of land-use or management change are considered to be moderate (±22.36 percent). At the same time, combined uncertainties, presented as a percent of total sectoral emissions were estimated at ±2.80 percent. Uncertainties introduced in trend in sectoral emissions were estimated at ±0.94 percent (see Annex 7-3.4).

In view of ensuring time-series consistency of the obtained results, the same approach was used for the entire period under review, in conformity with the recommendations included in the Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories (IPCC, 2000).

QA/QC and Verification

Standard verification and quality control forms and checklists were filled in for the respective source category under the Agriculture Sector, following the Tier 1 and Tier 2 approaches (see in Annex 6). Also, the AD and methods used for estimating direct N_2O emissions from nitrogen mineralization associated with loss of soil carbon as a result of land-use or management change under the category 4D 'Agriculture Soils' were documented and archived both in hard copies and electronically. For identifying the data entry and emission estimation process related errors there were applied verifications and quality control procedures. Verification was focused on correct use of AD obtained from different sources of reference (i.e., Statistical Yearbooks of the RM and ATLBD); as well as on ensuring correct use of the default emission factors available in the 2006 IPCC Guidelines (IPCC, 2006). Inventory quality assurance activities for the Agriculture Sector, inclusive for the 4D 'Agriculture Soils', were supported by an expert representing the Institute of Pedology, Agrochemistry and Soil Protection "N. Dimo".

Following the recommendations included into the Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories (IPCC, 2000), N_2O emissions originated from the 4D 'Agriculture Soils' were estimated based on AD and EFs from official sources of reference.

Recalculations

The direct N_2O emissions from nitrogen mineralization associated with loss of soil carbon as a result of land-use or management change were not recalculated, as emissions from this source category were not calculated within the FNC of the RM under the UNFCCC (2000).

The obtained results allow assert that within the 1990-2005 time series (for the RM the 1990 is the reference year under the UNFCCC, while emissions for 1988 year are presented here for comparison purposes), direct N_2O emissions from nitrogen mineralization associated with loss of soil carbon as a result of land-use or management change under 4D 'Agriculture Soils' source category increased by circa 5.7 percent (Table 6-71). Increase in direct N_2O emissions from nitrogen mineralization associated with loss of soil carbon can be explained by increased areas of arable lands in the Republic of Moldova in the respective period, as well as of a result of land-use changes.

Table 6-71: Direct N_2O Emissions from Nitrogen Mineralization Associated with Loss of Soil Carbon as a Result of Land-Use or Management Change under 4D 'Agriculture Soils' Source Category in the RM, 1988-2005

Years	$N_2O_{(SOM)}$, Gg	Years	$N_2O_{(SOM)}$, Gg
1988	0.8435	1998	0.8500
1990	0.8142	1999	0.8519
1991	0.8155	2000	0.8551
1992	0.8193	2001	0.8640
1993	0.8194	2002	0.8654
1994	0.8260	2003	0.8667
1995	0.8332	2004	0.8643
1996	0.8383	2005	0.8610
1997	0.8434	1990-2005, %	5.7

Planned Improvements

It is planned to undertake activities on obtaining more precise country specific values for rhythm of changing the soil carbon reserves in the RM for the next inventory cycle.

6.4.2 Indirect N_2O Emissions from Managed Soils

In addition to the direct emissions of N_2O from managed soils that occur through a direct pathway (i.e., directly from the soils to which N is applied), emissions of N_2O also take place through two indirect pathways. The first of these pathways is the volatilization of N as NH_3 and oxides of N (NO_x), and the deposition of these gases and their products NH_4^+ and NO_3^- onto soils and the surface of lakes and other waters. The sources of N as NH_3 and NO_x are not confined to agricultural fertilizers and manures, but also include fossil fuel combustion, biomass burning, and processes in the chemical industry. Thus, these processes cause N_2O emissions in an exactly analogous way to those resulting from deposition of agriculturally derived NH_3 and NO_x, following the application of synthetic and organic N fertilizers and/or urine and dung deposition from grazing animals.

The second pathway is the leaching and runoff from land of N from synthetic and organic fertilizer additions, crop residues, mineralization of N associated with loss of soil C in mineral and drained/managed organic soils through land-use change or management practices, and urine and dung deposition from grazing animals. Some of the inorganic N in or on the soil, mainly in the NO_3^- form, may bypass biological retention mechanisms in the soil/vegetation system by transport in overland water flow (runoff) and/or flow through soil macropores or pipe drains. Where NO_3^- is present in the soil in excess of biological demand, e.g., under cattle urine patches, the excess leaches through the soil profile. The nitrification and denitrification microbial processes transform some of the NH_4^+ and NO_3^- to N_2O. This may take place in the groundwater below the land to which the N was applied, or in riparian zones receiving drain or runoff water, or in the ditches, streams, rivers and estuaries (and their sediments) into which the land drainage water eventually flows.

6.4.2.1 Atmospheric Deposition of N Volatilized from Managed Soils

Source Category Description

Atmospheric deposition of nitrogen oxides (NO_x^-) and ammonia (NH_4^+) induce soil and surface waters fertilization, entailing biogenic formation of N_2O. When synthetic N or organic (manure) fertilizer are applied on managed soils, a portion of nitrogen is lost through volatilization as ammonia and nitrogen oxides. The volatilized nitrogen is then re-deposited in soils and waters may incur further changes through nitrification denitrification entailing N_2O emissions. The amount of volatilized nitrogen depend on a series of factors, such as type of fertilizer, technology and time of application, type of soils, atmospheric precipitations, temperature, soil pH, etc.

Methodological Issues and Data Sources

N_2O emissions from atmospheric deposition of N volatilized from managed soil were estimated by using a Tier 1 methodology (2006 IPCC Guidelines, Volume 4, Chapter 11, Equation 11.9):

$$N_2O_{(ATD)} = \{(F_{SN} \cdot Frac_{GASF}) + ((F_{ON} + F_{PRP}) \cdot Frac_{GASM})\} \cdot EF_4 \cdot 44/28$$

Where:

F_{SN} = annual amount of synthetic N fertilizer applied to soils (kg N/yr);

$Frac_{GASF}$ = fraction of synthetic fertilizer N that volatilizes as NH_3 and NO_x, kg N volatilized (the default value is 0.1 kg NH_3-N + NO_x-N/kg N in synthetic N fertilizer applied to soils) (range from 0.03-0.3 kg NH_3-N + NO_x-N/kg N in synthetic N fertilizer applied to soils);

F_{ON} = annual amount of managed animal manure, compost, sewage sludge and other organic N additions applied to soils (kg N/yr);

F_{PRP} = annual amount of urine and dung N deposited by grazing animals on pasture, range and paddock (kg N/yr);

$Frac_{GASM}$ = fraction of applied organic N fertilizer materials (F_{ON}) and of urine and dung N deposited by grazing animals (F_{PRP}) that volatilizes as NH_3 and NO_x, (the default value is 0.2 kg NH_3-N + NO_x-N/kg N in manure), (range from 0.05 to 0.5 kg NH_3-N + NO_x-N/kg N in manure);

EF_4 = emission factor for N_2O emissions from atmospheric deposition of N on soils and water surfaces (the default value is 0.01 kg N_2O-N/kg per kg NH_4-N and NO_x-N emitted), (range from 0.002 to 0.05 kg N_2O-N/kg per kg NH_4-N and NO_x-N emitted);

[44/28] = stoichiometric ratio of nitrogen content in N_2O-N and N_2O.

Activity data on the amount of N in synthetic and organic fertilizers, urine and dung of grazing animals applied to soils are available in Tables 6-55, 6-58 and respectively in Table 6-61.

Uncertainties and Time-Series Consistency

Uncertainties related to estimation of indirect N_2O emissions from this source are very high. Uncertainties mostly pertain to estimating the amount of volatilized fertilizer, amount of N in manure and emission factors, for which it is extremely difficult to verify to what extent they reflect the conditions specific to Republic of Moldova. Also, the uncertainties associated with the estimation the amount of nitrogen lost through volatilization of NO_x and NH_4 are quite high. Nitrogen volatilization fraction vary a lot, from negligible to very high, depending on environment conditions, soil characteristics, climate conditions, etc. It should be noted that according the GPG (IPCC, 2000) uncertainties related to estimating indirect N_2O emissions from this source can vary up to Factor of 2. In the Republic of Moldova, combined uncertainties related to indirect N_2O emissions from this source category are considered to be very high (±211.90 percent). Combined uncertainties presented as a percent of total sectoral emissions were estimated at ±1.98 percent. Uncertainties introduced in trend in sectoral emissions were estimated at ±0.99 percent (see Annex 7-3.4).

In view of ensuring time-series consistency of the obtained results, the same approach was used for the entire period under review, in conformity with the recommendations included in the Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories (IPCC, 2000).

QA/QC and Verification

Standard verification and quality control forms and checklists were filled in for the respective source category under the Agriculture Sector, following the Tier 1 and Tier 2 approaches (see in Annex 6). Also, the AD and methods used for estimating indirect N_2O emission from atmospheric deposition of N volatilized from managed soil under the category 4D 'Agriculture Soils' were documented and archived both in hard copies and electronically. For identifying the data entry and emission estimation process related errors there were applied verifications and quality control procedures. Verification was focused on correct use of AD obtained from different sources of reference (i.e., Statistical Yearbooks of the RM and ATLBD); as well as on ensuring correct use of the default emission factors available in the 2006 IPCC Guidelines (IPCC, 2006). Inventory quality assurance activities for the Agriculture Sector, inclusive for the 4D 'Agriculture Soils', were supported by an expert representing the Institute of Pedology, Agrochemistry and Soil Protection "N. Dimo".

Following the recommendations included into the Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories (IPCC, 2000), N_2O emissions originated from the 4D 'Agriculture Soils' were estimated based on AD and EFs from official sources of reference.

Recalculations

The indirect N_2O emissions from atmospheric deposition of N volatilized from managed soil under the category 4D 'Agriculture Soils' were not recalculated, as emissions from this source category were not calculated within the FNC of the RM under the UNFCCC (2000). The obtained results allow assert that within the 1990-2005 time series (for the RM the 1990 is the reference year under the UNFCCC, while emissions for 1988 year are presented here for comparison purposes), N_2O emissions from atmospheric deposition of N volatilized from managed soil decreased by 87.7 percent (Table 6-72). A significant decrease of indirect N_2O emissions from atmospheric deposition of nitrogen oxides (NO_x) and ammonia (NH_4) can be explained by a drastic drop in amounts of synthetic and organic N fertilizer applied to soils, and a significant reduction of the total population of livestock over the period under review.

Table 6-72: Indirect N_2O Emissions from Atmospheric Deposition of N Volatilized from Managed Soil under the Category 4D 'Agriculture Soils' in the RM, 1988-2005

Years	$N_2O_{(ATD)}$, Gg	Years	$N_2O_{(ATD)}$, Gg
1988	0.5218	1998	0.0691
1990	0.3586	1999	0.0585
1991	0.3331	2000	0.0616
1992	0.2411	2001	0.0627
1993	0.1729	2002	0.0712
1994	0.1106	2003	0.0662
1995	0.1092	2004	0.0660
1996	0.0934	2005	0.0640
1997	0.0769	1990-2005, %	-87.7

Planned Improvements

Activities aiming at précising and updating the activity data used to estimate indirect N_2O emissions from atmospheric deposition of N volatilized from managed soil under the 4D 'Agriculture Soils' category, are planned as future improvements.

6.4.2.2 Nitrogen Leaching and Runoff

Source Category Description

A big part of nitrogen applied to soil through application of synthetic and organic fertiliser additions, crop residues, mineralization of nitrogen associated with loss of soil C in mineral and drained/managed organic soils through land-use change or management practices, and urine and dung deposition from grazing animals, is lost through leaching and runoff.

Some of the inorganic N in or on the soil, mainly in the NO_3^- form, may bypass biological retention mechanisms in the soil/vegetation system by transport in overland water flow (runoff) and/or flow through soil macropores or pipe drains. Where NO_3^- is present in the soil in excess of biological demand, e.g., under cattle urine patches, the excess leaches through the soil profile. This may take place in the groundwater below the land to which the N was applied, or in riparian zones receiving drain or runoff water, or in the ditches, streams, rivers and estuaries (and their sediments) into which the land drainage water eventually flows, where biogenic production of N_2O emissions is more intense.

Methodological Issues and Data Sources

The indirect N_2O emissions from leaching and runoff were estimated by using a Tier 1 methodology (2006 IPCC Guidelines, Volume 4, Chapter 11, Equation 11.10):

$$N_2O_{(L)} = \{(F_{SN} + F_{ON} + F_{PRP} + F_{CR} + F_{SOM}) \cdot Frac_{LEACH-(H)})\} \cdot EF_5 \cdot 44/28$$

Where:

F_{SN} = annual amount of synthetic N fertilizer applied to soils (kg N/yr);

F_{ON} = annual amount of managed animal manure, compost, sewage sludge and other organic N additions applied to soils (kg N/yr);

F_{PRP} = annual amount of urine and dung N deposited by grazing animals on pasture, range and paddock (kg N/yr);

F_{CR} = N in crop residues (above- and below-ground), including N-fixing crops and forage/pasture renewal returned to soils (kg N/yr);

F_{SOM} = annual amount of N mineralised in mineral soils associated with loss of soil C from soil organic matter as a result of changes to land use or management (kg N/yr);

$Frac_{LEACH}$ = fraction of all N added to/mineralised in managed soils that is lost through leaching and runoff, kg N (kg of N additions) (the default value is 0.3 kg N/kg N applied (range: 0.1-0.8 kg N/kg N applied with synthetic N and organic fertilizer);

EF_5 = emission factor for N_2O emissions from N leaching and runoff, kg N_2O–N (kg N leached and runoff) (the default value is 0.0075 kg N_2O-N/kg N), (range: 0.0005-0.025 kg N_2O-N/kg N leached and runoff);

[44/28] =stoichiometric ratio of nitrogen content in N_2O-N and N_2O.

Activity data on the amount of soil nitrogen from application of synthetic and organic fertiliser additions, crop residues, mineralization of N associated with loss of soil C in mineral and drained/managed organic soils through land-use change or management practices, and urine and dung deposition are available in Tables 6-55, 6-58, 6-61, 6-66 and respectively, in Table 6-70.

Uncertainties and Time-Series Consistency

The uncertainties associated with estimation of indirect N_2O emissions from leaching and runoff are very high, being caused by uncertainties related to natural variability and to the emission and leaching factors, activity data and lack of measurements. Additional uncertainty is introduced in the inventory, as values of emission factors might be not representative of all condition of the Republic of Moldova. According the GPG (IPCC, 2000), uncertainties associated with estimation of indirect N_2O emissions from leaching and runoff may vary up to Factor of 2. Combined uncertainties associated with indirect N_2O emissions from leaching and runoff are considered to be very high (±213.60 percent). At the same time, combined uncertainties, presented as a percent of total sectoral emissions were estimated at ±11.97 percent. Uncertainties introduced in trend in sectoral emissions were estimated at ±2.38 percent (see Annex 7-3.4).

In view of ensuring time-series consistency of the obtained results, the same approach was used for the entire period under review, in conformity with the recommendations included in the Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories (IPCC, 2000).

QA/QC and Verification

Standard verification and quality control forms and checklists were filled in for the respective source category under the Agriculture Sector, following the Tier 1 and Tier 2 approaches (see in Annex 6). Also, the AD and methods used for estimating indirect N_2O emission from leaching and runoff under the category 4D 'Agriculture Soils' were documented and archived both in hard copies and electronically. For identifying the data entry and emission estimation process related errors there were applied verifications and quality control procedures. Verification was focused on correct use of AD obtained from different sources of reference (i.e., Statistical Yearbooks of the RM and ATULBD); as well as on ensuring correct use of the default emission factors available in the 2006 IPCC Guidelines (IPCC, 2006). Inventory quality assurance activities for the Agriculture Sector, inclusive for the 4D 'Agriculture Soils', were supported by an expert representing the Institute of Pedology, Agrochemistry and Soil Protection "N. Dimo".

Following the recommendations included into the Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories (IPCC, 2000), N_2O emissions originated from the 4D 'Agriculture Soils' were estimated based on AD and EFs from official sources of reference.

Recalculations

The indirect N_2O emissions from leaching and runoff under the category 4D 'Agriculture Soils' were not recalculated, as emissions from this source category were not calculates within the FNC of the RM under the UNFCCC (2000). The obtained results allow assert that within the 1990-2005 time series (for the RM the 1990 is the reference year under the UNFCCC, while emissions for 1988 year are presented here for comparison purposes), N_2O emissions from leaching and runoff decreased by 58.6 percent (Table 6-73).

Table 6-73: Indirect N_2O Emissions from Soil Nitrogen Leaching and Runoff under the Category 4D 'Agriculture Soils' in the RM, 1988-2005

Years	$N_2O_{(L)}$, Gg	Years	$N_2O_{(l)}$, Gg
1988	1.3275	1998	0.3921
1990	0.9290	1999	0.3437
1991	0.9373	2000	0.3496
1992	0.8023	2001	0.3690
1993	0.6619	2002	0.3887
1994	0.5421	2003	0.3514
1995	0.4897	2004	0.3834
1996	0.4269	2005	0.3846
1997	0.4552	1990-2005, %	-58.6

The significant decrease of indirect $N_2O_{(L)}$ emissions from soil nitrogen leaching and runoff can be explained by a sharp reduction of amounts of synthetic and organic N fertiliser applied to soils (due to decreased number of livestock population), as well as due to smaller amounts of crop residues returned to soils (as a consequence of irrational soil management and non-observance of crop rotation, with a strong negative effect on the stabilization of humus balance in soils), and due to significant soil carbon losses resulting from inefficient management of agricultural lands.

Planned Improvements

Activities aiming at précising and updating the activity data used to estimate indirect N_2O emissions from soil N leaching and runoff under the 4D 'Agriculture Soils' category, are planned as future improvements.

7. LAND USE, LAND-USE CHANGE AND FORESTRY SECTOR

7.1 Overview

Estimation of GHG emissions and removals covered by Land Use Land-Use Change and Forests (LULUCF) Sector are described in the respective chapter.

According to data of the General Land Cadastre by 01.01.2005, forest lands accounted for 362.7 thousand ha or 10.7 percent of the country's surface. Most forest lands (90.7 percent) are under state ownership, the rest belongs to local public authorities (9.2 percent) and as little as 0.1 percent are in private property.

The total standing volume of wood mass in the forests of the Republic of Moldova is circa 45 million m^3, on average 124 m^3 per hectare. The average growth of forests is around 3.3 m^3/ha/yr and the total average growth is circa 1085 thousand m^3/yr.

The evolution of emissions/removals reported for the time period from 1990 through 2005 was greatly affected by the social-political and economic changes that occurred over this period in the Republic of Moldova (transition to market economy, land parcelling, a sharp drop in industrial manufacturing indicators, etc.).

7.1.1 Summary of CO_2 Emissions/Removals Trends

Over the period from 1990 through 2005, CO_2 net removals covered by LULUCF Sector tended to decrease by circa 17.6 percent (Figure 7-1), from -1676.5 Gg CO_2 reported in 1990 to -1381.4 Gg CO_2 in 2005 (Table 7-1).

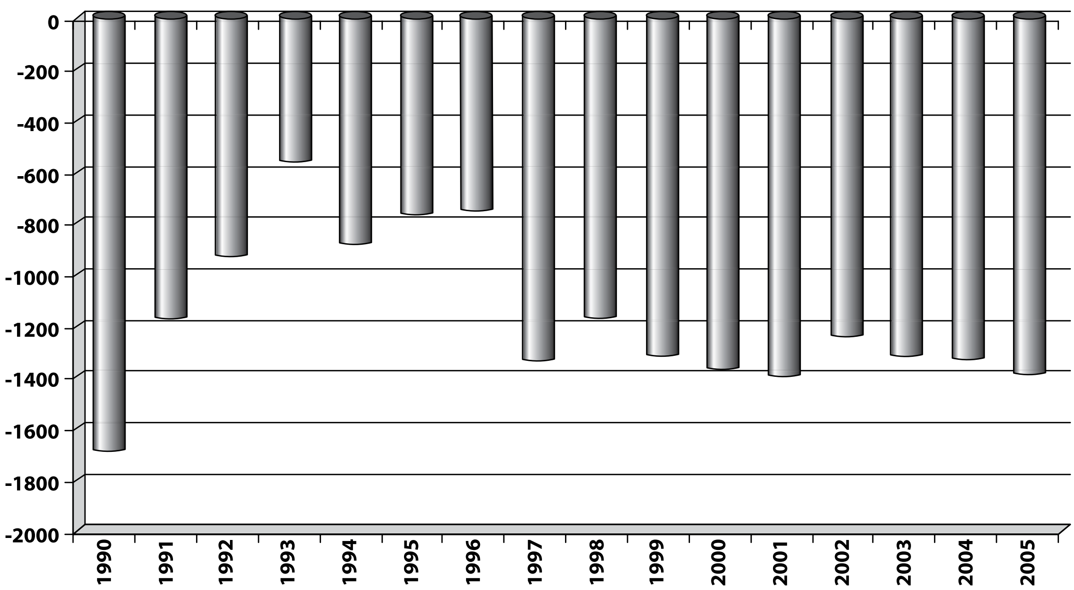

Figure 7-1: Trends in the Net Removals of CO_2 from LULUCF Sector in the Republic of Moldova within the 1990-2005 time series, Gg

The analysis of the obtained results revealed a significant decrease of the general amount of CO_2 removed in the time period from 1991 through 1996. The removed amounts over this period of time represented less than 70 percent of removals reported in 1990. This situation became more vivid in particular in 1993, when the lowest level of removals was reported, as much as circa 32.5 percent of the level of the reference year (1990). It was due, first of all, to changes in forest management and forest land use (increase of authorised harvesting of wood mass, significant increase of illegal logging, increased conversion of forest lands to agricultural lands, etc.), as well as gradual increase of emissions from soils, also due to decreased amounts of organic fertiliser applied to soils, and quantities of crop residues returned to soils (also a result of circa 2-3 times decrease of the basic crops yields).

Table 7-1: CO_2 Emissions/Removals from LULUCF Sector by Source and Sink Category in the Republic of Moldova within 1990-2005 time series, Gg

Year	5A1	5B1.1	5B1.2	5C1	5C2	Total
1990	-2197.6	-725.2	2032.8	-780.1	-6.4	-1676.5
1991	-1924.1	-613.1	2036.0	-783.2	125.6	-1158.8
1992	-1766.5	-614.0	2045.6	-785.8	202.1	-918.6
1993	-1491.4	-611.9	2045.8	-787.6	299.8	-545.2
1994	-1743.7	-590.3	2062.3	-802.1	198.4	-875.4
1995	-1620.8	-598.6	2080.2	-808.1	188.5	-758.8
1996	-1705.1	-551.0	2092.9	-813.3	235.2	-741.4
1997	-2132.2	-573.4	2105.8	-818.4	89.5	-1328.8
1998	-2027.9	-551.0	2122.3	-823.0	119.6	-1160.0
1999	-2111.2	-533.4	2126.9	-827.2	30.8	-1314.2
2000	-2140.3	-523.4	2135.0	-828.1	2.6	-1354.3
2001	-2195.4	-507.7	2157.2	-839.5	-4.6	-1390.0
2002	-2134.9	-477.6	2160.6	-781.2	0.7	-1232.3
2003	-2135.9	-474.0	2163.9	-840.6	-27.5	-1314.0
2004	-2183.7	-466.4	2157.8	-829.4	2.2	-1319.4
2005	-2246.2	-465.3	2149.6	-821.7	2.2	-1381.4
1990-2005, %	2.2	-35.8	5.7	5.3	134.4	-17.6

The most serious situation was reported for forests and other types of forest vegetation managed by local public authorities. In particular due to the population's need to get fuel wood, construction materials, etc., the total volume of illegal logging over the period from 1990 through 2005 was circa 1300 thousand m^3 (Figures 7-2 and 7-3). In these terms, the forest areas managed by the state forest authorities lost circa 1 percent through illegal logging, while forests managed by other owners were destroyed at circa 13 percent.

Gradual decrease of areas occupied by perennial plantations (vineyards, orchards, sycamine plantations, etc.) was also typical for this period of time. In comparison with the base year (1990), by 2005 year the total area of perennial plantations decreased by 37 percent. Since 1997 the situation started to gradually improve, reaching to 80 percent of the level of 1990 (for example: in 2001 – 82.9 percent, while in 2005 – 82.4 percent). The above mentioned improvement was due to both gradual increase of grasslands (in comparison with 1990 there was a circa 5 percent increase), of forests (a circa 12 percent increase), decisive decrease of illegal logging and slowing down the rhythm of diminishing areas occupied by perennial plantations.

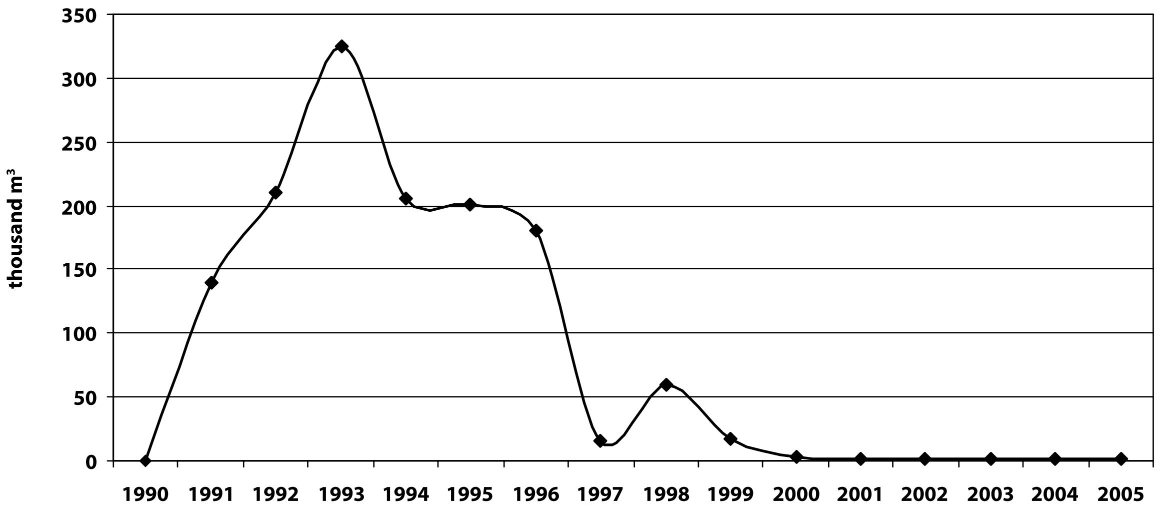

Figure 7-2: Volumes of Illegal Logging within 1990-2005 time series in Forests and Other Types of Forest Vegetation Managed by Local Public Authorities, thousand m^3

To be noted that the main source of CO_2 emissions/removals under the LULUCF Sector is forest vegetation (forests, protection forest strips, etc.), accounting for 69 percent of the total. Another relevant source is grasslands, accounting for 24 percent (Figure 7-4).

Perennial plantations contribute with as much as circa 7 percent of the total, due to gradual diminishing of respective areas. In general, by the end of the reference period (1990-2005), the contribution of forest ecosystems to removal of GHG under LULUCF Sector was continuously growing, explained, in particular, by expansion of forestlands. This growth can also be enhanced on the account of increased productivity of existent forests by a wider reconstruction of degraded and low productivity rammels. Improved management of the national forestry resources will implicitly generate and enhance the climatic and oxical functions of forests in the Republic of Moldova.

Having different biological features, productivity and areas occupied, the forest species occurring on the national forest areas have a different participation in CO_2 removal process. So, due to large areas occupied (*Quercus genus,* – circa 40 percent of the total forestlands, *Robinia pseudoacacia* –

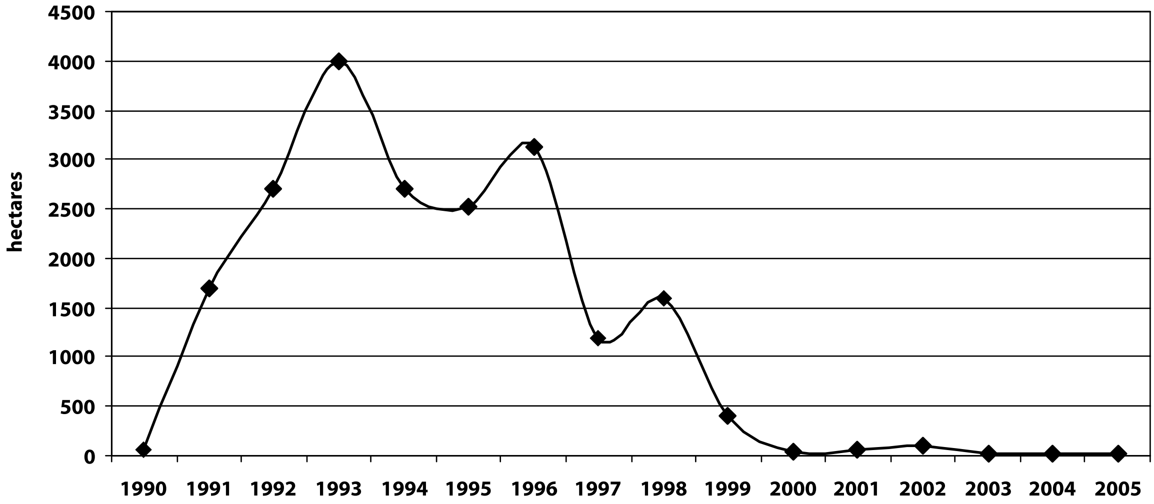

Figure 7-3: Areas of Illegal Logging of Forests and Other Forest Vegetation Managed by Local Public Administrations within the 1990-2005 time series, ha

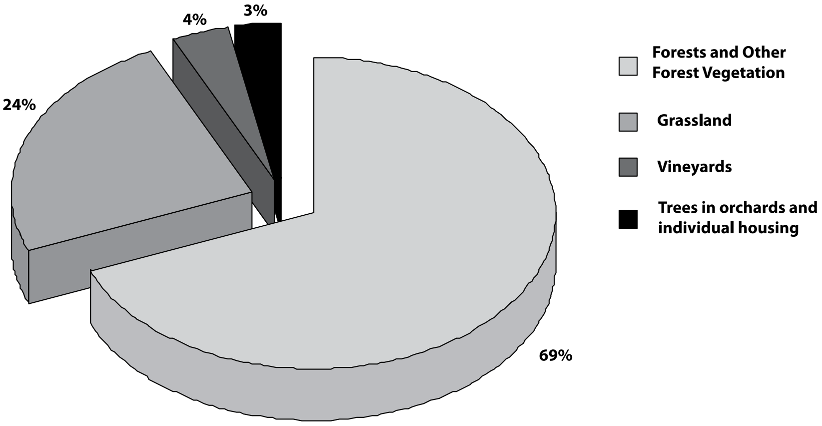

Figure 7-4: Breakdown of CO_2 Removals under LULUCF Sector by Vegetation Categories, percent

circa 36 percent, *Fraxinus genus* – circa 5 percent, *Populus genus /Salix genus* – circa 2 percent etc.), the *Quercus genus* and *Robinia pseudoacacia* account for the largest share - 46 percent and 32 percent, respectively of the CO_2 removals, the remaining species accounting for as much as circa 22 percent of the total amount of CO_2 removed (Figure 7-5).

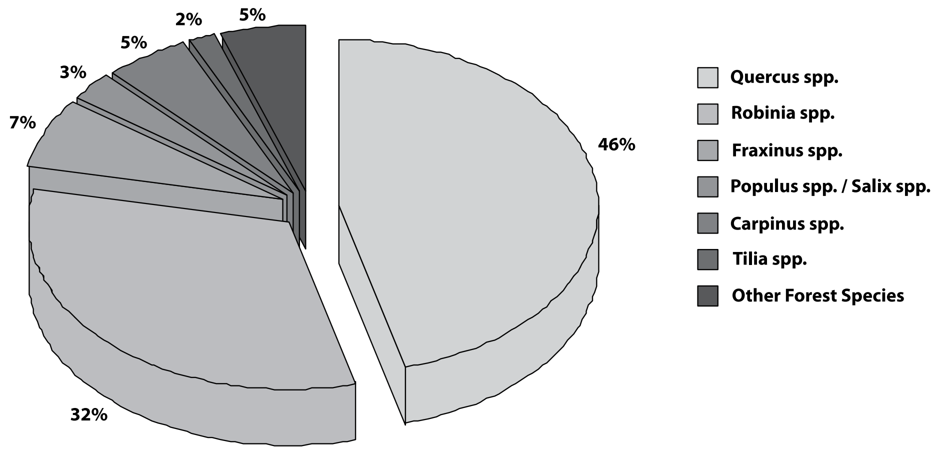

Figure 7-5: Share of Forest Species in CO_2 Removals from 5A1 'Forest Land Remaining Forest Land' under LULUCF Sector in the Republic of Moldova, percents

For current National GHG Inventory, CO_2 emissions/removals from LULUCF Sector were estimated according the methodologies available separately in the Revised 1996 Guidelines (IPCC, 1997), as well as in the Good Practice Guidance for LULUCF (IPCC, 2003). Estimation results are set forth below in Table 7-2. The differences revealed between the two sets of obtained results are significant (reaching to maximum 46 percent).

This is explained by the fact that the estimation methodological approach proposed in the GBP LULUCF (IPCC, 2003) differs significantly from the estimation methodologies available in the Revised 1996 Guidelines (IPCC, 1997). So, new factors and estimation methods used produced different results.

Emissions originated from the 5B1 'Cropland Remaining Cropland' ('Annual Change in Carbon Stocks in Mineral Soils') source category essentially contributed to occurrence of such differences. For other source categories (including those comprising growth of biomass in forests, other types of forest vegetation, perennial plantations, grasslands, etc.) the differences are much smaller.

Table 7-2: The Comparative Analysis of CO_2 Emissions/Removals from the LULUCF Sector Estimated by Following Different Methodological Approaches, 1990-2005

Year	CO_2 emissions/removals estimates in conformity with the Revised 1996 Guidelines (IPCC, 1997)		CO_2 emissions/removals estimates in conformity with GBP for LULUCF (IPCC, 2003)		Difference between two methodological approaches	
	Total, Gg	In comparison with 1990, %	Total, Gg	In comparison with 1990, %	Gg	%
1990	-1440.30	100.0	-1676.5	100.0	236.2	16.4
1991	-1220.16	84.7	-1158.8	69.1	-61.4	-5.0
1992	-1285.57	89.3	-918.6	54.8	-367.0	-28.5
1993	-548.20	38.1	-545.2	32.5	-3.0	-0.5
1994	-1429.43	99.2	-875.4	52.2	-554.0	-38.8
1995	-1353.98	94.0	-758.8	45.3	-595.2	-44.0
1996	-1370.67	95.2	-741.4	44.2	-629.3	-45.9
1997	-1754.32	121.8	-1328.8	79.3	-425.5	-24.3
1998	-1737.92	120.7	-1160.0	69.2	-577.9	-33.3
1999	-1746.89	121.3	-1314.2	78.4	-432.7	-24.8
2000	-1515.97	105.3	-1354.3	80.8	-161.7	-10.7
2001	-1552.29	107.8	-1390.0	82.9	-162.3	-10.5
2002	-1361.50	94.5	-1232.3	73.5	-129.2	-9.5
2003	-1513.40	105.1	-1314.0	78.4	-199.4	-13.2
2004	-1471.83	102.2	-1319.4	78.7	-152.4	-10.4
2005	-1558.77	108.2	-1381.4	82.4	-177.4	-11.4

The current inventory cycle comprised estimation of non-CO_2 emissions (CH_4, N_2O, NO_x and CO). These emissions were reported under the 5A1 'Forest Land Remaining Forest Land' (Non-CO_2 Emissions from Vegetation Fires) source and sink category, resulting from forest fires that occurred in the Republic of Moldova over the period under review (1990-2005), as well as under the 5B1 'Cropland Remaining Cropland' (Non-CO_2 Emissions from Vegetation Fires) source and sink category, resulting from burning of stubble fields (to be noted that though burning of stubble fields is prohibited by law, this practice still persists in the Republic of Moldova). Non-CO_2 emissions (CH_4, N_2O, CO and NO_x) reported under LULUCF Sector decreased significantly over the time period from 1990 through 2005. Evolution of these emissions was influenced both by effective measures designed to protect forestlands from fires, and measures to combat the practice of illegal burning of stubble fields, as well as due to climate conditions in certain years in the Republic of Moldova over the period of time under review.

It should be noted that direct greenhouse gas emissions expressed in CO_2 equivalent by using the global warming potential for 100 years time horizon ($GWP_{100\ years}$), decreased by circa 89.5 percent over the respective period of time: from circa 3.29 Gg CO_2 equivalent in 1990, to circa 0.35 Gg CO_2 equivalent in 2005 (Figure 7-6).

Table 7-3: Total Non-CO_2 Emissions under LULUCF Sector Resulting from Vegetation Fires within the 1990-2005 time series, Gg

GHG	1990	1991	1992	1993	1994	1995	1996	1997
CH_4	0.1099	0.0939	0.0869	0.1279	0.0842	0.0953	0.0739	0.1339
N_2O	0.0032	0.0025	0.0023	0.0033	0.0023	0.0025	0.0019	0.0035
CO	3.6180	3.1773	2.9378	4.3572	2.8331	3.2438	2.5046	4.5606
NO_x	0.0985	0.0864	0.0799	0.1184	0.0770	0.0882	0.0681	0.1239
GHG	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**
CH_4	0.1196	0.1106	0.0391	0.0578	0.0123	0.0032	0.0105	0.0116
N_2O	0.0032	0.0029	0.0010	0.0017	0.0004	0.0002	0.0005	0.0003
CO	4.0403	3.7409	1.3303	1.9094	0.3876	0.0750	0.2649	0.3878
NO_x	0.1099	0.1017	0.0362	0.0520	0.0106	0.0021	0.0074	0.0106

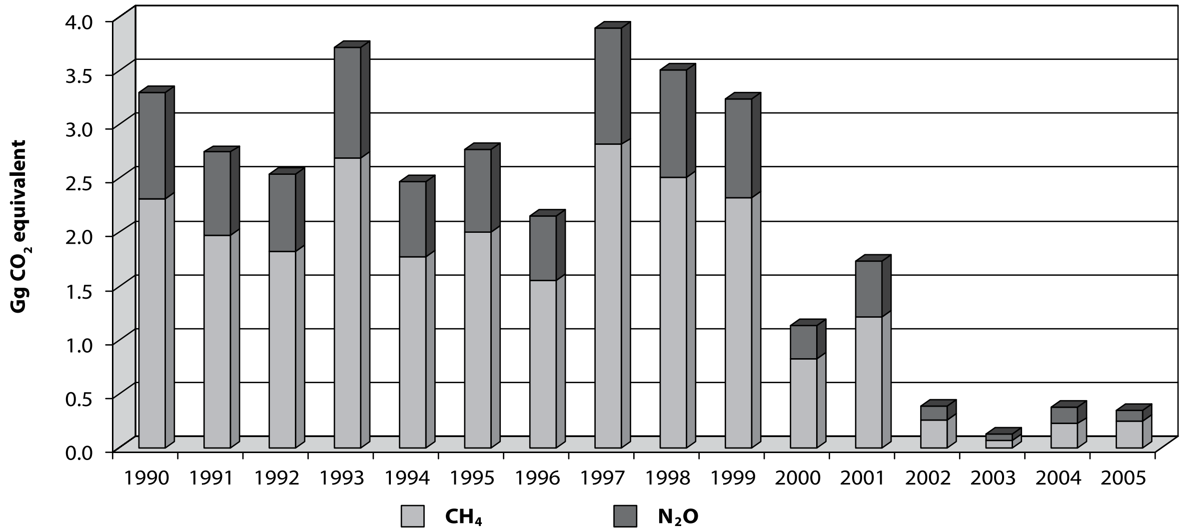

Figure 7-6: Direct GHG (Non-CO_2) Emissions under LULUCF Sector Resulting from Vegetation Fires within the 1990-2005 time series, Gg CO_2 equivalent

7.1.2 Key Categories

The results of key source assessment (including LULUCF) carried out following a Tier 1 approach (IPCC, 2000), are provided in Chapter 1.5, as well as in the Annex 1. Table 7-4 provides information on identified key categories (by level and trend) under the LULUCF Sector of the Republic of Moldova.

7.1.3 Methodological Issues and Data Sources

Tier 1 and Tier 2 methodologies (IPCC, 2003, 2006), as well as default and country specific emissions/removals factors (ex., average annual net increment in volume suitable for industrial processing; basic wood density; carbon fraction of dry matter, etc.) were employed to estimate emissions/removals under LULUCF Sector. The summary of estimation methods used to calculate emissions by source and sink categories are presented in Table 7-5, and a more detailed description is provided in the respective sub-chapters of this report (7.2-7.4).

Table 7-4: Key Source and Sink Categories Identified under the LULUCF Sector

IPCC Category	GHG	Source Category	Key Source
5A1	CO_2	Forest Land Remaining Forest Land	Yes (L, T)
5A1	non-CO_2	Forest Land Remaining Forest Land	No
5A2	CO_2	Land Converted to Forest Land	No
5B1	CO_2	Cropland Remaining Cropland	Yes (L, T)
5B1	non-CO_2	Cropland Remaining Cropland	No
5B2	CO_2	Land Converted to Cropland	No
5C1	CO_2	Grassland Remaining Grassland	Yes (L, T)
5C2	CO_2	Land Converted to Grassland	No
5D1	CO_2	Wetlands Remaining Wetlands	No
5D2	CO_2	Land Converted to Wetlands	No
5E1	CO_2	Settlements Remaining Settlements	No
5E2	CO_2	Land Converted to Settlements	No
5F1	CO_2	Other Land Remaining Other Land	No
5F2	CO_2	Land Converted to Other Land	No

The main sources of reference for the activity data used under the LULUCF Sector were: data pertaining to Reports of State Accounting of Forest Resources: areas occupied by forests, distribution by species, volume of standing wood mass, etc.; Forest Planning Materials: areas occupied and dendrometrical features of forests and other types of forest vegetation; General Land Cadastres: areas occupied by forest vegetation not included in forestry resources, grasslands, perennial plantations, arable lands, settlement lands, other land categories, etc.; Statistical Reports of the State Forestry Agency "Moldsilva": the volumes of woody mass harvested during forest clearings (by categories and species); Statistical Reports of State Forestry Agency "Moldsilva": illegal fellings from the forestry resources managed by the Agency, as well as from forests and forest vegetation managed by other owners; Reports of the State Ecological Inspectorate: illegal logging revealed by its territorial sub-divisions; Reports of the State Ecological Inspectorate: the volumes of wood mass subjected to authorized harvesting from forests and forest vegetation managed by local and central public authorities; National Environment Reports of the Republic of Moldova: areas where the stubble fields were burnt; Statistical Yearbooks of the RM: harvesting of wood products, forestlands that suffered from fires, cropping, etc.

Table 7-5: Summary of Methods and Emission Factors Used to Estimate CO_2 Emissions / Removals from the LULUCF Sector of the Republic of Moldova

IPCC Categories	Source and Sink Categories	Method used	EF	Notes
5A Forest Land	A1. Forest Land Remaining Forest Land	T1, T2	D, CS	Above-ground biomass (biomass increment in forests, carbon losses due to authorised commercial fellings, illegal logging and fuel wood gathering)
	A2. Land Converted to Forest Land	T2	D, CS	There was included in the category Forest Land Remaining Forest Land
5B Cropland	B1.1. Cropland Covered with Woody Vegetation	T1, T2	CS	Above-ground biomass (forest strips, other types of forest vegetation, orchards, vineyards, trees from individual gardens)
	B1.2. Annual Change in Carbon Stocks in Mineral Soils	T2	D, CS	Cropland: annual change in carbon stocks in mineral soils
	B2.Land Converted to Cropland	T2	CS	There was included in the category Cropland Remaining Cropland
5C Grassland	C1. Grassland Remaining Grassland	T2	CS	Change in carbon stocks in living biomass from grassland covered with grasses (lands included in 'pastures' and 'hayfields')
	C2. Land Converted to Grassland	T2	CS	Change in carbon stocks in living biomass from area of land converted to grassland from some initial use (protection forest strips, other types of forest vegetation and degraded arable lands)
5D Wetlands	D1. Wetlands Remaining Wetlands	NE		
	D2. Land Converted to Wetlands	NE		
5E Settlements	E1. Settlements Remaining Settlements	IE		Depending on the type of vegetation a part of settlement lands were included in the following categories: 5A 'Forest Land' (urban forests), 5B 'Cropland' (parks, squares, green spaces), 5C 'Grassland' (pastures and hayfields)
	E2. Land Converted to Settlements	IE		
5F Other lands	F1. Other Land Remaining Other Lands	NE		
	F2. Land Converted to Other Land Category	NE		

Abbreviations: T1, T2 – Tier 1 and 2 Methods; CS – country specific emission/removal factors; D – Default emission/removal factors; NE –Not Estimated; IE –Included Elsewhere.

7.1.4 Uncertainties and Time-Series Consistency

The uncertainty analysis of the GHG emissions from the LULUCF Sector (by source/removal source and sink category) is described in detail in the respective sub-chapters (7.2-7.4) of the NIR, as well as in the Annex 7-3.5.

Combined uncertainties as a percentage of total direct sectoral emissions/removals were estimated at ±58.0 percent (inclusive, ±58.0 percent for CO_2; ±54.7 percent for CH_4 and ±62.7 percent for N_2O). The uncertainties introduced in trend in sectoral emissions were estimated at ±56.1 percent (inclusive, ±56.0 percent for CO_2; ±6.8 percent for CH_4 and ±6.1 percent for N_2O).

In view of ensuring time-series consistency of the results, the same approach was used for the entire period under review, in conformity with the recommendations included in the Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories (IPCC, 2000).

7.1.5 QA/QC and Verification

Standard verification and quality control forms and checklists by individual source and sink categories were filled in for each category under the LULUCF Sector, following the Tier 1 and Tier 2 approaches (see in Annex 6).

Also, the AD and methods used for estimating GHG emissions/removals under the LULUCF Sector were documented and archived both in hard copies and electronically. To identify the data entry, as well GHG emissions/removals estimation related errors there were applied AD and EFs verifications and quality control procedures. Inventory quality assurance activities for the LULUCF Sector were supported by an expert representing the Forest Research and Management Institute.

Following the recommendations included into the Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories (IPCC, 2000), GHG emissions/removals under the LULUCF Sector were estimated based on AD and EFs from official sources of reference.

7.1.6 Recalculations

GHG emission/removals recalculations under the LULUCF Sector are due to the availability of an updated set of activity data (Statistical Yearbooks of the RM and of the ATULBD, General Land Cadastres, other relevant publications pertaining to LULUCF sector [Statistical Reports of the State Forestry Agency "Moldsilva"; Reports of State Accounting of Forest Resources, Forest Planning Materials, Reports of the State Ecological Inspectorate, etc.]), as well as due to updated methodologies and EFs available in the Good Practice Guidance for LULUCF (IPCC, 2003) and in the 2006 IPCC Guidelines (IPCC, 2006), which have replaced the methodologies contained into the Revised 1996 IPCC Guidelines (IPCC, 1997) used within the FNC of the RM under the UNFCCC (2000).

In comparison with the results included into the FNC, the performed recalculation resulted in a significant decrease of CO_2 net removals for the 1990-1998 time periods, varying from a minimum of 9.4 percent in 1990, up to maximum of 69.6 percent in 1993 (Table 7-6). The results of recalculations performed at the category level are presented in the respective sub-chapters (7.2-7.4) of the NIR.

Table 7-6: Recalculated Net CO_2 Removals under the LULUCF Sector for the 1990-1998 time series in the Republic of Moldova, Gg

	1990	1991	1992	1993	1994	1995	1996	1997	1998
FNC	-1849.9	-1864.9	-1816.3	-1791.9	-1718.7	-1494.3	-1585.3	-1720.3	-1729.4
SNC	-1676.5	-1158.8	-918.6	-545.2	-875.4	-758.8	-741.4	-1328.8	-1160.0
Difference, %	-9.4	-37.9	-49.4	-69.6	-49.1	-49.2	-53.2	-22.8	-32.9

Abbreviations: FNC – First National Communication; SNC – Second National Communication.

Table 7-7: Assessment of Completeness under the LULUCF Sector in the RM

Category IPCC	Source and Sink Category	CO_2	CH_4	N_2O	NO_x	CO
5A1	Forest Land Remaining Forest Land	X	X	X	X	X
5A2	Land Converted to Forest Land	IE	NE	NE	NE	NE
5B1	Cropland Remaining Cropland	X	X	X	X	X
5B2	Land Converted to Cropland	IE	NE	NE	NE	NE
5C1	Grassland Remaining Grassland	X	NE	NE	NE	NE
5C2	Land Converted to Grasslands	X	NE	NE	NE	NE
5D1	Wetlands Remaining Wetlands	NE	NE	NE	NE	NE
5D2	Land Converted to Wetlands	NE	NE	NE	NE	NE
5E1	Settlements Remaining Settlements	IE	NE	NE	NE	NE
5E2	Land Converted to Settlements	IE	NE	NE	NE	NE
5F1	Other Land Remaining Other Land	NE	NE	NE	NE	NE
5F2	Land converted to Other Land	NE	NE	NE	NE	NE

Abbreviations: X – source and sink categories included in inventory; IE –Included Elsewhere; NE –Not Estimated.

7.1.7 Assessment of Completeness

The current inventory covers CO_2 emissions/removals from 4 source and sink categories: 5A1 'Forest Lands Remaining Forest Lands', 5B1 'Cropland Remaining Cropland', 5C1 'Grassland Remaining Grassland' and 5C2 'Land Converted to Grassland'. CO_2 emissions/removals from the source category 5A2 'Land Converted to Forest Land' were included in the source category 5A1 'Forest Land Remaining Forest Land', while CO_2 emissions/removals from the source and sink category 5B2 'Land Converted to Cropland', were included in category 5B1 'Cropland Remaining Cropland'. To be noted that CO_2 emissions/removals from the source and sink categories 5E1 'Settlements Remaining Settlements' and 5E2 'Land Converted to Settlements' were included in categories 5A1 'Forest Land Remaining Forest Land', 5B1 'Cropland Remaining Cropland' and 5C1 'Grassland Remaining Grassland' (Table 7-7). Non-CO_2 emissions from forest fires were estimated only for the source and sink categories 5A1 'Forest Lands Remaining Forest Lands' and 5B1 'Cropland Remaining Cropland'.

7.1.8 Planned Improvements

Planned improvements at the source and sink categories level within the LULUCF Sector are described in detail in respective sub-chapters (7.2-7.4) of this report.

7.2 Forest Land (Category 5A)

7.2.1 Source Category Description

The category 5A 'Forest Land" covers estimation of CO_2 removals from the forests of the Republic of Moldova, including above-ground and below-ground biomass (biomass increments in forests, losses from authorized and illegal harvesting of fuel wood).

According to the national notion, '*forest*' is an element of geographical landscape, a functional unit of the biosphere, composed of the totality of forest vegetation (dominated by trees and shrubbery), live layers, animals and microorganisms which are interdependent in their biological development and affect their habitat. Lands covered with forest vegetation occupying areas over 0.25 ha are regarded as forests. The minimal consistency of trees and shrubbery for the lands with forest vegetation to be considered forests should reach an operational level of 30 percent. The consistency requirement should apply only to trees and shrubbery with a natural potential to reach a minimum height of 5 meters at maturity.

In the Republic of Moldova, the areas covered with forests varied considerably over time, from 366.2 thousand ha in 1848 to 362.7 thousand ha in 2005[30] or circa 10.7 percent of the country's territory (Figure 7-7).

In conformity with scientific research studies the current surfaces covered with forests are obviously insufficient to meet the ecological and social-economic needs of the Republic of Moldova. In order to ensure a constant ecological equilibrium and a stronger effect on the climate and hydrological conditions, enhance productivity of agricultural lands, forest lands should occupy at least 15 percent of the country's territory. The total volume of standing wood mass in the forests of the Republic of Moldova is circa 45 million m^3, on average 124 m^3 per hectare. The average forest increment is 3.3 m^3/yr/ha, and the total average increment is circa 1085 thousand m^3/yr. The average production class is 2.3 (see Annex 3-5). The structure by age in all forest species is misbalanced, in particular in those of low productivity.

In conformity with Article 14 of the Forest Code, the forests in the Republic of Moldova are included in the functional group I, having exclusively environment protection functions. In terms of functions, there are 5 functional subgroups:

[30]Gh. Vdovii, D. Galupa et al. (1997), National Report on the Conditions of the Forest Resources of Republic of Moldova, Galupa D., Talmaci I., Spitoc L. (2006), Forest Land Sector in the Republic of Moldova – issues, accomplihments, perspectives.

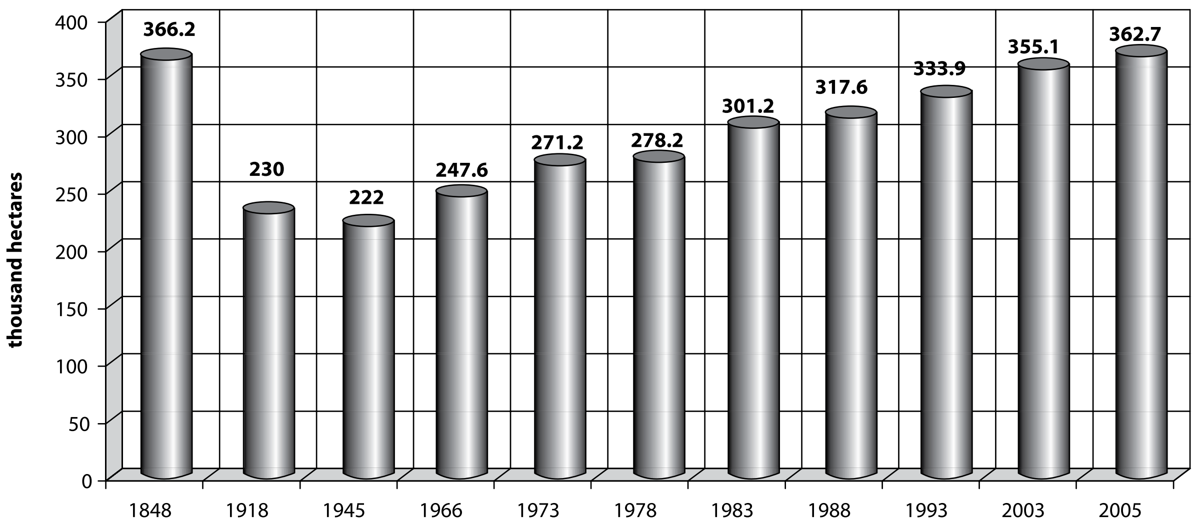

Figure 7-7: Evolution of Areas Covered with Forests in Moldova, 1848-2005

- forests with water protection functions – 1.6%;
- forests with land and soil protection functions – 6.7%;
- forests with protection functions against harmful climatic and industrial factors– 48.6%;
- forests with recreational functions – 29.5%;
- forests presenting scientific interest and for protection of forestry genetic and ecological pool – 13.6%.

7.2.2 Methodological Issues and Data Sources

To estimate CO_2 removals from the category 5A 'Forest Land', current biomass increments in forests values were used (in conformity with production tables and forest planning materials on annual growth of species growing in the forests of the RM), as well as losses from authorised and illegal harvesting of fuel wood. The calculations were performed using the following equations:

$$CO_{2\ B} = \Delta C_B \bullet 44/12$$

Where:

$CO_{2\ B}$ = CO_2 removals from annual change in carbon stocks in biomass, Gg/yr;

ΔC_B =annual increase in carbon stocks in biomass, tC/yr;

[44/12] = stoichiometric ratio of carbon fraction in CO_2 and C.

$$\Delta C_B = \Delta C_G - \Delta C_L$$

Where:

ΔC_G =annual increase in carbon stocks due to biomass growth, tC/yr;

ΔC_L =annual decrease in carbon stocks due to biomass loss, tC/yr;

$$\Delta_G = A \bullet CF \bullet G_{TOTAL}$$

Where:

A = area of forest land remaining forest land, ha;

CF =carbon fraction of dry matter, t C/tonne dm;

G_{TOTAL} = mean annual biomass growth, t dm/ha/yr;

$$G_{TOTAL} = G_w \bullet (1+R)$$

Where:

R = ratio of below-ground biomass to above-ground biomass for a specific vegetation type, t dm below-ground biomass/t dm above-ground biomass;

G_w = average annual above-ground biomass growth for a specific woody vegetation type, t dm/ha/yr;

$$G_w = I_v \bullet D \bullet BCEF_I$$

Where:

I_v = average net annual increment for specific vegetation type, m^3/ha/yr;

D = basic wood density, tonnes (t dm /m^3 standing volume);

$BCEF_I$ = biomass conversion and expansion factor for conversion of net annual increment in volume (including bark) to above ground biomass growth for specific vegetation type, tonnes above-ground biomass growth/m^3 net annual increment.

Annual decrease in biomass carbon stocks due to losses (from authorised fellings and illegal logging), was calculated in conformity with the following formula:

$$\Delta C_L = L_{wood\text{-}removals} + L_{fuel\ wood} + L_{disturbance}$$

Where:

ΔC_L = annual decrease in carbon stocks due to biomass loss, tonnes C/yr;

$L_{wood\text{-}removals}$ = annual carbon loss due to wood removal (harvesting), tonnes C/yr;

$L_{fuel\ wood}$ = annual biomass carbon loss due to fuel wood removals, tonnes C/yr;

$L_{disturbance}$= annual carbon losses due to disturbances (losses from fire on managed land, including wildfires and controlled fires), tonnes C/yr;

$$L_{wood\text{-}removals} = \{H \bullet BCEF_R \bullet (1+R) \bullet CF\}$$

Where:

H = annually wood removals, round wood, m^3/yr;

R = ratio of below-ground biomass to above-ground biomass, t dm below-ground biomass/t dm above-ground biomass;

CF =carbon fraction of dry matter, t C /t dm;

$BCEF_R$ = biomass conversion and expansion factor for conversion of removals in merchantable volume to total biomass removals (including bark), tonnes biomass removals/ m^3 removals; however, if BCEFR values are not available and if the biomass expansion factor for wood removals (BEFR) and basic wood density (D) values are separately estimated, then the following conversion is used:

$$BCEF_R = BEF_R \bullet D$$

Where:

D = basic wood density, t dm/m^3;

BEF_R = biomass expansion factor expand merchantable wood removals to total aboveground biomass volume to account for non-merchantable components of the tree, stand and forest, dimensionless.

$$L_{fuel\ wood} = [\{FG_{trees} \bullet BCEF_R \bullet (1+R)\} + FG_{part} \bullet D] \bullet CF$$

Where:

FG_{trees} = annual volume of fuel wood removal of whole trees, m^3/yr;

FG_{part} = annual volume of fuel wood removal of tree part, m^3/yr;

R = ratio of below-ground biomass to above-ground biomass, t dm below-ground biomass/t dm above-ground biomass;

CF =carbon fraction of dry matter, t C (tonne dm);

D = basic wood density, t dm/m^3;

$BCEF_R$ = biomass conversion and expansion factor for conversion of removals in merchantable volume to total biomass removals (including bark), tonnes biomass removals/ m^3 removals.

$$L_{disturbance} = \{A_{disturbance} \bullet B_W \bullet (1+R) + CF \bullet fd\}$$

Where:

$L_{disturbance}$= annual carbon losses due to disturbances (losses from fire on managed land, including wildfires and controlled fires), tonnes C/yr; to be noted, that in the RM these volumes were included in $L_{wood\text{-}removals}$ and $L_{fuelwood}$, as the forests in the RM are intensively managed, being regularly draw in cleaning cuttings (including selective sanitation treatments), forestry thinning (including clean sanitation cuttings) and various cuttings (including cleaning from fallen trees etc.);

$A_{disturbance}$ = area of forest land affected by disturbances, ha/yr;

B_W = average above-ground biomass of land areas affected by disturbances, tonnes dm/ha;

R = ratio of below-ground biomass to above-ground biomass, t dm below-ground biomass/t dm above-ground biomass;

CF =carbon fraction of dry matter, t C (tonne dm);

fd =fraction of biomass lost in disturbances; ex., a stand-replacing disturbance will kill all biomass (*fd*=1), while an insect disturbance may only remove a portion of the average biomass density (e.g., *fd*=0.3) .

Methodologies described in the Revised 1996 Guidelines (IPCC, 1996), GPG LULUCF (IPCC, 2003) and 2006 IPCC Guidelines (IPCC, 2006) were used in the Republic of Moldova in the inventory development process. Country specific removals factors on average annual net increment in volume suitable for industrial processing; basic wood density; carbon fraction of dry matter and others, were used, as well as sectoral activity data (forest land by species/categories of species, area of forest land, annual extracted volume of round wood, annual volume of fuel wood, etc.). The total wood mass harvested includes both wood mass harvested as authorised and planned fellings, as well as illegal logging revealed by forestry and environment protection authorities. To be noted that the FAO data for the RM (<http://faostat.fao.org>) in this sector are incomplete.

To simplify the inventory development process, eleven groups of species were formed, to include all diversity of forest species growing in the forests of the RM (Table 7-8).

To estimate biomass increments in forests and implicitly, resulting in CO_2 stocks, there were used data on the area of forest land in the RM in the time series from 1990 through 2005, available into the National Reports on Forestry Resources of the RM (1997) and General Land Cadastres of the RM (Table 7-9).

Table 7-8: Groups of Forest Species and their Structure in the Republic of Moldova

No.	Groups of species by name		Species included in categories	Abbreviations
	Scientific	Common		
1.	Quercus spp.	Oak tree	Ilex, durmast, oak, red oak	QU
2.	Carpinus ssp.	Hornbeam	Hornbeam (Carpinus betulus)	CA
3.	Fraxinus spp.	Ash tree	Ash tree	FR
4.	Acer spp.	Sycamore maple	Field maple, Common maple, Mountain maple	AC
5.	Ulmus spp.	Elm	Field elm, Elm tree, Turkestan elm, etc.	UL
6.	Tilia spp.	Linden tree	Foul lime, Silver lime, big leaf linden tree	TI
7.	Salix spp.	Willow	Willow, Osier, etc.	SA
8.	Pinus spp.	Pine	Pine silvestre, Black pine, Spruce fir, Fir tree	PI
9.	Populus spp.	Poplar	Trembling poplar, Black poplar, Aspen tree	PO
10.	Robinia spp.	Acacia	Acacia, Honey locust, Sofora	RB
11.	Other species	Other species	Apple tree, Peer, Sweet cherry tree, Sour cherry tree magaleb, Apricot tree, sycamore, Weeping willow, Hazel tree, Corneal tree, Hawthorn, Sweet briar, Female cornel, etc.	OS

Table 7-9. Evolution of Forest Land Areas in the RM within 1990-2005, thousand ha

Year	Total	Forest Land Areas by Species										
		OU	CA	FS	AC	UL	TI	SA	PI	PO	RB	OS
1990	325.4	140.6	9.4	16.6	2.9	3.1	2.9	1.9	6.9	5.7	124.0	11.4
1991	328.2	141.3	9.4	16.7	2.9	3.1	2.9	2.0	6.9	5.9	125.7	11.4
1992	331.0	142.0	9.4	16.8	3.0	3.1	2.9	2.1	6.9	6.0	127.4	11.4
1993	333.9	142.7	9.5	16.9	3.0	3.1	2.9	2.2	6.9	6.1	129.1	11.5
1994	335.4	143.1	9.9	17.2	3.0	3.1	2.9	2.2	6.9	6.2	130.0	10.9
1995	336.9	143.5	10.2	17.6	3.0	3.1	2.9	2.3	6.9	6.2	130.9	10.4
1996	338.4	143.8	10.6	17.9	3.0	3.1	2.9	2.3	6.9	6.3	131.7	9.8
1997	339.9	144.2	11.0	18.2	3.0	3.1	2.9	2.4	6.9	6.3	132.6	9.3
1998	341.4	144.6	11.3	18.6	3.0	3.1	2.9	2.4	6.9	6.4	133.5	8.7
1999	342.9	145.0	11.7	18.9	3.0	3.1	2.9	2.5	6.9	6.5	134.4	8.1
2000	344.4	145.3	12.1	19.2	3.0	3.1	2.9	2.5	6.9	6.5	135.3	7.6
2001	345.9	145.7	12.4	19.6	3.0	3.1	2.9	2.6	6.9	6.6	136.1	7.0
2002	347.3	146.0	12.8	19.9	3.0	3.1	2.9	2.6	6.9	6.6	137.0	6.5
2003	352.4	148.4	12.6	20.1	3.2	3.2	3.1	2.5	6.9	6.7	137.9	7.8
2004	357.6	151.7	12.4	20.2	3.4	3.4	3.2	2.4	6.9	6.8	138.8	8.4
2005	362.7	153.6	12.1	20.3	3.7	3.8	3.4	2.4	7.0	6.9	139.7	9.8

Source: National Report on Forestry Resources of the RM (1997), General Land Cadastres for 1990-2005 period; Records/Reports of the State Forestry Agency "Moldsilva" on afforestations over the 1998-2005 period.

Final data on species distribution over the period of time under review was obtained by modelling using the primary data set obtained from the Records and Reports of State Forestry Agency "Moldsilva", which featured the following distribution of forest species planted over the reference period: Robinia species - accounted for circa 60 percent, Quercus species – for 25 percent, Populus and Salix species – for 7 percent, other species – for 8 percent.

The volume of commercial timber, as well as the quantity of fuel wood gathered in the RM, there were identified based on statistical data and reports on commercial fellings in managed forest land (by species and sort categories, etc.), revealed illegal logging (on other owners lands, inclusively), data being provided by the State Forestry Agency "Moldsilva", and the State Ecological Inspectorate, on authorized fellings and illegal logging in forests and other woody vegetation areas managed by local public authorities (Table 7-10)

The State Forestry Agency "Moldsilva" keeps records of harvested wood by species (except for some precious species suitable for industrial processing, ex.: (1) hardwood - oak, durmust, hornbeam, ash tree, sycamore maple tree, elm, acacia, honey locust, etc.; (2) softwood - poplar, willow, linden tree etc.

The ratio of the estimated volume by species to total volume harvested per year provided data of acceptable quality (the difference between the estimated volume and harvested volume is on average 5-10 percent). Distribution by species of wood suitable for industrial processing and fuel wood is presented in Tables 7-11 and 7-12..

Table 7-10: Trends in Fuel Wood Harvests in the RM, 1990-2005

Year	Commercial timber, thousand m^3	Fuelwood gathering, thousand m^3	Illegal fuelwood logging, thousand m^3	Total fuelwood harvested, thousand m^3
1990	39.4	184.2	0.6	184.8
1991	27.0	260.7	140.8	401.5
1992	27.4	314.7	213.4	528.1
1993	31.5	402.6	328.1	730.7
1994	39.8	347.4	210.7	558.1
1995	68.5	420.1	205.7	625.8
1996	51.7	402.5	187.4	589.9
1997	52.7	280.2	21.4	301.6
1998	38.0	332.4	64.2	396.6
1999	38.8	326.1	22.0	348.1
2000	39.7	330.5	7.5	338.0
2001	37.3	308.1	6.0	314.1
2002	50.4	337.3	5.4	342.7
2003	47.0	372.8	5.9	378.7
2004	43.5	372.3	4.4	376.7
2005	39.0	352.2	4.2	356.4

Source: Statistical Records/Reports of "Moldsilva" State Forestry Agency and State Ecological Inspectorate for the 1990-2005 time series; D. Galupa, I. Talmaci, L. Spitoc, Study for the Republic of Moldova "Ensuring sustainability of forests and livelihoods through improving governance and control of illegal logging". Chisinau, 2005, 116 pages

Data on the volume of fuel wood gathered also include the volume of twigs, boughs, branches, etc., which are also used as fuel. Taking into account that most illegal loggings occur in forests managed by local public authorities, situated near settlements and composed preponderantly of acacia, the respective volumes were attributed to *Robinia* group of species.

Table 7-11: Trends in Commercial Timber Harvest in the Republic of Moldova within 1990-2005 time series, thousand m^3

Species	1990	1991	1992	1993	1994	1995	1996	1997
Quercus spp.	7.16	4.32	4.09	4.41	6.88	9.59	10.05	10.26
Carpinus spp.	1.05	0.71	0.72	0.83	1.04	1.79	1.35	1.39
Fraxinus spp.	3.65	2.99	3.24	3.94	4.03	8.56	4.47	4.47
Acer spp.	0.31	0.23	0.23	0.27	0.34	0.58	0.45	0.44
Ulmus spp.	0.17	0.10	0.10	0.12	0.15	0.26	0.19	0.21
Tilia spp.	3.78	2.48	2.52	2.90	3.66	6.31	4.70	4.91
Salix spp.	0.26	0.19	0.19	0.22	0.28	0.48	0.37	0.36
Pinus spp.	0.28	0.17	0.18	0.20	0.26	0.44	0.32	0.35
Populus spp.	4.87	3.20	3.26	3.74	4.73	8.14	6.07	6.33
Robinia spp.	16.74	12.02	12.26	14.18	17.54	30.83	22.66	22.70
Other species	1.15	0.59	0.60	0.69	0.89	1.51	1.06	1.28
Total	39.4	27.0	27.4	31.5	39.8	68.5	51.7	52.7
Species	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**
Quercus spp.	7.40	7.51	7.77	5.18	10.12	10.31	9.34	7.63
Carpinus spp.	1.00	0.99	1.07	1.09	1.85	1.00	0.92	1.05
Fraxinus spp.	3.23	3.49	3.17	2.96	4.45	3.41	3.03	3.12
Acer spp.	0.32	0.37	0.28	0.30	0.42	0.26	0.19	0.28
Ulmus spp.	0.15	0.13	0.18	0.19	0.24	0.22	0.22	0.18
Tilia spp.	3.54	3.34	3.97	4.86	4.82	4.22	4.47	3.90
Salix spp.	0.26	0.30	0.24	0.32	0.29	0.20	0.21	0.24
Pinus spp.	0.25	0.22	0.30	0.33	0.00	0.00	1.10	0.30
Populus spp.	4.56	4.32	5.11	2.89	5.82	8.28	6.62	5.02
Robinia spp.	16.37	17.67	16.13	18.19	19.94	16.43	15.93	15.85
Other species	0.92	0.45	1.46	0.97	2.46	2.66	1.44	1.44
Total	38.0	38.8	39.7	37.3	50.4	47.0	43.5	39.0

Source: Statistical Records/Reports of State Forestry Agency "Moldsilva" and State Ecological Inspectorate for the 1990-2005 time-series.

Table 7-12: Trends in Fuel Wood Harvest in the Republic of Moldova within 1990-2005 time series, thousand m^3

Species	1990	1991	1992	1993	1994	1995	1996	1997
Quercus spp.	30.1	50.4	49.3	51.1	39.1	63.6	59.0	49.1
Carpinus spp.	12.5	18.0	13.2	13.2	10.0	11.3	15.5	20.4
Fraxinus spp.	15.8	39.0	56.5	73.1	55.8	72.0	73.7	25.8
Acer spp.	8.7	11.4	6.6	6.2	4.7	5.3	5.0	14.1
Ulmus spp.	3.5	6.2	6.5	10.2	7.8	8.8	2.3	5.7
Tilia spp.	10.6	19.0	20.4	29.2	22.3	20.1	19.5	17.3
Salix spp.	3.4	6.7	8.0	12.4	9.5	10.6	4.1	5.6
Pinus spp.	0.4	2.1	4.1	6.6	5.0	5.6	3.8	0.7
Populus spp.	11.8	34.3	55.0	73.1	55.8	74.4	70.1	19.2
Robinia spp.	76.8	197.6	294.6	439.9	336.0	340.3	323.9	125.3
Other species	11.2	16.9	13.8	16.1	12.3	13.8	13.0	18.3
Total	184.8	401.5	528.1	731.0	558.4	625.7	589.8	301.6
Species	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**
Quercus spp.	64.6	55.3	53.7	48.3	56.9	65.5	64.2	56.6
Carpinus spp.	26.8	24.1	23.4	22.5	23.4	23.1	25.3	24.7
Fraxinus spp.	33.9	30.1	29.2	28.3	28.9	32.4	30.6	30.8
Acer spp.	18.6	16.6	16.2	14.2	17.5	16.5	17.1	17.0
Ulmus spp.	7.5	6.4	6.2	5.8	6.4	8.3	7.1	6.5
Tilia spp.	22.7	19.6	19.0	18.9	18.4	21.6	23.4	20.1
Salix spp.	7.3	6.3	6.1	5.5	6.5	6.3	8.2	6.5
Pinus spp.	0.9	0.7	0.7	1.4	0.0	0.0	2.1	0.8
Populus spp.	25.3	20.3	19.7	17.4	21.3	29.0	28.2	20.8
Robinia spp.	164.8	148.2	143.9	132.9	149.2	148.2	147.8	151.8
Other species	24.1	20.4	19.8	18.0	20.8	27.5	22.1	20.9
Total	396.6	348.1	338.0	313.1	349.3	378.3	376.0	356.4

Source: Statistical Records/Reports of State Forestry Agency "Moldsilva" and State Ecological Inspectorate for the 1990-2005 time-series.

To estimate annual above and below-ground biomass increments and losses, country specific removals factors were developed based on production tables, as well as on data on actual productivity of stands in the RM, in conformity with forest planning records (Tables 7-13 and 7-14).

Table 7-13: Factors Used to Estimate CO_2 Removals from the 5A 'Forest Land' Category

Species	Average annual net increments, m^3/ha/yr	Basic wood density tones dm/m^3 fresh volume	Biomass expansion factor for conversion of annual net increment to above- ground tree increment	Biomass expansion factor for converting volumes of extracted round wood to total aboveground biomass
Quercus spp.	3.0	0.835	1.20	1.20
Carpinus spp.	3.5	0.85	1.20	1.10
Fraxinus spp.	3.5	0.72	1.20	1.20
Acer spp.	2.6	0.75	1.20	1.15
Ulmus spp.	3.2	0.70	1.20	1.15
Tilia spp.	3.7	0.55	1.20	1.15
Salix spp.	7.4	0.38	1.20	1.20
Pinus spp.	2.8	0.535	1.15	1.10
Populus spp.	7.9	0.51	1.20	1.20
Robinia spp.	3.9	0.78	1.20	1.20
Other spp.	2.1	0.70	1.20	1.15

Source: Ukrainian Forest Management Service: Forestry Resources of the Moldavian Soviet Socialist Republic, as of 1.01.1988, Irpeni, 1988 (in Russian); National Report on Forestry Resources of the Republic of Moldova, 1997; Osadcev V.G., Ivankov P.T., Sergovskii P.S. et al. (1955), Guidebook on Woodworking (for forest farms consumer goods manufacturing workshops). Moscow, 1955 (in Russian); Wood Samples Trial Report, Furniture and Wooden Goods Trial and Certification Centre, 2003 (in Russian); Giurgiu V., Decei I., Armasescu S. Biometry of Trees And Stands in Romania, 1972; Shvidenko A.Z., Savich J.N. (1987), Reference Materials for Evaluation of forests in Ukraine and Moldova. Kiev, Urozhai, 1987 (in Russian); Kapp G., Velsen-Zerweck M., Horst A., Horn L., Galupa D. Talmaci I. et al., The Baseline Study for the Soil Conservation Project in Moldova, 2003.

Table 7-14: Factors Used to Estimate CO_2 Removals from the 5A 'Forest Land' Category

Species	Root-shoot ratio appropriate to increments	Carbon fraction of dry matter	Fraction of biomass left to decay in forest
Quercus spp.	0.40	0.50	0.05
Carpinus ssp.	0.35	0.50	0.05
Fraxinus spp.	0.28	0.49	0.05
Acer spp.	0.28	0.49	0.05
Ulmus spp.	0.28	0.49	0.05
Tilia spp.	0.21	0.50	0.05
Salix spp.	0.21	0.49	0.05
Pinus spp.	0.46	0.51	0.05
Populus spp.	0.21	0.50	0.05
Robinia spp.	0.28	0.49	0.05
Other spp.	0.28	0.50	0.05

Source: Osadcev .G., Ivankov P.T., Sergovskii P.S. et al. (1955), Guidebook on Woodworking (for Forest Farms Consumer Goods Manufacturing Workshops). Moscow, 1955 (in Russian); Giurgiu V., Decei I., Armasescu S. Biometriy of Trees and Stands in Romania, 1972; Shvidenko A.Z., Savich J.N. (1987), Reference Materials for Evaluation of Forests in Ukraine and Moldova. Kiev, Urozhai, 1987 (in Russian); Kapp G., Velsen-Zerweck M., Horst A., Horn L., Galupa D. Talmaci I. et al.: The Baseline Study for the Soil Conservation Project in Moldova, 2003; Vanin S. I. (1949), Wood Science, Moscow (in Russian)

Non-CO_2 emissions from the 5A 'Forest Land' category were estimated by using a Tier 1 methodology.

$$L_{fire} = A \bullet M_B \bullet C_f \bullet G_{ef} \bullet 10^{-3}$$

Where:

L_{fire} = amount of non-CO_2 greenhouse gas emissions from fire, t GHG/yr;

A = area burnt, ha/yr;

M_B = mass of fuel available for combustion (biomass, ground litter and dead wood), tonnes/ha;

C_f = combustion factor; IPCC default value is 0.45 (IPCC, 2006);

$M_B \bullet C_f$ = amount of fuel actually burnt; IPCC default for 'Other temperate forests' under wildfire is 19.8 t dm/ha (IPCC, 2006);

G_{ef} = default EF (kg/t dm) (see Table 7-15).

Table 7-15: EFs for Various Types of Burning, kg GHG /tonnes dry matter burnt

Category	CO	CH_4	N_2O	NO_x
Tropical forests	104	6.8	0.20	1.6
Temperate zone forests	107	4.7	0.26	3.0

Activity data on burnt forestlands are available in Statistical Yearbooks of the Republic of Moldova and of ATULBD (Table 7-16).

Table 7-16: Forest Areas Affected by Fires in the RM within 1990-2005 time series, ha

Years	Forest area affected by fires, ha	Years	Forest area affected by fires, ha
1990	120.10	1999	25.20
1991	20.10	2000	0.90
1992	22.00	2001	57.00
1993	1.50	2002	30.60
1994	33.50	2003	33.50
1995	1.93	2004	88.00
1996	11.20	2005	8.40
1997	3.40	2006	90.80
1998	33.70	1990-2006, %	-24.4

Source: Statistical Yearbooks of the RM for 1994 (page 38), 1999 (page 20), 2007 (page 22); Statistical Yearbooks of the ATULBD for 2000 (page 88), 2002 (page 91), 2007 (page 81).

7.2.3 Uncertainties and Time-Series Consistency

Estimation of uncertainties is a very important element in national greenhouse gas inventory development. The information on CO_2 emissions uncertainties is used to define priority measures in terms of improving future inventory quality, inclusive by choosing the appropriate methodology. CO_2 removals estimation range is quite wide, varying from veridical values to results that are inferred from intermediary data.

Uncertainties associated with the process of estimating the CO_2 removals from the 5A 'Forest Land' category at the beginning of the reference period (year 1990), were rather low (±5 percent). Since 1991, due to social-political developments, the level of uncertainties increased significantly. For 2005, the level of precision of activity data related to the production processes reached circa ±25 percent. Uncertainties related to removals factors in both cases are of circa ±5 percent.

General uncertainties on CO_2 removals from the 5A 'Forest Land' category are affected by a number of factors. So, a part of data needed to estimate CO_2 removals from forests in the Republic o Moldova need to be updated. This refers, in the first place, to distribution of total area by species of trees and shrubs, which for current inventory were calculated based on forests accounting data for 1988 (partially updated in 1997 in the National Report on Forestry Resources of the Republic of Moldova) and share of forest species in woody crops planted over the inventory period. The uncertainties by sections are also determined by the volumes of wood mass actually harvested by local public authorities and other forests owners. There is no accurate statistic on the volumes of wood mass harvested during forest clearings. Some consolidated information in this field is available to the State Ecological Inspectorate (SEI) only, as an institution that authorises fellings of any type of forest vegetation (based on Article 40 of the Law on Environment Protection, Article 22 of the Forest Code dealing with state control and state control data). So, over the period from 2000 through 2005, the IES authorised harvesting of 32.8 thousand m^3 of wood mass from he forestry resources and other types of forest vegetation managed by local public authorities. At the same time, in conformity with an estimative study, the annual volume of wood mass from unidentified sources was circa 400 thousand m^3. The current system of monitoring and control of production processes in Forestry Sector is applied only in forests managed by the State Forestry Agency "Moldsilva". The forest resources managed by local public authorities are practically beyond these activities. A considerable part of illicit logging is not even reported. As a consequence, it generates massive illegal logging on forest land managed by local public authorities.

Combined uncertainties for 5A 'Forest Land' category are considered medium (±25.5 percent). As the same time, the combined uncertainties as a percentage of total direct sectoral removals were estimated at ±41.5 percent. The uncertainties introduced in trend in sectoral removals were estimated at ±4.5 percent.

Uncertainties related to estimation of non-CO_2 emissions from forest areas affected by fires result from uncertainties related to the mass of fuel available for combustion, as well as those related to emission factors. Uncertainties related to annual activity data on forest areas affected by fires are considered relatively small (±10 percent). Uncertainties related to default emission factors for different types of burnings (dry matter burnt), are moderate for CH_4 (±30 percent) and medium for N_2O (±50 percent). So, combined uncertainties related to non-CO_2 emissions (CH_4 and N_2O) from 5A 'Forest Land' category are considered relatively high (±31.62 percent for CH_4 and ±50.99 percent for N_2O), while combined uncertainties as a percentage of total direct sectoral emissions/removals are quite insignificant (Annex 7-3.5).

In view of ensuring time-series consistency of the obtained results, the same approach was used for the entire period under review, in conformity with the recommendations included in the Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories (IPCC, 2000).

7.2.4 QA/QC and Verification

Following the recommendations included into the Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories (IPCC, 2000), CO_2 removals under the 5A 'Forest Land' category were estimated based on AD and EFs from official sources of reference.

So, data on total forest area was taken from the General Land Cadastre by years, annual forest land balance drafted annually by the state forest authorities, periodical records (once in 5 years) of forests, forest planning materials, etc. Annual biomass increments were taken from production tables, periodical state records (once in 5 years) of forests, forest planning materials, by-laws and technical regulations in forestry. Data on the volume of wood mass was obtained from the following statistical reports by branches: Statistical Report 3 g.s. 'Statistic report on volumes of standing wood withdrawn from forest'; Statistical Report 5 g.s.' Statistic report on volumes of illegal logging'; Statistical Report 2 g.s. 'Report on attaining production indicators in forestry' (section "Wood mass movement"). At the same time data on illicit logging revealed by the State Ecological Inspectorate are confirmed by the official letter from the respective authority.

Standard verification and quality control forms and checklists were filled in for 5A 'Forest Land' category, following the Tier 1 and Tier 2 approaches (see in Annex 6). Also, the AD and methods used for estimating CO_2 removals from 5A 'Forest Land' category were documented and archived both in hard copies and electronically. To identify the data entry, as well CO_2 removals estimation related errors there were applied AD and EFs verifications and quality control procedures. Verification was focused on correct use of AD obtained from different sources of reference; as well as on ensuring correct use of the removals factors available in the scientific literature as well as in the GPG LULUCF (2003) and 2006 IPCC Guidelines (IPCC, 2006). Inventory quality assurance activities for the LULUCF Sector were supported by an expert representing the Forest Research and Management Institute.

7.2.5 Recalculations

The CO_2 removals from the 5A 'Forest Land' category were recalculated for the 1990 through 1998 time series, in particular due to the fact that the categories of the IPCC GPG on LULUCF were used within the SNC of the RM under UNFCCC, also due to use higher tier methodologies available in the GPG LULUCF (IPCC, 2003) and IPCC 2006 Guidelines (IPCC, 2006), replacing the categories and estimation methodologies available in the Revised 1996 IPCC Guidance (IPCC, 1997) used within the FNC of the RM under the UNFCCC (2000); as well as due to use of a new set of activity data (areas with woody vegetation, annual biomass increments, etc.).

In the above mentioned context, it should be noted that the amount of removals currently reported under the IPCC GPG on LULUCF category 5A 'Forest Land', in the FNC there was included into the category 5A 'Changes in Forestry and Other Woody Biomass Stocks', which have been estimated by using methodological approaches available in the Revised 1996 Guidelines (IPCC, 1997). Also, within the category 5A 'Changes in Forestry and Other Woody Biomass Stocks' under the FNC (2000), there were not comprised all CO_2 sources and sinks, in particular there were not taken into account the volume of fuel wood originated from illegal logging.

In comparison with CO_2 removal estimates included into the FNC under the former category 5A 'Changes in Forest and Other Woody Biomass Stocks', the changes performed resulted in increased CO_2 removals reported currently under the 5A 'Forest Land' category. For the period 1999-2005, CO_2 removals resulting from 5A 'Forest Land' category were estimated for the first time. The obtained results allow assert that within the 1990-2005 time series CO_2 removals from 5A 'Forest Land' category increased by circa 2.2 percent (Table 7-17).

Table 7-17: CO_2 Removals from the Category 5A 'Forest Land' in the Republic of Moldova within the 1990-2005 time series

Years	$CO_{2\ B}$, Gg	Years	$CO_{2\ B}$, Gg
1990	-2197.6	1998	-2027.9
1991	-1924.1	1999	-2111.2
1992	-1766.5	2000	-2140.3
1993	-1491.4	2001	-2195.4
1994	-1743.7	2002	-2134.9
1995	-1620.8	2003	-2135.9
1996	-1705.1	2004	-2183.7
1997	-2132.2	2005	-2246.2

Non-CO_2 emissions from the 5A 'Forest Land' category was not recalculated, as such emissions were not estimated under the FNC of the RM under the UNFCCC (2000). Thus, the non-CO_2 emissions from the 5A 'Forest Land' category, over the time period from 1990 through 2005, were estimated for the first time. The obtained results demonstrate that over the period under review, the non-CO_2 emissions (CH_4, CO, N_2O and NO_x) from forest areas affected annually by fires in the RM decreased by circa 93 percent (Table 7-18).

Table 7-18: Non-CO_2 Emissions from Areas Annually Affected by Fires in the Republic of Moldova in the time series from 1990 through 2005, Gg

GHG	1990	1991	1992	1993	1994	1995	1996	1997
CH_4	0.01118	0.00187	0.00205	0.00014	0.00312	0.00018	0.00104	0.00032
N_2O	0.00062	0.00010	0.00011	0.00001	0.00017	0.00001	0.00006	0.00002
CO	0.25444	0.04258	0.04661	0.00318	0.07097	0.00409	0.02373	0.00720
NO_x	0.00713	0.00119	0.00131	0.00009	0.00199	0.00011	0.00067	0.00020
GHG	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**
CH_4	0.00314	0.00235	0.00008	0.00530	0.00285	0.00312	0.00819	0.00078
N_2O	0.00017	0.00013	0.00000	0.00029	0.00016	0.00017	0.00045	0.00004
CO	0.07140	0.05339	0.00191	0.12076	0.06483	0.07097	0.18644	0.01780
NO_x	0.00200	0.00150	0.00005	0.00339	0.00182	0.00199	0.00523	0.00050

7.2.6 Planned Improvements

Possibilities to improve accounting of distribution of forests by species, actual consumption of fuel wood from the managed forest land of the Republic of Moldova, and undertake actions aimed at verification of country specific removals factors (annual net increment in volume suitable for industrial processing, basic wood density, biomass expansion factors, etc.) will be considered for the next inventory cycle.

7.3 Cropland (Category 5B)

7.3.1 Source Category Description

5B 'Cropland' comprises GHG emissions/removals originated from two categories (5B1 'Cropland Remaining Cropland' and 5B2 'Land Converted to Cropland'). In the Republic of Moldova, under the 5B1 'Cropland Remaining Cropland' category there are reported CO_2 emissions/removals estimates originated from 'Annual Change in Carbon Stocks in Living Biomass' and 'Annual Change in Carbon Stocks in Mineral Soils', as well as non-CO_2 emissions from post harvest field burning of agricultural residues (stubble fields burning).

Annual Change in Carbon Stocks in Living Biomass

The 'Annual Change in Carbon Stocks in Living Biomass' sink category comprises CO_2 removals from cropland covered with woody vegetation, including aboveground and belowground biomass in protection forest strips, woody crops an shrubs plantations, other types of forest vegetation, as well as from perennial plantations: orchards, vineyards, trees from private gardens. Though having a smaller share in CO_2 removals in comparison with forests, the respective sink category is still quite important in the total balance per sector, as the quantitative share in the general land structure per country of these sources reach up to 10 percent.

According the General Land Cadastre of the Republic of Moldova (standing as of 01.01.2005), the areas with forest vegetation not regarded as forest resources covered 49.3 thousand ha or 1.5 percent of the country's territory, including 30.8 thousand ha – protection forest strips (by the side of agricultural fields, roads, rivers and water pools, etc.), and 18.5 thousand ha–other types of forest vegetation (woody crops and shrubs plantations, green spaces, parks, squares, etc.), which also substantially contribute to maintaining the ecological balance.

In conformity with records available in the Republic of Moldova, forest vegetation not regarded as forest resources includes the following categories: (a) protection forest strips by the side of agricultural fields; (b) protection forest strips and woody crops and shrubs plantations along the communication ways; (c) water protection forest strips; (d) groups of trees and separately standing trees within the urban and settlement areas.

The Republic of Moldova has a relatively wide experience in planting protection forest strips (in particular after the Second World War period). At the time of starting and along the entire process, the main emphasis was laid on anti-erosion component, and partially, on obtaining additional amounts of food products, etc. This focus determined the composition of protection forest strips (Paladiiciuk, 1986), comprising: Juglans spp. – 38 percent; Robinia spp. – 36 percent; Quercus spp. – 9 percent; Populus spp. – 4 percent; other species – 13 percent. At the same time, in this sphere the Republic of Moldova has 297.8 thousand ha (8.8 percent of the country's territory) of perennial plantations (orchards, plantations of walnut species, vineyards, etc.).

Annual Change in Carbon Stocks in Mineral Soils

Under the 'Annual Change in Carbon Stocks in Mineral Soils' category there are reported CO_2 emissions from mineral soils. This source has a significant share in the total national emissions from the LULUCF Sector, as according the General Land Cadastre of the Republic of Moldova (standing as of 01.01.2005), this source includes arable lands which occupy 1839.7 thousand ha or 54.4 percent of the territory of the country. It should be mentioned that over the period from 1990 through 2005, the areas of arable lands remained relatively constant, increasing only by circa 6 percent.

Cropland change and soil management change can considerably affect the organic carbon stocks in mineral soils (according the FAO classification: mineral soils are soils with moderate content of organic matter; unlike organic soils which contain 12-20 percent of organic matter from total mass, it should be noted that there are no such types of soils in the Republic of Moldova).

Mineral soils are a carbon pool that is influenced by land-use and management activities. Land use can have a large effect on the size of the pool through activities such as conversion of native 'Grassland' and 'Forest Land' to 'Cropland', where 20-40 percent of the original soil carbon can be lost. Within a land-use type, a variety of management practices can also have a significant impact on soil organic carbon storage, particularly in Cropland and Grassland. In principle, soil organic C stocks can change with management or disturbance if the net balance between C inputs and C losses from soil is altered. Management activities influence organic C inputs through changes in plant production (such as fertilization or irrigation to enhance crop growth), direct additions of C in organic amendments, and the amount of carbon left after biomass removal activities, such as crop harvest, timber harvest, fire, or grazing. Decomposition largely controls C outputs and can be influenced by changes in moisture and temperature regimes as well as the level of soil disturbance resulting from the management activities. Other factors also influence decomposition, such as climate and edaphic characteristics.

Non-CO_2 Emissions from Post Harvest Field Burning of Agricultural Residues (Stubble Fields Burning)

'Post Harvest Field Burning of Agricultural Residues' (stubble fields burning) is a rather frequent practice, in particular, in developing countries. According to more recent estimations, in some developing countries, up to 40 percent of crop residues are burnt in fields (in developed countries this percentage is much smaller, less than 10 percent).

It should be noted that in cases when crop residues are removed from fields to be used as fuel for heating and cooking, emissions from burning are estimated under Energy Sector. Only non-CO_2 emissions (CH_4, N_2O, NO_x and CO) are monitored under this category, as CO_2 emissions are not regarded as a source of emissions (carbon emitted in atmosphere is considered to be re-absorbed in the following agricultural cycle). The amount of crops residues vary in different years, and depend on crops and management technologies.

Crop residues are burnt in fields to clear the stubble fields from the straw left after reaping (in the Republic of Moldova, stubble fields are most often burnt after reaping of wheat and barley) and to prepare the fields for the next agricultural cycle. It should be noted that though burning of stubble fields is prohibited by law, this practice still persist in the Republic of Moldova.

7.3.2 Methodological Issues and Data Sources

Annual Change in Carbon Stocks in Living Biomass

For estimating CO_2 removals from the 'Annual Change in Carbon Stocks in Living Biomass' under the 5B1 'Cropland Remaining Cropland' category, it was necessary to determine annual biomass increments in woody vegetation not included in forestry resources and perennial plantations (according to production tables and forest planning). The calculations was done based on annual change in carbon stocks in as a result of perennial woody crops growth (in stem, shoots, roots and leaves), by using the following equation:

$$CO_2\,cc_{LB} = \Delta Ccc_{LB} \bullet 44/12$$

Where:

$CO_2\,cc_{LB}$ = CO_2 removals from annual change in C stocks in living biomass (Gg/yr);

ΔCcc_{LB} =annual change in carbon stocks in living biomass, tC/yr;

[44/12] = stoichiometric ratio of carbon fraction in CO_2 and C.

$$\Delta Ccc_{LB} = A \bullet (G + L)$$

Where:

A = area of cropland with perennial woody biomass;

G = annual biomass increments in perennial woody crops, t C/ha/yr;

L = annual volume of harvested biomass, t C/ha/ yr.

Under the 5B1 'Cropland Remaining Cropland' category there were used estimation methods available in the Revised 1996 Guidelines (IPCC, 1996), GBP LULUCF (IPCC, 2003) and 2006 IPCC Guidelines (IPCC, 2006).

Country specific removal factors were used (pertaining to annual growth rate of perennial woody biomass and annual carbon stock in biomass removed), as well as other relevant information (areas covered with forests strips, trees and shrubs plantations, orchards, vineyards, wood harvesting, etc.).

Annual wood harvesting from orchards and vineyards occurs during the cleaning cuttings. Wood harvesting from forest strips and other types of vegetation, 95 percent of which are managed by local public authorities, is not specified statistically, as the available national records for this type of vegetation are insufficient.

The volume of commercial timber and illegal logging from forests and other types of woody vegetation were included in 5A 'Forest Land' category. So, the total CO_2 balance reported under the LULUCF Sector is not affected.

Most orchards follow the 4 x 3 m and 5 x 4 m planting schemes. In this case, the number of trees per 1 ha is respectively, 850 and 500. For estimating the number of trees growing in orchards, it was agreed to develop an average of the two schemes. So, the reference figure is 675 trees per 1 ha of orchards. For estimating the participation level of trees growing in private rural orchards, there was used a conventional average number of 10 trees per household. In order to estimate the biomass increments in perennial woody crops on croplands, and implicitly, the resulting CO_2 stocks, there were used activity data available in the General Land Cadastre of the Republic of Moldova on areas occupied by such crops over the period from 1990 through 2005 (Tables 7-19 and 7-20).

Table 7-19: Areas of Other Types of Woody Vegetation in the Republic of Moldova within the 1990-2005 time series, thousand ha

Year	Total	Woody vegetation not included in forest resources	
		Protection forest strips	Other types of forest vegetation
1990	47.0	31.4	15.6
1991	47.0	31.0	16.0
1992	47.8	31.7	16.1
1993	48.5	31.5	17.0
1994	47.0	30.6	16.4
1995	54.1	30.4	23.7
1996	45.2	30.6	14.6
1997	54.6	30.8	23.8
1998	51.5	30.6	20.9
1999	49.4	31.0	18.4
2000	50.9	30.7	20.2
2001	50.5	31.1	19.4
2002	50.0	30.7	19.3
2003	50.5	30.6	19.9
2004	49.1	30.5	18.6
2005	49.3	30.8	18.5

Source: General Land Cadastre of the Republic of Moldova for the period of time from 1990 through 2005.

Table 7-20: Area of Cropland with Perennial Woody Biomass in the Republic of Moldova within the 1990-2005 time series

Year	Area of vineyards, thousand ha	Area of orchards, thousand ha	Total number of trees, thousand	Number of households	Total number of trees, thousand
1990	211.5	262.6	177255.0	837891	8378.9
1991	212.8	260.7	175972.5	837400	8374.0
1992	213.0	257.8	174015.0	837205	8372.0
1993	212.0	254.0	171450.0	857616	8576.2
1994	205.5	242.9	163957.5	878978	8789.8
1995	201.6	229.1	154642.5	887432	8874.3
1996	195.9	216.7	146272.5	899714	8997.1
1997	191.4	207.7	140197.5	912835	9128.3
1998	185.8	200.0	135000.0	908577	9085.8
1999	176.9	193.9	130882.5	907396	9074.0
2000	168.7	183.6	123930.0	906611	9066.1
2001	162.2	172.7	116572.5	905422	9054.2
2002	153.6	152.1	102667.5	827224	8272.2
2003	152.8	148.0	99900.0	805754	8057.5
2004	153.0	145.0	97875.0	852404	8524.0
2005	155.5	142.3	96052.5	830665	8306.7

Source: General Land Cadastre of the Republic of Moldova for the period of time from 1990 through 2005.

For estimating annual biomass increments and losses in perennial woody crops, country specific emission factors were developed. Calculation of such factors was based on production tables, data on productivity of protection woody vegetation taken from data accounting and forest planning records, as well as data from scientific literature on perennial plantations management (Table 7-21).

Table 7-21: Removals Factors Used under the 5B1 'Cropland Remaining Cropland' Category

Category	Annual biomass increments, t C/ha/yr	Annual volume of harvested biomass, t C/ha/yr
Protection forest strips	1.42	-
Other types of forest vegetation	0.98	-
Vineyards	0.20	0.08
Orchards	0.50	0.20
Trees in private gardens	0.50	0.20

Source: Ukrainian Forest Management Service: Forestry Resources of the Moldavian Soviet Socialist Republic, standing as of 1.01.1988, Irpeni, 1988; Gh. Vdovii, D. Galupa et al. (1997), National Report on Forestry Resources of the Republic of Moldova, Giurgiu V., Decei I., Armasescu S. Biometry of Trees and Rammels in Romania, 1972; Kapp G., Velsen-Zerweck M., Horst A., Horn L., Galupa D. Talmaci I. et al.: The Baseline Study for the Soils Conservation Project, in Moldova, 2003; Vanin S. I. (1949), Wood Science. Moscow.

Annual Change in Carbon Stocks in Mineral Soils

The method used to estimate CO_2 emissions from the loss of soil carbon due to land use change and soil management practices in the Republic of Moldova, is a simplified Tier 2 method (IPCC, 2006). The following equations were used to calculate respective emissions:

$$CO_{2\ soils} = \Delta C_{\ mineral} \bullet 44/12$$

Where:

$CO_{2\ soils}$ = CO_2 emissions from annual change in carbon stocks in soils due to land use change and soil management practices (Gg/yr);

$\Delta C_{\ mineral}$ = annual change in organic carbon stocks in mineral soils (t C/yr);

[44/12] = stoichiometric ratio of carbon fraction in CO_2 and C.

$$\Delta C_{\ mineral} = (SOC_0 - SOC_{(0\text{-}T)}) / D$$

Where:

$\Delta C_{\ mineral}$ = annual change in organic carbon stocks in mineral soils (t C/yr);

T = number of years over a single inventory time period;

D = time dependence of stock change factors, the default value used is commonly 20 years;

SOC_0=soil organic carbon stock in the last year of an inventory time period (tC);

$SOC_{(0\text{-}T)}$=soil organic carbon stock at the beginning of the inventory time period (tC).

$$SOC = \Sigma\ (SOC_{REF} \bullet F_{LU} \bullet F_{MG} \bullet F_I \bullet A)$$

Where:

SOC_{REF} = the reference carbon stock for mineral soils (tC/ha in 0-30 cm depth);

F_{LU} = stock change factor for land-use systems or sub-system for a particular land-use for 20 years; default value for regions with temperate climate is 0.82;

F_{MG} = stock change for management regime, dimensionless; the default value used for regions with temperate climate, where substantial soil disturbance with full inversion and/or frequent tillage operations are undertaken and at planting time, little of the surface is covered by residues, is 1;

F_I = stock change factor for input of organic matter, dimensionless; the default values used for regions with temperate climate, representative for annual cropping with cereals where all crop residues are returned to the field and/or if residues are removed, then supplemental organic matter (e.g. manure) is added, was assumed to be 1.0 (in the RM it is characteristic for the base year), while in case of low residue return due to removal of residues via collection or burning (in the RM it is characteristic to the last inventory years), was assumed to be around 0.90-0.92;

A = land area of the stratum being estimated (ha/year).

The following has been taken into account while estimating annual soil carbon losses:

By agricultural practices used on arable lands in the RM as well as soil and climate conditions there is one single agricultural area by land use criteria (the range of soils in the RM is rather homogenous, being preponderantly represented by chernozems);

No significant changes in soil management practices occurred over the time period from 1990 through 2005: as substantial soil disturbance with full inversion is predominant on all arable lands, the default value of the coefficient used for soil management practices or frequent tillage operation, was used (F_{MG} = 1);

Since 1990, the amount of carbon removed from arable soils increased essentially, in particular, due to the fact that the amount of organic fertilizer applied to soils, and crop residues returned to soils gradually decreased (also as a consequence of 2-3 times decrease in basic crop yields);

Taking into account the national circumstances and keeping in mind the recommendations set forth in the GPG for LULUCF (IPCC, 2003), there were selected F_I values corresponding to moving over the inventory covered period, from moderate input of organic matter returned in soil (for $SOC_{(0\text{-}T)}$, F_I = 1) to low input of organic matter returned in soil (for SOC_0, F_I = 0.9);

The stocks of organic soil carbon at the beginning of the inventory period were estimated based on default values of F_{LU}, F_{MG}, and F_I, as well as based on a factor identified in the national scientific literature – the results of long term research were taken into account (Ursu, 2000), indicating that in 1990 the content of humus in arable soils in the RM (layer of 0-30 cm) was circa 3 percent or 110 tones humus/ha, respectively, $SOC_{(0-T)}$ = 64 t C/ha (in 1897 the content of humus in the soils in the RM was circa 200 tones humus/ha or 116 t C/ha, in 1950 - circa 150 tones humus/ha or 87 t C/ha, in 1965 - circa 130 tones humus/ha or 75 t C/ha);

The stocks of organic soil carbon in the last year of the inventory (SOC_0) were estimated based on default values of F_{LU}, F_{MG}, and F_I, as well as based on national coefficients of the SOC_0 and $SOC_{(0-T)}$. By 2005, the stocks of organic soil carbon in the Republic of Moldova were circa 57.6 t C/ha, which corresponds to medium annual soil carbon losses of circa 320 kg/ha;

It should be noted that the major part of soils of the RM became managed soils circa 100-150 years ago and over time lost about 25-30 percent of the carbon stock. The direct measurements performed on the leached chernozems in the Northern part of the country showed that over the past 60 years the managed soil lost 37 percent of the carbon stock, and the average annual loss rate is 300 kg C/ha/year (Soils of Moldova, Volume 1, 1989). The 30-40 years long term experience of the Institute of Pedology, Agrochemistry and Soil Protection "Nicolae Dimo", manly in the soils and climate zones of the country by sub-types of chernozems predominant among other soils, shows that annual soil carbon loss rates are greatly dependant on the zone and sub-type of the chernozems, being circa 325 kg C/ha/yr (Ecopedological Monitoring Bulletin, 7th edition, 2000). The rates with very close values were determined under the oldest long term experiments in the country performed by the State Agrarian University of Moldova in Chetrosu village, Anenii Noi district, on carbonated chernozems (Zagorcea, 1990). Other researchers identified values between 300-330 kg C/ha/year of carbon losses in currently managed soils (Ungureanu et al., 1997; Andries, 1999; Banaru, 2001).

Estimation of emissions from the 'Annual Change in Carbon Stocks in Mineral Soils' category was based on activity data on areas of arable lands available in Statistical Yearbooks of the RM and General Land Cadastres of the RM (Table 7-22)

Table 7-22: Areas of Arable Lands in the Republic of Moldova, 1990-2005

Years	Arable lands, thousand ha	Years	Arable lands, thousand ha
1990	1733.6	1998	1809.9
1991	1736.3	1999	1813.8
1992	1744.5	2000	1820.7
1993	1744.7	2001	1839.7
1994	1758.7	2002	1842.6
1995	1774.0	2003	1845.4
1996	1784.8	2004	1840.2
1997	1795.8	2005	1833.2

Source: General Land Cadastres of the RM (1990-2005); Statistical Yearbooks of the RM (1990-2005).

Based on information and activity data provided above, there were calculated the annual change in carbon stocks in mineral soils ($\Delta C_{mineral}$) (Table 7-23).

Table 7-23: Annual Change in Carbon Stocks in Mineral Soil in the RM, 1990-2005

Years	ΔC mineral, kt C/yr	Years	ΔC mineral, kt C/yr
1990	554.41	1998	578.81
1991	555.27	1999	580.05
1992	557.89	2000	582.26
1993	557.96	2001	588.34
1994	562.43	2002	589.26
1995	567.33	2003	590.16
1996	570.78	2004	588.50
1997	574.30	2005	586.26

Source: Zagorcea, 1990; Ungureanu, et al., 1997; Andries, 1999; Banaru, 2001.

The obtained results indicate on certain rhythm of changes in soil carbon stocks over the period under review in the RM equivalent to 320 kg C/ha/yr, ranging from 300 to 330 kg C/ha/yr, which is a value close to experimental results obtained by a range of authors in the RM (Zagorcea, 1990; Ungureanu et al., 1997; Andries, 1999; Banaru, 2001).

Non-CO_2 Emissions from Post Harvest Field Burning of Agricultural Residues (Stubble Fields Burning)

Non-CO_2 emissions from the 5B1 'Cropland Remaining Cropland' category were estimated by using a Tier 1 methodology.

$$L_{fire} = A \bullet M_B \bullet C_f \bullet G_{ef} \bullet 10^{-3}$$

Where:

L_{fire} = amount of non-CO_2 greenhouse gas emissions from vegetation fires (field burning of agricultural residues or stubble fields burning), t GHG/yr;

A = area burnt, ha/yr;

M_B = mass of fuel available for combustion, tonnes/ha;

C_f = combustion factor; IPCC default value is 0.90 (IPCC, 2006);

$M_B \bullet C_f$ = amount of fuel actually burnt; default for 'Agricultural Residues" (post harvest field burning), in particular, for wheat and barley residues, which are more frequently burned in the RM, is 4 t dm/ha (IPCC, 2006);

G_{ef} = default EF (kg/t dm) (see Table 7-24).

Table 7-24: EFs for Various Types of Burning, kg GHG /tonnes dry matter burnt

Category	CO	CH_4	N_2O	NO_x
Agricultural residues	92	2.7	0.07	2.5
Grassland	65	2.3	0.21	3.9

The activity data on areas sown with grain crops (wheat and barley) are available in the Statistical Yearbooks of the Republic of Moldova and of ATULBD (Table 7-25).

Table 7-25: Sown Areas with Cereals in the Republic of Moldova, 1990-2005

Years	Sown areas, thousand hectares	Years	Sown areas, thousand hectares
1990	401.4	1998	539.3
1991	442.4	1999	518.9
1992	421.9	2000	545.6
1993	553.6	2001	596.3
1994	499.3	2002	633.9
1995	529.1	2003	305.3
1996	489.6	2004	479.5
1997	539.5	2005	561.5

Source: Statistical Yearbooks of the RM for 1996 (page 324), 1999 (page 328), 2006 (page 341); Statistical Yearbooks of the ATULBD for 1998 (page 218), 2002 (page 113) and 2005 (page 101).

Table 7-26 below provides the information on post harvest field burning of agricultural residues (stubble fields burning) cases in the RM reported annually by the Territorial State Environmental Agency's inspectors. As activity data were not available for the period of time from 1990 through 1994, these data were extrapolated based on the assumption that the areas of stubble fields combusted annually make circa 3 percent of the total areas under the respective cereals (wheat and barley).

The activity data on the amount of crop residues available to be combusted onsite (Table 7-27) were inferred from information on average crop yield per hectare, by multiplying it to the dry matter fraction in the basic yield of the respective crop (default value is 0.89). While estimating the amount of agricultural residues available for combustion on site, a mean arithmetic value between wheat and barley was used which is closely related to the average yield per hectare, actually reported in the Republic of Moldova over the reference period.

Table 7-26: Post Harvest Field Burning of Agricultural Residues (Stubble Fields Burning) in the Republic of Moldova, 1990-2005

Source	1990	1991	1992	1993	1994	1995	1996	1997
Burnt stubble fields, thousand ha	12.0	13.3	12.7	16.6	15.0	15.8	18.6	20.7
Burnt stubble fields, % from total	3.0	3.0	3.0	3.0	3.0	3.0	3.8	3.8
Source	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**
Burnt stubble fields, thousand ha	21.5	24.0	11.5	9.5	2.0	0.1	0.4	2.2
Burnt stubble fields, % from total	4.0	4.6	2.1	1.6	0.3	0.0	0.1	0.4

Source: National Environmental Reports of the Republic of Moldova for years of 2002 (page 73) and 2006 (page 57)

Table 7-27: Amount of Crop Residues Available for Combustion Onsite in the Republic of Moldova within the 1990-2005 time series, t dm/ha

Crops	1990	1991	1992	1993	1994	1995	1996	1997
Wheat	3.5	3.1	2.9	3.6	1.9	2.9	2.0	3.0
Barley	3.2	2.6	2.6	2.8	2.5	2.1	1.3	2.3
Cereals (average)	3.4	2.9	2.8	3.2	2.2	2.5	1.6	2.7
Crops	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**
Wheat	2.6	2.1	1.7	2.4	2.2	0.4	2.7	2.4
Barley	1.9	1.6	1.1	2.1	1.8	0.6	2.1	1.7
Cereals (average)	2.2	1.9	1.4	2.3	2.0	0.5	2.4	2.0

7.3.3 Uncertainties and Time-Series Consistency

Annual Change in Carbon Stocks in Living Biomass

Uncertainties related to CO_2 removals from the 'Annual Change in Carbon Stocks in Living Biomass' source and sink category may be considered relatively acceptable, however exceeding values were reported for other source categories under LULUCF Sector. So, for production processes the uncertainties account for circa ±25 percent, and uncertainties related to emission/removal factors are of circa ±10 percent. The main uncertainty pertains to the actual volume of wood mass harvested from woody vegetation managed by local public authorities and other owners, as for this category there is no accurate statistics on about the volume of wood mass harvested during forest clearings. Some consolidated information in this field is available at the State Ecological Inspectorate (SEI), which is as an institution that authorises fellings of any type of forest vegetation (based on Article 40 of the Law on Environment Protection, and Article 22 of the Forest Code, on state control and state control data). So, over the period from 2000 through 2005, the IES authorised harvesting of 32.8 thousand m^3 of wood mass from the forestry resources and other types of forest vegetation managed by local public authorities. This volume was not separated by categories of woody vegetation. The current system of monitoring and control of production processes in forestry sector is applied (with some imperfection) only in forests managed by the State Forestry Agency "Moldsilva". Forest resources and woody vegetation managed by local public authorities is practically beyond these activities. A considerable part of illicit logging is not even reported. As a consequence, it generates massive illegal logging on forest land managed by local public authorities. According to the National Complex

Program on Rehabilitation of Degraded Lands and Enhancing Soils Fertility (Government Resolution No. 636 from 26 of May 2003), circa 12 percent of areas of protection forest strips need partial reconstruction (because of low consistency of 0.3-0.6), and circa 6 percent need a total reconstruction (consistencies under 0.3). In some districts, the portion of areas that need reconstruction (partial or total) are quite significant (Rezina – 94 percent, Anenii Noi – 45 percent, Soroca – 44.5 percent, Drochia – 26.5 percent etc.). Combined uncertainties for category 5B1 'Cropland Remaining Cropland' ('Annual Change in Carbon Stocks in Living Biomass') are considered medium (±26.93 percent). The combined uncertainties as a percentage of total direct sectoral emissions/removals were estimated at ±9.07 percent. The uncertainties introduced in trend in sectoral emissions were estimated at ±9.87 percent (see Annex 7-3.5).

In view of ensuring time-series consistency of the obtained results, the same approach was used for the entire period under review, in conformity with the recommendations included in the Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories (IPCC, 2000).

Annual Change in Carbon Stocks in Mineral Soils

Uncertainties related to activity data on areas of arable lands in the Republic of Moldova are deemed to be low (±10 percent). Uncertainties related to factors used to estimate CO_2 emissions from change in carbon stocks in mineral soils due to land use change and soil management practices are considered being moderate (±20 percent). So, combined uncertainties related to CO_2 emissions from the 'Annual Change in Carbon Stocks in Mineral Soils' can be regarded also as being moderate (±22.36 percent). At the same time, the combined uncertainties as a percentage of total direct sectoral emissions/removals were estimated at ±34.80 percent. The uncertainties introduced in trend in sectoral emissions/removals were estimated at ±19.05 percent (see Annex 7-3.5).

In view of ensuring time-series consistency of the obtained results, the same approach was used for the entire period under review, in conformity with the recommendations included in the Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories (IPCC, 2000).

Non-CO_2 Emissions from Post Harvest Field Burning of Agricultural Residues (Stubble Fields Burning)

Uncertainties associated with the non-CO_2 emissions from post harvest field burning of agricultural residues result from uncertainties related to activity data on the amounts of agricultural residues available to be burnt onsite, as well as those related to emission factors for various types of burning. Uncertainties related to activity data on areas occupied by cereals and average yield per hectare reported for these crops are considered relatively small (up to ±10 percent). At the same time uncertainties related to estimation the areas of stubble fields actually burnt are considered to be medium (up to ±50 percent). Uncertainties associated with the default emission factors for various types of burning are moderate for CH_4 (±30 percent) and medium for N_2O (±50 percent), however, in agricultural seasons with high humidity these uncertainties can increase to higher levels. So, combined uncertainties related to non-CO_2 emissions from post harvest field burning of agricultural residues are regarded to be relatively high (±58.31 percent for CH_4 and ±70.71 percent for N_2O). At the same time, the combined uncertainties as a percentage of total direct sectoral emissions/removals are quite insignificant.

In view of ensuring time-series consistency of the obtained results, the same approach was used for the entire period under review, in conformity with the recommendations included in the Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories (IPCC, 2000).

7.3.4 QA/QC and Verification

Standard verification and quality control forms and checklists by individual source and sink categories were filled in for 5B 'Cropland' category, following the Tier 1 and Tier 2 approaches (see in Annex 6). Also, the AD and methods used for estimating CO_2 emissions/removals from 5B 'Cropland' were documented and archived both in hard copies and electronically. To identify the data entry, as well CO_2 emission/removal estimations related errors there were applied AD and EFs verifications and quality control procedures. Verification was focused on correct use of AD obtained from different sources of reference; on ensuring correct use of the emission/removal factors available in the Revised 1996 IPCC Guidance (IPCC, 1997), GPG LULUCF (IPCC, 2003), 2006 IPCC Guidelines (IPCC, 2006) and in scientific literature, as well as in comparing EFs used with values used by other countries within the region for their inventory development. Inventory quality assurance activities for the LULUCF Sector were supported by an expert representing the Forest Research and Management Institute.

Following the recommendations included into the GPG (IPCC, 2000), CO_2 emissions/ removals under the 5B 'Cropland' in the Republic of Moldova were estimated based on AD from official sources of reference (Statistical Yearbooks of the RM and ATULBD; General Land Cadastres of the RM; Production Tables and Forest State Records (prepared periodically, once in 5 years); Forest Planning Materials;

Legislative, Normative and Technical Forestry Regulations Acts, etc.

7.3.5 Recalculations

Annual Change in Carbon Stocks in Living Biomass

The CO_2 removals from 'Annual Change in Carbon Stocks in Living Biomass' (5B1 'Cropland Remaining Cropland') there were recalculated for the 1990 through 1998 time series, in particular due to the fact that under the current inventory cycle, the categories of the IPCC GPG on LULUCF (IPCC, 2003) have replaced the source and sink categories available under the Land-Use Change and Forestry Sector (IPCC, 1997); also due to the fact that an essential part of indicators and activity data used (ex., areas with forest vegetation, annual biomass increments, etc.) were also revised.

To be noted as well that in the FNC of the RM under the UNFCCC (2000) there were not included all sources of CO_2 removals, in particular those associated with the vineyards and the trees in individual housing (private gardens). Also, in the FNC the amount of removals currently reported under the IPCC GPG on LULUCF category 5B 'Cropland', there was included into the category 5A 'Changes in Forestry and Other Woody Biomass Stocks', which have been estimated by using methodological approaches available in the Revised 1996 Guidelines (IPCC, 1997).

In comparison with CO_2 removal estimates included into the FNC under the former category 5A 'Changes in Forest and Other Woody Biomass Stocks', the changes performed resulted in increased CO_2 removals reported currently under the 5B1 'Cropland Remaining Cropland' category. For the period 1999-2005, CO_2 removals resulting from 'Annual Change in Carbon Stocks in Living Biomass' (5B1 'Cropland Remaining Cropland') were estimated for the first time. The obtained results allow assert that within the 1990-2005 time series, CO_2 removals resulting from the respective sink category decreased by circa 35.8 percent (Table 7-28).

Table 7-28: CO_2 Removals under the Category 5B1 'Cropland Remaining Cropland' (Annual Change in Carbon Stocks in Living Biomass) in the RM, 1990-2005

Years	CO_2 CC_{LB}, Gg	Years	CO_2 CC_{LB}, Gg
1990	-725.2	1998	-551.0
1991	-613.1	1999	-533.4
1992	-614.0	2000	-523.4
1993	-611.9	2001	-507.7
1994	-590.3	2002	-477.6
1995	-598.6	2003	-474.0
1996	-551.0	2004	-466.4
1997	-573.4	2005	-465.3

Annual Change in Carbon Stocks in Mineral Soils

In the FNC the CO_2 emission resulted from the 'Annual Change in Carbon Stocks in Mineral Soils' was not included into the national greenhouse gas inventory. Despite this fact, the respective emissions were calculated for the 1990-1999 time series by using a country specific methodology (Banaru, 2000), the obtained results being reported in the Chapter 7 'Systematic Research and Observation' of FNC of the RM under the UNFCCC (2000) under the item 'Research in the Area of Greenhouse Gas Inventory'.

Under the current inventory cycle, CO_2 emissions from the 'Annual Change in Carbon Stocks in Mineral Soil's were estimated using both a simplified Tier 2 methodology (Table 7-29), and the same country specific methodology, that is equivalent to a Tier 3 methodological approach (see more details in the Annex 3-5).

When the simplified Tier 2 methodology (IPCC, 2006) was applied, the CO_2 emissions from the 'Annual Change in Carbon Stocks in Mineral Soils' tended to increase: in comparison with the reference year (1990), an increase by circa 5.7 percent was reported in 2005 year. The growth of respective emissions occurred due to the increase in the area of arable lands over the period under review, as well as due to the gradual decrease of amounts of organic fertiliser applied and amounts of crop residues returned to soils as a result of decrease in basic crop yields.

Table 7-29: CO_2 Emissions from 'Annual Change in Carbon Stocks in Mineral Soils' (Category 5B1 'Cropland Remaining Cropland') in the RM calculated following a simplified Tier 2 Methodology

Years	$CO_{2\ soils}$, Gg	Years	$CO_{2\ soils}$, Gg
1990	2032.8	1998	2122.3
1991	2036.0	1999	2126.9
1992	2045.6	2000	2135.0
1993	2045.8	2001	2157.2
1994	2062.3	2002	2160.6
1995	2080.2	2003	2163.9
1996	2092.9	2004	2157.8
1997	2105.8	2005	2149.6

A country specific methodological approach (Banaru, 2000) was also used (that is equivalent to a Tier 3 method). In comparison with the results included in the Chapter 7 'Systematic Research and Observation' of the FNC of the RM under the UNFCCC (2000), there were performed some minor recalculations due to usage of update input data for the respective model. The comparative analysis of results obtained in the First and Second National Communications under the CO_2 emissions from 'Annual Change in Carbon Stocks in Mineral Soils' (5B1 'Cropland Remaining Cropland') category is presented below (Table 7-30). However, the use of respective methodology still implies high uncertainties, as a consequence of usage incomplete activity data (not enough input data for covering the whole territory of the Republic of Moldova). In these circumstances, it was not deemed appropriate for now to report the obtained results in the National Greenhouse Gas Inventory (the results are presented here just for comparison purposes).

Table 7-30: Comparative Results of the CO_2 Emissions from 'Annual Change in Carbon Stocks in Mineral Soils' in the RM, calculated following a Tier 3 Methodological Approach, reported in the FNC and SNC of the RM under the UNFCCC, Gg

	1990	1991	1992	1993	1994	1995	1996	1997
FNC	289	289	216	1629	998	1479	1299	2323
SNC	202	257	205	1747	1127	1596	1321	2323
Difference, %	-30.1	-11.1	-5.1	7.2	12.9	7.9	1.7	0.0
	1998	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**
FNC	1649	2099						
SNC	1644	2250	1699	1787	2011	1699	2279	2554
Difference, %	-0.3	7.2						

Non-CO_2 Emissions from Post Harvest Field Burning of Agricultural Residues (Stubble Fields Burning)

The non-CO_2 emissions from 'Post Harvest Field Burning of Agricultural Residues' (Stubble Fields Burning) there were recalculated for the 1990 through 1998 time series, in particular due to the fact that under the current inventory cycle, the categories of the IPCC GPG on LULUCF (IPCC, 2003) have replaced the source and sink categories available under the Revised 1996 IPCC Guidance (IPCC, 1997); also due to the fact that an essential part of activity data used (in particular, those available in the Statistical Yearbooks of the RM and ATULBD) were also revised. To be noted also, that the respective emissions have been reported in the FNC into the Agriculture Sector under the category 4F 'Field Burning of Agricultural Residues', while under the current inventory cycle, respectively under the category 5B1 'Cropland Remaining Cropland'.

The changes made for the period of time from 1990 to 1998 generally, resulted in lower values of non-CO_2 emissions from 'Post Harvest Field Burning of Agricultural Residues', except for CO emissions for certain reported years (ex., for 1989-1991, 1993, 1995 and 1997-1998 years).

Thus, for CH_4 emissions, the decrease varied from a minimum of 95.3 percent in 1997 to a maximum of 97.7 percent in 1996; for N_2O emissions the reported decrease varied from a minimum of 85.3 percent in 1997, to a maximum of 92.8 percent in 1996, while for NO_x emissions the decrease varied from a minimum of 85.4 percent in 1997 to a maximum 92.8 percent in 1996; for CO emissions, the reported decrease varied from a minimum of 5.9 percent in 1994, to a maximum of 10.3 percent in 1996, the minimal increase being reported in 1991 (7.8 percent) and the maximal increase in 1997 (82.9 percent).

For the period 1999-2005, non-CO_2 emissions resulting from 'Post Harvest Field Burning of Agricultural Residues' were estimated for the first time. The obtained results allow assert that within the 1990-2005 time series, the non-CO_2 emissions resulting from vegetation fires under the 5B1 'Cropland Remaining Cropland' category decreased by circa 89 percent (Table 7-31). To be noted that the reported decrease was due to combating measures aimed at controlling burning of stubble fields, as well as lower productivity of grain crops in the last years (as a result of inefficient land management and due to unfavourable climate conditions; ex., very severe droughts affected the RM in 2003 and 2007 years).

7.3.6 Planned Improvements

Annual Change in Carbon Stocks in Living Biomass

The possibility to improve records pertaining to actual consumption of fuel wood from forest strips and other types of woody vegetation, as well as pursue activities aimed at verification of the country specific emission/removal factors (annual biomass increments, biomass harvesting during the cleaning cuttings of perennial plantations, etc.), will be considered for the next inventory cycle.

Table 7-31: Non-CO_2 Emissions from 'Post Harvest Field Burning of Agricultural Residues' in the RM within the 1990-2005 time series, Gg

GHG	1990	1991	1992	1993	1994	1995	1996	1997
CH_4	0.0987	0.0920	0.0849	0.1278	0.0811	0.0951	0.0728	0.1336
CO	3.3636	3.1348	2.8912	4.3540	2.7621	3.2398	2.4809	4.5534
N_2O	0.0026	0.0024	0.0022	0.0033	0.0021	0.0025	0.0019	0.0035
NO_x	0.0914	0.0852	0.0786	0.1183	0.0751	0.0880	0.0674	0.1237
GHG	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**
CH_4	0.1165	0.1082	0.0390	0.0525	0.0095	0.0001	0.0023	0.0109
CO	3.9689	3.6875	1.3284	1.7887	0.3228	0.0041	0.0785	0.3700
N_2O	0.0030	0.0028	0.0010	0.0014	0.0002	0.0000	0.0001	0.0003
NO_x	0.1078	0.1002	0.0361	0.0486	0.0088	0.0001	0.0021	0.0101

Annual Change in Carbon Stocks in Mineral Soils

It is planned to carry out activities aimed at reducing uncertainties associated with the results obtained under the respective source category, inclusive by improving the country specific methodology (Banaru, 2000) and improving the quality of used activity data, in order to make possible estimation of CO_2 emissions/removals from 'Annual Change in Carbon Stocks in Mineral Soils', based on the higher tier methodology in the next inventory cycle.

Non-CO_2 Emissions from Post Harvest Field Burning of Agricultural Residues (Stubble Fields Burning)

It is planned to carry out activities aimed at updating activity data used to estimate non-CO_2 emissions from post harvest field burning of agricultural residues (stubble fields burning) in the next inventory cycle.

7.4 Grassland (Category 5C)

7.4.1 Source Category Description

5C 'Grassland' comprises GHG emissions/removals originated from two source and sink categories, 5C1 'Grassland Remaining Grassland' and 5C2 'Land Converted to Cropland'.

Grassland is an area of land covered with perennial herbaceous vegetation used for grazing animals (pastures and hayfields). Under LULUCF Sector grassland account for 24 percent of the total CO_2 removals, being a very important sink category in the Republic of Moldova. At the same time the quantitative share of the grassland in the general land structure of the country is only around 11 percent. So, according to the General Land Cadastre (standing as of 01.01.2005), the area of grassland was 373.5 thousand ha (33.4 thousand ha – in public ownership of the state, 336.9 thousand ha – in public ownership of local public authorities and 3.2 thousand ha – in private ownership).

Activity data used within the development of inventory for the period of time from 1990 through 2005 are available in the General Land Cadastres of the RM, as well as in the Reports of the State Forestry Agency "Moldsilva" and in the Reports of the State Ecological Inspectorate.

Current inventory comprised estimation of CO_2 removals from the 5C1 'Grassland Remaining Grassland' category, resulting from the growth of aboveground biomass included in "pastures" and "hayfields" categories, and CO_2 emissions/removals from the 5C2 'Land Converted to Grassland' category resulting from growth of grassland vegetation after conversion of cropland to grassland, and from former forest land converted to grassland.

Conversion of cropland to grassland is a regular process over the past 15 years in the Republic of Moldova, because a considerable part of cropland is severely affected by erosion and reached to an extremely low level of economic efficiency of cropping.

Another negative process that started in the 1990' along with the social-political changes is conversion of lands with woody vegetation. This process mostly affected lands managed by local public authorities and agricultural enterprises (in particular in the time period from 1990 through 1996). Over 80 percent of such vegetation is *Robinia pseudoacacia* rammels. In most cases (90 percent of the total), the wood mass harvested on these lands is used as fuel used for heating. Circa 10 percent only (shoots, bark etc.) remain on the cutting site. Brush burning on site is not practiced. This process started in 1991, the lowest indicators being reported for the time period from 1993 through 1997.

7.4.2 Methodological Issues and Data Sources

5C1 'Grassland Remaining Grassland'

For estimating CO_2 removals from the 5C1 'Grassland Remaining Grassland' category, it was necessary to determine average annual biomass growth of grasses in conformity with national available data. The calculation was done based on annual change in carbon stocks in living biomass, by using the following equations:

$$CO_2\ {}^{GG}{}_{LB} = \Delta C\ {}^{GG}{}_{LB} \bullet 44/12$$

Where:

$CO_2\ {}^{CC}{}_{LB}$ = CO_2 removals from annual change in C stocks in living biomass (Gg/yr);

$\Delta C\ {}^{GG}{}_{LB}$ =annual change in carbon stocks in living biomass, tC/yr;

[44/12] = stoichiometric ratio of carbon fraction in CO_2 and C.

$$\Delta C\ {}^{GG}{}_{LB} = (\Delta B_{perennial} + \Delta B_{grasses}) \bullet CF$$

Where:

$\Delta B_{perennial}$ = change in above and belowground perennial woody biomass (in case of the RM, the respective areas were included under category 5B1 'Cropland Remaining Cropland'), t dm/ha/yr;

$\Delta B_{grasses}$ = change in belowground biomass of grasses, t dm/ha/yr;

CF =carbon fraction of dry matter (0.5).

$$\Delta B_{grasses} = A_{grasses} \bullet (G_{grasses} - L_{grasses})$$

Where:

$A_{grasses}$ = area of grasslands covered with grasses, thousand ha;

$G_{grasses}$ = average annual biomass growth of grasses, t dm/ha/yr;

$L_{grasses}$ = average annual biomass loss of grasses, t dm/ha/yr.

The main source of reference for the activity data on area of grassland covered with grasses (Table 7-32) is the General Land Cadastres of the RM for the period under review.

Table 7-32: Area of Grassland Covered with Grasses in the Republic of Moldova within the time series, 1990-2005

Years	Area of grassland, thousand ha	Years	Area of grassland, thousand ha
1990	354.6	1998	374.1
1991	356.0	1999	376.0
1992	357.2	2000	376.4
1993	358.0	2001	381.6
1994	364.6	2002	355.1
1995	367.3	2003	382.1
1996	369.7	2004	377.0
1997	372.0	2005	373.5

Source: Stat General Land Cadastre for the period of time from 1990 through 2005.

Under the 5C1 'Grassland Remaining Grassland' category there were used estimation methods available in the Revised 1996 Guidelines (IPCC, 1996), GBP LULUCF (IPCC, 2003) and 2006 IPCC Guidelines (IPCC, 2006).

Country specific removals factors were used (pertaining to average annual growth of grasses and carbon fraction of dry matter), as well as other relevant information (area covered with grasses), taking into account the distribution of grasslands by categories (meadows, grasslands on eroded soils, grasslands on slopes) and data from scientific specialty literature in the Republic of Moldova. According to the national sources of reference, the productivity of grasses on slopes is 0.4-1.2 t dm/ha/yr, the productivity of meadows is 2.0-4.2 t dm/ha/yr.

Distribution by categories is as following: meadows – 15.3 percent (2.3 t dm/ha/yr); eroded soils – 31.7 percent (0.6 t dm/ha/yr); slopes – 53 percent (1.2 t dm/ha/yr). The average annual growth value used was 1.2 t dm/ha/yr and the carbon fraction of dry matter used was 0.5.

5C2 'Land Converted to Grassland'

For estimating CO_2 emissions/removals from the 5C2 'Land Converted to Grassland' category, it was necessary to determine area of land converted to grassland from some initial use, carbon stocks in biomass immediately after conversion to grassland, carbon stocks in biomass immediately before conversion to grassland, carbon stock change per area for the type of conversion and carbon stocks from one year of growth of grassland vegetation after conversion in conformity with the national available data.

The main source of reference for the activity data on the area of cropland converted to grassland and area of forest land and other types of forest vegetation cleared through illegal logging and converted to grassland (Table 7-33) is the General Land Cadastres of the RM, as well as the Reports of the State Forestry Agency "Moldsilva" and the Reports of the State Ecological Inspectorate for the period under review. The respective areas were calculated as a difference between area of grassland in the period of years under review and similar values in the precedent years.

Table 7-33: Area of Land Converted to Grassland from Some Initial Use in the Republic of Moldova, 1990-2005

Years	Area of forest land converted to grassland, thousand ha	Area of cropland converted to grassland, thousand ha
1990	-	5.8
1991	1.69	1.4
1992	2.72	1.2
1993	4.02	0.8
1994	2.75	6.6
1995	2.56	2.7
1996	3.18	2.4
1997	1.23	2.3
1998	1.63	2.1
1999	0.44	1.9
2000	0.04	0.4
2001	0.02	5.2
2002	0.01	-26.5
2003	0.03	27
2004	0.03	-5.1
2005	0.03	-3.5

Source: General Land Cadastres of the RM; Reports of State Forestry Agency "Moldsilva"; Reports of State Ecological Inspectorate.

The calculation was done based on annual change in carbon stocks in living biomass, by using the following equations:

$$CO_2\,{}^{LG}{}_{LB} = \Delta C\,{}^{GG}{}_{LB} \bullet 44/12$$

Where:

$CO_2\,{}^{CC}{}_{LB}$ = CO_2 emissions/removals from annual change in C stocks in living biomass (Gg/yr);

$\Delta C\,{}^{GG}{}_{LB}$ =annual change in carbon stocks in living biomass, tC/yr;

[44/12] = stoichiometric ratio of carbon fraction in CO_2 and C.

$$\Delta C_{GG_{LB}} = A \bullet (L_{Conversion} + \Delta C_{Growth})$$

Where:

A = area of lands converted to grasslands from some initial use, ha/yr;

$L_{Conversion}$ = carbon stock change per area for that type of conversion, when land is converted to grassland (tC/ha/yr).

$$L_{Conversion} = C_{After} - C_{Before}$$

Where:

C_{After} = C stocks in biomass immediately after conversion to grassland, tC/ha;

C_{Before} = C stocks in biomass immediately before conversion to grassland, tC/ha;

ΔC_{Growth} = carbon stocks from one year of growth of grassland vegetation after conversion (tC/ha/yr).

Country specific emission/removals factors were used to estimate annual changes in carbon stocks in living biomass on land converted to grassland from some initial use. Thus, for forest land converted to grassland, the amount of biomass before conversion to grassland (70 m^3/ha or 51 t dm/ha) was provided in conformity with the results of controls performed by the state forest authorities to reveal illegal logging. The default value of 10 t dm/ha used for biomass remaining after conversion of forest land to grassland (roots, grasses, etc.) was taken from GBP LULUCF (IPCC, 2003). The annual rate of biomass accumulation on cropland converted to grassland was the same as the one used for grassland on degraded land, which is 0.6 t dm/ha/yr (Table 7-34).

Table 7-34: Factors Used to Estimate Emissions/Removals from the 5C2 'Land Converted to Grasslands' Category

Categories	Carbon fraction of dry matter	C stocks in biomass after conversion to grassland, tC/ha	C stocks in biomass before conversion to grassland, tC/ha	Carbon stocks from one year of growth of vegetation after conversion, tC/ha
Cropland Converted to Grassland	0.5	-	-	0.6
Forest Land Converted to Grassland	0.5	5.0	26.0	0.3

Source: Giurgiu V., Decei I., Armasescu S. Biometry of Trees and Rammels in Romania, 1972; Kapp G., Velsen-Zerweck M., Horst A., Horn L., Galupa D. Talmaci I. et al.: The baseline study for the „Soils Conservation Project in Moldova", 2003; Official Monitor No. 46-49, Government Resolution No. 367 from 13.04.2000, 'On approval the National Program to Combat Desertification'; Postolache, Gh., Vegetation of the Republic of Moldova, 1995; Sabanova G. A., Bulat A., Tofan E., Report on Floral and Phytocenotical of the Herbaceous Stratum by Sectors under the "Soil Conservation Project in Moldova", 2005.

7.4.3 Uncertainties and Time-Series Consistency

5C1 'Grassland Remaining Grassland'

Uncertainties associated with the CO_2 removals from 5C1 'Grassland Remaining Grassland', pertain mainly to the actual grassland productivity in the Republic of Moldova. Being situated in different pedoclimatice conditions the grasses productivity ranges from 0.4 to 4.2 t dm/ha. By using the weighted average grasses productivity, the uncertainties have been reduced in some extent to relatively acceptable values: ±30 percent for production processes and ±10 percent for removal factors (Annex 7-3.5). So, combined uncertainties related to CO_2 removals from the 5C1 'Grassland Remaining Grassland' can be regarded as being moderate (±31.62 percent). At the same time, the combined uncertainties as a percentage of total direct sectoral removals were estimated at ±18.82 percent. The uncertainties introduced in trend in sectoral emissions were estimated at ±20.87 percent (see Annex 7-3.5).

In view of ensuring time-series consistency of the obtained results, the same approach was used for the entire period under review, in conformity with the recommendations included in the Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories (IPCC, 2000).

5C2 'Land Converted to Grassland'

Uncertainties associated with the CO_2 emissions/removals resulted from 5C2 'Land Converted to Grassland' category are higher, however, within acceptable limits. To be noted that conversion of forest land to grassland started after 1990. The uncertainty level was circa ±15 percent for production processes, due the fact that the state forestry authorities were responsible for regular (twice a year, in spring and autumn) total control of forest land and other woody vegetation land managed by local the public authorities and agricultural enterprises. By the end of the reference period (2005), the uncertainties increased up to ±30 percent, what is explained by lack of veridical records on evolution of land use of forest land damaged by illegal logging, as well as by grazing and cropping. In both cases emission/removal factors have an uncertainty level of ±5 percent.

In conformity with current practices, most of converted forest land are continuously used for grazing, because most of such lands are degraded, or situated on slopes over 7^0, where cropping is economically inefficient. Conversion of cropland was a contradictory process, as uncertainties associated with area of grassland were conditioned both by conversion of arable lands, and their afforestation and planting perennial vegetation (orchards, vineyards, etc.). Land cadastres contain only general information in this sense, without specifying to what categories the cropland (arable lands, perennial plantations, etc.) were converted to. One part of them was converted to forest land, while the other (depending on condition) was transferred to other categories (grassland, ravines, landslides, etc.). Practically, only the land-use category (in many cases determined by local traditions) to some extent reflects the condition of such land after conversion. Taking into account all these information, the deviation from actual indicators can generate high uncertainties, exceeding ±70 percent for production processes, and ±5 percent for emission/removal factors (Annex 7-3.5).

Combined uncertainties related to CO_2 emissions/removals from the 5C2 'Land Converted to Grassland' can be regarded as moderate (±30.41 percent). At the same time, the combined uncertainties as a percentage of total direct sectoral removals were estimated at ±0.05 percent. The uncertainties introduced in trend in sectoral emissions were estimated at ±0.06 percent (see Annex 7-3.5).

In view of ensuring time-series consistency of the obtained results, the same approach was used for the entire period under review, in conformity with the recommendations included in the Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories (IPCC, 2000).

7.4.4 QA/QC and Verification

Standard verification and quality control forms and checklists were filled for the 5C 'Grassland' category, following the Tier 1 and Tier 2 approaches (see in Annex 6). Also, the AD and methods used for estimating CO_2 emissions/removals under the 5C 'Grassland' category were documented and archived both in hard copies and electronically. To identify the data entry, as well CO_2 emissions/removals estimation related errors there were applied AD and EFs verifications and quality control procedures. Verification was focused on correct use of AD obtained from different sources of reference; on ensuring correct use of the emission/removal factors available in the Revised 1996 Guidelines (IPCC, 1997), GPG LULUCF (2003) and 2006 IPCC Guidelines (IPCC, 2006) and in scientific literature, as well as in comparing EFs used with values used by other countries within the region for their inventory development. Inventory quality assurance activities for the LULUCF Sector were supported by an expert representing the Forest Research and Management Institute.

Following the recommendations included into the GPG (IPCC, 2000), CO_2 emissions/ removals under the 5C 'Grassland' category were estimated based on AD from official sources of reference (Statistical Yearbooks of the RM and ATULBD; General Land Cadastres of the RM; Production Tables and Forest State Records; Forest Planning Materials; Legislative, Normative and Technical Forestry Regulations Acts, results of direct measurements and the scientific specialty literature.

7.4.5 Recalculations

5C1 'Grassland Remaining Grassland'

The CO_2 removals from 5C1 'Grassland Remaining Grassland' category there were recalculated for the 1990 through 1998 time series, in particular due to the fact that under the current inventory cycle, the categories of the IPCC GPG on LULUCF (IPCC, 2003) have replaced the source and sink categories available under the Land-Use Change and Forestry Sector (IPCC, 1997); also due to the fact that an essential part of indicators and activity data used (ex., areas of grassland covered with grasses, average annual biomass growth of grasses, etc.) were also revised.

In the FNC the amount of removals currently reported under the IPCC GPG on LULUCF category 5C1 'Grassland Remaining Grassland', there was included into the category 5B 'Forest and Grassland Conversion', which have been estimated by using methodological approaches available in the Revised 1996 Guidelines (IPCC, 1997).

In comparison with CO_2 removal estimates included into the FNC under the former category 5B 'Forest and Grassland Conversion', the changes performed resulted in increased CO_2 removals reported currently under the 5C1 'Grassland Remaining Grassland' category. For the period 1999-2005, CO_2 removals resulting from the respective category were estimated for the first time. The obtained results allow assert that within the 1990-2005 time series, CO_2 removals resulting from 'Annual Change in Carbon Stocks in Living Biomass' under the category 5C1 'Grassland Remaining Grassland' increased by 5.3 percent (Table 7-35).

Table 7-35: CO_2 Removals under the Category 5C1 'Grassland Remaining Grassland' (Annual Change in Carbon Stocks in Living Biomass) in the RM, 1990-2005

Years	CO_2 GG_{LB}, Gg	Years	CO_2 GG_{LB}, Gg
1990	-780.1	1998	-823.0
1991	-783.2	1999	-827.2
1992	-785.8	2000	-828.1
1993	-787.6	2001	-839.5
1994	-802.1	2002	-781.2
1995	-808.1	2003	-840.6
1996	-813.3	2004	-829.4
1997	-818.4	2005	-821.7

5C2 'Land Converted to Grassland'

The CO_2 emissions/removals from 5C2 'Land Converted to Grassland' category there were recalculated for the 1990 through 1998 time series, in particular due to the fact that under the current inventory cycle, the categories of the IPCC GPG on LULUCF (IPCC, 2003) have replaced the source and sink categories available under the Land-Use Change and Forestry Sector (IPCC, 1997); also due to the fact that an essential part of indicators and activity data used (ex., area of land covered to grassland from some initial use, carbon stocks in biomass immediately after conversion to grassland, carbon stocks in biomass immediately before conversion to grassland, carbon stocks from one year of growth of grassland vegetation after conversion, etc.) were also revised.

In the FNC the amount of emissions/removals currently reported under the IPCC GPG on LULUCF category 5C2 'Land Converted to Grassland', there was included into the category 5C 'Abandonment of Managed Land', which have been estimated by using methodological approaches available in the Revised 1996 Guidelines (IPCC, 1997).

In comparison with CO_2 removal estimates included into the FNC under the former category 5C 'Abandonment of Managed Land', the changes performed resulted generally, in increased CO_2 emissions (in particular for the 1991-1996 time series), reported currently under the 5C1 'Grassland Remaining Grassland' category (except the 1997-1998 period, for which a decrease of CO_2 emissions was registered). For the period 1999-2005, CO_2 emissions / removals resulting from 5C2 'Land Converted to Grassland' category were estimated for the first time. The obtained results allow assert that within the 1990-2005 time series, CO_2 emissions resulting from 'Annual Change in Carbon Stocks in Living and Dead Biomass' under the category 5C2 'Land Converted in Grassland' tended to increase, however values reported for the time period from 1990 through 2005 are still insignificant at sector level (Table 7-36). To be mentioned that the noted increase in CO_2 emissions over the period from 1991 to 1998 is explained by reported problems encountered by the local public authorities and the agricultural enterprises, in relation to management of forest land and land covered with other type of forest vegetation, which resulted in a significant deforestation.

Table 7-36: CO_2 Emissions/Removals under the Category 5C2 'Land Converted to Grassland' in the RM, 1990-2005

Years	CO_2 LG $_{LB}$, Gg	Years	CO_2 LG $_{LB}$, Gg
1990	-6.4	1998	119.6
1991	125.6	1999	30.8
1992	202.1	2000	2.6
1993	299.8	2001	-4.6
1994	198.4	2002	0.7
1995	188.5	2003	-27.5
1996	235.2	2004	2.2
1997	89.5	2005	2.2

7.4.6 Planned Improvements

The possibility to improve the cadastral records pertaining to specification of land use categories to which converted lands are transferred to, will be considered for the next inventory cycle in the Republic of Moldova.

8. WASTE SECTOR

8.1 Overview

Waste Sector includes CH_4 emissions emitted during the anaerobic decomposition of organic waste disposed of in solid waste disposal sites (SWDS), CH_4 emission from handling of domestic and industrial wastewater under anaerobic conditions, as well as N_2O emissions from human sewage. Direct GHG emissions resulted from Waste Sector have been estimated based on the Revised 1996 Guidelines (IPCC, 1997) and Good Practice Guidance and Uncertainty Management in National GHG Inventories (IPCC, 2000).

The source categories covered by this sector are: 6A 'Solid Waste Disposal on Land' and 6B 'Wastewater Handling'. As the waste incineration is not practiced in the RM, respectively there were registered no direct greenhouse gas emissions from the source category 6C 'Waste Incineration'.

A brief overview, methodological issues and data sources, key categories, uncertainties and times-series consistency, QA/QC and verification, recalculations made and planned improvements are described for each source category in this sector.

Human activities inevitably induce generation of different types of waste. Increased consumption over the past decades contributed to global increase of solid waste. Most waste can be recycled, however finally a large part goes to the solid waste disposal sites.

The lifestyle characteristic for the beginning of this century, to a great extent determined by increased wellbeing of people, induced a quantitative and qualitative growth of waste generation process. In the Republic of Moldova, the average daily waste generation rate vary from circa 0.25 kg/person/day in towns such as Nisporeni and Cimislia, up to circa 1.1 – 1.3 kg/person/day in municipalities such as Balti and Chisinau.

This situation can be explained by different waste management practices (for example, a considerable part of urban population in the RM can not benefit from sanitation services, either because of payment incapacity, or due to lack of such services at the place where they live). Another practice widely applied in the RM, is intentional dumping of waste on unauthorised waste disposal sites, what entails major problems in monitoring the amount of waste generated on a national level.

At present there is only one managed solid waste disposal site (landfill) built and operated in compliance with up to date environment protection requirements (situated in Cretoaia, Anenii Noi district). Under these circumstances, it is absolutely necessary to look into new solutions for the sanitation process planning and new managed landfills construction. It should be noted that construction, operation and recovery of landfills, in conformity with Landfill Directive 99/31/EC of 26 of April 1999, require large financial investments, which is a serious impediment in terms of providing each settlement with its own landfill.

At the initial stage it is reasonably to create a centralized deposit for circa 100 thousand population, and taking into account the territorial organization of the country to have such deposits in each district of the country. In conformity with international practices, one deposit can serve circa 300-500 thousand population, meaning that the Republic of Moldova would need circa 8-12 landfills, organized and managed in conformity with current environment protection requirements.

8.1.1 Summary of Emission Trends

In 2005, Waste Sector accounted for circa 11.8 percent of total national greenhouse gas direct emissions (without LULUCF), being the third major source of GHG emissions in the Republic of Moldova, following the Energy and Agriculture Sectors.

To be noted that Waste Sector represents a major source of CH_4 and N_2O emissions, accounting for circa 45.3 percent and respectively 6.6 percent of total methane and nitrous oxide emissions reported at the national level.

Table 8-1: GHG Emissions from Waste Sector by Gas in the Republic of Moldova within 1990-2005 time series, Gg CO_2 equivalent

	1990	1991	1992	1993	1994	1995	1996	1997
CH_4	1498.29	1638.52	1767.82	1790.28	1771.21	1744.81	1796.20	1737.95
N_2O	129.05	118.01	107.07	101.67	88.04	82.75	80.37	82.22
Total	1627.34	1756.53	1874.89	1891.95	1859.26	1827.57	1876.57	1820.17
	1998	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**
CH_4	1682.68	1753.00	1653.59	1522.49	1446.28	1414.61	1368.48	1307.22
N_2O	80.70	77.55	77.68	80.31	82.90	84.71	83.57	92.74
Total	1763.38	1830.55	1731.27	1602.80	1529.18	1499.32	1452.05	1399.96

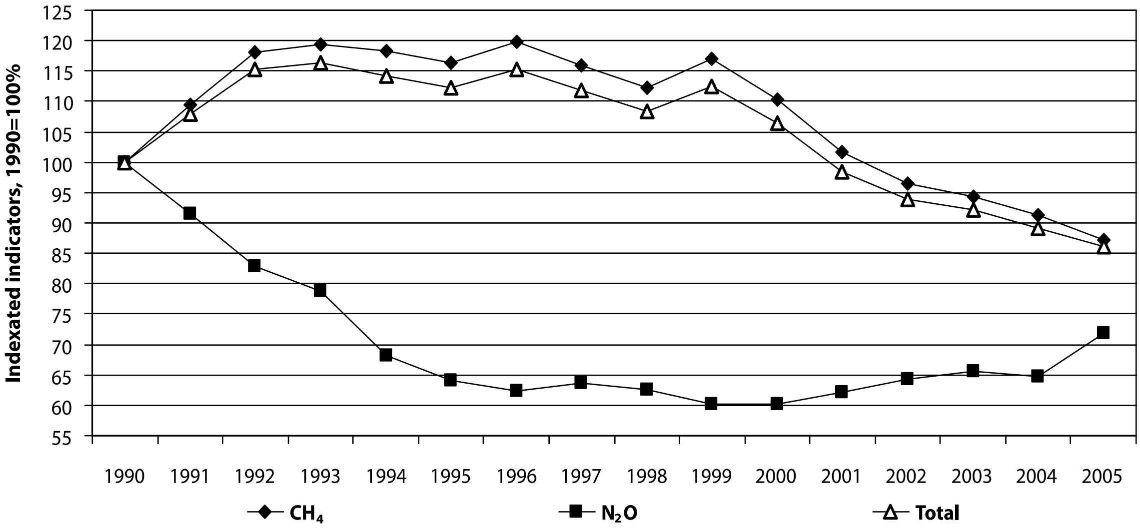

Figure 8-1: Trends in GHG Emissions from Waste Sector of the RM, 1990-2005

In 1990, CH_4 and N_2O emissions accounted for circa 92.1 percent and respectively 7.9 percent of the total GHG emissions from the Waste Sector. By 2005, the share of CH_4 increased to 93.4 percent, while that of N_2O, on the contrary, dropped to 6.6 percent.

As stated above, between the 1990-2005 time series, the total GHG emissions originated from the Waste Sector decreased by circa 14.0 percent, while those of CH_4 and N_2O emissions, by circa 12.8 percent and respectively, by 28.1 percent (Table 8-2).

Table 8-2: Methane and Nitrous Oxide Emissions from Waste Sector by Category in the Republic of Moldova within the 1990-2005 time series, Gg

Year	CH_4 emissions			N_2O emissions
	6A	6B	Total	6B
1990	62.9108	8.4363	71.3471	0.4163
1991	70.1993	7.8254	78.0247	0.3807
1992	77.1248	7.0571	84.1819	0.3454
1993	78.1765	7.0749	85.2514	0.3280
1994	77.7414	6.6021	84.3435	0.2840
1995	76.9801	6.1063	83.0864	0.2669
1996	79.5359	5.9974	85.5333	0.2593
1997	76.7563	6.0032	82.7595	0.2652
1998	74.3283	5.7992	80.1275	0.2603
1999	77.9046	5.5714	83.4760	0.2502
2000	73.1627	5.5799	78.7426	0.2506
2001	66.8245	5.6748	72.4993	0.2591
2002	63.1911	5.6795	68.8706	0.2674
2003	61.6285	5.7338	67.3623	0.2733
2004	59.7384	5.4272	65.1656	0.2696
2005	56.4860	5.7626	62.2486	0.2992

The 6A 'Solid Waste Disposal on Land' source category was the largest source of CH_4 emissions in the time segment from 1990 through 2005 (with a share varying between 88.2 to 93.3 percent of the total), while the 6B 'Wastewater Handling' source categories is the only source of N_2O emissions under Waste Sector (Table 8-3).

Table 8-3: Breakdown of the Republic of Moldova's Waste Sector Methane Emissions by Category within 1990-2005, %

Year	CH_4, % of the total		Total
	6A	6B	
1990	88.2	11.8	100.0
1991	90.0	10.0	100.0
1992	91.6	8.4	100.0
1993	91.7	8.3	100.0
1994	92.2	7.8	100.0
1995	92.7	7.3	100.0
1996	93.0	7.0	100.0
1997	92.7	7.3	100.0
1998	92.8	7.2	100.0
1999	93.3	6.7	100.0
2000	92.9	7.1	100.0
2001	92.2	7.8	100.0
2002	91.8	8.2	100.0
2003	91.5	8.5	100.0
2004	91.7	8.3	100.0
2005	90.7	9.3	100.0

8.1.2 Key Categories

The results of key source assessment (including LULUCF) carried out following a Tier 1 approach (IPCC, 2000), are provided in Chapter 1.5, as well as in the Annex 1. Table 8-4 provides information on identified key categories (by level and trend) under the Waste Sector of the Republic of Moldova.

Table 8-4: Key Categories Identified under the Waste Sector of the RM

IPCC Category	GHG	Source Category	Key source
6A	CH_4	Solid Waste Disposal on Land	Yes (L, T)
6B	CH_4	Wastewater Handling	Yes (L)
6B	N_2O	Human Sewage	No

8.1.3 Methodological Issues

Emissions originated from the source categories 6A 'Solid Waste Disposal on Land' and 6B 'Wastewater Handling' were estimated using both, the Tier 1 methodological approach and default EFs values, as well as the Tier 2 methodological approach and country specific emission factors, in particular for the key sources. A summary description of methods used to estimate emissions by source categories is provided in Table 8-5, while a more detailed description is available in the respective sub-chapters of this report (8.2-8.3).

Table 8-5: Summary of Methods and Emission Factors Used to Estimate GHG Emissions from the Waste Sector of the Republic of Moldova

IPCC Category	Source Category	CH_4		N_2O	
		Method	EF	Method	EF
6A	Solid Waste Disposal on Land	T1, T2	D, CS	NA	NA
6B	Wastewater Handling	T1	D, CS	T1	D
6C	Waste Incineration	NO	NO	NO	NO

Abbreviations: T1 – Tier 1; T2 – Tier 2; CS – country specific; D – default; NA – not applicable; NO –Not Occurring

8.1.4 Uncertainties and Time-Series Consistency

The uncertainty analysis of the GHG emissions from the Waste Sector (by source categories) is described in detail in the respective sub-chapters (8.2-8.3) of the NIR, as well as in the Annex 7-3.6. Combined uncertainties as a percentage of total direct sectoral emissions were estimated at ±35.5 percent (inclusive, ±37.9 percent for CH_4 and ±36.1 percent for N_2O). The uncertainties introduced in trend in sectoral emissions were estimated at ±41.3 percent (inclusive, ±44.9 percent for CH_4 and ±20.3 percent for N_2O).

In view of ensuring time-series consistency of the results, the same approach was used for the entire period under review, in conformity with the recommendations included in the Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories (IPCC, 2000).

8.1.5 QA/QC and Verification

Standard verification and quality control forms and checklists by individual source categories were filled in for each source category under the Waste Sector, following the Tier 1 and Tier 2 approaches (see in Annex 6).

Also, the AD and methods used for estimating GHG emissions under the Waste Sector were documented and archived both in hard copies and electronically. To identify the data entry, as well GHG emissions estimation related errors there were applied AD and EFs verifications and quality control procedures. Inventory quality assurance activities for the Waste Sector were supported by an expert representing the Soil, Waste and Chemical Substances Inspection Division of the State Ecological Inspectorate.

Following the recommendations included into the Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories (IPCC, 2000), GHG emissions from the Waste Sector were estimated based on AD and EFs from official sources of reference.

8.1.6 Recalculations

GHG emission recalculations under the Waste Sector are due to the availability of an updated set of activity data (Statistical Yearbooks of the RM and of the ATULBD, other relevant sectoral publications), as well as due to updated methodologies and EFs available in the Good Practice Guidance (IPCC, 2000), which have replaced the methodologies contained into the Revised 1996 IPCC Guidelines (IPCC, 1997) used under the FNC of the RM under the UNFCCC (2000).

In comparison with the results included into the FNC, the performed recalculation resulted in increased GHG emission values for the 1998-1998 time periods, varying from a minimum of 111.8 percent in 1990, up to maximum of 275.3 percent in 1996 (Table 8-6). The results of recalculations performed at the category level are presented in the respective sub-chapters (8.2-8.3) of the NIR.

Table 8-6: Recalculated GHG Emissions under the Waste Sector for the 1990-1998, Gg CO_2 equivalent

	1990	1991	1992	1993	1994	1995	1996	1997	1998
FNC	768.2	766.6	519.4	512.4	508.6	507.3	500.0	498.0	497.8
SNC	1627.3	1756.5	1874.9	1892.0	1859.3	1827.6	1876.6	1820.2	1763.4
Difference, %	111.8	129.1	261.0	269.2	265.5	260.3	275.3	265.5	254.2

Abbreviations: FNC – First National Communication; SNC – Second National Communication.

8.1.7 Assessment of Completeness

The current inventory covers greenhouse gas emissions from two source categories under the Republic of Moldova's Waste Sector (Table 8-7). As the waste incineration is not practiced in the Republic of Moldova, respectively no GHG emissions were reported under the 6C 'Waste Incineration' source category.

8.1.8 Planned Improvements

Planned improvements at the source categories level within the Waste Sector are described in detail in respective sub-chapters (8.2-8.3) of the NIR.

Table 8-7: Assessment of Completeness under the Waste Sector in the Republic of Moldova

IPCC Category	Source Category	CO_2	CH_4	N_2O
6A	Solid Waste Disposal on Land	NE	X	NE
6B	Wastewater Handling	NE	X	X
6C	Waste Incineration	NO	NO	NO

Abbreviations: X – source categories included in the inventory; NO –Not Occurring; NE –Not Estimated.

8.2 Solid Waste Disposal on Land (Category 6A)

8.2.1 Source Category Description

Current situation with the management of 'Municipal Solid Waste' (MSW) in the Republic of Moldova is similar to the situation in other developing countries; it is in the budding stage and includes two basic elements: municipal solid waste generating sources and the landfills. The most widely used method of MSW management is their disposal on the site, which results in soil and underground waters pollution.

According the official statistical data (situation as of 01.01.2007), the area of authorised SWD sites is circa 177 ha. According to various sources of information, the total area of SWDS in the RM is around 1300 ha, the total number of such sites being approximately 1700. So, it can be inferred that circa 1100 ha are occupied by the so called "dump sites" (unauthorized landfills) situated especially in the rural areas of the RM. Most landfills in the Republic of Moldova do not comply with sanitary and environment protection requirements and the total amount of solid wastes accumulated on sites, estimated by the ecologic inspectors following the expert judgement, amounts to circa 34 million tonnes.

By the way the landfills are organized and managed in the RM, there are far from meeting environmental requirements. It is acknowledged that only the landfill situated in Cretoaia village, Anenii Noi district was built in conformity with the designed project and is managed in conformity with in strata waste disposal technology, with compacting and by using intermediary cover material. Though some other landfills are authorised to operate as well, they are not properly organized and managed, and inappropriate management entails soil and phreatic water contamination and emissions of GHG and other toxic gases, directly affecting the human health and the environment (Duca, Tugui, 2006).

To be noted that between 1990 and 2005, the methane emissions originated from the 6A 'Solid Waste Disposal on Land' source category decreased by circa 10.2 percent, from 62.9 Gg in 1990 to 56.5 Gg in 2005 (Figure 8-2).

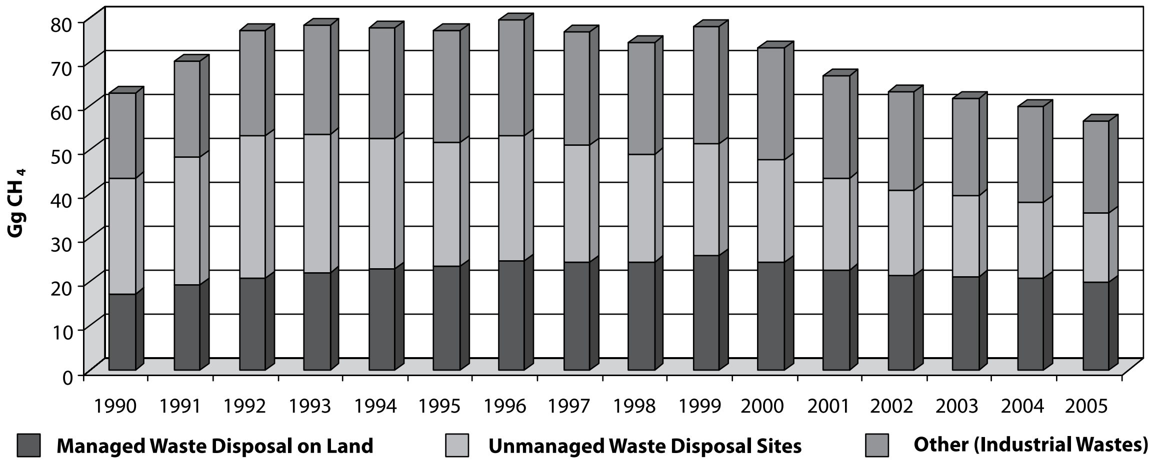

Figure 8-2: Methane Emissions from 6A 'Solid Waste Disposal on Land' source category in the RM within the 1990-2005 time series

8.2.2 Methodological Issues and Data Sources

According to the GPG (IPCC, 2000), CH_4 emissions from solid waste disposal on land can be estimated using two alternative methodological approaches: the Default Method (Tier 1) and the First Order Decay Method (Tier 2). The main difference between the two methods is that the First Order Decay (FOD) method produces a time-dependent emission profile that better reflects the true pattern of the degradation process over time, whereas the default method is based on the assumption that all potential CH_4 is released in the year the waste is disposed of. The default method will give a reasonable annual estimate of actual emissions if the amount and composition of deposited waste have been constant or slowly varying over a period of several decades. If the amount or composition of waste disposed of at SWDS is changing more rapidly over time, the IPCC default method (Tier 1) will not provide an accurate trend. It is *good practice* to use the FOD method, because it more accurately reflects the emission trend. The use of the FOD method requires data on current, as well as historic waste quantities, composition and disposal practices for several decades.

8.2.2.1 First Order Decay Method

Republic of Moldova has used the FOD method to estimate the methane emissions from 6A 'Solid Waste Disposal on Land' source category. Calculations have been performed by using the following equation below.

$$CH_4 = \Sigma_x [(A \bullet k \bullet MSW_T(x) \bullet MSW_F(x) \bullet L_o(x)) \bullet e^{-k(t-k)}],$$

Where:

CH_4 = amount of methane generated in year t, Gg/yr;

Σ_x = amount of methane generated over a period of years x;

t = year of inventory;

x = years for which input data should be added;

A = $(1-e^{-k})$ /k; normalisation factor which corrects the summation;

k = methane generation rate constant, 1/yr;

$MSW_T(x)$ =total MSW generated in year t, Gg/an;

$MSW_F(x)$ = fraction of MSW disposed at solid waste disposal sites in year x;

$L_o(x)$ = methane generation potential, Gg CH_4/Gg MSW.

Methane generation potential $L_o(x)$ depends on morphologic composition of municipal solid waste, disposal practices and landfill characteristics, being calculated by use the following equation.

$$L_o = [MCF_{(x)} \bullet DOC_{(x)} \bullet DOC_F \bullet F \bullet 16/12]$$

Where:

$MCF_{(x)}$ = methane correction factor in year x (fraction);

$DOC_{(x)}$ = degradable organic carbon (DOC) in year x (fraction), Gg C/Gg waste;

DOC_F = fraction DOC dissimilated;

F = fraction of CH_4 in landfill gas;

16/12 = conversion from C to CH_4.

The obtained results for all year (x) are then summed.

CH_4 emitted in year t (Gg/yr) = [CH_4 generated in year t - R(t)] • (1 - OX)]

Where:

R(t) = recovered CH_4 in inventory year t, Gg/yr;

OX = oxidation factor (fraction).

Information available on landfill characteristics allows draw the conclusion that the Republic of Moldova does not have sites built and managed in conformity with the environmental requirements, except the landfill situated in Cretoaia, Anenii Noi district, where more than ½ of CH_4 emissions originated from municipal solid waste per country are emitted.

Circa 3/4 of district town's landfills are being explored for circa 20-35 years at 80-100 percent of their capacity, and currently need to be closed down and recovered. In most towns the dump sites are overfilled, the disposed waste layer being 7-8 m deep (ex., in Ungheni, Cahul, Ocnita, etc.), at some landfills the layer is circa 10-15 m deep (ex., in Briceni, Balti, Ialoveni etc.) and even 25-30 m deep (at Cretoaia, Anenii Noi district).

The existent landfills were set into operation between 1960 and 1990 time series, sometimes without any execution project and proper arrangements, with no dam or fence. Mechanical compacting and isolation are occasional operations, and a part of waste is disposed beyond the authorised and specially arranged boundaries.

To be noted that until the year of 1991, the solid municipal waste generated in Chisinau was disposed to the unmanaged waste disposal site situated in the proximity of Singera village (MCF value used – 0.8), and since 1992 at the managed waste disposal site situated in the proximity of Cretoaia, Anenii Noi district (MCF value used – 1.0) (Table 8-8).

Table 8-8: Methane Correction Factors Used to Estimate CH_4 Emissions from Solid Waste Disposal Sites in the RM within 1986-2005 time series

SWDS Classification	MCF	SWD sites
Managed	1.0	Chisinau municipality, starting 1992
Unmanaged – deep (≥5 m waste)	0.8	Chisinau municipality, up to 1991
Unmanaged – shallow (<5 m waste)	0.4	Unmanaged shallow sites in rural areas
Uncategorised SWDS	0.6	Balti municipality and district towns

8.2.2.2 Degradable Organic Carbon (DOC)

Degradable organic carbon (DOC) is the organic carbon that is accessible to biochemical decomposition. It is based on the composition of waste and can be calculated from a weighted average of the carbon content of various components of the waste stream. The following equation estimates DOC using carbon content values:

$$DOC = (0.4 \bullet A) + (0.17 \bullet B) + (0.15 \bullet C) + (0.3 \bullet D)$$

Where:

A = fraction of MSW that is paper and textiles (default value - 40 percent DOC by weight);

B = fraction of MSW that is garden waste, park waste or other non-food organic putrescibles (default value - 17 percent DOC by weight),

C = fraction of MSW that is food waste (default value - 15 percent DOC by weight);

D = fraction of MSW that is wood or straw (default value - 30 percent DOC by weight).

Based on waste morphologic composition studies performed in the RM between 1986 and 2005 years, there were calculated the country specific DOC values. Bibliographical sources do not provide information on fraction of garden and park waste and other (non-food) putrescibles disposed to sites. At the same time, under the current waste management practices applied in the RM, garden and park waste are not collected and consequently not disposed at the SWDS. In Chisinau, garden and park vegetal waste are disposed in special places meant for waste disposal, including the Purcel quarry. For these reasons, while estimating the DOC value, the product of (0.17 • B), characteristic to the fraction of MSW that is garden waste, was omitted from the equation presented above.

Figure 8-3 illustrates the shares of biodegradable fractions (food waste, paper, textiles and leather, wood and straw) in the waste stream in the RM, indicating a decrease from circa 71 percent in 1993 to circa 56 percent in 2001, and a further increase to 72 percent in 2005.

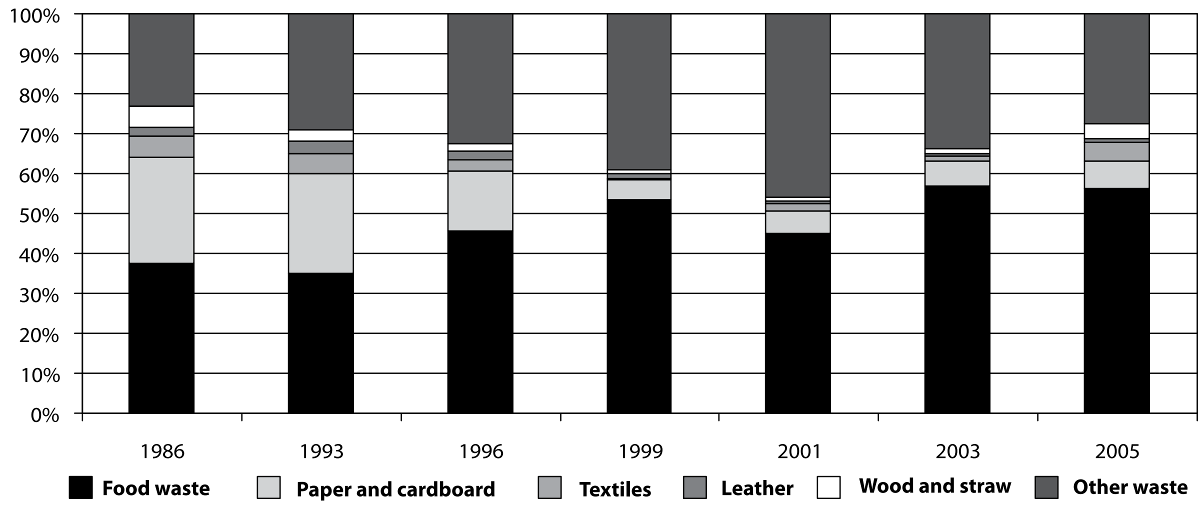

Figure 8-3: Biodegradable Waste in the Major Waste Streams in the Republic of Moldova

Table 8-9: Degradable Organic Carbon (DOC) Country Specific Values for Major Waste Streams in the RM between 1985 and 2005 time series

Years	Degradable Fractions (A/C/D)	DOC
1986	0.320/0.375/0.029	0.1930
1993	0.300/0.350/0.030	0.1815
1996	0.179/0.456/0.021	0.1463
1999	0.054/0.535/0.010	0.1049
2001	0.077/0.449/0.008	0.1006
2003	0.075/0.565/0.011	0.1181
2005	0.117/0.561/0.035	0.1415

Note: The values of degradable fractions for 1996 year were calculated by interpolation.

8.2.2.3 Fraction of Degradable Organic Carbon Dissimilated (DOC_F)

Fraction of degradable organic carbon dissimilated (DOC_F) is an estimate of the fraction of carbon that is ultimately degraded and released from SWDS, and reflects the fact that some organic carbon does not degrade, or degrades very slowly, when deposited in SWDS. It is assumed that fraction of DOC_f depends on the temperature in the anaerobic zone of the site, characterized by the relation: 0.014T + 0.28 (Tabasaran, 1981).

The IPCC Guidelines provide a default value of 0.77 for DOC_F. Based on a review of recent literature, it appears that the default value may be an overestimate. To avoid this, it is good practice to use a value of 0.5-0.6 as a default (only 50-60 percent of DOC decays and is converted in landfill gas).

In the RM, country specific DOC and DOC_f values (Table 8-10) were developed using „MSW Learning Tool" developed by Florida University (1996) on the base of laboratory experiments carried out by Dr. Morton Barlaz (1987, 1997) and investigations made by Chandler, Van Soest (1980).

Table 8-10: Country Specific DOC and DOC_f Values Used to Estimate CH_4 Emissions from 6A'Solid Waste Disposal on Land', 1986-2005

	1986	1993	1996	1999	2001	2003	2005
DOC_f	0.518	0.525	0.562	0.630	0.613	0.621	0.585
DOC	0.216	0.199	0.155	0.104	0.100	0.116	0.146

8.2.2.4 Fraction of CH_4 in Landfill Gas (F)

Landfill gas consists mainly of CH_4 and carbon dioxide (CO_2). The CH_4 fraction F is usually taken to be 0.5, but can vary between 0.4 and 0.6, depending on several factors including waste composition (e.g. carbohydrate and cellulose) (Bingemer, Crutyen, 1987). The concentration of CH_4 in recovered landfill gas may be lower than the actual value because of potential dilution by air, so F values estimated in this way will not necessarily be representative.

The results of the measurements undertaken at the national level (Table 8-11) denote CH_4 concentrations in landfill gas varying between 53 and 66 percent and CO_2 concentrations varying between 16 and 20 percent (Ţugui, Duca, Ţăranu et al., 2005).

To be noted that composition of landfill gas can be calculated also based on extended Buswell equation using the results of the waste morphologic composition, which also served as basis to estimate DOC and DOC_f values. Evolution of the composition of the landfill gas emitted from the landfill situated in the proximity of Cretoaia village, Anenii Noi district is relatively constant, the ratio of CH_4 to CO_2 being 55/45 (Figure 8-4).

The results of the studies carried out in order to identify landfill gas composition at the SWDS in the Republic of Moldova revealed that the average ratio of CH_4 to CO_2 is 60/40.

Table 8-11: Fractions of Gases in the Landfill Gas Composition from Different SWDS in the RM and Countries Abroad

Gases	Landfill gas composition in developed countries, %	Landfill gas composition in developing countries, %	Composition of landfill gas in Cretoaia, %	Composition of landfill gas in Balti , %	Composition of landfill gas in Straseni , %	Average composition of landfill gas in the RM, %
CH_4	40-60	33-88	60-70[1]/63-65[2]	75-85	23-43	53-66
CO_2	40-60	35-89	15-18[1]/32-34[2]	14-19	20-22	16-20
N_2	2.4-5.0	87	7-19	11-38	38-69	18-42
O_2	0.16	20,9	1-8[1]/0.5-1[2]	0.5-16	0.5-19	0.7-14

Note: [1] – results obtained by national experts; [2] – results obtained by DEPA experts.

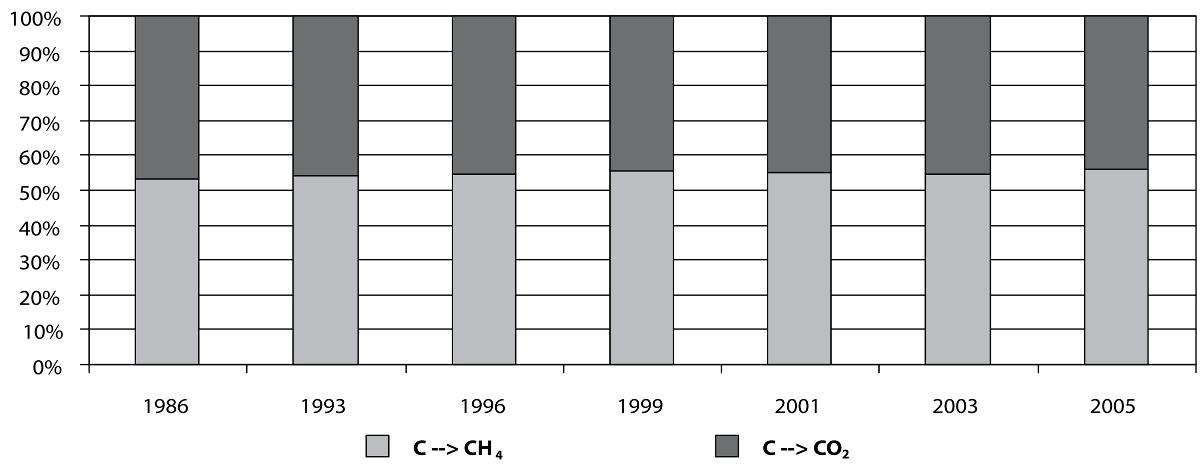

Figure 8-4: Biogas Composition in Landfill Gas Calculated Based on Extended Buswell Equation

In comparison with the results included in the FNC of the RM under the UNFCCC, calculated by using the default method (Tier 1), the use of the FOD method (Tier 2) and country specific values for the fraction of CH_4 in landfill gas (F = 0.6), methane correction factors (MCF), biodegradable organic carbon (DOC) and fraction of degradable organic carbon dissimilated (DOC_F) values, resulted in a significant increase in methane emissions originated from 6A 'Solid Waste Disposal on Land' source category,.

8.2.2.5 Data Sources

In the frame of FNC of the RM under the UNFCCC, the methane emissions from the 6A 'Solid Waste Disposal on Land' source category were estimated based on the activity data on the amount of municipal solid waste transported to the landfills. To be noted that besides municipal solid waste, industrial wastes are also disposed to the landfills. In most cases waste disposal is performed by sanitation services and partially, in particular waste from agricultural processing enterprises, by beneficiary transport units.

No official data are available in the national statistics on the amount of waste transported to the landfills through beneficiary transport units. For this reason, the respective amounts of waste were not taken into consideration while calculating the CH_4 emissions from category 6A 'Solid Waste Disposal on Land' in the frame of the FNC of the RM.

More data sources have been consulted in the actual inventory cycle, including the Statistical Yearbooks of the RM (Chapter 1.3 'Environment', items: 'Municipal Solid Waste in Urban Area', 'Generation and Use of Waste in Enterprises and Organisation' and 'Toxic Waste'). It has been revealed that the amount of waste generated and disposed to landfills is accounted by the National Bureau of Statistics through two Statistical Forms: F-1 'Toxic Waste' and F-2 'Waste'.

According to information available in the Statistical Yearbooks of the Republic of Moldova, collected through the Statistical Form F-2 'Waste', the amount of waste generated and disposed in the past years in the RM tends to grow. For comparison purposes two sets of data were used: (1) before the year of 2003, data was collected through the Statistical Form 'Special Road Transport', while since the 2003 year, through the Statistical Form No.2–gc 'Urban Settlements Sanitation', both of them reflecting the amounts of municipal solid waste transported to landfills (dumps); (2) since the year of 1998, the data are collected also through the Statistical Form F-2 'Waste', containing information on waste generation, waste utilisation and amount of waste disposed to dumps during the year.

To be noted that only the information on municipal solid waste which are transported to dumps by means of sanitation services (being collected through the Statistical Form 'Special Road Transport' and Form No.2–gc 'Urban Settlements Sanitation'), is available for the whole time series (Figure 8-5).

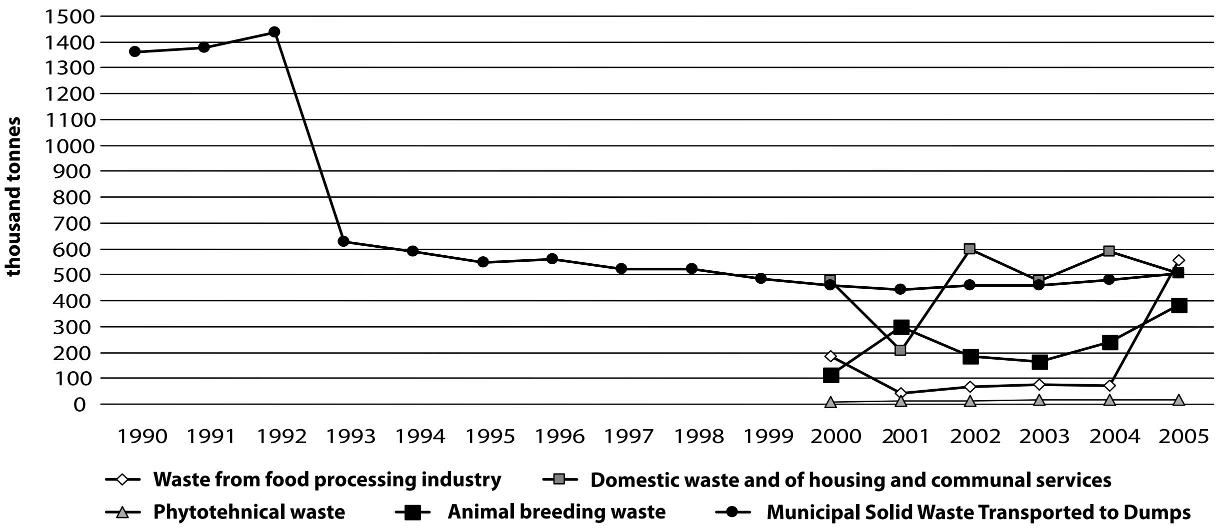

Figure 8-5: Evolution of Waste Disposal by Depositing, thousand tonnes

Other organic types of waste (ex., waste from food processing industry, from animal breeding and phytotechnical waste, as well as the domestic waste and waste resulting from housing and communal services) are disposed as well to the dumps, however, due to the fact that these types of waste are reported statistically only since 1998, the respective amounts have been not taken into consideration into the FNC of the RM under UNFCCC.

Unlike the FNC of the RM (2000), under the current inventory cycle, in the frame of the SNC of the RM, there were estimated CH_4 emissions from the 6A 'Solid Waste Disposal on Land' category based on activity data on: (1) 'Managed Waste Disposal on Land' (municipal solid waste disposed to Cretoaia managed landfill); (2) 'Unmanaged Waste Disposal Sites' (domestic solid waste disposed to the unmanaged landfills of district towns and other urban settlements on the right and left banks of the Dniester)'; and (3) 'Other' (Industrial Waste disposed to landfills) (Tables 8-12).

Table 8-12: Activity Data on the Amount of Solid Waste Disposed on Land in the RM within the 1985-2005 time series, thousand tonnes

	1985	1986	1987	1988	1989	1990	1991
6A1 'Managed WD on Land'	385.30	404.90	414.87	424.66	444.36	450.40	450.96
6A2 'Unmanaged WD Sites'	778.02	817.32	837.61	857.50	897.20	909.32	926.92
6A3 'Other' (Industrial Waste)	581.66	611.11	626.24	641.08	670.78	679.85	688.95
6A 'SWDL' (Total)	1744.98	1833.33	1878.72	1923.24	2012.34	2039.57	2066.83
	1992	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**
6A1 'Managed WD on Land'	351.76	347.72	332.00	333.24	322.76	329.16	326.32
6A2 'Unmanaged WD Sites'	995.76	414.84	391.48	351.16	372.12	328.16	331.16
6A3 'Other' (Industrial Waste)	718.75	565.80	546.25	526.70	531.95	513.15	513.25
6A 'SWDL' (Total)	2066.27	1328.36	1269.73	1211.10	1226.83	1170.47	1170.73
	1999	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**
6A1 'Managed WD on Land'	312.20	293.68	276.40	296.40	300.80	309.20	314.20
6A2 'Unmanaged WD Sites'	307.36	299.16	299.36	297.96	291.60	305.80	328.20
6A3 'Other' (Industrial Waste)	494.30	526.68	516.48	527.58	526.44	540.00	556.44
6A 'SWDL' (Total)	1113.86	1119.52	1092.24	1121.94	1118.84	1155.00	1198.84

Note: The conversion factor used to generate the data included in the table above was 0.4 t MSW per 1 m^3 MSW

8.2.3 Uncertainties and Time-Series Consistency

For countries with efficient statistical systems the GPG (IPCC, 2000) recommends to use values implying circa ±10 percent of uncertainties associated with Total Municipal Solid Waste (MSW_T) and Fraction of MSW sent to SWDS (MSW_F). For countries with poor quality data, the uncertainties are more than a factor of two.

In the Republic of Moldova it was deemed rational to use the value of ±20 percent uncertainties related to 'Total Municipal Solid Waste' and 'Fraction of Municipal Solid Waste' sent to 'Managed Waste Disposal on Land', respectively, ±50 percent for uncertainties related to 'Total Solid Waste' and 'Fraction of Solid Waste' sent to 'Unmanaged Waste Disposal Sites'.

To be noted that some types of waste (ex., waste from food processing industry, accounting for approximately 8-10 percent of the total amount of solid waste generated in the country), were not taken into account while estimating the methane emissions from the 6A1 'Solid Waste Disposal on Land' source category. Another important issue, is associated with the fact that according to the data gathered through the Statistical Form F-2 'Waste', a bigger amount of solid waste are disposed to land, than if consider the data gathered through the Statistical Form No. 2 – gc 'Urban Settlements Sanitation'. It should be also mentioned, that uncertainties associated with activity data on generation industrial waste are much higher (±100 percent) than the uncertainties associated with the activity data on MSW. Taking into account the results of the studies undertaken in the Republic of Moldova to identify the waste morphologic composition, respectively the country specific values for Degradable Organic Carbon (DOC), Fraction of Degradable Organic Carbon Dissimilated (DOC_F), Fraction of Methane in Landfill Gas (F), it was deemed opportune to use the value of ±20 percent for uncertainties related to emission factors.

So, combined uncertainties related to CH_4 emissions from 6A1 'Managed Solid Waste Disposal on Land' source category can be considered moderate (±28.28 percent), uncertainties related to the CH_4 emissions from 6A2 'Unmanaged Waste Disposal Sites' can be considered medium (±53.85 percent), while the respective uncertainties related to the CH_4 emissions from 6A3 'Other' (Industrial Waste) are considered high (±101.98 percent). At the same time, combined uncertainties presented as a percent of total sectoral emissions were estimated at ±8.40 percent for 6A1 'Managed Solid Waste Disposal on Land' source category, ±12.89 percent for 6A2 'Unmanaged Waste Disposal Sites', and ±31.72 percent for the 6A3 'Other' (Industrial Waste) source category. Uncertainties introduced in trend in sectoral emissions were estimated at ±7.34 percent for 6A1 'Managed Solid Waste Disposal on Land' source category, ±14.65 for the 6A2 'Unmanaged Waste Disposal Sites' source category, and ±37.86 percent for the 6A3 'Other' (Industrial Waste) source category (Annex 7-3.6).

In view of ensuring time series consistency of results, the same approach was used for the entire period under review, in conformity with good practices applied in the GHG emissions inventory (IPCC, 2000).

8.2.4 QA/QC and Verification

Standard verification and quality control forms and checklists were filled in for the category 6A 'Solid Waste Disposal on Land' following the Tier 1 and Tier 2 approaches (see in Annex 6). Also, the AD and methods used for estimating CH_4 emissions under the category 6A 'Solid Waste Disposal on Land' were documented and archived both in hard copies and electronically. For identifying the data entry and emission estimation process related errors there were applied verifications and quality control procedures. Verification was focused on correct use of AD obtained from different sources of reference (i.e., Statistical Yearbooks of the RM and ATLBD, National Bureau of Statistics, and other relevant sources); as well as on ensuring correct use of the default emission factors available in the Revised 1996 IPCC Guidelines (IPCC, 1997), GPG (IPCC, 2000) and country specific factors developed under the UNDP-GEF Regional Project "Capacity Building for Improving the Quality of Greenhouse Gas Inventories (Europe/CIS region)" and comparing the results obtained by using different estimating methodologies (Tier 1 and Tier 2), by explaining the identified discrepancies, etc. Inventory quality assurance activities for the Waste Sector, inclusive for the 6A 'Solid Waste Disposal on Land' source category, were supported by an expert representing the Soil, Waste and Chemical Substances Inspection Division of the State Ecological Inspectorate.

Following the recommendations included into the Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories (IPCC, 2000), CH_4 emissions originated from the 6A 'Solid Waste Disposal on Land' were estimated based on AD and EFs from official sources of reference.

8.2.5 Recalculations

The CH_4 emissions from the category 6A "Solid Waste Disposal on Land' were recalculated for the 1990 through 1998 time series, in particular due to use higher tier methodology available in the GPG (IPCC, 2000), replacing the CH_4 estimations calculated following the methodologies available in the Revised 1996 IPCC Guidance (IPCC, 1997) used within the FNC (2000); as well as due to use of a new set of activity data.

Aiming at optimising the process of estimating methane emissions from the 6A 'Solid Waste Disposal on Land' source category, a Swiss 'INFRAS' estimation tool for the FOD method (Tier 2) was used, being provided to the national experts under the UNDP-GEF Regional Project "Capacity Building for Improving the Quality of Greenhouse Gas Inventories (Europe/CIS region)".

The parallel use of default (Tier 1) and FOD (Tier 2) methods resulted in significant discrepancies of obtained results.

Over the period of time from 1990 through 2005, CH_4 emissions from the source category 6A 'Solid Waste Disposal on Land', calculated by using the default method (Tier 1), decreased by 50.9 percent: from 117.60 Gg in 1990 to 57.74 Gg in 2005. To be noted that some years were marked by large inter-annual fluctuations in CH_4 emissions: -36.7 percent between 1992 and 1993, -16.1 percent between 1995 and 1996, -28.4 percent between 1998 and 1999, +17.5 percent between 2002 and 2003, and +22.7 percent between 2004 and 2005 (Table 8-13). The significant reduction of CH_4 emissions registered between 1992 and 1993 is explained both, by smaller amounts of solid waste disposed on the sites within the country, as well as by the impact of separation of the administrative territorial units on the left bank of the Dniester and lack of statistical data for this region (activity data have been extrapolated, however the related uncertainties are rather high). Other fluctuations are explained by the fact that the recycled fractions in waste stream (ex., paper and cardboard, textiles, glass and metals) has dropped significantly within the period under review (for example, the fraction of paper and cardboard in the waste stream constituted 25 percent in 1993, 15 percent in 1996, 4.8 percent in 1999, 6.2 percent in 2003 and 7.0 percent in 2005).

As the methane estimates calculated through the use of the First Order Decay (FOD) method produces a time-dependent emission profile that better reflects the true pattern of the degradation process over time, within the national greenhouse gas inventory of the Republic of Moldova there were included CH_4 emissions from the 6A 'Solid Waste Disposal on Land' category calculate through the use of respective methodology. In the time period from 1990 through 2005, CH_4 emissions from respective source category, decreased by 10.2 percent: from 62.91 Gg in 1990 to 56.49 Gg in 2005 (Table 8-14); the noted decrease being explained by the both economic decline during the market economy transition period, as well as due to the impact of the administrative separation of ATULBD.

Table 8-13: CH_4 Emissions from the 6A 'Solid Waste Disposal on Land' Source Category for the 1990-2005 Time Series, Calculated by Using the Default Method (Tier 1), Gg

	1990	1991	1992	1993	1994	1995	1996	1997
6A1 'Managed WD on Land'	32.2524	32.2925	31.4862	29.0624	27.7486	27.8522	22.4925	22.9385
6A2 'Unmanaged WD Sites'	48.8362	49.7814	53.4785	20.8034	19.6319	17.6100	15.5594	13.7213
6A3 'Other' (Industrial Waste)	36.5122	37.0009	38.6014	28.3737	27.3933	26.4130	22.2423	21.4562
6A 'SWDL' (Total)	117.6007	119.0748	123.5661	78.2395	74.7738	71.8752	60.2942	58.1160
Compared to 1990, %	100	1.3	5.1	-33.5	-36.4	-38.9	-48.7	-50.6
Inter-annual fluctuations, %	100	1.3	3.8	-36.7	-4.4	-3.9	-16.1	-3.6
	1998	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**
6A1 'Managed WD on Land'	22.7406	16.3643	15.3935	13.5547	14.5355	17.3347	17.8188	21.4687
6A2 'Unmanaged WD Sites'	13.8467	9.6663	9.4085	8.8084	8.7672	10.0827	10.5737	13.4551
6A3 'Other' (Industrial Waste)	21.4604	15.5455	16.5639	15.1969	15.5235	18.2029	18.6717	22.8123
6A 'SWDL' (Total)	58.0477	41.5761	41.3659	37.56	38.8262	45.6203	47.0642	57.7361
Compared to 1990, %	-50.6	-64.6	-64.8	-68.1	-67.0	-61.2	-60.0	-50.9
Inter-annual fluctuations, %	-0.1	-28.4	-0.5	-9.2	3.4	17.5	3.2	22.7

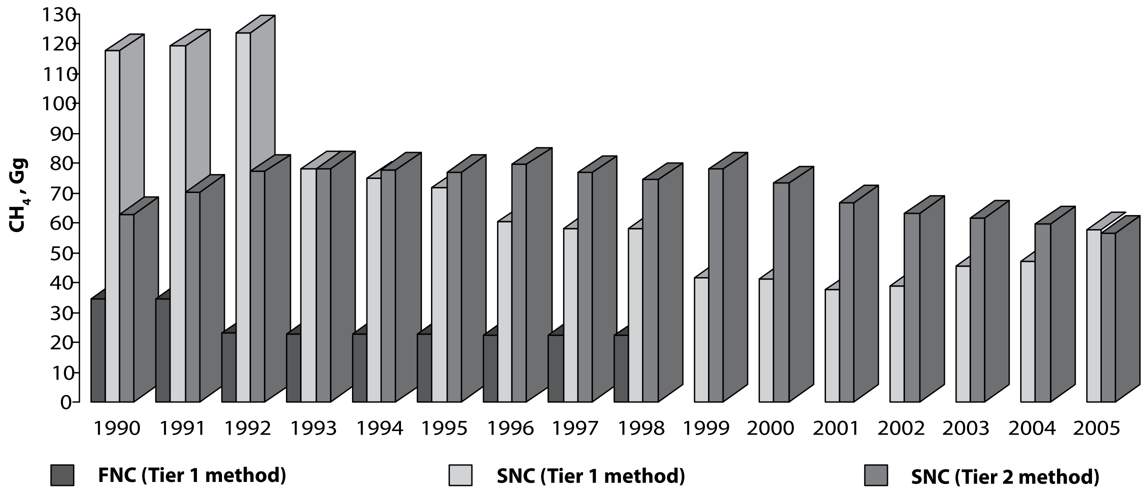

Figure 8-6: CH_4 Emissions from the 6A 'Solid Waste Disposal on Land' Source Category, Included in the FNC and SNC of the RM to the UNFCCC

Table 8-14: CH_4 Emissions from the 6A 'Solid Waste Disposal on Land' Source Category for the 1990-2005 Time Series, Calculated by Using the FOD Method (Tier 2), Gg

	1990	1991	1992	1993	1994	1995	1996	1997
6A1 'Managed WD on Land'	17.2529	19.2046	20.7984	22.1155	22.8465	23.4961	24.8069	24.5644
6A2 'Unmanaged WD Sites'	26.1254	29.1953	32.3466	31.2290	29.7240	28.1519	28.2443	26.3597
6A3 'Other' (Industrial Waste)	19.5325	21.7994	23.9798	24.8320	25.1709	25.3321	26.4847	25.8322
6A 'SWDL' (Total)	62.9108	70.1993	77.1248	78.1765	77.7414	76.9801	79.5359	76.7563
Compared to 1990, %	100	11.6	22.6	24.3	23.6	22.4	26.4	22.0
Inter-annual fluctuations, %	100	11.6	9.9	1.4	-0.6	-1.0	3.3	-3.5
	1998	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**
6A1 'Managed WD on Land'	24.3277	25.8559	24.4981	22.5027	21.4688	21.1761	20.7404	19.7969
6A2 'Unmanaged WD Sites'	24.7358	25.3848	23.3115	20.8820	19.3098	18.3317	17.3249	15.9536
6A3 'Other' (Industrial Waste)	25.2648	26.6639	25.3531	23.4398	22.4125	22.1207	21.6731	20.7355
6A 'SWDL' (Total)	74.3283	77.9046	73.1627	66.8245	63.1911	61.6285	59.7384	56.4860
Compared to 1990, %	18.1	23.8	16.3	6.2	0.4	-2.0	-5.0	-10.2
Inter-annual fluctuations, %	-3.2	4.8	-6.1	-8.7	-5.4	-2.5	-3.1	-5.4

To be noted that in comparison with results obtained by using the default method (Tier 1), the CH_4 emission annual fluctuations are much smaller in the case of using the FOD method (Tier 2). The analysis of obtained results reveal that the use of FOD method induces a slower evolution of emissions, avoiding thus the noted fluctuations in case of using the default method, reflecting thus the respective emissions in a more accurate way.

In comparison with the results reported in the FNC of the RM under the UNFCCC (2000), the changes performed in the process of development the current greenhouse gas inventory resulted in a significant increase of CH_4 emissions originated from the 6A 'Solid Waste Disposal on Land' Source Category (Figure 8-6, Table 8-15).

Table 8-15: Comparative Results of CH_4 Emissions from 6A 'Solid Waste Disposal on Land' Category Included into the FNC and SNC of the RM under the UNFCCC, Gg

	1990	1991	1992	1993	1994	1995	1996	1997
FNC	34.6038	34.6757	23.0076	22.8619	22.8311	22.7924	22.4672	22.3697
SNC	62.9108	70.1993	77.1248	78.1765	77.7414	76.9801	79.5359	76.7563
Difference, %	81.8	102.4	235.2	242.0	240.5	237.7	254.0	243.1
	1998	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**
FNC	22.2800							
SNC	74.3283	77.9046	73.1627	66.8245	63.1911	61.6285	59.7384	56.4860
Difference, %	233.6							

To be noted that under the FNC, CH_4 emission estimates for the 1990-1992 period, included the whole territory of the country, while for the time period from 1993 to 1998, only the part of the country on the right bank of the Dniester. In the SNC, there were included CH_4 emissions from 6A 'Solid Waste Disposal on Land' covering the whole territory of the country for the entire time series.

8.2.6 Planned Improvements

From sustainable development perspectives and European Union adherence, a new approach is needed to address the environmental issues, complying with the commitments under the ratified international conventions and agreements. Among the main priorities of the EU strategy on waste management is the need to promote statistical accounting of the generated waste, focused on the main criterion of relevance and comparability among the member states. At the same time, European environmental legislation is a benchmark for other numerous countries in developing national legislation on environment, thus representing an efficient model of interstate collaboration. Taking into account the international practice in municipal solid waste management and political declarations on the intended aligning to EU standards, the waste management in the Republic of Moldova has to be essentially restructured. In this context, it is deemed appropriate to transpose the Resolution of the EU Commission 2000/532/EC regarding the waste list, including hazardous waste. Adoption of the waste list, including hazardous waste, will contribute to improving national statistical records on waste management, to comply with the EU requirements, and will allow fulfil the commitments under the international environmental treaties, ratified by the RM, and efficient reporting on consistent implementation. In this context it is planned to improve the quality of activity data pertaining to the amount of generated and disposed municipal solid waste and industrial waste.

8.3 Wastewater Handling (Category 6B)

8.3.1 Source Category Description

The source category 6B 'Wastewater Handling', deals with CH_4 emission from handling of domestic and industrial wastewater under anaerobic conditions, as well as N_2O emissions from human sewage.

6B1 'Industrial Wastewater'

In the RM the industrial wastewater are released into municipal sewer lines where it combines with domestic wastewater, the CH_4 emission generated being covered there. Under the Industry Sector, the Food Processing Industry generates most industrial wastewater with high content of biodegradable organic matter. Wastewater is treated by classical aerobic method (mechanic and biological), however due to incorrect operation of the existent treatment facilities, a portion of wastewater (around 20 percent of the total) is treated anaerobically. Another relevant source of CH_4 emissions is the sludge removed from wastewater which is treated aerobically and anaerobically, and applied to land.

6B2 'Domestic Wastewater'

Domestic wastewater is the product of using water for domestic purposes. The process of treating domestic wastewaters and sludge from treatment facilities implies CH_4 generation. The amount of CH_4 generated under this source category depends on domestic wastewater management practices used in the RM, as well as the degree to which population is covered by services of centralized sewer systems and wastewater treatment scope.

In the time period from 1990 to 1999, domestic wastewater treatment systems were managed by state enterprise „Apa-Canal". In 2000, these systems were divested to local public authorities, which were not ready to take over management of these systems, as they lacked the infrastructure and the financial resources needed to ensure proper operation. Under such circumstances the treatment facilities fell into disrepair and most of them are out of operation. At present domestic wastewater are treated in most urban settlements of the RM, but only partially. It should be mentioned that in most rural settlements sewage systems are also deteriorated. In urban areas, where wastewater treatment facilities are operational, sludge is treated by placing it on sludge platforms. Starting from the point that project capacities of all existent treatment facilities, as a rule are bigger (by 2 to 10 times, and in some places even more) than the amount of actually generated wastewaters, all such facilities have spare space for sludge depositing. Only in big cities, such as Chisinau, Balti and Cahul, due to lack of sludge treatment technologies, sludge is deposited in layers thicker than 50 cm, what generates anaerobic processes and induces methane emissions. However, in comparison with the total area of deposited sludge, the areas with deposited sludge are insignificant and are not taken into account for emissions calculation. Under these circumstances, it was not deemed necessary to estimate methane emissions resulting from sludge treatment, in particular keeping in mind that the deposited sludge undergoes fermentation in aerobic conditions. According to recent inventory of existent wastewater treatment facilities carried out by the experts of the Ministry of Environment and Natural Resources it has been stated that due to small amounts of generated wastewater needed for adequate operation of domestic wastewater treatment facilities, "Apa-Canal" J.S.C. allowed to release wastewater produced by a number of industrial enterprises into the municipal sewage system, what entailed decreased amounts of industrial wastewaters being treated on-site.

In the frame of 6B "Wastewater Handling' category, the human sewage is a relevant source of N_2O emissions, being calculated based on activity data on the number of population the RM and protein consumption per capita. Between 1990 and 2005, the GHG emissions from 6B 'Wastewater Handling' have decreased by 30.2 percent: from 306.21 Gg CO_2 eq. in 1990 to 213.75 Gg CO_2 eq. in 2005. The share of CH_4 emissions decreased from 57.9 percent in 1990, to 56.6 percent in 2005, while the share of N_2O emissions increased from 42.1 percent in 1990, to 43.4 percent in 2005 (Figure 8-7).

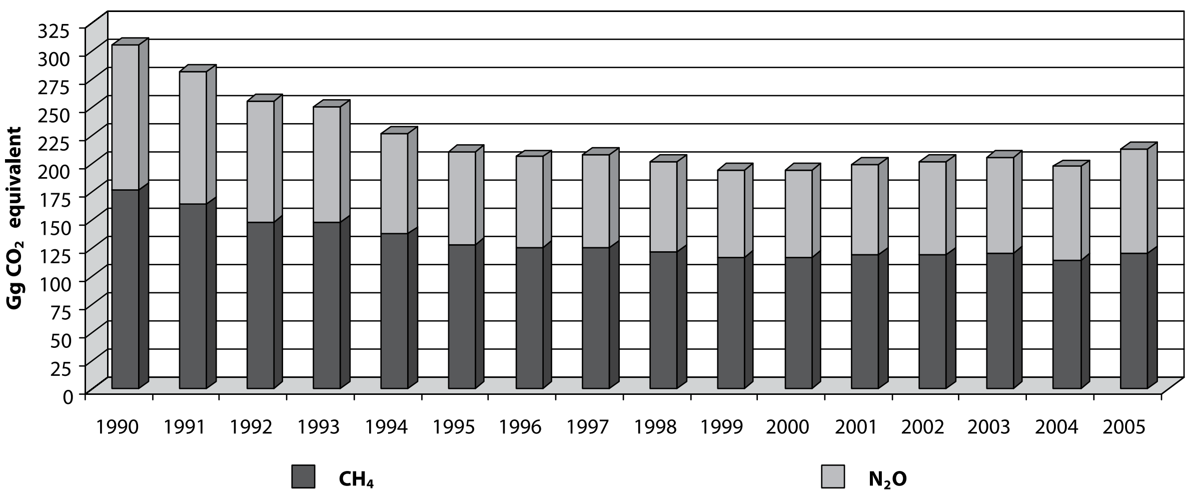

Figure 8-7: GHG Emissions from 6B 'Wastewater Handling' Source Category in the Republic of Moldova, 1990-2005

Table 8-16: Emission Factors Used to Estimate Methane Emissions from the 6B1 'Industrial Wastewater' Source Category

Industry Production by Type	BOD value, kg BOD_5/m^3 wastewater	Wastewater Produced, m^3/t of product
Canned meat	0.80	20.50
Canned fruit and vegetables	1.15	15.00
Beer	1.00	7.31
Wine	1.05	4.02
Sparkling wine	1.80	6.80
Cognac (divin)	8.90	12.05
Brandy and liqueurs	8.90	6.30
Meat	0.80	18.10
Sausages	0.80	20.50
Butter	1.00	2.60
Cheese and cottage cheese	1.20	4.30
Whole milk products	1.10	4.40
Sugar	3.35	3.40
Fish	0.67	16.40
Vegetable oil	1.20	1.60
Non-alcoholic drinks	0.70	3.81
Corrugated cardboard	0.80	17.25
Synthetic resins and plastics	1.40	0.60
Paint and varnishes	0.003	0.57
Synthetic detergents	0.48	0.95
Laundry soap	30.00	2.48
Soft and man made leather	1.80	229.30
Cotton yarn and fabrics	0.60	40.70

Source: Mircea Gh. Negulescu et al., 1968 Industrial Wastewater Treatment, Technical Publishing House, Bucharest, 1968; CEC All Union Scientific Research Institute for Water Supply, Sewage, Hydraulic Engineering Works and Engineering Hydrogeology (VNII VODGEO GOSSTROI of the USSR), 1982 Consolidated Norms in Water Supply and Water Disposal for Different Industries, Moscow, 1982; Revised 1996 Guidelines (IPCC, 1997); GPG (IPCC, 2000).

8.3.2 Methodological Issues and Data Sources

6B1 'Industrial Wastewater'

Methane emissions from the 6B1 'Industrial Wastewater' source category were estimated by following recommendations set forth in the Revised 1996 Guidelines (IPCC, 1997) and GPG (IPCC, 2000), based on a IPCC default method (Tier 1). The respective approach implies substitution of the organic load value from industry sector, by the equivalent number of population connected to centralized sewage systems.

For this purpose there were used activity data on industrial wastewater generation (by industry branches) and their discharging into the sewage systems. Each industry branch was assigned a certain value for organic load in biochemical oxygen demand (BOD), expressed in kg BOD_5/m^3 of industrial wastewater, amount of wastewater produced per industrial production output unit in m^3/t of product (Table 8-16), as well as the amount of annual output for each industry type (Table 8-17, Annex 3-6).

In the Republic of Moldova the amount of total organic wastewater (TOW_{ind}) calculation for a particular industry was estimated by following the equations below.

$$TOW_{ind\ (wastewater)} = O \bullet W_{ind} \bullet D_{ind} \bullet (1 - DS_{ind}) \text{ and}$$

$$TOS_{ind\ (sludge)} = O \bullet W_{ind} \bullet D_{ind} \bullet DS_{ind}$$

Where:

TOW_{ind} = total industrial organic wastewater, kg BOD_5[31]/yr;

TOS_{ind} = total industrial organic sludge, kg BOD_5/yr;

O = total annual industrial output by selected industry, t[32]/yr;

W_{ind} = amount of wastewater consumed, m^3/tonne of industrial output;

D_{ind} = industrial degradable organic component, kg BOD_5/m^3;

DS_{ind} = fraction of industrial degradable organic component removed as sludge.

The obtained value for total industrial organic wastewater (TOW_{ind}) (see in Table 8-18) was converted in „population equivalent number" (P_{EQ}).

$$P_{EQ} = TOW_{ind} / B / D$$

Where:

TOW_{ind} = total industrial organic wastewater, kg BOD_5/yr;

B = organic load in biochemical oxygen demand per person, g BOD/person/day, overall default = 60 g BOD/person/day (IPCC, 2000);

D = number of days in a calendar year (365 days in normal years and 366 days in leap years: 1992, 1996, 2000 and 2004).

[31]BOD – Biochemical Oxigen Demand; the BOD concentration indicates only the amount of carbon that is aerobically biodegradable; the standard measurement for BOD is a 5-day test, denoted as BOD_5.

[32]The following conversion factors were used : 1 jar equivalent = 0.5 kg; 1 m^2 fabric = 0.2 kg; 1m^2 of soft man made leather = 0.7 kg; 1 m^2 of corrugated cardboard = 0.3 kg; 1 dal of alcoholic drinks (wine, sparkling wine, brandy, brandies and liqueurs, beer) = 10 kg.

Table 8-17: Activity Data on Industrial Output Used to Estimate CH_4 Emissions from the 6B1 'Industrial Wastewater' Source Category within 1990-2005 time series, tonnes

	1990	1991	1992	1993	1994	1995	1996	1997
Canned meat	24400	15550	8700	5700	3200	2100	2000	3100
Canned fruit and vegetables	1242750	982250	740350	822000	563000	178200	126200	200100
Beer	76000	66000	43000	36000	28500	30290	25600	26270
Grapes wine	163000	143000	92000	103000	97780	99690	145800	194150
Sparkling wine	8040	7830	8540	8880	7420	9480	14190	13450
Cognac (divin)	13940	14020	7500	7400	7930	10270	4570	5860
Brandy and liqueurs	5590	5560	6760	13940	26470	41270	33580	23700
Meat	257900	218500	136000	105700	81100	58400	52600	50800
Sausages	50000	45100	22700	16000	9400	9000	8000	9600
Butter	27000	21800	16700	11000	9600	6800	4700	3000
Cheese and cottage cheese	12200	10000	5800	5200	3300	2100	1700	1200
Whole milk products	454800	382600	180500	175100	135500	61200	48000	32700
Sugar	284000	205100	192200	209000	166700	218700	264500	213300
Fish	9500	5200	6500	9500	2100	-	-	-
Vegetable oil	125600	117900	57300	60300	50400	50700	39400	35200
Non-alcoholic drinks	131000	86000	35000	19000	17000	20490	15080	14330
Corrugated cardboard	5340	4650	1110	1020	240	420	510	720
Synthetic resins and plastics	17500	14600	5800	4800	1500	1300	2100	700
Paint and varnishes	11700	8800	4300	2300	1000	600	500	500
Synthetic detergents	15000	10100	7300	4000	900	1200	1500	300
Laundry soap	11700	8000	4800	2700	500	600	466	608
Soft and man made leather	4270	3150	2240	1610	420	210	125	222
Cotton yarn	31600	32600	21200	13000	7600	2700	6524	5364
Fabrics	48920	45620	36140	19840	16520	5400	8601	7817
	1998	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**
Canned meat	2350	1900	2100	2171	2313	3292	2174	836
Canned fruit and vegetables	135400	98600	93850	113875	80861	111200	81077	86208
Beer	30010	21910	25920	33620	46240	59910	69570	77780
Grapes wine	123960	69250	108900	156423	149398	193183	329451	367274
Sparkling wine	5190	6750	4160	5843	6130	7385	9383	11177
Cognac (divin)	4970	4860	7177	9556	10381	13611	14280	17108
Brandy and liqueurs	17410	8700	4890	5940	7790	13980	21290	21980
Meat	27300	25700	13400	7301	11262	14855	10181	6658
Sausages	8000	9400	10200	11655	13842	15026	13226	17084
Butter	2895	2374	2844	3360	2717	2863	3840	3593
Cheese and cottage cheese	1328	1325	1212	1484	1895	1895	1941	2435
Whole milk products	38400	32500	30200	38471	45360	22525	19749	26284
Sugar	194500	100500	105400	132600	167600	107100	110900	133500
Fish	-	-	-	-	-	-	-	-
Vegetable oil	28700	24300	31300	43486	53632	76754	97229	83318
Non-alcoholic drinks	15570	14910	19660	30910	51370	63450	68930	71130
Corrugated cardboard	390	169	168	385	259	185	471	605
Synthetic resins and plastics	900	900	1300	1300	2800	2700	2989	3175
Paint and varnishes	370	674	2054	2870	4095	3443	5136	6269
Synthetic detergents	172	258	386	821	255	243	493	85
Laundry soap	301	231	231	280	232	306	386	240
Soft and man made leather	67	12	12	4.2	0.7	0.8	1.1	1.2
Cotton yarn	10552	8131	13030	12400	12501	13300	16200	18000
Fabrics	14004	11606	17604	16335	16837	19292	20619	23823

Source: Statistical Yearbooks of the RM for 1994 (page 284-291), 1999 (page 302-306), 2003 (page 391-395), 2004 (page 441-445), 2006 (page 309-312); Statistical Bulletin for 2006, IV quarter (for 2001-2006 period) (page 23-29); Statistical Yearbooks of the ATULBD for 1998 (page 176-184), 2000 (page 99-100), 2002 (page 103-104) and 2006 (page 93-94).

Table 8-18: Total Industrial Organic Wastewater in the Republic of Moldova, 1990-2005

Years	TOW_{ind}, t BOD_5/yr	Years	TOW_{ind}, t BOD_5/yr
1990	40500.90	1998	8383.95
1991	32795.12	1999	5711.12
1992	23362.18	2000	6005.23
1993	23689.30	2001	7242.15
1994	17705.48	2002	7541.98
1995	11579.55	2003	8507.71
1996	10298.84	2004	9224.54
1997	10705.98	2005	10270.30

The calculated population equivalent values (P_{EQ}) are added to the number of inhabitants connected to sewage system (P_{WS}) (according to the World Bank estimates, 68 percent of the population of the RM is connected to sewage system). The sum obtained corresponds to the fictitious number of population (P) connected to sewage system. The respective figures were used to estimate CH_4 emissions from industrial and domestic wastewater handling (Table 9-19).

6B2 'Domestic Wastewater'

Methane emissions from the 6B2 'Domestic Wastewater' source category were estimated by following recommendations set forth in the Revised 1996 Guidelines (IPCC, 1997) and GPG (IPCC, 2000), based on a IPCC default method (Tier 1). Three basic steps are required for estimating CH_4 emissions from wastewater handling.

Table 8-19: Activity Data Used to Estimate Methane Emissions from the 6B2 'Domestic Wastewater' Source Category, 1990-2005

	1990	1991	1992	1993	1994	1995	1996	1997
P_{WS}, thousand inhabitant	2965.89	2969.08	2964.19	2956.50	2959.84	2956.57	2947.39	2937.60
P_{EQ}, thousand inhabitant	1849.36	1497.49	1063.85	1081.70	808.47	528.75	468.98	488.86
P, thousand inhabitant	4815.24	4466.58	4028.04	4038.21	3768.31	3485.32	3416.37	3426.46
TOW_{dom}, t BOD_5	87878.20	81515.05	73511.72	73697.28	68771.57	63607.06	62472.92	62532.85
	1998	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**
P_{WS}, thousand inhabitant	2927.20	2919.24	2911.42	2908.36	2897.34	2884.22	2677.64	2820.16
P_{EQ}, thousand inhabitant	382.83	260.78	273.46	330.69	344.38	388.48	420.06	468.96
P, thousand inhabitant	3310.02	3180.02	3184.88	3239.05	3241.73	3272.70	3097.70	3289.13
TOW_{dom}, t BOD_5	60407.96	58035.39	58124.10	59112.69	59161.51	59726.77	56532.97	60026.57

Source: Statistical Yearbooks of the RM for 1994 (page 52), 1999 (page 52), 2003 (page 45), 2004 (page 55), 2005 (page 36), 2006 (page 37); Statistical Yearbooks of the ATLBD for 2006 (page 29) and 2007(page 27)

Step 1: Determine the total amount of organic material in the wastewater produced for domestic wastewater handling system (TOW_{dom}). The most common parameters used to measure the degradable organic component (DC_{dom}) of the wastewater are the Biochemical Oxygen Demand (BOD) and Chemical Oxygen Demand (COD). The DC indicator, usually indicated in units of mass DC per unit of volume (e.g., kg BOD per m^3 wastewater) is multiplied by the volume of the source of wastewater to estimate the total amount of organic wastewater produced. This value is influenced in particular, by the population (P) number connected to sewage system, and respectively by the domestic degradable organic component (D) (in kg BOD/1000 persons/yr); the default value for Europe and Former USSR countries is 18250 kg BOD_5/1000 persons/yr.

$$TOW_{dom\ (wastewater)} = P \bullet D_{dom} \bullet (1-DS_{dom})$$ and

$$TOS_{dom\ (sludge)} = P \bullet D_{dom} \bullet DS_{dom}$$

Where:

TOW_{dom} = total domestic organic wastewater, kg BOD_5/yr;

TOS_{dom} = total domestic organic sludge, kg BOD_5/yr;

P = fictitious country population connected to sewage system: which is the number of country population connected to sewage systems (P_{WS}), plus population equivalent number (P_{eq}), calculated under the 6B1 'Industrial Wastewater', in 1000 persons/yr;

D_{dom} = domestic degradable organic component, kg BOD/1000 persons/yr;

DS_{dom} = fraction of domestic degradable organic component removed as sludge.

Step 2: Estimate emissions factors for domestic wastewater handling system. The emission factors depend on the fraction of wastewater managed by domestic wastewater handling method, maximum CH_4 producing capacity of the wastewater, and the characteristics of the wastewater handling process (principally, the degree to which it is anaerobic). To calculate emission factors for domestic wastewater handling system, a weighted average of methane conversion factor (MCF) is calculated using estimates of wastewater managed by each wastewater handling method. The average MCF is then multiplied by the maximum methane producing capacity (B_0) of the wastewater type. Since aerobic and anaerobic handling are the only handling system considered, the CH_4 conversion rate can be used to characterise a broad range systems failing between aerobic and anaerobic handling system. Equations below present the emission factor calculation for wastewater:

$EF_i = B_{oi} \bullet \Sigma(WS_{ix} \bullet MCF_x)$ and $EF_j = B_{oj} \bullet \Sigma(SS_{jy} \bullet MCF_y)$

Where:

EF_{ij} =emissions factor for wastewater and sludge, kg CH_4/kg BOD_5;

B_{oij} = maximum methane producing capacity in wastewater and sludge, kg CH_4/kg BOD_5; default value is 0.6 kg CH_4/kg BOD_5 (IPCC, 2000);

MCF_{xj} = methane conversion factors for each wastewater handling system x or y (MCF varies between 0.0 for a completely aerobic system to 1.0 for a completely anaerobic system; in the RM the used value of MCF_x was 80 percent);

WS_{ix} = fraction of wastewater type i treated using wastewater handling system x; in the RM, the used value of WS_{ix} was 20 percent);

SS_{jy} = fraction of sludge type j treated using sludge handling system y.

Step 3: Multiply the emission factors for each wastewater handling system by the total amount of organic material in the wastewater produced for each system, and sum across the wastewater systems to estimate CH_4 emissions. The amount of CH_4 that is recovered, and thus not emitted into the atmosphere should be subtracted. Equations below present how to estimate the total CH_4 emissions from wastewater and sludge handling:

$TM = WM+SM,\ WM = \Sigma_i\ (TOWi \bullet EF_i - MR_i),\ SM = \Sigma_j\ (TOS_i \bullet EF_i - MR_i)$

Where:

TM = total methane from wastewater and sludge handling, kg CH_4/yr;

WM = total methane emissions from wastewater, kg CH_4/yr;

SM = total methane emissions from sludge, kg CH_4/yr;

TOW_i = total organic waste for wastewater type i, kg BOD_5/yr;

TOS_i = total organic waste for sludge type j, kg BOD_5/yr;

EFi = EF from wastewater type i and for sludge type j, kg CH_4/kg BOD_5;

MR_i = total amount of methane recovered or flared from wastewater type i or from sludge type j, if no data are available, the default value of zero is used.

6B2 'Nitrous Oxide from Human Sewage'

Nitrous oxide emissions from the 6B2 'Domestic Wastewater' (Nitrous Oxide from Human Sewage) source category were estimated by following recommendations set forth in the Revised 1996 Guidelines (IPCC, 1997) based on a IPCC default method (Tier 1). Equations below present how to estimate the N_2O emissions from human sewage:

$N_2O_{(s)} = PROTEIN \bullet Frac_{NPR} \bullet NR_{PEOPLE} \bullet EF_6 \bullet 44/28$

Where:

N_2O = N_2O emissions from human sewage, kg N_2O/yr

PROTEIN = annual per capita protein intake, kg/person/yr (Table 8-20);

NR_{PEOPLE} = number of people in the Republic of Moldova (Table 8-20);

EF_6 = emission factor; default value is 0.01 kg N_2O-N/kg N sewage-N produced;

$Frac_{NPR}$ = fraction of nitrogen in proteins, default value is 0.16 kg N/kg proteins;

[44/28] = stoichiometric ratio of N_2O-N to N_2O.

Annual per capita protein intake AD for the Republic of Moldova is available in the FAO data base. For the base year (1990), activity data for the former USSR were used (104 g/person/day) (see Annex 3-6).

Table 8-20: Activity Data Used to Estimate N_2O Emissions from 'Nitrous Oxide from Human Sewage' in the RM, 1990-2005

	1990	1991	1992	1993	1994	1995	1996	1997
P_{RM}, thousand inhabitants	4361.60	4366.30	4359.10	4347.80	4352.70	4347.90	4334.40	4320.00
Protein, g/person/day	104.00	95.00	86.10	82.20	71.10	66.90	65.00	66.90
Protein, kg/person/yr	37.96	34.68	31.43	30.00	25.95	24.42	23.73	24.42
	1998	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**
P_{RM}, thousand inhabitants	4304.70	4293.00	4281.50	4277.00	4260.80	4241.50	3937.70	4147.30
Protein, g/person/day	65.90	63.50	63.60	66.20	68.60	70.20	74.40	78.60
Protein, kg/person/yr	24.05	23.18	23.21	24.16	25.04	25.62	27.16	28.69

Source: Statistical Yearbooks of the RM, 1994 (page 52), 1999 (page 52), 2003 (page 45), 2004 (page 55), 2005 (page 36), 2006 (page 37); Statistical Yearbooks of the ATULBD for 2006 (page 29), 2007 (page 27); and FAO data base.

To be noted that the previous version of the FAO data base (covering the 1990-2002 period) annual data were provided, while the new version of the FAO data base provides average data, for a 3 years period. As no activity data were available for years 1991 and 2005, the respective figures were extrapolated by using a regresional trend analysis[33].

[33]Polynomial equation used: $y = 0.4868\ x^2 - 9.7503\ x + 111.62$. R^2=0,9717

8.3.3 Uncertainties and Time-Series Consistency

The quality of GHG emissions estimates for wastewater handling is directly related to the quality and availability of the waste management data used to derive these estimates. The principal sources of uncertainty are associated with the amount of degradable organic wastewater and their composition; limitations exist also for quantifying the fraction of wastewater subject to specific systems; certain uncertainties raised from the physical and chemical wastewater characteristics and volumes of process wastewater streams; as well as from wastewater handling facility efficiency, output characteristics and emission factors used to estimate emissions under this source category.

Thus, uncertainties associated with the default emission factors used to estimate CH_4 and N_2O emissions from the 6B 'Wastewater Handling' source category reach up to ±30 percent. Uncertainties related to activity data vary from low (±5 percent) for number of population; to moderate (±20 percent) for industrial output; and to medium (±30 percent) for annual per capita protein intake. So, average uncertainties associated with the activity data used to estimate GHG emissions from the 6B 'Wastewater Handling' source category were considered to be moderate (±20 percent).

Combined general uncertainties associated with the GHG emissions from the 6B 'Wastewater Handling' source category were considered to be medium (±36.06 percent). At the same time, combined uncertainties presented as a percent of total sectoral emissions were estimated at ±3.12 percent for methane emissions and at ±2.39 percent for nitrous oxide emissions. Uncertainties introduced in trend in sectoral emissions were estimated at ±2.18 percent for CH_4 emissions and at ±1.65 percent for N_2O emissions (Annex 7-3.6).

In view of ensuring time series consistency of results, the same approach was used for the entire period under review, in conformity with good practices applied in the GHG emissions inventory (IPCC, 2000).

8.3.4 QA/QC and Verification

Standard verification and quality control forms and checklists were filled in for the category 6B 'Wastewater Handling' following the Tier 1 and Tier 2 approaches (see in Annex 6). Also, the AD and methods used for estimating GHG emissions from the category 6B 'Wastewater Handling' were documented and archived both in hard copies and electronically. For identifying the data entry and emission estimation process related errors there were applied verifications and quality control procedures. Verification was focused on correct use of AD obtained from different sources of reference (i.e., Statistical Yearbooks of the RM and ATULBD, National Bureau of Statistics, FAO database and other relevant sectoral sources); as well as on ensuring correct use of the default emission factors available in the Revised 1996 IPCC Guidelines (IPCC, 1997), GPG (IPCC, 2000), and other relevant sources, ex., planning water norms for different industries: Mircea Gh. Negulescu et al., 1968 'Industrial Wastewater Treatment'. Technical Publishing House, Bucharest, 1968; CEC VNII VODGEO GOSSTROI of the URSS, 1982 'Consolidated norms for water supply and sewage for different industries', Moscow, 1982; Stroiizdat Publishing House, 1981 'Sewage Systems for Settlements and Industrial Enterprises', Projector's Guidebook, Moscow, 1981; Current Issues of Urbanism and Territory Development, Technical Scientific Conference, Volume II, Collection of articles, Chisinau, 2006, etc. Inventory quality assurance activities for the Waste Sector, inclusive for the 6B 'Wastewater Handling' source category, were supported by an expert representing the Soil, Waste and Chemical Substances Inspection Division of the State Ecological Inspectorate.

Following the recommendations included into the Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories (IPCC, 2000), GHG emissions originated from the 6B 'Wastewater Handling' were estimated based on AD and EFs from official sources of reference.

8.3.5 Recalculations

The CH_4 emissions from the category 6B 'Wastewater Handling' were recalculated for the 1990 through 1998 time series, in particular due to use of updated methodological approaches and EFs available in the GPG (IPCC, 2000), as well as some country specific parameters, partly replacing the estimates calculated following the methodologies and EFs available in the Revised 1996 IPCC Guidance (IPCC, 1997) used within the FNC (2000); as well as due to use of a new set of activity data, in particular those related to industrial output in the RM, available in the Statistical Yearbooks of the RM and ATULBD.

In comparison with the previously obtained results for the 1990-1998 time periods, the above mentioned changes resulted in increased values, with a variation from a minimum of 309.5 percent in 1992 to a maximum of 363.5 percent in 1994 (Table 8-21). For the period 1999-2005, CH_4 emissions resulting from wastewater handling were estimated for the first time. The results allow assert that within the 1990-2005 time series CH_4 emissions from 6B 'Wastewater Handling' source category decreased by circa 31.7 percent, with interannual fluctuations ranging within 10 percent.

N_2O emissions from the 6B 'Wastewater Handling' (Human Sewage) were estimated for the first time, decreasing in the respective period by circa 28.1 percent (Table 8-22).

Table 8-21: Comparative Results of CH_4 Emissions from 6B 'Wastewater Handling' Source Category Included into the FNC and SNC of the RM under the UNFCCC, Gg

	1990	1991	1992	1993	1994	1995	1996	1997
FNC	1.9777	1.8280	1.7232	1.5857	1.4243	1.3922	1.3654	1.3684
SNC	8.4363	7.8254	7.0571	7.0749	6.6021	6.1063	5.9974	6.0032
Difference , %	326.6	328.1	309.5	346.2	363.5	338.6	339.2	338.7
	1998	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**
FNC	1.3462							
SNC	5.7992	5.5714	5.5799	5.6748	5.6795	5.7338	5.4272	5.7626
Difference , %	330.8							

Table 8-22: N_2O Emissions from the 6B2 'Wastewater Handling' (Human Sewage) in the Republic of Moldova, 1990-2005

	1990	1991	1992	1993	1994	1995	1996	1997
N_2O emissions, Gg	0.4163	0.3807	0.3454	0.3280	0.2840	0.2669	0.2593	0.2652
Compared to 1990, %	100.0	-8.6	-17.0	-21.2	-31.8	-35.9	-37.7	-36.3
Inter-annual fluctuations, %	100.0	-8.6	-9.3	-5.0	-13.4	-6.0	-2.9	2.3
	1998	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**
N_2O emissions, Gg	0.2603	0.2502	0.2506	0.2591	0.2674	0.2733	0.2696	0.2992
Compared to 1990, %	-37.5	-39.9	-39.8	-37.8	-35.8	-34.4	-35.2	-28.1
Inter-annual fluctuations, %	-1.8	-3.9	0.2	3.4	3.2	2.2	-1.3	11.0

8.3.6 Planned Improvements

It will be possible to improve the monitoring of GHG emissions from the 6B 'Wastewater Handling' source category along with achieving an improvement of the wastewater management system in the RM, in conformity with up to date environmental requirements.

This perspective seems become real, in particular, due to the fact that the Republic of Moldova has commitments under the international conventions on water resources, as a result of ratifying in 2005 the Protocol on Water and Health (London, 1999). Meeting the provisions of the *Protocol* would mean establishment of criteria to assess the condition of the wastewater systems and for the operation of wastewater treatment plants. This will provide updated activity data to be used in estimation of GHG emissions from this source category. Another option regarding improving of wastewater management in the Republic of Moldova is related to engagements to reduce the share of population not having access to drinking water and to build wastewater sewage and treatment systems in conformity with the provisions of the Strategy on Water Supply and Sewage of the RM (2007).

Harmonization of national legislation on water with the EU Directives also provides an additional chance to improve wastewater management, as well as the statistical system used to monitor information pertaining to wastewater management. By accomplishing the abovementioned, along with sustainable development of the economy of the RM, it will become possible to substantially reduce GHG emissions originated from the 6B 'Wastewater Handling' source category. At the same time, at the national level, it is absolutely necessary to apply sludge treatment technologies, allowing to recover and sustainable use the methane emissions from sludge platforms (inclusively, for electric and heat power production).

For the next inventory cycle it is planned to study the possibility of using country specific information on fraction of BOD removed with the sludge, maximum methane producing capacity, methane correction factor, fraction of wastewater and sludge treated by different handling systems and other relevant parameters used to estimate methane emissions from the 6B 'Wastewater Handling' source category.

9. RECALCULATIONS AND IMPROVEMENTS

This chapter of the report summarise the recalculations made to the Republic of Moldova GHG Inventory for the 1990-1998 period, since First National Communication (2000) was issued, as well as planned improvements for the future inventory cycle, to be undertaken in the frame of the Third National Communication. It summarises material that has already been presented and discussed in more detail in Chapter 3 to Chapter 8.

9.1 Explanations and Justification for Recalculations

The National GHG Inventory Team revised and recalculated GHG emissions and CO_2 removals for each calendar year covered by the First National GHG Inventory for the period from 1990 through 1998, a component part of the FNC of the RM to the UNFCCC (2000). These activities were carried out during the on-going process of improving the quality of the National GHG Inventory (inclusive, by taking into account the updated activity data, using new methodological approaches, emission factors, implementing new methodological guidelines and correcting the identified errors).

Under current inventory cycle, improvements were made in all sectors (use of higher tier methodologies, revision of previously used methodological approaches and emission factors, activity data, inclusion of new emission sources, etc.), entailing the need to make recalculations of national GHG emissions for the time period from 1990 through 1998, reflected in the FNC of the RM to the UNFCCC (Chapter 2 'National GHG Inventory').

In comparison with the results reported under the FNC (2000), the changes made during the development of the current inventory, resulted in increased values of national direct GHG emissions in the time period from 1990 through 1998, with a variation from a minimum of 18.7 percent in 1998, to a maximum of 34.5 percent in 1995 (Table 9-1).

Table 9-1: Recalculations of Direct GHG Emissions for the 1990-1998 time series included in the FNC of the RM under the UNFCCC, Gg CO_2 equivalent

	1990	1991	1992	1993	1994	1995	1996	1997	1998
FNC	33272.57	30141.62	23538.68	17777.10	15358.77	12455.06	12861.18	11604.91	10620.59
SNC	42886.02	38175.48	28376.24	22760.89	19847.63	16758.16	16771.33	14650.82	12605.12
Difference, %	28.9	26.7	20.6	28.0	29.2	34.5	30.4	26.2	18.7

Abbreviations: FNC – First National Communication; SNC – Second National Communication.

9.1.1 Energy

Recalculations of direct GHG emissions from the Energy Sector were performed due to the following:

- availability of an updated set of activity data in:
  - Official statistical sources (Energy Balances of the RM, Statistical Yearbooks of the RM and of the ATULBD);
  - Departmental sources (information received from the Ministry of Transport and Roads, Ministry of Agriculture and Food Industry, Ministry of Defence, National Bureau of Statistics, State Administration of Civil Aviation);
  - Information provided by businesses (such enterprises as: „Moldavian Railways" J.S.C., "MOLDOVAGAZ" J.S.C.);
- concretizing the activity data associated with:
  - fuel consumption in road, railway, water borne and aviation transport, based on information received from National Bureau of Statistics, Ministry of Transport and Roads, "Moldavian Railways' J.S.C. and Civil Aviation State Administration;
  - fuel consumption for heating in commercial, institutional, residential, agriculture, forestry and fishery sectors, based on information available in the Energy Balances of the RM, Statistical Yearbooks of the RM and of the ATULBD, and based on information received from Ministry of Agriculture and Food Industry, Ministry of Transport and Roads and National Bureau of Statistics of the RM;
  - fuel consumption for pipeline transportation, based on information available in Energy Balances of the RM;
  - amounts of natural gas transited across the territory of the RM to the Balkans countries and amount of natural gas sold in the RM, based on information received from the national operator in the field of natural gas "MOLDOVAGAZ" J.S.C.;
  - biomass consumption in the RM, based on information received from the National Bureau of Statistics of the RM and Forestry Agency "MOLDSILVA";

- redistribution of 90 percent of fuel consumed for operation of agricultural transport from the source category 1A3b 'Road Transport', to the source category 1A4c 'Agriculture/Forestry/Fishing' (mobile sources), based on expert judgement provided by specialists from the Ministry of Transport Roads and Ministry of Agriculture and Food Industry;
- use of methodologies available in the 2006 IPCC Guidelines, replacing the methodologies available in the Revised 1996 IPCC Guidelines (IPCC, 1997), used within the FNC of the RM under the UNFCCC (2000);
- use of higher methods (Tier 2), replacing the default methods (Tier 1), used within the FNC of the RM under the UNFCCC (ex., 'Memo Items': International Aviation);
- use of country specific factors (Net Caloric Values), replacing the default values used under the FNC (IPCC, 1997);
- change of carbon oxidation factor values, etc.

In comparison with the results reported in the FNC of the RM under the UNFCCC (2000), the changes performed in the current inventory development process (in the frame of the SNC of the RM under the UNFCCC), resulted in increased values of direct GHG emissions for the 1990-1998 time series, with a variation from a minimum of 5.2 percent in 1998 to a maximum of 27.1 percent in 1990 (Table 9-2). The results of recalculations performed by categories are presented in the respective sub-chapters (3.2-3.9) of the NIR.

Table 9-2: Recalculations of Direct GHG Emissions for the 1990-1998 time series included in the FNC of the RM under the UNFCCC within the Energy Sector, Gg CO_2 eq.

	1990	1991	1992	1993	1994	1995	1996	1997	1998
FNC	27149.5	24552.5	19369.6	14234.1	12203.3	9431.3	10023.1	9014.8	7544.9
SNC	34520.4	30220.4	21384.2	16475.2	13975.2	11135.7	11430.3	9526.6	7938.3
Difference, %	27.1	23.1	10.4	15.7	14.5	18.1	14.0	5.7	5.2

Abbreviations: FNC – First National Communication; SNC – Second National Communication.

9.1.2 Industrial Processes

Recalculations of direct GHG emissions from the Industrial Processes Sector were performed due to the following:

- availability of an updated set of activity data in:
  - official national and international statistical sources (Statistical Yearbooks of the RM and of the ATULBD, Steel Statistical Yearbooks, published by the International Iron and Steel Institute);
  - departmental sources (Ministry of Agriculture and Food Industry, Ministry of Transport and Roads, National Bureau of Statistics, Ministry of Health, Ministry of Environment and Natural Resources, Ministry of Development and Infrastructure, Academy of Science of Moldova, Customs Service, Civil Protection and Emergency Situations Service);
  - industrial associations and enterprises (Republican Association of Refrigeration Technicians, 'Lafarge Ciment' J.S.C., 'Moldelectrica' J.S.C., 'CRICOVA' Winery Combined Works J.S.C., joint venture 'Vinaria-Bardar' Winery J.S.C., joint venture 'GRAPE-VALLEY' J.S.C, 'BRAVICEA-VIN' J.S.C., 'PRUT Winery' J.S.C., 'Migdal-P' J.S.C., State Enterprise 'CVC Milestii Mici', Winery Combined Works 'National-Vin', 'Nectar-S' J.S.C., 'Tiganca Winery' J.S.C., 'Deus Vin' J.S.C., 'Vinuri Ialoveni' J.S.C., 'Vitis Hincesti' J.S.C., 'Zubresti' J.S.C.);
- use the methodologies and emission factors available in the 2006 IPCC Guidelines, replacing the methodologies and EFs available in the Revised 1996 IPCC Guidelines (IPCC, 1997) used within the FNC of the RM under the UNFCCC (2000);
- use of higher methods, by taking into account the manufacturing technologies (2A1 'Cement Production', 2A2 'Lime Production', 2A7 'Bricks Production', 2C1 'Steel Production', 2E1 ''Refrigeration and Air Conditioning Equipment'), replacing the default methods, used within the FNC of the RM under the UNFCCC;
- use of country specific emission factors (2A1 'Cement Production', 2A7 'Bricks Production', 2D2 'Food and Drink'), replacing the default emissions factors used within the FNC of the RM under the UNFCCC (2000);
- including new emission sources: 2A7 'CO_2 Emissions From Glass Production', 2A7 'CO_2 Emissions From Bricks Production', 2D2 'CO_2 Emissions From Food and Drink', 2F1 'HFC Emissions from Refrigeration and Air Conditioning Equipment', 2F3 'HFC Emissions from Aerosols', 2F8 'SF_6 Emissions from Electrical Equipment'.

In comparison with the results reported in the FNC of the RM under the UNFCCC (2000), the changes performed in the current inventory development process (in the frame of the SNC of the RM under the UNFCCC), resulted in a significant decrease of direct GHG emissions over the time period from 1990 through 1998, with a variation from a minimum of 42.4 percent in 1993, to a maximum of 71.1 percent in 1998 (Table 9-3). The results of recalculations performed by categories are presented in the respective sub-chapters (4.2-4.6) of the NIR.

Table 9-3: Recalculations of Direct GHG Emissions for the 1990-1998 time series included in the FNC of the RM under the UNFCCC within the Industrial Processes Sector, Gg CO_2 eq.

	1990	1991	1992	1993	1994	1995	1996	1997	1998
FNC	2538.5	2107.7	1157.8	896.9	689.2	692.3	858.3	1056.2	1227.9
SNC	1348.7	1103.6	575.8	516.9	382.1	380.6	389.8	435.0	354.7
Difference, %	-46.9	-47.6	-50.3	-42.4	-44.5	-45.0	-54.6	-58.8	-71.1

Abbreviations: FNC – First National Communication; SNC – Second National Communication.

9.1.3 Solvents and Other Products Use

Recalculations of direct GHG emissions from the Solvents and Other Product Use Sector were performed due to the following:

- availability of an updated set of activity data in the official statistical sources (Statistical Yearbooks of the RM), departmental sources (National Bureau of Statistics, Ministry of Health, Customs Service) and in information provided by the private companies ('Mezon' J.S.C.);
- use of methodologies and emission factors available in the 3rd edition of the EMEP CORINAIR Guidebook and in the National GHG Inventories of some UNFCCC Annex I Parties (National Inventory Reports of Portugal and Czech Republic, submissions of 2007 year), replacing the methodologies available in the 1st edition of EMEP CORINAIR Guidebook, used within the FNC of the RM under the UNFCCC (2000);
- use of higher methodological approaches: in the SNC greenhouse gas emissions were estimated based on activity data on total national solvent consumption, while in the FNC by using default factors on average solvent per capita consumption specific for Western European countries, multiplied by the number of country population;
- including new emissions sources: 3A 'CO_2 Emissions From Paint Application', 3B 'CO_2 Emissions From Degreasing and Dry Cleaning', 3C 'CO_2 Emissions From Chemical Products, Manufacture and Processing', 3D1 'CO_2 Emissions From Adhesives Use', 3D2 'CO_2 Emissions From Graphic Arts (Inks)' and 3D5 'Use of N_2O for Anaesthesia'.

In comparison with the results reported in the FNC of the RM under the UNFCCC (2000), the changes performed in the current inventory development process (in the frame of the SNC of the RM under the UNFCCC), resulted in a significant increase of direct GHG emissions in the period from 1990 through 1998, with a variation from a minimum of 429 percent in 1996, to a maximum of 1187 percent in 1991 (Table 9-4). The results of recalculations performed by categories are presented in the respective sub-chapters (5.2-5.5) of the NIR.

Table 9-4: Recalculations of Direct GHG Emissions for the 1990-1998 time series included in the FNC of the RM under the UNFCCC within the Solvents and Other Products Use Sector, Gg CO_2 eq.

	1990	1991	1992	1993	1994	1995	1996	1997	1998
FNC	5.19	4.64	4.81	4.78	4.48	4.84	5.33	4.63	4.78
SNC	65.62	59.68	46.88	37.07	31.29	28.06	28.21	29.88	30.39
Difference, %	1165.6	1187.0	874.1	674.8	597.6	479.3	429.1	544.9	535.3

Abbreviations: FNC – First National Communication; SNC – Second National Communication.

9.1.4 Agriculture

Recalculations of direct GHG emissions from the Agriculture Sector were performed due to the following:

- availability of an updated set of activity data in:
  - official statistical sources (Statistical Yearbooks of the RM and of the ATULBD),
  - electronic data base of the United Nations Food and Agriculture Organisation (FAO);
  - sector statistical publications (Agriculture of the Republic of Moldova (2004), Agriculture Activity of Households and Farms in the Republic of Moldova in 2002, 2003, 2004 and 2005 years (Results of the Statistical Surveys);
  - departmental sources (Ministry of Agriculture and Food Industry, National Bureau of Statistics);
  - scientific specialty literature; ex., publications of the Institute of Pedology, Agrochemistry and Soil Protection 'Nicolae Dimo'; publications of the National Rural Development Agency (ACSA);
  - legislation acts ('Complex Program for Reclamation of Degraded Lands and Enhancing Soils Fertility', approved through the Government Resolution No. 841 from 26th of July 2004);

- use of methodologies and emission factors available in the 2006 IPCC Guidelines and in the National GHG Inventories of some UNFCCC Annex I Parties (National Inventory Reports of Portugal, submissions of 2007 year), replacing the methodologies and emission factors available in the Revised 1996 IPCC Guidelines used within the FNC of the RM under the UNFCCC (2000);
- use of a higher tier methodologies: 4A 'Enteric Fermentation' (cattle, sheep and goats), 4B 'Manure Management' (cattle and swine), replacing the default methods and emission factors, used within the FNC of the RM under the UNFCCC;
- use of country specific emission factors: 4A 'Enteric Fermentation' (cattle, sheep and goats), 4B 'Manure Management' (cattle and swine), replacing the IPCC default emission factors used within the FNC of the RM under the UNFCCC (2000);
- including a new emissions source: 4B 'N_2O Emissions From Manure Management'.

In comparison with the results reported in the FNC of the RM under the UNFCCC (2000), the changes performed in the current inventory development process (in the frame of the SNC of the RM under the UNFCCC), resulted in a significant increase of direct GHG emissions in the period from 1990 through 1998, with a variation from a minimum of 80.4 percent in 1993, to a maximum of 101.3 percent in 1997 (Table 9-5). The results of recalculations performed by categories are presented in the respective sub-chapters (6.2-6.4) of the NIR.

Table 9-5: Recalculations of Direct GHG Emissions for the 1990-1998 time series included in the FNC of the RM under the UNFCCC within the Agriculture Sector, Gg CO_2 eq.

	1990	1991	1992	1993	1994	1995	1996	1997	1998
FNC	2811.1	2710.2	2487.1	2128.9	1953.3	1821.8	1641.2	1410.1	1345.1
SNC	5323.9	5035.3	4615.1	3839.8	3599.8	3386.2	3046.5	2839.2	2518.3
Difference, %	89.4	85.8	85.6	80.4	84.3	85.9	85.6	101.3	87.2

Abbreviations: FNC – First National Communication; SNC – Second National Communication.

9.1.5 Land Use, Land-Use Change and Forestry

Recalculations of direct GHG emissions from the Land Use, Land-Use Change and Forestry Sector were performed due to the following:

- availability of an updated set of activity data in:
  - State Records of Forest Lands – areas covered with forest vegetation, distribution by species, volume of standing wood mass;
  - Forest Planning Materials – areas and dendrometrical features of forests and other types of forest vegetation;
  - General Land Cadastres – areas of forest vegetation not included in forest resources, areas of grasslands, perennial plantations, arable lands, settlements and other land categories, etc.;
  - Statistical Reports of Forestry Agency 'Moldsilva' – volume of wood harvested during cleaning cuttings, by categories and species, volume of revealed illegal logging from the forestry resources managed by the state, as well as in other forests and forest vegetation managed by other owners;
- Reports of the State Ecological Inspectorate – volume of illegal logging revealed by its territorial sub-divisions, volume of authorised commercial timbers from forests and forest vegetation managed by local and central public administrations, departments, etc.;
- National Environmental Reports of the Republic of Moldova – areas of burnt stubble fields;
- Statistical Yearbooks of the RM and ATULBD – harvesting of wood products, forest areas suffering from fires, cropping, etc.
- use of methodologies and emission factors available in the 2006 IPCC Guidelines (IPCC, 2006) and GPG for LULUCF Sector (IPCC, 2003), replacing the methodologies available in the Revised 1996 IPCC Guidelines (IPCC, 1997) used within the FNC of the RM under the UNFCCC (2000);
- use of a higher tier methodologies (5A 'Forest Land', 5B 'Cropland' and 5C 'Grassland'), to replace the default methods within the FNC of the RM under the UNFCCC;
- use of country specific emission/removal factors (5A 'Forest Land', 5B 'Cropland' and 5C 'Grassland'), to replace the default emission factors used within the FNC of the RM under the UNFCCC;
- including a new CO_2 emission/removal source (5B 'Cropland').

In comparison with the results reported in the FNC of the RM under the UNFCCC (2000), the changes performed in the current inventory development process (in the frame of the SNC of the RM under the UNFCCC), resulted in a significant decrease of CO_2 removals in the period from 1990 through 1998, with a variation from a minimum of 9.4 percent in 1990 to a maximum of 69.6 percent in 1993 (Table 9-6). The results of recalculations performed by categories are presented in the respective sub-chapters (7.2-7.4) of the NIR.

Table 9-6: Recalculations of Net CO_2 Removals for the 1990-1998 time series included in the FNC of the RM under the UNFCCC within the Land Use, Land-Use Change and Forestry Sector, Gg

	1990	1991	1992	1993	1994	1995	1996	1997	1998
FNC	-1849.9	-1864.9	-1816.3	-1791.9	-1718.7	-1494.3	-1585.3	-1720.3	-1729.4
SNC	-1676.5	-1158.8	-918.6	-545.2	-875.4	-758.8	-741.4	-1328.8	-1160.0
Difference, %	-9.4	-37.9	-49.4	-69.6	-49.1	-49.2	-53.2	-22.8	-32.9

Abbreviations: FNC – First National Communication; SNC – Second National Communication.

9.1.6 Waste

Recalculations of direct GHG emissions from the Waste Sector were performed due to the following:

- availability of an updated set of activity data in:
  - national statistical sources – Statistical Yearbook of the RM and of the ATULBD, contain information on the amount of solid municipal waste generated and transported to landfills; generation and disposal of different types of waste (extraction enterprises, livestock breeding, food processing industry, domestic waste, inorganic chemistry, phytotechnical waste, waste from forestry sector, secondary raw materials in ferrous and non-ferrous metallurgy, etc.);
  - Sector Statistical Sources – Statistical Form F-1 'Toxic Waste', contains information on generation and disposal of toxic waste; Statistical Form F-2 'Waste', contains information o generation and disposal of solid domestic waste; Statistical Form 'Special Road Transport', and Statistical Form No. 2 – gc 'Urban Sanitation Services', reflect the amount of municipal solid waste transported to landfills;
  - electronic data base of the United Nations Food and Agriculture Organisation (FAO), containing information on per capita protein consumption;
  - World Bank publications, containing information on number of population having actual access to sewage systems;
- use of methodologies, emission factors and other relevant parameters available in the GPG (IPCC, 2000) and scientific specialty literature (Negulescu, 1968; Chandler, Van Soest, 1980; Tabasaran, 1981; Morton Barlaz, 1987, 1997; Bingemer, Crutzen, 1987; Tugui, Duca, Ţăranu et al., 2004; Tugui, Duca, Ţăranu et. al, 2005; Tugui, Duca, 2006; Calos, Guvir, 2006; Liurca, Ungureanu et. al, 2006; Tugui, 2006, 2007), replacing those available in the Revised 1996 IPCC Guidelines (IPCC, 1997) used within the FNC of the RM under the UNFCCC (2000);
- use of higher tier methodology (6A 'Solid Waste Deposits on Land'), replacing the default method used within the FNC of the RM under the UNFCCC (2000), allowing to take into account waste disposing practices, ensuring a more adequate pattern of the degradation process over time in the Republic of Moldova;
- use of country specific emission factors (6A 'Solid Waste Deposits on Land'), replacing the default emission factors used within the FNC of the RM under the UNFCCC (2000);
- including a new emissions source, N_2O Emissions from Human Sewage under the category 6B 'Wastewater Handling'.

In comparison with the results reported in the FNC of the RM under the UNFCCC (2000), the changes performed in the current inventory development process (in the frame of the SNC of the RM under the UNFCCC), resulted in a significant increase of direct GHG emissions in the period from 1990 through 1998, with a variation from a minimum of 111.8 percent in 1990, to a maximum of 275.3 percent in 1996 (Table 9-7). The results of recalculations performed by categories are presented in the respective sub-chapters (8.2-8.3) of the NIR.

Table 9-7: Recalculations of Direct GHG Emissions for the 1990-1998 time series included in the FNC of the RM under the UNFCCC within the Waste Sector, Gg CO_2 eq.

	1990	1991	1992	1993	1994	1995	1996	1997	1998
FNC	768.2	766.6	519.4	512.4	508.6	507.3	500.0	498.0	497.8
SNC	1627.3	1756.5	1874.9	1892.0	1859.3	1827.6	1876.6	1820.2	1763.4
Difference, %	111.8	129.1	261.0	269.2	265.5	260.3	275.3	265.5	254.2

Abbreviations: FNC – First National Communication; SNC – Second National Communication.

9.2 Planned Improvements

A series of improvements is planned for the next inventory cycle. Below are presented the planned improvements by sectors.

9.2.1 Energy

Monitoring the GHG emissions from Energy Sector is planned to be improved along with:

- collecting additional information pertaining to the 1A1 'Energy Industries' source category, including information on technologies used at electric and thermal power plants in the Republic of Moldova (MTPP in Dnestrovsc, CHP-1 and CHP-2 in Chisinau, CHP-North in Balti, etc.), features of heat parameters of energy groups (gas-steam turbines installations, condensing installations, turbines and steam boilers, hot water boilers, etc.), installed electric and thermal power, thermal power supply indicators, global rated capacity, electric rated capacity, total and specific fuel consumption, type of fuel, energy produced etc., allowing to adopt a higher tier methodology to replace the default methodologies (Tier 1);
- specifying / précising the activity data related to fuel consumption under the 1A4 'Other' source category (commercial / institutional, residential /agriculture/ forestry / fishing sectors on the administrative-territorial units on the left bank of the Dniester;
- closer cooperation with the national operator of natural gas 'MOLDOVAGAZ' J.S.C., in view of collecting additional information for the 1B2 'Fugitive Emissions from Oil and Natural Gas' source category, what will allow to adopt a higher tier methodology and use of country specific factors to replace the default ones;
- specifying/précising emission factors typical for types of aircraft used in the Republic of Moldova in the international air transport (landing/take-off cycle and cruise cycle) under the 'Memo Items: International Aviation'.

9.2.2 Industrial Processes

Monitoring of GHG emissions from Industrial Processes Sector is planned to be improved along with:

- collecting activity data needed to estimate CO_2 emissions from the 2A3 'Limestone and Dolomite Use' source category (limestone and dolomite use in sugar refinery, production of iron and steel, construction and agriculture);
- updating activity data used to estimate GHG emissions from 2B 'Chemical Industry' category;
- updating activity data used to estimate NMVOC emissions from 2D2 'Food and Drink' source category (bread, food products, alcoholic drinks, etc.);
- improving methodological approaches and emission factors used to estimate CO_2 emissions from 2D2 'Food and Drink' source category;
- updating activity data used to estimate F-gas (HFC, PFC and SF_6) emissions from the 2F 'Consumption of Halocarbons and Sulphur Hexafluorides' category.

9.2.3 Solvents and Other Products Use

Monitoring of GHG emissions from the Solvents and Other Products Use Sector is planned to be improved along with:

- updating activity data used to estimate GHG emissions from the 3A 'Paint Application' source category (paint production, import and export);
- updating activity data used to estimate GHG emissions from the 3B 'Degreasing and Dry Cleaning' source category (production, import and export of solvents used in degreasing and dry cleaning);
- updating activity data used to estimate GHG emissions from the 3C 'Chemical Products, Manufacture and Processing' source category (production, import and export of chemical products);
- updating activity data used to estimate GHG emissions from the 3D 'Other' source category (production, import and export of glues, inks, solvents used in oil extraction, household cleaning products, N_2O used for anaesthesia).

9.2.4 Agriculture

Monitoring of GHG emissions from Agriculture Sector is planned to be improved along with:

- specifying the values of parameters/factors used under the 4A 'Enteric Fermentation' source category to develop the country specific emission factors (cattle, sheep and goats), using the Tier 2 method;
- specifying the values of parameters/factors used under the 4B 'Manure Management' source category to develop the country specific emission factors (cattle and swine), using the Tier 2 method;
- collect additional information on the share of different manure management systems in the Livestock Breeding Sector of the Republic of Moldova and annual average N excretion per head of species/category *T* in the country,

to be used for estimating the methane and nitrous oxide emissions under the 4B 'Manure Management' source category;

- updating activity data used to estimate direct N_2O emissions from the 4D 'Agricultural Soils' source category.

9.2.5 Land Use, Land-Use Change and Forestry

Monitoring of CO_2 emissions/removals from Land Use, Land-Use Change and Forestry Sector is planned to be improved along with:

- improving record keeping pertaining to distribution of forests by species, actual consumption of wood from the forests of the Republic of Moldova, as well as verification of country specific emission/removal factors (annual net increment in volume suitable for industrial processing, basic wood density, biomass expansion factors, etc.) under the category 5A 'Forest Land';
- improving record keeping pertaining to actual consumption of wood mass from forest belts and other types of forest vegetation, as well as verification of country specific emission/removal factors (such as: annual biomass increments, biomass harvesting during the cleaning cuttings of perennial plantations, etc.) under the source category 5B 'Cropland' (Annual Change in Carbon Stocks in Living Biomass);
- improve the country specific method (Tier 3) (Banaru, 2000) and collecting additional activity data, what will allow to calculate CO_2 emissions/removals from the 5B 'Cropland' (Annual Change in Carbon Stocks in Mineral Soils);
- updating activity data used to estimate non-CO_2 emissions from post harvest field burning of agricultural residues (stubble fields burning), including areas of stubble fields burnt annually in the Republic of Moldova;
- improving cadastral records (as a main source of activity data), by specifying land use categories to which converted croplands are transferred.

9.2.6 Waste

Monitoring of direct GHG emissions from Waste Sector is planned to be improved along with the following:

- environmental management restructuring in the context of the Waste List Resolution 2000/532/EC, to improve the national statistical records on waste management, in view of complying with the EU requirements and to fulfil the commitments under the international environmental treaties, ratified by the RM, and efficient reporting on consistent implementation;
- promoting a more accurate and complete statistical accounting on waste generation, contributing to improving the quality of activity data on the amount of solid household and industrial waste generated and disposed, used to estimate methane emissions from 6A 'Solid Waste Disposal on Land';
- wastewater management restructuring in the RM, in conformity with the country's commitments under the Protocol on Water and Health (London, 1999) ratified by the Republic of Moldova, as well as from the perspective of implementing the 'National Strategy on Water Supply and Sewage' (2007); meeting the provisions of the *Protocol* would mean establishment of criteria to assess the condition of the wastewater systems and for the operation of wastewater treatment plants, what will provide updated activity data used in estimation of GHG emissions from 6B 'Wastewater Handling' source category.

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ANNEXES

Annex 1. Key Categories

Annex 1-1: Key Categories –Methodology

Both the IPCC Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories (IPCC, 2000) and the IPCC Good Practice Guidance for Land Use, Land-Use Change and Forestry (IPCC, 2003) recommend as good practice the identification of key categories of emissions and removals. The intent is to help inventory agencies prioritize their efforts to improve overall estimates. A key category is defined as "one that is prioritize within the national inventory system because its estimates has a significant influence on a country's total inventory of direct greenhouse gases in terms of the absolute level of emissions, the trend in emissions, or both" (IPCC, 2000).

This annex describes the category analysis conducted for the Republic of Moldova's inventory (covering the 1990-2005 time-series), according to IPCC approaches.

Good Practice first requires that inventories be disaggregated into categories from which key sources and sinks may be identified. Source and sink categories are defined according to the following guidelines:

IPCC categories should be used with emissions specified in CO_2 equivalent units according to standard GWPs;

A category should be identified for each gas emitted by the source, since the methods, emission factors, and related uncertainties differ for each gas;

Source categories that use the same emission factors based on common assumptions should be aggregated before analysis.

The analysis of categories for key sources and sinks proceeds according to the Tier 1 Good Practice Guidance approaches of IPCC (2000, 2003). Using the Tier 1 method, key categories were identified by quantitative methods using a predetermined cumulative emission threshold.

The quantitative approach identifies key categories from two perspectives. The first analyzes the emission contribution that each category makes to the national total (with and without LULUCF). The second perspective analyzes the trend of emission contributions from each category to identify where the greatest absolute changes (either increases or reductions) have taken place over a given time (with and without LULUCF categories). The percent contributions to both levels and trends in emissions are calculated and sorted from greatest to least. A cumulative total is calculated for both approaches. IPCC has determined that a cumulative contribution threshold of 95 percent for both level and trend assessments is a reasonable approximation of 90 percent uncertainty for Tier method of determining key categories (IPCC, 2000). The 95 percent cumulative contribution threshold has been used in this analysis to define an upper boundary for key category identification. Therefore, when source and/or sink contributions are sorted in decreasing order of importance, those that contribute to 95 percent of the cumulative total are considered quantitatively to be key.

Level contribution of each source is calculated according to Equation A1– 1, which follows IPCC (2000), whereas Equation A1– 2 is used to calculate the level contribution from both sources and sinks following IPCC (2003):

Equation A1-1.1 for source category level assessment:

$$L_{x,t} = E_{x,t}/E_t$$

Where:

$L_{x,t}$ = the level assessment for source x in year t;

$E_{x,t}$ = the emission estimate (CO_2 eq.) estimate of source category x in year t

E_t = the total inventory estimate (CO_2 eq.) in year *t*

Equation A1-1.2 for source/sink category level assessment:

$$L_{x,t}^* = E_{x,t}^* / E_t^*$$

Where:

$L_{x,t}^*$ = level assessment for source or sink x in year t. The asterisk (*) indicates that contributions from all categories (including LULUCF) are entered as absolute values (i.e. negative values are always recorded as the equivalent positive values);

$E_{x,t}^* = E_{x,t}|$ the absolute value of the emission or removal estimate of source or sink category x in year t;

$E_t^* = \Sigma |E_t|$ total contribution, which is the sum of the absolute values of all emissions and removals in year t.

Trend contribution of each source is calculated according to Equation A1– 3, which follows IPCC (2000), whereas Equation A1– 4 is used to calculate the trend contribution from both sources and sinks following IPCC (2003):

Equation A1-1.3 for source category trend assessment:

$$T_{x,t} = L_{x,t} \bullet |\{[(E_{x,t} - E_{x,0})/E_{x,t}] - [(E_t - E_0) / E_t]\}|$$

Where:

$T_{x,t}$ = the contribution of the source category trend to the overall inventory trend (i.e. the trend assessment); the contribution is always recorded as an absolute value);

$L_{x,t}$ = the level assessment for source x in year t (derived in Equation A1-1.1);

$E_{x,t}$ and $E_{x,0}$ = the emissions estimates of source category x in years t and 0, respectively;

E_t and E_0 = the total inventory estimates in years t and 0, respectively.

Equation A1-1.4 for source and sink category trend assessment:

$$T_{x,t} = E_{x,t}^{*}/E_t \bullet |\{[(E_{x,t} - E_{x,0})/E_{x,t}] - [(E_t - E_0)/E_t]\}|$$

Where:

$T_{x,t}$ = trend assessment, which is the contribution of the source or sink category trend to the overall inventory trend (i.e. the trend assessment); the trend assessment is always recorded as an absolute value (i.e. the trend assessment); the contribution is always recorded as an absolute value);

$E_{x,t}^{*} = |E_{x,t}|$: absolute value of the emission or removal estimate of source or sink category x in year t;

$E_{x,t}$ and $E_{x,0}$ = real values of estimates of source or sink category x in years t and 0, respectively;

E_t and E_0 = ΣE_t and ΣE_0 total inventory estimates in years t and 0, respectively; E_t differs from E_t^{*} in Equation A1-1.2 in that the removals are not entered as absolute values.

The key sources analysis was performed using the Key Emissions Estimation Tool developed by the United States Environment Protection Agency (US EPA).

Annex 1-2: Summary Overview of the Republic of Moldova's Key Source Categories (1990-2005) Based on Tier 1 Approach

IPCC Classification	Key Categories of Emissions and Removals by Gas	Gas	Tier 1				2005 Emissions /Removals (Gg CO_2 eq.)
			With LULUCF		Without LULUCF		
			L	T	L	T	
1A	Stationary Fuel Combustion – Natural Gas	CO_2	X	X	X	X	4441.8224
5A	Forest Land	CO_2	X	X			-2246.2332
5B	Cropland	CO_2	X	X			1684.2815
1A3b	Road Transportation	CO_2	X	X	X	X	1459.4096
6A	Solid Waste Disposal on Land	CH_4	X	X	X	X	1186.2060
5C	Grassland	CO_2	X	X			-819.4560
4A	Enteric Fermentation	CH_4	X	X	X	X	792.8592
1B2	Fugitive Emissions from Oil and Natural Gas	CH_4	X	X	X	X	652.0090
4D	Direct Emissions from Agricultural Soils	N_2O	X	X	X	X	560.1846
4B	Direct Emissions from Manure Management	N_2O	X	X	X	X	469.1675
1A	Stationary Fuel Combustion – coal	CO_2	X	X	X	X	450.0661
2A1	Cement Production	CO_2	X	X	X	X	373.2628
7	CO_2 Emissions from Biomass	CO_2	X	X	X	X	295.0374
1A	Stationary Fuel Combustion –Oil	CO_2	X	X	X	X	231.9371
1A4c	Mobile Fuel Combustion: Agriculture/Forestry/Fishing	CO_2	X	X	X	X	177.6497
4D	Indirect Emissions from Agricultural Soils	N_2O	X	X	X		139.0628
6B	Wastewater handling	CH_4	X		X		121.0136
1A3c	Railways	CO_2	X		X		115.1175
1A5	Mobile Fuel Combustion: Other Works and Needs in Energy Sector	CO_2			X	X	107.9239
4B	Indirect Emissions from Manure Management	N_2O			X		95.9399
Subtotal Without LULUCF							11668.6691
Total Emissions Without LULUCF							11883.4583
Percent of Total Without LULUCF							98.2%
Subtotal With LULUCF							10287.2613
Total Emissions With LULUCF							10502.3958
Percent of Total With LULUCF							98.0%

Annex 1-3: 1990 Key Sources Category Tier 1 Analysis – Level Assessment, Without LULUCF

Inventory Categories	Inventory Sector	Basic Year Estimate (Gg CO_2 eq.)	Current Year Estimate (Gg CO_2 eq.)	Total	Cumulative Sum	Status
CO_2 Emissions from Stationary Combustion - Coal	Energy	11280.4287	11280.4287	26.04%	26.04%	**Key Source**
CO_2 Emissions from Stationary Combustion - Oil	Energy	9047.7243	9047.7243	20.89%	46.93%	**Key Source**
CO_2 Emissions from Stationary Combustion - Gas	Energy	7341.2894	7341.2894	16.95%	63.88%	**Key Source**
CO_2 Mobile Combustion: Road Vehicles	Energy	3364.2178	3364.2178	7.77%	71.64%	**Key Source**
CH_4 Emissions from Enteric Fermentation in Domestic Livestock	Agriculture	1903.4057	1903.4057	4.39%	76.04%	**Key Source**
CO_2 Mobile Combustion: Agriculture/Forestry/Fishing	Energy	1778.8921	1778.8921	4.11%	80.14%	**Key Source**
CH_4 Emissions from Solid Waste Disposal Sites	Waste	1321.1268	1321.1268	3.05%	83.19%	**Key Source**
N_2O Direct Emissions from Agricultural Soils	Agriculture	1319.4237	1319.4237	3.05%	86.24%	**Key Source**
N_2O Direct Emissions from Manure Management	Agriculture	1064.3570	1064.3570	2.46%	88.70%	**Key Source**
CO_2 Emissions from Cement Production	Industrial Processes	988.2518	988.2518	2.28%	90.98%	**Key Source**
CH_4 Fugitive Emissions from Oil and Gas Operations	Energy	682.2942	682.2942	1.58%	92.55%	**Key Source**
CO_2 Mobile Combustion: Railways	Energy	452.3598	452.3598	1.04%	93.60%	**Key Source**
N_2O Indirect Emissions from Agricultural Soils	Agriculture	399.1500	399.1500	0.92%	94.52%	**Key Source**
CH_4 Emissions from Manure Management	Agriculture	387.6121	387.6121	0.89%	95.41%	**Key Source**
CH_4 (Non-CO_2) Emissions from Stationary Combustion	Energy	250.7355	250.7355	0.58%	95.99%	Non-Key Source
N_2O Indirect Emissions from Manure Management	Agriculture	249.9689	249.9689	0.58%	96.57%	Non-Key Source
CO_2 Emissions from International Bunkers: Aviation	Bunkers	217.3668	217.3668	0.50%	97.07%	Non-Key Source
CO_2 Emissions from Biomass	Biomass	210.8274	210.8274	0.49%	97.56%	Non-Key Source
CH_4 Emissions from Wastewater Handling	Waste	177.1625	177.1625	0.41%	97.97%	Non-Key Source
CO_2 Emissions from Lime Production	Industrial Processes	149.2228	149.2228	0.34%	98.31%	Non-Key Source
N_2O Emissions from Wastewater Handling	Waste	129.0471	129.0471	0.30%	98.61%	Non-Key Source
N_2O (Non-CO_2) Emissions from Stationary Combustion	Energy	82.7151	82.7151	0.19%	98.80%	Non-Key Source
CO_2 Mobile Combustion: Other (Energy)	Energy	81.0989	81.0989	0.19%	98.99%	Non-Key Source
CO_2 Emissions from Glass Production	Industrial Processes	59.4234	59.4234	0.14%	99.12%	Non-Key Source
CO_2 Emissions from the Iron and Steel Industry	Industrial Processes	56.7016	56.7016	0.13%	99.26%	Non-Key Source
N_2O Mobile Combustion: Railways	Energy	54.1488	54.1488	0.13%	99.38%	Non-Key Source

CO_2 Emissions from Brick Production	Industrial Processes	52.6166	52.6166	0.12%	99.50%	Non-Key Source
N_2O Mobile Combustion: Road Vehicles	Energy	49.6041	49.6041	0.11%	99.62%	Non-Key Source
CO_2 Emissions from Other Products	Solvents	32.8744	32.8744	0.08%	99.69%	Non-Key Source
CO_2 Emissions from Paint Application	Solvents	30.1849	30.1849	0.07%	99.76%	Non-Key Source
CH_4 Mobile Combustion: Road Vehicles	Energy	24.4646	24.4646	0.06%	99.82%	Non-Key Source
CO_2 Emissions from Food and Drink	Industrial Processes	19.6395	19.6395	0.05%	99.86%	Non-Key Source
CO_2 Mobile Combustion Water Borne Navigation	Energy	18.9048	18.9048	0.04%	99.91%	Non-Key Source
CH_4 Emissions from the Iron and Steel Industry	Industrial Processes	13.3958	13.3958	0.03%	99.94%	Non-Key Source
CO_2 Emissions from Mineral Wool Production	Industrial Processes	8.0816	8.0816	0.02%	99.96%	Non-Key Source
CH_4 Mobile Combustion: Agriculture/Forestry/Fishing	Energy	5.0502	5.0502	0.01%	99.97%	Non-Key Source
N_2O Mobile Combustion: Agriculture/Forestry/Fishing	Energy	4.4731	4.4731	0.01%	99.98%	Non-Key Source
N_2O Emissions from International Bunkers: Aviation	Bunkers	2.1560	2.1560	0.00%	99.98%	Non-Key Source
CO_2 Emissions from Degreasing and Dry Cleaning	Solvents	1.9978	1.9978	0.00%	99.99%	Non-Key Source
N_2O Emissions from the Iron and Steel Industry	Industrial Processes	1.0986	1.0986	0.00%	99.99%	Non-Key Source
CH_4 Emissions from International Bunkers: Aviation	Bunkers	0.9036	0.9036	0.00%	99.99%	Non-Key Source
CO_2 Fugitive Emissions from Oil and Gas Operation	Energy	0.6377	0.6377	0.00%	99.99%	Non-Key Source
CO_2 Emissions from Chemical Products, Manufacture and Processing	Solvents	0.5470	0.5470	0.00%	100.00%	Non-Key Source
CH_4 Mobile Combustion: Railways	Energy	0.5323	0.5323	0.00%	100.00%	Non-Key Source
N_2O Mobile Combustion: Other (Energy)	Energy	0.4911	0.4911	0.00%	100.00%	Non-Key Source
CO_2 Emissions from Road Paving with Asphalt	Industrial Processes	0.1874	0.1874	0.00%	100.00%	Non-Key Source
N_2O Mobile Combustion Water Borne Navigation	Energy	0.1582	0.1582	0.00%	100.00%	Non-Key Source
CH_4 Mobile Combustion: Other (Energy)	Energy	0.1350	0.1350	0.00%	100.00%	Non-Key Source
CH_4 Emissions from Road Paving with Asphalt	Industrial Processes	0.1281	0.1281	0.00%	100.00%	Non-Key Source
CH_4 Mobile Combustion Water Borne Navigation	Energy	0.0375	0.0375	0.00%	100.00%	Non-Key Source
N_2O Emissions from Use of N_2O for Anesthesia	Solvents	0.0205	0.0205	0.00%	100.00%	Non-Key Source
N_2O Fugitive Emissions from Oil and Gas Operation	Energy	0.0002	0.0002	0.00%	100.00%	Non-Key Source
Total				100.00%		

Annex 1-4: 1990 Key Sources Category Tier 1 Analysis – Level Assessment, With LULUCF

Inventory Categories	Inventory Sector	Basic Year Estimate (Gg CO_2 eq.)	Current Year Estimate (Gg CO_2 eq.)	Total	Cumulative Sum	Status
CO_2 Emissions from Stationary Combustion - Coal	Energy	11280.4287	11280.4287	23.69%	23.69%	**Key Source**
CO_2 Emissions from Stationary Combustion - Oil	Energy	9047.7243	9047.7243	19.00%	42.70%	**Key Source**
CO_2 Emissions from Stationary Combustion - Gas	Energy	7341.2894	7341.2894	15.42%	58.11%	**Key Source**
CO_2 Mobile Combustion: Road Vehicles	Energy	3364.2178	3364.2178	7.07%	65.18%	**Key Source**
CO_2 from Forest Land Remaining Forest Land	LULUCF	-2197.5790	-2197.5790	4.62%	69.80%	**Key Source**
CH_4 Emissions from Enteric Fermentation in Domestic Livestock	Agriculture	1903.4057	1903.4057	4.00%	73.79%	**Key Source**
CO_2 Mobile Combustion: Agriculture/Forestry/Fishing	Energy	1778.8921	1778.8921	3.74%	77.53%	**Key Source**
CH_4 Emissions from Solid Waste Disposal Sites	Waste	1321.1268	1321.1268	2.77%	80.30%	**Key Source**
N_2O Direct Emissions from Agricultural Soils	Agriculture	1319.4237	1319.4237	2.77%	83.08%	**Key Source**
CO_2 from Cropland remaining Cropland	LULUCF	1307.5879	1307.5879	2.75%	85.82%	**Key Source**
N_2O Direct Emissions from Manure Management	Agriculture	1064.3570	1064.3570	2.24%	88.06%	**Key Source**
CO_2 Emissions from Cement Production	Industrial Processes	988.2518	988.2518	2.08%	90.13%	**Key Source**
CO_2 from Grassland remaining Grassland	LULUCF	-786.5000	-786.5000	1.65%	91.78%	**Key Source**
CH_4 Fugitive Emissions from Oil and Gas Operations	Energy	682.2942	682.2942	1.43%	93.22%	**Key Source**
CO_2 Mobile Combustion: Railways	Energy	452.3598	452.3598	0.95%	94.17%	**Key Source**
N_2O Indirect Emissions from Agricultural Soils	Agriculture	399.1500	399.1500	0.84%	95.01%	**Key Source**
CH_4 Emissions from Manure Management	Agriculture	387.6121	387.6121	0.81%	95.82%	Non-Key Source
CH_4 (Non-CO_2) Emissions from Stationary Combustion	Energy	250.7355	250.7355	0.53%	96.35%	Non-Key Source
N_2O Indirect Emissions from Manure Management	Agriculture	249.9689	249.9689	0.53%	96.87%	Non-Key Source
CO_2 Emissions from International Bunkers: Aviation	Bunkers	217.3668	217.3668	0.46%	97.33%	Non-Key Source
CO_2 Emissions from Biomass	Biomass	210.8274	210.8274	0.44%	97.77%	Non-Key Source
CH_4 Emissions from Wastewater Handling	Waste	177.1625	177.1625	0.37%	98.14%	Non-Key Source
CO_2 Emissions from Lime Production	Industrial Processes	149.2228	149.2228	0.31%	98.46%	Non-Key Source
N_2O Emissions from Wastewater Handling	Waste	129.0471	129.0471	0.27%	98.73%	Non-Key Source
N_2O (Non-CO_2) Emissions from Stationary Combustion	Energy	82.7151	82.7151	0.17%	98.90%	Non-Key Source
CO_2 Mobile Combustion: Other (Energy)	Energy	81.0989	81.0989	0.17%	99.07%	Non-Key Source
CO_2 Emissions from Glass Production	Industrial Processes	59.4234	59.4234	0.12%	99.20%	Non-Key Source
CO_2 Emissions from the Iron and Steel Industry	Industrial Processes	56.7016	56.7016	0.12%	99.32%	Non-Key Source
N_2O Mobile Combustion: Railways	Energy	54.1488	54.1488	0.11%	99.43%	Non-Key Source

CO_2 Emissions from Brick Production	Industrial Processes	52.6166	52.6166	0.11%	99.54%	Non-Key Source
N_2O Mobile Combustion: Road Vehicles	Energy	49.6041	49.6041	0.10%	99.64%	Non-Key Source
CO_2 Emissions from Other Products	Solvents	32.8744	32.8744	0.07%	99.71%	Non-Key Source
CO_2 Emissions from Paint Application	Solvents	30.1849	30.1849	0.06%	99.78%	Non-Key Source
CH_4 Mobile Combustion: Road Vehicles	Energy	24.4646	24.4646	0.05%	99.83%	Non-Key Source
CO_2 Emissions from Food and Drink	Industrial Processes	19.6395	19.6395	0.04%	99.87%	Non-Key Source
CO_2 Mobile Combustion Water Borne Navigation	Energy	18.9048	18.9048	0.04%	99.91%	Non-Key Source
CH_4 Emissions from the Iron and Steel Industry	Industrial Processes	13.3958	13.3958	0.03%	99.94%	Non-Key Source
CO_2 Emissions from Mineral Wool Production	Industrial Processes	8.0816	8.0816	0.02%	99.95%	Non-Key Source
CH_4 Mobile Combustion: Agriculture/ Forestry/Fishing	Energy	5.0502	5.0502	0.01%	99.96%	Non-Key Source
N_2O Mobile Combustion: Agriculture/ Forestry/Fishing	Energy	4.4731	4.4731	0.01%	99.97%	Non-Key Source
N_2O Emissions from International Bunkers: Aviation	Bunkers	2.1560	2.1560	0.00%	99.98%	Non-Key Source
CH_4 from Cropland Remaining Crop-land	LULUCF	2.0730	2.0730	0.00%	99.98%	Non-Key Source
CO_2 Emissions from Degreasing and Dry Cleaning	Solvents	1.9978	1.9978	0.00%	99.99%	Non-Key Source
N_2O Emissions from the Iron and Steel Industry	Industrial Processes	1.0986	1.0986	0.00%	99.99%	Non-Key Source
CH_4 emissions from international bunkers: aviation	Bunkers	0.9036	0.9036	0.00%	99.99%	Non-Key Source
N_2O from Cropland remaining Crop-land	LULUCF	0.7934	0.7934	0.00%	99.99%	Non-Key Source
CO_2 Fugitive Emissions from Oil and Gas Operation	Energy	0.6377	0.6377	0.00%	99.99%	Non-Key Source
CO_2 Emissions from Chemical Prod-ucts, Manufacture and Processing	Solvents	0.5470	0.5470	0.00%	100.00%	Non-Key Source
CH_4 Mobile Combustion: Railways	Energy	0.5323	0.5323	0.00%	100.00%	Non-Key Source
N_2O Mobile Combustion: Other (Energy)	Energy	0.4911	0.4911	0.00%	100.00%	Non-Key Source
CH_4 from Forest Land Remaining For-est Land	LULUCF	0.2347	0.2347	0.00%	100.00%	Non-Key Source
N_2O from Forest Land Remaining For-est Land	LULUCF	0.1917	0.1917	0.00%	100.00%	Non-Key Source
CO_2 Emissions from Road Paving with Asphalt	Industrial Processes	0.1874	0.1874	0.00%	100.00%	Non-Key Source
N_2O Mobile Combustion Water Borne Navigation	Energy	0.1582	0.1582	0.00%	100.00%	Non-Key Source
CH_4 Mobile Combustion: Other (Energy)	Energy	0.1350	0.1350	0.00%	100.00%	Non-Key Source
CH_4 Emissions from Road Paving with Asphalt	Industrial Processes	0.1281	0.1281	0.00%	100.00%	Non-Key Source
CH_4 Mobile Combustion Water Borne Navigation	Energy	0.0375	0.0375	0.00%	100.00%	Non-Key Source
N_2O Emissions from Use of N_2O for Anesthesia	Solvents	0.0205	0.0205	0.00%	100.00%	Non-Key Source
N_2O Fugitive Emissions from Oil and Gas Operation	Energy	0.0002	0.0002	0.00%	100.00%	Non-Key Source
Total				100.00%		

Annex 1-5: 2005 Key Sources Category Tier 1 Analysis – Level Assessment, Without LULUCF

Inventory Categories	Inventory Sector	Basic Year Estimate (Gg CO_2 eq.)	Current Year Estimate (Gg CO_2 eq.)	Total	Cumulative Sum	Status
CO_2 Emissions from Stationary Combustion - Gas	Energy	7341.2894	4441.8224	36.28%	36.28%	**Key Source**
CO_2 Mobile Combustion: Road Vehicles	Energy	3364.2178	1459.4096	11.92%	48.20%	**Key Source**
CH_4 Emissions from Solid Waste Disposal Sites	Waste	1321.1268	1186.2060	9.69%	57.89%	**Key Source**
CH_4 Emissions from Enteric Fermentation in Domestic Livestock	Agriculture	1903.4057	792.8592	6.48%	64.37%	**Key Source**
CH_4 Fugitive Emissions from Oil and Gas Operations	Energy	682.2942	652.0090	5.33%	69.69%	**Key Source**
N_2O Direct Emissions from Agricultural Soils	Agriculture	1319.4237	560.1846	4.58%	74.27%	**Key Source**
N_2O Direct Emissions from Manure Management	Agriculture	1064.3570	469.1675	3.83%	78.10%	**Key Source**
CO_2 Emissions from Stationary Combustion - Coal	Energy	11280.4287	450.0661	3.68%	81.77%	**Key Source**
CO_2 Emissions from Cement Production	Industrial Processes	988.2518	373.2628	3.05%	84.82%	**Key Source**
CO_2 Emissions from Biomass	Biomass	210.8274	295.0374	2.41%	87.23%	**Key Source**
CO_2 Emissions from Stationary Combustion - Oil	Energy	9047.7243	231.9371	1.89%	89.13%	**Key Source**
CO_2 Mobile Combustion: Agriculture/Forestry/Fishing	Energy	1778.8921	177.6497	1.45%	90.58%	**Key Source**
N_2O Indirect Emissions from Agricultural Soils	Agriculture	399.1500	139.0628	1.14%	91.71%	**Key Source**
CH_4 Emissions from Wastewater Handling	Waste	177.1625	121.0136	0.99%	92.70%	**Key Source**
CO_2 Mobile Combustion: Railways	Energy	452.3598	115.1175	0.94%	93.64%	**Key Source**
CO_2 Mobile Combustion: Other (Energy)	Energy	81.0989	107.9239	0.88%	94.52%	**Key Source**
N_2O Indirect Emissions from Manure Management	Agriculture	249.9689	95.9399	0.78%	95.31%	**Key Source**
N_2O Emissions from Wastewater Handling	Waste	129.0471	92.7379	0.76%	96.07%	Non-Key Source
CO_2 Emissions from the Iron and Steel Industry	Industrial Processes	56.7016	83.8512	0.68%	96.75%	Non-Key Source
CH_4 Emissions from Manure Management	Agriculture	387.6121	70.5761	0.58%	97.33%	Non-Key Source
CO_2 Emissions from International Bunkers: Aviation	Bunkers	217.3668	63.9592	0.52%	97.85%	Non-Key Source
CO_2 Emissions from Food and Drink	Industrial Processes	19.6395	40.7669	0.33%	98.18%	Non-Key Source
CH_4 (Non-CO_2) Emissions from Stationary Combustion	Energy	250.7355	33.2023	0.27%	98.45%	Non-Key Source
CO_2 Emissions from Other Products	Solvents	32.8744	29.4689	0.24%	98.69%	Non-Key Source
N_2O Mobile Combustion: Road Vehicles	Energy	49.6041	22.2825	0.18%	98.88%	Non-Key Source
CO_2 Emissions from Glass Production	Industrial Processes	59.4234	20.8035	0.17%	99.05%	Non-Key Source
CH_4 Emissions from the Iron and Steel Industry	Industrial Processes	13.3958	19.8098	0.16%	99.21%	Non-Key Source
HFCs Emissions from Refrigeration and Air Conditioning Equipment	Industrial Processes	0.0000	18.7189	0.15%	99.36%	Non-Key Source

CO_2 Emissions from Paint Application	Solvents	30.1849	17.9812	0.15%	99.51%	Non-Key Source
CO_2 Emissions from Brick Production	Industrial Processes	52.6166	16.1150	0.13%	99.64%	Non-Key Source
N_2O Mobile Combustion: Railways	Energy	54.1488	13.7799	0.11%	99.75%	Non-Key Source
N_2O (Non-CO_2) Emissions from Stationary Combustion	Energy	82.7151	8.4637	0.07%	99.82%	Non-Key Source
CH_4 Mobile Combustion: Road Vehicles	Energy	24.4646	7.3663	0.06%	99.88%	Non-Key Source
CO_2 Emissions from Lime Production	Industrial Processes	149.2228	6.6468	0.05%	99.94%	Non-Key Source
CO_2 Fugitive Emissions from Oil and Gas Operation	Energy	0.6377	1.8809	0.02%	99.95%	Non-Key Source
N_2O Emissions from the Iron and Steel Industry	Industrial Processes	1.0986	1.6246	0.01%	99.96%	Non-Key Source
CO_2 Emissions from Degreasing and Dry Cleaning	Solvents	1.9978	1.2401	0.01%	99.97%	Non-Key Source
N_2O Emissions from International Bunkers: Aviation	Bunkers	2.1560	0.6589	0.01%	99.98%	Non-Key Source
CH_4 Mobile Combustion: Agriculture/Forestry/Fishing	Energy	5.0502	0.5040	0.00%	99.98%	Non-Key Source
N_2O Mobile Combustion: Agriculture/Forestry/Fishing	Energy	4.4731	0.4464	0.00%	99.99%	Non-Key Source
N_2O Mobile Combustion: Other (Energy)	Energy	0.4911	0.3426	0.00%	99.99%	Non-Key Source
CO_2 Mobile Combustion Water Borne Navigation	Energy	18.9048	0.3308	0.00%	99.99%	Non-Key Source
CO_2 Emissions from Chemical Products, Manufacture and Processing	Solvents	0.5470	0.2931	0.00%	99.99%	Non-Key Source
SF_6 Emissions from Electrical Equipment	Industrial Processes	0.0000	0.2839	0.00%	100.00%	Non-Key Source
CH_4 Mobile Combustion: Railways	Energy	0.5323	0.1355	0.00%	100.00%	Non-Key Source
CH_4 Mobile Combustion: Other (Energy)	Energy	0.1350	0.1295	0.00%	100.00%	Non-Key Source
CH_4 Emissions from International Bunkers: Aviation	Bunkers	0.9036	0.0203	0.00%	100.00%	Non-Key Source
N_2O Emissions from Use of N_2O for Anaesthesia	Solvents	0.0205	0.0189	0.00%	100.00%	Non-Key Source
CO_2 Emissions from Road Paving with Asphalt	Industrial Processes	0.1874	0.0100	0.00%	100.00%	Non-Key Source
CH_4 Emissions from Road Paving with Asphalt	Industrial Processes	0.1281	0.0068	0.00%	100.00%	Non-Key Source
N_2O Fugitive Emissions from Oil and Gas Operation	Energy	0.0002	0.0052	0.00%	100.00%	Non-Key Source
N_2O Mobile Combustion Water Borne Navigation	Energy	0.1582	0.0028	0.00%	100.00%	Non-Key Source
CH_4 Mobile Combustion Water Borne Navigation	Energy	0.0375	0.0007	0.00%	100.00%	Non-Key Source
CO_2 Emissions from Mineral Wool Production	Industrial Processes	8.0816	0.0000	0.00%	100.00%	Non-Key Source
Total				100.00%		

Annex 1-6: 2005 Key Sources Category Tier 1 Analysis – Level Assessment, With LULUCF

Inventory Categories	Inventory Sector	Basic Year Estimate (Gg CO_2 eq.)	Current Year Estimate (Gg CO_2 eq.)	Total	Cumulative Sum	Status
CO_2 Emissions from Stationary Combustion - Gas	Energy	7341.2894	4441.8224	26.14%	26.14%	**Key Source**
CO_2 from Forest Land Remaining Forest Land	LULUCF	-2197.5790	-2246.2332	13.22%	39.36%	**Key Source**
CO_2 from Cropland remaining Cropland	LULUCF	1307.5879	1684.2815	9.91%	49.27%	**Key Source**
CO_2 Mobile Combustion: Road Vehicles	Energy	3364.2178	1459.4096	8.59%	57.86%	**Key Source**
CH_4 Emissions from Solid Waste Disposal Sites	Waste	1321.1268	1186.2060	6.98%	64.84%	**Key Source**
CO_2 from Grassland Remaining Grassland	LULUCF	-786.5000	-819.4560	4.82%	69.66%	**Key Source**
CH_4 Emissions from Enteric Fermentation in Domestic Livestock	Agriculture	1903.4057	792.8592	4.67%	74.32%	**Key Source**
CH_4 Fugitive Emissions from Oil and Gas Operations	Energy	682.2942	652.0090	3.84%	78.16%	**Key Source**
N_2O Direct Emissions from Agricultural Soils	Agriculture	1319.4237	560.1846	3.30%	81.46%	**Key Source**
N_2O Direct Emissions from Manure Management	Agriculture	1064.3570	469.1675	2.76%	84.22%	**Key Source**
CO_2 Emissions from Stationary Combustion - Coal	Energy	11280.4287	450.0661	2.65%	86.87%	**Key Source**
CO_2 Emissions from Cement Production	Industrial Processes	988.2518	373.2628	2.20%	89.06%	**Key Source**
CO_2 emissions from biomass	Biomass	210.8274	295.0374	1.74%	90.80%	**Key Source**
CO_2 Emissions from Stationary Combustion - Oil	Energy	9047.7243	231.9371	1.36%	92.16%	**Key Source**
CO_2 Mobile Combustion: Agriculture/ Forestry/Fishing	Energy	1778.8921	177.6497	1.05%	93.21%	**Key Source**
N_2O Indirect Emissions from Agricultural Soils	Agriculture	399.1500	139.0628	0.82%	94.03%	**Key Source**
CH_4 Emissions from Wastewater Handling	Waste	177.1625	121.0136	0.71%	94.74%	**Key Source**
CO_2 Mobile Combustion: Railways	Energy	452.3598	115.1175	0.68%	95.42%	**Key Source**
CO_2 Mobile Combustion: Other (Energy)	Energy	81.0989	107.9239	0.64%	96.05%	Non-Key Source
N_2O Indirect Emissions from Manure Management	Agriculture	249.9689	95.9399	0.56%	96.62%	Non-Key Source
N_2O Emissions from Wastewater Handling	Waste	129.0471	92.7379	0.55%	97.16%	Non-Key Source
CO_2 Emissions from the Iron and Steel Industry	Industrial Processes	56.7016	83.8512	0.49%	97.66%	Non-Key Source
CH_4 Emissions from Manure Management	Agriculture	387.6121	70.5761	0.42%	98.07%	Non-Key Source
CO_2 Emissions from International Bunkers: Aviation	Bunkers	217.3668	63.9592	0.38%	98.45%	Non-Key Source
CO_2 Emissions from Food and Drink	Industrial Processes	19.6395	40.7669	0.24%	98.69%	Non-Key Source
CH_4 (Non-CO_2) Emissions from Stationary Combustion	Energy	250.7355	33.2023	0.20%	98.88%	Non-Key Source
CO_2 Emissions from Other Products	Solvents	32.8744	29.4689	0.17%	99.06%	Non-Key Source
N_2O Mobile Combustion: Road Vehicles	Energy	49.6041	22.2825	0.13%	99.19%	Non-Key Source
CO_2 Emissions from Glass Production	Industrial Processes	59.4234	20.8035	0.12%	99.31%	Non-Key Source
CH_4 Emissions from the Iron and Steel Industry	Industrial Processes	13.3958	19.8098	0.12%	99.43%	Non-Key Source
HFCs Emissions from Refrigeration and Air Conditioning Equipment	Industrial Processes	0.0000	18.7189	0.11%	99.54%	Non-Key Source

CO_2 Emissions from Paint Application	Solvents	30.1849	17.9812	0.11%	99.64%	Non-Key Source
CO_2 Emissions from Brick Production	Industrial Processes	52.6166	16.1150	0.09%	99.74%	Non-Key Source
N_2O Mobile Combustion: Railways	Energy	54.1488	13.7799	0.08%	99.82%	Non-Key Source
N_2O (Non-CO_2) Emissions from Stationary Combustion	Energy	82.7151	8.4637	0.05%	99.87%	Non-Key Source
CH_4 Mobile Combustion: Road Vehicles	Energy	24.4646	7.3663	0.04%	99.91%	Non-Key Source
CO_2 Emissions from Lime Production	Industrial Processes	149.2228	6.6468	0.04%	99.95%	Non-Key Source
CO_2 Fugitive Emissions from Oil and Gas Operation	Energy	0.6377	1.8809	0.01%	99.96%	Non-Key Source
N_2O Emissions from the Iron and Steel Industry	Industrial Processes	1.0986	1.6246	0.01%	99.97%	Non-Key Source
CO_2 Emissions from Degreasing and Dry Cleaning	Solvents	1.9978	1.2401	0.01%	99.98%	Non-Key Source
N_2O emissions from international bunkers: aviation	Bunkers	2.1560	0.6589	0.00%	99.98%	Non-Key Source
CH_4 Mobile Combustion: Agriculture/ Forestry/Fishing	Energy	5.0502	0.5040	0.00%	99.99%	Non-Key Source
N_2O Mobile Combustion: Agriculture/ Forestry/Fishing	Energy	4.4731	0.4464	0.00%	99.99%	Non-Key Source
N_2O Mobile Combustion: Other (Energy)	Energy	0.4911	0.3426	0.00%	99.99%	Non-Key Source
CO_2 Mobile Combustion Water Borne Navigation	Energy	18.9048	0.3308	0.00%	99.99%	Non-Key Source
CO_2 Emissions from Chemical Products, Manufacture and Processing	Solvents	0.5470	0.2931	0.00%	99.99%	Non-Key Source
SF_6 Emissions from Electrical Equipment	Industrial Processes	0.0000	0.2839	0.00%	100.00%	Non-Key Source
CH_4 from Cropland Remaining Cropland	LULUCF	2.0730	0.2281	0.00%	100.00%	Non-Key Source
CH_4 Mobile Combustion: Railways	Energy	0.5323	0.1355	0.00%	100.00%	Non-Key Source
CH_4 Mobile Combustion: Other (Energy)	Energy	0.1350	0.1295	0.00%	100.00%	Non-Key Source
N_2O from Cropland Remaining Cropland	LULUCF	0.7934	0.0873	0.00%	100.00%	Non-Key Source
CH_4 Emissions from International Bunkers: Aviation	Bunkers	0.9036	0.0203	0.00%	100.00%	Non-Key Source
N_2O Emissions from Use of N2O for Anaesthesia	Solvents	0.0205	0.0189	0.00%	100.00%	Non-Key Source
CH_4 from Forest Land Remaining Forest Land	LULUCF	0.2347	0.0164	0.00%	100.00%	Non-Key Source
N_2O from Forest Land Remaining Forest Land	LULUCF	0.1917	0.0134	0.00%	100.00%	Non-Key Source
CO_2 Emissions from Road Paving with Asphalt	Industrial Processes	0.1874	0.0100	0.00%	100.00%	Non-Key Source
CH_4 Emissions from Road Paving with Asphalt	Industrial Processes	0.1281	0.0068	0.00%	100.00%	Non-Key Source
N_2O Fugitive Emissions from Oil and Gas Operation	Energy	0.0002	0.0052	0.00%	100.00%	Non-Key Source
N_2O Mobile Combustion Water Borne Navigation	Energy	0.1582	0.0028	0.00%	100.00%	Non-Key Source
CH_4 Mobile Combustion Water Borne Navigation	Energy	0.0375	0.0007	0.00%	100.00%	Non-Key Source
CO_2 Emissions from Mineral Wool Production	Industrial Processes	8.0816	0.0000	0.00%	100.00%	Non-Key Source
Total				100.00%		

Annex 1-7: 1990-2005 Key Source Category Tier 1 Analysis – Trend Assessment, Without LULUCF

Inventory Categories	Inventory Sector	Basic Year Estimate (Gg CO_2 eq.)	Current Year Estimate (Gg CO_2 eq.)	Total	Cumulative Sum	Status
CO_2 Emissions from Stationary Combustion - Coal	Energy	11280.4287	450.0661	24.76%	24.76%	Key Source
CO_2 Emissions from Stationary Combustion - Gas	Energy	7341.2894	4441.8224	21.40%	46.16%	Key Source
CO_2 Emissions from Stationary Combustion - Oil	Energy	9047.7243	231.9371	21.02%	67.18%	Key Source
CH_4 Emissions from Solid Waste Disposal Sites	Waste	1321.1268	1186.2060	7.35%	74.53%	Key Source
CO_2 Mobile Combustion: Road Vehicles	Energy	3364.2178	1459.4096	4.60%	79.13%	Key Source
CH_4 Fugitive Emissions from Oil and Gas Operations	Energy	682.2942	652.0090	4.15%	83.28%	Key Source
CO_2 Mobile Combustion: Agriculture/Forestry/Fishing	Energy	1778.8921	177.6497	2.94%	86.22%	Key Source
CH_4 Emissions from Enteric Fermentation in Domestic Livestock	Agriculture	1903.4057	792.8592	2.30%	88.53%	Key Source
CO_2 Emissions from Biomass	Biomass	210.8274	295.0374	2.13%	90.66%	Key Source
N_2O Direct Emissions from Agricultural Soils	Agriculture	1319.4237	560.1846	1.69%	92.35%	Key Source
N_2O Direct Emissions from Manure Management	Agriculture	1064.3570	469.1675	1.52%	93.87%	Key Source
CO_2 Emissions from Cement Production	Industrial Processes	988.2518	373.2628	0.85%	94.72%	Key Source
CO_2 Mobile Combustion: Other (Energy)	Energy	81.0989	107.9239	0.77%	95.49%	Key Source
CH_4 Emissions from Wastewater Handling	Waste	177.1625	121.0136	0.64%	96.13%	Non-Key Source
CO_2 Emissions from the Iron and Steel Industry	Industrial Processes	56.7016	83.8512	0.61%	96.74%	Non-Key Source
N_2O Emissions from Wastewater Handling	Waste	129.0471	92.7379	0.51%	97.25%	Non-Key Source
CH_4 Emissions from Manure Management	Agriculture	387.6121	70.5761	0.35%	97.61%	Non-Key Source
CH_4 (Non-CO_2) Emissions from Stationary Combustion	Energy	250.7355	33.2023	0.34%	97.95%	Non-Key Source
CO_2 Emissions from Lime Production	Industrial Processes	149.2228	6.6468	0.32%	98.27%	Non-Key Source
CO_2 Emissions from Food and Drink	Industrial Processes	19.6395	40.7669	0.32%	98.59%	Non-Key Source
N_2O Indirect Emissions from Agricultural Soils	Agriculture	399.1500	139.0628	0.24%	98.82%	Non-Key Source
N_2O Indirect Emissions from Manure Management	Agriculture	249.9689	95.9399	0.23%	99.05%	Non-Key Source
CO_2 Emissions from Other Products	Solvents	32.8744	29.4689	0.18%	99.23%	Non-Key Source
CH_4 Emissions from the Iron and Steel Industry	Industrial Processes	13.3958	19.8098	0.14%	99.38%	Non-Key Source
N_2O (Non-CO_2) Emissions from Stationary Combustion	Energy	82.7151	8.4637	0.13%	99.51%	Non-Key Source
CO_2 Mobile Combustion: Railways	Energy	452.3598	115.1175	0.12%	99.63%	Non-Key Source

CO_2 Emissions from Paint Application	Solvents	30.1849	17.9812	0.09%	99.71%	Non-Key Source
N_2O Mobile Combustion: Road Vehicles	Energy	49.6041	22.2825	0.07%	99.79%	Non-Key Source
CO_2 Mobile Combustion Water Borne Navigation	Energy	18.9048	0.3308	0.05%	99.83%	Non-Key Source
CO_2 Emissions from Glass Production	Industrial Processes	59.4234	20.8035	0.04%	99.87%	Non-Key Source
CO_2 Emissions from International Bunkers: Aviation	Bunkers	217.3668	63.9592	0.02%	99.89%	Non-Key Source
CO_2 Emissions from Mineral Wool Production	Industrial Processes	8.0816	0.0000	0.02%	99.91%	Non-Key Source
CO_2 Fugitive Emissions from Oil and Gas Operation	Energy	0.6377	1.8809	0.02%	99.93%	Non-Key Source
N_2O Mobile Combustion: Railways	Energy	54.1488	13.7799	0.01%	99.94%	Non-Key Source
N_2O Emissions from the Iron and Steel Industry	Industrial Processes	1.0986	1.6246	0.01%	99.95%	Non-Key Source
CO_2 Emissions from Brick Production	Industrial Processes	52.6166	16.1150	0.01%	99.97%	Non-Key Source
CH_4 Mobile Combustion: Agriculture/Forestry/Fishing	Energy	5.0502	0.5040	0.01%	99.97%	Non-Key Source
N_2O Mobile Combustion: Agriculture/Forestry/Fishing	Energy	4.4731	0.4464	0.01%	99.98%	Non-Key Source
CO_2 Emissions from Degreasing and Dry Cleaning	Solvents	1.9978	1.2401	0.01%	99.99%	Non-Key Source
CH_4 Mobile Combustion: Road Vehicles	Energy	24.4646	7.3663	0.00%	99.99%	Non-Key Source
CH_4 Emissions from International Bunkers: Aviation	Bunkers	0.9036	0.0203	0.00%	99.99%	Non-Key Source
N_2O Mobile Combustion: Other (Energy)	Energy	0.4911	0.3426	0.00%	100.00%	Non-Key Source
CO_2 Emissions from Chemical Products, Manufacture and Processing	Solvents	0.5470	0.2931	0.00%	100.00%	Non-Key Source
CH_4 Mobile Combustion: Other (Energy)	Energy	0.1350	0.1295	0.00%	100.00%	Non-Key Source
N_2O Emissions from International Bunkers: Aviation	Bunkers	2.1560	0.6589	0.00%	100.00%	Non-Key Source
CO_2 Emissions from Road Paving with Asphalt	Industrial Processes	0.1874	0.0100	0.00%	100.00%	Non-Key Source
N_2O Mobile Combustion Water Borne Navigation	Energy	0.1582	0.0028	0.00%	100.00%	Non-Key Source
CH_4 Emissions from Road Paving with Asphalt	Industrial Processes	0.1281	0.0068	0.00%	100.00%	Non-Key Source
CH_4 Mobile Combustion: Railways	Energy	0.5323	0.1355	0.00%	100.00%	Non-Key Source
N_2O Emissions from Use of N_2O for Anaesthesia	Solvents	0.0205	0.0189	0.00%	100.00%	Non-Key Source
CH_4 Mobile Combustion Water Borne Navigation	Energy	0.0375	0.0007	0.00%	100.00%	Non-Key Source
N_2O Fugitive Emissions from Oil and Gas Operation	Energy	0.0002	0.0052	0.00%	100.00%	Non-Key Source
SF_6 Emissions from Electrical Equipment	Industrial Processes	0.0000	0.2839	0.00%	100.00%	Non-Key Source
HFCs Emissions from Refrigeration and Air Conditioning Equipment	Industrial Processes	0.0000	18.7189	0.00%	100.00%	Non-Key Source
Total				100.00%		

Annex 1-8: 1990-2005 Key Source Category Tier 1 Analysis – Trend Assessment, With LULUCF

Inventory Categories	Inventory Sector	Basic Year Estimate (Gg CO_2 eq.)	Current Year Estimate (Gg CO_2 eq.)	Total	Cumulative Sum	Status
CO_2 Emissions from Stationary Combustion - Coal	Energy	11280.4287	450.0661	24.36%	24.36%	**Key Source**
CO_2 Emissions from Stationary Combustion - Oil	Energy	9047.7243	231.9371	20.16%	44.52%	**Key Source**
CO_2 from Forest Land Remaining Forest Land	LULUCF	-2197.5790	-2246.2332	10.72%	55.24%	**Key Source**
CO_2 from Cropland Remaining Cropland	LULUCF	1307.5879	1684.2815	8.04%	63.28%	**Key Source**
CH_4 Emissions from Solid Waste Disposal Sites	Waste	1321.1268	1186.2060	5.66%	68.95%	**Key Source**
CO_2 Emissions from Stationary Combustion - Gas	Energy	7341.2894	4441.8224	3.95%	72.90%	**Key Source**
CO_2 from Grassland Remaining Grassland	LULUCF	-786.5000	-819.4560	3.91%	76.81%	**Key Source**
CH_4 Emissions from Enteric Fermentation in Domestic Livestock	Agriculture	1903.4057	792.8592	3.79%	80.60%	**Key Source**
CO_2 Mobile Combustion: Agriculture/Forestry/Fishing	Energy	1778.8921	177.6497	3.33%	83.93%	**Key Source**
N_2O Direct Emissions from Agricultural Soils	Agriculture	1319.4237	560.1846	2.67%	86.61%	**Key Source**
N_2O Direct Emissions from Manure Management	Agriculture	1064.3570	469.1675	2.24%	88.85%	**Key Source**
CO_2 Emissions from Cement Production	Industrial Processes	988.2518	373.2628	1.78%	90.63%	**Key Source**
CH_4 Fugitive Emissions from Oil and Gas Operations	Energy	682.2942	652.0090	1.51%	92.14%	**Key Source**
CO_2 Emissions from Biomass	Biomasa	210.8274	295.0374	1.41%	93.54%	**Key Source**
CO_2 Mobile Combustion: Road Vehicles	Energy	3364.2178	1459.4096	0.94%	94.48%	**Key Source**
N_2O Indirect Emissions from Agricultural Soils	Agriculture	399.1500	139.0628	0.66%	95.15%	**Key Source**
CH_4 Emissions from Wastewater Handling	Waste	177.1625	121.0136	0.58%	95.73%	Non-Key Source
CO_2 Mobile Combustion: Railways	Energy	452.3598	115.1175	0.51%	96.24%	Non-Key Source
N_2O Indirect Emissions from Manure Management	Agriculture	249.9689	95.9399	0.46%	96.70%	Non-Key Source
N_2O Emissions from Wastewater Handling	Waste	129.0471	92.7379	0.44%	97.14%	Non-Key Source
CH_4 (Non-CO_2) Emissions from Stationary Combustion	Energy	250.7355	33.2023	0.43%	97.57%	Non-Key Source
CO_2 Emissions from the Iron and Steel Industry	Industrial Processes	56.7016	83.8512	0.40%	97.97%	Non-Key Source
CH_4 Emissions from Manure Management	Agriculture	387.6121	70.5761	0.34%	98.31%	Non-Key Source
CO_2 Mobile Combustion: Other (Energy)	Energy	81.0989	107.9239	0.32%	98.63%	Non-Key Source
CO_2 Emissions from International Bunkers: Aviation	Bunkers	217.3668	63.9592	0.31%	98.94%	Non-Key Source
CO_2 Emissions from Food and Drink	Industrial Processes	19.6395	40.7669	0.19%	99.13%	Non-Key Source
N_2O (Non-CO_2) Emissions from Stationary Combustion	Energy	82.7151	8.4637	0.15%	99.29%	Non-Key Source
CO_2 Emissions from Other Products	Solvents	32.8744	29.4689	0.14%	99.43%	Non-Key Source
CO_2 Emissions from Glass Production	Industrial Processes	59.4234	20.8035	0.10%	99.53%	Non-Key Source
CH_4 Emissions from the Iron and Steel Industry	Industrial Processes	13.3958	19.8098	0.09%	99.62%	Non-Key Source
CO_2 Emissions from Paint Application	Solvents	30.1849	17.9812	0.09%	99.71%	Non-Key Source

CO_2 Emissions from Brick Production	Industrial Processes	52.6166	16.1150	0.08%	99.78%	Non-Key Source
N_2O Mobile Combustion: Railways	Energy	54.1488	13.7799	0.06%	99.85%	Non-Key Source
CO_2 Mobile Combustion Water Borne Navigation	Energy	18.9048	0.3308	0.04%	99.89%	Non-Key Source
CO_2 Emissions from Lime Production	Industrial Processes	149.2228	6.6468	0.03%	99.92%	Non-Key Source
CH_4 Mobile Combustion: Road Vehicles	Energy	24.4646	7.3663	0.02%	99.94%	Non-Key Source
N_2O Mobile Combustion: Road Vehicles	Energy	49.6041	22.2825	0.01%	99.95%	Non-Key Source
CH_4 Mobile Combustion: Agriculture/Forestry/Fishing	Energy	5.0502	0.5040	0.01%	99.96%	Non-Key Source
N_2O Mobile Combustion: Agriculture/Forestry/Fishing	Energy	4.4731	0.4464	0.01%	99.97%	Non-Key Source
N_2O Emissions from the Iron and Steel Industry	Industrial Processes	1.0986	1.6246	0.01%	99.98%	Non-Key Source
CO_2 Fugitive Emissions from Oil and Gas Operation	Energy	0.6377	1.8809	0.01%	99.99%	Non-Key Source
CO_2 Emissions from Degreasing and Dry Cleaning	Solvents	1.9978	1.2401	0.01%	99.99%	Non-Key Source
N_2O Emissions from International Bunkers: Aviation	Bunkers	2.1560	0.6589	0.00%	99.99%	Non-Key Source
CO_2 Emissions from Chemical Products, Manufacture and Processing	Solvents	0.5470	0.2931	0.00%	100.00%	Non-Key Source
CH_4 from Cropland Remaining Cropland	LULUCF	2.0730	0.2281	0.00%	100.00%	Non-Key Source
CH_4 Mobile Combustion: Railways	Energy	0.5323	0.1355	0.00%	100.00%	Non-Key Source
N_2O Mobile Combustion: Other (Energy)	Energy	0.4911	0.3426	0.00%	100.00%	Non-Key Source
N_2O from Cropland Remaining Cropland	LULUCF	0.7934	0.0873	0.00%	100.00%	Non-Key Source
N_2O Mobile Combustion Water Borne Navigation	Energy	0.1582	0.0028	0.00%	100.00%	Non-Key Source
CH_4 Mobile Combustion: Other (Energy)	Energy	0.1350	0.1295	0.00%	100.00%	Non-Key Source
CH_4 Emissions from International Bunkers: Aviation	Bunkers	0.9036	0.0203	0.00%	100.00%	Non-Key Source
N_2O Emissions from Use of N_2O for Anaesthesia	Solvents	0.0205	0.0189	0.00%	100.00%	Non-Key Source
CH_4 Mobile Combustion Water Borne Navigation	Energy	0.0375	0.0007	0.00%	100.00%	Non-Key Source
CH_4 from Forest Land Remaining Forest Land	LULUCF	0.2347	0.0164	0.00%	100.00%	Non-Key Source
N_2O from Forest Land Remaining Forest Land	LULUCF	0.1917	0.0134	0.00%	100.00%	Non-Key Source
CO_2 Emissions from Road Paving with Asphalt	Industrial Processes	0.1874	0.0100	0.00%	100.00%	Non-Key Source
CH_4 Emissions from Road Paving with Asphalt	Industrial Processes	0.1281	0.0068	0.00%	100.00%	Non-Key Source
N_2O Fugitive Emissions from Oil and Gas Operation	Energy	0.0002	0.0052	0.00%	100.00%	Non-Key Source
CO_2 Emissions from Mineral Wool Production	Industrial Processes	8.0816	0.0000	0.00%	100.00%	Non-Key Source
SF_6 Emissions from Electrical Equipment	Industrial Processes	0.0000	18.7189	0.00%	100.00%	Non-Key Source
HFCs Emissions from Refrigeration and Air Conditioning Equipment	Industrial Processes	0.0000	0.2839	0.00%	100.00%	Non-Key Source
Total				100.00%		

Annex 2. Data for Estimating Emissions from Fuel Combustion

Annex 2-1: Energy Balance of the Republic of Moldova for 2005 Year (Without ATULBD)

Chapter S.1.1. Resources (in natural measure units)

No.	Type of fuel and energy	Measure unit	Resources				
			Stock at the start of the year	Production (final)	Inputs from other national sources	Import	Resources - TOTAL (1+2+3+4)
A	B	C	1	2	3	4	5
100	Coal	THOUS. TONNES	110	0	0	166	276
101	including: Anthracite	THOUS. TONNES	70	0	0	136	206
110	Brown Coal	THOUS. TONNES	0	0	0	0	0
200	Coke	THOUS. TONNES	0	0	0	0	0
300	Oil	THOUS. TONNES	2	5	0	0	7
301	Diesel Oil	THOUS. TONNES	32	1	0	333	366
302	Fuel for Ovens	THOUS. TONNES	0	0	0	2	2
303	Residual Fuel Oil	THOUS. TONNES	10	3	3	13	29
305	Jet Fuel	THOUS. TONNES	1	0	0	15	16
306	Aviation Fuel	THOUS. TONNES	0	0	0	0	0
307	Gasoline	THOUS. TONNES	35	0	0	216	251
3071	including: Lead Free Gasoline	THOUS. TONNES	35	0	0	216	251
308	LPG	THOUS. TONNES	0	0	0	1	1
309	Lubricants	THOUS. TONNES	4	1	0	12	17
310	Bitumen	THOUS. TONNES	1	0	1	16	18
311	White-Spirit	THOUS. TONNES	0	0	0	0	0
312	Paraffin	THOUS. TONNES	0	0	0	0	0
313	Processed Oils	THOUS. TONNES C.E.	0	0	0	0	0
314	Other Oil Products	THOUS. TONNES C.E.	0	0	0	2	2
400	Natural Gases	MIL M^3 STANDARD	18	0	0	1419	1437
500	Liquiefied Petroleum Gases	THOUS. TONNES	8	0	0	54	62
600	Fuel Wood	THOUS.M^3 COMP	64	266	0	0	330
610	Wood Waste	THOUS. TONNES C.E.	2	14	0	1	17
620	Agricultural Waste	THOUS. TONNES C.E.	0	16	0	0	16
630	Other types of fuel	THOUS. TONNES C.E.	0	0	0	0	0
700	Electrictricity, total	MIL KWH	0	1229	1367	1600	4196
800	Heat, total	THOUS. GCAL	0	3591	0	0	3591

Chapter S.1.2. Distributed (in natural measure units)

No.	Type of fuel and energy	Measure unit	Distributed				
			Consumed-TOTAL (2+3+4+5)	consumed			
				for electricity production	for heat production	as raw material and for non-power purposes	as fuel and energy
A	B	C	1	2	3	4	5
100	Coal	THOUS. TONNES	180	0	5	0	175
101	including: Anthracite	THOUS. TONNES	142	0	3	0	139
110	Brown Coal	THOUS. TONNES	0	0	0	0	0
200	Coke	THOUS. TONNES	0	0	0	0	0
300	Oil	THOUS. TONNES	6	0	0	6	0
301	Diesel Oil	THOUS. TONNES	331	1	2	0	328
302	Fuel for Ovens	THOUS. TONNES	1	0	0	0	1
303	Residual Fuel Oil	THOUS. TONNES	21	3	13	0	5
305	Jet Fuel	THOUS. TONNES	15	0	0	0	15
306	Aviation Fuel	THOUS. TONNES	0	0	0	0	0
307	Gasoline	THOUS. TONNES	215	0	0	0	215
3071	including: Lead Free Gasoline	THOUS. TONNES	215	0	0	0	215
308	LPG	THOUS. TONNES	1	0	0	0	1
309	Lubricants	THOUS. TONNES	11	0	0	1	10
310	Bitumen	THOUS. TONNES	16	0	0	16	0
311	White-spirit	THOUS. TONNES	0	0	0	0	0
312	Paraffin	THOUS. TONNES	0	0	0	0	0
313	Processed Oils	THOUS. TONNES C.E	0	0	0	0	0
314	Other Oil Products	THOUS. TONNES C.E	2	0	0	1	1
400	Natural Gases	MIL M^3 STANDARD	1339	281	411	5	642
500	Liquiefied Petroleum Gases	THOUS. TONNES	53	0	0	0	53
600	Fuel wood	THOUS. M^3 COMP.	253	0	0	2	251
610	Wood waste	THOUS. TONNES C.E.	13	0	1	0	12
620	Agricultural Waste	THOUS. TONNES C.E.	16	0	8	0	8
630	Other Type of Fuel	THOUS. TONNES C.E.	0	0	0	0	0
700	Electricity, total	MIL KWH	2921	0	0	0	2921
800	Heat, total	THOUS. GCAL	3084	0	0	0	3084

Chapter S.1.2. Distributions (in natural measure units) (continuation)

No.	Type of fuel and energy	Measure unit	Distribution				
			export	losses	other distribu-tion articles	stock by the end of the year end of the year	distributed- TOTAL including stock by the (1+6+7+8+9)
A	B	C	6	7	8	9	10
100	Coal	THOUS. TONNES	0	2	1	93	276
101	including Anthracite	THOUS. TONNES	0	1	1	62	206
110	Brown Coal	THOUS. TONNES	0	0	0	0	0
200	Coke	THOUS. TONNES	0	0	0	0	0
300	Oil	THOUS. TONNES	0	0	0	1	7
301	Diesel Oil	THOUS. TONNES	0	0	0	35	366
302	Fuel for Ovens	THOUS. TONNES	0	0	0	1	2
303	Residual Fuel Oil	THOUS. TONNES	1	0	0	7	29
305	Jet Fuel	THOUS. TONNES	0	0	0	1	16
306	Aviation Fuel	THOUS. TONNES	0	0	0	0	0
307	Gasoline	THOUS. TONNES	0	2	1	33	251
3071	including Lead Free Gasoline	THOUS. TONNES	0	2	1	33	251
308	LPG	THOUS. TONNES	0	0	0	0	1
309	Lubricants	THOUS. TONNES	1	0	1	4	17
310	Bitumen	THOUS. TONNES	0	0	0	2	18
311	White-spirit	THOUS. TONNES	0	0	0	0	0
312	Paraffin	THOUS. TONNES	0	0	0	0	0
313	Processed Oils	THOUS. TONNES C.E.	0	0	0	0	0
314	Other Oil Products	THOUS. TONNES C.E.	0	0	0	0	2
400	Natural Gases	MIL M^3 STANDARD	0	81	0	17	1437
500	Liquiefied Petroleum Gases	THOUS.TONNES	0	1	0	8	62
600	Fuel Wood	THOUS. M^3 COMP	0	0	1	76	330
610	Wood Waste	THOUS. TONNES C.E.	0	0	0	4	17
620	Agricultural Waste	THOUS. TONNES C.E.	0	0	0	0	16
630	Other Types of Fuel	THOUS. TONNES C.E.	0	0	0	0	0
700	Electricity, total	MIL KWH	14	783	478	0	4196
800	Heat, total	THOUS. GCAL	0	507	0	0	3591

Chapter S.2.1. Consumed as fuel or energy (in natural measure units)

No.	Type of fuel and energy	Measure unit	Used as fuel or energy-TOTAL (2+3+4+5+6+7+8+9)	of which			
				For consumer goods manu-facturing	For con-struction	For transport opera-tion (including indus-trial transport)	For ag-ricul ture
A	B	C	1	2	3	4	5
100	Coal	THOUS.TONNES	175	8	0	0	0
101	including: Anthracite	THOUS.TONNES	139	6	0	0	0
110	Brown Coal	THOUS.TONNES	0	0	0	0	0
200	Coke	THOUS.TONNES	0	0	0	0	0
300	Oil	THOUS.TONNES	0	0	0	0	0
301	Diesel Oil	THOUS.TONNES	328	4	3	155	56
302	Fuel for Oven	THOUS.TONNES	1	0	0	0	0
303	Residual Fuel Oil	THOUS.TONNES	5	4	0	0	0
305	Jet Fuel	THOUS.TONNES	15	0	0	12	0
306	Aviation Fuel	THOUS.TONNES	0	0	0	0	0
307	Gasoline	THOUS.TONNES	215	0	0	69	0
3071	including: Lead Free Gasoline	THOUS.TONNES	215	0	0	69	0
308	LPG	THOUS.TONNES	1	0	0	0	0
309	Lubricants	THOUS.TONNES	10	0	0	2	2
310	Bitumen	THOUS.TONNES	0	0	0	0	0
311	White-spirit	THOUS.TONNES	0	0	0	0	0
312	Paraffin	THOUS.TONNES	0	0	0	0	0
313	Processed Oils	THOUS.TONNES C.E.	0	0	0	0	0
314	Other Oil Products	THOUS.TONNES C.E.	1	0	0	0	0
400	Natural Gas	MIL M^3 STANDARD	642	179	1	22	3
500	Liquiefied Petroleum Gases	THOUS.TONNES	53	0	0	5	0
600	Fuel Wood	THOUS. M^3 COMP	251	1	0	0	1
610	Wood Waste	THOUS.TONNES C.E.	12	1	0	0	0
620	Agricultural Waste	THOUS.TONNES C.E.	8	0	0	0	0
630	Other Types of Fuel	THOUS.TONNES C.E.	0	0	0	0	0
700	Electricity, total	MIL KWH	2921	974	10	50	51
800	Heat, total	THOUS. GCAL	3084	1007	5	2	20

Chapter S.2.1. Consumed as fuel or energy (in natural measure units) (continuation)

No.	Type of fuel and energy	Measure unit	of which			
			For trade	For utilities	Sold to population	For other works and needs
A	B	C	6	7	8	9
100	Coal	THOUS.TONNES	2	83	81	1
101	including: Anthracite	THOUS.TONNES	1	54	77	1
110	Brown Coal	THOUS.TONNES	0	0	0	0
200	Coke	THOUS.TONNES	0	0	0	0
300	Oil	THOUS.TONNES	0	0	0	0
301	Diesel Oil	THOUS.TONNES	0	1	107	2
302	Fiel for Oven	THOUS.TONNES	0	0	0	1
303	Residual Fuel Oil	THOUS.TONNES	0	0	0	1
305	Jet Fuel	THOUS.TONNES	0	0	0	3
306	Aviation Fuel	THOUS.TONNES	0	0	0	0
307	Gasoline	THOUS.TONNES	0	0	146	0
3071	including: Lead Free Gasoline	THOUS.TONNES	0	0	146	0
308	LPG	THOUS.TONNES	0	0	0	1
309	Lubricants	THOUS.TONNES	0	0	2	4
310	Bitumen	THOUS.TONNES	0	0	0	0
311	White-spirit	THOUS.TONNES	0	0	0	0
312	Paraffin	THOUS.TONNES	0	0	0	0
313	Processed Oils	THOUS.TONNES C.E.	0	0	0	0
314	Other Oil Products	THOUS.TONNES C.E.	0	0	0	1
400	Natural Gas	MIL M^3 STANDARD	3	73	357	4
500	Liquiefied Petroleum Gases	THOUS.TONNES	0	1	45	2
600	Fuel Wood	THOUS.M^3 COMP.	1	26	218	4
610	Wood Waste	THOUS.TONNES C.E.	0	1	10	0
620	Agricultural Waste	THOUS.TONNES C.E.	0	0	7	1
630	Other types of Fuel	THOUS.TONNES C.E.	0	0	0	0
700	Electricity, total	MIL KWH	90	581	1041	124
800	Heat, total	THOUS. GCAL	24	544	1395	87

Annex 3. Additional Methodologies and Data Sources

Annex 3-1: Additional Methodologies and Data Sources for Energy

The basic equation used to estimate CO_2 emissions is described below:

CO_2 Emissions = Σ (Fuel Consumption $_j$ • Conversion Factor (TJ/unit) • Carbon Emission Factor $_j$ (t C/TJ) – Carbon Stored • Oxidation Fraction $_j$ • 44/12)

Where: j – type of fuel.

For the types of fuel used, country specific net calorific values were used, available in the Energy Balances of the Republic of Moldova (Table A3-1).

The estimation of GHG emissions for the FNC of the RM to the UNFCCC was based on default values of "Net Calorific Values", while the current inventory relied on country specific Net Calorific Values (Table A3-1). In conformity with recommendations in the 2006 IPCC Guidelines, the value of oxidation fraction was assumed as being 1 for all types of fuel (in the FNC, it was 0.99 for liquid fuels, 0.98 – for solid fuels and 0.995 – for gaseous fuels).

Table A3-1: Emission Factors and Other Relevant Parameters Used to Estimate GHG Emissions from the Energy Sector of the Republic of Moldova

Fuel type	Net Calorific Value (Country Specific), TJ/kt		Net Calorific Value, TJ/kt		Emission Factors, t C/TJ		Fraction of Carbon Oxidized	
	Ranges according to the NBS	Value used	IPCC, 1997	IPCC, 2006	IPCC, 1997	IPCC, 2006	IPCC, 1997	IPCC, 2006
Coal	15.40 - 29.13		18.58				0.98	1
Anthracite	22.83 - 29.13		18.58	26.7	26.8	26.8	0.98	1
Brown Coal, including :	6.31 - 15.37		14.65	11.9	27.6	27.6	0.98	1
Donetsk	25.70	25.70			26.8		0.98	1
Kuznetsk	25.44	25.44			26.8		0.98	1
Ukraine	6.31 - 11.68	11.68			27.6		0.98	1
Kansk-Acinsk	15.14	15.14			25.8		0.98	1
Brown Coal Briquettes	17.75	17.75		20.7	25.8	26.6	0.98	1
Coking Coal	26.41 - 29.05	26.41	18.58	28.2	25.8	25.8	0.98	1
Diesel Oil	42.54	42.54	43.33	43.0	20.2	20.2	0.99	1
Fuel for Oven	42.54	42.54			21.1		0.99	1
Residual Fuel Oil	39.02 - 40.20	40.20	40.19	40.4	21.1	21.1	0.99	1
Fuel for Engines	41.96	41.96			20.0		0.99	1
including Jet Engines	43.13				19.5		0.99	1
Aviation Gasoline	43.72	43.72	44.80	44.3	18.9	19.1	0.99	1
Gasoline	43.72	43.72	44.80	44.3	18.9	18.9	0.99	1
Kerosene	43.13	43.13	44.75	43.8	19.6	19.6	0.99	1
Lubricants	42.19	42.19	40.19	40.2	20.0	20.0	0.99	1
Bitumen	39.61	39.61	40.19	40.2	22.0	22.0	0.99	1
Other Oil Products	40.19	40.19	40.19	40.2	20.0	20.0	0.99	1
Natural Gas	33.15 - 34.03	33.86	33.70	48.0	15.3	15.3	0.995	1
Liquefied Petroleum Gases lichefiate	46.06	46.06	47.31	47.3	17.2	17.2	0.99	1
Fuel Wood	12.32	12.32	15	15.6	29.9	30.5	0.98	1
Agricultural Residues	14.67	14.67	15.2		29.9		0.98	1

Source: Instructions for Compiling the Statistical Report No.1-EB "Energy Balance", approved through Order No. 106 from 16.09.2003 of the Department of Statistics and Sociology of the Republic of Moldova.

SO_2 emissions from 1A 'Fuel Combustion' were estimated following a default method (Tier 1). The basic equations used to estimate SO_2 emissions are described as follows:

Emissions SO_2 (Gg) = Σ [Activity $_{ab}$ (TJ) x EF $_{ab}$ (kg/TJ)]

Emission Factor = 2 • (s/100) • (1/ Q) • 10^6 • (100-r)/100 • ((100-n) /100,

Where:

Activity = Energy Input (TJ);

EF = Emission Factor (kg/TJ);

a = type of fuel;

b = sector or activity;

2 = SO_2/S (kg/kg);

S = sulphur content in fuel (percent);

r = retention of sulphur in ash (percent);

Q = net calorific value (TJ/kt);

10^6 = conversion factor;

n = efficiency of abatement technology and/or reduction efficiency (percent).

Default emission factors available in the Revised 1996 Guidelines (IPCC, 1997) and 2006 IPCC Guidelines were used to estimate SO_2 emissions (Table A3-2), except for the coefficient of sulphur fraction in fuels imported in the Republic of Moldova (these values were provided by the Customs Service of the Republic of Moldova).

Table A3-2: Emission Factors Used to Estimate SO_2 Emissions in the RM

Type of fuel	Sulphur fraction in fuel, %	Retention of sulphur in ash, %	Net Calorific Values, TJ/kg
Anthracite	1.5	5	25.70
Other Bituminous Coals	1.5	5	26.41
Lignite	1.5	30	11.68
Residual Fuel Oil	3	0	40.20
Diesel Oil	0.3	0	42.54
Gasoline	0.1	0	43.72
Natural Gas	0.3	0	33.86
Kerosen	0.05	0	43.13
Fire Wood	0.2	0	12.32

Source: Revised 1996 Guidelines, Vol. 3, Tab. 1-12, page1.44; National Bureau of Statistics of the RM and Customs Service of the RM.

Annex 3-2: Additional Data Sources for Industrial Processes

Table A3-2.1: Chemical-Mineralogical Composition of Cement Powder Produced at Cement Plant in Rezina "LAFARGE CIMENT" J.S.C. [Filter Powder, Cement Mill No. 1]

Date	Time	SiO_2	Al_2O_3	Fe_2O_3	CaO	Free CaO	SO_2	MgO	K_2O	Na_2O	LOI
Conveyor №1, snec. №2											
26.09.05	11-00	18.10	5.39	3.41	54.14	1.20	7.85	1.77	1.00	0.21	6.41
Conveyor №1											
26.09.05	13-00	18.65	5.12	3.41	54.74	1.00	7.88	1.75	0.98	0.21	5.95
Conveyor №2											
29.09.05	13-00	18.98	5.31	3.42	55.09	1.06	7.49	1.82	0.93	0.19	5.38
Date	**Time**	**Total**	**SM**	**AR**	**LSF**	**C3S**	**C2S**	**C3A**	**C4AF**	**Allcali**	**I.R.**
Conveyor №1, snec. №2											
26.09.05	11-00	98.28	2.06	1.58	89.74	14.41	41.01	8.53	10.38	0.87	0.09
Conveyor №1											
26.09.05	13-00	98.69	2.19	1.50	89.23	15.27	41.95	7.81	10.37	0.85	0.09
Conveyor №2											
29.09.05	13-00	98.61	2.17	1.55	88.00	13.68	44.12	8.30	10.41	0.80	0.09

Table A3-2.2: Chemical-Mineralogical Composition of Cement Produced at Cement Plant in Rezina "LAFARGE CIMENT" J.S.C. [Cement, Cement Mill No. 1]

Date	Time	SiO_2	Al_2O_3	Fe_2O_3	CaO	Free CaO	SO_2	MgO	K_2O	Na_2O	LOI
26.09.05	13-00	22.78	5.3	3.67	61.09	0.58	2.71	1.98	0.63	0.23	1.2
Date	**Time**	**Total**	**SM**	**AR**	**LSF**	**C3S**	**C2S**	**C3A**	**C4AF**	**Allcali**	**I.R.**
26.09.05	13-00	99.58	2.54	1.45	83.84	24.6	46.77	7.85	11.16	0.64	0.2

Table A3-2.3: Raw Materials and Energy Balance for Cement Production at Cement Plant in Rezina "LAFARGE CIMENT" J.S.C.

No.	Name	Measuring unit	Consumption norm	No.	Name	Measuring unit	Consumption norm
Input				**Output**			
Materials							
1	Clinker	kg/t cement	786.9	1	Cement	kg	1000
2	Gypsum	-„ –„ -	57.7	2	Technological loss	kg/t cement	30
3	Mineral supple-ments	-„ –„ -	185.4				
Fuel							
1	Total fuel	kg c.e./t cement	126.4	1	Clinker drying	kg c.e./t cement	121.7
				2	Supplements drying	kg c.e./t cement	4.7

Table A3-2.4: Raw Materials Consumption Norms for Cement Production at Cement Plant in Rezina "LAFARGE CIMENT" J.S.C.

No.	Name	Supplier	Normative acts	Measure unit	Consumption norm
1	**Raw material**				
1.1	Limestone and red clay	Cement and slate works in Ribnita, ATULBD	CT 21 RSSM 115-87	kg/t clinker	1710
2	**Correction supplements**				
2.1	Burning residues	Construction Materials Works in Evpatoria, Ukraine	CT 6-08-385-77	-„ –„ -	50
2.2	Lime residue	Metal Combined Works in Novolipetk, Ukraine	CT 14-106-198-83	-„ –„ -	50
2.3	Aluminised clay	Mining Department in Kirovograd, Ukraine	CT 14-8-419-83 CT 14 RSSU 136-82 CT 14-14-150-88	-„ –„ -	90
3	**Mineral supplements**				
3.1	Granulated slag	Metal Works in Krivoi Rog, Ukraine	STaS 3476-74	kg/t cement	180
4	Gypsum	Gypsum quarries in Criva, Republic of Moldova	STaS 4013-82	-„ –„ -	56
4.	**Additional materials**				
5.	**Refraction**				
5.1	Alumosilicates, of normal size including : magnesial „Lovinit"	Donetk, Ukraine Czech Republic	STaS 21436-75	kg/t clinker	1.65 0.31 1.34 3.65
5.2	Crushing pieces including: steel balls	Dneprodzerjinsk, Ukraine, the Works in Kataev-Ivanovsk, Experimental Works in Malinsk, Jitomir region, Ukraine	STaS 7524-83 STaS 24384-80	kg/t cement -„ –„ - -„ –„ -	1.30 0.73 0.57
5.3	Steel-clad plates	Metallic Works in Volisk, Ukraine	STaS 26645-85	-„ –„ -	-
6.	**Energy**				
6.1	Fuel for clinker drying Fuel for supplements drying	Petroleum tank farm in Kre-menciug, Ukraine	STaS 10585	kg c.e./t clinker -„ –„ -	155.8 20.0
6.2	Electricity	Moldglavenergo, Republic of Moldova		kWh/t cement	164.0

Table A3-2.5: Glass Production at the "Chisinau Glass Plant" J.S.C., 1990-2006

Year	Glass produced total, t	Recyclable glass used, t	Glass packaging, mil. conventional jars of 0.5 litre	Glass packaging, mil. conventional jars of 0.7 litre
1990	98060	48815	222.2	102.6
1991	99093	45917	245.7	91.3
1992	77874	43094	187.4	72.6
1993	93220	53575	248.9	84.2
1994	64687	52467	152.7	72.9
1995	67658	52613	87.4	123.5
1996	53765	31913	39.6	113.5
1997	61441	42037	86.4	109.1
1998	43493	37371	84.2	58.2
1999	51056	38726	104.6	62.2
2000	94342	51135	156.2	141.3
2001	86112	45838	148.8	121.9
2002	84706	44390	137.4	136.6
2003	81837	42080	107.4	143.6
2004	88121	47695	98.9	154.5
2005	80579	47450	103.2	135.2
2006	69756	38861	121.3	102.1

Table A3-2.6: Row Materials Used for Brick Production at State Enterprises "MACON" J.S.C. in Chisinau, 1990-2005

Year	Clay, tonnes			Average Concentration of CaO in Clay Used, %			Average Concentration of MgO in Clay Used, %		
	From Purcel Quarry	From Micauti Quarry	From Pruncul Quarry	From Purcel Quarry	From Micauti Quarry	From Pruncul Quarry	From Purcel Quarry	From Micauti Quarry	From Pruncul Quarry
1990	61297			8.44			3.03		
1991	65761			8.44			3.03		
1992	64689			8.44			3.03		
1993	80269			8.44			3.03		
1994	34601			8.44			3.03		
1995	31954			8.44			3.03		
1996	35022			8.44			3.03		
1997		43430		4.08			3.21		
1998		61060		4.08			3.21		
1999		61420		4.08			3.21		
2000		58265		4.08			3.21		
2001		58155	3326	4.08	8.22		3.21	3.57	
2002		73264	6671	4.08	8.22		3.21	3.57	
2003		71620	14280	4.08	8.22		3.21	3.57	
2004		70114	24093	4.08	8.22		3.21	3.57	
2005		8183	82203	4.08	8.22		3.21	3.57	

Table A3-2.7: Natural Gas Consumption and Brick Production at State Enterprises "MACON" J.S.C. in Chisinau, 1990-2005

	1990	1991	1992	1993	1994	1995	1996	1997
Gas, thousand m^3	9334	8339	7084	7104	2949	2451	2334	3410
Bricks, mil. pieces	29.0	30.2	30.5	34.7	14.8	16.8	17.3	20.2
	1998	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**
Gas, thousand m^3	3371	3819	3586	3861	4635	5620	5756	5710
Bricks, mil. pieces	28.4	28.6	27.1	27.4	31.5	35.7	35.9	36.2

Annex 3-3: Additional Data Sources for Solvents and Other Products Use

Table A3-3.1: Import of Chemical Products in the Republic of Moldova within 1995-2005 time series, tone

Denumirea substanței	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Varnishes and paints based on polyesters and acrylic/ vinyl and other synthetic polymers dissolved in a non-water medium	1.16	1.48	834.90	951.70	738.00	1546.96	1288.00	3397.53	3868.24	6479.21	5267.02
Varnishes and paints based on natural modified polymers	205.35	138.00	128.00	141.40	73.80	83.34	89.98	116.04	199.09	170.64	194.62
Oil based paints and varnishes (including enamels)	168.69	377.80	239.60	217.20	121.80	166.62	238.07	143.965	83.15	158.83	83.93
Varnishes and paints based on acrylic or vinyl polymers dispersed or dissolved in water medium	247.18	289.60	337.70	444.20	572.200	586.65	660.31	367.55	2862.42	285.00	189.18
Typing, writing and drawing inks	56.97	65.50	71.20	64.40	47.10	70.51	110.74	124.73	149.96	192.92	259.93
Products used as adhesives or glues	499.64	337.10	703.60	1356.00	800.60	827.84	947.64	1231.15	803.56	1819.20	2128.69

Source: National Bureau of Statistics of the RM, Letter No. 07-21/121 from 20.06.2006 and Customs Service (Export and Import Customs Declarations); information does not include export and import operations of organisations on the left bank of the Dniester river and Bender municipality.

Table A3-3.2: Import of Solvents in the Republic of Moldova within 1995-2005 time series, tonnes

Denumirea substanței	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Aromatic Hydrocarbons	-	17.00	26.00	-	0.40	0.27	20.15	0.20	484.398	104.93	108.98
Halogenated Hydrocarbons	14.96	13.30	24.50	3.50	11.90	16.52	1.154	39.94	1.51	26.23	9.95
Alcohols	-	0.50	-	5.00	3.90	7.37	72.71	45.71	38.29	43.78	44.60
Cetone	20.83	61.70	123.10	33.40	54.30	34.43	41.04	130.21	92.08	96.72	97.58
Esters	30.92	78.60	65.70	35.00	67.60	46.87	93.66	116.99	115.84	121.63	136.78
Glycolic /acetate ethers	4.25	40.20	59.80	34.00	60.70	0.27	20.15	0.20	484.398	104.93	108.98

Note: Rudd's solvents classification (1995).

Source: National Bureau of Statistics of the RM, Letter No. 07-21/121 from 20.06.2006 and Customs Service (Export and Import Customs Declarations); information does not include export and import operations of organisations on the left bank of the Dniester river and Bender municipality.

Annex 3-4: Additional Data Sources for Agriculture

Features of Races of Livestock and Poultry Bred in the Republic of Moldova

Cattle

In early 1990`, *Steppe Red* and *Estonian Red* (in the South and partially in the Centre), *Simmental* (in the North and partially in the Centre), and *Spotted Black* (most often used in cross-breeding with local races, but also bred as pure blood) were the most widely bred races in the RM; *Holstein, Ayrshire* and *Jersey* were not bred as pure blood, but used for cross-breeding (Bucataru, Rodionov, 1997; Bucataru, Radionov, Urzica, 2002; Bivol, Ciubotaru, 2005) (Table A3-4.1).

Table A3-4.1: Features of Cattle Races Bred in the Republic of Moldova

Cattle race	Production	Live weight, kg		Milk yield, kg	Content of :		Weight of calf at birth, kg
		♀	♂		fat in milk, %	protein in milk, %	
Spotted Black	milk	650-750	900-1100	5000-7000	3,4-3,7	3,2-3,3	35-39
Simmental	mixed	600-800	1100-1300	3000-5500	3,9-4,2	3,4-3,5	40-43
Steppe Red	milk	450-550	800-900	3000-5000	3,7-3,9	3,3-3,5	28-35
Estonian Red	milk	500-550	850-950	3500-5000	3,8-4,3	3,2-3,5	34-38
Holstein	milk	650-750	900-1150	6000-10000	3,3-3,6	3,0-3,1	40-45
Ayrshire	milk	400-500	600-700	4000-5000	3,9-4,5	3,5-3,6	30-33
Jersey	milk	300-350	400-450	3000-4000	5,0-6,5	3,7-4,5	20-25

At present most cattle bred in the RM are not pure blood, but represent half-breeds from crossbreeding. It should be mentioned that lately, a new kind of cattle *Moldovan Spotted Black*[34] has been crossbred as a result of crossbreeding of *Steppe Red* and *Simmental* with the improved races *Spotted Black* and *Holstein*.

[34]The features of the type *Moldovan Spotted Black* are cows yield big amounts of milk (6000 kg) after the first birth, the milking intensity is 1.8-2.5 kg/minute, production maturity is 25-27 months, effective production term is 4-6 births, weight of calf at birth is 30-35 kg; breeding heifers at 6 months of age weight 165 kg, at 12 months - circa 270 kg. And at 18 months - circa 375 kg and young cattle left for fattening has a daily weight gain of 1200 g, slaughtering efficiency being of 55%.

Swine

The following races and types of swine are bred in the country: *Big White* (as pure blood and as maternal form in industrial crosses and in crossbreeding), *Bacon Estonian* (used for industrial crosses with *Big White*, *Steppe White Ukrainian* and other for crossbreeding), *Steppe White Ukrainian* (boars are used for industrial crosses with other races), Southern Moldavian type for meat "Sudic" (used in crossbreeding as paternal form) (Bucataru, Rodionov, Urzica, 2002; Bivol, Ciubotaru, 2005) (Table A3-4.2).

Table A3-4.2: Features of Swine Races and Types Bred in the Republic of Moldova

Races and Types of Swine	Production	Live weight, kg		Proliferation, piglets in one birth	Average daily weight gain, g	Nutrition units per 1 kg of weight gain
		♂	♀			
The Big White	meat	300-350	220-260	11-12	600-650	4.0-4.1
Bacon Estonian	bacon	280-310	230-250	10-11	600-700	3.8-4.0
Steppe White Ukrainian	meat and fat	300-350	230-250	10-12	600-650	3.9-4.2
Moldavian type for meat "Sudic"	meat	330-350	240-250	10-11	700-800	3.3-3.7
Ladrace	bacon	300-320	230-250	10-12	600-700	3.8-3.9
Duroc	meat	270-300	230-250	8-9	700-750	3.5-3.9
Hampshire	meat	230-280	200-230	9-10	650-700	3.7-4.0

Races more often used for crossbreeding in the RM are *Landrace* (used in crossbreeding with other races to obtain half breed gilts F_1), *Duroc* (used as a paternal race in three-racial and tetra-racial crossbreeding), and *Hampshire* (used as paternal form in various crossbreeding schemes).

Sheep

The sheep bred in the Republic of Moldova are represented by races *Karakul, Tigai, Turcana* and *Frisian* (Table A3-4.3). The most typical colours of *Karakul* race are black and frosty. This race was regionalized in the northern and central part of the country; it is well adaptable and is not demanding in terms of feed and maintenance conditions. The sheep of *Tigai* race are well adaptable to warm climate, are bred in the South of the country and are a race of sheep with semi-fine wool and has considerable fattening abilities. In comparison with other races, *Frisian* race has high milk yield indicators and high fertility performance at crossbreeding and improves these features in crossbreeds on condition special feeding and maintenance conditions are provided (Bucataru, Radionov, Urzica, 2002; Bucataru, Rodionov, Varban, 2003; Bivol, Ciubotaru, 2005).

Table A3-4.3: Features of Sheep Races Bred in the Republic of Moldova

Sheep races	Production	Live weight, kg		Fertility, lambs per 100 sheep	Wool sheared, kg	Milk yield, kg	Content in Milk, %	
		♂	♀				fats	proteins
Karakul	skins-milk	70-80	45-50	110-120	2.0-3.5	60-80	7.0-8.0	5.5-6.5
Tigai	wool-milk, wool-meet	85-95	45-50	110-130	3.5-7.5	75-120	6.5-7.0	5.0-6.0
Frisian	milk	80-90	65-70	190-210	3.5-5.0	500-600	5.9-6.5	5.0-5.5

Goats

Most of the native goats (90 percent) have thick and short hairy caver, consisting of thick and long fibbers (over 70 percent) and down (less than 30 percent) of white (21.2 percent), red (20.9 percent), black (25.2 percent) colour, and spotted (32.7 percent), with horns (73.0 percent) and with no "ear rings" (73.3 percent). The research made revealed that the goats gene pool to a large extent is represented by less productive crossbreeds, however, well adapted to the climate conditions of the country. Among the improved races, recommended for improving goats productivity in the Republic of Moldova are *Saanen* (a race with remarkable milking abilities high fertility performance and longevity, which is used for crossbreedings aimed to improve the milking abilities of local goats), *French Alpine* (is well adapted for grasslands and not demanding in terms of feeding and maintenance conditions, is used to improve native breeds) and *Angora* (is the most valuable race of wool goats, may be used for crossbreeding with other races in view of improving the quality of the hairy caver) (Bucataru, Radionov, Urzica, 2002; Bucataru, Rodionov, Varban, 2003; Bivol, Ciubotaru, 2005) (Table A3-4.4).

Table A3-4.4: Features of Goat Races in the Republic of Moldova

Goat races	Production	Live weight, kg		Fertility per 100 goats	Amount of wool sheared, kg	Milk yield, kg	Contents in milk, %	
		♂	♀				fat	proteins
Saanen	milk	75-85	45-55	150-170	2.0-3.5	700-800	3.7	3.0
French Alpine	milk	80-95	50-65	125-135	2.5-3.5	550-650	3.7	3.0
Angora	wool, down	50-60	30-40	120-130	3.0-4.0	150-200	4.2	3.8
Local Goats	milk	42-49	35-41	164-169	2.0-3.0	224-323	4.7	3.4

Horses and Mules

The following races of horses and interspecies hybrids are bred in the RM: *Orlov* (resistant, easily adaptable, hound-gutted, with light traction and riding abilities, live weight: 500-550 kg), *of Don* (resistant, can be used for different kinds of work in the most diverse environmental conditions, with light traction and riding abilities, live weight: 500-550 kg) and *Vladimir Heavy Harness* has harmonious features and energetic temper, with heavy traction and rapid motion abilities, live weight: 700-750 kg), and also assess and mules[35] in the South (Bucataru, Rodionov, Urzica, 2002).

Rabbits

Races of rabbits bred in the RM (Table 3-4.5) can be classified by the following criteria: main production – meat, fur, mix, wool; live weight – big (over 5 kg), medium (3-5 kg), small (2-3 kg) and dwarf (less than 2 kg); length of hair– normal, short, long (Bucataru, Maciuc, 2005).

[35]A mule is an interspecies hybrid, obtained by crossbreeding of a mare and an ass, with a live weight of 370-390 kg, of 130-150 cm height in withers and a span of life of 30-40 years, is pest resistant, and is well adaptable to the environment, not demanding in terms of feeding and maintenance conditions, has a greater working power than a horse, but is sterile.

Table A3-4.5: Features of Rabbit Races Bred in the Republic of Moldova

Rabbit Races	Production	Live weight, kg	Fertility, rabbits per one birth
Big White	Meat and fur	5.5-9.0	6-8
Big Grey	Meat and fur	5.5-6.5	6-8
Butterfly	Meat and fur	5.0-6.0	6-8
Big Chinchila	Meat and fur	3.5-5.5	6-8
Vienna Blue	Meat and fur	4.0-5.0	6-12
Silver	Meat and fur	4.0-5.0	6-12
Black-red	Meat and fur	4.5-5.5	8-12
White New Zeeland	Meat and fur	3.5-5.5	8-12
California	Meat and fur	3.6-4.8	6-8
Himalaya (Russian)	Meat and fur	2.4	6-8
Angora	Meat and fur	2.5-5.0	6-9

Chicken

The most widely spread races of chicken bred in the Republic of Moldova are: *Leghorn, Moldovan Bare Neck, Silver Adler, Kucino, Rhode Island, Plymouth-Rock, New-Hampshire* and *Cornish* (Bucataru, Rodionov, Urzica, 2002; Bivol, Ciubotaru, 2005) (Table A3-4.6).

Table A3-4.6: Features of Chicken Races Bred in the Republic of Moldova

Chicken races	Production	Live weight, kg		Annual number of laid eggs, pieces	Egg weight, g
		♂	♀		
Leghorn	eggs	2.6-3.0	1.8-2.0	220-240	57-61
Moldovan Bare Neck	meat-eggs	2.7-3.3	2.0-2.5	160-190	58-62
Silver Adler	meat-eggs	3.3-3.7	2.5-3.0	170-180	58-61
Kucino	meat-eggs	3.7-4.1	2.5-3.0	170-190	58-61
Rhode Island	meat-eggs	3.5-4.0	2.5-3.0	170-180	55-63
Plymouth-Rock	meat-eggs	3.5-4.0	2.5-3.0	160-180	58-60
New-Hampshire	meat-eggs	3.8-4.1	2.5-3.0	170-200	56-62
Cornisch	meat	4.5-5.0	3.4-4.0	100-130	60-65

Turkeys

Turkeys of preponderantly three races are bred in the Republic of Moldova: *Suntanned with Large Chest, White with Large Chest* and *North-Caucasian Suntanned* (Bucataru, Rodionov, Urzica, 2002) (Table A3-4.7).

Table A3-4.7: Features of Turkey Races Bred in the Republic of Moldova

Races of turkeys	Live weight, kg		Annual number of laid eggs, pieces	Egg weight, g
	♂	♀		
Suntanned with Large Chest	14-17	8-11	70-90	80-90
White with Large Chest	9-20	6-10	70-110	78-82
North-Caucasian Suntanned	13-14	6.5-7.0	75-80	80-85

Geese

The most widely spread races of geese bred in the Republic of Moldova are: *Holmogor, White Italian, Kuban* and *Chinese* (Bucataru, Rodionov, Urzica, 2002) (Table A3-4.8).

Table A3-4.8: Features of Geese Races Bred in the Republic of Moldova

Races of Geese	Category	Live weight, kg		Annual number of laid eggs, pieces	Egg weight, g
		♂	♀		
Holmogor	Heavy race	9.0-10.0	7.0-8.0	30-40	180-200
White Italian	Semi-heavy race	7.5-8.5	6.5-7.5	30-40	160-170
Kuban	Light race	5.0-5.5	4.0-4.5	70-75	140-160
Chinese	Light race	5.0-5.5	4.0-4.5	60-70	140-160

Ducks

Preponderantly four races of ducks are bred in the Republic of Moldova: *Beijing, Mirror, Grey Ukrainian* and *Polish* (Bucataru, Rodionov, Urzica, 2002) (Table A3-4.9).

Table A3-4.9: Features of Ducks Races Bred in the Republic of Moldova

Races of ducks	Production	Live weight, kg		Annual number of laid eggs, pieces	Egg weight, g
		♂	♀		
Beijing	meat	3.5-4.5	3.0-3.5	90-120	80-90
Mirror	meat-eggs	3.2-3.8	2.8-3.2	150-180	80-90
Grey Ukrainian	meat	3.3-3.7	2.8-3.2	110-130	80-90
Polish	meat	5.0-6.0	2.0-3.0	80-100	70-80

Annex 3-5: Additional Methodologies and Data Sources for LULUCF

Table A3-5.1: Average Dendrometrical Indicators of the Main Species of Trees Occurring in the Forests of the Republic of Moldova

Species	Average production class	Average consistency	Average amount per 1 ha of forest, m^3	Average amount per 1 ha of workable rammel, m^3	Average total growth, thousand m^3	Average growth per ha of forest, m^3
Pine	2.1	0.64	34		16.5	2.8
Quercus species	2.8	0.73	150	92	415.4	3.0
Beech	1.7	0.78	281	1313	1.2	2.4
Hornbeam	2.4	0.78	178	234	33.3	3.5
Ash tree	2.1	0.78	177	235	56.0	3.5
Sycamore maple tree	1.7	0.69	55	200	44.4	2.6
Field maple	2.5	0.75	103	165	3.0	3.8
Elm tree	2.6	0.73	87	152	2.9	3.2
Acacia	1.6	0.75	69	132	276.6	3.9
Birch tree	1.6	0.63	50	100	2.0	3.3
Trembling poplar	1.1	0.70	204	237	1.0	5.0
Linden tree	2.2	0.76	171	239	10.7	3.7
Poplar	2.8	0.69	186	310	44.9	7.9
Willow	3.3	0.65	179	248	14.1	7.4
Total forests	2.3	0.73	124	180	1196.9	3.3
Recommendable indicators	1.7	0.8-0.9	140	216	1451	4.0

Table A3-5.2: Annual Changes in Carbon Stocks in Mineral Soils (5B 'Cropland'), calculated following the Balance Method (Banaru, 2000)

Year	Area, ha	C stocks in soil, Gg			C removed from soil, Gg	C balance		CO_2 emissions	
		crop residues	organic fertiliser	total		Gg	t/ha	Gg	t/ha
1990	1557000	+699	+242	+941	-996	-55	-0.03	202	0.11
1991	1541000	+653	+215	+868	-938	70	-0.05	257	0.18
1992	1368000	+497	+132	+629	-685	-56	-0.05	205	0.18
1993	1387000	+657	+77	+734	-1210	-476	-0.34	1747	1.25
1994	1229000	+352	+35	+387	-694	-307	-0.21	1127	0.77
1995	1234000	+478	+37	+515	-950	-435	-0.3	1596	1.10
1996	1275000	+350	+20	+370	-730	-360	-0.29	1321	1.06
1997	1309000	+553	-	+553	-1186	-633	-0.46	2323	1.69
1998	1242000	+397	-	+397	-845	-448	-0.35	1644	1.28
1999	1291000	+516	-	+516	-1129	-613	-0.44	2250	1.61
2000	1511000	+383	-	+383	-846	-463	-0.31	1699	1.14
2001	1528000	+492	2.0	+494	-981	-487	-0.32	1787	1.17
2002	1558000	+486	-	+486	-1034	-548	-0.35	2011	1.28
2003	1467000	+338	-	+338	-801	-463	-0.32	1699	1.17
2004	1543000	+530	+1	+531	-1152	-621	-0.4	2279	1.47
2005	1500000	+550	-	+550	1246	-696	-0.46	2554	1.70

The balance method (Banaru, 2000) was developed for calculating the annual changes in carbon stocks in mineral soils under the 5B 'Cropland' source and sink category. The respective country specific methodology is equivalent to a Tier 3 method and is supported by a mathematical model, an algorithm and an interactive model for estimating CO_2 emissions from soils, as a function of climatic indices, soil texture, crop, amount of nutrients used and technology applied. The estimation method is based on the carbon flux balance going into the soil (humification of vegetal residues and organic nutrients) and the carbon flux going out of the soil (mineralization of organic matter). The interactive model allows the map drawing of emissions from soil starting with plot level maps and ending with the map for the whole surface of the country for any period of time. According to assessments carried out for the 1990-2005 time period for the whole country, the CO_2 emissions from cropland of the Republic of Moldova showed considerable increase trend. The maximal amount of CO_2 emissions from soils was registered in 2005 and equalled to 2,554 Gg or 1.7 t/ha (Table A3-5.2).

Annex 3-6: Additional Data Sources for Waste

Table A3-6.1: Activity Data Used to Estimate CH_4 Emissions from the 6B1 'Industrial Wastewater' Source Category

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Canned meat (LBD), mil conventional jars	41.3	24.0	8.0	3.9	1.7	1.2	0.0	0.0	0.1	0.4	0.6	0.5	1.7	1.2	0.0	0.4
Canned meat (LBD), t	20650	12000	4000	1950	850	600	0	0	50	200	300	250	850	600	0	200
Canned meat (RBD), t	3750	3550	4700	3750	2350	1500	2000	3100	2300	1700	1800	1921	1463	2692	2174	636
Canned meat (MD), t	24400	15550	8700	5700	3200	2100	2000	3100	2350	1900	2100	2171	2313	3292	2174	836
Canned fruit and vegetables (LBD), mil jars	671.6	518.2	366.1	345.8	226.9	160.6	77.4	134.0	68.4	49.2	43.3	55.1	43.3	25.4	4.4	9.8
Canned fruit and vegetables (LBD), t	335800	259100	183050	172900	113450	80300	38700	67000	34200	24600	21650	27550	21650	12700	2200	4900
Canned fruit and vegetables (RBD), mil jars	1142.3	928.1	748.5	952.4	672.2	-	-	-	-	-	-	-	-	-	-	-
Canned fruit and vegetables (MD), mil jars	1813.9	1446.3	1114.6	1298.2	899.1	-	-	-	-	-	-	-	-	-	-	-
Canned fruit and vegetables (RBD), t	906950	723150	557300	649100	449550	97900	87500	133100	101200	74000	72200	86325	59211	98500	78877	81308
Canned fruit and vegetables (MD), t	1242750	982250	740350	822000	563000	178200	126200	200100	135400	98600	93850	113875	80861	111200	81077	86208
Beer (LBD), mil dal	2.003	1.000	0.800	0.600	0.550	0.229	0.260	0.227	0.201	0.191	0.092	0.180	0.248	0.329	0.425	0.538
Beer (RBD), mil dal	5.597	5.600	3.500	3.000	2.300	2.800	2.300	2.400	2.800	2.000	2.500	3.182	4.376	5.662	6.532	7.240
Beer (MD), mil dal	7.600	6.600	4.300	3.600	2.850	3.029	2.560	2.627	3.001	2.191	2.592	3.362	4.624	5.991	6.957	7.778
Beer (MD), t	76000	66000	43000	36000	28500	30290	25600	26270	30010	21910	25920	33620	46240	59910	69570	77780
Grapes wine (LBD), mil dal	1.992	1.877	0.919	1.000	0.878	0.669	0.380	0.315	0.396	0.225	0.190	0.188	0.132	0.167	0.434	0.147
Grapes wine (RBD), mil dal	14.308	12.423	8.281	9.300	8.900	9.300	14.200	19.100	12.000	6.700	10.700	15.454	14.808	19.151	32.511	36.580
Grapes wine (MD), mil dal	16.300	14.300	9.200	10.300	9.778	9.969	14.580	19.415	12.396	6.925	10.890	15.642	14.940	19.318	32.945	36.727
Grapes wine (MD), t	163000	143000	92000	103000	97780	99690	145800	194150	123960	69250	108900	156423	149398	193183	329451	367274
Sparkling wine (MD), thousand dal	804.0	783.0	854.0	888.0	742.0	948.0	1419.0	1345.0	519.0	675.0	416.0	584.3	613.0	738.5	938.3	1117.7
Sparkling wine (MD), t	8040	7830	8540	8880	7420	9480	14190	13450	5190	6750	4160	5843	6130	7385	9383	11177
Cognac (LBD), thousand dal	430.0	408.0	214.0	188.0	265.0	438.0	267.0	279.0	210.0	178.0	291.0	360.0	364.0	700.0	616.0	521.0
Cognac (RBD), thousand dal	964.0	994.0	536.0	552.0	528.0	589.0	190.0	307.0	287.0	308.0	426.7	595.6	674.1	661.1	812.0	1189.8
Cognac (MD), thousand dal	1394.0	1402.0	750.0	740.0	793.0	1027.0	457.0	586.0	497.0	486.0	717.7	955.6	1038.1	1361.1	1428.0	1710.8
Cognac (MD), t	13940	14020	7500	7400	7930	10270	4570	5860	4970	4860	7177	9556	10381	13611	14280	17108
Brandy and liqueur (LBD), thousand dal	165.0	163.0	185.0	395.0	825.0	1436.0	1451.0	855.0	372.0	238.0	159.0	146.0	139.0	120.0	113.0	136.0

Brandy and liqueur (RBD), thousand dal	394.0	393.0	491.0	999.0	1822.0	2691.0	1907.0	1515.0	1369.0	632.0	330.0	448.0	640.0	1278.0	2016.0	2062.0
Brandy and liqueur (MD), thousand dal	559.0	556.0	676.0	1394.0	2647.0	4127.0	3358.0	2370.0	1741.0	870.0	489.0	594.0	779.0	1398.0	2129.0	2198.0
Brandy and liqueur (MD), t	5590	5560	6760	13940	26470	41270	33580	23700	17410	8700	4890	5940	7790	13980	21290	21980
Meat (LBD), kt	45.700	28.500	15.600	11.000	9.000	6.000	3.300	2.400	2.200	2.100	1.600	0.900	1.200	0.700	1.200	0.800
Meat (RBD), kt	212.200	190.000	120.400	94.700	72.100	52.400	49.300	48.400	25.100	23.600	11.800	6.401	10.062	14.155	8.981	5.858
Meat (MD), kt	257.900	218.500	136.000	105.700	81.100	58.400	52.600	50.800	27.300	25.700	13.400	7.301	11.262	14.855	10.181	6.658
Meat (MD), t	257900	218500	136000	105700	81100	58400	52600	50800	27300	25700	13400	7301	11262	14855	10181	6658
Sausages (LBD), kt	12.700	9.800	6.700	3.600	2.400	1.600	1.200	1.400	1.200	1.600	1.700	1.500	1.600	2.400	2.600	3.000
Sausages (RBD), kt	37.300	35.300	16.000	12.400	7.000	7.400	6.800	8.200	6.800	7.800	8.500	10.155	12.242	12.626	10.626	14.084
Sausages (MD), kt	50.000	45.100	22.700	16.000	9.400	9.000	8.000	9.600	8.000	9.400	10.200	11.655	13.842	15.026	13.226	17.084
Sausages (MD), t	50000	45100	22700	16000	9400	9000	8000	9600	8000	9400	10200	11655	13842	15026	13226	17084
Butter (LBD), kt	4.100	3.800	2.100	1.700	1.400	1.200	0.800	0.400	0.300	0.400	0.300	0.200	0.100	0.100	0.200	0.200
Butter (RBD), kt	22.900	18.000	14.600	9.300	8.200	5.600	3.900	2.600	2.595	1.974	2.544	3.160	2.617	2.763	3.640	3.393
Butter (MD), kt	27.000	21.800	16.700	11.000	9.600	6.800	4.700	3.000	2.895	2.374	2.844	3.360	2.717	2.863	3.840	3.593
Butter (MD), t	27000	21800	16700	11000	9600	6800	4700	3000	2895	2374	2844	3360	2717	2863	3840	3593
Cheese, cottage cheese (LBD), kt	3.500	2.900	2.100	1.400	0.800	0.400	0.300	0.100	0.100	0.200	0.100	0.041	0.043	0.059	0.037	0.055
Cheese, cottage cheese (RBD), kt	8.700	7.100	3.700	3.800	2.500	1.700	1.400	1.100	1.228	1.125	1.112	1.443	1.852	1.836	1.904	2.380
Cheese, cottage cheese (MD), kt	12.200	10.000	5.800	5.200	3.300	2.100	1.700	1.200	1.328	1.325	1.212	1.484	1.895	1.895	1.941	2.435
Cheese, cottage cheese (MD), t	12200	10000	5800	5200	3300	2100	1700	1200	1328	1325	1212	1484	1895	1895	1941	2435
Dairy products (LBD), kt	138.000	115.400	70.100	65.100	48.800	21.700	11.900	6.100	6.000	6.500	3.400	3.300	2.300	5.600	3.700	5.500
Dairy products (RBD), kt	316.800	267.200	110.400	110.000	86.700	39.500	36.100	26.600	32.400	26.000	26.800	35.171	43.060	16.925	16.049	20.784
Dairy products (MD), kt	454.800	382.600	180.500	175.100	135.500	61.200	48.000	32.700	38.400	32.500	30.200	38.471	45.360	22.525	19.749	26.284
Dairy products (MD), t	454800	382600	180500	175100	135500	61200	48000	32700	38400	32500	30200	38471	45360	22525	19749	26284
Sugar (LBD), kt	26.9	21.4	15.8	21.2	13.1	21.5	12.1	9.5	7.9	1.5	3.0	2.7	2.1	0.0	0.0	0.0
Sugar (RBD), kt	257.1	183.7	176.4	187.8	153.6	197.2	252.4	203.8	186.6	99.0	102.4	129.9	165.5	107.1	110.9	133.5
Sugar (MD), kt	284.0	205.1	192.2	209.0	166.7	218.7	264.5	213.3	194.5	100.5	105.4	132.6	167.6	107.1	110.9	133.5
Sugar (MD), t	284000	205100	192200	209000	166700	218700	264500	213300	194500	100500	105400	132600	167600	107100	110900	133500
Fish, kt	9.5	5.2	6.5	9.5	2.1	-	-	-	-	-	-	-	-	-	-	-
Fish, t	9500	5200	6500	9500	2100	-	-	-	-	-	-	-	-	-	-	-
Vegetal oil (LBD), kt	44.300	43.900	19.100	21.000	19.000	19.200	15.900	15.900	10.600	6.800	8.800	5.800	1.900	4.000	4.800	0.200
Vegetal oil (RBD), kt	81.300	74.000	38.200	39.300	31.400	31.500	23.500	19.300	18.100	17.500	22.500	37.686	51.732	72.754	92.429	83.118
Vegetal oil (MD), kt	125.600	117.900	57.300	60.300	50.400	50.700	39.400	35.200	28.700	24.300	31.300	43.486	53.632	76.754	97.229	83.318

Vegetal oil (MD), t	125600	117900	57300	60300	50400	50700	39400	35200	28700	24300	31300	43486	53632	76754	97229	83318
Soft drinks (LBD), mil dal	2.433	1.900	0.800	0.300	0.100	0.049	0.008	0.033	0.057	0.091	0.066	0.529	0.601	0.376	0.441	0.553
Soft drinks (RBD), mil dal	10.667	6.700	2.700	1.600	1.600	2.000	1.500	1.400	1.500	1.400	1.900	2.562	4.536	5.969	6.452	6.560
Soft drinks (MD), mil dal	13.100	8.600	3.500	1.900	1.700	2.049	1.508	1.433	1.557	1.491	1.966	3.091	5.137	6.345	6.893	7.113
Soft drinks (MD), t	131000	86000	35000	19000	17000	20490	15080	14330	15570	14910	19660	30910	51370	63450	68930	71130
Corrugated cardboard, mil m^2	17.800	15.500	3.700	3.400	0.800	1.400	1.700	2.400	1.300	0.564	0.560	1.284	0.863	0.617	1.570	2.017
Corrugated cardboard, t	5340.0	4650.0	1110.0	1020.0	240.0	420.0	510.0	720.0	390.0	169.2	168.0	385.2	258.9	185.1	471.0	605.1
Synthetic resins and plastics, kt	17.5	14.6	5.8	4.8	1.5	1.3	2.1	0.7	0.9	0.9	1.3	1.3	2.8	2.7	3.0	3.2
Synthetic resins and plastics, t	17500	14600	5800	4800	1500	1300	2100	700	900	900	1300	1300	2800	2700	2988.9	3175.2
Paints and varnishes, kt	11.700	8.800	4.300	2.300	1.000	0.600	0.500	0.500	0.370	0.674	2.054	2.870	4.095	3.443	5.136	6.269
Paints and varnishes, t	11700	8800	4300	2300	1000	600	500	500	370	674	2054	2870	4095	3443	5136	6269
Synthetic detergents, kt	15.000	10.100	7.300	4.000	0.900	1.200	1.500	0.300	0.172	0.258	0.386	0.821	0.255	0.243	0.493	0.085
Synthetic detergents, t	15000	10100	7300	4000	900	1200	1500	300	172	258	386	821	255	243	493	85
Laundry soap, kt	11.700	8.000	4.800	2.700	0.500	0.600	0.466	0.608	0.301	0.231	0.231	0.280	0.232	0.306	0.386	0.240
Laundry soap, t	11700	8000	4800	2700	500	600	466	608	301	231	231	280	232	306	386	240
Soft man made leather, mil m^2	6.100	4.500	3.200	2.300	0.600	0.300	0.179	0.317	0.095	0.017	0.017	0.006	0.001	0.001	0.002	0.002
Soft man made leather, t	4270.0	3150.0	2240.0	1610.0	420.0	210.0	125.3	221.9	66.5	11.9	11.9	4.2	0.7	0.849	1.066	1.235
Cotton yarn (LBD), kt	31.2	32.2	20.8	12.6	7.4	2.6	6.4	5.3	10.5	8.1	13.0	12.4	12.5	13.3	16.2	18.0
Cotton yarn (RBD), kt	0.400	0.400	0.400	0.400	0.200	0.100	0.124	0.064	0.052	0.031	0.030	0.000	0.001	0.000	0.000	0.000
Cotton yarn (MD), kt	31.600	32.600	21.200	13.000	7.600	2.700	6.524	5.364	10.552	8.131	13.030	12.400	12.501	13.300	16.200	18.000
Cotton yarn (MD), t	31600	32600	21200	13000	7600	2700	6524	5364	10552	8131	13030	12400	12501	13300	16200	18000
Fabrics (LBD), mil m^2	218.400	208.000	171.400	96.600	82.100	26.400	42.700	38.800	69.800	57.900	87.900	81.600	84.000	96.300	103.000	119.000
Fabrics (RBD), mil m^3	26.200	20.100	9.300	2.600	0.500	0.600	0.305	0.283	0.221	0.129	0.120	0.077	0.186	0.162	0.095	0.114
Fabrics (MD), mil m^2	244.600	228.100	180.700	99.200	82.600	27.000	43.005	39.083	70.021	58.029	88.020	81.677	84.186	96.462	103.095	119.114
Fabrics (MD), t	48920.0	45620.0	36140.0	19840.0	16520.0	5400.0	8601.0	7816.6	14004.2	11605.8	17604.0	16335.4	16837.2	19292.4	20619.0	23822.8

Sources: Statistical Yearbooks of the RM for 1994 (pages 284-291), 1999 (pages 302-306), 2003 (pages 391-395), 2004 (pages 441-445), 2006 (pages 309-312); Statistical Bulletin for year 2006, IV Quarter (period from 2001 through 2006) (pages 23-29); Statistical Yearbooks of the ATULBD for 1998 (pages 176-184), 2000 (pages 99-100), 2002 (pages 103-104), 2006 (pages 93-94).

Conversion Factors: 1 jar equivalent = 0.5 kg; 1 m^2 fabrics = 0.2 kg; 1m^2 soft man made leather = 0.7 kg; 1 m^2 corrugated cardboard = 0.3 kg; 1 dal alcoholic drinks (wine, sparkling wine, cognac, brandies and liqueurs, beer) = 10 kg.

Abbreviations: LBD – left bank of the Dniester river (ATULBD); RBD – right bank of the Dniester river (Republic of Moldova); MD – Republic of Moldova (total); kt – thousand tonnes; t – tonnes; mil – million; m^2 – square meters; dal – dekalitre.

Table A3-6.2: Activity Data Used to Estimate Nitrous Oxide Emissions from the 6B2 'Domestic Wastewater' (Human Sewage) Source Category

Protein consumption (g/person/day)						
Countries (Europe)	**1979-1981**	**1990-1992**	**1993-1995**	**1995-1997**	**2001-2003**	**2003-2005**
Albania		80	94	94	96	97
Armenia			59	58	68	70
Austria	96	102		105	106	107
Azerbaijan			64		71	73
Belarus			97		87	88
Belgium					92	98
Bosnia Herzegovina			81	84	85	86
Bulgaria		91	86	84	82	79
Croatia			64	64	74	74
Cyprus	77	97		101	100	99
Denmark	87	100		104	110	110
Estonia			99	96	94	88
Russian Federation			90	88	91	92
Finland	94	98		99	102	104
France	112	117		115	115	116
Georgia			61	70	71	77
Germany	96	97		94	97	99
Greece	105	112		113	116	117
Hungary		98	89	85	87	90
Iceland	132	114		115	124	127
Ireland	112	114		109	111	114
Israel	106	113		114	124	126
Italy	106	111		108	111	113
Latvia			98	89	83	87
Lithuania			90	94	110	110
Luxemburg						124
Macedonia			71	70	72	74
Malta	102	102		111	113	116
Moldova			**73**	**66**	**66**	**73**
Netherlands	93	99		105	108	104
Norway	102	98		103	104	104
Poland		102	99	98	99	100
Portugal	76	103		109	110	114
Great Britain	89	94	98	96	104	104
Czech Republic			92	94	94	95
Romania		91		95	100	110
Serbia and Montenegro			86	88	75	75
Slovakia			82	77	77	72
Slovenia			93	100	102	102
Spain	96	107		108	110	110
Sweden	97	95		98	107	107
Switzerland	96	95		91	91	91
Turkey	96	103		98	96	96
Ukraine			87	83	84	86

Sources: Food and Agriculture Organisation of the United Nations
(ses FAOSTAT database <http://www.fao.org/faostat/foodsecurity/index_en.htm>)

Table A3-6.3: Activity Data Used to Estimate Nitrous Oxide Emissions from the 6B2 'Domestic Wastewater' (Human Sewage) Source Category

Countries (Europe)	Energy, (kcal/person/day)			Proteins, (g/persons/day)			Fats, (g/persons/day)		
	1979-1981	1989-1991	2001-2003	1979-1981	1989-1991	2001-2003	1979-1981	1989-1991	2001-2003
Albania	2690	2560	2860	79	79	96	62	66	86
Armenia	3360	3240	2260	103	104	68	94	100	47
Austria	3330	3490	3740	96	101	111	146	156	162
Azerbaijan	3360	3240	2620	103	104	77	94	100	41
Belarus	3360	3240	2960	103	104	87	94	100	99
Belgium			3640			92			162
Bosnia and Herzegovina	3650	3540	2710	106	101	72	104	110	58
Bulgaria	3620	3460	2850	104	107	89	107	116	95
Croatia	3650	3540	2770	106	101	74	104	110	87
Cyprus	2790	3050	3240	77	95	105	104	123	132
Denmark	3100	3190	3450	87	102	110	135	132	140
Estonia	3360	3240	3160	103	104	90	94	100	96
Russian Federation	3360	3240	3080	103	104	91	94	100	83
Finland	3040	3160	3150	94	99	102	129	127	127
France	3390	3540	3640	112	117	118	148	163	170
Georgia	3360	3240	2520	103	104	71	94	100	52
Germany	3330	3390	3490	96	98	100	136	142	141
Greece	3310	3570	3680	105	112	117	124	141	145
Hungary	3450	3670	3500	97	102	95	131	151	149
Iceland	3300	3110	3240	132	114	124	143	123	130
Ireland	3570	3610	3690	112	114	117	137	137	136
Israel	3150	3390	3680	106	111	124	108	120	149
Italy	3560	3600	3670	106	111	113	129	151	157
Latvia	3360	3240	3020	103	104	83	94	100	109
Lithuania	3360	3240	3370	103	104	110	94	100	100
Luxemburg			3710			118			161
Macedonia	3650	3540	2800	106	101	72	104	110	91
Malta	3280	3260	3530	102	101	118	112	114	110
Great Britain	3170	3250	3440	89	94	104	137	137	138
Moldova			**2730**			**66**			**54**
Netherlands	3050	3260	3440	93	96	108	130	138	144
Norway	3320	3170	3480	102	98	107	144	130	144
Poland	3530	3380	3370	111	103	99	117	113	112
Portugal	2780	3410	3750	76	101	119	87	120	141
Czech Republic	3360	3520	3240	99	102	93	123	131	115
Romania	3210	3020	3520	98	91	109	95	92	101
Serbia and Montenegro	3650	3540	2670	106	101	75	104	110	118
Slovakia	3360	3520	2830	99	102	77	123	131	107
Slovenia	3650	3540	2970	106	101	102	104	110	108
Spain	3050	3270	3410	96	104	113	113	140	154
Sweden	2980	2970	3160	97	95	107	124	123	125
Switzerland	3460	3310	3500	96	95	96	158	151	157
Turkey	3230	3510	3340	96	101	96	77	89	90
Ukraine	3360	3240	3030	103	104	84	94	100	79
Former URSS	**3360**	**3240**		**103**	**104**		**94**	**100**	

Sources: Food and Agriculture Organisation of the United Nations
(ses FAOSTAT database on <http://www.fao.org/statistics/yearbook/vol_1_1/xls/d01.xls>)

Annex 4. Comparison of Sectoral and Reference Approaches

Annex 4-1: Comparison of CO_2 Emissions

In conformity with recommendations provided in the GPG (IPCC, 2000), CO_2 emissions, calculated by using two distinct approaches: reference method and sectoral method, were compared (Table A4-1.1).

Below is presented the difference between CO_2 emission estimates calculated by using "top down" (reference) approach and "bottom up" (sectoral) approach (Table A4-1.2). It has been stated that total national CO_2 emissions calculated based on "bottom up" (sectoral) approach have higher values than the values calculated by using a "top down" (reference) approach, the differences varying from a minimum of 0.28 percent in 1994 and maximum of 1.35 percent in 2000. These differences result from activity data on liquid fuels consumption, in particular from the amount of kerosene used in aviation international transport.

Table A4-1.1: Comparison of CO_2 Emissions Estimated by Using Sectoral and Reference Approaches in the Republic of Moldova, Gg

Year	Reference Approach					Sectoral Approach				
	Liquids	Solids	Gaseous	Other	Total	Liquids	Solids	Gaseous	Other	Total
1990	14515.72	11280.43	7356.94	0.64	33153.09	14727.55	11280.43	7356.94	0.64	33364.92
1991	12655.55	8952.19	7356.94	0.61	28964.68	12883.34	8952.19	7356.95	0.61	29192.48
1992	8540.41	5427.33	6524.94	0.52	20492.67	8634.61	5427.33	6524.94	0.52	20586.87
1993	6402.16	5109.04	4203.70	0.43	15714.89	6462.90	5109.04	4203.70	0.43	15775.64
1994	3804.92	5201.34	4260.68	0.41	13266.94	3841.92	5201.34	4260.68	0.41	13303.94
1995	3223.33	2774.80	4417.20	0.42	10415.33	3264.34	2774.80	4417.20	0.42	10456.35
1996	2880.69	2840.41	4902.35	0.47	10623.45	2945.13	2840.41	4902.35	0.47	10687.89
1997	2640.94	1326.18	4890.00	1.11	8857.12	2714.96	1326.18	4890.00	1.11	8931.13
1998	2198.44	917.65	4201.07	1.07	7317.16	2269.36	917.65	4201.07	1.07	7388.07
1999	1426.52	374.70	3782.57	1.02	5583.79	1497.45	374.70	3782.57	1.02	5654.72
2000	1275.29	307.21	3222.58	1.00	4805.08	1340.04	307.21	3222.58	1.00	4869.83
2001	1399.55	266.50	4350.53	1.02	6016.58	1456.42	266.50	4350.61	1.02	6073.53
2002	1568.35	390.17	4101.31	1.01	6059.83	1625.72	390.17	4101.27	1.01	6117.16
2003	1861.01	557.33	4176.95	1.07	6595.29	1929.50	557.33	4176.95	1.07	6663.78
2004	2013.60	464.93	4244.57	1.80	6723.10	2079.41	464.93	4244.57	1.80	6788.91
2005	2007.02	450.07	4464.62	1.88	6921.70	2069.57	450.07	4464.62	1.88	6984.26

Table A4-1.2: The Differences Reported in the Republic of Moldova on Total National CO_2 Emissions Estimated by Sectoral and Reference Approaches, percent

Years	Liquids	Solids	Gaseous	Other	Total	Years	Liquids	Solids	Gaseous	Other	Total
1990	1.46	0.00	0.00	0.00	0.64	1998	3.23	0.00	0.00	0.00	0.97
1991	1.80	0.00	0.00	0.00	0.79	1999	4.97	0.00	0.00	0.00	1.27
1992	1.10	0.00	0.00	0.00	0.46	2000	5.08	0.00	0.00	0.00	1.35
1993	0.95	0.00	0.00	0.00	0.39	2001	4.06	0.00	0.00	0.00	0.95
1994	0.97	0.00	0.00	0.00	0.28	2002	3.66	0.00	0.00	0.00	0.95
1995	1.27	0.00	0.00	0.00	0.39	2003	3.68	0.00	0.00	0.00	1.04
1996	2.24	0.00	0.00	0.00	0.61	2004	3.27	0.00	0.00	0.00	0.98
1997	2.80	0.00	0.00	0.00	0.84	2005	3.12	0.00	0.00	0.00	0.90

Annex 4-2: Comparison of Fuel Consumption

Consumption of liquid fuels (gasoline, kerosene, diesel oil, residual fuel oil, liquefied petroleum gas, bitumen, lubricants and other petroleum products), was compared against consumption of solid (anthracite, bituminous coal, coke, lignite), and gaseous (natural gases) fuels accounted for estimation of total national CO_2 emissions calculated by using "top down" (reference) approach and "bottom up" (sectoral) approach (Table A4-2.1).

Table A4-2.1: Comparison of Total Fuel Consumption Accounted for Estimation the Total National CO_2 Emissions Calculated by Using the Sectoral and Reference Approaches in the Republic of Moldova, TJ

Year	Reference Approach				Sectoral Approach			
	Liquids	Solids	Gaseous	Total	Liquids	Solids	Gaseous	Total
1990	194691.32	117316.86	131139.78	443147.96	197653.92	117316.86	131139.78	446110.56
1991	169544.40	94213.63	131139.78	394897.81	172730.29	94213.63	131139.88	398083.80
1992	113783.60	57655.84	116309.10	287748.54	115009.18	57655.84	116309.03	288974.05
1993	85030.30	53754.00	74932.18	213716.48	85879.87	53754.00	74932.18	214566.05
1994	51031.40	54773.26	75947.98	181752.64	51548.83	54773.26	75947.98	182270.07
1995	43623.33	29226.52	78738.04	151587.89	44197.01	29226.52	78738.04	152161.57
1996	39040.39	29913.31	87385.89	156339.59	39941.72	29913.31	87385.89	157240.92
1997	36108.13	13908.77	87165.80	137182.70	37143.34	13908.77	87165.80	138217.91
1998	30067.70	9650.11	74885.39	114603.20	31059.52	9650.11	74885.39	115595.02
1999	19598.70	3901.97	67425.42	90926.09	20590.69	3901.97	67425.42	91918.08
2000	17680.53	3171.23	57443.49	78295.25	18586.05	3171.23	57443.49	79200.77
2001	19479.71	2773.20	77549.56	99802.47	20275.20	2773.20	77550.91	100599.31
2002	21881.87	4034.32	73107.13	99023.32	22684.21	4034.32	73107.13	99825.66
2003	25899.81	5731.25	74455.43	106086.49	26857.69	5731.25	74455.43	107044.37
2004	28003.15	4771.22	75660.85	108435.22	28917.03	4771.22	75660.85	109349.10
2005	27950.76	4616.12	79583.19	112150.07	28825.70	4616.12	79583.19	113025.01

In the Republic of Moldova the differences were reported for consumption of liquid fuels only (Table A4-2.2), with a variation between a minimum of 0.28 percent in 1994 and a maximum of 1.16 percent in 2000.

The reported differences refer, in particular to kerosene consumption for international aviation transport, accounted for in “bottom up” (sectoral) approach, and excluded from the total national (being reported under the Memo Items: ‘International Bunkers’) in “top down” (reference) approach.

Table A4-2.2: The Differences Reported in the Republic of Moldova on Total Fuel Consumption Accounted for Estimation the Total National CO_2 Emissions Calculated by Using the Sectoral and Reference Approaches, percent

Years	Liquids	Solids	Gaseous	Total	Years	Liquids	Solids	Gaseous	Total
1990	1.52	0.00	0.00	0.67	1998	3.30	0.00	0.00	0.87
1991	1.88	0.00	0.00	0.81	1999	5.06	0.00	0.00	1.09
1992	1.08	0.00	0.00	0.43	2000	5.12	0.00	0.00	1.16
1993	1.00	0.00	0.00	0.40	2001	4.08	0.00	0.00	0.80
1994	1.01	0.00	0.00	0.28	2002	3.67	0.00	0.00	0.81
1995	1.32	0.00	0.00	0.38	2003	3.70	0.00	0.00	0.90
1996	2.31	0.00	0.00	0.58	2004	3.26	0.00	0.00	0.84
1997	2.87	0.00	0.00	0.75	2005	3.13	0.00	0.00	0.78

Annex 5. Assessment of Completeness

National GHG Inventory of the Republic of Moldova is a complete register of the following direct greenhouse gases – CO_2, CH_4, N_2O, HFC and SF_6 (in the time period from 1990 to 2005 no perfluorocarbons (PFC) emissions have been reported in the Republic of Moldova).

The national inventory also covered ozone and aerosol precursors emissions (NO_x, CO, NMVOC and SO_2).

Some gaps have been registered in the national inventory, such as:

- CO_2 emissions from the 2A3 ‘Limestone and Dolomite Use’ source category;
- F-gas (HFC, PFC and SF_6) emissions from the 2F2 ‘Foam Blowing’, 2F3 ‘Fire Extinguishes’, 2F5 ‘Solvents’ and 2F6 ‘Other Applications with ODS’ source categories;
- CO_2 emissions/removals from the 5D ‘Wetlands’ source category;
- GHG emissions from the 6C ‘Waste Incineration’ source category (in particular, from incineration of medical waste)
- The gaps are explained by lack of activity data used to estimate the above mentioned emissions and removals.

Other relevant information regarding the source categories not covered by the national inventory is provided in sectoral chapters (3-8) of the NIR (see in the ‘Completeness Assessment’ section).

Annex 6. Quality Assurance and Quality Control

Annex 6-1: Forms and Checklist for Quality Control for Specific Source Categories

Annex 6-1.1: Tier 1 - Individual Source Category Checklist

National Inventory Report: 1990-2005 Source Category: ____________________

Title(s) and Date(s) of Inventory Spreadsheet(s): ____________________

Source category estimates prepared by (name/affiliation): ____________________

INSTRUCTIONS FOR COMPLETING THIS FORM:

This form is to be completed for each source category, and provides a record of the checks performed and any corrective actions taken. The form may be completed by hand or electronically. If appropriate actions to correct any errors that are found are not immediately apparent, the QC staff performing the check should discuss the results with the National Inventory Team Leader and the QA Expert. Once completed, the form should be filed in the project file, with copies to the National Inventory Team Leader.

The first page of this form summarizes the results of the checks (once completed) and highlights any significant findings or actions. The remaining pages in this form list categories of checks to be performed. The expert has discretion over how the checks are implemented. Not all checks will be applicable to every source category; checks/rows that are not relevant or not available should indicate “n/r” or “n/a” (not be left blank or deleted). Rows for additional checks that are relevant to the source category should be added to the form. Additional information on the activities indicated on the form may be found in the IPCC Good Practice Guidance.

The column for supporting documentation should be used to reference any relevant Supplemental Reports (Form 6A-5) or Contact Reports (Form 6A-4) providing additional information. Note that, if a source-category specific QC plan has been developed and implemented, this Tier 1 form should still be completed. Any documents associated with the source-category specific plan should be clearly referenced in the column for supporting documentation.

Summary of Tier 1 Source Category Checks and Corrective Action	
Summary of results of checks and corrective actions taken:	
Suggested checks to be performed in the future:	Any residual problems after corrective actions are taken:

Checklist for Tier 1: Individual Source Category:								
Item		**Check Completed**			**Corrective Action**		**Supporting documents (provide reference)**
		Date	**Individual (first initial, last name)**	**Errors (Y/N)**	**Date**	**Individual (first initial, last name)**	
DATA GATHERING, INPUT, AND HANDLING ACTIVITIES: QUALITY CHECKS							
1.	Check a sample of input data for transcription errors						
2.	Review spreadsheets with computerized checks and/or quality check reports						
3.	Identify spreadsheet modifications that could provide additional controls or checks on quality						
4.	Other (specify):						
DATA DOCUMENTATION: QUALITY CHECKS							

Checklist for Tier 1: Individual Source Category:							
Item		Check Completed			Corrective Action		Supporting documents (provide reference)
		Date	Individual (first initial, last name)	Errors (Y/N)	Date	Individual (first initial, last name)	
5.	Check project file for completeness						
6.	Confirm that bibliographical data references are included (in spreadsheet) for every primary data element						
7.	Check that all appropriate citations from the spreadsheets appear in the *Inventory* document						
8.	Check that all citations in spreadsheets and inventory are complete (i.e., include all relevant information)						
9.	Randomly check bibliographical citations for transcription errors						
10.	Check that originals of new citations are in current docket submittal						
11.	Randomly check that the originals of citations (including *Contact Reports*) contain the material & content referenced						
12.	Check that assumptions and criteria for selection of activity data and emission factors are documented						
13.	Check that changes in data or methodology are documented						
14.	Check that citations in spreadsheets and inventory document conform to acceptable style guidelines						
15.	Other (specify):						
CALCULATING EMISSIONS AND CHECKING CALCULATIONS							
16.	Check that all emission calculations are included (i.e., emissions are not hard-wired)						
17.	Check whether emission units, parameters, and conversion factors are inappropriately hardwired						
18.	Check if units are properly labeled and correctly carried through from beginning to end of calculation						
19.	Check that conversion factors are correct						
20.	Check that temporal and spatial adjustment factors are used correctly						
21.	Check the data relationships (comparability) and data processing steps (e.g., equations) in the spreadsheets						
22.	Check that spreadsheet input data and calculated data are clearly differentiated						
23.	Check a representative sample of calculations, by hand or electronically						
24.	Check some calculations with abbreviated calculations						
25.	Check the aggregation of data within a source category						
26.	When methods or data have changed, check consistency of time series inputs and calculations						
27.	Check for consistency with IPCC inventory guidelines and good practices, particularly if changes occur						
28.	Other (specify):						

Annex 6-1.2: Tier 2 - Source Category Checklist

National Inventory Report: 1990-2005 Source Category: ______________________________

Key source category (or includes a key source sub-category): (Y/N) ______________________________

Title(s) and Date(s) of Inventory Spreadsheet(s):______________________________

Source category estimates prepared by (name/affiliation): ______________________________

GENERAL INSTRUCTIONS FOR COMPLETING THIS FORM:

Tier 2 checks focus on the data and methodology used for an individual source category. Not all Tier 2 checks occur each inventory cycle; the specificity and frequency of Tier 2 checks vary across source categories. The form may be completed by hand or electronically. Once completed, the form should be filed in the project file, with copies to the National Inventory Team Leader.

The first table on this form summarizes generally the results of the Tier 2 checks and highlights any significant findings or corrective actions. If appropriate actions—to correct any errors that are found or to follow up on the investigation—are not immediately apparent, the QC staff performing the check should discuss the results with the National Inventory Team Leader and the QA Expert.

The remaining pages in this form are lists of categories of checks to be performed or types of questions to be asked. PART A checks are designed to identify potential problems in the estimates, factors, and activity data. PART B checks focus on the quality of secondary data and direct emission measurement. The expert has discretion over how the checks are implemented. Checks/rows that are not relevant or not available should indicate "n/r" or "n/a" (not be left blank or deleted). Rows for additional checks that are relevant to the source category should be added to the form. Additional information on the activities indicated on the form may be found in the IPCC Good Practice Guidance.

The column for supporting documentation should be used to reference any relevant Supplemental Reports (Form 6A-5) or Contact Reports (Form 6A-4) that provide additional information. Other sources may be included here, if they can be clearly referenced. Note that, if a source-category specific QC plan has been developed and implemented, this Tier 2 form should still be completed. Any documents associated with the source-category specific plan should be clearly referenced in the column for supporting documentation.

Summary of All Tier 2 Activities **Individual Source Category:**	
Summary of results of checks and corrective actions taken:	
Suggested Checks to be performed in the future:	Any residual problems after corrective actions are taken:

ADDITIONAL INSTRUCTIONS FOR PART A

The checklist below indicates the types of checks and comparisons that can be performed and is not intended to be exhaustive. Supplemental Reports, Contact Reports, or other documents may be used to report detailed information on the checks conducted. For example, a Supplemental Report could provide information on the variables or sub-variables checked, comparisons made, conclusions that were drawn and rationale for conclusions, sources of information (published, unpublished, meetings, etc.) consulted, and corrective actions required.

Checklist for Tier 2: Part A, Data Gathering and Selection Individual Source Category:								
Item		**Check Completed**			**Corrective Action**		**Supporting documents (provid e reference)**
		Date	**Individual (first initial, last name)**	**Errors (Y/N)**	**Date**	**Individual (first initial, last name)**	
EMISSION DATA QUALITY CHECKS							
1.	Emission comparisons: historical data for source, significant sub-source categories						
2.	Order of magnitude checks						
3.	Reference calculations						
4.	Completeness checks						
5.	Other (detailed checks)						

Checklist for Tier 2: Part A, Data Gathering and Selection Individual Source Category:							
Item		Check Completed			Corrective Action		Supporting documents (provid e reference)
		Date	Individual (first initial, last name)	Errors (Y/N)	Date	Individual (first initial, last name)	
EMISSION FACTOR QUALITY CHECK							
6.	Assess representativeness of emission factors, given national circumstances and analogous emissions data						
7.	Search for options for more representative data						
8.	Other (detailed checks)						
ACTIVITY DATA QUALITY CHECK: NATIONAL LEVEL ACTIVITY DATA							
9.	Check historical trends						
10.	Compare multiple reference sources						
11.	Check applicability of data						
12.	Check methodology for filling in time series for data that are not available annually						
13.	Other (detailed checks)						
ACTIVITY DATA QUALITY CHECK: SITE-SPECIFIC ACTIVITY DATA							
14.	Inconsistencies across sites						
15.	Compare aggregated and national data						
16.	Other (detailed checks)						

ADDITIONAL INSTRUCTIONS FOR PART B

Completing the Tier 2 checks on secondary data and direct emission measurement may require consulting the primary data sources or authors. The checklist below is intended to be indicative, not exhaustive. Additional information on appropriate checks can be found in the Source Category Chapters of the IPCC Good Practice Guidance.

Additional documentation is likely to be necessary to record the specific actions taken to check the data underlying the source category estimates. For example, Supplemental Reports may be needed to record the data or variables that were checked, and the published references and individuals or organizations consulted as part of the investigation. Contact Reports should be used to report the details of personal communications. Supplemental Reports may also be used to explain the rationale for a finding reported in the summary, the results of research into the QC procedures associated with a survey, or checks of site measurement procedures. Be sure to provide references to all supporting documentation.

Checklist for Tier 2. Part B: Secondary Data and Direct Emission Measurement Individual Source category:							
Item		Check Completed			Corrective Action		Supporting documents (provide reference)
		Date	Individual (first initial, last name)	Errors (Y/N)	Date	Individual (first initial, last name)	
SECONDARY DATA: SAMPLE QUESTIONS REGARDING THE QUALITY OF INPUT DATA							
1.	Are QC activities conducted during the original preparation of the data (either as reported in published literature or as indicated by personal communications) consistent with and adequate when compared against (as a minimum), Tier 1 QC activities?						
2.	Does the National Bureau of Statistics have a QA/QC plan that covers the preparation of the data?						
3.	For surveys, what sampling protocols were used and how recently were they reviewed?						
4.	For site-specific activity data, are any national or international standards applicable to the measurement of the data; if so, have they been employed?						
5.	Have uncertainties in the data been estimated and documented?						

Checklist for Tier 2. Part B: Secondary Data and Direct Emission Measurement Individual Source category:							
Item		Check Completed			Corrective Action		Supporting documents (provide reference)
		Date	Individual (first initial, last name)	Errors (Y/N)	Date	Individual (first initial, last name)	
6.	Have any limitations of the secondary data been identified and documented, such as biases or incomplete estimates? Have errors been found?						
7.	Have the secondary data undergone peer review and, if so, of what nature?						
8.	Other (detailed checks)						
DIRECT EMISSION MEASUREMENT: CHECKS ON PROCEDURES TO MEASURE EMISSIONS							
9.	Identify which variables rely on direct emission measurement						
10.	Check procedures used to measure emissions, including sampling procedures, equipment calibration and maintenance.						
11.	Identify whether standard procedures have been used, where they exist (such as IPCC methods or ISO standards).						
12.	Other (detailed checks)						

Annex 6-1.3: Data/Reference Tracking Sheet

This form illustrates a spreadsheet that was developed to track the data sources used for each variable in the inventory from one inventor cycle to another. The particular citation, reference, contact person, form in which data is received, or other information is indicated for each variable. This tracking is particularly useful for sources that have a large number of variables to be tracked. The spreadsheet can easily be expanded to include each new inventory cycle, and so is useful for tracking sources of data over time. In the table, color- and pattern-coding in a cell is used to indicate, for the current inventory cycle, whether the expert has received or is still waiting for data, or other "status" of the data. The columns within the table should be made wider to accommodate the necessary data. Different formats may be needed to accommodate sources with different data characteristics.

National Inventory Report: 1990-2005 Source Category: ______________________

Key source category (or includes a key source sub-category): (Y/N) ______________________

Title(s) and Date(s) of Inventory Spreadsheet(s): ______________________

Source category estimates prepared by (name/affiliation): ______________________

Color key code

No action yet taken

Source investigated, but awaiting arrival or publication

Source obtained

Not obtained/needed

Spreadsheet Name	Worksheet Name	Data needed (variable/parameter)	1990 data source	2000 data source	2005 data source
Insert spreadsheet name	Insert name of worksheet within spreadsheet	Give name of data item on worksheet	Provide citation or individual	Provide citation or individual	Provide citation or individual

Annex 6-1.4: Contact Report

This form is used to record personal communications, including telephone conversations or meetings. It is used, as necessary, as a cover sheet for facsimile or e-mail communications.

Date: ______________________________ Originator ____

Contact by: Telephone _______________ Meeting __________________Other (specify) ____________________________

Contact Name:
Title and Organization:
Phone number: Fax number:
Address:
E-mail address:

Purpose and/or Subject of contact:

Attendees or participants in meeting/telephone conversation (name, affiliation):

Summary of meeting:

Recommended Follow-up Actions:

Annex 6-1.5: Supplemental Report

This form is to be used as needed to provide additional documentation or explanation of QA/QC activities, and to supplement other checklists and forms that are completed. Among other uses, it can record information gathered from sources other than a personal communication (e.g., internet sites or published sources), describe in detail the results of an investigation, or be a cover page for other supporting documentation (such as a source category specific QA/QC plan).

Date:	Source Category:
Subject:	
If part of another report, provide the report name and purpose of supplemental report:	
If not part of another report, provide purpose:	
Sheet # __ of ______	Name, affiliation:

Discussion:

Annex 6-2: Forms and Checklist for Cross-Cutting Quality Control

Annex 6-2.1: Tier 1 - Overall Inventory and Cross-Source Category Checklist

National Inventory Report: 1990-2005 ______________________________

Source Categories included in check: ______________________________

____

____

Title(s) and Date(s) of Inventory Spreadsheet(s): ______________________________

*Source category estimates prepared by (name/affiliation):*______________________________

INSTRUCTIONS FOR COMPLETING THIS FORM:

This form is completed under each inventory cycle, and provides a record of the checks performed and any corrective actions taken. The form may be completed by hand or electronically. The checklist below is completed as a record of the checks conducted. It should include information on the variables or sub-variables checked, comparisons made, conclusions that were drawn and rationale for conclusions, sources of information (published, unpublished, meetings, etc.) consulted, and corrective actions required. If appropriate actions to correct any errors that are found are not immediately apparent, the QC staff performing the check should discuss the results with the National Inventory Team Leader and the QA Expert. Once completed, the form should be filed in the project file, with copies to the National Inventory Team Leader.

The first page of this form summarizes the results of the checks (once completed) and highlights any significant findings or actions. The remaining pages in this form list categories of checks to be performed. The expert has discretion over how the checks are implemented. Rows for additional checks that are relevant should be added to the form.

The column for supporting documentation should be used to reference any relevant *Supplemental Reports* (Form 6-2.5) or *Contact Reports* (Form 6-2.4) providing additional information.

Summary of Tier 1 Overall and Cross-Category Checks and Corrective Action	
Summary of results of checks and corrective actions taken:	
Suggested checks to be performed in the future:	Any residual problems after corrective actions are taken:

Detailed Checklist for Tier 1: Overall Inventory Quality and Cross-Source Categories							
Item		**Check Completed**			**Corrective Action**		**Supporting documents (provide reference)**
		Date	**Individual (first initial, last name)**	**Errors (Y/N)**	**Date**	**Individual (first initial, last name)**	
CHECKING EMISSION CALCULATIONS ACROSS SOURCE CATEGORIES							
1.	Check that sources using same data inputs report comparable values (i.e., analogous in magnitude)						
2.	Check across source categories that same electronic data set is used for common data						
3.	Identify common parameters across source categories and check for consistency						
4.	Check that the number of significant digits or decimal places for common parameters, conversion factors, emission factors, or activity data is consistent across source categories						

Detailed Checklist for Tier 1: Overall Inventory Quality and Cross-Source Categories								
Item		Check Completed			Corrective Action			Supporting documents (provide reference)
		Date	Individual (first initial, last name)	Errors (Y/N)	Date	Individual (first initial, last name)		
5.	Check that total emissions are reported consistently (in terms of significant digits or decimal places) across source categories							
6.	Check that emissions data are correctly aggregated from lower reporting levels to higher reporting levels							
7.	Other (specify)							
DOCUMENTATION								
8.	Check if internal documentation practices are consistent across source categories							
9.	Other (specify)							
COMPLETENESS								
10.	Check for completeness across source categories and years							
11.	Check that data gaps are identified and reported as required							
12.	Compare current national inventory estimates with previous years'							
13.	Other (specify):							
MAINTAINING MASTER INVENTORY FILE: SPREADSHEETS AND INVENTORY DOCUMENT								
14	Have file control procedures been followed?							
15.	Other (specify)							
OTHER								
16.	Specify							
17.	Specify							
18.	Specify							

Annex 6-2.2: Master Tracking Sheet for Inventory

National Inventory Report: 1990-2005____

Tracking form prepared by (name/affiliation): ________________________________

Date of most recent update: ____

INSTRUCTIONS FOR USING THIS TRACKING SHEET:

This form illustrates a spreadsheet that was developed to track the status of the inventory spreadsheets and inventory document during the process of developing and updating the greenhouse gas inventory each inventory cycle. The same form could be used to track either the inventory spreadsheets, or the text for the inventory document. Each row represents a sector or source category. Columns should be self-explanatory. The columns should be made wider to accommodate the necessary data. Different formats or columns may be used to reflect preferences of the National Inventory Team Leader or to accommodate changes in the methodological structure or organizational assignments of the inventory. The comment column can be used to record other relevant information, such as the cause of a delay, when new data supporting data is expected and from whom, when the revised document/estimates are expected, or dates on which revised drafts were submitted.

		Source Responsibilities						
Sector / Source Category	**Annex Included (letter)**	**National Inventory Team Staff**	**Contractor / Contact**	**Date due?**	**Delivered Date?**	**Expect mods?**	**Current Owner?**	**Comments**
Give sector & source category name	Give letter of relevant annex, if any	Lead at NIT for source category	Contractor involved in analysis, or other contact	Date that first draft was due	Date of most recent draft	Y/N—whether modifications to latest draft are expected	Who has the original spreadsheet or text, currently	Any other important information

Annex 6-2.3: Inventory Document Checklist - MSWord Document

Summary of Document Check	
Summary of results of checks and corrective actions taken:	
Suggested checks to be performed in the future:	Any residual problems after corrective actions are taken:

Detailed Checklist for Inventory Document								
Item		**Check Completed**			**Corrective Action**		**Supporting documents (provide reference)**
		Date	**Individual (first initial, last name)**	**Errors (Y/N)**	**Date**	**Individual (first initial, last name)**	
FRONT SECTION							
1.	Cover page has correct date, title, and contact address						
2.	Document number listed on title page						
3.	Correct footer on every section (draft/date, correct Inventory title, page numbers)						
4.	Tables of contents/tables/figures are accurate: titles match document, page #s match; numbers run consecutively and have correct punctuation						
5.	The Executive Summary and Introduction are updated with appropriate years and discussion of trends						
TABLES AND FIGURES							
6.	All numbers in tables match numbers in spreadsheets						
6a.	All numbers in tables match in the Executive Summary						
6b.	All numbers in tables match in the Changes Section						
6c.	All numbers in tables match in the Introduction						
6d.	All numbers in tables match in the Energy Chapter						
6e.	All numbers in tables match in the Industrial Processes Chapter						
6f.	All numbers in tables match in the Solvent and Other Product Use Chapter						
6g.	All numbers in tables match in the Agriculture Chapter						
6h.	All numbers in tables match in the LULUCF Chapter						
6i.	All numbers in tables match in the Waster Chapter						
6j.	All numbers in tables match in the Annexes						
7.	Check that all tables have correct number of significant digits						

Detailed Checklist for Inventory Document							
Item		Check Completed			Corrective Action		Supporting documents (provide reference)
		Date	Individual (first initial, last name)	Errors (Y/N)	Date	Individual (first initial, last name)	
8.	Check alignment in columns and labels						
9.	Check all symbols in tables ("+")						
10.	Check bold in tables						
11.	Table formatting is consistent						
12.	Check that all figures are updated with new data and referenced in the text						
13.	Check table and figure titles for accuracy and consistency with content						
14.	Include all figures with drafts (they are in separate file)						
EQUATIONS-SHOULD ALL HAVE THE FOLLOWING TRAITS							
15.	Equation as follows: $z = x + y$						
16.	Use times symbol, not the letter x or the * symbol						
17.	Equation centered						
18.	Following the equation use: where, (return) (definition of variables)						
19.	Definition of variables are indented and in Table Text style (and first word capitalized)						
REFERENCES							
20	Check consistency of references used in multiple sections (e.g., IPCC Guidance not IPCC Guidelines)						
21.	In text, citations and references match						
22.	Style of references is consistent						
23.	Use of a,b,c is consistent for same author and year references						
24.	Web addresses should not be hyperlinks, should be enclosed with <> and not hyperlinked or underlined						
GENERAL FORMAT							
25.	All acronyms are spelled out first time and not subsequent times throughout each chapter						
26.	All dashes are the same–use insert symbol to insert a long "em" dash (—)						
27.	All fonts in text, headings, and subheadings are consistent						
28.	All headers/titles are consistent						
29.	All highlighting, notes, and comments are removed from document						
30.	Annex referencing in text matches correct Annex letters						
31.	Auto numbering for tables and figures sometimes inserts hard return, check all table citations and fix						
32.	Heading formats are used appropriately						
33.	All gases, such as CO_2 and N_2O use the letter "O" rather than the number "0"						
34.	All occurrences of "percent" are spelled out, not % (except in tables)						
35.	All numbers that should be subscripted are subscripted (e.g., CO_2, SF_6, CH_4, N_2O, etc.)						
36.	No comma in citations						

Detailed Checklist for Inventory Document							
Item		Check Completed			Corrective Action		Supporting documents (provide reference)
		Date	Individual (first initial, last name)	Errors (Y/N)	Date	Individual (first initial, last name)	
37.	Notes under tables should be in smaller font than text of document						
38.	Number of decimal points used in the text is consistent						
39.	Section breaks: (1) Each section starts on right-hand (i.e., "odd") side (2) All sections in landscape move to and from landscape properly						
40.	Size, style, and indenting of bullets are consistent						
41.	Spaces–two after a period, one everywhere else						
42.	Spelling check is complete						
43.	Table/figure/box numbering and referencing in text is correct						
OTHER ISSUES							
44.	All numbers in text match tables						
45.	Each section is updated with current year						
46.	In discussion of "Recent Trends in Greenhouse Gas Emissions," all years and explanations are updated						
47.	Other (specify)						
48.	Other (specify)						
49.	Other (specify)						
50.	Other (specify)						

Annex 6-2.4: Inventory Document Checklist - Page Maker Document

National Inventory Report: 1990-2005 Stage of Document: ____________________

Circle all categories of checks conducted: Front Section, Tables & Figures, Equations, References, General Editing, Editing for Content

INSTRUCTIONS FOR COMPLETING THIS FORM:

This form is to be completed each inventory cycle, and provides a record of the checks performed and any corrective actions taken. The form may be completed by hand or electronically. The checklist below should be completed as a record of the checks conducted. If appropriate actions to correct any errors that are found are not immediately apparent, the QC staff performing the check should discuss the results with the National Inventory Team Leader and the QA Expert. Once completed, the form should be filed in the project file, with copies to the National Inventory Team Leader.

The first page of this form summarizes the results of the checks (once completed) and highlights any significant findings or actions. The remaining pages in this form list categories of checks to be performed. The expert has discretion over how the checks are implemented. Rows for additional checks that are relevant should be added to the form.

The column for supporting documentation should be used to reference any relevant *Supplemental Reports* (Form 6-2.5) or *Contact Reports* (Form 6-2.4) providing additional information.

Summary of Inventory Document Check: Page Maker Document	
Summary of results of checks and corrective actions taken:	
Suggested checks to be performed in the future:	Any residual problems after corrective actions are taken:

Detailed Checklist for Inventory Document							
Item		Check Completed			Corrective Action		Supporting documents (provide reference)
		Date	Individual (first initial, last name)	Errors (Y/N)	Date	Individual (first initial, last name)	
FRONT SECTION							
1.	Cover page has correct date, title, and contact address						
2.	Cover has the logo of the MENR						
3.	Correct footer on every section (correct Inventory title and page number)						
4.	Table of contents/tables/figures etc. is accurate						
TABLES AND FIGURES							
5.	Check alignment in columns and tables						
6.	Check all symbols in tables ("+")						
7.	Check bold in tables						
8.	All line widths are consistent in tables						
9.	All column widths are consistent in tables						
10.	Table formatting is consistent						
11.	All figures have been inserted into text and are accurate (correct proportions, etc.)						
EQUATIONS-SHOULD ALL HAVE THE FOLLOWING TRAITS							
12.	Equation as follows: $z = x + y$						
13.	Equation centered						
GENERAL FORMAT							
14.	All dashes are the same–use insert symbol.						
15.	All fonts are consistent						
16.	All headers/titles are consistent						
17.	All numbers that should be subscripted are (CO_2, SF_6, CH_4, N_2O, etc.)						
18	Notes under tables should be in smaller font than text of document						
19.	All sections in Landscape go to and from landscape properly						
20.	Size and style of bullets is consistent						
21.	Spaces–two after a period, one everywhere else						
22.	No widows/orphans in document						
23.	Fractions are formatted correctly						
OTHER ISSUES							
24.	Bookmarks are correct and function properly						
25.	The entire document has been scanned for any erroneous looking items or data that may have been altered during the software transition						

Annex 6-2.5: Contact Report

This form is to be used to record personal communications, including telephone conversations or meetings. It can also be used, as necessary, as a cover sheet for facsimile or e-mail communications.

Date: ________________________ Originator ____

Contact by: Telephone _____________ Meeting _____________ Other (specify) _________________

Contact Name:
Title and Organization:
Phone number:
Fax number:
Address:
E-mail address:

Purpose and/or Subject of contact:

Attendees or participants in meeting/telephone conversation (name, affiliation):

Summary of meeting:

Recommended Follow-up Actions:

Annex 6-2.6: Supplemental Report

This form is to be used as needed to provide additional documentation or explanation of QA/QC activities, and to supplement other checklists and forms that are completed. Among other uses, it can record information gathered from sources other than a personal communication (e.g., internet sites or published sources), describe in detail the results of an investigation, or be a cover page for other supporting documentation (such as a source category specific QA/QC and Uncertainty Management Plan).

Date:	Source Category:
Subject:	
If part of another report, provide the report name and purpose of supplemental report:	
If not part of another report, provide purpose:	
Sheet # __ of ______	Name, affiliation:

Discussion:

Annex 7. Uncertainty

Annex 7-1: Overall Inventory Uncertainty for 2005

	IPCC source categories	Pollutant	Base year emissions (1990)	Year t emissions (2005)	Activity data uncertainty	Emission factor uncertainty	Combined uncertainty	Combined uncertainty as % of total sectoral emissions in the year t (2005)	Type A sensitivity	Type B sensitivity	Uncertainty introduced in trend in sectoral emissions introduced by emission factor uncertainty	Uncertainty introduced in trend in sectoral emissions introduced by activity data uncertainty	Uncertainty introduced in trend in sectoral emissions
			Gg CO_2 eq		%								
1.A.1	Energy Industries	CO_2	19332.7655	2986.5715	7	5	8.6023	2.4462	-0.0469	0.0725	-0.2343	0.7174	0.7547
1.A.1	Energy Industries	CH_4	9.2887	1.2256	7	50	50.4876	0.0059	0.0000	0.0000	-0.0014	0.0003	0.0014
1.A.1	Energy Industries	N_2O	51.2316	1.9774	7	50	50.4876	0.0095	-0.0003	0.0000	-0.0134	0.0005	0.0134
1.A.2	Manufacturing Industries and Construction	CO_2	2188.7285	396.3804	5	5	7.0711	0.2669	-0.0039	0.0096	-0.0196	0.0680	0.0708
1.A.2	Manufacturing Industries and Construction	CH_4	2.0005	0.2149	5	50	50.2494	0.0010	0.0000	0.0000	-0.0004	0.0000	0.0004
1.A.2	Manufacturing Industries and Construction	N_2O	5.1641	0.3989	5	50	50.2494	0.0019	0.0000	0.0000	-0.0011	0.0001	0.0011
1.A.3b	Transport: Road Transportation	CO_2	3364.2178	1459.4096	10	5	11.1803	1.5536	0.0146	0.0354	0.0730	0.5008	0.5061
1.A.3b	Transport: Road Transportation	CH_4	24.4646	7.3663	10	50	50.9902	0.0358	0.0000	0.0002	0.0014	0.0025	0.0029
1.A.3b	Transport: Road Transportation	N_2O	49.6041	22.2825	10	50	50.9902	0.1082	0.0002	0.0005	0.0117	0.0076	0.0140
1A3c	Transport: Railways	CO_2	452.3598	115.1175	5	5	7.0711	0.0775	0.0000	0.0028	0.0000	0.0198	0.0198
1A3c	Transport: Railways	CH_4	0.5323	0.1355	5	50	50.2494	0.0006	0.0000	0.0000	0.0000	0.0000	0.0000
1A3c	Transport: Railways	N_2O	54.1488	13.7799	5	50	50.2494	0.0659	0.0000	0.0003	0.0000	0.0024	0.0024
1A3d	Transport: Navigation	CO_2	18.9048	0.3308	10	5	11.1803	0.0004	-0.0001	0.0000	-0.0005	0.0001	0.0006
1A3d	Transport: Navigation	CH_4	0.0375	0.0007	10	50	50.9902	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1A3d	Transport: Navigation	N_2O	0.1582	0.0028	10	50	50.9902	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1A3e	Transport: Other (Pipeline Transport)	CO_2	91.1782	36.0914	5	5	7.0711	0.0243	0.0003	0.0009	0.0016	0.0062	0.0064
1.A.4a	Other Sectors: Commercial / Institutional	CO_2	1412.4933	361.5198	5	5	7.0711	0.2434	0.0000	0.0088	0.0002	0.0620	0.0620
1.A.4a	Other Sectors: Commercial / Institutional	CH_4	5.2253	2.3681	5	50	50.2494	0.0113	0.0000	0.0001	0.0013	0.0004	0.0013
1.A.4a	Other Sectors: Commercial / Institutional	N_2O	6.3499	1.4277	5	50	50.2494	0.0068	0.0000	0.0000	-0.0002	0.0002	0.0003
1.A.4b	Other Sectors: Residential	CO_2	4407.6336	1327.4402	10	5	11.1803	1.4131	0.0050	0.0322	0.0248	0.4555	0.4562
1.A.4b	Other Sectors: Residential	CH_4	230.2856	29.3264	10	50	50.9902	0.1424	-0.0007	0.0007	-0.0356	0.0101	0.0370
1.A.4b	Other Sectors: Residential	N_2O	19.4047	4.6454	10	50	50.9902	0.0226	0.0000	0.0001	-0.0004	0.0016	0.0016
1.A.4c	Other Sectors: Agriculture/Forestry/Fishing	CO_2	1942.3629	183.3484	5	5	7.0711	0.1234	-0.0076	0.0044	-0.0378	0.0315	0.0492
1.A.4c	Other Sectors: Agriculture/Forestry/Fishing	CH_4	8.9856	0.5714	5	50	50.2494	0.0027	0.0000	0.0000	-0.0021	0.0001	0.0021
1.A.4c	Other Sectors: Agriculture/Forestry/Fishing	N_2O	5.0378	0.4607	5	50	50.2494	0.0022	0.0000	0.0000	-0.0010	0.0001	0.0010
1.A.5	Other (Other Works and Needs in Energy)	CO_2	154.2715	118.0475	5	5	7.0711	0.0795	0.0019	0.0029	0.0096	0.0203	0.0224
1.A.5	Other (Other Works and Needs in Energy)	CH_4	0.1350	0.1295	5	50	50.2494	0.0006	0.0000	0.0000	0.0001	0.0000	0.0001

1.A.5	Other (Other Works and Needs in Energy)	N_2O	0.4911	0.3426	5	50	50.2494	0.0016	0.0000	0.0000	0.0003	0.0001	0.0003
1.B.2	Fugitive Emissions From Oil and Natural Gas	CO_2	0.6377	1.8809	5	200	200.0625	0.0358	0.0000	0.0000	0.0083	0.0003	0.0083
1.B.2	Fugitive Emissions From Oil and Natural Gas	CH_4	682.2942	652.0090	5	200	200.0625	12.4203	0.0116	0.0158	2.3200	0.1119	2.3226
1.B.2	Fugitive Emissions From Oil and Natural Gas	N_2O	0.0002	0.0052	5	200	200.0625	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000
2.A.1	Cement Production	CO_2	988.2518	373.2628	10	2	10.1980	0.3624	0.0029	0.0091	0.0059	0.1281	0.1282
2.A.2	Lime Production	CO_2	149.2228	6.6467	15	2	15.1327	0.0096	-0.0008	0.0002	-0.0015	0.0034	0.0037
2.A.6	Road Paving with Asphalt	CO_2	0.1874	0.0100	50	100	111.8034	0.0001	0.0000	0.0000	-0.0001	0.0000	0.0001
2.A.6	Road Paving with Asphalt	CH_4	0.1281	0.0068	50	200	206.1553	0.0001	0.0000	0.0000	-0.0001	0.0000	0.0001
2.A.7	Other: Glass Production	CO_2	59.4234	20.8035	20	50	53.8516	0.1067	0.0001	0.0005	0.0069	0.0143	0.0158
2.A.7	Other: Mineral Wool Production	CO_2	8.0816	0.0000	20	30	36.0555	0.0000	0.0000	0.0000	-0.0015	0.0000	0.0015
2.A.7	Other: Bricks Production	CO_2	52.6166	16.1150	20	5	20.6155	0.0316	0.0001	0.0004	0.0003	0.0111	0.0111
2.C.1	Steel Production	CO_2	56.7016	83.8512	5	25	25.4951	0.2036	0.0017	0.0020	0.0421	0.0144	0.0445
2.C.1	Steel Production	CH_4	13.3958	19.8098	5	150	150.0833	0.2831	0.0004	0.0005	0.0597	0.0034	0.0598
2.C.1	Steel Production	N_2O	1.0986	1.6246	5	300	300.0417	0.0464	0.0000	0.0000	0.0098	0.0003	0.0098
2.D.2	Food and Drink	CO_2	19.6395	40.7669	10	20	22.3607	0.0868	0.0009	0.0010	0.0174	0.0140	0.0223
2.F.1	Refrigeration and Air Conditioning Equipment	HFC	0.0000	18.7185	50	50	70.7107	0.1260	0.0005	0.0005	0.0227	0.0321	0.0393
2.F.4	Aerosols	HFC	0.0000	0.0004	10	50	50.9902	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2.F.8	Electrical Equipment	SF_6	0.0000	0.2839	10	50	50.9902	0.0014	0.0000	0.0000	0.0003	0.0001	0.0004
3.A.1	Application of Conventional Solvent Paint	CO_2	29.4837	17.4044	20	50	53.8516	0.0892	0.0002	0.0004	0.0120	0.0119	0.0169
3.A.2	Application of Water-Borne Paint	CO_2	0.7013	0.5767	20	200	200.9975	0.0110	0.0000	0.0000	0.0019	0.0004	0.0020
3.B	Degreasing and Dry Cleaning	CO_2	1.9978	1.2401	10	30	31.6228	0.0037	0.0000	0.0000	0.0005	0.0004	0.0007
3.C	Chemical Products, Manufacture and Processing	CO_2	0.5470	0.2931	10	50	50.9902	0.0014	0.0000	0.0000	0.0002	0.0001	0.0002
3.D.1	Other: Adhesive Use	CO_2	5.8905	3.9807	20	100	101.9804	0.0387	0.0001	0.0001	0.0060	0.0027	0.0066
3.D.2	Other: Graphic Arts (Inks)	CO_2	0.5408	0.3428	20	100	101.9804	0.0033	0.0000	0.0000	0.0005	0.0002	0.0006
3.D.3	Other: Seed Oil Extraction and Seed Drying	CO_2	1.9745	1.8791	20	100	101.9804	0.0182	0.0000	0.0000	0.0033	0.0013	0.0036
3.D.4	Other: Household Products	CO_2	24.4686	23.2664	10	200	200.2498	0.4436	0.0004	0.0006	0.0826	0.0080	0.0830
3.D.5	Other: Use of N_2O in Anaesthesia	N_2O	0.0205	0.0189	10	10	14.1421	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
4.A.1	Enteric Fermentation: Cattle	CH_4	1630.8944	598.4914	10	20	22.361	1.2742	0.0044	0.0145	0.0887	0.2054	0.2237
4.A.3	Enteric Fermentation: Sheep	CH_4	166.7501	116.8926	10	20	22.361	0.2489	0.0018	0.0028	0.0361	0.0401	0.0540
4.A.4	Enteric Fermentation: Goats	CH_4	4.4486	16.6848	10	20	22.361	0.0355	0.0004	0.0004	0.0075	0.0057	0.0095
4.A.6	Enteric Fermentation: Horses	CH_4	17.5014	28.8414	10	30	31.623	0.0868	0.0006	0.0007	0.0177	0.0099	0.0203
4.A.7	Enteric Fermentation: Asses	CH_4	0.4200	0.4200	20	30	36.056	0.0014	0.0000	0.0000	0.0002	0.0003	0.0004
4.A.8	Enteric Fermentation: Swine	CH_4	64.4175	13.3025	10	30	31.623	0.0401	-0.0001	0.0003	-0.0023	0.0046	0.0051
4.A.9	Enteric Fermentation: Poultry	CH_4	0.0000	0.0000	20	30	36.056	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
4.A.10	Enteric Fermentation: Rabbits	CH_4	18.9736	18.2266	20	30	36.056	0.0626	0.0003	0.0004	0.0097	0.0125	0.0159
4.B.1	Manure Management: Cattle	CH_4	191.0580	31.0258	10	30	31.623	0.0934	-0.0004	0.0008	-0.0129	0.0106	0.0167
4.B.3	Manure management : Sheep	CH_4	5.2109	3.3448	10	50	50.990	0.0162	0.0000	0.0001	0.0024	0.0011	0.0027

4.B.4	Manure Management: Goats	CH_4	0.0874	0.3311	10	50	50.990	0.0016	0.0000	0.0000	0.0004	0.0001	0.0004
4.B.6	Manure Management: Horses	CH_4	1.5168	2.4996	10	50	50.990	0.0121	0.0001	0.0001	0.0026	0.0009	0.0027
4.B.7	Manure Management: Asses	CH_4	0.0319	0.0319	20	50	53.852	0.0002	0.0000	0.0000	0.0000	0.0000	0.0000
4.B.8	Manure Management: Swine	CH_4	170.9211	19.2442	10	30	31.623	0.0579	-0.0006	0.0005	-0.0177	0.0066	0.0189
4.B.9	Manure Management: Poultry	CH_4	16.2771	11.6885	20	50	53.852	0.0599	0.0002	0.0003	0.0091	0.0080	0.0122
4.B.10	Manure Management: Rabbits	CH_4	2.5089	2.4101	20	50	53.852	0.0124	0.0000	0.0001	0.0021	0.0017	0.0027
4.B.11a	Manure Management: Cattle	N_2O direct	467.1252	168.7875	10	50	50.990	0.8195	0.0012	0.0041	0.0603	0.0579	0.0836
4.B.11b	Manure Management: Sheep	N_2O direct	107.6465	69.0965	10	50	50.990	0.3355	0.0010	0.0017	0.0505	0.0237	0.0558
4.B.11c	Manure Management: Goats	N_2O direct	3.0678	11.6290	10	75	75.664	0.0838	0.0003	0.0003	0.0197	0.0040	0.0201
4.B.11d	Manure Management: Horses	N_2O direct	16.8890	27.8321	10	75	75.664	0.2005	0.0006	0.0007	0.0428	0.0096	0.0439
4.B.11e	Manure Management: Asses	N_2O direct	0.2490	0.2490	20	75	77.621	0.0018	0.0000	0.0000	0.0003	0.0002	0.0004
4.B.11f	Manure Management: Swine	N_2O direct	307.1506	71.5496	10	50	50.990	0.3474	-0.0002	0.0017	-0.0082	0.0246	0.0259
4.B.11g	Manure Management: Poultry	N_2O direct	142.5865	101.1546	20	50	53.852	0.5187	0.0016	0.0025	0.0786	0.0694	0.1049
4.B.11h	Manure Management: Rabbits	N_2O direct	19.6425	18.8691	20	75	77.621	0.1395	0.0003	0.0005	0.0252	0.0129	0.0284
4.B.12a	Manure Management: Cattle	N_2O indi-rect	105.8732	32.3370	10	100	100.499	0.3094	0.0001	0.0008	0.0130	0.0111	0.0171
4.B.12b	Manure Management: Sheep	N_2O indi-rect	17.4926	11.2282	10	100	100.499	0.1074	0.0002	0.0003	0.0164	0.0039	0.0169
4.B.12c	Manure Management: Goats	N_2O indi-rect	0.4985	1.8897	10	150	150.333	0.0270	0.0000	0.0000	0.0064	0.0006	0.0064
4.B.12d	Manure Management: Horses	N_2O indi-rect	2.7445	4.5227	10	150	150.333	0.0647	0.0001	0.0001	0.0139	0.0016	0.0140
4.B.12e	Manure Management: Asses	N_2O indi-rect	0.0405	0.0405	20	150	151.327	0.0006	0.0000	0.0000	0.0001	0.0000	0.0001
4.B.12f	Manure Management: Swine	N_2O indi-rect	83.8484	17.0849	10	100	100.499	0.1635	-0.0001	0.0004	-0.0104	0.0059	0.0119
4.B.12g	Manure Management: Poultry	N_2O indi-rect	36.2794	25.7707	20	100	101.980	0.2502	0.0004	0.0006	0.0401	0.0177	0.0438
4.B.12h	Manure Management: Rabbits	N_2O indi-rect	3.1919	3.0662	20	150	151.327	0.0442	0.0001	0.0001	0.0082	0.0021	0.0085
4.D.1a	Applied Synthetic Nitro-gen Fertiliser	N_2O direct	427.7114	78.4397	10	6	11.662	0.0871	-0.0007	0.0019	-0.0044	0.0269	0.0273
4.D.1b	Applied Organic Nitro-gen Fertiliser	N_2O direct	264.6160	1.2058	50	6	50.359	0.0058	-0.0016	0.0000	-0.0096	0.0021	0.0099
4.D.1c	Urine and Dung Inputs to Grazed Soils	N_2O direct	116.7439	89.0786	50	50	70.711	0.5997	0.0014	0.0022	0.0720	0.1528	0.1689
4.D.1d	Nitrogen in Crop Residues	N_2O direct	257.9462	124.5529	10	50	50.990	0.6047	0.0014	0.0030	0.0714	0.0427	0.0832
4.D.1e	Nitrogen Mineralization Associated with Loss of Soil Carbon	N_2O direct	252.4061	266.9076	10	20	22.361	0.5683	0.0049	0.0065	0.0983	0.0916	0.1344
4.D.2a	Atmospheric Deposition of Nitrogen Volatilized from Managed Soils	N_2O indi-rect	111.1544	19.8399	70	200	211.896	0.4003	-0.0002	0.0005	-0.0412	0.0477	0.0630
4.D.2b	Nitrogen Leaching and Runoff	N_2O indi-rect	287.9955	119.2229	75	200	213.600	2.4248	0.0011	0.0029	0.2224	0.3068	0.3790

5.A.1	Forest Land Remaining Forest Land: Annual Change in Carbon Stocks in Biomass	CO_2	-2197.579	-2246.233	25	5	25.4951	41.4675	0.2549	1.3428	1.2743	47.4759	47.4930
5.A.1	Forest Land Remaining Forest Land: Vegetation Fires	CH_4	0.2347	0.0164	10	30	31.6228	-0.0004	0.0001	0.0000	0.0032	-0.0001	0.0032
5.A.1	Forest Land Remaining Forest Land: Vegetation Fires	N_2O	0.1917	0.0134	10	50	50.9902	-0.0005	0.0001	0.0000	0.0043	-0.0001	0.0043
5.B.1	Cropland Remain-ing Cropland: Annual Changes in Carbon Stocks in Living Biomass	CO_2	-725.2315	-465.3288	25	10	26.9258	9.0725	-0.0794	0.2782	-0.7941	9.8351	9.8671
5.B.1	Cropland Remain-ing Cropland: Annual Changes of Carbon Stocks in Mineral Soils	CO_2	2032.8194	2149.6103	10	20	22.3607	-34.8049	-0.2852	-1.2851	-5.7046	-18.1735	19.0478
5.B.1	Cropland Remaining Cropland: Post Harvest Field Burning of Agricul-tural Residues	CH_4	2.3077	0.2445	50	30	58.3095	-0.0103	0.0010	-0.0001	0.0298	-0.0103	0.0315
5.B.1	Cropland Remaining Cropland: Post Harvest Field Burning of Agricul-tural Residues	N_2O	0.9850	0.1007	50	50	70.7107	-0.0052	0.0004	-0.0001	0.0213	-0.0043	0.0217
5.C.1	Grassland Remaining Grassland	CO_2	-780.1200	-821.7000	30	10	31.6228	18.8152	0.1057	0.4912	1.0570	20.8407	20.8675
5.C.2	Land Converted to Grassland	CO_2	-6.3800	2.2440	30	5	30.4138	-0.0494	-0.0045	-0.0013	-0.0225	-0.0569	0.0612
6.A.1	Managed Waste Disposal on Land	CH_4	362.3109	415.7349	20	20	28.2843	1.1196	0.0078	0.0101	0.1569	0.2853	0.3256
6.A.2	Unmanaged Waste Disposal Sites	CH_4	548.6334	335.0256	50	20	53.8516	1.7179	0.0047	0.0081	0.0947	0.5748	0.5826
6.A.3	Other: Industrial Waste	CH_4	410.1825	435.4455	100	20	101.9804	4.2283	0.0080	0.0106	0.1606	1.4942	1.5028
6.B	Wastewater Handling	CH_4	177.1625	121.0136	20	30	36.0555	0.4154	0.0018	0.0029	0.0552	0.0831	0.0997
6.B	Wastewater Handling: Human Sewage	N_2O	129.0471	92.7377	20	30	36.0555	0.3184	0.0015	0.0023	0.0436	0.0636	0.0771
	TOTAL		**41212.8206**	**10502.3956**				**16.0060**					**3.9123**

Annex 7-2: Summary of Greenhouse Gases Uncertainties

Annex 7-2.1: Carbon Dioxide Uncertainties

	IPCC source categories	Pollutant	Base year emissions (1990)	Year t emissions (2005)	Activity data uncertainty	Emission factor uncertainty	Combined uncertainty	Combined uncertainty as % of total sectoral emissions in the year t (2005)	Type A sensitivity	Type B sensitivity	Uncertainty introduced in trend in sectoral emissions introduced by emission factor uncertainty	Uncertainty introduced in trend in sectoral emissions introduced by activity data uncertainty	Uncertainty introduced in trend in sectoral emissions
			Gg CO2 eq		%								
1.A.1	Energy Industries	CO_2	19332.7655	2986.5715	7	5	8.6023	4.1470	-0.0190	0.0903	-0.0951	0.8935	0.8986
1.A.2	Manufacturing Industries and Construction	CO_2	2188.7285	396.3804	5	5	7.0711	0.4524	-0.0004	0.0120	-0.0020	0.0847	0.0847
1.A.3b	Transport: Road Trans-portation	CO_2	3364.2178	1459.4096	10	5	11.1803	2.6338	0.0250	0.0441	0.1252	0.6238	0.6362
1A3c	Transport: Railways	CO_2	452.3598	115.1175	5	5	7.0711	0.1314	0.0009	0.0035	0.0046	0.0246	0.0250
1A3d	Transport: Navigation	CO_2	18.9048	0.3308	10	5	11.1803	0.0006	-0.0001	0.0000	-0.0005	0.0001	0.0005

1A3e	Transport: Other (Pipeline Transport)	CO_2	91.1782	36.0914	5	5	7.0711	0.0412	0.0006	0.0011	0.0029	0.0077	0.0082
1.A.4a	Other Sectors: Commercial/Institutional	CO_2	1412.4933	361.5198	5	5	7.0711	0.4126	0.0029	0.0109	0.0147	0.0773	0.0786
1.A.4b	Other Sectors: Residential	CO_2	4407.6336	1327.4402	10	5	11.1803	2.3956	0.0152	0.0401	0.0758	0.5673	0.5724
1.A.4c	Other Sectors: Agricultural/Forestry/Fishing	CO_2	1942.3629	183.3484	5	5	7.0711	0.2093	-0.0054	0.0055	-0.0272	0.0392	0.0477
1.A.5	Other: Other Works and Needs in Energy	CO_2	154.2715	118.0475	5	5	7.0711	0.1347	0.0027	0.0036	0.0135	0.0252	0.0286
1.B.2	Fugitive Emissions from Operations with Oil and Natural Gases	CO_2	0.6377	1.8809	5	200	200.0625	0.0607	0.0001	0.0001	0.0106	0.0004	0.0107
2.A.1	Cement Production	CO_2	988.2518	373.2628	10	2	10.1980	0.6144	0.0057	0.0113	0.0114	0.1595	0.1599
2.A.2	Lime Production	CO_2	149.2228	6.6467	15	2	15.1327	0.0162	-0.0006	0.0002	-0.0013	0.0043	0.0045
2.A.6	Road Paving with Asphalt	CO_2	0.1874	0.0100	50	100	111.8034	0.0002	0.0000	0.0000	-0.0001	0.0000	0.0001
2.A.7	Other: Glass Production	CO_2	59.4234	20.8035	20	50	53.8516	0.1808	0.0003	0.0006	0.0146	0.0178	0.0230
2.A.7	Other: Mineral Wool Production	CO_2	8.0816	0.0000	20	30	36.0555	0.0000	0.0000	0.0000	-0.0014	0.0000	0.0014
2.A.7	Other: Bricks Production	CO_2	52.6166	16.1150	20	5	20.6155	0.0536	0.0002	0.0005	0.0009	0.0138	0.0138
2.C.1	Steel Production	CO_2	56.7016	83.8512	5	25	25.4951	0.3451	0.0022	0.0025	0.0553	0.0179	0.0582
2.D.2	Food and Drink	CO_2	19.6395	40.7669	10	20	22.3607	0.1471	0.0011	0.0012	0.0224	0.0174	0.0284
3.A.1	Application of Conventional Solvent Paint	CO_2	29.4837	17.4044	20	50	53.8516	0.1513	0.0004	0.0005	0.0180	0.0149	0.0233
3.A.2	Application of Water-Borne Paint	CO_2	0.7013	0.5767	20	200	200.9975	0.0187	0.0000	0.0000	0.0027	0.0005	0.0027
3.B	Degreasing and Dry Cleaning	CO_2	1.9978	1.2401	10	30	31.6228	0.0063	0.0000	0.0000	0.0008	0.0005	0.0009
3.C	Chemical Products, Manufacture and Processing	CO_2	0.5470	0.2931	10	50	50.9902	0.0024	0.0000	0.0000	0.0003	0.0001	0.0003
3.D.1	Other: Adhesive Use	CO_2	5.8905	3.9807	20	100	101.9804	0.0655	0.0001	0.0001	0.0087	0.0034	0.0093
3.D.2	Other: Graphic Arts (Inks)	CO_2	0.5408	0.3428	20	100	101.9804	0.0056	0.0000	0.0000	0.0007	0.0003	0.0008
3.D.3	Other: Seed Oil Extraction and Seed Drying	CO_2	1.9745	1.8791	20	100	101.9804	0.0309	0.0000	0.0001	0.0046	0.0016	0.0048
3.D.4	Other: Household Products	CO_2	24.4686	23.2664	10	200	200.2498	0.7521	0.0006	0.0007	0.1129	0.0099	0.1134
5.A.1	Forest Land Remaining Forest Land: Annual Change in Carbon Stocks in Biomass	CO_2	-2197.5790	-2246.2332	25	5	25.4951	-9.2440	-0.0555	-0.0679	-0.2774	-2.4001	2.4161
5.B.1	Cropland Remaining Cropland: Annual Changes in Carbon Stocks in Living Biomass	CO_2	-725.2315	-465.3288	25	10	26.9258	-2.0224	-0.0100	-0.0141	-0.0996	-0.4972	0.5071
5.B.1	Cropland Remaining Cropland: Annual Changes of Carbon Stocks in Mineral Soils	CO_2	2032.8194	2149.6103	10	20	22.3607	7.7587	0.0534	0.0650	1.0686	0.9187	1.4092
5.C.1	Grassland Remaining Grassland	CO_2	-780.1200	-821.7000	30	10	31.6228	-4.1943	-0.0204	-0.0248	-0.2042	-1.0536	1.0732
5.C.2	Land Converted to Grassland	CO_2	-6.3800	2.2440	30	5	30.4138	0.0110	0.0001	0.0001	0.0005	0.0029	0.0029
	TOTAL		**33088.7913**	**6195.1698**				**14.1001**					**3.2914**

Annex 7-2.2: Methane Uncertainties

	IPCC source categories	Pollutant	Base year emissions (1990)	Year t emissions (2005)	Activity data uncertainty	Emission factor uncertainty	Combined uncertainty	Combined uncertainty as % of total sectoral emissions in the year t (2005)	Type A sensitivity	Type B sensitivity	Uncertainty introduced in trend in sectoral emissions introdu ced by emission factor uncertainty	Uncertainty introduced in trend in sectoral emissions introduced by activity data uncertainty	Uncertainty introduced in trend in sectoral emissions
			Gg CO2 eq		%								
1.A.1	Energy Industries	CH_4	9.2887	1.2256	7	50	50.4876	0.0215	-0.0009	0.0003	-0.0461	0.0025	0.0461
1.A.2	Manufacturing Industries and Constructions	CH_4	2.0005	0.2149	5	50	50.2494	0.0037	-0.0002	0.0000	-0.0104	0.0003	0.0104
1.A.3b	Transport: Road Transportation	CH_4	24.4646	7.3663	10	50	50.9902	0.1302	-0.0016	0.0015	-0.0779	0.0218	0.0809
1A3c	Transport: Railways	CH_4	0.5323	0.1355	5	50	50.2494	0.0024	0.0000	0.0000	-0.0020	0.0002	0.0020
1A3d	Transport: Navigation	CH_4	0.0375	0.0007	10	50	50.9902	0.0000	0.0000	0.0000	-0.0002	0.0000	0.0002
1.A.4a	Other Sectors: Commercial / Institutional	CH_4	5.2253	2.3681	5	50	50.2494	0.0413	-0.0002	0.0005	-0.0083	0.0035	0.0090
1.A.4b	Other Sectors: Residential	CH_4	230.2856	29.3264	10	50	50.9902	0.5185	-0.0230	0.0062	-1.1524	0.0870	1.1557
1.A.4c	Other Sectors: Agriculture/Forestry/Fishing	CH_4	8.9856	0.5714	5	50	50.2494	0.0100	-0.0010	0.0001	-0.0510	0.0008	0.0510
1.A.5	Other (Other Works and Needs in Energy)	CH_4	0.1350	0.1295	5	50	50.2494	0.0023	0.0000	0.0000	0.0005	0.0002	0.0005
1.B.2	Fugitive Emissions from Operations with Oil and Natural Gases	CH_4	682.2942	652.0090	5	200	200.0625	45.2287	0.0501	0.1367	10.0241	0.9669	10.0707
2.A.6	Road Paving with Asphalt	CH_4	0.1281	0.0068	50	200	206.1553	0.0005	0.0000	0.0000	-0.0030	0.0001	0.0030
2.C.1	Steel Production	CH_4	13.3958	19.8098	5	150	150.0833	1.0309	0.0025	0.0042	0.3683	0.0294	0.3695
4.A.1	Enteric Fermentation: Cattle	CH_4	1630.8944	598.4914	10	20	22.361	4.6402	-0.0811	0.1255	-1.6215	1.7750	2.4042
4.A.3	Enteric Fermentation: Sheep	CH_4	166.7501	116.8926	10	20	22.361	0.9063	0.0034	0.0245	0.0672	0.3467	0.3531
4.A.4	Enteric Fermentation: Goats	CH_4	4.4486	16.6848	10	20	22.361	0.1294	0.0029	0.0035	0.0587	0.0495	0.0768
4.A.6	Enteric Fermentation: Horses	CH_4	17.5014	28.8414	10	30	31.623	0.3162	0.0038	0.0060	0.1149	0.0855	0.1432
4.A.7	Enteric Fermentation: Asses	CH_4	0.4200	0.4200	20	30	36.056	0.0053	0.0000	0.0001	0.0010	0.0025	0.0027
4.A.8	Enteric Fermentation: Swine	CH_4	64.4175	13.3025	10	30	31.623	0.1459	-0.0054	0.0028	-0.1614	0.0395	0.1662
4.A.9	Enteric Fermentation: Poultry	CH_4	0.0000	0.0000	20	30	36.056	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
4.A.10	Enteric Fermentation: Rabbits	CH_4	18.9736	18.2266	20	30	36.056	0.2279	0.0014	0.0038	0.0425	0.1081	0.1162
4.B.1	Manure Management: Cattle	CH_4	191.0580	31.0258	10	30	31.623	0.3402	-0.0177	0.0065	-0.5316	0.0920	0.5395
4.B.3	Manure management : Sheep	CH_4	5.2109	3.3448	10	50	50.990	0.0591	0.0000	0.0007	0.0020	0.0099	0.0101
4.B.4	Manure Management: Goats	CH_4	0.0874	0.3311	10	50	50.990	0.0059	0.0001	0.0001	0.0029	0.0010	0.0031
4.B.6	Manure Management: Horses	CH_4	1.5168	2.4996	10	50	50.990	0.0442	0.0003	0.0005	0.0166	0.0074	0.0182
4.B.7	Manure Management: Asses	CH_4	0.0319	0.0319	20	50	53.852	0.0006	0.0000	0.0000	0.0001	0.0002	0.0002
4.B.8	Manure Management: Swine	CH_4	170.9211	19.2442	10	30	31.623	0.2110	-0.0176	0.0040	-0.5291	0.0571	0.5322
4.B.9	Manure Management: Poultry	CH_4	16.2771	11.6885	20	50	53.852	0.2182	0.0004	0.0025	0.0193	0.0693	0.0720

4.B.10	Manure Management: Rabbits	CH_4	2.5089	2.4101	20	50	53.852	0.0450	0.0002	0.0005	0.0094	0.0143	0.0171
5.A.1	Forest Land Remaining Forest Land: Vegetation Fires	CH_4	0.2347	0.0164	10	30	31.6228	0.0002	0.0000	0.0000	-0.0008	0.0000	0.0008
5.B.1	Cropland Remaining Cropland: Post Harvest Field Burning of Agricultural Residues	CH_4	2.0730	0.2281	50	30	58.3095	0.0046	-0.0002	0.0000	-0.0065	0.0034	0.0073
6.A.1	Managed Waste Disposal on Land	CH_4	362.3109	415.7349	20	20	28.2843	4.0772	0.0412	0.0872	0.8240	2.4660	2.6000
6.A.2	Unmanaged Waste Disposal Sites	CH_4	548.6334	335.0256	50	20	53.8516	6.2556	0.0007	0.0703	0.0134	4.9681	4.9681
6.A.3	Other: Industrial Waste	CH_4	410.1825	435.4455	100	20	101.9804	15.3973	0.0393	0.0913	0.7851	12.9145	12.9383
6.B.2	Wastewater Handling	CH_4	177.1625	121.0136	20	30	36.0555	1.5129	0.0029	0.0254	0.0872	0.7178	0.7231
	TOTAL		**4768.3880**	**2884.0632**				**48.6299**					**17.5733**

Annex 7-2.3: Nitrous Oxide Uncertainties

	IPCC source categories	Pollutant	Base year emissions (1990)	Year t emissions (2005)	Activity data uncertainty	Emission factor uncertainty	Combined uncertainty	Combined uncertainty as % of total sectoral emissions in the year t (2005)	Type A sensitivity	Type B sensitivity	Uncertainty introduced in trend in sectoral emissions introduced by emission factor uncertainty	Uncertainty introduced in trend in sectoral emissions introduced by activity data uncertainty	Uncertainty introduced in trend in sectoral emissions
			Gg CO_2 equivalent		%								
1.A.1	Energy Industries	N_2O	51.2316	1.9774	7	50	50.4876	0.0711	-0.0058	0.0006	-0.2899	0.0058	0.2900
1.A.2	Manufacturing Industries and Construction	N_2O	5.1641	0.3989	5	50	50.2494	0.0143	-0.0005	0.0001	-0.0263	0.0008	0.0263
1.A.3b	Transport: Road Transportation	N_2O	49.6041	22.2825	10	50	50.9902	0.8092	0.0005	0.0066	0.0227	0.0939	0.0966
1A3c	Transport: Railways	N_2O	54.1488	13.7799	5	50	50.2494	0.4931	-0.0026	0.0041	-0.1323	0.0290	0.1354
1A3d	Transport: Navigation	N_2O	0.1582	0.0028	10	50	50.9902	0.0001	0.0000	0.0000	-0.0009	0.0000	0.0009
1.A.4a	Other Sectors: Commercial / Institutional	N_2O	6.3499	1.4277	5	50	50.2494	0.0511	-0.0004	0.0004	-0.0183	0.0030	0.0186
1.A.4b	Other Sectors: Residential	N_2O	19.4047	4.6454	10	50	50.9902	0.1687	-0.0010	0.0014	-0.0518	0.0196	0.0553
1.A.4c	Other Sectors: Agriculture/Forestry/Fishing	N_2O	5.0378	0.4607	5	50	50.2494	0.0165	-0.0005	0.0001	-0.0245	0.0010	0.0246
1.A.5	Other (Other Works and Needs in Energy)	N_2O	0.4911	0.3426	5	50	50.2494	0.0123	0.0000	0.0001	0.0020	0.0007	0.0022
1.B.2	Fugitive Emissions from Operations with Oil and Natural Gases	N_2O	0.0002	0.0052	5	200	200.0625	0.0007	0.0000	0.0000	0.0003	0.0000	0.0003
2.C.1	Steel Production	N_2O	1.0986	1.6246	5	300	300.0417	0.3471	0.0003	0.0005	0.1041	0.0034	0.1042
3.D.5	Use of N_2O in Anaesthesia	N_2O	0.0205	0.0189	10	10	14.1421	0.0002	0.0000	0.0000	0.0000	0.0001	0.0001
4.B.11a	Manure Management: Cattle	N_2O direct	467.1252	168.7875	10	50	50.990	6.1293	-0.0079	0.0503	-0.3970	0.7113	0.8146
4.B.11b	Manure Management: Sheep	N_2O direct	107.6465	69.0965	10	50	50.990	2.5091	0.0072	0.0206	0.3583	0.2912	0.4617
4.B.11c	Manure Management: Goats	N_2O direct	3.0678	11.6290	10	75	75.664	0.6266	0.0031	0.0035	0.2312	0.0490	0.2364
4.B.11d	Manure Management: Horses	N_2O direct	16.8890	27.8321	10	75	75.664	1.4997	0.0062	0.0083	0.4641	0.1173	0.4787
4.B.11e	Manure Management: Asses	N_2O direct	0.2490	0.2490	20	75	77.621	0.0138	0.0000	0.0001	0.0032	0.0021	0.0039

4.B.11f	Manure Management: Swine	N_2O direct	307.1506	71.5496	10	50	50.990	2.5982	-0.0170	0.0213	-0.8482	0.3015	0.9002
4.B.11g	Manure Management: Poultry	N_2O direct	142.5865	101.1546	20	50	53.852	3.8794	0.0124	0.0301	0.6179	0.8526	1.0530
4.B.11h	Manure Management: Rabbits	N_2O direct	19.6425	18.8691	20	75	77.621	1.0431	0.0032	0.0056	0.2380	0.1590	0.2863
4.B.12a	Manure Management: Cattle	N_2O indirect	105.8732	32.3370	10	100	100.499	2.3144	-0.0036	0.0096	-0.3565	0.1363	0.3816
4.B.12b	Manure Management: Sheep	N_2O indirect	17.4926	11.2282	10	100	100.499	0.8036	0.0012	0.0033	0.1165	0.0473	0.1257
4.B.12c	Manure Management: Goats	N_2O indirect	0.4985	1.8897	10	150	150.333	0.2023	0.0005	0.0006	0.0751	0.0080	0.0756
4.B.12d	Manure Management: Horses	N_2O indirect	2.7445	4.5227	10	150	150.333	0.4842	0.0010	0.0013	0.1508	0.0191	0.1520
4.B.12e	Manure Management: Asses	N_2O indirect	0.0405	0.0405	20	150	151.327	0.0044	0.0000	0.0000	0.0011	0.0003	0.0011
4.B.12f	Manure Management: Swine	N_2O indirect	83.8484	17.0849	10	100	100.499	1.2228	-0.0054	0.0051	-0.5363	0.0720	0.5411
4.B.12g	Manure Management: Poultry	N_2O indirect	36.2794	25.7707	20	100	101.980	1.8717	0.0032	0.0077	0.3155	0.2172	0.3831
4.B.12h	Manure Management: Rabbits	N_2O indirect	3.1919	3.0662	20	150	151.327	0.3304	0.0005	0.0009	0.0774	0.0258	0.0816
4.D.1a	Applied Synthetic Nitrogen Fertiliser	N_2O direct	427.7114	78.4397	10	6	11.662	0.6515	-0.0299	0.0234	-0.1795	0.3306	0.3762
4.D.1b	Applied Organic Nitrogen Fertiliser	N_2O direct	264.6160	1.2058	50	6	50.359	0.0432	-0.0326	0.0004	-0.1957	0.0254	0.1973
4.D.1c	Urine and Dung Inputs to Grazed Soils	N_2O direct	116.7439	89.0786	50	50	70.711	4.4858	0.0120	0.0265	0.5992	1.8771	1.9704
4.D.1d	Nitrogen in Crop Residues	N_2O direct	257.9462	124.5529	10	50	50.990	4.5230	0.0049	0.0371	0.2474	0.5249	0.5803
4.D.1e	Nitrogen Mineralization Associated with Loss of Soil Carbon	N_2O direct	252.4061	266.9076	10	20	22.361	4.2504	0.0480	0.0795	0.9606	1.1249	1.4792
4.D.2a	Atmospheric Deposition of Nitrogen Volatilized from Managed Soils	N_2O indirect	111.1544	19.8399	70	200	211.896	2.9940	-0.0079	0.0059	-1.5892	0.5853	1.6935
4.D.2b	Nitrogen Leaching and Runoff	N_2O indirect	287.9955	119.2229	75	200	213.600	18.1361	-0.0004	0.0355	-0.0767	3.7684	3.7692
5.A.1	Forest Land Remaining Forest Land: Vegetation Fires	N_2O	0.1917	0.0134	10	50	50.9902	0.0005	0.0000	0.0000	-0.0010	0.0001	0.0010
5.B.1	Cropland Remaining Cropland: Post Harvest Field Burning of Agricultural Residues	N_2O	0.7934	0.0873	50	50	70.7107	0.0044	-0.0001	0.0000	-0.0036	0.0018	0.0041
6.B	Wastewater Handling : Human Sewage	N_2O	129.0471	92.7377	20	30	36.0555	2.3813	0.0115	0.0276	0.3462	0.7817	0.8549
	TOTAL		**3355.6413**	**1404.1599**				**22.0105**					**5.3217**

Annex 7-3: Summary of Sector Uncertainties

Annex 7-3.1: Energy Sector

	IPCC source categories	Pollutant	Base year emissions (1990)	Year t emissions (2005)	Activity data uncertainty	Emission factor uncertainty	Combined uncertainty	Combined uncertainty as % of total sectoral emissions in the year t (2005)	Type A sensitivity	Type B sensitivity	Uncertainty introduced in trend in sectoral emissions introduced by emission factor uncertainty	Uncertainty introduced in trend in sectoral emissions introduced by activity data uncertainty	Uncertainty introduced in trend in sectoral emissions
			Gg CO_2 equivalent		%								
1.A.1	Energy Industries	CO_2	19332.7655	2986.5715	7	5	8.6023	3.1779	-0.0423	0.0854	-0.2113	0.8459	0.8719
1.A.1	Energy Industries	CH_4	9.2887	1.2256	7	50	50.4876	0.0077	0.0000	0.0000	-0.0013	0.0003	0.0014
1.A.1	Energy Industries	N_2O	51.2316	1.9774	7	50	50.4876	0.0123	-0.0003	0.0001	-0.0141	0.0006	0.0141
1.A.2	Manufacturing Industries and Construction	CO_2	2188.7285	396.3804	5	5	7.0711	0.3467	-0.0031	0.0113	-0.0157	0.0802	0.0817
1.A.2	Manufacturing Industries and Construction	CH_4	2.0005	0.2149	5	50	50.2494	0.0013	0.0000	0.0000	-0.0004	0.0000	0.0004
1.A.2	Manufacturing Industries and Construction	N_2O	5.1641	0.3989	5	50	50.2494	0.0025	0.0000	0.0000	-0.0011	0.0001	0.0011
1.A.3b	Transport: Road Transportation	CO_2	3364.2178	1459.4096	10	5	11.1803	2.0183	0.0195	0.0418	0.0974	0.5905	0.5985
1.A.3b	Transport: Road Transportation	CH_4	24.4646	7.3663	10	50	50.9902	0.0465	0.0000	0.0002	0.0024	0.0030	0.0039
1.A.3b	Transport: Road Transportation	N_2O	49.6041	22.2825	10	50	50.9902	0.1405	0.0003	0.0006	0.0155	0.0090	0.0179
1A3c	Transport: Railways	CO_2	452.3598	115.1175	5	5	7.0711	0.1007	0.0003	0.0033	0.0015	0.0233	0.0233
1A3c	Transport: Railways	CH_4	0.5323	0.1355	5	50	50.2494	0.0008	0.0000	0.0000	0.0000	0.0000	0.0000
1A3c	Transport: Railways	N_2O	54.1488	13.7799	5	50	50.2494	0.0856	0.0000	0.0004	0.0018	0.0028	0.0033
1A3d	Transport: Navigation	CO_2	18.9048	0.3308	10	5	11.1803	0.0005	-0.0001	0.0000	-0.0006	0.0001	0.0006
1A3d	Transport: Navigation	CH_4	0.0375	0.0007	10	50	50.9902	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1A3d	Transport: Navigation	N_2O	0.1582	0.0028	10	50	50.9902	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1A3e	Transport: Other (Pipeline Transport)	CO_2	91.1782	36.0914	5	5	7.0711	0.0316	0.0004	0.0010	0.0021	0.0073	0.0076
1.A.4a	Other Sectors: Commercial / Institutional	CO_2	1412.4933	361.5198	5	5	7.0711	0.3162	0.0010	0.0103	0.0050	0.0731	0.0733
1.A.4a	Other Sectors: Commercial / Institutional	CH_4	5.2253	2.3681	5	50	50.2494	0.0147	0.0000	0.0001	0.0017	0.0005	0.0017
1.A.4a	Other Sectors: Commercial / Institutional	N_2O	6.3499	1.4277	5	50	50.2494	0.0089	0.0000	0.0000	-0.0001	0.0003	0.0003
1.A.4b	Other Sectors: Residential	CO_2	4407.6336	1327.4402	10	5	11.1803	1.8358	0.0088	0.0380	0.0440	0.5371	0.5389
1.A.4b	Other Sectors: Residential	CH_4	230.2856	29.3264	10	50	50.9902	0.1850	-0.0007	0.0008	-0.0342	0.0119	0.0362
1.A.4b	Other Sectors: Residential	N_2O	19.4047	4.6454	10	50	50.9902	0.0293	0.0000	0.0001	0.0002	0.0019	0.0019
1.A.4c	Other Sectors: Agriculture/Forestry/Fishing	CO_2	1942.3629	183.3484	5	5	7.0711	0.1604	-0.0076	0.0052	-0.0380	0.0371	0.0531
1.A.4c	Other Sectors: Agriculture/Forestry/Fishing	CH_4	8.9856	0.5714	5	50	50.2494	0.0036	0.0000	0.0000	-0.0022	0.0001	0.0022
1.A.4c	Other Sectors: Agriculture/Forestry/Fishing	N_2O	5.0378	0.4607	5	50	50.2494	0.0029	0.0000	0.0000	-0.0010	0.0001	0.0010
1.A.5	Other (Other Works and Needs in Energy)	CO_2	154.2715	118.0475	5	5	7.0711	0.1032	0.0024	0.0034	0.0118	0.0239	0.0266
1.A.5	Other (Other Works and Needs in Energy)	CH_4	0.1350	0.1295	5	50	50.2494	0.0008	0.0000	0.0000	0.0001	0.0000	0.0001
1.A.5	Other (Other Works and Needs in Energy)	N_2O	0.4911	0.3426	5	50	50.2494	0.0021	0.0000	0.0000	0.0003	0.0001	0.0003

1.B.2	Fugitive Emissions From Oil and Natural Gas	CO_2	0.6377	1.8809	5	200	200.0625	0.0465	0.0000	0.0001	0.0099	0.0004	0.0099
1.B.2	Fugitive Emissions From Oil and Natural Gas	CH_4	682.2942	652.0090	5	200	200.0625	16.1349	0.0141	0.0187	2.8273	0.1319	2.8304
1.B.2	Fugitive Emissions From Oil and Natural Gas	N_2O	0.0002	0.0052	5	200	200.0625	0.0001	0.0000	0.0000	0.0000	0.0000	0.00003
MI	Memo Items: International Bunkers (Aviation)	CO_2	217.3668	63.9592	10	5	11.1803	0.0885	0.0004	0.0018	0.0020	0.0259	0.0260
MI	Memo Items: International Bunkers (Aviation)	CH_4	0.9036	0.0203	10	75	75.6637	0.0002	0.0000	0.0000	-0.0004	0.0000	0.0004
MI	Memo Items: International Bunkers (Aviation)	N_2O	2.1560	0.6589	10	100	100.4988	0.0082	0.0000	0.0000	0.0005	0.0003	0.0005
MI	Memo Items: CO_2 Emissions from Biomass	CO_2	210.8274	295.0374	20	75	77.6209	2.8327	0.0070	0.0084	0.5284	0.2388	0.5799
	TOTAL		**34951.6472**	**8084.4842**				**16.9188**					**3.1265**

Annex 7-3.2: Industrial Processes Sector

	IPCC source categories	Pollutant	Base year emissions (1990)	Year t emissions (2005)	Activity data uncertainty	Emission factor uncertainty	Combined uncertainty	Combined uncertainty as % of total sectoral emissions in the year t (2005)	Type A sensitivity	Type B sensitivity	Uncertainty introduced in trend in sectoral emissions introduced by emission factor uncertainty	Uncertainty introduced in trend in sectoral emissions introduced by activity data uncertainty	Uncertainty introduced in trend in sectoral emissions
			Gg CO_2 equivalent		%								
2.A.1	Cement Production	CO_2	988.2518	373.2628	10	2	10.1980	6.5416	-0.0391	0.2767	-0.0782	3.9138	3.9146
2.A.2	Lime Production	CO_2	149.2228	6.6467	15	2	15.1327	0.1729	-0.0428	0.0049	-0.0855	0.1045	0.1351
2.A.6	Road Paving with Asphalt	CO_2	0.1874	0.0100	50	100	111.8034	0.0019	-0.0001	0.0000	-0.0053	0.0005	0.0053
2.A.6	Road Paving with Asphalt	CH_4	0.1281	0.0068	50	200	206.1553	0.0024	0.0000	0.0000	-0.0072	0.0004	0.0072
2.A.7	Other: Glass Production	CO_2	59.4234	20.8035	20	50	53.8516	1.9252	-0.0036	0.0154	-0.1791	0.4363	0.4716
2.A.7	Other: Mineral Wool Production	CO_2	8.0816	0.0000	20	30	36.0555	0.0000	-0.0026	0.0000	-0.0775	0.0000	0.0775
2.A.7	Other: Bricks Production	CO_2	52.6166	16.1150	20	5	20.6155	0.5709	-0.0049	0.0119	-0.0244	0.3379	0.3388
2.C.1	Steel Production	CO_2	56.7016	83.8512	5	25	25.4951	3.6738	0.0440	0.0622	1.1003	0.4396	1.1849
2.C.1	Steel Production	CH_4	13.3958	19.8098	5	150	150.0833	5.1093	0.0104	0.0147	1.5602	0.1039	1.5637
2.C.1	Steel Production	N_2O	1.0986	1.6246	5	300	300.0417	0.8377	0.0009	0.0012	0.2559	0.0085	0.2561
2.D.2	Food and Drink	CO_2	19.6395	40.7669	10	20	22.3607	1.5666	0.0239	0.0302	0.4788	0.4275	0.6418
2.F.1	Refrigeration and Air Conditioning Equipment	HFC	0.0000	18.7185	50	50	70.7107	2.2746	0.0139	0.0139	0.6939	0.9814	1.2019
2.F.4	Aerosols	HFC	0.0000	0.0004	10	50	50.9902	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2.F.8	Electrical Equipment	SF_6	0.0000	0.2839	10	50	50.9902	0.0249	0.0002	0.0002	0.0105	0.0030	0.0109
	TOTAL		**1348.7472**	**581.9002**				**9.7359**					**4.6322**

Annex 7-3.3: Solvents and Other Products Use Sector

	IPCC source categories	Pollutant	Base year emissions (1990)	Year t emissions (2005)	Activity data uncertainty	Emission factor uncertainty	Combined uncertainty	Combined uncertainty as % of total sectoral emissions in the year t (2005)	Type A sensitivity	Type B sensitivity	Uncertainty introduced in trend in sectoral emissions introduced by emission factor uncertainty	Uncertainty introduced in trend in sectoral emissions introduced by activity data uncertainty	Uncertainty introduced in trend in sectoral emissions
			Gg CO_2 equivalent		%								
3.A.1	Application of Conventional Solvent Paint	CO_2	29.4837	17.4044	10	50	53.8516	19.1268	-0.0700	0.2652	-3.4976	7.5013	8.2766
3.A.2	Application of Water-Borne Paint	CO_2	0.7013	0.5767	10	200	200.9975	2.3655	0.0008	0.0088	0.1616	0.2486	0.2965
3.B	Degreasing and dry cleaning	CO_2	0.6410	0.3979	10	30	31.6228	0.8003	-0.0038	0.0189	-0.1150	0.2672	0.2909
3.C	Chemical Products, Manufacture and Processing	CO_2	0.5470	0.2931	10	50	50.9902	0.3050	-0.0018	0.0045	-0.0879	0.0632	0.1082
3.D.1	Other: Adhesive Use	CO_2	5.8905	3.9807	20	100	101.9804	8.2844	-0.0064	0.0607	-0.6360	1.7157	1.8298
3.D.2	Other: Graphic Arts (Inks)	CO_2	0.5408	0.3428	20	100	101.9804	0.7134	-0.0009	0.0052	-0.0930	0.1477	0.1746
3.D.3	Other: Seed Oil Extraction and Seed Drying	CO_2	1.9745	1.8791	10	100	101.9804	3.9107	0.0062	0.0286	0.6166	0.8099	1.0179
3.D.4	Other: Household Products	CO_2	24.4686	23.2664	5	200	200.2498	95.0792	0.0758	0.3545	15.1682	5.0139	15.9754
3.D.5	Other: Use of N_2O in Anaesthesia	N_2O	0.0205	0.0189	10	10	14.1421	0.0055	0.0001	0.0003	0.0006	0.0041	0.0041
	TOTAL		**65.6247**	**49.0022**				**97.4508**					**18.1195**

Annex 7-3.4: Agriculture Sector

	IPCC source categories	Pollutant	Base year emissions (1990)	Year t emissions (2005)	Activity data uncertainty	Emission factor uncertainty	Combined uncertainty	Combined uncertainty as % of total sectoral emissions in the year t (2005)	Type A sensitivity	Type B sensitivity	Uncertainty introduced in trend in sectoral emissions introduced by emission factor uncertainty	Uncertainty introduced in trend in sectoral emissions introduced by activity data uncertainty	Uncertainty introduced in trend in sectoral emissions
			Gg CO_2 equivalent		%								
4.A.1	Enteric Fermentation: Cattle	CH_4	1630.8944	598.4914	10	20	22.3607	6.2895	-0.0100	0.1124	-0.1997	1.5898	1.6023
4.A.3	Enteric Fermentation: Sheep	CH_4	166.7501	116.8926	10	20	22.3607	1.2284	0.0094	0.0220	0.1887	0.3105	0.3634
4.A.4	Enteric Fermentation: Goats	CH_4	4.4486	16.6848	10	20	22.3607	0.1753	0.0028	0.0031	0.0560	0.0443	0.0714
4.A.6	Enteric Fermentation: Horses	CH_4	17.5014	28.8414	10	30	31.6228	0.4286	0.0041	0.0054	0.1231	0.0766	0.1450
4.A.7	Enteric Fermentation: Asses	CH_4	0.4200	0.4200	20	30	36.0555	0.0071	0.0000	0.0001	0.0014	0.0022	0.0026
4.A.8	Enteric Fermentation: Swine	CH_4	64.4175	13.3025	10	30	31.6228	0.1977	-0.0023	0.0025	-0.0701	0.0353	0.0785
4.A.9	Enteric Fermentation: Poultry	CH_4	0.0000	0.0000	20	30	36.0555	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
4.A.10	Enteric Fermentation: Rabbits	CH_4	18.9736	18.2266	20	30	36.0555	0.3089	0.0020	0.0034	0.0600	0.0968	0.1139

4.B.1	Manure Management: Cattle	CH_4	191.0580	31.0258	10	30	31.6228	0.4611	-0.0085	0.0058	-0.2554	0.0824	0.2683
4.B.3	Manure management : Sheep	CH_4	5.2109	3.3448	10	50	50.9902	0.0802	0.0002	0.0006	0.0119	0.0089	0.0148
4.B.4	Manure Management: Goats	CH_4	0.0874	0.3311	10	50	50.9902	0.0079	0.0001	0.0001	0.0028	0.0009	0.0029
4.B.6	Manure Management: Horses	CH_4	1.5168	2.4996	10	50	50.9902	0.0599	0.0004	0.0005	0.0178	0.0066	0.0190
4.B.7	Manure Management: Asses	CH_4	0.0319	0.0319	20	50	53.8516	0.0008	0.0000	0.0000	0.0002	0.0002	0.0002
4.B.8	Manure Management: Swine	CH_4	170.9211	19.2442	10	30	31.6228	0.2860	-0.0092	0.0036	-0.2764	0.0511	0.2811
4.B.9	Manure Management: Poultry	CH_4	16.2771	11.6885	20	50	53.8516	0.2958	0.0010	0.0022	0.0487	0.0621	0.0789
4.B.10	Manure Management: Rabbits	CH_4	2.5089	2.4101	20	50	53.8516	0.0610	0.0003	0.0005	0.0132	0.0128	0.0184
4.B.11a	Manure Management: Cattle	N_2O direct	467.1252	168.7875	10	50	50.9902	4.0448	-0.0034	0.0317	-0.1680	0.4484	0.4788
4.B.11b	Manure Management: Sheep	N_2O direct	107.6465	69.0965	10	50	50.9902	1.6558	0.0049	0.0130	0.2448	0.1835	0.3060
4.B.11c	Manure Management: Goats	N_2O direct	3.0678	11.6290	10	75	75.6637	0.4135	0.0020	0.0022	0.1465	0.0309	0.1498
4.B.11d	Manure Management: Horses	N_2O direct	16.8890	27.8321	10	75	75.6637	0.9897	0.0040	0.0052	0.2970	0.0739	0.3060
4.B.11e	Manure Management: Asses	N_2O direct	0.2490	0.2490	20	75	77.6209	0.0091	0.0000	0.0000	0.0021	0.0013	0.0025
4.B.11f	Manure Management: Swine	N_2O direct	307.1506	71.5496	10	50	50.9902	1.7146	-0.0096	0.0134	-0.4806	0.1901	0.5169
4.B.11g	Manure Management: Poultry	N_2O direct	142.5865	101.1546	20	50	53.8516	2.5601	0.0083	0.0190	0.4147	0.5374	0.6788
4.B.11h	Manure Management: Rabbits	N_2O direct	19.6425	18.8691	20	75	77.6209	0.6883	0.0021	0.0035	0.1552	0.1002	0.1848
4.B.12a	Manure Management: Cattle	N_2O in-direct	105.8732	32.3370	10	100	100.4988	1.5273	-0.0019	0.0061	-0.1874	0.0859	0.2061
4.B.12b	Manure Management: Sheep	N_2O in-direct	17.4926	11.2282	10	100	100.4988	0.5303	0.0008	0.0021	0.0796	0.0298	0.0850
4.B.12c	Manure Management: Goats	N_2O in-direct	0.4985	1.8897	10	150	150.3330	0.1335	0.0003	0.0004	0.0476	0.0050	0.0479
4.B.12d	Manure Management: Horses	N_2O in-direct	2.7445	4.5227	10	150	150.3330	0.3195	0.0006	0.0008	0.0965	0.0120	0.0973
4.B.12e	Manure Management: Asses	N_2O in-direct	0.0405	0.0405	20	150	151.3275	0.0029	0.0000	0.0000	0.0007	0.0002	0.0007
4.B.12f	Manure Management: Swine	N_2O in-direct	83.8484	17.0849	10	100	100.4988	0.8069	-0.0031	0.0032	-0.3085	0.0454	0.3118
4.B.12g	Manure Management: Poultry	N_2O in-direct	36.2794	25.7707	20	100	101.9804	1.2351	0.0021	0.0048	0.2117	0.1369	0.2521
4.B.12h	Manure Management: Rabbits	N_2O in-direct	3.1919	3.0662	20	150	151.3275	0.2181	0.0003	0.0006	0.0504	0.0163	0.0530
4.D.1a	Applied Synthetic Nitro-gen Fertiliser	N_2O direct	427.7114	78.4397	10	6	11.6619	0.4299	-0.0174	0.0147	-0.1042	0.2084	0.2329
4.D.1b	Applied Organic Nitrogen Fertiliser	N_2O direct	264.6160	1.2058	50	6	50.3587	0.0285	-0.0196	0.0002	-0.1178	0.0160	0.1189
4.D.1c	Urine and Dung Inputs to Grazed Soils	N_2O direct	116.7439	89.0786	50	50	70.7107	2.9603	0.0080	0.0167	0.3983	1.1831	1.2484
4.D.1d	Nitrogen in Crop Residues	N_2O direct	257.9462	124.5529	10	50	50.9902	2.9848	0.0040	0.0234	0.2015	0.3309	0.3874
4.D.1e	Nitrogen Mineralization Associated with Loss of Soil Carbon	N_2O direct	252.4061	266.9076	10	20	22.3607	2.8049	0.0312	0.0501	0.6234	0.7090	0.9441
4.D.2a	Atmospheric Deposition of Nitrogen Volatilized from Managed Soils	N_2O in-direct	111.1544	19.8399	70	200	211.8962	1.9758	-0.0046	0.0037	-0.9234	0.3689	0.9943
4.D.2b	Nitrogen Leaching and Runoff	N_2O in-direct	287.9955	119.2229	75	200	213.6001	11.9683	0.0008	0.0224	0.1547	2.3752	2.3803
	TOTAL		**5323.9174**	**2127.7901**				**15.8069**					**3.6948**

Annex 7-3.5: Land Use, Land Use Change and Forestry Sector

	IPCC source categories	Pollutant	Base year emissions (1990)	Year t emissions (2005)	Activity data uncertainty	Emission factor uncertainty	Combined uncertainty	Combined uncertainty as % of total sectoral emissions in the year t (2005)	Type A sensitivi ty	Type B sensitivity	Uncertainty introduced in trend in sectoral emissions introduced by emission factor uncertainty	Uncertainty introduced in trend in sectoral emissions introduced by activity data uncertainty	Uncertainty introduced in trend in sectoral emissions
			Gg CO_2 equivalent		%								
5.A.1	Forest Land Remaining Forest Land: Annual Change in Carbon Stocks in Biomass	CO_2	-2197.579	-2246.233	25	5	25.4951	41.4675	0.2549	1.3428	1.2743	47.4759	47.4930
5.A.1	Forest Land Remaining Forest Land: Vegetation Fires	CH_4	0.2347	0.0164	10	30	31.6228	-0.0004	0.0001	0.0000	0.0032	-0.0001	0.0032
5.A.1	Forest Land Remaining Forest Land: Vegetation Fires	N_2O	0.1917	0.0134	10	50	50.9902	-0.0005	0.0001	0.0000	0.0043	-0.0001	0.0043
5.B.1	Cropland Remaining Cropland: Annual Changes in Carbon Stocks in Living Biomass	CO_2	-725.2315	-465.3288	25	10	26.9258	9.0725	-0.0794	0.2782	-0.7941	9.8351	9.8671
5.B.1	Cropland Remaining Cropland: Annual Changes of Carbon Stocks in Mineral Soils	CO_2	2032.8194	2149.6103	10	20	22.3607	-34.8049	-0.2852	-1.2851	-5.7046	-18.1735	19.0478
5.B.1	Cropland Remaining Cropland: Post Harvest Field Burning of Agricultural Residues	CH_4	2.3077	0.2445	50	30	58.3095	-0.0103	0.0010	-0.0001	0.0298	-0.0103	0.0315
5.B.1	Cropland Remaining Cropland: Post Harvest Field Burning of Agricultural Residues	N_2O	0.9850	0.1007	50	50	70.7107	-0.0052	0.0004	-0.0001	0.0213	-0.0043	0.0217
5.C.1	Grassland Remaining Grassland	CO_2	-780.1200	-821.7000	30	10	31.6228	18.8152	0.1057	0.4912	1.0570	20.8407	20.8675
5.C.2	Land Converted to Grassland	CO_2	-6.3800	2.2440	30	5	30.4138	-0.0494	-0.0045	-0.0013	-0.0225	-0.0569	0.0612
	TOTAL		**-1672.7720**	**-1381.0327**				**58.0281**					**56.1357**

Annex 7-3.6: Waste Sector

Clasificarea CISC	IPCC source categories	Pollutant	Base year emissions (1990)	Year t emissions (2005)	Activity data uncertainty	Emission factor uncertainty	Combined unce rtainty	Combined uncertainty as % of total sectoral emissions in the year t (2005)	Type A sensitivity	Type B sensitivity	Uncertainty introduced in trend in sectoral emissions introduced by emission factor uncertainty	Uncertainty introduced in trend in sectoral emissions introduced by activity data uncertainty	Uncertainty introduced in trend in sectoral emissions
			Gg CO_2 equivalent		%								
6.A.1	Managed Waste Disposal on Land	CH_4	362.3109	415.7349	20	20	28.2843	8.3994	0.0638	0.2555	1.2759	7.2258	7.3376
6.A.2	Unmanaged Waste Disposal Sites	CH_4	548.6334	335.0256	50	20	53.8516	12.8873	-0.0839	0.2059	-1.6775	14.5575	14.6538
6.A.3	Other: Industrial Waste	CH_4	410.1825	435.4455	100	20	101.9804	31.7202	0.0506	0.2676	1.0123	37.8418	37.8553
6.B	Wastewater Handling	CH_4	177.1625	121.0136	20	30	36.0555	3.1167	-0.0193	0.0744	-0.5781	2.1033	2.1813
6.B	Wastewater Handling: Human Sewage	N_2O	129.0471	92.7377	20	30	36.0555	2.3884	-0.0112	0.0570	-0.3367	1.6118	1.6466
	TOTAL		**1627.3364**	**1399.9573**				**35.4714**					**41.3409**