ROMANIA

Ministry of Environment and Water Management

Romania's Third National Communication on Climate Change under the United Nations Framework Convention on Climate Change

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Content

Introduction

The submission to the UNFCCC Secretariat of Romania's Third National Communication was pending for a long period due to the lack of financial support. As many other countries with economy in transition, Romania faces a lack of financial and human resources for climate change activities. Therefore, I wish to take this opportunity to express my gratitude to the Government of Denmark, who through the Danish Environmental Protection Agency, has supported Romania in editing, publishing and printing the Third National Communication to the UNFCCC. This again proves that regional and international cooperation in the field of climate change can be very beneficial and efficient for the parties involved.

Environmental protection in Romania is the main responsibility of the Ministry of Environment and Water Management, developing and implementing also the National Strategy and National Action Plan on Climate Change, which are to be approved by the Romanian Government in 2005. Romania was the first Annex I Party to ratify the Kyoto Protocol and in doing so has committed to reduce greenhouse gas emissions by 8% in the first commitment period. As shown in the last National Greenhouse Gas Inventory, submitted to the UNFCCC Secretariat in May 2004, Romania's total aggregate greenhouse gas emissions decreased in 2002 to 50 percent of the 1989 value.

This important decrease in emissions is mainly due to reduced industrial activity and the promotion of pollution control measures, as a consequence of the implementation of new regulations, which are harmonized, with those of the European Union. At the same time, taking into account the increasing trend of Romania's economic growth in the last four years, the greenhouse gas emissions are expected to increase slightly by 2012. In this respect, Romania's main objective is to decouple the increase of GHG emissions and the industrial growth, by implementing coherent measures for energy efficiency, renewable energy and others, and to preserve achieved reductions.

Romania has suffered from some climate related extreme events in previous years. In Romania, as in other regions of Europe, the change in the climate conditions may affect agriculture, water management, forests, and in general the way people live. The expected changes in average temperature and precipitation conditions may lead to changes in vegetation periods as well as the displacement of the borderline between grasslands and the forest areas. The change in precipitation regime may also increase the erosion and the compaction of the soil. It can be assumed that extreme phenomena (e.g. floods, droughts) could appear more often in the future and the risks and damages of such may become more significant.

In our vision, sustainable development should be the driving force for a coherent integration of adaptation and mitigation measures. Therefore, the international community should take full account of the need for predictable and adequate levels of funding to help countries with economies in transition meeting their obligations under the Convention and the Kyoto Protocol.

Romania recognizes the urgent need to strengthen the national institutional and human capacity regarding climate change related activities, and considers that the developed country Parties should take action in this regard for a better understanding of the phenomena at the regional and national level. Romania wishes also to contribute further to these international activities, which would allow the properly implementation of such international agreements relating to climate change.

Mrs. Sulfina BARBU
Minister of Environment and Water Management

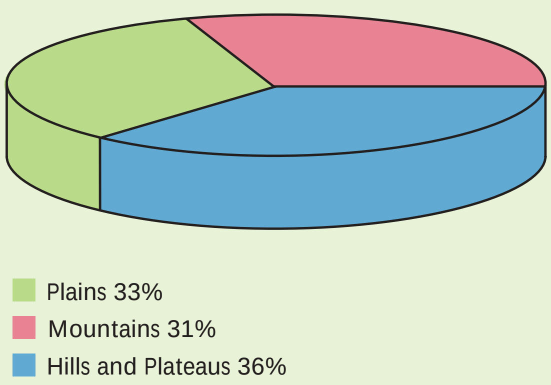
Executive Summary

1.1. Romania General Facts

Geographical position

Romania is located in the southeastern part of Central Europe, north of the Balkan Peninsula, on the Lower Danube and bordering the Black Sea. Parallel 45 crosses Romania 70 km north of the capital Bucharest and meridian 25 longitude east runs 90 km west of Bucharest. The total surface of Romania is 238,391 km^2 (91,843 miles^2).

Figure 1.1. Territory according to relief



The main relief components of Romania are: Carpathian Mountains, Sub-Carpathians, hills and plateaus, plains, river meadows, the Danube Delta and the Black Sea.

The Danube Delta is one of the most magnificent deltas in the world, and in 1991 was declared as both a Natural World Heritage and Ramsar site, and has a surface of 580.000 ha – 2,5 % of Romania's surface (The 3rd largest delta in Europe). The Danube, the second longest river in Europe (2,860 km), flows on Romania's territory along 1,075 km and empties into the Black Sea through three arms (Chilia, Sulina, Sfantu Gheorghe), which form the Danube Delta.

The network of Romania's rivers is radial-shaped, with 98% of the rivers springing from the Carpathian Mountains and being collected directly or through tributaries by the Danube. In addition Romania has around 3,500 *lakes*, but only 1% of them have an area exceeding 1 km^2. Romania is endowed with a wide range of natural resources from crude oil to gold, with a special category of resources being the large number of mineral water springs and geothermal water deposits.

The flora and fauna

The relief and pedo-climatic elements in Romania, being displayed in stairs, determine the vegetation. Romania's fauna was and still is one of the richest and most varied in Europe, boasting some rare and even unique species on the continent.

The climate profile

Romania has a temperate-continental climate of transitional type, specific to Central Europe, with four clearly defined seasons. The mean annual temperature is 11°C in the south of the country and 8°C in the north of the country. The average annual precipitation slightly decreases from west (over 600 mm/year in the Western Plain) to east (below 400 mm/year in the Danube Delta) and the mean annual rainfall totals 637 mm. The duration of sun shine has a high value in plain areas (2100 - 2200 hours yearly) and a lower one in mountain areas (1800 hours).

Territorial organization

According to Art. 3 of the Constitution, Romania's territory is divided from an administrative point of view into counties, cities, towns and communes. The Capital of Romania: Bucharest municipality has a population of 1,926,334 (2002) and is the most important city in Romania. In 2002, Romania had a population of 21,680,974 and ranked 43rd in the world and 13th in Europe.

Environment

In December 1989, Romania entered into a transition to a free market economy. Previously, concepts like sustainable development and the human dimension of sustainability were not well known or understood and were therefore neglected. In this respect, Romania adopted in 1999 a long-term National Sustainable Development Strategy (NSDS) and subsequently prepared a National Action Plan for the implementation of the NSDS and the introduction of the Local Agenda 21 process in the country. In protecting the environment in the context of sustainable development and global warming, Romania agreed to respect the ratified multilateral environmental agreements. Then to implement their provisions through policies and measures in sectors and activities that result in the generation of greenhouse gas emissions, mainly in the production and consumption of energy and transports which are responsible for approximately 85% of Romania's CO_2 emissions.

Climate change related activities

This type of activities are mainly the responsibility of the Ministry of Water and Environmental Protection (MWEP). The National Commission on Climate Change was established in 1996 to promote the necessary measures and actions for an unitary implementation of the UNFCCC's objectives in Romania.

1.2. Inventories of anthropogenic emissions and sinks of greenhouse gases

Romania will be able to meet its 8% GHG emissions reduction commitment under the Kyoto Protocol as the trend for the period 1989-2001 shows a decrease of 47% in the overall GHG emissions. The total value of the gross GHG emissions in 2001 was 148,202.41 Gg CO_2 equivalent, where the emissions inventory includes the following gases: CO_2, CH_4, N_2O, PFCs, and the precursors NO_X, CO, NMVOC, SO_2. The year 1989 was established as the base year for Romania, because 1989 best expressed, Romania's economic output potential directly connected with the Romania's emissions potential.

Originally, the inventories for Romania were prepared by the National Research and Development Institute for Environmental Protection (ICIM-Bucharest) according to the published IPCC "Draft IPCC Guidelines for National Greenhouse Gas Inventories" methodology, which regulated only the calculation of the carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O) emissions. In 2003, the ICIM-Bucharest prepared the National Inventory of Greenhouse Gas Emissions for 2001, in compliance with a Ministry of Water and Environmental Protection contract.

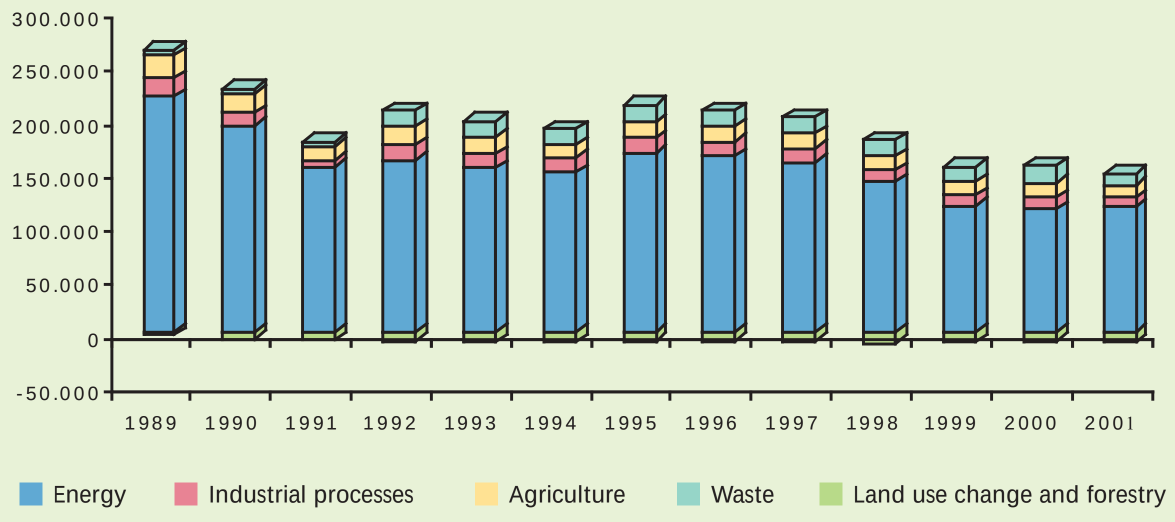
The necessary information to perform the national GHG inventory was provided by the National Institute for Statistics in the form of the Statistical Yearbook. In May 2004 Romania will submit to the UNFCCC Secretariat the whole time series inventories (1989 - 2002) completed.

Table 1.1. Total net GHG emissions

Year	1989	2001
Total net GHG emissions (Gg)	261,355	139,171

The *Energy sector* represents the biggest share in total GHG emissions, while the *Solvent and Other Product Use sector* includes emissions resulted from the paint application and other products use. The *Agriculture sector* contains the emissions from domestic livestock enteric fermentation, animal waste management systems, rice cultivation and field burning of agricultural residues, while the municipal *waste management systems* and *the wastewater treatment* provide the biggest amount of emissions in the waste sector.

Figure 1.2. Various sector's contribution to the GHG emissions (Gg CO_2 eq.)



In 2003, the Ministry of Water and Environmental Protection of Romania asked the UNFCCC Secretariat to support the inventory development process in Romania by organizing an „in-country" review of the 2001 national GHG emissions inventory. This activity took place in the period 29 September - 3 October 2003 at the ICIM Bucharest headquarters. Taking into account that the 2001 GHG inventory was the first one submitted in time to the UNFCCC Secretariat, the main conclusions of this first review are very important for the future development of Romania's GHG inventory system.

1.3. Policies and Measures to Mitigate Greenhouse Gas Emissions

In recent years, Romania has been preparing for a complex process of integration in the European Union by reviving economic development within an international context. Environmental protection has a high priority in the development strategies and policies of the Romanian Government. Special attention is given to the commitments resulting from international agreements signed and ratified by Romania. As mentioned in article 20 of the Romanian Constitution, the provisions of international agreements adopted by Romania have priority for compliance, even if there is no domestic regulation on that matter.

Romania signed the United Nations Framework Convention on Climate Change (UNFCCC), in 1992 at the Rio de Janeiro Earth Summit, ratified then by Law no. 24/1994. Romania was the first UNFCCC's Annex I Party to ratify the Kyoto Protocol by Law no. 3/2001, thus committing itself to reduce the GHG emissions by 8% in the first commitment period 2008 - 2012, comparing with the base year (1989), thus harmonizing with the EU reduction commitment.

According to the provisions of article 4.6 of the UNFCCC and Decisions 9/CP.2 and 11/CP.4, the year 1989 was established as the base year for Romania. In this context, Romania has to develop its institutional capacity and legal framework, so that in 2007 (according to the Kyoto Protocol) a national system for the assessment of greenhouse gas emissions will be operational.

Greenhouse gas emissions mitigation is one of the most important activities presented in the Romanian Strategy on Atmosphere Protection. This Strategy is evidences of the commitment Romania has made to meet its target for 8% reduction of greenhouse gases emissions in the period 2008 - 2012 comparing to the 1989 levels. Policies and measures to reduce CO2 and other GHG emissions will deliver indirect benefits, including improvements in air quality. Some measures which target the reduction of greenhouse gas emissions have the added benefits of reducing emissions of pollutants that are harmful to human health and environment. The transfer to more efficient forms of energy production, improvement in transportation system, such as better public transportation and better engine technology for private and commercial vehicles, all result in reductions of greenhouse gas emissions. While at the same time lead to reductions in pollutants such as nitrogen dioxide, carbon monoxide and particulates that have a proven adverse impact on human health.

Romania, represented by the Ministry of Environment and Water Management (MEWM), has requested assistance from Denmark (Danish Environmental Protection Agency) in drawing up a National Strategy and Action Plan on Climate Change. Thus allowing for compliance with the provisions and requirements deriving from the UNFCCC and the Kyoto Protocol, which are key concerns to the Romanian Government. The National Strategy and Action Plan will serve as the overall document, which reflects the strategic considerations, and practical steps for climate change related activities that

Romania will undertake. While taking into account the commitments made by Romania under the UNFCCC and the Kyoto Protocol.

Joint Implementation (JI) is one of the three „flexible mechanisms” provided by the Kyoto Protocol, for achieving greenhouse gas (GHG) emissions reduction commitments in a cost effective manner. Joint Implementation is based on the Kyoto Protocol's Article 6 and is a project-based economic instrument.

In order to realize sustained economic growth, Romania's GHG emissions are expected to increase slightly untill 2008. This increase may continue into the first commitment period unless Romania is able to preserve the reductions of emissions by implementing energy efficiency and other GHG emissions reduction measures, and also by decoupling economical development and GHG emissions trends.

Following the signing of the Kyoto Protocol in 1997 Romania started to cooperate with different countries on preparing for the implementation of the protocol's flexible mechanisms. Romania was involved in the Activities Implemented Jointly (AIJ) as a „pilot” stage for JI. The main objective of the cooperation between governments in this phase was the need to understand the possibilities of implementing these kinds of projects fin future stages. In this context Romania carried out 5 AIJ projects.

Taking into account the possibilities identified in developing JI projects the first Memorandum of Understanding was signed with the Switzerland in 1999, thus creating a framework for JI project implementation. The first JI project started in 2000 (initially as AIJ).

In the last several years Romania has signed a number of Memoranda of Understanding with different countries like: the Netherlands, Norway, Denmark, Austria, Sweden and the World Bank's Prototype Carbon Fund. To date, a total of 11 JI projects have started implementation or have already been commissioned in Romania, with the investments from some of the countries mentioned above, as presented in the table. Important investments will generate over 7.5 million ERUs in the first commitment period (2008-2012).

1.4. Projections and Assessment of Measures Effects to Mitigate Greenhouse Gas Emissions

The emission projections in Romania are influenced by the uncertainties related to the privatization process and the continuous efforts for the approximation of national legislation with the EU acquis communautaire. The assumptions for these projections are in accordance with the economical situation in the period 2000-2003, the „Road Map for the energy sector of Romania” elaborated by the Romanian Government on July 2003 and the „Romanian Government strategy for the period 2004-2025”. The economical development assessment up to 2020 is based on the following main considerations:

- structural change and modernization of the economy;
- different options for the energy supply and for the development of the electricity generation capacity;
- evolution of cogeneration;
- energy intensity reduction.

The adopted measures for the reduction of GHG emissions were estimated and the projections of GHG emissions for the period 2005-2020 were presented using the following scenarios:

- reference scenario – defined as „without measures” scenario;
- low scenario – defined as „with measures” scenario;
- high scenario – defined as „with additional measures” scenario.

Table 1.2. Aggregated GHG Emissions (CO_2 eq.) for „without measures" scenario in Gg Carbon Dioxide Equivalent / year

Parameter	1998	1999	2000	2001	2002	2005	2010	2015	2020
Total CO_2 emission	89487,59	73388,34	76891,86	80218,13	89669,69	98500,00	110000,00	117950,00	129000,00
Total CH_4 emission	31213,49	30028,92	30015,44	29288,77	28378,35	30270,98	32653,35	34287,75	35532,11
Total N_2O emission	6128,00	6800,00	6768,00	7235,20	6262,40	6828,80	7603,20	8220,80	8582,40
Total PFC emission	488,69	477,06	503,23	508,08	525,06	550,00	570,00	590,00	600,00
Total aggregated emissions	127317,77	110694,32	114178,53	117250,18	124835,50	136149,78	150826,55	161048,55	173714,51

Table 1.3. Aggregated GHG Emissions (CO_2 eq.) for „with measures" scenario in Gg Carbon Dioxide Equivalent / year

Parameter	1998	1999	2000	2001	2002	2005	2010	2015	2020
Total CO_2 emission	89487,59	73388,34	76891,86	80218,13	89669,69	95200,00	107200,00	113550,00	119200,00
Total CH_4 emission	31213,49	30028,92	30015,44	29288,77	28378,35	29998,50	31707,90	33108,80	34305,90
Total N_2O emission	6128,00	6800,00	6768,00	7235,20	6262,40	6694,40	7340,80	7830,40	8192,00
Total PFC emission	488,69	477,06	503,23	508,08	525,06	550,00	570,00	590,00	600,00
Total aggregated emissions	127317,77	110694,32	114178,53	117250,18	124835,50	132442,90	146818,70	155079,20	162297,90

Table 1.4. Aggregated GHG Emissions (CO_2 eq.) for „with additional measures" scenario in Gg Carbon Dioxide Equivalent / year

Parameter	1998	1999	2000	2001	2002	2005	2010	2015	2020
Total CO_2 emission	89487,59	73388,34	76891,86	80218,13	89669,69	93100,00	101950,00	111400,00	115350,00
Total CH_4 emission	31213,49	30028,92	30015,44	29288,77	28378,35	29620,30	31040,00	32283,40	33395,70
Total N_2O emission	6128,00	6800,00	6768,00	7235,20	6262,40	6544,00	7104,00	7564,80	7990,40
Total PFC emission	488,69	477,06	503,23	508,08	525,06	550,00	570,00	590,00	660,00
Total aggregated emissions	127317,77	110694,32	114178,53	117250,18	124835,50	129814,30	140664,00	151838,20	157396,10

It is obvious that the total GHG emission level in 2020 for all scenarios will not exceed the aggregated emission level of the base year (1989) of 261,355 Gg CO2 eq. although all projections show an increasing trend taking into consideration the Romanian Government's efforts regarding the economic growth and also the harmonization with the EU acquis communautaire in the social and economic fields.

The small differences of about 7%, and respectively 10% between the projections in the „without measures" scenario and „with measures" scenario, are presented in the figure. These small differences can be explained, as the „without measures" scenario is defined without any measures for the reduction of GHG emissions. The „without measures" scenario reflects the progress of Romania towards a functional market economy through the implemented reforms in order to respond to the requirements of the EU acquis communautaire.

If the „without measures" scenario does not present the reorganization of the Romanian economy and is defined as an inertial scenario, which shows the evolution trends at the level of year 1996 without the structural adjustment of economy and privatization. The difference between projections will be higher and will better reflect the effects of the adopted measures for the reduction of GHG emissions.

1.5. Climate Change Impacts, Vulnerability Assessment and Adaptation Measures

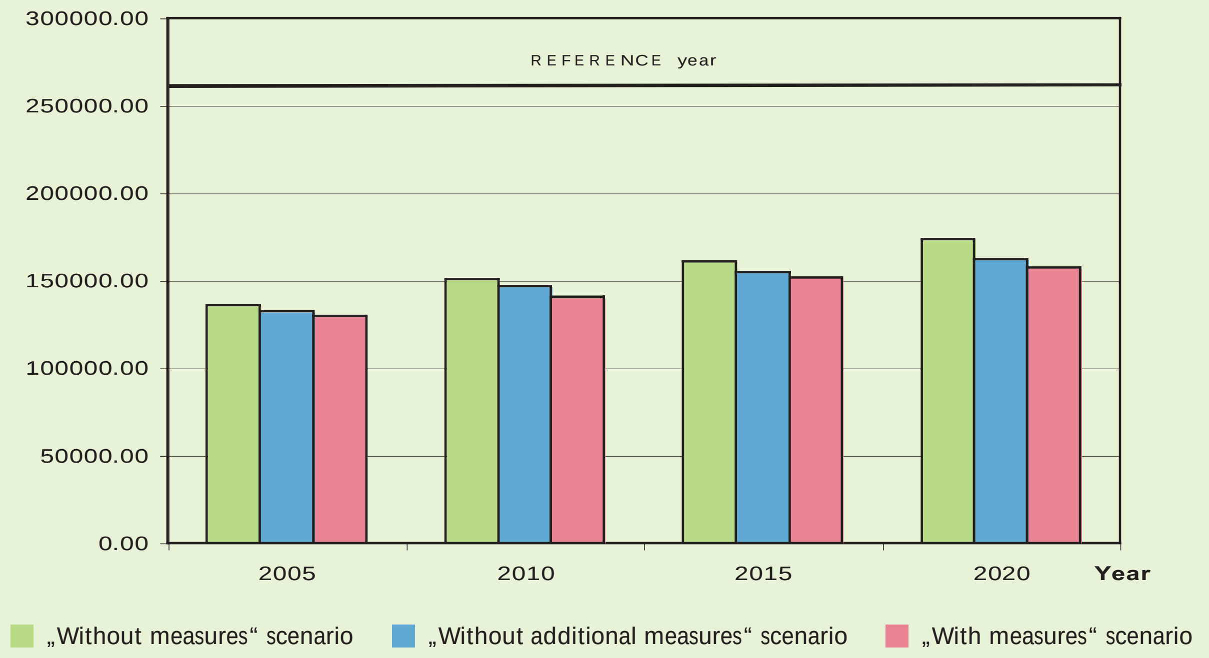
The consequences of global warming on a time scale can only be roughly estimated, especially at the regional level, due to the low performance of GCMs in simulating the complex characteristics of the climate system and the uncertainties related to emissions scenarios. Like in other regions of Europe, the change in climate conditions may also affect the Romanian agriculture, water management, forests, human life etc.

The shift in temperature and precipitation conditions may result in the modification of vegetation periods and the displacement of the borderline between the grassland and the forest areas. The change in precipitation regime may also increase the erosion and compaction of the soil. It was assumed that extreme weather related events (floods, droughts) may appear more often and their associated risks and damages may become more significant.

The improvement of water management and irrigation systems, the change of land use technologies, and hybrids use, together with other measures presented as an integrated approach in a future national adaptation strategy, are expected to mitigate most of the negative effects of climate change in Romania's agriculture.

General Circulation Models (GCMs) are the most widely used tools to generate climate change scenarios for impact assessment. Four eq-

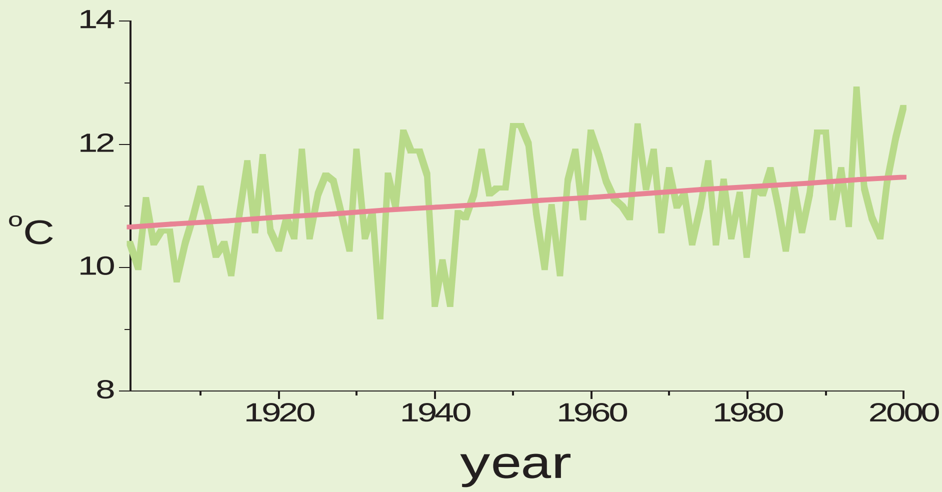
Figure 1.3. Aggregated emissions projections of all GHG



uilibrium GCMs were considered by the Romanian experts: GISS (Godard Institute for Space Studies), GFDL R-30 (Geophysical Fluid Dynamics Laboratory, GFD3), UK89 (United Kingdom Meteorological Office), CCCM (Canadian Climate Center Model) and as a transient GCM the GFDL (GFD1) has been used. All the models showed the same climate signals of increases in air temperature as a consequence of CO2 doubling, but there are some differences between models regarding the warming intensity. From the precipitation point of view the problem is more complex. Some models simulated precipitation closer to observed values in some months and other models simulated better in other months. The annual variation of precipitation in Romania was not well simulated by any model.

The changes in temperature and precipitation regime measured at long-term observational stations are periodically evaluated. A significant warming of about 0.8°C was identified at some stations in the extra-Carpathian region, showing the relief influence. On the seasonal scale the changes are highest in the winter season (reaching 1.9°C at Bucharest-Filaret station), and in autumn season a slightly downward shift in the western part was identified after 1969.

Figure 1.4. Temporal evolution of the annual mean temperature at Bucuresti-Filaret station over the period 1901-2000



Visible anthropogenic effects were noticed at several observational stations (e.g. Bucuresti-Filaret), at these stations the warming is more significant. Influence from other local factors overlaps in large-scale events, and similar conclusions result in mean maximum temperature.

A spatial extension of the surfaces affected by various degrees of dryness was identified in the last decades in Romania. Most of the drought events affected only some parts of the Romanian territory and often in the same time there were areas with floods. Droughts and floods have occurred oin the same territory, in the same year. Droughts represent a relative frequent phenomenon in Romania, like many other countries in southeastern Europe. In the last decades the Romanian climate was characterized by the occurrence of very short wet events (floods) within long dry periods, both of them producing a lot of economic and social damages. A recent research study showed that the extreme wet events were most frequent in the second half of the 20th century. Therefore, the annual frequency of very wet intervals (one-two days) exhibits an increasing trend for some regions with an upward shift between 1990 and 2000.

During past years, due to financial constrains, vulnerability and adaptation related research activities were developed at a small scale for agriculture, water management and forestry in order to continue the work initiated in this field. Like in other regions of Europe, the change in climate conditions may also affect Romanian agriculture, water management, forests, human life etc.

Among the reasons for relevant vulnerability assessments is the fact that climate changes are likely to happen and many anticipatory measures that would be taken in response to climate changes are „no regret actions" that will produce benefits even if the climate does not change. The adaptation measures to mitigate the effects of climate changes on agriculture and water management in Romania can be roughly classified into two groups. The first group is related to the national decision level and it refers to various governmental laws regarding the protection, conservation and improvement of soil and water resources and, therefore, indirectly refers to drought, desertification and soil degradation. The second group of strategies refers to those derived from the research studies.

Negative impacts of climate changes on agricultural crops can be reduced by using some technological measures such as the application of irrigation, being the most reliable tool of drought control, regardless of drought intensity and duration.

1.6. Research and Systematic Observations

At the present time, research activities related to climate change are not so developed in Romania as with other countries with economy in transition in the region due to the lack of financial resources. There are also some problems with communication and dissemination of research

achievements like studies or reports that focus on different activities in the variety of climate change related fields. Many involving some important aspects on the development of the future national strategy on climate change. Some studies relating directly or indirectly to climate change were elaborated in recent years by some interested research institutes or NGOs.

The most important actors in the climate change related research are the Ministry of Water and Environmental Protection through its national research institutes (The National Research and Development Institute for Environmental Protection - ICIM Bucharest and the

National Institute for Meteorology, Hydrology and Water Management - INMH Bucharest) and the Ministry of Education and Research. Some research work on climate change related activities was also initiated by the Romanian Academy Institutes, the Academy of Agriculture and Forestry Sciences, the National Research and Development Institute for Marine Activities „Grigore Antipa", the National Institute for Geography, National Institute for Statistics and Research Institute for Agriculture, Agro-chemistry and Soil. The National Committee for Global Environmental Changes, under the Romanian Academy is coordinating several institutes and organizations and provides some opportunities for financial support of the research studies based on international co-operation and projects.

The systematic observation in Romania is developed on the basis of several projects implemented for addressing the reporting commitments made by Romania, but is still not directly linked with climate change activities.

INMH coordinates the National Meteorological Observations Network which includes: 151 stations, 3 aero-logical stations, 7 radar centres, 729 pluvial-metrical stations, 60 agro-meteorological stations and 8 actinometrical stations. The National Hydrological Observations Network, coordinated by the National Administration „Romanian Waters", includes 956 hydrometrical stations, 300 precipitation stations and 57 hydrological stations.

One of the most important issues in the international co-operation between the Romanian scientists and other international research centres is related to the development of regional climate change scenarios. In the last couple of years the research in the climate related activities has developed further and one of the most important is the co-operation between Romanian experts and international experts for developing research studies at the national and regional scale.

1.7. Education, Training and Public Awareness

In Romania climate change related activities are under the responsibility of the Ministry of Water and Environmental Protection which has undertaken a series of activities in this field in recent years in close co-operation with foreign partners like the Netherlands, Switzerland, Denmark and Norway and also with some NGOs. Some of the activities developed in this regard were related to distributing the Second National Communication to the UNFCCC, preparing the National GHG Inventory in the specified format (CRF and NIR), re-organizing the National Commission on Climate Change, publishing media articles on climate change issues, and raising awareness through the ministry web page. Awareness of the causes and effects of climate change is not yet widespread in Romania due to a lack of capacity and financial resources.

The institutions involved in this process are the Ministry of Water and Environmental Protection (MWEP), the National Commission on Climate Change, the Environmental Protection Agencies, the NGO „Infoterra" Romania and other Romanian NGOs.

The highest authority involved in education in Romania is the Ministry of Education and Research.

The climate change process is not specifically addressed in curricula, but it is presented in the broad framework of environmental protection and sustainable development education. Regarding higher education climate change activities are addressed at the environmental departments or faculties in the state owned or private universities.

The Ministry of Waters and Environmental Protection uses different channels for providing information to relevant target groups: mass media, NGOs, business sector. One of the instruments is the ministry's website - www.mappm.ro. Three NGOs working groups on energy, transport and agriculture developed several national or small-scale public awareness campaigns on related issues. Several training programmes and activities were developed in Romania based on direct co-operation between the government, NGOs and with international cooperation.

Public participation in addressing climate change is under the responsibility of the MWEP and in the last years increased on the basis of requesting public inputs on Joint Implementation projects. Some exercises have been developed also on NGOs initiatives.

Romania General Facts

2.1. Geographical profile

Geographical position

Romania is situated in south-eastern part of Central Europe, north of the Balkan Peninsula, on the Lower Danube and bordering the Black Sea, it lies between 43°37'07“ and 48°15'06“ latitude north and 20°15'44“ and 29°41'24“ longitude east. Parallel 45 (midway between the Equator and the North Pole) crosses Romania 70 km north of its capital Bucharest and meridian 25 longitude east (midway between the Atlantic coast and the Urals) runs 90 km west of Bucharest.

Figure 2.1. Romania’s position in Europe and in the World

Romania borders

The Republic of Ukraine to the north and the Republic of Moldova to the east. To the west is the boarder with Hungary, and to the southwest on Serbia and Montenegro. To the south Romania boarders Bulgaria and to the southeast the Black Sea. Two thirds of its frontiers follow the courses of rivers (the Danube, the Prut and the Tisa) and the seashore (the Black Sea) and one third is traced by land. The total surface area of Romania is 238,391 km^2 (91,843 miles^2).

Figure 2.2. Romania's territorial map

The relief

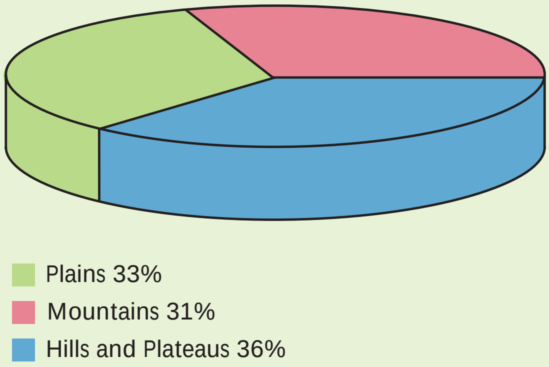
Nature has been particularly generous with Romania, a country whose relief is not only varied but also harmoniously distributed. There are three major well-differentiated relief levels: the highest is represented by the *Carpathian Mountains* (the highest peak is Moldoveanu at 2544 m) the middle by *Sub-Carpathians, hills and plateaus* and the lowest are the *plains*, river meadows and the Danube Delta (the youngest relief unit under permanent formation with an average height of 0.52 m). The main feature of Romania's relief components is their proportional distribution in the form of an amphitheater. The mountains stretch in the shape of an arch in central Romania and cover 31% of the country's area. The hills and plateaus which descend from them occupy 36%, and the plains and meadows, which extend towards the borders, make up the remaining 33%. To the east and south are the Carpathians which are extended the Sub-Carpathians with a similar genesis but lower altitudes (500 - 1,000 m). To the west are the Western Hills which do not rise beyond 300 - 400 m. To the east and southeast lie the two plateaus - the Moldavian Plateau and the Dobrudja Plateau with altitudes of 400 - 600m.

The plains and meadows (formerly sea and lake bottoms) cover the southern and western parts of the country and are low and extremely flat. Between the Carpathians and the Danube lies the Romanian Plain, the principal granary of the country. To the west stretches the Western Plain, which is crossed by many of Romania's rivers.

The multi-tiered relief disposition brings about a similar disposition of the climate, soil, vegetation, fauna and implicitly of the human settlements.

The main relief components of Romania are: Carpathian Mountains, Sub-Carpathians, hills and plateaus, plains, river meadows, the Danube Delta and the Black Sea.

Figure 2.3. Territory according to relief



The Danube Delta

The Danube Delta is one of the most magnificent deltas in the world, and was declared in 1991 as both a Natural World Heritage and Ramsar site.

The Danube Delta has a surface area of 580,000 ha – 2,5 % of Romania's surface (the 22nd delta in the world and the 3rd delta in Europe).

The Danube Delta Biosphere Reserve, at the end of a 2.860 km long river, is a labyrinth of water and land, made up of countless lakes, channels, islands. The Danube Delta is the largest European wetland which forms Europe's largest water purification system. The area is particularly well known for its abundance of birdlife: 312 important bird species are present in the delta. About 90 fish species are found here, including populations of sturgeon. It is also one of the last refuges for the European mink, the wildcat and the freshwater otter.

Natural resources

Romania is endowed with a wide range of natural resources, amongst which are a fertile agricultural base, crude oil, natural gas, large deposits of

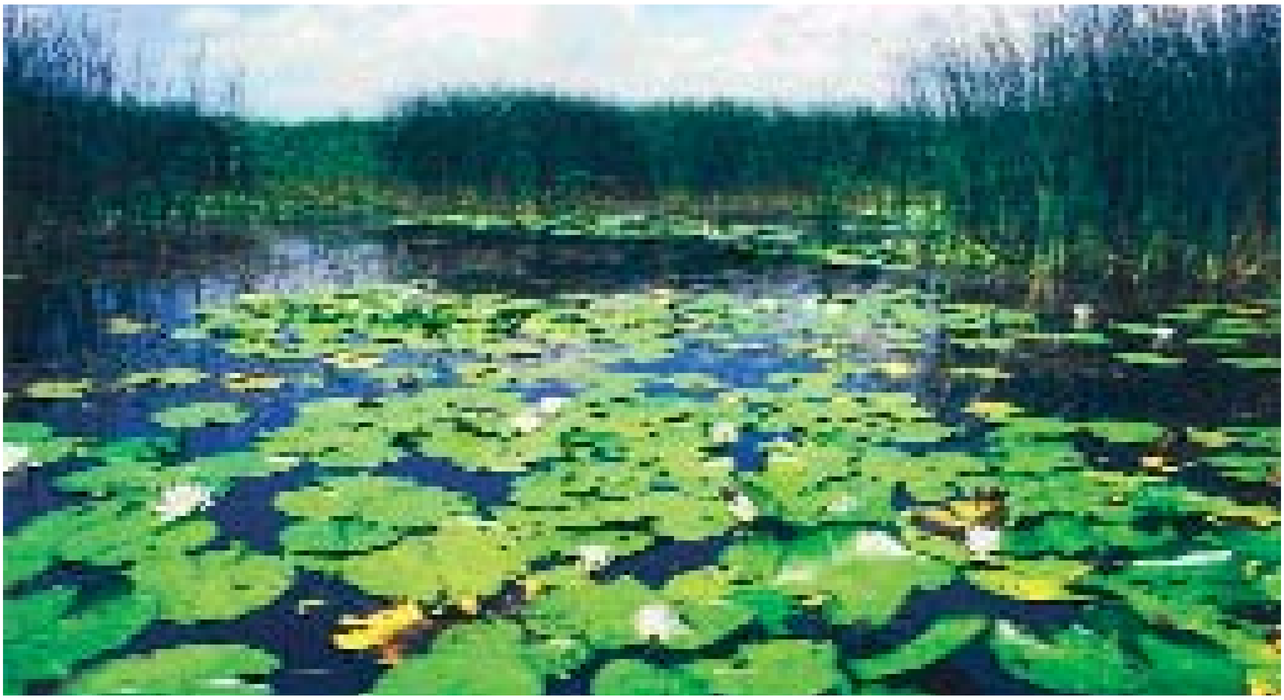
Figure 2.4. The Danube Delta Biosphere Reserve

brown coal and lignite, as well as mineral deposits, ferrous and non-ferrous ores, gold, silver, bauxite, salt, copper, limestone, kaolin sands, siliceous sands, quartz, molybdenum, manganese, iron, graphite mica, etc. A special category of resources is considered to be the large number of mineral water springs and geothermal water deposits.

Rivers

The Romanian network of rivers is radial-shaped, with 98% of the rivers springing from the Carpathian Mountains and feeding directly or through tributaries to the Danube. The Danube is the second longest river in Europe (2,860 km), and flows along 1,075 km of Romania's territory and empties into the Black Sea through three arms (Chilia, Sulina, Sfantu Gheorghe) which form the Danube Delta. The other main rivers in Romania are: Mures (761 km on Romania's territory), Prut (742 km on Romania's territory), Olt (615 km), Siret (559 km on Romania's territory), Ialomita (417 km), Somes (376 km on Romania's territory), Arges (350 km).

Figure 2.5. Rivers and lakes



Lakes

Romania has around 3,500 lakes, but only 1% of them have an area exceeding 1 km^2. More important are the lagoons and the Black Sea coastal lakes (Razim 41,500 ha, Sinoie 17,150 ha) and the lakes along the Danube bank (Brates 2,111 ha, Bistret 1,867 ha). Glacial lakes are mostly spread in the Carpathian Mountains (Bucura is the largest of them, 10.5 ha). Out of the man-made lakes, the most important reservoir lakes for power generation are those on the Danube, at the Hydro-Power Plants of Iron Gates II (40,000 ha) and Iron Gates I (10,000 ha – with a water volume of 2,400 million cubic meters, which is three times as much as that of Iron Gates II), plus the reservoir lakes of Stânca-Costesti (5,900 ha) on the Prut and Izvorul Muntelui on the Bicaz (3,100 ha).

Vegetation

In Romania, the vegetation is determined by the relief and pedo-climatic elements, being displayed in stairs. The forests, which in ancient times and during the Middle Ages used to cover almost the entire area of Romania (except for its southeast), were gradually cut to provide for farming land. Nowadays, forests account for 26.2%

(6,367,000 ha) of the country's area, consisting of beech (1.95 million ha), common oak and evergreen oak (1.12 million ha), coniferous trees (1.85 million ha), hornbeam, elm, ashtree, limetree and other species (1.3 million ha). Alpine pastures cover extensive areas at altitudes higher than 1,800 m and are used mainly for sheep breeding. Over 400,000 ha (6.3% of the total area) is affected by drying as a consequence of pollution.

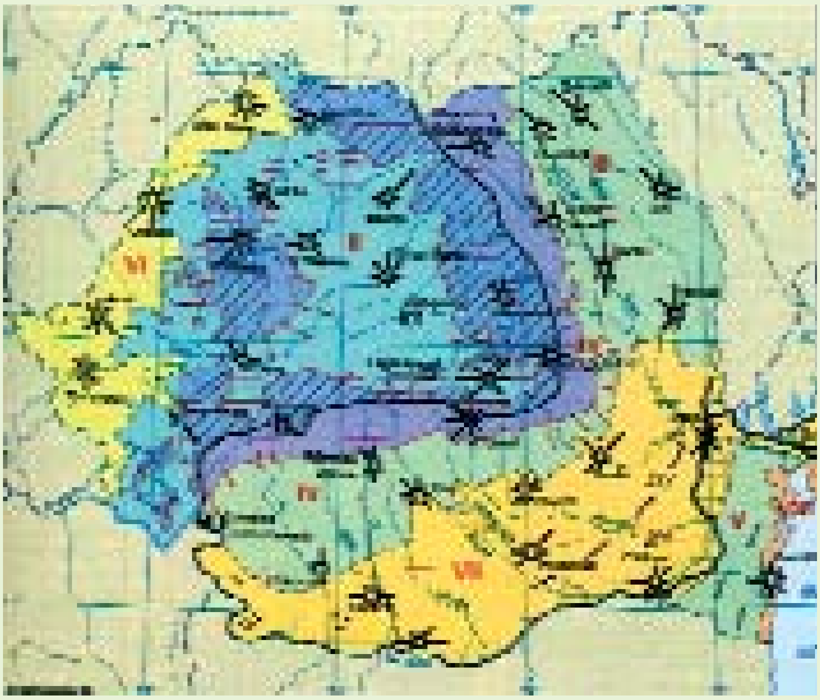
Fauna

Romania's fauna was and still is one of the richest and most varied in Europe, boasting some of the rare and even unique species on the continent. Chamois, brown bears, Carpathian deer, wolves, lynx, martens, capercaillies populate the mountains, while hares, foxes, wild boars, roes, partridges quails and several bird species are typically found in the hills and plains. The Danube Delta with an area of 5,050 km^2 (of which 4,340 km^2 on Romania's territory) remains a sanctuary of native and migrating waterfowl and of fish (carp, sheat fish, pike, zander, etc.). Sturgeons (which produce caviar) can be found in the lower course of the Danube with dolphins, herrings, horse mackerels, grey mullets, gudgeon and others in the Black Sea. Intensive fishing and growing pollution (to which poaching has added in the past few years) have steadily diminished the amount of fish caught over the past two decades. The expansion of populated areas has reduced the freedom of movement of animals and hunting resources have decreased by 10-20% in the past few years.

2.2. Climate profile

Romania has a temperate-continental climate of a transitional type, specific to Central Europe, with four clearly defined seasons. Local differences are caused by altitude and by slight oceanic (to the west), Mediterranean (to the southwest) and continental (to the east) influences.

Figure 2.6. The climate Map of Romania



Temperature

In Romania, the mean temperature in the winter period falls below – 3°C and in the summertime it ranges between 22°C and 24°C. The mean annual temperature is 11°C in the south of the country and 8°C in the north of the country. The absolute minimum temperature registered was -38.5°C at Bod in the Brasov Depression, and the absolute maximum temperature was + 44.5°C (at Ion Sion in the Baragan Plain).

Precipitation

The annual average precipitation slightly decreases from west (over 600 mm/year in the Western Plain) to east (below 400 mm/year in the Danube Delta). The mean annual rainfalls total 637 mm, with higher values in the mountain areas (1,400 -1,000 mm/year) and lower values in the Baragan Plain (500 mm/year), and Dobrudja (400 mm/year).

The west slopes of the Carpathians that stand in front of the wet oceanic air masses get the most important quantities of rainfall. An important part of rainfalls is represented by snowfall in the mountain areas, where snow cover lasts 120-150 days a year.

Winds

Direction and intensity of wind are very different over Romania. The Carpathians represent an obstacle in air masses traveling.

Heigh wind velocity can reach sometimes 30

Figure 2.7. Annual Average temparatures (°C)

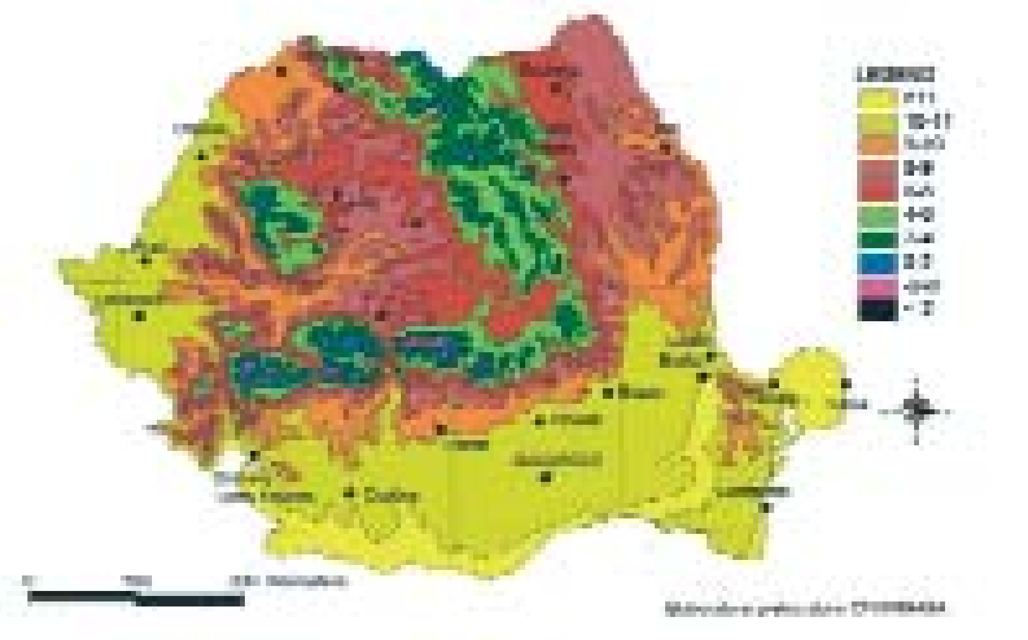
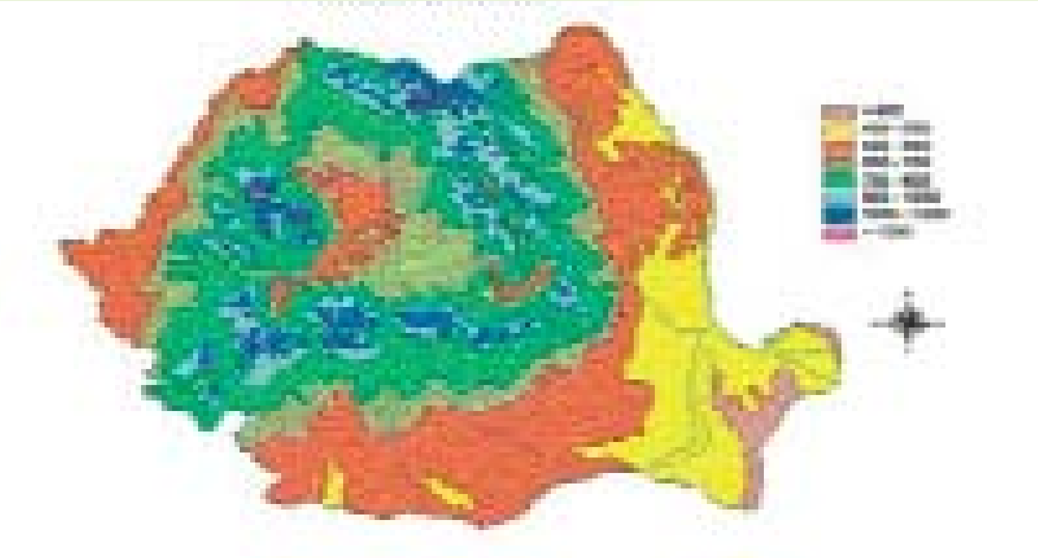


Figure 2.8. Precipitation Annual amounts



m/s, while in low regions it decreases intensely, the wind direction being substantially modified by the relief.

The prevailing winds are from the north to northeast and are hot and dry during the summer, while in winter they are cold and severe. Humid winds from the northwest are most common, but often the drier winds from the northeast are strongest. A hot southwesterly wind, the „Austru“, blows over Western Romania, particu-

Table 2.1. Temperature and prescription values in selected cities of Romania

	Bucuresti	Timisoara	Constanta	Cluj-Napoca
Mean air temperature (°C)				
• January*	-2.4	-1.6	0.0	-4.3
• July*	22.8	21.4	22.1	19.1
Mean air temperature (°C)				
• January 2001	1.4	2.3	4.1	-0.9
• July 2001	24.6	22.2	25.8	19.7
Mean precipitation (mm)				
• Annual*	589.3	609.4	382.6	581.7
• 2001	522.5	685.6	400.4	819.4
• Driest month*	34.0	37.6	23.5	25.6
• Wettest month*	86.0	81.1	41.7	90.0

* Annual average in the period 1901-1990

larly in the summer. In the winter, cold and dense air masses encircle the eastern parts of the country, with a cold wind known as the „Crivat“ blowing in from the East European Plain, while oceanic air masses from the Azores, in the west, bring rain and mitigate the severity of the cold.

Sunshine

Time of sun shine is highest in plain areas (2100 -2200 hours yearly) and a lowest in mountain areas (1800 hours). The highest values are registered on the Black Sea Coast (2300 hours) and in the Danube Delta (2400-2500 hours).

2.3. State organization

The Constitution

Approved by the Constituent Assembly on November 1991 and ratified by the referendum of 8 December 1991 proclaims Romania as a state of law, democratic and social, in which human dignity, civic rights and freedoms, the unhindered development of human personality, justice and political pluralism are supreme and guaranteed values. The Constitution stipulates the separation of the three public authorities (the legislative, the executive and the judiciary). A new revised Constitution will be adopted soon.

The two-chamber Parliament (the Deputies Chamber and The Senate)

Elected by universal vote for a 4 years term, is the people's supreme representative body and the only law-making authority.

The President of Romania

Elected by universal vote, for a 5 years term (the President can be elected only for two terms), represents the Romanian State, watches over the activity of public authorities, fulfill the office of Supreme Commander of the Armed Forces and Chairman of the Supreme Defense Council.

The Government

Ensures the fulfillment of the countries domestic and foreign policies and provides general management of public administration. Public administration in territorial administrative units is grounded on the principles of local autonomy and decentralization of public services.

Local councils and mayors

Elected by direct vote, are the public administration authorities in communes and towns. The county council is the public administration authority that co-ordinates the activities of all commune and town councils in the county. The Government appoints a prefect at the head of each county and of Bucharest municipality.

The judicial authority

Comprises the law courts, the Public Ministry and the Higher Council of Magistracy. The judiciary is made up of the Supreme Court of Justice, the County Courts and other law courts, and Military Tribunals. In the judicial activity the Public Ministry represents the general interests of the society and protects order under the law, as well as the citizens' rights and freedoms.

Climate change related activities

Are mainly under the responsibility of the Ministry of Environment and Water Management (MEWM). The National Commission on Climate Change was established in 1996 to promote the necessary measures and actions for an unitary implementation of the UNFCCC's objectives in Romania. It is an inter-ministerial consultative body under the coordination of the MEWM, which also provides the secretariat for the Commission. The members of the Commission are the representatives of the relevant ministries, several NGOs, universities, traders and invited experts.

2.4. Territorial and population profile

According to Art. 3 of the Constitution, Romania's' territory is divided from an administrative point of view into counties, cities, towns and communes.

County

Administrative unit, headed by a County Council and by a Prefect. The County Council's function is to coordinate the activities of communal and town Councils for securing the public services of county interest. In Romania there are 41 counties and the capital, Bucharest, with a status similar to that of a county. A county has an average area of 5,800 km^2 and an average population of 500,000 inhabitants.

Town

Administrative unit headed by an elected Local Council and an elected mayor. The towns with an important function can be declared municipalities. In Romania there are 262 towns and cities of which 80 have been declared municipalities. The first cities, according to population, are: Bucharest (2,032,000), Iasi (349,000), Constanta (344,000).

Figure 2.9. The Administrative Map of Romania

Commune

The basic unit of administrative organization, being made up of one or more villages and being headed by an elected Local Council and an elected mayor. In Romania there are 2,686 communes with 13,285 villages, with an average of five villages for one commune. Capital of Romania: Bucharest municipality with a population of

1,926,334 (2002) is situated in the south of the country in the Romanian Plain (alt 85 m), and it is the most populous and most important town in Romania, the principal political, administrative, economic, financial, banking, educational, scientific and cultural center of the country.

Table 2.2. Population 1989-2002 in millions

Year	1989	1990	1991	1995	2002
Population	23.151	23.207	23.185	22.680	21.681

Population

In 2002, Romania had a population of 21,680,974 and ranked 43rd in the world and 13th in Europe in this respect.

In urban areas there are 11,435,080 inhabitants (52.7% of Romania's population), in rural areas there are 10,245,894 inhabitants (47.3%) and the ratio for male/female population is 48.8/51.2%. Regarding the classification of localities there are 24 towns which have over 100,000 inhabitants covering 6,231,482 people, which represent 56% of the urban population. Population growth in the present-day territory of Romania is presented through the following census years: 8,600,000 (1859); 12,923,600 (1912); 14,280,729 (1930); 15,872,624 (1948); 17,489,450 (1956); 19,103,163 (1966); 21,559,910 (1977); 23,151,564 (1989); 22,810,035 (1992); 21,680,974 (2002). Today around eight million Romanians live outside the country's boundaries.

Density of population (2001): 91 inhabitants/km^2, about the same density as Austria or Slovenia, and ranks 74th in the world and 26th in Europe.

Vital statistics (rates per 1000 inhabitants): birth rate 9.8%, death rate 11.6%, and natural growth – 1.8%. The negative natural growth registered since 1992 has resulted in the diminishing of the country's population.

Life expectancy (1999-2001): 71.19 years in general, and 67.69 years for males and 74.84 years for females, 71.94 years in urban areas, 70.20 years in rural areas.

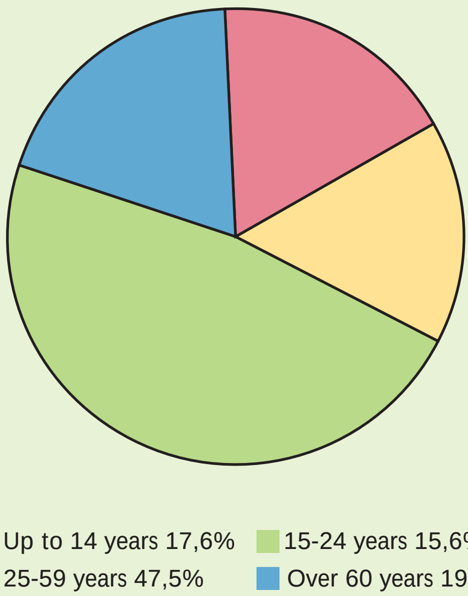
Structure of population by age (2002): 0-14 years – 17.6%, 15-24 years – 15.6%, 25-59 years – 47.5%, 60 years and over – 19.3%.

Emigration

329,783 Romanian citizens emigrated between 1990 and 2001. In 1990, after Ceausescu's dictatorship collapsed, 96,929 persons emigrated and in 2001 - 9,921 persons. During the same period of time 81,526 persons repatriated themselves.

Between 1989 (the base year for Romania) and 2002 the population decreased with 1.47 million inhabitants and the projections show a continuation of this trend Unemployment has been registered in Romania after the collapse of the Communist regime and it represented 0.3 mil. persons in 1991 and about 1 mil. persons in 2002.

Figure 2.10. Population according to age groups



2.5. Economical development

From 1948 until 1989, Romania had a Soviet-style planned economy in which nearly all agricultural and industrial enterprises were state controlled. During those years, it built an economy based largely on heavy industry. Romania remains one of the poorest European countries. Industry contributes to over half of the country's gross national product (GNP) and accounts for one third of the labor force. Major manufactures include steel products, machinery, transport vehicles and chemicals.

In real terms, Romania's economy grew by 4.9% in 2002, far beyond expectations. Romania thus achieved the highest growth rate among all EU candidate countries. The Romanian National Bank has forecast a similarly high growth rate for 2003 and 2004. However, it must be said that according to official estimates the underground economy accounts for roughly 30% of GDP.

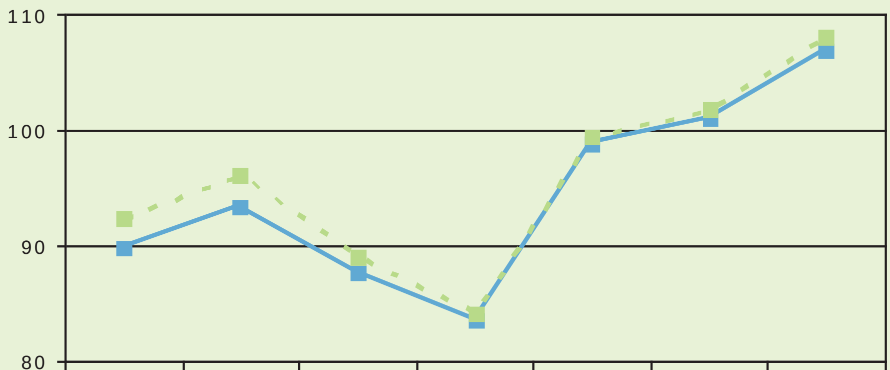
Despite an overall favorable macroeconomic development during the last few years, there is still a considerable need for reform in the Romanian economy. The main areas of favorable economic development in 2002 were industry (+ 7.2% compared to 2001) and the construction industry, which grew by 6.9% compared to 2001. The service sector grew by 5.2%, a much higher level of growth than in 2001 (1.7%), due to the rise in income and improved functional market structures. These three sectors accounted for 78.8% of GDP. The agricultural sector fell to 3.9% as a result of drought and floods. The most important industrial sectors are clothes and textile production, metallurgy, machine production, as well as wood and food processing.

The main macroeconomic index is the *Gross Domestic Product (GDP)*, which represents the value of the goods and services resulted from the production processes which take place within the national economy in order to be consumed, invested, stored or exported.

- *Gross Domestic Product:* 1,167,242.8 (billion ROL current prices)
- *Per capita Gross Domestic Product:* 52,089.5 (thou. ROL current prices)

Romania's foreign trade registered dramatic disruptions after the 1989 revolution. The decrease in domestic production, the dissolution of the Common market, and the costs of observing United Nations sanctions against Iraq and Serbia (two of Romania's traditional trading partners) were the main factors causing a sharp decline in

Figure 2.11. The evolution of the Gross Domestic Product



	1995	1996	1997	1998	1999	2000	2001
Gross Domestic Product	89,8	93,4	87,7	83,5	98,8	101	106,8
Gross value added	92,4	96	89	84,2	99,5	101,7	108,1

Romanian exports and a significant increase in the country's balance of trade deficit. Romania's current foreign trade policy aims at the country's integration into Western markets. Romania is an associate member of the European Union (EU) and the Central European Free Trade Association (CEFTA).

Romania's foreign trade continued to grow substantially in 2002. Among other things, the export industry had an impact on growth. The foreign trade volume, which totaled USD 31.726 billion and represented a growth rate of 35.6%, (exports: USD 13.8 billion, + 21.8%; imports: USD 17.8 billion, + 14.8%). At the end of 2002, the foreign trade deficit was USD 3.98 billion (6.6% of GDP). It was thus slightly above the rate of the previous year.

As shown in following table, the inflation rate has decreased since January 1998. The historical increase in the period 1990-1998 was determined by factors such as price liberalization and the elimination of direct and indirect subsidies for certain products. Inflation was further induced by poor economic performance, the increase of interest rates for circulating loans, high-energy consumption per product unit, low productivity and the increase of wages under social and union pressure.

In order to establish and implement efficient economic policies, which take into account ecological components, research and development activities and technologies deployed are of utmost importance. These determine both production capacities and the extent to which the objectives regarding sustainable development are achieved and all the costs incurred. Most activities shall be undertaken by the private sector. That is why signals coming from the market are so important on the long run and price changes measure still remains the most problematic issue.

The above mentioned data present the extremely fluctuating and contradicting economic development within emerging markets, the decreasing role of the Government and the increase of the private sector, changes in the social sector as well as signals of recovery and stabilisation trends which have been revealed within the last two years. As far as we can see, transition costs are incurred by most of the population, which leads to a sense of impoverishment.

These situations are reflected in the evolution of environment conditions, sometimes generating apparently paradoxical phenomena. The quality of certain environment factors, such as air and water has improved in the last few years, mostly due to accelerated economic downfall.

Figure 2.12. The Inflation Rate in Romania in the period 98-03

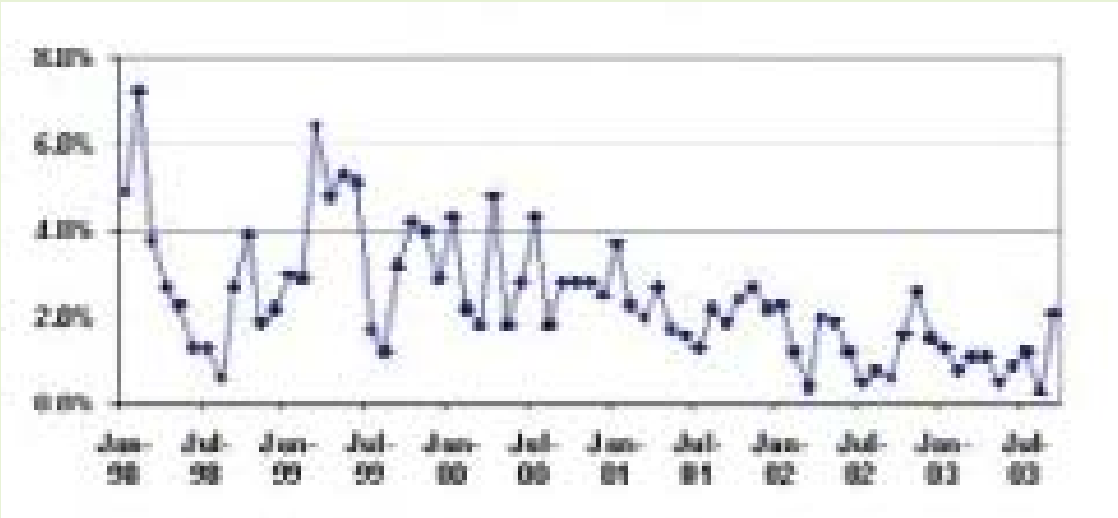
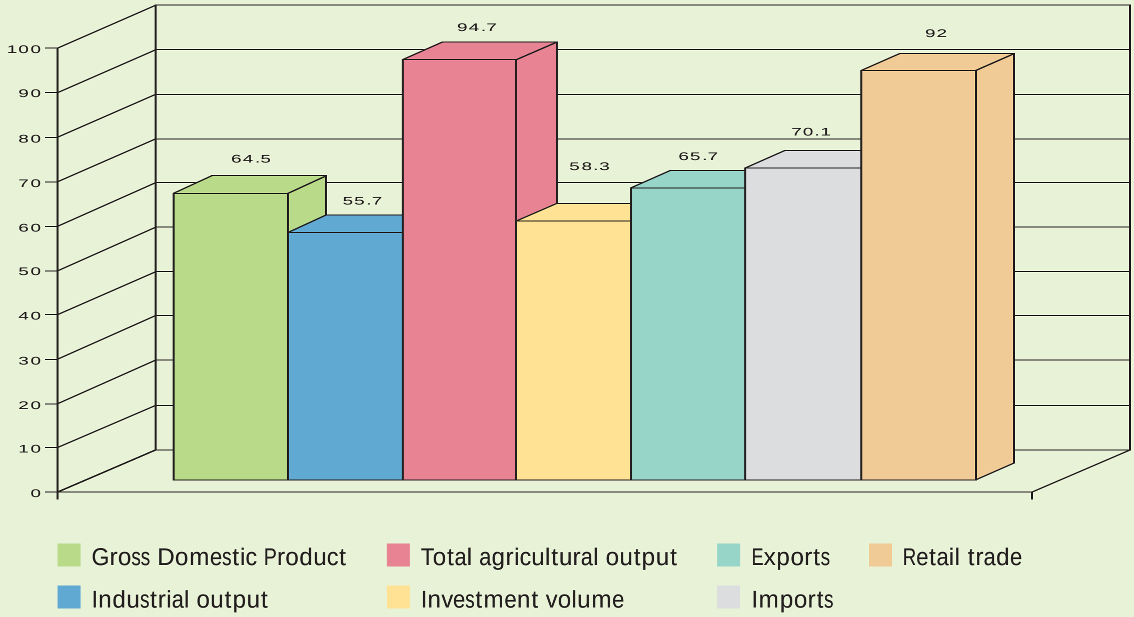


Figure 2.13. Trend of the exchange rate ROL/USD

Figure 2.14. Private sector weight (year 2000)



Unfortunately, the privatisation in part of the forest stock has been followed by deforestation.

In December 1989, Romania moved to a free market economy. Since then, social and economic development goals have been essential parts of the country's development strategy, but were difficult to comprehend in an integrated way. Concepts like sustainable development and the human dimension of sustainability were not well known or understood and were therefore neglected.

In this respect, Romania adopted in 1999 a long-term National Sustainable Development Strategy (NSDS) and subsequently prepared a National Action Plan for the implementation of the NSDS and the introduction of the Local Agenda 21 process in the country.

Political factors are aware that the overall improvement of economic and social conditions as well as of the natural environment in Romania can be accomplished only by adopting a new development model - the sustainable development, focused on the improvement of the standard of living and of environment health (a new Strategy for Sustainable Development in Romania is under preparation and is going to be adopted in 2004).

The essential benchmarks of Romania's development now and in the near future are defined within the national Strategy for medium term economic development (2000 - 2004), which is mainly aimed at the setting up of a functional market economy, compatible with the principles, norms, mechanisms, institutions and policies of the European Union. In doing so Romania has made significant steps in the process of joining the European Union.

In order to accomplish its sustainable development, Romania needs besides its own funds, significant foreign investments and support. Romania has managed to set up favourable conditions in order to attract foreign investors and to develop co-operation with other countries.

The government has significantly improved the conditions for foreign investments and the legislation regarding privatisation. Companies that are sold to private investors have been made more attractive by means of different types of facilities offered.

Regarding the protection of the environment in the context of the sustainable development, in line with addressing global warming, Romania agreed to respect the multilateral environmental agreements ratified and to implement such provisions through policies and measures in sectors and activities that result in generating greenhouse gas emissions, mainly in the production and consumption of energy and transports that are responsible togheter for about 85% of Romania's CO2 emissions.

2.6. Energy

The energy sector in Romania has been plagued by the specific problems faced by most countries with economies in transition:

- High energy intensity combined with low energy efficiency;
- High marginal cost of energy production;
- Low level of legislative, institutional and regulatory infrastructure leading to high transaction costs;
- Consistent energy price increases above the rate of inflation;
- Low collection rates especially from industrial users but also from individual consumers because of the high share of energy bills in total household expenditure;
- Poor record on energy conservation and compliance with environmental requirements.

In the case of Romania these problems have become serious because of the stagnation of the economy, particularly over the past few years, high inflation rates and a disappointing level of foreign direct and portfolio investment. The most important incentive for meaningful reform has been the prospect of accession to the European Union.

Institutional aspects

As part of economic reform measures passed in 1990, the energy sector was reorganized by establishing two types of autonomous state enterprises: Regia Autonomous (RAs) for the production and supply of energy products, and Commercial Companies (CCs) for support services and activities. This enabled the government to separate policy and regulation from operational functions, to bring accountability, and to institute commercial practices in the energy sector. RAs are state holding companies for sectors considered strategic by the Government of Romania including electric power, oil, natural gas, lignite and coal. CCs are joint stock companies established under commercial law.

In June 1998 a restructuring programme was adopted by RENEL, the Romanian Regis Autonomous for Electricity. This resulted in the creation of CONEL, the National Electricity Company.

Also, in July 2000, the Romanian Government decided to divide CONEL into four companies:

- Transelectrica S.A. - National company for the transport of electrical energy
- Termoelectrica S.A. - Commercial company for the production of electrical and thermal energy
- Hidroelectrica S.A. - Commercial company for the production and delivery of hydroelectric power
- Electrica S.A. - Commercial company for the Distribution and supply of electrical energy.

Nuclear activities were split off from the former RENEL and are now under the co-ordination of the Nuclear Power Company Nuclearoelectrica S.A. and the National Regia for Nuclear Activities. Under the structure before the decision, Termoelectrica, Hidroelectrica, and Electrica had been 100%-owned by CONEL. The current government policy is to develop an energy sector that promotes a market-oriented economy.

The National Electric and Heat Regulating Authority (ANRE) established in October 1998, is the independent institution to regulate the electricity market and price. Romania is opening up its electricity market to be compatible with EU practices. In February 2000, ANRE opened up 10% of the Romanian electricity market by allowing ten large industrial companies to select their electricity suppliers and granting electricity supply licenses to five independent electricity producers. In October 2001, the degree of liberalization was increased to 20%, which cleared the way for more large users, of more than 100 gigawatt-hours (GWh) annually, to choose their suppliers of electricity. ANRE plans to open the energy market up further in the next few years.

Energy Summary

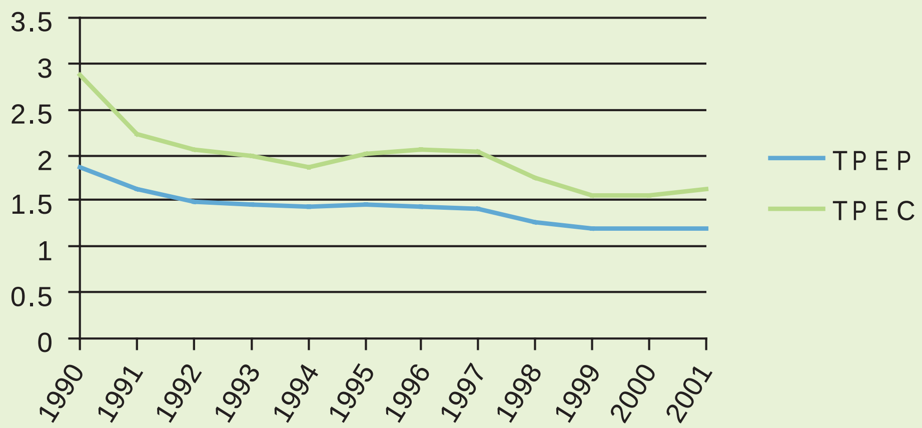
Romania has significant fossil fuel and hydroelectric resources, and has the potential to be energy self-sufficient for several decades. An historical summary of Romania's Total Primary Energy Production (TPEP) and Consumption (TPEC) is shown in the next table.

Table 2.3. Romania's TPEP and TPEC, 1990-2001 (in Quads)

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
TPEP	1.87	1.62	1.49	1.47	1.43	1.46	1.43	1.41	1.26	1.21	1.20	1.21
TPEC	2.88	2.24	2.06	1.99	1.88	2.02	2.06	2.03	1.75	1.56	1.55	1.64

note: 1 Quad = 1 quadrillion Btu
Source: DOE/EIA

Figure 2.15. Romania's TPEP and TPEC, 1990-2001 (in Quads)



Energy Consumption

The evolution of energy indices in the period 1989-2001 corresponds to the general development of the national economy, which had a declining trend in the first 5 years of the period, followed by an increase in the last part of the period. The energy intensity of GDP, related to primary energy consumption, decreased from 1.68 toe/$1000 in 1989 to 1.09 toe/$1000 in 2001, which is a 3% average rate per year. The energy intensity of GDP related to final energy consumption decreased in the same period with 5 % per year.

The final energy consumption decreased significantly during in the same period. In 2001 the total energy consumption represented 46.7% of

the 1989 consumption. Industry represents the most important energy consumer with a decreased share in total consumption from 77% in 1989 to 48% in 2001. During the period 1989-2001 the energy consumption in the industrial sector decreased significantly from $43x10^6$ toe to $12.7x10^6$ toe. Household consumption represented 10% of the total energy consumption in 1989, 21% in 1994 and 32% in 2001. An opposite trend was identified regarding the final energy consumption by population in 2001 which increased 1.5 times the consumption in 1989.

The increase of final energy consumption was recorded not only in the case of household consumption, but also in transport - by more than 76% in 1994 as compared to 1989 and by 94% in 2001, compared with the same base year. As far as industry is concerned, the main branches characterized by significant energy consumption are: chemical industry and metallurgy, iron ores extraction and processing. Chemical industry which is the most important energy consumer in the industrial sector decreased its consumption more than 6 times in 2001 compared with the consumption in the base year.

As a matter of fact, all the industrial branches as well as construction, services and agriculture diminished their final energy consumption in 2001 as compared to 1989, due to their production decrease.

Energy supply

The main types of primary energy in Romania in the period 1989-2001 were natural gas, oil products and coal. In 1989 the natural gas consumption represented about 32.3% from the total primary energy consumption, the oil products and coal about 17% each.

Primary energy consumption is supplied mainly from domestic production. The imported energy represents between 25.5% (year 1999) and 36.3% (year 1990) from the primary energy resources.

The evolution of the domestic production in the period 1989-2001 shows a decrease from $49.57x10^6$ toe to $25.92x10^6$ toe. The imported energy decreased in the period 1989-2001 from $32.98x10^6$ toe to $7.6\ x10^6$ toe, that means about 76% reduction. The biggest share in the imports is represented by the crude oil and other oil products.

Oil

Production and consumption

Romania has crude oil reserves of about 1.4 billion barrels. Oil production has decreased from 294,000 barrels per day (b/d) in 1976 to 127,200 b/d in 2001. With the opening of 15 oil and gas blocks for exploration in 1996, and the influx of western technology, Romanian reserves and production are expected to rise slightly in the coming years.

Romania produces 10% of its crude from offshore wells in the Black Sea, and more exploration is being done there. TotalFinaElf, a French Belgian company signed a 30-year agreement with SNP Petrom to explore the resources there, which started in 1998. Other foreign operators now working in Romanian oil and natural gas fields include Amoco (U.S.), Shell (Dutch), and Enterprise Oil (British).

Additional oil and gas have recently been di-

Table 2.4. Petroleum Production and Consumption in Romania, 1990-2001 (in thousand b/d)

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
Production (total)*	171	148	143	137	142	141	142	141	138	132	128	127
Production (crude oil only)	163	140	136	133	138	135	135	134	132	125	120	119
Consumption	382	277	250	248	221	244	257	270	250	210	213	215

* includes crude oil, natural gas plant liquids, other liquids, and refinery processing gain
Source: DOE/EIA

Figure 2.16. Petroleum Production and Consumption in Romania, 1990-2001 (in thousand b/d)

scovered in the Black Sea, but the find is claimed by Ukraine. Petroleum consumption had been rising since reaching its lowest point in 1994, but exhibited another decline in the late 1990s. Oil consumption for 2004 is predicted to be 310,000 b/d. An historical summary of petroleum production and consumption in Romania is shown in the next table.

Refineries and Downstream Marketing

Romania's refining industry is the largest in Central and Eastern Europe. In the early 1990's, its 10 refineries had an annual crude distillation capacity of 34 million tons, far exceeding domestic demand for refined petroleum products.

SNP Petrom is the vertically integrated oil company of Romania; it is presently 93% state-owned, and scheduled for privatization before the end of 2004. In 1999 and 2000, world oil prices rose and state price ceilings on oil were removed. This led SNP Petrom to restart some of its wells and introduce new technology. At the same time SNP Petrom also began restructuring its operations and management.

Romania has a total refining capacity of 522,000 b/d from its 10 refineries.

However, these refineries are operating under capacity because of lack of oil supplies. Several of the refineries are in need of investments for maintenance and modernization. SNP Petrom plans to invest $236 million over the next two years in upgrading its refineries. An historical summary of refined petroleum products output by fuel type in Romania is shown in the next table.

Table 2.5. Output of Refined Petroleum Products in Romania, 1990-2000 (in thousands of b/d)

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Motor Gasoline	110	73	68	61	80	81	73	75	75	57	61
Jet Fuel	7	8	8	6	5	4	2	2	2	2	3
Kerosene	1	1	1	2	3	1	1	1	2	2	1
Distillate Fuel Oil	127	81	76	77	96	96	86	81	83	64	78
Residual Fuel Oil	156	101	90	73	65	58	47	41	39	36	29
Liquefied Petroleum Gases	8	8	8	8	9	9	9	8	10	9	11
Lubricants	7	6	5	5	4	4	4	3	3	0	n/a
Other *	69	39	19	40	35	46	47	53	52	58	53
Total Output	485	316	275	271	297	299	269	265	265	227	237
Refinery Fuel and Loss	24	12	11	17	11	12	10	10	10	9	9

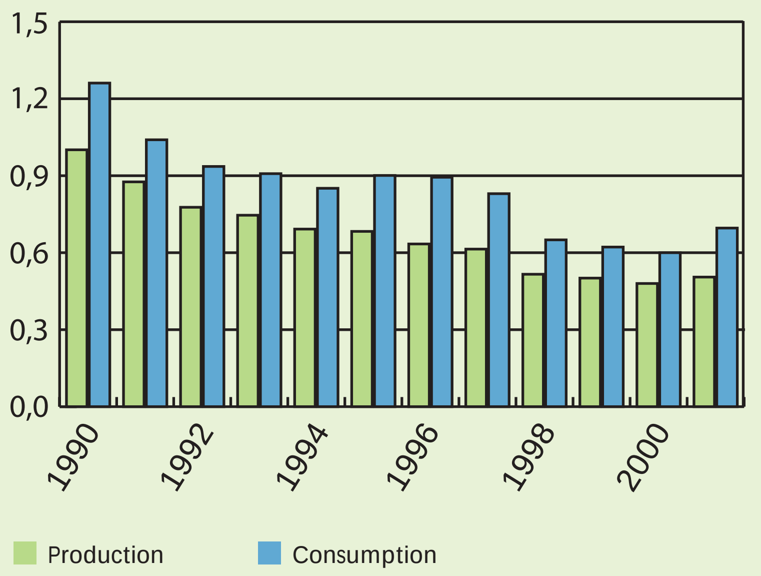
n/a - not available
* includes asphalt, coke, napthas, paraffin wax, and petrochemical feedstocks
note: components may not add to total due to rounding for year 2000, „lubricants“ included in „other“ category
Source: DOE/EIA

Table 2.6. Dry Natural Gas Production and Consumption in Romania, 1990-2001 (in TCF)

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
Production	1.001	0.876	0.777	0.746	0.692	0.683	0.634	0.614	0.516	0.501	0.480	0.505
Consumption	1.261	1.040	0.936	0.908	0.851	0.901	0.894	0.830	0.650	0.622	0.600	0.696

note: „dry“ gas means gas with condensates removed
Source: DOE/EIA

Figure 2.17. Dry Natural Gas Production and Consumption in Romania, 1990-2001 (in TCF)



Natural Gas

Production and Consumption

Romania has natural gas reserves estimated at 13.2 trillion cubic feet, enough for about 25 years at the current consumption rate.

Natural gas consumption in Romania has fallen sharply over the past decade, but now seems to be leveling off as economic recovery is progressing. The two in-country production companies, Exprogaz and SNP Petrom cover about 80% of Romania's natural gas needs; the rest is imported.

An historical summary of natural gas production and consumption in Romania is shown in the next table.

Industry Overview

Slightly more than half of Romania's natural gas is extracted by Exprogaz (a unit of Romgaz), with the remainder extracted by the national oil company, Petrom. While Romgaz is the country's leading gas producer, transporter and distributor of natural gas, it does not hold an exclusive monopoly. Romania's future growth in natural gas production should be stimulated by European Bank for Reconstruction and Development (EBRD) and World Bank projects aimed at introducing new equipment and new production methods.

In June 2000, the Romanian government approved restructuring Romgaz into six parts. The reorganization of Romgaz opened the way for foreign investment. In July 2001, Ruhrgas of Germany became the first foreign company to do so, investing in the Romanian natural gas distribution network.

Recently, the Romanian Government signed a joint venture with private foreign firms to launch an LPG project and potential importation of Liquified Natural Gas (LNG). The joint venture plans a pipeline to carry Liquified Petroleum Gas (LPG) to Bucharest, satellite terminals, deep water facilities at the port city of Constanta, and a potential expansion to include the importation of LNG when it becomes economic to do so. There are also downstream marketing ventures; Shell has a $4 million cooking gas-bottling plant in Romania.

Coal

Production and Consumption

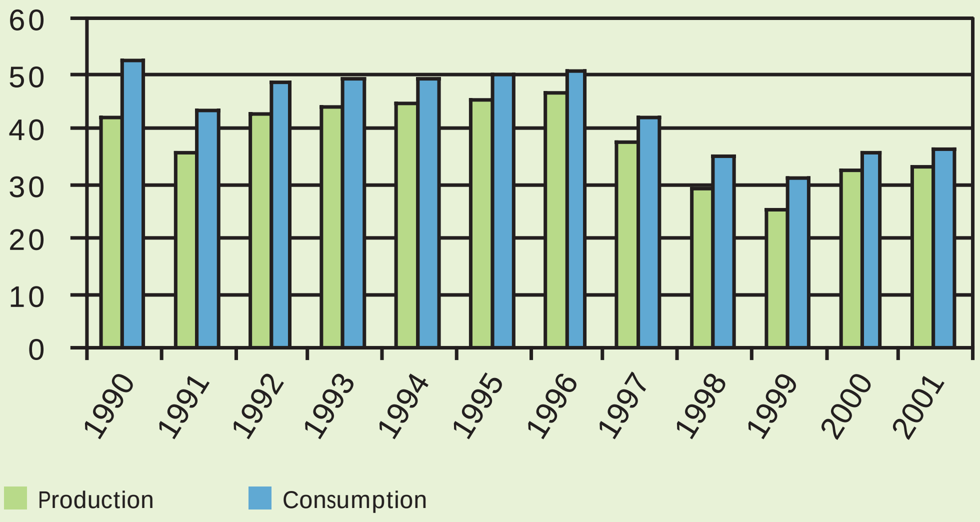
Romania has estimated coal reserves of 3.98 billion short tons. Most of these reserves are lignite and sub-bituminous coal, with the largest reserves located in the Jiu Valley. Less than 10% of the coal produced in Romania is bituminous.

Table 2.7. Coal Production and Consumption in Romania, 1990-2001 (in millions of short tons)

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
Production	42.09	35.72	42.30	43.82	44.70	45.33	46.15	37.27	28.91	25.22	32.28	33.08
Anthracite	*n/a*	*n/a*	*n/a*	*n/a*	*n/a*	*n/a*	*n/a*	*n/a*	*n/a*	*n/a*	*n/a*	*n/a*
Bituminous	*4.90*	*4.22*	*4.52*	*1.35*	*1.51*	*1.27*	*1.46*	*1.93*	*1.55*	*1.21*	*0.31*	*0.34*
Lignite	*37.19*	*31.50*	*37.78*	*42.47*	*43.19*	*44.06*	*44.69*	*35.34*	*27.37*	*24.01*	*31.97*	*32.74*
Consumption	51.97	43.32	48.62	48.85	49.35	49.85	50.12	42.07	34.57	30.79	35.65	36.40

n/a - not applicable
note: components may not add to total due to rounding
Source: DOE/EIA

Figure 2.18. Coal Production and Consumption in Romania, 1990-2001 (in millions of short tons)



An historical summary of coal production and consumption in Romania is shown in the next table.

Coal Mining

The Romanian coal industry has suffered from declines in production, outdated infrastructure, and labor unrest. Miners' unions have protested wage arrears, mine closures, and working conditions. However, the Romanian government is hoping for a resurgence of the coal industry, getting more output from existing mines.

This appears to have started in the year 2000, as Romanian coal mine output improved over the previous year's total for the first time in several years.

Nuclear

Romania has one nuclear power plant under construction with 5 nuclear reactors (the Cernavoda power station) 170 km east of Bucharest, where the Romanian Company Nuclearelectrica is the power plant operator. The energy production at the first reactor (Cernavoda 1) started in December 1996, with an installed capacity of 700 MWe.

This reactor was the first Western-designed nuclear reactor in Eastern Europe. A consortium of Atomic Energy of Canada and Ansaldo of Italy built the Cernavoda facility. Cernavoda 1 now accounts for 10% of the electricity produced in Romania, and the fuel requirement for Cernavoda is met by the Pitesti plant, which manufactures 100 metric tons of enriched uranium fuel annually.

Work on Cernavoda 2 is continuing and it is expected to be completed in 2007. The second reactor (Cernavoda 2) is now approximately 60% complete. Unfortunately, of the remaining units, Cernavoda 3 is 15% complete, Cernavoda 4 is 10% complete, and Cernavoda 5 is 5% complete. Construction is not currently proceeding on these last three units because they are still waiting financing.

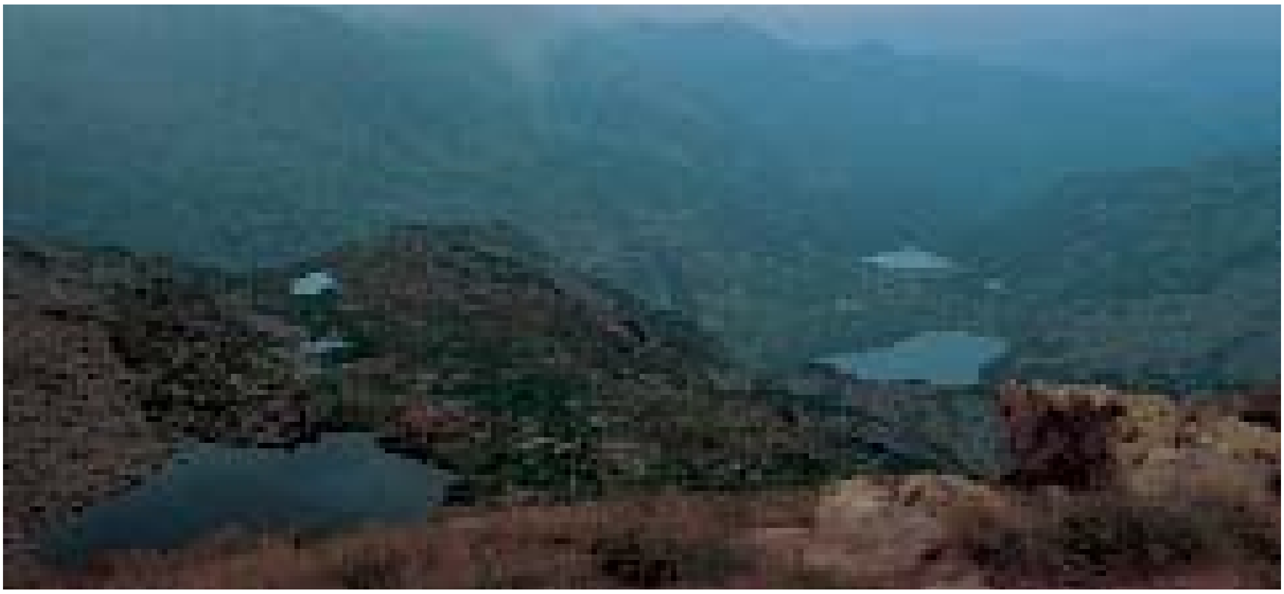
Hydroelectric Power and Other Renewable Energy

Hydroelectric Power

In Romania there are 362 Hydroelectric Power Plants (HPP) with an overall installed capacity of 6120 MW, which means 27.9% of the overall installed capacity of the Romanian power system (21905 MW).

The structure of these HPPs is the following:

- 95% of them are owned by SC HIDROELECTRICA SA and have an installed capacity of 5899.3 MW;
- 2.5% are owned by SC ELECTRICA SA and have an installed capacity of 156 MW;



- 1.9% are owned by SC TERMOELCTRICA SA and have installed capacity of 117.6 MW;
- 0.6% other producers.

Out of these 362 hydroelectric power plants there are:
- 317 HPPs with capacities between 0 and 30 MW, totaling 1069 MW installed;
- 32 HPPs with capacities between 30 and 100 MW, totaling 1529 MW installed;
- 13 HPPs with capacities over 100MW, totaling 3552 MW installed.

With its many rivers, Romania has great potential for hydroelectric power (as much as 14,800 MWe), but the current generating capacity only contributes to a relatively small amount of Romania's power needs. The total hydroelectric power potential is about 40 terawatt-hours (TWh) per year of which 12 TWh per year has already been developed. There may be as many as 5,000 locations in Romania that are favorable for small hydroelectric power plants.

The Romanian government has encouraged foreign investment in hydropower through Hydroelectrica, the state-owned hydropower producer. In 1999, Sulzer Hydro of Switzerland won a $154 million contract from Hydroelectrica to refurbish six turbines at the Portile de Fier I (Iron Gates I) power plant on the Danube River. There are twelve turbines at the Iron Gates plant; Romania operates six and Serbia operates six. It is expected that the project will be completed in 2005 and the capacity of the six Romanian turbines will increase to 1,290 MWe from their present capacity of 1,070 MWe. There is a small JI financing at this project, based on Romania's co-operation with the Netherlands.

In addition to Portile de Fier, there are eleven other hydroelectric facilities with capacities of at least 100 MWe, and dozens of medium-sized facilities of at least 30 MWe. Collectively, these power stations represent about 77% of Romania's currently operating hydroelectric generating capacity. In addition to these larger hydroelectric facilities, there are also many smaller power stations. The Raul Mare River has a series of 10 hydroelectric power plants, each between 10 and 15 MWe. Similarly, the Strei River has a series of seven small hydroelectric power plants, each less than 10 MWe. Hydroelectrica is looking for partners for about 15 hydropower projects with a combined capacity of 780 MWe. These projects will include construction completions, upgrading and management.

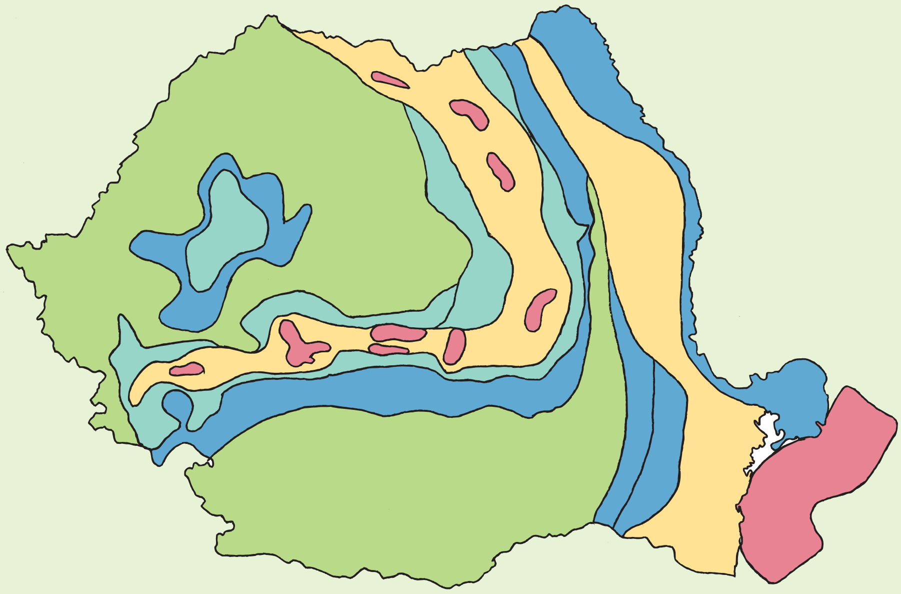
Wind Resources

A countrywide wind-atlas prepared by the Energy Research and Modernizing Institute (ICEMENERG SA) in 1993 is based on WASP software and meteorological data deserved during the period 1980-1990. Romanian wind atlas indicates wind speeds of 4.5 to 11.5 m/s at 50 m height in various areas of the country, notably offshore.

The wind atlas developed by ICEMENERG identifies huge areas with wind speeds over 11 m/s depending on topography. Highest measured wind speed is at Calimani at an altitude of 2022 m, with annual average of 10.3 m/s at 10 m above ground.

As of today there are only two wind/solar demonstration projects in Romania, consisting of 4 kW of wind and 0.85 kW of solar. Both are autonomous projects supplying needs of a household each. There were also two demonstration projects, at the Semenic Mountains and in Agigea (at Black Sea offshore). Due to the lack of funds, lack of subsidies and a electricity production inferior to the estimations, these two projects are not in operation any longer. No other wind turbines operate in Romania.

Figure 2.19. The Wind Map of Romania, ICEMENERG 1993



Wind Potential	A High Mountains	B Open Sea	C Sea Coast	D Open Plain	E Hills
I	>11.5	>9	>8.5	>7.5	>5
II	10-11.5	8-9	7-8.5	6.5-7.5	5-6
III	8.5-10	7-8	6-7	5.5-6.5	4.5-5
IV	7-8.5	5.5-7	5-6	4.5-5.5	3.5-4.5
V	<7	<5.5	<5	<4.5	<3.5

Solar Resources

Romanian areas with high potential for solar energy are: Black Sea coast (5.384 MJ/m2/year), South Plain (5.147 MJ/m2/year) and Danube Delta (5.046 MJ/m2/year).

The average solar radiation in Romania ranges from 1.100 to 1.300 kWh/m2/year for more than half of the country surface.

In Romania, starting from 1979, a large scale programme for various solar applications has been implemented (solar domestic hot water systems for hotels at the Black Sea and for apartment blocks, solar house near Bucharest, solar drying for agricultural products in the South Plain, solar cooling for fish preservation in Dobrogea region, industrial applications). A lot of efforts have been made in research and development activities and an important human potential and infrastructure were available. The peak of installations occurred in 1984-85.

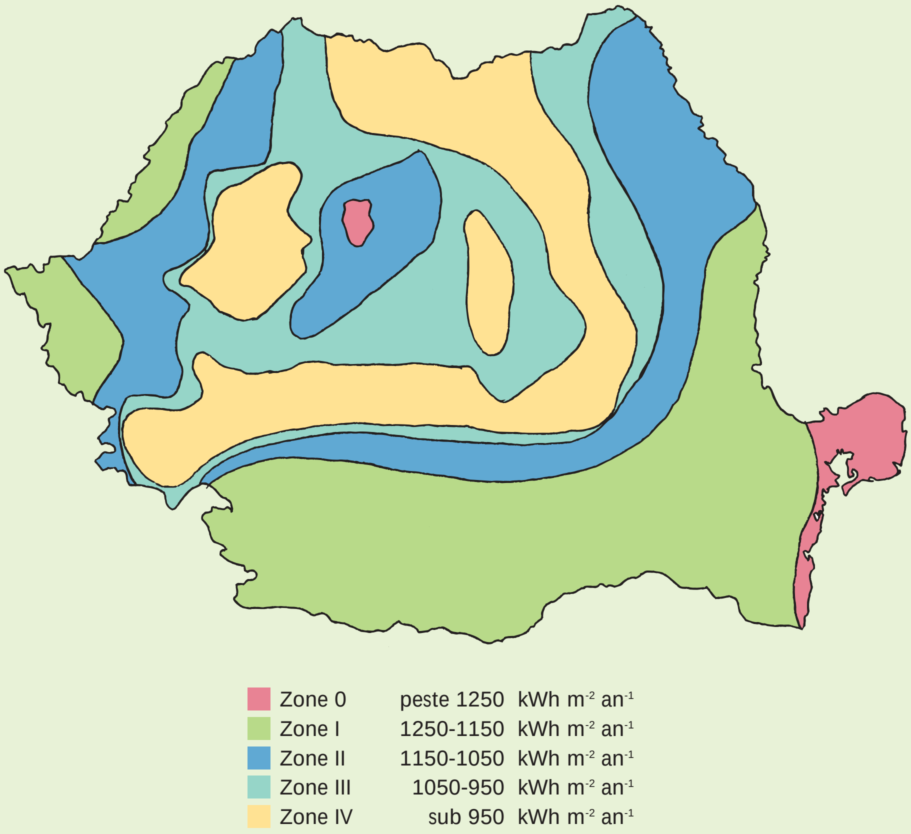
The poor quality of the equipment and installation and the lack of maintenance in many of the early installations resulted in a deep dissatisfaction, creating an additional barrier to further solar energy utilization. The manufacture, installation and research & development activities have practically stopped this activity since 1990 because of the market reforming and the resulting difficult economic situation.

Geothermal Resources

The Romanian hydrogeothermal systems are located in the Western part of the country where most of the proven resources and operating schemes exist, and in the Southern part of the country where proven potential is identified.

Regarding the theoretical potential, the main locations are the West Plain, where most of the proven resources and operating schemes exist, and the South Plains where proven potential is

Figure 2.20. The Romanian Solar Radiation Map, Energetica no 6, June 1999



identified in the region of Bucharest, as well as in the Carpathian Regions. From the theoretical perspective, Romania is endowed with the 3rd (after Italy and Greece) highest geothermal potential of all European countries.

Biomass Resources

The biomass sector in Romania is characterized by a twofold regional distribution. About 90% of fuel wood and 55% of woodwaste are found in the Carpathians and Sub-Carpathians. About 54% of agricultural wastes are found in the South Plain and Moldavia. About 52% of biogas resources are found in the South Plain and the Western Plain.

In Romanian statistical records, all biomass is grouped in two categories:

- firewood & agriculture waste, which accounts about 95%; and
- wood waste from industrial processes with about 5%.

From the total „firewood & agriculture waste" it is estimated that only a share of 30% is commercial biomass and the share of 70% represents the contribution of the biomass harvested by the owners from private forests and gardens and of the agriculture waste coming from rural households.

Great amounts of wastes are obtained at the cutting areas. According to the thickness of the wastes, wood materials are used for firewood, for production of plates from wood fibers, for production of plates from wood particles and for production of cellulose pulp and paper. Up to now in Romania the industry for production of pellets and briquettes was not so developed.

According to the strategy of the Autonomous Forest Company „Romsilva" the annual harvest of standing timber may reach 18 million m^3 by the year 2020; the largest part is allocated for the domestic wood and paper industry. The quanti-

ties of wood and wood wastes used as fuel are expected to remain approximately constant until the 2020.

Humidity of wood varies to a large extent, related to the moment of cutting, sort of wood, climate, regions etc. So the humidity of branches having diameters of 10-40 mm varies between 73-86% for beech and 70 - 96% for fir-tree.

The calorific value of different sorts of wood wastes biomass varies in the limits of 4-7 MJ/kg.

Regarding the crop production structure, the area under grain cereals has the highest share (66%).

The rest of surfaces are under fodder crops (14%) and technical (industrial) crops (13%). Taken together, these groups account for 93% of the entire cultivated area. This reflects the poor diversification of agricultural crops, requiring measures for the enlargement of agricultural crops, especially of those incorporating a high rate of technicality.

Energy Transmission Infrastructure

Petroleum Pipelines

Romania's 2,796 miles of petroleum pipelines are under the control of two state-owned companies. There are two distinct crude pipeline systems within Romania.

The first (owned and operated by Petrotrans) is for transport of crude imported from the Black Sea port of Constanta to inland refineries, while the second (owned and operated by Conpet, a joint stock company presently with 70% ownership by the Romanian State Ownership Fund), transports crude from producing fields in southern and eastern Romania to refineries.

Romania has long advocated building a Constanta-Trieste oil pipeline, which would move Kazakh, oil to Italy by going through the Romanian refinery area and port at Constanta. This pipeline would be especially advantageous to Romania since it would utilize Romanian refineries, and Romania already has agreements with Kazakhstan to refine Kazakh oil.

Natural Gas Pipelines

There are approximately 7,457 miles of gas pipelines with a capacity of about 4,767 million cubic feet per day, or 1,412 Bcf per year. Gas pipelines transport gas from Greece and Bulgaria at the rate of about 388 Bcf per year. Romgaz has had a programme to replace some of its pipeline system. Most of the natural gas imported into Romania comes from Russia, with some of this gas arriving via a pipeline through Ukraine. Romania plans to upgrade its 9,000-mile pipeline network and reduce natural gas leakage.

Electricity Transmission

Romania has an extensive interconnected power transmission and distribution network with an overall length of about 368,000 miles, and a total transformer capacity of about 172,000 MVA (Megavolt-amperes). The national grid operates on 750 Kilovolt (kV), 400 kV, and 220 kV for transmission and 20 kV, 10 kV, 6 kV, 1 kV and 0.4 kV for distribution.

As a limited member of the Interconnected Power System-Central Dispatching Organization, Romania has strong interconnections with Ukraine and Bulgaria, substantial interconnections with the former Yugoslavia, and weaker links to the Republic of Moldavia and Hungary.

The Romanian grid operator, Transelectrica, is currently cooperating with the electric power systems of Greece and the former Yugoslavia (both UCPTE members) and is working to become more fully integrated into the UCPTE system.

Romania's electricity distribution companies are presently all state-owned, but this will likely soon change.

Electricity

Generation and Consumption

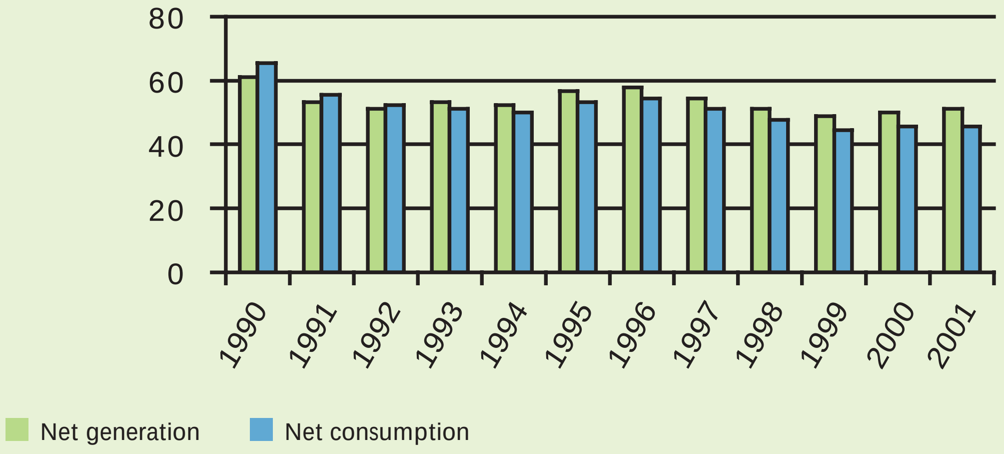
Romania's demand for electricity has been mostly flat over the past decade, unlike some of its neighboring countries. The electricity supply is dominated by thermal-electric sources, with hydroelectric power supplying about one-third of the generation. An historical summary of electricity generation and consumption in Romania is shown in the next table.

Table 2.8. Electricity Generation and Consumption in Romania, 1990-2001 (in billion kWh)

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
Net Generation	60.6	53.8	51.5	52.8	52.5	56.6	58.1	54.6	51.1	48.5	49.6	50.9
hydroelectric	*10.9*	*14.1*	*11.6*	*12.6*	*12.9*	*16.5*	*15.6*	*17.3*	*18.7*	*18.1*	*14.6*	*14.0*
nuclear	*n/a*	*n/a*	*n/a*	*n/a*	*n/a*	*n/a*	*0.9*	*5.1*	*4.9*	*4.8*	*5.2*	*5.0*
geo/solar/wind/biomass	*n/a*	*n/a*	*n/a*	*n/a*	*n/a*	*n/a*	*n/a*	*n/a*	*n/a*	*n/a*	*n/a*	*n/a*
conventional thermal	*49.7*	*39.7*	*39.9*	*40.1*	*39.6*	*40.0*	*41.6*	*32.2*	*27.5*	*25.6*	*29.8*	*31.8*
Net Consumption	65.8	55.2	52.1	51.0	49.6	52.9	54.8	51.0	48.0	44.4	45.5	46.1
Imports	9.5	7.0	4.4	3.0	1.8	0.8	2.2	1.0	1.2	1.2	0.8	0.4
Exports	0.0	1.9	0.2	1.1	1.1	0.5	1.4	0.8	0.7	1.9	1.5	1.6

n/a - not applicable
note: generation components may not add to total due to rounding
Source: DOE/EIA

Figure 2.21. Electricity Generation and Consumption in Romania, 1990-2001
(in billion kWh)



Installed Capacity

An historical summary of installed electricity generating capacity in Romania is shown in the next table.

Industry Overview

Most of the technology in place in Romania's thermal plants is from the 1960's and early 1970's. Because of the decline in demand, many plants that have exceeded their operating life have been decommissioned or mothballed. Only the higher efficiency plants are operated. A number of units are being refurbished to increase availability and efficiency. Romania is actively seeking foreign partners in an effort to modernize and refurbish their thermal plants.

It is estimated that 8,000 MWe of Romania's thermal-electric capacity will need to be replaced or rehabilitated by 2010.

The Romanian Government plans to rehabilitate ten thermal power plants with a combined capacity of 1,360 MWe by 2007, at a cost of $460 million.

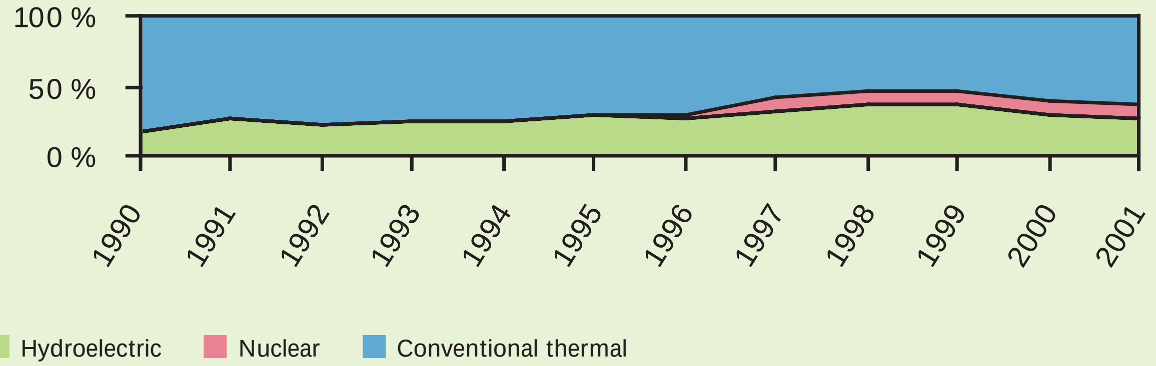
Many of the older power plants, representing a cumulative capacity of 5,900 MWe, will most likely be shut down.

Table 2.9. Installed Electricity Generation Capacity in Romania, 1990-2001
(in thousands of MWe)

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
Hydroelectric	5.58	5.67	5.72	5.69	5.87	5.91	5.87	5.84	5.93	5.93	5.93	6.08
Nuclear	n/a	n/a	n/a	n/a	n/a	n/a	0.71	0.71	0.71	0.71	0.71	0.71
Geothermal/Solar/ Wind/Biomass	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Conventional Thermal	17.32	16.81	16.55	16.58	16.39	16.12	16.28	16.11	15.28	15.56	15.56	15.86
Total Capacity	22.90	22.48	22.27	22.27	22.26	22.04	22.85	22.66	21.91	22.19	22.20	22.65

n/a - not applicable
note: components may not add to total due to rounding
Source: DOE/EIA

Figure 2.22. Net energy generation 1990-2001 (in billion kWh)



The Romanian Government has announced that it would seek $90 million in investments for new gas turbines and heat recovery boilers from independent power producers; there is need for new power generating facilities in the cities of Bucharest, Cluj, and Targoviste. As much as 100 MWe of new capacity could be needed.

Additional challenges faced by Romania include uncollected debt and environmental problems. Romania hopes to get heavy industries to pay for electricity consumed and improve its generation efficiency so that it can reduce emissions.

Kyoto Protocol's Joint Implementation is an important mechanism for financing in part energy efficiency and rehabilitation projects at thermal power plants.

2.7. Transports

Lying in the center of Europe, Romania contributes to the achievement of international economic exchanges between the West and East, North and South of the continent, between Europe and the Middle East.

The Carpathian Mountains are crossed by scores of railways. Bucharest is Romania's foremost railway node, with 8 main lines leaving from the City, most of which are connected to international routes. Romania manufactures all kinds of railway cars, mainly electric and Diesel-electric engines.

The length of roads that add to the railway and river transportation routes exceeds 72,800 km, with an average density of 30.7 km per hundred km^2. As in the railway system, Romania's capital city is the no. 1 road junction, where routes which cross the territory extend in every direction. Some of these roads are connected to major European roads, such as E60 running from Hamburg to Constanta, via Oradea and Bucharest.

River navigation is practiced on most of the Danube. Ships with a draught exceeding 7 m. can navigate on the maritime Danube downstream from Braila. Upstream from Braila there navigate ships with a smaller deadweight and a draught of up to 2-2.5 m.

The Danube-Black Sea Canal and the commissioning of the Danube-Main-Rhine Canal contributed to the creation of a waterway of European importance that connects the North Sea to the Black Sea. The Iron Gates I an II hydropower and navigation systems, which include a set of locks, facilitate more intense traffic.

Maritime navigation mostly involves big-deadweight ships. Romania's fleet boasts 568 ships of all categories, up to 165,000-170,000 tdw. Sixty percent of this country's imports and exports pass the port of Constanta where big shipyards exist.

Besides the traditional partners (China, Greece, the Republic of South Africa and Belgium), new major outlets have emerged (the Netherlands, Germany, Sweden, Norway, South Korea).

The internal airlines connect the Capital to major cities like: Craiova, Timisoara, Arad, Oradea, Cluj-Napoca. Several international lines connect Bucharest to Budapest, Prague, Berlin, Copenhagen, Vienna, Frankfurt, Brussels, London, Moscow, New York, as well as to Rome, Sofia, Athens, Istanbul, Tel Aviv, Beijing, Cairo, etc.

Romanian civil aviation is comprised of commercial companies and regies autonomous, 17 airports, as well as units for the training of personnel. The Romanian fleet is one of the youngest in Europe with most of the planes being 3-5 years old.

The Government has drawn up a bill of law on modernizing the country's air and maritime transports. 13 highways are to be built covering 3000 km, and so are railway lines totaling another 1200 km, bridges over the Danube and the Prut and four new airports at Brasov, Galati, Alba Iulia and Bistrita. Meanwhile railways will be upgraded to suit high-speed trains. Several pan-European corridors will cross the territory of Romania: the Danube connected to the Rhine-Main-Danube Canal, the main railway lines, the Westward highway and the Bucharest-Chisinau-Kiev road.

Regarding freight cars, emphasis goes to the purchasing of cars for combined traffic, so that Romania may be connected to the major European axes of railway transport.

More than 40 maritime cargo ships, aggregating 491,750 tdw under construction in Romanian shipyards. It was estimated that in 2010 Romania will need 80 ships totaling 4,500,000 tdw. The strategic fleet will make it possible to maintain the national transport capacity at 4 million tdw between 2003 and 2007.

2.8. Industry

Industry in Romania was state-owned until the fall of the Communist government in 1989. Privatization of state-owned businesses began in 1991. The economy of Romania was dominated by the big industry, especially in the period 1979-1990, covering almost all the industrial branches: from those linked with oil extraction up to those representing fine mechanics.

At present the iron and steel industry, machine, and petrochemicals are the country's leading industries. A large investment in petrochemical plants coincided with a decrease in Romania's reserves and the need to import oil.

The manufacturing industry produces tractors, motor vehicles, ships, machine tools, and other equipment. The textile industry is significant and produces clothing for export. The forestry industry supplies material to be used in the manufacture of furniture and pulp and paper.

After a period of profound restructuring, Romanian industry showed a recovery, especially in the high-tech domains (automatics, electronics and computer industry).

The main areas of favorable economic development in 2002 were industry (+ 7.2% compared to 2001) and the construction industry, which grew by 6.9% compared to 2001.

2.9. Agriculture

Since 1989, state farms have been retained as large units, but collective farms have been broken up into individual peasant holdings-although in the main arable areas they have been replaced by loose cooperative associations. Romania faces major problems in improving the quality of farm production (especially livestock breeding) and is setting up an efficient system for marketing.

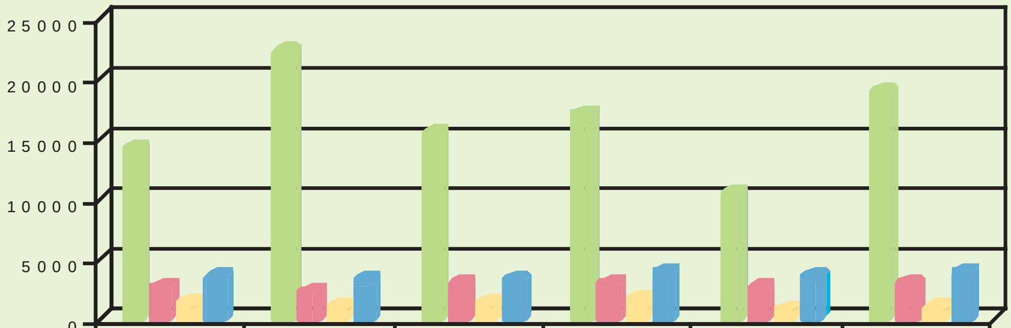
The climate and relief of the extensive Romanian plains are most favourable to the development of cereal crops, although these also are found in the Subcarpathians and in the Transylvanian Basin, where they occupy a high share of the total arable land. Wheat and corn (maize) are most important, followed by barley, rye, and oats.

Two-row barley is cultivated in the Brasov, Cluj, and Mures areas, where it is used for brewing. The tendency is for the acreage of cereals to fall as yields increase and industrial crops require more land.

Vegetables - peas, beans, and lentils - are planted on a relatively small area. Peas are the predominant crop; maturing in time for an early harvest, they allow a second crop, usually fodder plants, to be grown on the same ground. Vegetable cultivation is particularly marked around the city of Bucharest, with specialization in the production of early potatoes, tomatoes, onions, cabbages, and green peppers. Similar gardening areas are found around major cities. Other important vegetables and technical plants include potatoes, sugar beets, sunflower seeds, and hemp, flax, rape, soybeans, and tobacco.

Romania can be counted among the main wine-producing countries of Europe. It specializes in the production of high-quality wines, using modern methods; with the growth of the tourist trade, its wines are becoming known and appreciated by a larger international public. Large quantities are exported annually. The major vineyards are at Odobesti, Panciu, and Nicoresti, with 5 or more other major centres. Both white and red wines have won various international awards.

Figure 2.23. The dynamics of vegetal agricultural production

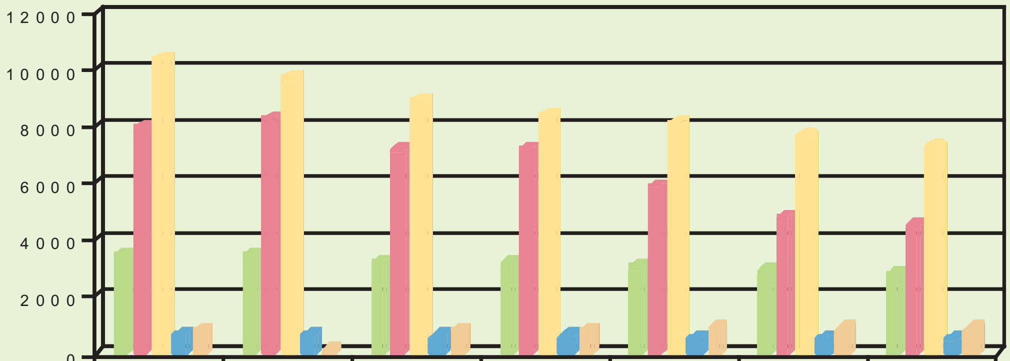


	1996	1997	1998	1999	2000	2001
Cereal grains	14199,7	22107,3	15452,7	17037,3	10477,5	18870,9
Vegetables	2727,5	2427,6	2819,1	3049,4	2527,8	2877,4
Oil plants	1218,7	1001,6	1317,6	1606,6	868,5	1005,5
Potatoes	3591,4	3206,1	3319,2	3957,1	3469,8	3997,1

At altitudes between 1,000 and 1,600 feet (300 and 500 metres), orchards are found on almost all the hillsides on the fringe of the Carpathians. There is specialization in fruits with a high economic yield. Orchards have solved problems of soil erosion on many unstable hillsides.

Livestock breeding has a very long history in Romania. Sheep can be raised wherever grass is available, whether in the Alpine pastures or the Danube plain and valley. About half of the cattle stock is raised for beef, which is an important export.

Figure 2.24. The number of animals in the period 1996-2002



	1996	1997	1998	1999	2000	2001	2002
cattle	3496	3435	3235	3143	3051	2870	2800
pigs	7960	8235	7097	7194	5848	4797	4447
sheep	10381	9663	8937	8409	8121	7657	7251
goats	705	654	610	585	558	538	525
horses	806	86	822	839	858	865	860

Compared to 1989, a considerable reduction of animal livestock has been registered: by 48% for bovine, 44% for poultry, 36% for pigs and by 27% for sheep. Only the number of horses recorded an increase by 23%. The reduction manifested also for breeding stocks, which is an extremely alarming trend. The decrease under the existing level, which represents a technological minimum, can impair the animal breeding genetic fund. The average yields in livestock sector are far from the technical and technological progress recorded in the European Union Member States.

After 1989 the number of cows and heifers was kept at an acceptable level which linked with an adequate breeding practices in the private led to the increase of average yield exceeding that obtained in the agricultural co-operatives production units.

The causes that determined the decrease of pigs number were due especially to the problems that the huge complexes for fattening pig raising had faced. As these complexes belonged to the state, the delivery prices have not been liberalized for many years and the prices were kept at levels under the production expenditure. This occurred due to the lack of adaptation to the requirements of a market economy, plus through competition with the prices of meat obtained in the private sector and with meat imports at prices which were subsidized in the countries of ori-

gin. The privatization or the liquidation of the units for fattening pig raising started after 1996. The industrial complexes of fattening pig raising had to become suppliers of piglets for fattening by the individual farmers and by the small and medium size farms. These complexes faced problems related to pollution, equipment and shelter maintenance. They also have an oversized administrative structure, large supply costs and financial problems, so that they will hardly become competitive without implementing major investments.

The evolution of sheep and goats number has permanently shown a downward trend. The decrease in the sheep stock was due to the same causes as the decrease in the cattle stock. The slaughtering and the export of live sheep without any restriction were also the causes that led to this situation. The private sector maintained the animal numbers, especially for milk and meat production. Regarding the wool production, it should be mentioned that not all of the stocks were traded and the prices obtained are not welcome by the sheep breeders.

2.10. Land use and forestry

Land use

The most important natural resource of the country is represented by its land stock, which includes all the land plots (including the areas covered with water), regardless of their use.

From the next figure and table we notice that the most important type of soil is represent by agricultural land (62%), followed by forests and other land with forest vegetation (27%). Other types of land occupy 11% of the total area of the country (waters, ponds, lakes, yards and buildings, means of communication, etc).

Agricultural surface has increased in the year 2000 by 68,115 ha (0.46%) compared to 1996, while forest and water surface has decreased by 233,009 ha (3.48%).

Arable land surface is about 63% of the total agricultural area, while the rest is represented by pastures (about 23%), hay fields (about 10%), vineyards (1.95%) and orchards (1.83%). As a result of the demographic index growth, during the last 65 years arable area per inhabitant has decreased from 0.71 ha (in 1930) to 0.42 ha in 2000. According to the ownership structure in 2000, owners-

Figure 2.25. Territory according to physical use in Romania

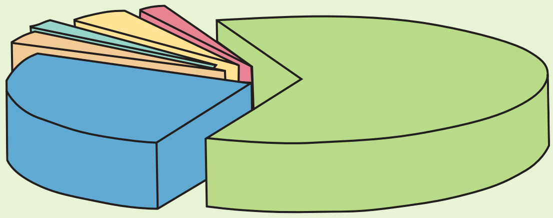


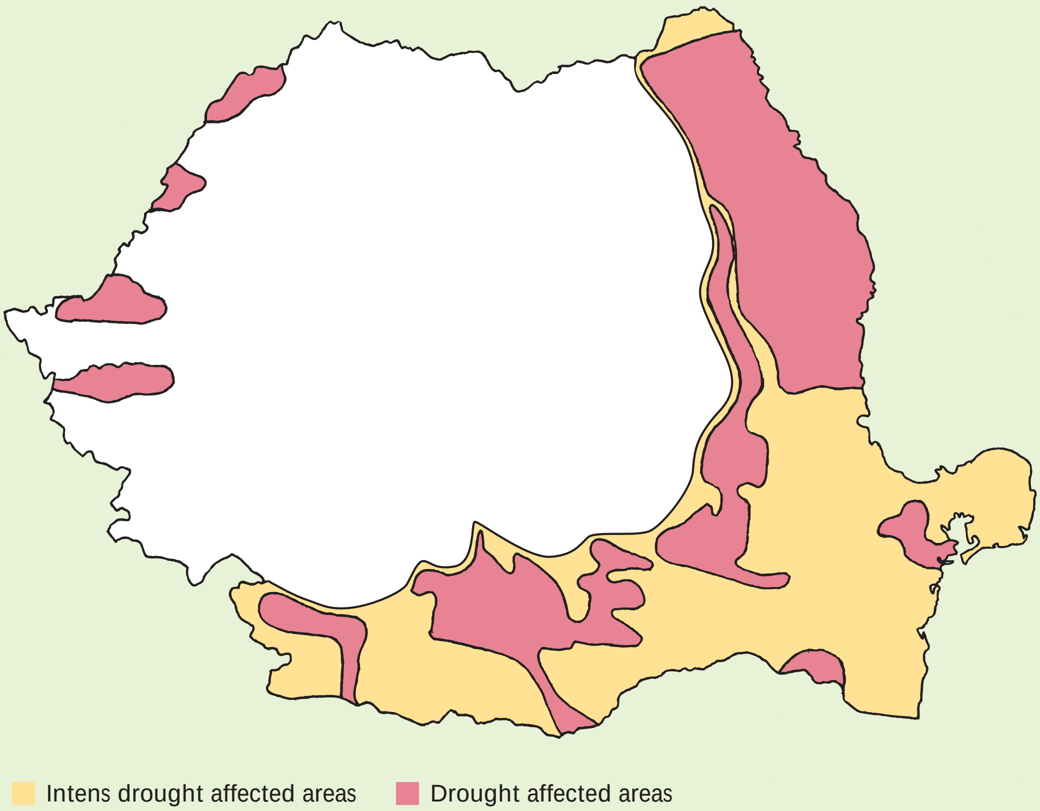
Table 2.10. Territory according to physical use in Romania (absolute value)

Type of use	Surface ha	%
Agricultural lands	14,856,845	62.32
Forests and other land covered by forests	6,457,283	27.09
Buildings and yards	632,856	2.65
Roads and railways	388,147	1.63
Waters, ponds, lakes	867,839	3.64
Other surfaces	636,101	2.67
TOTAL	**23,839,071**	**100**

Table 2.11. Change in territory according to physical use in Romania

Type of use	Year (%)				
	1996	1997	1998	1999	2000
Agricultural land	100	100.00	100.09	99.61	100.46
Forests and other types of land covered with forests	100	99.97	99.73	101.50	96.52
Buildings and yards	100	99.99	100.67	100.19	101.05
Roads and railways	100	100.03	100.67	100.19	101.05
Waters, ponds, lakes	100	99.90	99.28	99.14	97.85
Other areas	100	99.41	101.91	93.96	141.40

Figure 2.26. Areas affected by drought in Romania



hip is rather significant (10,548,726 ha, of which 7,700,359 ha are arable), most of it belonging to individual households and simple associations (9,157,596 ha, of which 6,301,176 ha are arable), while the rest belongs to companies or local and co-operative funds.

The existing data and the other environmental factors provide an overall picture of the problems caused by desertification in certain areas in Romania.

In certain areas, the soil humidity during the summer-autumn season has reached the drooping coefficient level or levels close to this one. In the period 1990 - 2000 the irrigated area has decreased from 62.5% to 9.4% of the total area. In 2001 about 400,000 ha were irrigated without reaching the target in view.

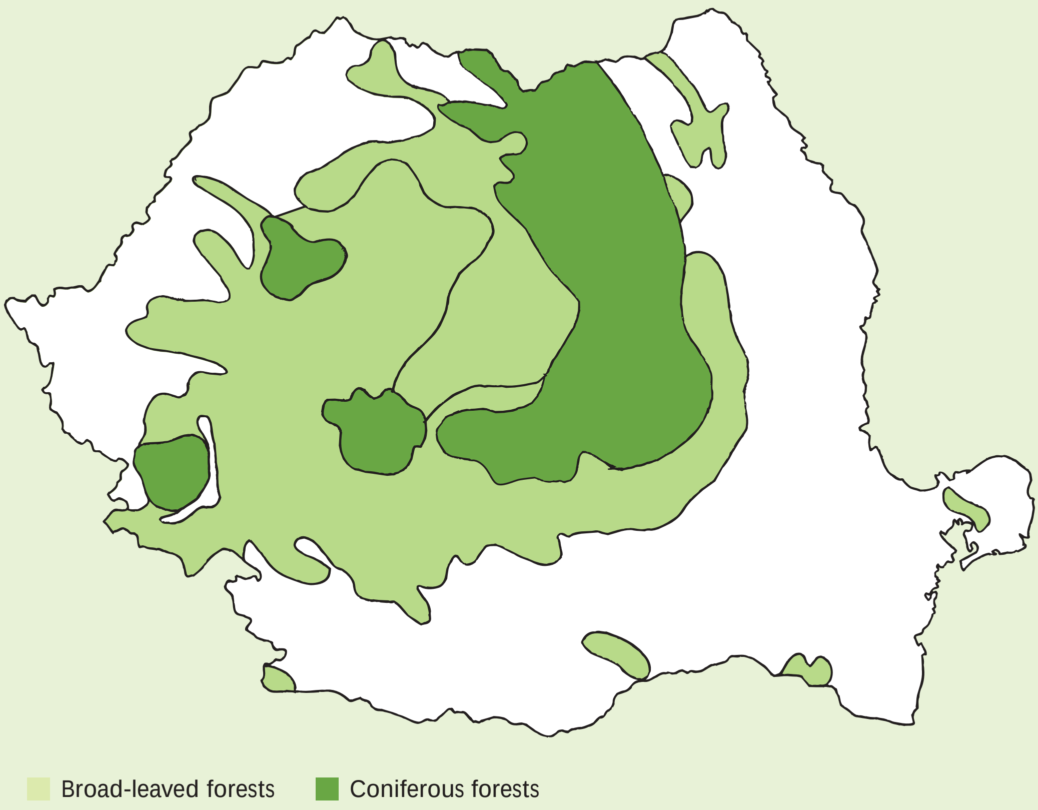
The main problem facing the areas affected by drought is that of adopting management policies which are adequate for drought forecasts in such a way as to provide short term measures (the compensation of the humidity deficit by means of irrigation, the cultures structure, adjustment of soil and fertilisation technologies, etc.) and medium and long term measures (the provision of water reserves for accumulation lakes, the setting up of forest covers for protection, etc.).

Forestry

The Romanian forest area is of approximately 6,370 thousand ha of forest, to which approximately 320 thousand ha of land is covered with wood vegetation (forested pastures, alignments, etc.) are added. The national forest stock occupies 26.7% of the total area of the country, and is not uniformly divided in regards to geographic areas (65% mountain, 28% hill, and 7% field).

Due to the physical and geographical features of the natural environment (irregular relief, deep slopes, friable lithological sub-stratum, accentua-

Figure 2.27. The map of forest covered areas (ICAS Bucharest)



ted torrential character, etc.) and to the social and economic requirements, approximately 52% of the Romanian forests are utilized for special protection functions, mainly hydrological, anti-erosion and climate protection.

Taking into account the role that forests play for the preservation of biodiversity a number of steps will be taken in order to recover the ecosystems damaged through the ecological re-construction of degraded land and the expansion of areas covered with forests. These steps include the field area, by creating forest covers, fighting against drought and desertification, the increase of the absorption capacity for carbon dioxide and to provide a greater climate stability.

Romanian forests have a high tourist and hunting potential. There are more than 400,000 ha of virgin woods in Romania, and their resources are very valuable taking into account the natural bio-diversity.

2.11. Waste management

One of the most important problems regarding environmental protection is the waste management. Due to increased consumption during the last ten years, but also to old technology and installations, Romania generates millions of tons of waste products on a yearly basis. There are also huge amounts of waste stored in urban and industrial waste deposits, which cover a lot of space and negatively affect the quality of the environment, especially that of underground and surface water.

Mining, industry and municipalities are the main waste generators. The significant decrease in waste generation has is a consequence of the economic decline due to decreased output. Municipal waste is constant, but the year 2002 witnessed a slight decrease to 7.9 million tons per year.

Variation in waste composition is a function of area and season.

In 1989, industry contributed more than 50% to the Gross Domestic Product (GDP), but today this weight is 10%. Industrial output dropped 30-50% in 2002 as compared to 1989. The main reason is the loss of some of the traditional outlets, as well as the failure to update technology. All these contribute to the incapacity to set up a competitive and developed market economy, taking into account the fact that Romania's economy has accumulated long periods of liquidity crises.

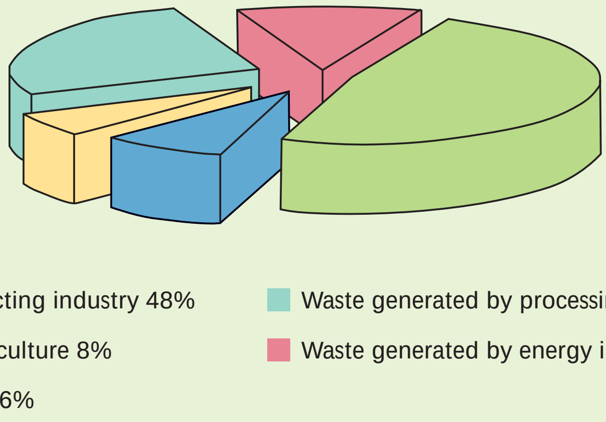
The privatization of the state-owned industrial sector has led to significant changes regarding ownership and increased responsibility involved in setting out environmental protection issues. Historical pollution is mainly the responsibility of the state, and currently is emerging in several fields of activity.

Industrial privatization and modernization has to be achieved together with the introduction of best technologies and practices already used in the EU Member States. Industrial output generates the amount and the composition of industrial waste. The situation may be highlighted as follows:

The main categories of industrially generated waste:
- mine barren gangue;
- ashes and thermal plant slag;
- metal waste;
- residual mud;
- chemical waste;
- iron waste;
- construction waste.

Waste generating industrial activities:
- the extracting industry;
- the energy industry;
- metallurgy;
- the chemical industry;
- machinery and chemical products industry;
- the food industry;
- crude oil refinery.

Figure 2.28. Waste production structure in 2001



A separate type of output waste is represented by hazardous waste. In Romania, 145 types of hazardous waste have been identified out of the 237 listed in the European Waste Catalogue.

Over 380 million tons of waste have been generated during the year 2002 of which approximately 2% is represented by municipal waste, 7% is waste generated by industry, agriculture, construction, and 91% is mining waste.

Municipalities have collected over 7.9 million tons of waste during the year 2002. The weight of urban waste of the total of waste generated in

Romania has increased during the last few years, due to the decrease in industrial and agricultural waste.

The separation of household waste in urban areas is only in an experimental stage in some towns. That is why, only 7% of the household waste made up of recyclable materials (paper, carton, glass, plastic, metals) was recovered for reutilization, and the rest was eliminated through storage. The burning of the municipal waste is not so developed in Romania.

Medium index calculated for the municipal waste is 0.38 tons/inhabitant/year representing 1.04 kg/inhabitant/day. The urban population with direct access to the waste collecting services is around 10 million inhabitants.

Table 2.12. Structure, composition and characteristics of waste in Romania

Components		**% weight**	
	1975-1979	**2001-2002**	**Differences**
Paper	6.4	11.1	+ 4.7
Glass	2.6	5.1	+ 3.5
Plastic	3.3	9.9	+ 6.6
Metals	2.9	4.5	+ 1.6
Textiles	2.2	5.3	+ 3.1
Other organic waste	70.4	50.6	- 19.8
Other non-organic waste	12.2	13.3	+ 1.1
Characteristics			
Humidity (%)	54.96	40.81	- 14.15
Ashes (%)	20.42	27.92	+ 7.5
Inferior caloric power (kcal/kg)	693	1885	+ 1192
Superior caloric power (kcal/kg)	1125	2267	+ 1142

In 2002 the recorded number of urban waste deposits belonging to towns and municipalities was 252. Urban deposits lie on approximately 125 hectares of land, which compose 10% of the total area used for waste deposits.

Most urban waste deposits are mixed (60%), as they are used to store both urban waste and usually not dangerous industrial waste.

Approximately 30% of urban deposits are simple household deposits, while 10% are special purpose deposits for the treatment of urban mud. 7% of the total urban waste deposits are situated within built-up area, 87% are situated outside town limits and 6% are situated on water shores.

Approximately 80% of deposits are situated on relatively small areas (between 0.5 and 5 hectares), the remaining 20% are large urban deposits and lie on areas between 5 to 20 hectares. The area occupied by waste in the case of the Glina landfill in Bucharest is 40 hectares (of the 110 hectares used for depositing). 14 ecological urban deposits are functioning in Romania in compliance with the EU Directive 1999/31/EC.

During the last few years, Romania has concentrated on several important facts regarding environment protection and waste management. Thus, the Ministry of Environment and Water Management via its Waste and Dangerous Chemical Substances Management Division pursues

Figure 2.29. The seperation of household waste in urban areas experimental stage 1975-1979

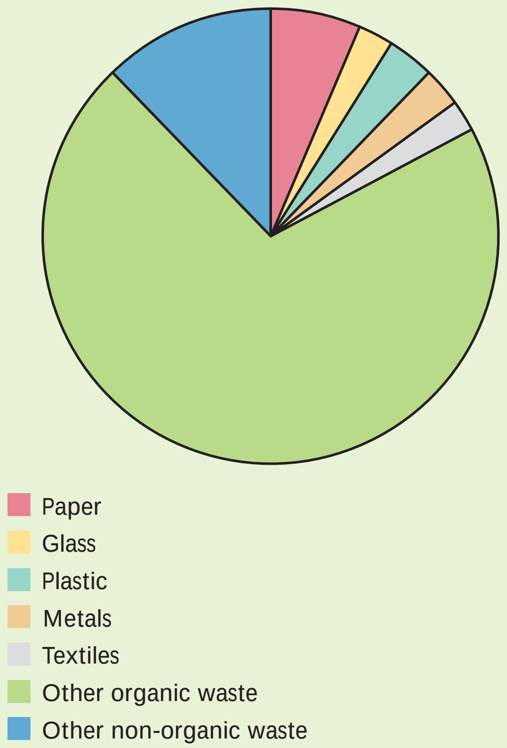
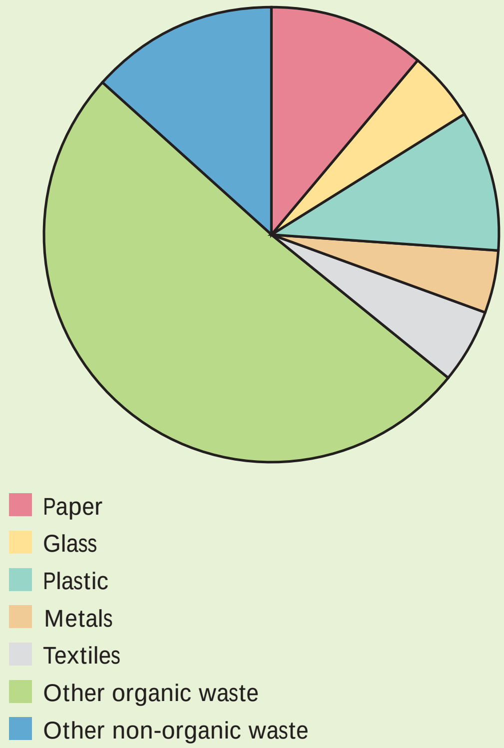


Figure 2.30. The seperation of household waste in urban areas experimental stage 2001-2002



the harmonization of the Romanian legislation in the field of waste management and has initiated the setting up of a national strategy and the implementation of a National Activity Plan for the Management of industrial and urban waste.

During the last few years, important regulations in the field of waste management have been passed. These regulations mainly regarde waste and dangerous waste management, the management of used oils, the management of various compounds, the management of recyclable industrial waste, batteries and accumulators which contain dangerous substances, the depositing of waste, the burning up of wastes, packages management and public sanitation services. The National Strategy and the National Action Plan for Waste Management were adopted by the Government.

The Ministry of Environment and Water Management, via the National Institute of Research and Development for Environment Protection - ICIM Bucharest draws up annual reports regarding waste management in Romania. ICIM and the district Environment Protection Divisions conduct annual surveys based on questionnaires addressed to both industrial waste producers and urban and industrial waste managers.

The transition from a centralized economy to a free market economy asks for the adoption of new financial management practices both in the private and in the public sector. Training courses on specific economic issues shall take place in order to provide for better waste management. These courses will mainly aim at the drawing up of the necessary business plans in order to claim external financing and long-lasting financial management in the new market economy. Joint Implementation, the Kyoto Protocol flexible mechanism could have a positive impact in the short term in the process of closing the old landfills and also could provide economical benefits for the owners.

Waste management is one of the beneficiaries of the new partnerships between public and private entities in order to transfer clean technologies for the development of facilities such as selective collecting systems, recovery or incineration installations, waste deposits.

Bilateral co-operation programmes with different international organizations, which aim at the development of institutional capacity (twinning and training) play a very important part in waste management. These programmes will be oriented towards waste management with the approval of both parties involved, and National and international specific objectives will be then established. In this regard Romania is determined to use more effectively all the available external finances (until Romania will be an EU Member State and afterwards) in order to deal more efficiently with the issue of waste management.

Inventories of Anthropogenic Emissions and Sinks of Greenhouse Gases

3.1. Introduction

This chapter presents the results of Romania's greenhouse gas emission inventory within the period 1989-2001. The inventory was developed in compliance with the „Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories”.

Aggregate emissions of all greenhouse gases (GHGs) calculated in CO_2 equivalent were evaluated using global warming potentials (GWP). The emission inventory includes the following gases: CO_2, CH_4, N_2O, PFCs, and the precursors NO_X, CO, NMVOC, SO_2.

The year established as the base year for Romania is the year 1989, because 1989 best expresses, Romania's economic output potential directly connected with the Romania's emissions potential. Since 1989 the country's economic decline has resulted in a relevant decrease of the GHG emissions. When the new GHGs were also defined (HFC, PFC, SF_6), it became necessary to determine the base year for these gases, too. Romania has not determined yet the base year for these gases. It is considered very important to establish the base year especially for HFCs, which have began to be used intensively since the mid-90s as a necessity to replace the Freon type gases. Therefore, 1995 shall be considered as the base year for these gases in accordance with the Kyoto Protocol's Art. 3.8.

The lack of data concerning new GHGs still remains an important problem and it may be possible to solve this for the next submission by asking for data from the companies producing and importing the gases and not using National Institute for Statistics documents.

In 2003, the Ministry of Environment and Water Management of Romania asked the UNFCCC Secretariat to support the inventory development process in Romania by organizing an „in-country” review of the 2001 national GHG emissions inventory. This activity took place in the period from 29 September - 3 October 2003 at the ICIM Bucharest headquarters. Taking into account that the 2001 GHG inventory was the first one submitted in time to the UNFCCC Secretariat, the main conclusions of this first review are very important for the future development of Romania's GHG inventory system. The final report of the expert review team is available on the Secretariat's web page.

3.2. Inventory preparation process

Originally, the inventories were prepared by the National Research and Development Institute for Environmental Protection (ICIM-Bucharest) according to the published IPCC "Draft IPCC Guidelines for National Greenhouse Gas Inventories" methodology, which regulated only the calculation of the carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O) emissions. Starting with 1996, the updated methodology „Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories" regulated in addition the calculation of perfluorocarbons (PFCs), hydrofluorocarbons (HFCs) and sulphur hexafluoride (SF_6) emissions.

This new methodology was used by Romania to calculate the GHG emissions for the 1992-2001 period.

In 2003, the National Research and Development Institute for Environmental Protection (ICIM-Bucharest) prepared the National Inventory of Greenhouse Gas Emissions for 2001, in compliance with the Ministry's of Environment and Water Management contract.

In the institutional framework of ICIM - Bucharest, the CCAMFDP Compartment (Compartment for Air Quality Control, Fluids Mechanics and Pollutants Dispersion) is in charge of preparing the National GHG Inventory. The IPCC software was simultaneously used with the new working methodology (Good Practice Guidance, Reference Manual, and Guidebook). In addition, the new methodology also includes the calculation of the precursor gases emissions: NO_X, CO, NMVOC and SO_2.

In 1999, the UNFCCC Secretariat launched the „Common Reporting Format (CRF)" software, which was used to report the results of the GHG emissions inventory for 2001 and for the 1992-2000 inventories. The GHG emissions inventories for all the period 1992-2001 contain the following gases: CO_2, CH_4, N_2O, NO_X, CO, NMVOC,

SO_2 and PFC (out of the PFCs, only CF_4 and C_2F_6 emission could be estimated from the aluminum production). The HFC, SF_6 and other PFC emissions could not be calculated due to the lack of statistical data referring to the halocarbons production and consumption or due to the confidentiality of data.

The trends of these gases emissions calculated with the „Revised 1996 IPCC Guidelines" are compatible with the trends of the same gases emissions calculated with the CORINAIR methodology in 2001.

The necessary information to perform the national GHG inventory was provided by the National Institute for Statistics in the form of the Statistical Yearbook. The National Research and Development Institute for Environmental Protection (ICIM - Bucharest) provided the supplementary data needed. The additional data requested in the National Institute for Statistics was provided in the form of „The Energy Balance and the Structure of the Energetic Equipment".

The emission factors were taken from the „Revised 1996 IPCC Guidelines", as for this moment, Romania has no national emission factors defined on the basis of some research made on the existing emission sources. The needs to elaborate a GHG inventory as close to reality as possible give the reason to start research on national emission factors, which is very important for the next submissions of the national GHG inventory.

Considering that the inventories were not calculated, for the 1989-1991 period, in accordance with the „Revised 1996 IPCC Guidelines", in the same time with the elaboration of the 2002 GHG inventory, the same team from ICIM will perform the recalculation of these first 3 years. Fortunately, by May 2004 Romania will submit to the UNFCCC Secretariat the whole time series inventories (1989 - 2002) completed.

Key sources analysis

The „Key-source" analysis gives a general overview on the current situation and indicates the major GHG emissions sources, which the future actions must focus on. The main CO_2 emissions sources are the fossil fuels combustion in the

„Energy Industries" and the „Manufacturing Industries and Construction". The CH_4 emissions are mainly provided by the Energy sector as fugitive emissions in the oil and natural gas extraction, processing and distribution and the Waste sector in the „Solid Waste Disposal on Land". The N_2O emissions are provided in principal by the „Agriculture" sector in the „Agricultural Soils" and the „Industrial processes" sector in the „Chemical industry" (adipic acid and nitric acid production).

Choice of the methodology

The CO_2 emissions estimated in the „Energy" sector were calculated on the basis of two methods indicated in the guidelines: „Reference Approach" and „Sectoral Approach". The second method is more detailed needing input data (regarding the fuels consumption) on each sub-sector (thermal energy production, fuels consumption in the processing and construction industry, and transports, fuels consumption in trade, institutional and residential sectors, as well as fuels consumption in agriculture and other economic branches).

The GHG emissions calculated by the „Sectoral Approach” are bigger than those resulted from the general „Reference Approach” method. The difference occurs from the fact that the reference method is not as detailed as the sectoral method. It uses in the calculation methodology the fuels production, imports and exports, as well as the stored amounts of fuels. In the 2001 national GHG inventory the difference between the GHG emissions values calculated with these two methods is 2.9%.

The methods used to calculate the GHG emissions by sectors are those indicated in the „Revised 1996 IPCC Guidelines” methodology, except for the „Solvent and other product use” sector, where the methodology does not provide any calculation algorithm. In this case, in order to estimate the emissions in this sector, the CORINAIR - 1996 methodology was used, but it does not provide any emission factors except for NMVOC. This is the reason for which the only emissions calculated in this sector were NMVOC (in fact, the largest part).

Emissions in the „Energy” and „Industrial processes” sectors were calculated according to the same Tier 1 methodology. Emissions in the „Industrial processes”, „Agriculture”, „Land Use Change and Forestry” and „Waste” sectors were calculated using the indicated methodology.

QA/QC

The GHG emissions inventories for the whole period 1992 - 2001 have been archived in the ICIM - Bucharest database. The inventories for the period 1989 - 1991 were verified some time ago by an international specialized institution (calculations were performed on a contract basis signed with the Environmental Protection Agency - U.S.A.). Due to the delay in providing and gathering the statistical data and the deadline for submitting the inventory there was no time left for an appropriate quality control of the inventory. For the following submissions it is important to have a quality control before submitting the inventories to the UNFCCC Secretariat, taking also into account the recommendations of the reviewing process.

Uncertainties calculation

The emission factors used are those recommended in the calculation methodology for the Eastern European countries, thus the uncertainties values are the specified ones presented in the „Revised 1996 IPCC Guidelines”. The National Institute for Statistics didn't provide any information concerning the uncertainty assessment of the input data.

International bunker fuels

Romania included emissions from international civil aviation and navigation under the respective domestic source categories. No distinction was made between domestic and international fuel use because of the lack of data, and all emissions were included in the national total. In this regard, Romania is applying a conservative approach, since the national total is overestimated. Romania will try to report emissions from bunker fuels separately for the next submissions and to separate domestic and international bunkers emissions in civil aviation. Unfortunately, for marine bunkers no information exists at this moment in Romania or in the IEA and Eurostat sources.

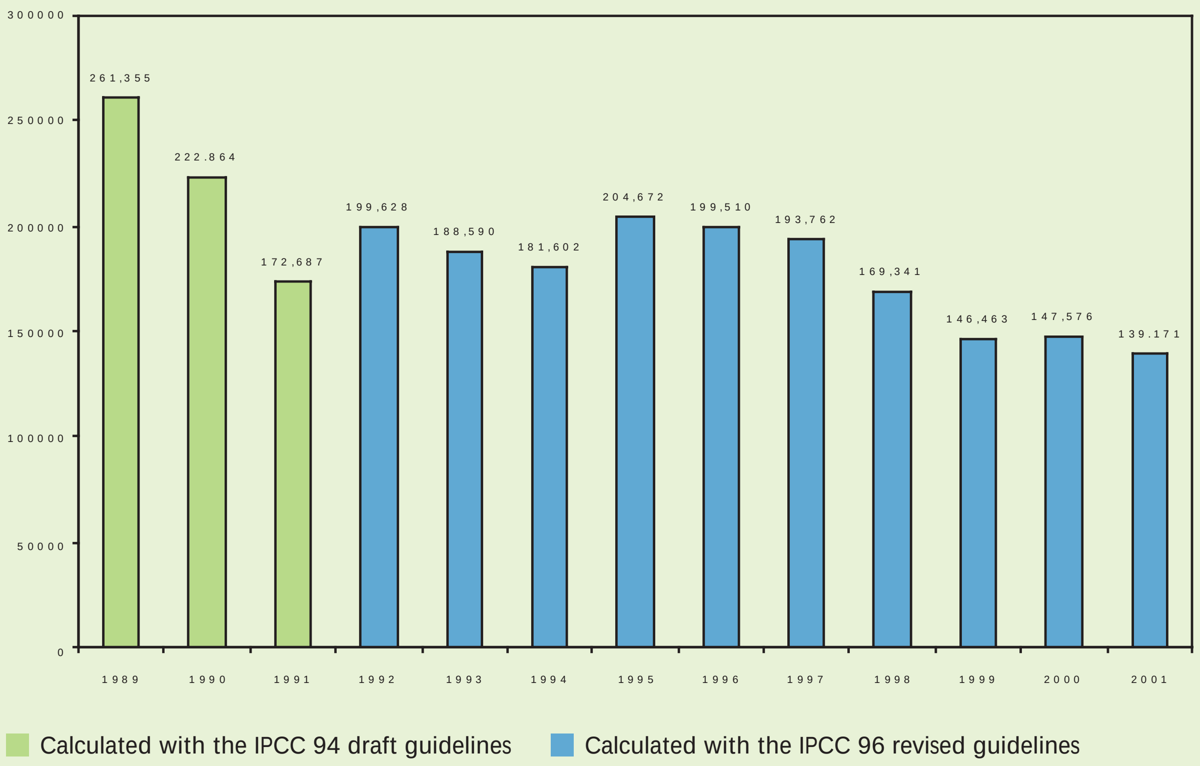
3.3. Trends in total GHG emissions

For the trend analysis the GHG emissions resulted from each sector were converted into CO_2 equivalent according to the IPCC's GWP. The next figure presents the GHG net emissions variation starting with the base year (1989) to the last year for which the inventory was completed, taking into account and subtracting the sinks resulting from the development process of the trees.

The first 3 years inventories (1989, 1990 and 1991) were not recalculated yet, based on the new „Revised 1996 IPCC Guidelines" and the revised values will be presented in the next submission.

There are some small changes in the total CO_2 equivalent net emissions in the period 1989 - 2000, comparing with the NIR submitted in 2002, due to the completion of the CRF's „Table 10 - Emissions Trends" for the first time in 2003.

Figure 3.1. Total net greenhouse gas emissions in CO_2 equivalent (with CO_2 removals)



The decrease of total GHG emissions over the period 1989-2001 was mainly due to a strong decline of the economy in this period of transition to a market economy, plus startup and operation of the first reactor at the Cernavoda nuclear power plant (1996).

An unusual increase of the total annual emissions was recorded in 1995 compared to the previous year, which was the worst economical year in the Romanian transition (1994); 1995 is considered a special year in which consumption in the energy sector and the production in various industrial branches increased significantly.

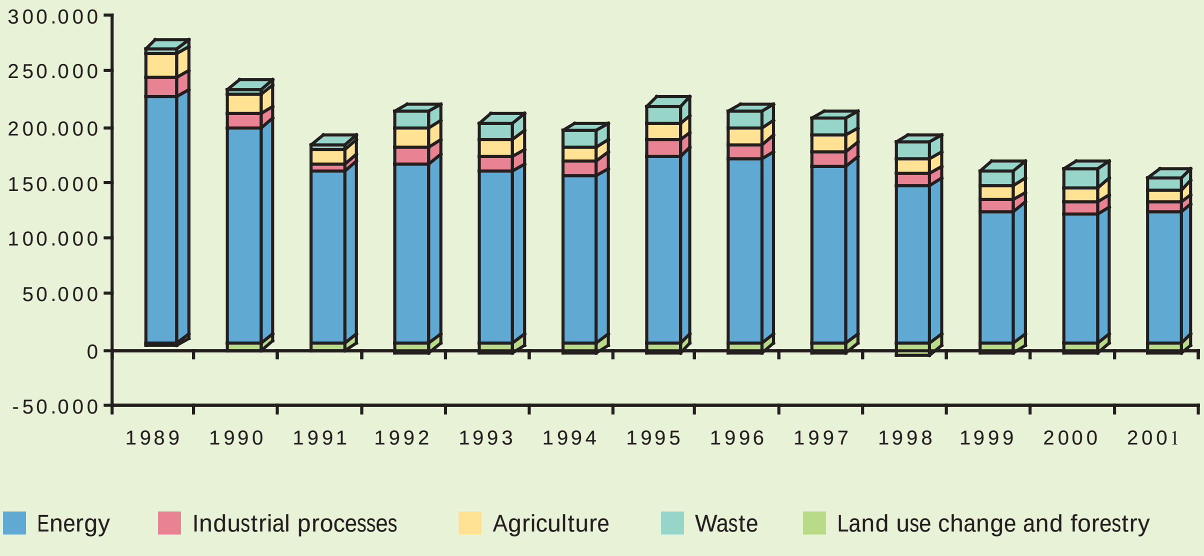
In 2001 a slight decrease of the total GHG emissions was recorded as compared with 2000, this increase is insignificant when is compared to the base year total GHG emissions. Based on these observations, it is very clear that Romania will meet the commitments to reduce GHG emissions in the Kyoto Protocol's first commitment period 2008-2012, as the trend for the period 1989-2001 shows a decrease of 46.8% in the overall GHG emissions.

Table 3.1. Total net GHG emissions in Romania

Year	1989	2001
Total net GHG emissions (Gg)	261,355	139,171

Important changes regarding the GHG emissions are not expected to occur in the first commitment period, but a geometrical increase of them could be noticed. As some model assessments presented, Romania's net GHG emissions in the 2008 - 2012 period could be between 175,000 - 200,000 Gg CO_2 equivalent, if the pace of the economic growth increases.

Figure 3.2. Various sector's contribution to the GHG emissions (Gg CO_2 eq.)

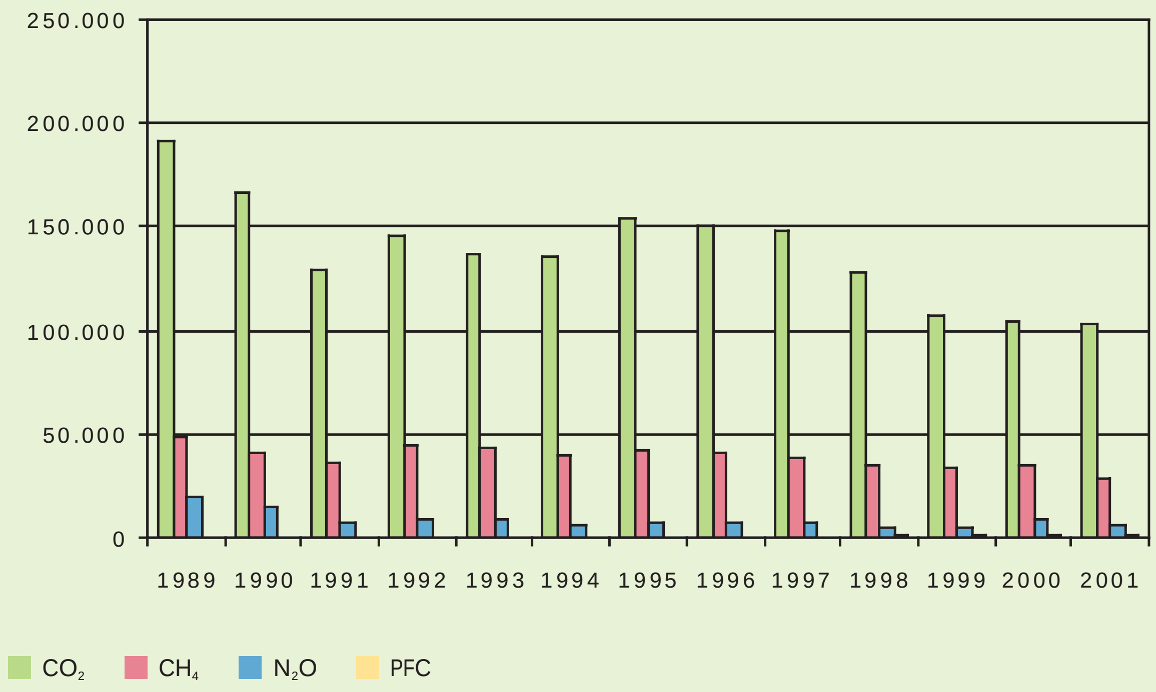


In the base year 1989, 83% of the GHG emissions were provided by the „Energy" sector. This sector's contribution decreased in 2001 to 79%, still remaining the main polluting sector in the Romanian economy.

In the „Industrial processes" sector, the biggest amount of the CO_2 emissions occurred in the „Mineral products" sub-sector. The emissions from the ferrous and non-ferrous metals production, the lime and cement production, the inorganic chemical compounds production (sulphuric acid, sodium carbonate, sodium hydroxide), organic chemical compounds (ethylene, propylene, dichlorethane, PVC, polystyrene, formaldehyde, ethyl benzene, carbon black, cellulose and paper) are also included in this sector.

The total GHG emissions, converted into CO_2 equivalent, provided by the non-burning industrial processes represented some 6.4% of the total 1989 GHG emissions and in 2001 they decreased slightly to 6.3% of the total GHG emis-sions. The total GHG emissions provided by the „Industrial processes” sector in 2001 are smaller than those recorded in 2000, due mainly to the lack of data regarding these activities.

Figure 3.3. GHG emissions variation by gas over 1989-2001



The difference between the 1989-1991 and 1992-2001 periods regarding the total GHG emissions is due to the different ways of calculating the inventories.

The annual CH_4 and N_2O emissions vary relatively constantly during the entire period considered. The PFC emissions were calculated starting with 1992. In this moment, these emissions are not so relevant, because of the lack of information regarding the halocarbons production and consumption. The HFC, SF_6 and the rest of the PFC could not be estimated due to the lack of data necessary to the calculation, to the limited access to the information regarding the halocarbons production, consumption and imports, and to the confidentiality of some information.

The inventories prepared until now are focusing on the GHGs in the Kyoto Protocol's Annex A, which have the most important effect on the global warming. In the last years, the „precursor” gases were, as well, included in the inventory. These gases (CO, NO_x and NMVOC) with effect on the global warming are helping the development of the tropospheric ozone and are major contributors in the aerosols formation process.

The annual GHG emissions (gross and net emissions), converted into CO_2 equivalent, are presented in the next tables. The CO_2 removal effect in the forests was considered in order to determine the net emissions and 1989 was taken as the base year.

Table 3.2. Greenhouse gas emissions (a. CO_2 equivalent Gg) (b. Gg)

Gas \ Year	1989	1990	1991	1992	1993	1994
CO_2	194,826	172,510	135,660	153,875	145,798	144,894
CH_4	48,965.9	41,031.1	36,059.4	44,950.3	42,944.5	39,309.6
N_2O	20,488.5	14,969.0	7,557.6	8,187.4	8,269.2	6,074.1
PFC	-	-	-	445.2	435.5	451.7
CO_2 removals	- 2,925.3	- 5,645.9	- 6,590.1	- 7,815.4	- 8,844.0	- 9,119.6
Net emissions	261,355	222,864	173,687	199,628	188,590	181,602
% of 1989	100	85	66	76	72	69
Total emissions	264,280	228,510	179,277	207,457	197,447	190,729
% of 1989	100	86	68	78	75	72

Gas \ Year	1989	1990	1991	1992	1993	1994
Net CO_2	191,901	166,864	129,070	146,045	136,941	135,767
CH_4	2,332	1,954	1,717	2,140	2,045	1,872
N_2O	66.1	48.3	24.4	26.4	26.7	19.6

Table 3.3. Greenhouse gas emissions by sectors and gases in 2001 (Gg)

Categories of sources	CO_2	CH_4	N_2O	HFC	PFC*	SF_6	NO_x	CO	NMVOC	SO_2
Emission/ Removals total	**103427**	**1360**	**20.97**		**677.5**		**404.8**	**1344.2**	**301.6**	**1062.1**
1. Energy	104812	565.7	1.32		-		393.1	1086.9	182.1	1055
2. Industrial processes	7646	0.88	3.28		677.5		2.43	35.18	12.3	7.13
3. Solvent and other product use	-	-	-		-		-	-	107.2	-
4. Agriculture	-	348.4	15.3		-		9.19	218.4	-	-
5. Land-use change and forestry	- 9031	0.42	-		-		0.11	3.71	-	-
6. Waste	-	444.8	1.06		-		-	-	-	-

* only PFC emissions are in CO2 equivalent

	1995	1996	1997	1998	1999	2000	2001
	161,892	158,301	155,349	138,049	115,403	112,150	112,459
	42,204.8	41,245.9	38,330.3	35,113.4	33,923.4	34,735.3	28,565.2
	8,076.9	7,233.5	7,188.9	5,595.9	5,434.6	8,193.3	6,500.7
	532.4	535.7	606.6	651.6	648.3	671.1	677.6
	- 8,027.9	- 7,798.7	- 7,707.9	- 10,063	- 8,939.4	- 8,165.0	- 9,022.6
	204,672	199,510	193,762	169,341	146,463	147,575	139,171
	78	76	74	65	56	56	53
	212,706	207,316	201,475	179,410	155,409	155,749	148,202
	80	78	76	68	59	59	56

	1995	1996	1997	1998	1999	2000	2001
	153,858	150,495	147,636	127,980	106,457	103,976	103,427
	2,010	1,964	1,825	1,672	1,615	1,654	1,360
	26.1	23.3	23.2	18.1	17.5	26.4	21.0

The economic collapse after 1989 meant a major decline in the industrial production resulting in a similar decrease of the GHG emissions. The emissions values remained significantly under the reference level. Based on this observation and on some projections, Romania will be able to meet its Kyoto Protocol commitment regarding the 8% GHG emissions reduction.

The total value of the gross GHG emissions in 2001 is 148,202.41 Gg CO_2 equivalent. The „Energy" sector accounted for the largest part of the GHG emissions and within it the biggest share belonged to the „Energy Industries" subsector.

„Agriculture" sector is the main N_2O source, while CH_4 comes mainly from the uncontrolled emissions of the oil and natural gas extraction and distribution, and also from the „Waste" sector.

Information linked to the sources of producing the fluorine compounds is incomplete. It should be considered that the single PFCs source is the aluminum industry.

Table 3.4. GHG emissions by gas in 2001

GHG	CO_2 equivalent (Gg)	Level Assessment	Cumulative Total
CO_2	112,458.91	0.759	0.759
CH_4	28,565.25	0.193	0.952
N_2O	6500.70	0.043	0.995
PFC	677.55	0.004	1.000
HFC	0	0	0
SF_6	0	0	0
Total	**148,202.41**	**1**	

Table 3.5. GHG emissions by sector in 2001

Sector	CO_2 equivalent (Gg)	Level Assessment	Cumulative Total
1. Energy	117,104.27	0.790	0.790
2. Industrial Processes	9,359.47	0.063	0.853
3. Solvent and other product use	0	0	0
4. Agriculture	12,060.24	0.081	0.934
5. Land-use change and forestry	0	0	0
6. Waste	9,669.61	0.065	1.000
Total	**148,202.41**	**1**	

The net GHG emissions converted into CO_2 equivalent in 2001 (139,170.96 Gg) represented 53.2% of the total net GHG emissions in the base year 1989 (261,355.22 Gg).

This decrease is mainly due to:
- the decline of the economic activity;
- the bringing into operation of the first reactor at the Cernavoda nuclear power plant;
- the failure of some production units and the rehabilitation and modernization of some old technologies with reduced energy efficiency, in some industrial activities.

3.4. Energy sector

The „Energy" sector represents the biggest share in the total GHG emissions. The energy sector emissions decreased in the whole period compared with the base year 1989. A relevant increase of the emissions was recorded in 1995, compared to the previous year, due to the stock output increase.

In the „Energy" sector, the biggest percentage of the overall GHG emissions (117,104.27 Gg CO_2 equivalent), resulted mainly from the fossil fuels combustion, is accounted by the CO_2 emissions and the most important sub-sector regarding the GHG emissions in the 2001 inventory is the „Energy Industries".

Figure 3.4. GHG emissions from the „Energy" sector 1989-2001

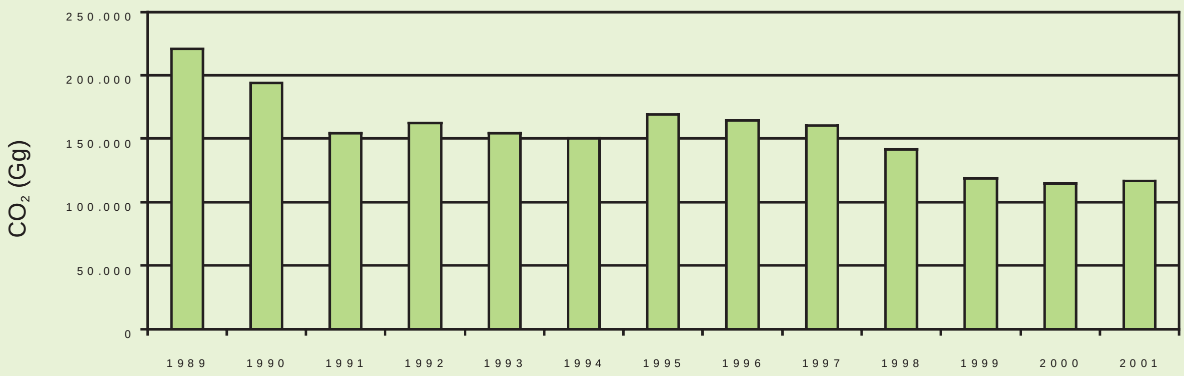
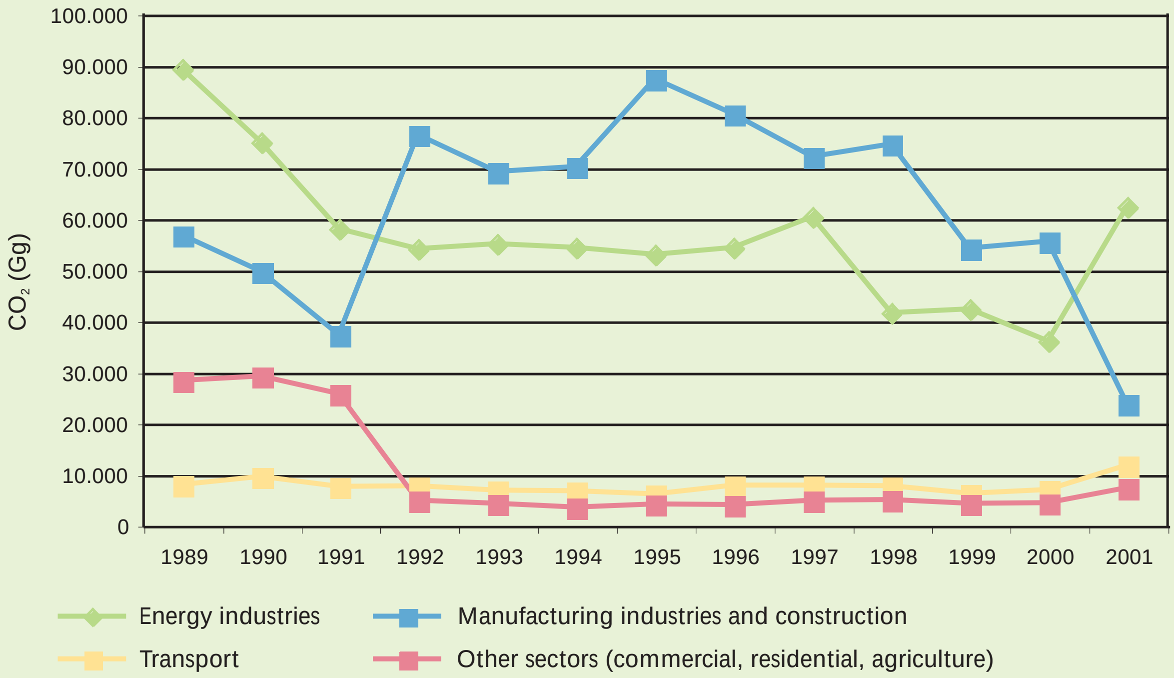


Figure 3.5. Various sub-sectors contribution to the CO2 emissions in the „Energy" sector over 1989-2001



The difference between the inventories from the periods 1989-1991 and 1992-2001 regarding the CO_2 emissions from the energy sector is due to the various methodologies used for the emissions calculation. The „Revised 1996 IPCC Guidelines" was used as calculation methodology for the second period, but for the first one the values considered were calculated with the old methodology.

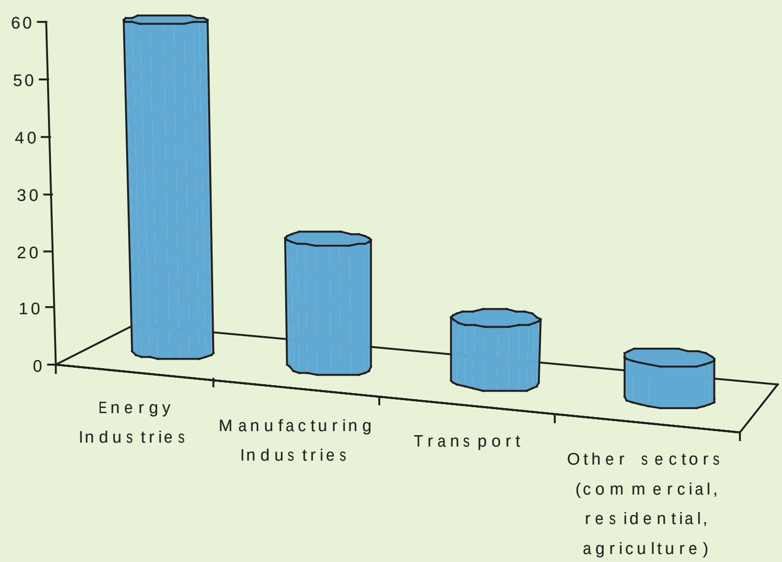
Table 3.6. GHG emissions in the „Energy" sector (year 2001) in CO_2 equivalent

Year / Gas	CO_2	CH_4	N_2O
Total GHG emissions (A + B)	**104,812.28**	**11,879.56**	**410.26**
A. Fossil fuels combustion	**104,812.28**	**619.48**	**410.26**
1. Energy industry	62,179.56	22.37	209.53
2. Manufacturing industries and construction	23,715.39	44.67	62.63
3. Transports	11,625.35	38.02	33.00
4. Other sectors	7,291.97	514.42	105.11
B. Fugitive emissions	**0**	**11,260.09**	**0**
1. Solid fuels	0	3,331.65	0
2. Liquid and gaseous fuels	0	7,928.44	0

As presented in the above table, the „Energy Industries" and the „Manufacturing Industries and Construction" sub-sectors are the main key-sources of the GHG emissions in the „Energy" sector. The fuels consumption in these sectors were taken from the „The Energy Balance and the Structure of the Energetic Equipment", a document published annually by the National Institute for Statistics of Romania.

The CO_2 emissions were estimated in accordance with both methodologies indicated (the „Reference Approach" and the „Sectoral Approach") and the emission factors used are those indicated in the „Revised 1996 IPCC Guidelines".

Figure 3.6. The various sub-sectors contribution (%) to the CO_2 emissions in the „Energy" sector in 2001



As the above figure shows, 59% of the total CO_2 emissions in the „Energy” sector comes from the „Energy Industries” (due to the important consumption of fuels used for electricity and heat production), 23% from the „Manufacturing Industries and Construction” (due to the large amounts of oil that are being refined), 11% from „Transport” and the rest of 7% from other sectors. Of these other sectors, the biggest part is represented by the „Residential” sector emissions (74%), followed by the emissions from the „Commercial/Institutional” sector with 25% and „Agriculture/Forestry” sector with 1%.

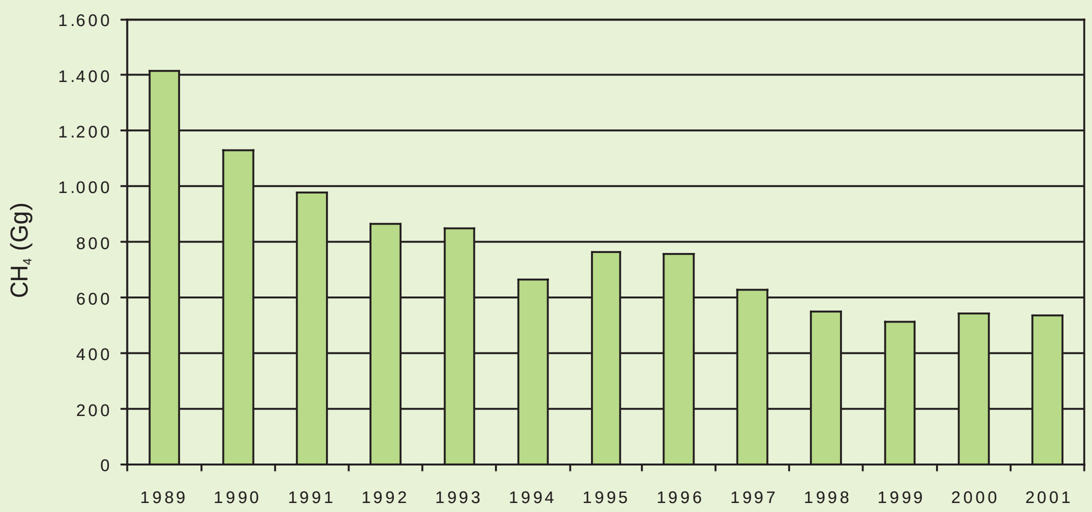
Fugitive emissions

Fossil fuels extraction and distribution results in a large amount of methane emissions. The emissions in this activity are so large because both the amounts of produced fuel and imported fuel are considered.

The emission factors used are those indicated in the „Revised 1996 IPCC Guidelines”. The methane fugitive emissions decreased compared to 1989 levels, both due to the quality improvement in the fuels distribution systems and to the production decline.

The N_2O emissions in the energy sector result only from the fuel combustion activities, most of them in the „Energy Industries” sub-sector. Fugitive emissions have been decreased almost three times, mainly due to the fuel consumption decrease, and also due to the modernization of the natural gas distribution systems (losses reduction).

Figure 3.7. Fugitive CH_4 emissions from fuels 1989-2001



3.5. Industrial Processes sector

The GHG emissions in this sector are mostly provided by the „Mineral Products” sub-sector. Industrial processes have been drastically decreased during the period 1989 -2001 due to the post-revolution social and economic problems (strikes, lack of legislation, etc.). The decline of the production activities recorded in the last years led to the emissions decrease in this sector as it is shown in the next figure.

The „Mineral Products” sub-sector in Romania includes the emissions from the cement and lime industry, the production and consumption of dolomite and limestone, and the soda ash pro-

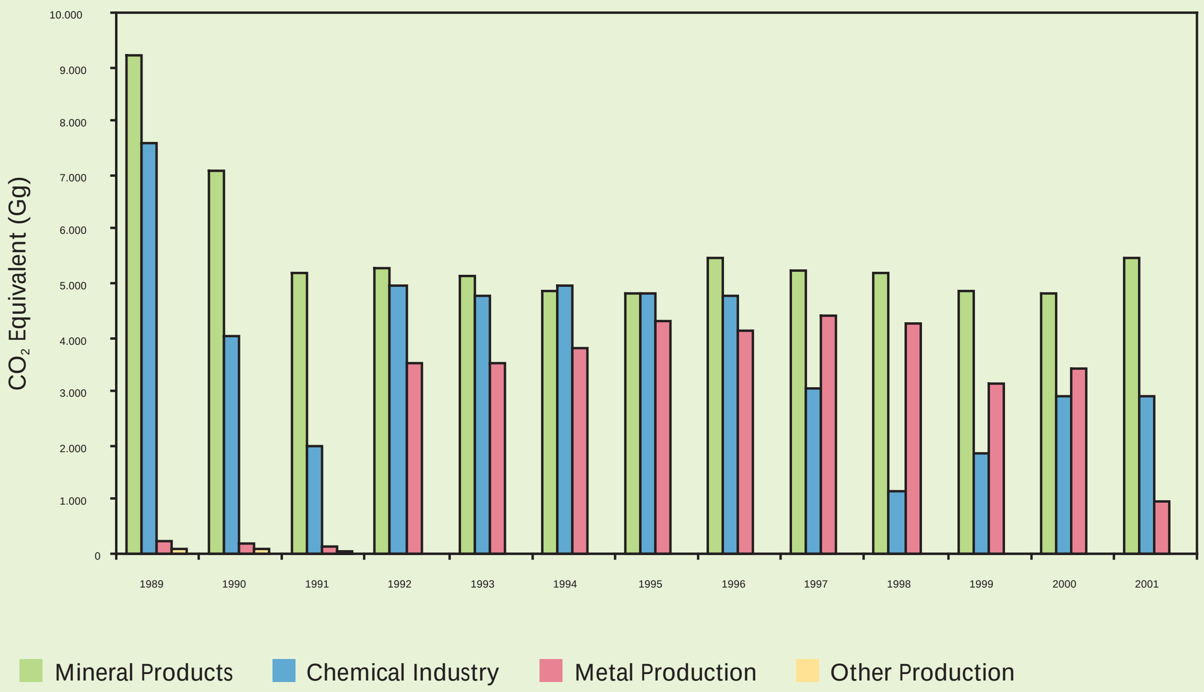
Table 3.7. Greenhouse gas emissions from the „Industrial Processes" sector, in CO_2 equivalent (Gg)

Year	1989	1990	1991	1992	1993	1994	
Mineral Products	9223.0	7098.4	5169.4	5282.5	5116.2	4844.7	
Chemical Industry	7592.6	4034.9	2004.8	4950.8	4790.7	4938.8	
Metal Production	244.9	171.6	123.9	3524.8	3505.1	3774.0	
Other Production	85.5	71.7	50.8	0	0	0	
Total	**17149.7**	**11377.6**	**7347.6**	**13757.6**	**13411.2**	**13557.5**	

duction. The National Institute for Statistics provided the input data and the emission factors used are those indicated at the respective sub-sectors in the „Revised 1996 IPCC Guidelines".

In the „Chemical Industry" sub-sector the emissions from the halocarbons production and consumption could not be estimated due to the lack of necessary input data (these data are not available now, they are to be obtained). The CO_2, CH_4 and N_2O emissions from the carbide production, the production of ammonia, nitric acid, adipic acid and other products (smoke black,

Figure 3.8. Various sub-sectors contribution to the CO_2 emissions in the „Industrial Processes" sector



	1995	1996	1997	1998	1999	2000	2001
	4831.0	5459.6	5213.4	5204.9	4875.4	4798.6	5483.8
	4819.3	4756.6	3044.2	1135.0	1872.4	2903.3	2921.8
	4314.2	4103.2	4407.9	4242.5	3138.1	3441.9	953.97
	0	0	0	0	0	0	0
	13964.5	**14319.4**	**12665.5**	**10582.4**	**9885.9**	**11145.1**	**9359.5**

ethylene and methanol) were estimated in this sub-sector. The N_2O emissions from the „Industrial processes" sector resulted from the nitric acid and adipic acid production.

The only PFCs emissions included in the inventory were estimated from the aluminum production in the „Metal Production" sub-sector. Considering this fact, PFCs emissions values are not so important.

The most important industrial sources of CO_2 emissions in Romania are cement and lime production. The CO_2 emissions were calculated from the production of cement, lime, ferrous and non ferrous metals, some inorganic chemicals (hydrochloric acid, sulfuric acid, sodium carbonate, sodium hydroxide) some organic chemicals (ethylene, propylene, dichlorethane, vinyl chloride, polyethylene, PVC, polystyrene, SBR, ABS, resins, formaldehyde, ethyl benzene) and wood, pulp and other products.

Methane emissions from the „Industrial processes" sector are not significant (less than 1 percent of the overall GHG emissions in 2001). During the last decade N_2O emission from the „Industrial processes" sector has been decreased by almost 89 percent.

Solvent and other product use

The „Solvent and Other Product Use" sector includes emissions resulted from the paint applica-

Table 3.8. NMVOC emissions provided by the „Solvent and Other Product Use" sector

SOURCE	NMVOC (Gg)									
	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
Paint Application	16.73	16.44	13.27	14.13	12.69	10.63	10.09	9.8	10.48	13.30
Degreasing and Dry Cleaning	9.95	9.95	9.94	9.93	9.91	9.89	9.88	9.87	9.87	40.36
Chemical Products, Manufacture and Processing	5.45	5.63	7.00	8.75	8.68	8.6	2.22	8.01	8.21	8.09
Other Solvents Use	49.64	49.92	49.10	49.58	49.72	49.84	51.25	51.68	51.64	45.45
TOTAL	**81.7**	**81.9**	**79.3**	**82.3**	**81.0**	**78.9**	**73.4**	**79.3**	**80.2**	**107.2**

tion and other products use. The National Institute for Statistics provided the necessary input data for the emissions calculation.

As the IPCC methodology does not indicate any calculation algorithm of the emissions resulted from this sector, the CORINAIR 1996 methodology was used, but it provides only the emission factors for NMVOC. This is why for this sector only NMVOC emissions were calculated. In fact, this type of emissions represents the biggest part in the „Solvent and Other Product Use" sector. At this moment, the GHG emissions in this sector cannot be approximated, due to the lack of statistical data from the National Institute for Statistics. The emissions are calculated only for the period 1992 - 2001. The NMVOC emission values are presented in the next table.

3.6. Agriculture sector

The agricultural sector in Romania has changed drastically during the last decade. Privatization has been almost completed. Poverty, new landowners' lack of practice, unattractive living conditions in the rural area, and natural calamities could be considered as the reasons for the serious production cut in this sector and as a consequence, the methane emissions decreased dramatically.

The emission values from transports and other equipment and installations used in agriculture are included in the „Energy" sector. This sector contains the emissions from domestic livestock enteric fermentation, animal waste management systems, rice cultivation and field burning of agricultural residues.

The CH_4 emissions in the „Agriculture" sector

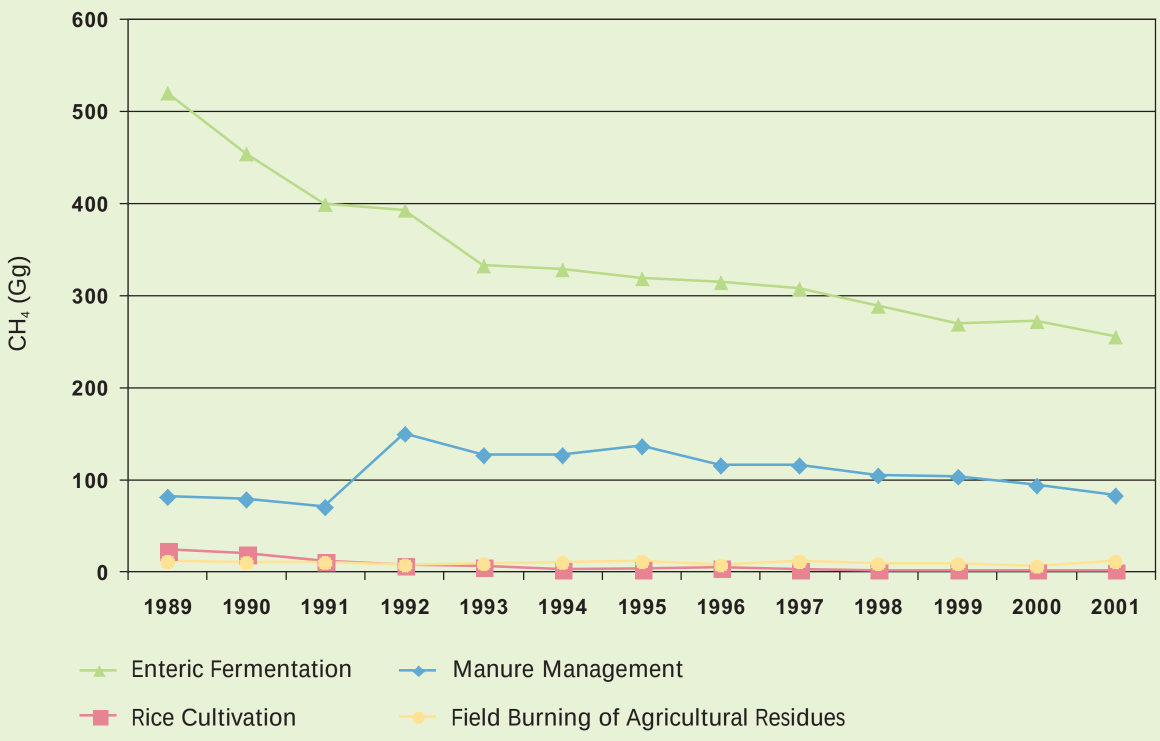
Agriculture in Romania suffered several important changes in the last decade. Large decrease of the methane emissions in the „Agriculture" sector could be explained by the agricultural production decline (animal breeding sector). Statistical data provided by the National Institute for Statistics showed a relevant livestock decrease, as well as an agricultural production decrease.

As presented in the next figure, the agriculture methane emissions in 2001 decreased almost to

half of the similar emissions recorded in the base year (42% decrease). An insignificant decrease of the methane emissions was recorded in 2001 compared to 2000 levels.

The trend shows a slowly decrease after 1992, with a slight increase in 1995. Because the methane emissions are mainly the result of domestic livestock, the shape of the curves shows the situation of this sector in Romania. The rice cultivation - an important sub-sector in the past - has been reduced significantly compared to the base year 1989. The emissions values for the field burning of agricultural residues were calculated, but they are small.

Figure 3.9. Various sub-sectors contribution to the methane emissions in „Agriculture" for 1989-2001



„Enteric Fermentation" is the main source of methane emissions in the „Agriculture" sector. The National Institute for Statistics provided the input data on the domestic livestock and the emission factors used are those indicated in the „Revised 1996 IPCC Guidelines" methodology.

Regarding the animal waste management systems, the same revised guidelines indicate several ways to calculate the manure management emissions, which were adapted to the conditions in Romania, depending on the number of farm breed animals or on the small owners domestic livestock. The classification of animals by state property and private property is found in the Statistical Yearbook of Romania 2001 - annual publication.

Due to the changes in methodology calculation for the „Rice Cultivation" sector, the values for CH_4 emissions in the 1992 - 2000 period submitted in 2002 were changed, and they will be reflected in the future recalculations of this period's inventories. The methane emissions provided by the rice cultivation were calculated by using the data in the National Institute for

Table 3.9. Methane emissions in the Agriculture sector over the 1989-2001 period (Gg)

Year	1989	1990	1991	1992	1993	1994
Enteric fermentation	519.85	453.81	399.13	391.13	331.58	327.17
Manure management	80.53	77.48	69.35	149.73	126.53	125.52
Rice cultivation	23.73	19.18	10.38	6.56	4.80	1.84
Field burning of agricultural residues	10.690	9.804	9.582	6.472	8.414	9.713

Table 3.10. N_2O emissions in the „Agriculture" sector over the period 1989-2001

Greenhouse gas sources	1989	1990	1991	1992	1993	1994
Agriculture	25.29	20.75	6.73	16.96	17.26	8.81
Enteric Fermentation						
Manure Management				0.187	0.178	0.103
Rice Cultivation						
Agricultural Soils	25.05	20.53	6.51	16.50	16.79	8.38
Field Burning of Agricultural Residues	0.24	0.22	0.22	0.28	0.29	0.33

Statistics Yearbooks and the emission factors from „Revised 1996 IPCC Guidelines".

The field burning of agricultural residues is not commonly used in Romania and there is also a lack of data for this activity. Using the handbook, emissions were calculated from the annual production and resulted in the amount of the biomass burnt.

N_2O emissions in the Agriculture sector

The „Agriculture" sector has the most important „contribution" to the N_2O emission meaning 73 percent of the whole N_2O emission in the year 2001. The N_2O emissions values are presented in the next table. The N_2O emissions are mainly provided by fertilizer use the agricultural fields.

The general trend shows a relevant decrease over the period 1989-2001 with a significant increase recorded in 2000 compared to 1999. This increase could be explained through the attention that the Romanian Government has been given to this sector through the funds allocated for increasing the overall agricultural production.

The emissions values for the period 1989-1991 were calculated with the „Draft IPCC Guidelines" and will be recalculated.

The largest part of the N_2O emissions in the „Agriculture" sector are mainly provided by the agricultural soils fertilization and the rest by the animal waste management systems and field burning of agricultural residues.

	1995	1996	1997	1998	1999	2000	2001
	318.34	314.09	306.64	288.19	268.65	270.80	255.23
	134.98	114.80	115.64	104.21	103.12	92.56	82.33
	2.48	3.40	1.60	0.68	0.64	0.56	0.48
	10.803	6.816	11.214	8.242	8.379	6.054	10.381

	1995	1996	1997	1998	1999	2000	2001
	16.74	14.42	15.33	14.13	13.36	21.21	15.30
	0.138	0.103	0.154	0.099	0.118	0.51	0.15
	16.24	14.03	14.79	13.64	12.86	20.5	14.9
	0.36	0.28	0.39	0.39	0.38	0.21	0.25

3.7. Land Use Change and Forestry sector

In Romania, the forest areas cover about 6.2 million hectares, which means about 26% of the total country area and a value of the forests/inhabitant indicator of about 0.28 hectares/inhabitant. The next table presents the variation of CO_2 removals (net sinks) over the period 1989-2001.

The main factors influencing CO_2 removals in forests are the afforested area, the annual growth rate and the commercial harvest cuttings rate.

As shown in the next figure, there is a strong influence between the commercial harvest cuttings and the amount of CO_2 absorbed by the forests (net sinks). For the period 1989-1991 there was no available data for commercial harvest.

Commercial harvest cuttings and firewood were taken into account for estimating the CO_2 removals in the forests. The biggest amount of CO2 removals was recorded in 1998, after which a decrease was observed in 1999 and 2000, as a result of the increase of the commercial harvest cuttings. In 2001 a decrease of harvest cuttings was observed which meant an increase of CO_2 removals comparing with the previous year.

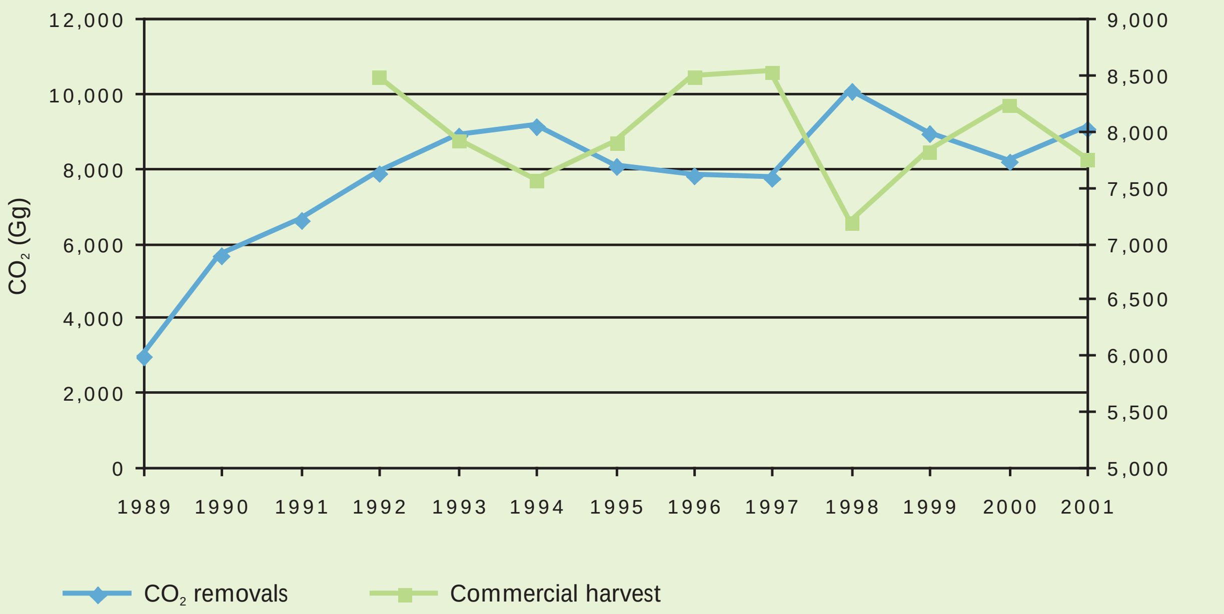
The grated cuttings (afforested areas that turned into grasslands) were calculated for the forests and grasslands conversion sub-sector.

After the relevant decrease in 1998, the following years recorded a relatively strong increase

Table 3.11. The CO_2 removals (net sinks) variation in the period 1989-2001 (Gg)

Year	1989	1990	1991	1992	1993	1994
Net CO_2 removals	2925	5646	6590	7830	8857	9127
Commercial harvest	-	-	-	8487	7921	7555

Figure 3.10. Relation between commercial harvest cuttings and CO_2 removals (net sinks)



of grated cuttings, which meant a decrease of CO_2 removals. The increase of CO_2 removals in 2001 could be compared with the similar increases from 1994 and 1998.

Sinks were calculated by using the data from the National Institute for Statistics Yearbooks, additional data from the Forest Research and Development Institute (ICAS) and the emission factors taken from the „Revised 1996 IPCC Guidelines”. Due to the lack of input data, which couldn't be taken from the National Institute for Statistics, the emissions from soils couldn't be estimated in this sector.

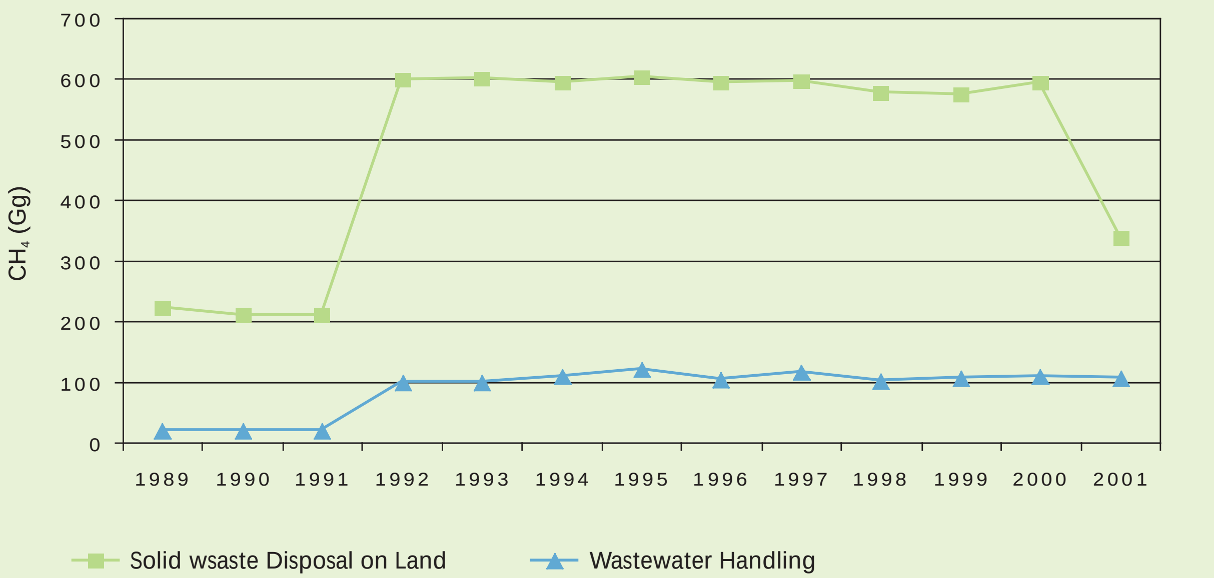
3.8. Waste sector

The „Waste” sector is an important methane emissions source in Romania. The methane emissions from this source represents approximately 10% of the total CH_4 emissions recorded in 1989 and 33% in 2001, due to the various contributions of other sectors and the increase of municipal solid waste disposal. Land filling is by far the most common technology applied in Romania, for the time being.

Municipal waste management systems and wastewater treatment provide the biggest

	1995	1996	1997	1998	1999	2000	2001
	8034	7805	7713	10069	8946	8174	9022
	7894	8472	8508	7178	7804	8216	7733

Figure 3.11. Methane emissions from the municipal solid waste disposal and wastewater treatment in the period 1989-2001



amount of emissions in this sector. Waste incineration it is not applied on a large scale in Romania and this sector's GHG emissions were not calculated due to the lack of data. The large difference between the inventories from the periods 1989-1991 and 1992-2001 is mostly due to the different IPCC methodology used. The first three inventories (1989-1991) will be recalculated for the next submission.

In this sector, the largest contributors for methane emissions are the municipal waste landfills. Urban solid waste is divided in two categories: waste disposed in fitted areas and waste deposited in unfitted areas (landfills >5m and pits <5m).

The relevant decrease occurred in 2001, compared with the same sector's emissions in 2000 is due to the fact that in 2001 the National Institute for Statistics didn't provide data concerning the generated quantity of municipal solid waste. In this case, the emissions in this sub-sector were estimated based upon the indicated methodology of the „Revised 1996 IPCC Guidelines”, using the number of population that benefit from waste collection and transfer to SWDS (Solid Waste Disposal Sites) and the MSW dispo-

Table 3.12. Methane emissions in the „Waste” sector over the period 1989-2001 (Gg)

Year	1989	1990	1991	1992	1993	1994
CH_4 total	240.6	229.7	228.6	699.1	700.0	703.1
Solid waste disposal on land	222.2	210.8	209.8	599.8	602.0	594.1
Waste water treatment	18.4	18.9	18.8	99.2	98.0	109.0

sal rate recommended for Eastern European countries.

The emissions from wastewater treatment were estimated considering the BOD (Oxygen biochemical consumption) value, provided by the population connected to the sewage system, as well as the treatment stations efficiency.

According to the statistical data provided, in Romania from 90 m^3/second wastewater discharged in the sewage system, only 42 m^3/second is biologically treated.

The BOD value of 54 grams/inhabitant/day is the standard value for the assessment of the equivalent inhabitants' number.

3.9. Indirect gases and SO_2 emissions

The following gases are included in this category: NO_X, CO, NMVOC and SO_2. The SO_2 emissions were not calculated over the period 1989-1991. In the next submissions, when the inventories for the period 1989-1991 will be recalculated with the new methodology „Revised 1996 IPCC Guidelines”, the SO_2 emissions will be calculated, too. The SO_2 emissions variation is caused by the utilization of fuels with various sulphur contents.

Power and heat generation in the „Energy” sector is the major source of SO_2, NO_X and CO emissions. For NMVOC emission the most important sources are coming from the „Solvent and Other Product Use” sector as paint application, degreasing and cleaning of metals, chemical products manufacturing and processing and the other use of solvents.

The NO_X, CO, NMVOC, SO_2 emissions in the period 1989-2001 are shown in the figure.

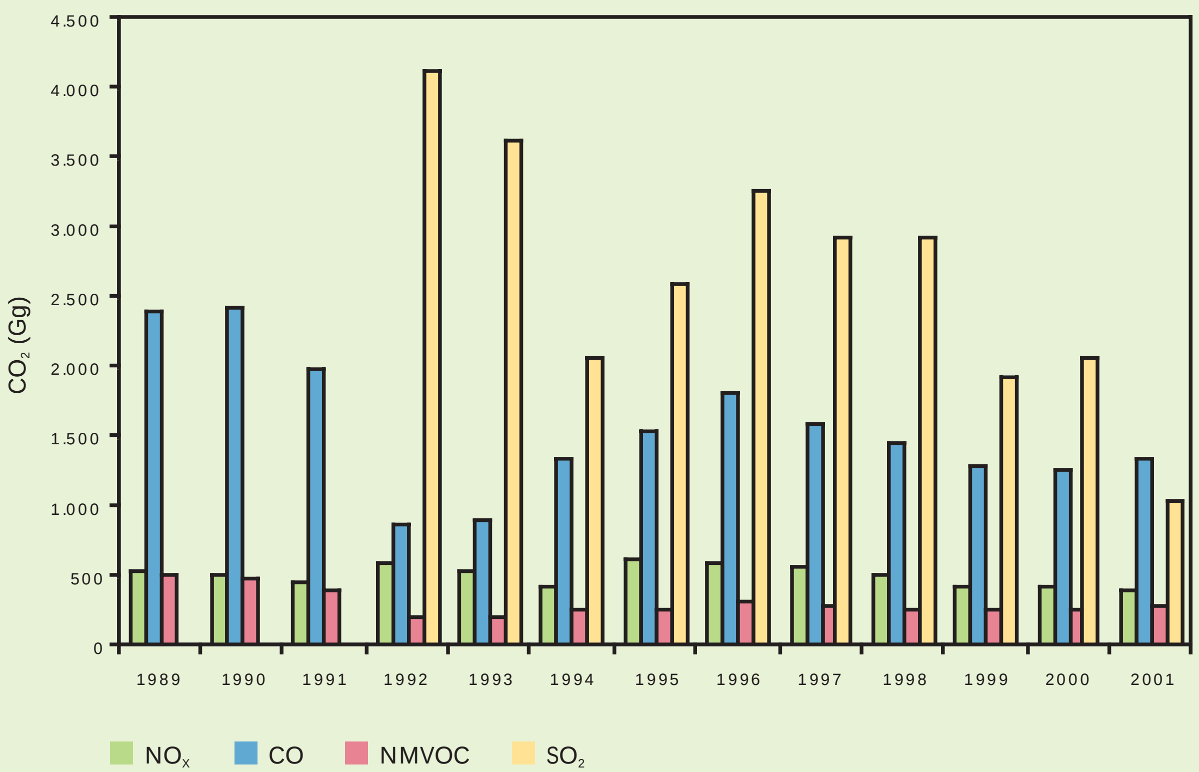
3.10. Conclusions

The most important cross-cutting issues for improving the GHG inventory that should be address by Romania in the next submissions are:

- Re-calculation and time-series consistency - the complete time series for all source categories from 1989 to the most recent year will be calculated using the same methods and data sources;
- Documentation and transparency - the NIR will be reviewed and will be adjusted taking into account the requested information in the guidelines;
- Basic QA/QC and error checking;
- Participation of other ministries and institutes - A comprehensive national inventory system requires the full-time participation of inventory coordinators and the part-time participation of experts with knowledge of specific sectors and sources;
- Resources and institutional support - The Romanian inventory will improve if additional resources and institutional support are provided to the review team;
- Selection of more appropriate default EFs - The inventory development is mainly based on the use of the average of IPCC default EFs for source categories, but it was proved that the average might not be the most appropriate value.

	1995	1996	1997	1998	1999	2000	2001
	722.9	698.7	712.3	677.4	682.0	703.1	444.8
	603.4	594.7	595.8	575.8	574.8	594.1	337.9
	119.5	104.0	116.5	101.6	107.2	109.0	106.9

Figure 3.12. Emissions variation of the „precursor” gases over the period 1989-2001



Policies and Measures to Mitigate Greenhouse Gas Emissions

4.1. Introduction

In recent years, Romania was preparing for a complex process of integration in the European Union by reviving economic development within the international context. Environmental protection has a high priority in the development strategies and policies of the Romanian Government. Special attention is given to the commitments resulting from the international agreements signed and ratified by Romania. As mentioned in the article 20 of the Romanian Constitution, the provisions of international agreements adopted by Romania have priority for compliance, even if there is no domestic regulation on that matter.

Air pollution prevention and control activities are based on the Environmental Protection Law no. 137/1995, modified and completed by Law 294/2003, and the Law 655/2001 regarding atmospheric protection.

Romania signed the United Nations Framework Convention on Climate Change (UNF CCC), in 1992 at the Rio de Janeiro Earth Summit, ratified then by Law no. 24/1994. Romania was the first UNFCCC's Annex I Party to ratify the Kyoto Protocol by Law no. 3/2001, thus committing itself to reduce GHG emissions by 8% in the first commitment period 2008 - 2012, comparing with the base year (1989), thus harmonizing with the EU reduction commitment.

According to the provisions of article 4.6 of the UNFCCC and Decisions 9/CP.2 and 11/CP.4, the year 1989 was established as the base year for Romania. In this context, Romania has to develop its institutional capacity and legal framework, so that in 2007 (according to the Kyoto Protocol) a national system for the assessment of the greenhouse gas emissions will be operational.

The total greenhouse gas emissions (without considering sinks) decreased by 48% in the period 1989-2001, and the net GHG emissions (taking into account the CO_2 removals) decreased with 51.8% in the same period. Based on these observations, Romania will be able to meet the 8% GHG emissions reduction commitment in the first commitment period 2008-2012. The difference in emissions is partially used by Romania for developing GHG emissions reduction projects based on the Kyoto Protocol flexible mechanisms (Joint Implementation, Emission Trading). The Government of Romania decided in 1996 (Governmental Decision no. 1275/1996) to establish the National Commission on Climate

Change, which is a consultative inter-ministerial body coordinated under the Ministry of Environment and Water Management who has the role to promote the necessary measures for unitary implementation in Romania of the UNFCCC and Kyoto Protocol.

Greenhouse gases emissions mitigation is one of the most important activities presented in the Romanian Strategy on Atmosphere Protection. This Strategy is evidence to the commitment Romania has made to meet its target for 8% reducing of greenhouse gases emissions in the period 2008 - 2012 comparing to the 1989 levels. Policies and measures to reduce CO_2 and other GHG emissions will deliver indirect benefits, including improvements in air quality. Some measures targeting reducing greenhouse gas emissions have the added benefits of reducing emissions of pollutants that are harmful to human health and environment. The transfer to more efficient forms of energy production, improvement in transportation system, such as better public transportation and better engine technology for private and commercial vehicles, all result in reductions of greenhouse gases emissions, but also lead to reductions in pollutants such as nitrogen dioxide, carbon monoxide and particulates that have a proven adverse impact on human health.

Romania represented by the Ministry of Environment and Water Management (MEWM), has requested assistance from Denmark (Danish Environmental Protection Agency) in drawing up a National Strategy and Action Plan on Climate Change. Thus allowing for compliance with the provisions and requirements deriving from the UNFCCC and the Kyoto Protocol, which are key concerns to the Romanian Government.

The National Strategy and Action Plan will serve as the overall document, which reflects the strategic considerations, and practical steps for climate change related activities that Romania will undertake. While taking into account the commitments made by Romania under the UNFCCC and the Kyoto Protocol.

The project to be financed by the Danish Government will support the Government of Romania in the process of elaborating a National Strategy and Action Plan on Climate Change.

The main expected benefits of the technical assistance are the following:

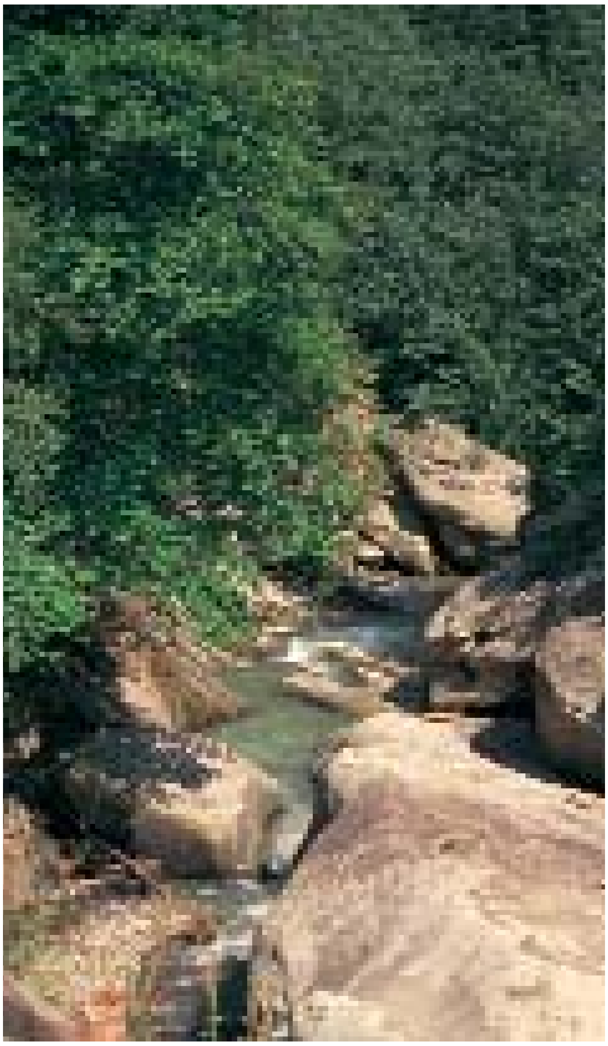
- The development of a Strategy and Action Plan will provide for a more coordinated approach to climate change in Romania.
- The process of designing the Strategy and Action Plan will help highlight the key challenges, opportunities, gaps and constraints in relation to Romania's implementation of the UNFCCC/KP.
- The Strategy and Action Plan will provide an excellent basis for targeted provision of further technical assistance from international cooperation partners.

The focus of the technical assistance provided by the project will be on assisting the Romanian Government in planning and managing the process of elaborating the Strategy and Action Plan. Input for this support will be provided by a combination of international and local consultants with expertise in climate change issues.

The Strategy and Action Plan will address the period from the time of its approval to January 1, 2008. Approval of the Strategy is expected in March-April 2005, and of the Action Plan in October-November 2005. Subsequent updates and revisions are to take place on a regular basis at the initiative of the Romanian Government.

A climate change strategy and an action plan were for a long time one of the most stringent objectives of the MEWM. This kind support provided by the Danish Government for achieving this objective was greatly needed in Romania and was based on the bilateral cooperation regarding Joint Implementation projects and climate change in general, and on the commitments made by Denmark under the Convention and Protocol for capacity-building activities in economies in transition (EITs) and developing countries.

The Romanian government has made significant progress since 2001 in the promotion of environmental management and harmonization of environmental legislations with the EU. Transposition and implementation of the EU environmental acquis communautaire is a complex process due to its cross-sectoral nature and the



potential impact on the Romanian economy caused by bringing environmental standards in line with EU ones. The process involves significant costs and structural changes in the Romanian economy including both legal and governmental ones.

The first long-term objective of the EU strategy is to limit climate change, first by meeting the commitments under the Kyoto Protocol and then by reducing greenhouse gas emissions up to 2020 by an average of 1% annually, compared with 1990 levels.

The European Union is implementing sustainable development by integrating environmental concerns in all policies, as required by the Amsterdam Treaty and the 2002 WSSD Johannesburg Plan of Action. Several EU policies have been designed in this regard. They relate to agric-

ulture, energy, transport and market. Progress towards sustainable development is measured through environmental indicators that are currently being developed, such as:

- total greenhouse gas emissions, emissions per capita, by sector and by unit GDP;
- energy consumption by means of transportation;
- urban population exposure to air pollution (ozone and particulate matter);
- emissions of air pollutants (ozone precursors, particulate matter and SO_2);

These and further developments at the EU level will have to be taken into account as this strategy evolves over time. Romania will have to be in line with existing EU strategies and plans in the near future.

4.2. Strategy and Policies

4.2.1. Strategy for economic development of Romania on medium term

Chapter VI of the Romanian strategy for economic development on medium term (adopted by the Romanian Government in 2000) refers to environmental protection territorial planning and regional development. The National Programme for Environmental Protection has been designed as an integral part of the restructuring and development programme. In terms of the assessment of the European Commission, Romania's annual spending requirements for environment protection would amount to USD 60-70 per capita.

The medium-term programmes envisage, inter alia, are the following:

(a)„protection and preservation of nature, of biological diversity and the durable use of its elements; development and good management of the national network of protected areas in line with the strategies, policies and practices applicable at the European and international levels; implementation of the national technical programme for evaluation and financing of costs incurred by the reduction of greenhouse gas emissions in accordance with the provisions under the UN Framework Convention on Climate Change (1992) and its Kyoto Protocol (1997)";

(b)enforcement of environmental legislation (Law no. 137/1995); adoption of a system of norms, standards and regulations in line with the EU requirements;

(c) promotion of environmentally friendly products and sustainable consumption;

(d)decentralization of the institutional system;

(e)introduction and use of economic instruments for environmental protection purposes.

In the period 2002 - 2006, Romania will pursue the harmonization of its environmental policy and practice with EU environmental acquis communautaire. To this end, the following issues need to be tackled:

(a)assessment of Romania's natural capital according to its current diversity and weak spots, development of the Protected Area National Network;

(b)promotion of measures to restore natural capital in the damaged areas;

(c)development of a long-lasting management of water resources in accordance with the provisions of the Dublin Conference, the Rio de Janeiro Summit (1992) and the Johannesburg WSSD (2002);

(d)ensuring the integrity of national forested areas while taking into account the shift in ownership and management by enforcing tough legal regulations to stop the reduction of present forest-covered areas and develop an increase up to 27.3 percent of the country's total area by 2006;

(e)implementation of the national programme for soil planning and the fight against soil erosion taking into account the sustainable use of this resource;

(f)implementation of the national programme for the management of industrial and urban waste and recycling of materials and products;

(g)design and promotion of necessary financial instruments related to environment for the gradual absorption of the EU acquis communautaire, particularly in the field of water management, environmental protection in industry and agriculture, protection of soil and degraded land, organic protection and certification of organic products;

(h)institutional capacity building and achievement of the necessary skills and knowledge in order to establish a viable partnership between the environmental institutions in Romania and those in the European Union, thus ensuring administrative support for benefiting from the opportunities provided by the European Union by means of strategies and financial instruments to support Romania in the accession process;

(i)establishment and operation of the Environmental Fund as an instrument suitable for achieving the main targets under the National Plan for Environmental Protection and the National Plan for Accession to the European Union;

(j)setting up the legal and institutional framework to stimulate the dialogue between the authorities and the civil society on the strategy, the policies, the programmes and the decisions on the environment and the social and economic development of Romania.

Environmental policy in Romania is to shift focus from recovery actions towards prevention ones. From this angle, the following issues need to be tackled:

(a)development of an integrated monitoring system of the environment, and an information system, a state-of-environment reporting system to implement environmental protection decisions and to assess the achievement of the environmental policy targets, informing also the public on environment-related issues;

(b) environmental-friendly products and sustainable consumption will stand out as the centerpiece of integrated prevention strategy for environment protection in the long term.
(c) decentralization of the institutional system is to be achieved by applying the principle of administrative autonomy and the „polluter pays principle". All actions must be taken with a view to establish environmental protection abilities for local communities, represented by local authorities, stimulating in the same time prevention policies for environmental protection to be developed by companies, thus entailing a cut in public spending;
(d) long-term environmental policy will result more frequently in economic instruments instead of command and control instruments. In this respect, budget subsidies will be restructured by both reducing those subsidies granted to the activities having a negative impact on the environment and boosting those activities that reduce polluting emissions or contribute to ecological restoration and preservation, by levying duties on polluting emissions, and by spurring incentive-compatible regulations;
(e) Romania is to grant support from the international enforcement of economic instruments (foreign taxes or harmonized national taxes, negotiable quotas on greenhouse gas emissions, the joint implementation and emissions trading mechanisms in terms of the United Nations Framework Convention on Climate Change and the Kyoto Protocol).

Romania accepted the acquis communautaire in the field of environmental protection (Chapter 22), in force on December 31, 2000. Romania has unilaterally assumed the date of 1st of January 2007 as the date for its accession to the European Union.

4.2.2. Policies and measures by sector

4.2.2.1. Energy

The main share of the GHG emissions in Romania is represented by the energy related CO_2 emissions. The following measures are considered in the Governmental Program for the energy sector:
- restructuring of the energy system by establishing integrated power plants whose sphere of activity should include the production of electric and heating power as well as heating coal, which will help control the price of energy and the smooth flow of payments;
- privatization in the energy field will cover both the production and distribution of energy, mainly by increasing the capital, and by stock exchange quotation, which provides a double advantage, namely facilitating the capitalization of companies and, ensuring the value increase of the stock left in state property after a period of efficient private operation.

The secure access and efficient functioning of the energy sector represents the basic and vital milestone for the Romanian economy. This is the main reason for the need of a coherent and economically viable strategy in the energy filed, which is a fundamental prerequisite for the achievement of the national objectives related to a sustainable growth and eradication of poverty.

For the past decade, radical institutional, regulatory and structural reforms were being carried out all over the world with the main goal of deregulation that will improve efficiency and quality of services.

The energy market model approach of Romania is based on the liberalization (gradual opening) as an integral part of the overall philosophy of liberalization of the national economy and free movement of goods and services. The aim is to create such structures and market environment to respond and cope with the increasingly integrated European energy market, where national markets are step by step losing their traditional borders and are becoming part of a common European market.

In the last three years, based on these trends, several important steps have been taken in the Romanian energy sector, by implementing a deregulation process, based on the need of setting more market principles and free competition, as well as promoting a sustained privatization process.

In this respect the following activities have been implemented:
- Unbundling of the vertically integrated power companies into autonomous: generation, transmission, distribution and supply companies: Electrica, Transelectrica, Hidroelectrica, Termoelectrica (based on Governmental Decision no. 627/2000);
- The National Power Grid Company - Transelectrica S.A. that includes the transport operator, the system operator and the market operator- OPCOM. Transelectrica S.A. is independent from the energy producers. Its main activities are: power transport, dispatching, organization and management of the energy market, international power transit, transport system exploitation and development. The commercial

transactions between energy producers and distributors are concluded within the framework established by the market operator OPCOM;
- The Electricity and Heat Generation Company - Termoelectrica produces and distributes the electric and heating power, obtained by using fossil fuels;
- The Hydro Power Generation Company - Hidroelectrica produces and distributes the power obtained in hydroelectric power stations;
- The Electricity Distribution and Supply Company - Electrica distributes the electric energy.
- Further unbundling of the generation side into: 5 thermal power producers, one hydro producer, one nuclear producer and 14 cogeneration producers, which where transferred to the local authorities;
- Unbundling of the natural gas sector into autonomous: production and storage (Romgaz), transmission (Transgaz) and two distribution companies (Distrigaz North and Distrigaz South);
- Reduction of the natural gas production and import concentration by authorizing and licensing of an increasing number of companies;
- The regulated third party access, on a non discrimination bases to the transmission system both for gas as well as for electricity has been secured by law, in line with the trend in the European Union;
- A decentralized market has been set up for long and medium term bilateral contracts, supplemented by short term centralized markets, which were initially compulsory and becoming voluntary on medium term;
- The National Energy and Heat Regulating Authority (ANRE) and also the National Gas Regulating Authority (ANRGN) have been established in 1999 and 2000 respectively, with the aim of creating strong and transparent rules encouraging commercial activity and safeguarding public interests, in accordance with the requirements of the EU Internal Electricity Market Directive 96/92/EC for the establishment of an independent regulatory body and of the Directive 98/30/EC of the European Parliament and of the Council of 22 June 1998 concerning common rules for the natural gas internal market;
- In the oil sector, necessary commercial framework has been established, which fixed the following aspects:
  - wellhead prices track international prices;
  - regulated tariffs for crude oil transmission;
  - consumer prices set by the market;
  - rules preclude oil pipeline transmission assets and oil production, supply and refining.
- Regulatory intervention on certain market participants was promoted to ensure that all customers are supplied with gas, including some groups which may be less attractive as clients (e.g. isolated locations, low users);
- A defined strategy for privatization and attraction of new investments was elaborated.

Further actions should be taken in order to improve some specific issues, like:

- Regulated prices in line with justified economic costs;
- Opening the energy prices to be formed freely based on competition and negotiation;
- Clear program for opening the energy market;
- Transparent, solid and proper functioning of the regulatory authorities and mechanisms;
- Understandable market rules and structures;
- Legal framework to respond the needs of transparency and stability.

For the implementation of the EU Directive 2001/80/EC, the Romanian Government has prepared a Governmental Decision for the limitation of the emissions in the atmosphere coming from large combustion plants i.e. over 50 MW, at the level of the EU Directives (for solid, SO_2 and NO_X emissions). These limits are compulsory for any new unit to be established.

Nuclear electricity

From 1996 the „CERNAVODA" nuclear power plant group no. 1. of 700 MW has been providing 7% of the total average annual electricity generation in Romania. This nuclear power plant is operating based on updated technologies (CANDU) and has an important contribution in satisfying the needs for electricity through reliable operation.

In Romania the nuclear power development is dealt with by achieving the requirements of the acquis communitaire, including the Treaty of the European Atomic Energy Community, as fundamental instruments for the improvement of the living standard in the Member States and development of relations with other countries. One of the Romanian Government priorities in the coming years is to start the operation activities at the second group of the nuclear power plant (2006-2007) and also to start the third group in the long term (2010-2015) having 707MW each. Nuclear energy is the main sector to cover the future increase of the energy demand. The nuclear energy represents one of the most efficient energies and is reducing the dependency of imported energy resources. After Unit 2 becomes operational, Cernavoda Nuclear Power Plant will cover approx. 20% of the national consumption.

Solid fuels

One of the major objectives of the National Strategy for the development of the energy sector (adopted by the Romanian Government in 2000) is to modernize the coal industry and to make it efficient. According to this strategy, the restructuring process will continue and will include the following objectives:

- Improvement of the economic and financial performance of the viable part of the sector, along with the environmental conservation;
- Implementation of a programme for closing non-feasible mines and environmental rehabilitation;
- Privatization encouragement;
- Reduction of the social effects in the mining areas affected by the restructuring process;
- Enhancement of the managerial capacity in the mining companies.

The Ministry of Economy and Trade is the responsible authority for the implementation of this strategy in the energy sector. The National Agency for the Development and Implementation of the Reconstruction Programme in the Mining Areas is an agency under the subordination of this ministry. The respective agency is the authority responsible for the implementation of the governmental strategy for the reconstruction of the areas where the mining activity has ceased, by creating occupational alternatives for the human resources unemployed as a consequence of the ceasing process.

The National Agency for Mineral Resources (ANRM), which issues the licenses for mineral resources exploitation, is the competent authority in the coal sector, for the application of the Mining Law (established in 1993), being subordinated directly to the Government.

ANRM has the following responsibilities:

- administrate and survey the Romanian mineral resources, the national geologic fund, all national property;
- compute, register and update all mineral resources of Romania in the Mining Book and Petroleum Book;
- negotiate the terms and conclude agreements for the exploration and exploitation of the mineral resources;
- regulate the activities and operations on the basis of different agreements;
- establish legal taxes, royalties and prices for prospecting exploration and production activities, as well as pipeline transportation tariffs;
- issue compulsory regulations and instructions for the mineral resources sector.

Law no. 143/1999 concerning state aid regulates the authorization of state aid granting in relation to its effects upon competition, as well as the supervision, registration, monitoring and reporting of state aid. The bodies responsible for applying the provisions of the above-mentioned law are the Competition Council as an autonomous administrative authority and the Competition Office as a specialized body subordinated to the Ministry of Public Finance, both being

established according to the provisions of the Competition Law no. 21/1996.

The production subsidies in the coal sector decreased by more than 75% from 1998 to 2002. Approximately 82% of the annual coal production does not receive any subsidy for operation, receiving allowances only for social security, investments, activity reduction or ecological rehabilitation. The restructuring process of the coal sector shall continue whereas the state aid shall be mainly directed to those mines that could become profitable on a medium term.

Natural gas

The National Natural Gas Regulatory Authority (ANRGN), established in 2000 (Governmental Ordinance no. 41/2000), ensures the regulation, authorization and control in the field of natural gas. The main responsibilities of ANRGN are:

- issuing authorizations and licenses in the natural gas sector,
- setting up calculation methodology for the regulated prices and tariffs,
- developing the rules for eligible consumers.

In order to ensure the transparency of natural gas prices, ANRGN elaborated and published in the Official Journal no. 199/20.04.2001, the Methodology for establishing the regulated prices and tariffs. According to this methodology, the price and tariff calculation considers the operators effective costs.

Energy efficiency

Romania aims, as mentioned in the National Strategy for the energy sector development, to increase the energy efficiency over the entire chain - natural resources, production, transport, distribution and consumption - by using the market economy mechanisms at an optimum level.

The Romanian Agency for Energy Conservation (ARCE), established in 1990, is the specialized body of the central public administration in energy efficiency under Government subordination, having functional, organizational and financial autonomy. One of the ARCE's responsibilities is to reduce the negative impacts on the environment.

The Strategy for Energy Sector and Energy Efficiency in Romania is based on setting long-term objectives, which are reflecting the needs of the National Economy for:

- securing energy supply and safety;
- promoting energy efficiency;
- using renewable energy sources;
- applying environmental protection.

Romania intends to develop a series of projects based on the use of renewable energy sources, such as biomass, micro hydro, geothermal energy, solar and wind energy, these sources having a great potential to be benefited from in the comming years.

In the next couple of years the following important power projects should be considered:

- Additional hydro power generation capacity, economically feasible, estimated at 500-900 MW;
- Power generation based on lignite and hard coal by rehabilitation of some of the existing power plants, where the upgrading costs are less than 50% than for a new capacity and/or built of new units, at the following locations: Turceni, Rovinari, Isalnita, Deva-Mintia. The rehabilitation projects could represent 35-45% of the total newly needed power generation capacity;
- Combined cycle gas turbines. Only 15% of the total power generation will be secured from natural gas.

Electricity

One of the main objectives of the electricity sector is to make the National Energetic System operators more competitive and efficient. In this respect, the capacities that will not be rehabilitated will be closed. On the other hand, those feasible capacities will be modernized and new technologies will be implemented. The results of such measures will be cost reduction and some profit for the operators.

The National Energy Regulatory Authority (ANRE), based on the methodologies issued, establishes the power prices and tariffs. These methodologies are approved by the Competition Office and are based on the following principles:

- Consumer protection;
- Ensuring the economic and financial feasibility of the operators;
- Encouraging the operators to increase the economic efficiency;
- Attracting investors.

ANRE was established in 1998, as a national autonomous public institution having the main objective to establish and implement the set of regulations in the energy sector, securing the operation, authorization, and control of the electricity and heat market taking also into account the needs for competition, efficiency, transparency, and consumer protection.

The price and tariffs policy envisaged will be governed only by economic criteria. The energy prices (gas and electricity) are fixed. An increase in the electricity production costs is expected due to the need of investment expenditures for setting up new power generation capacities and upgrading the existing capacities addressing also the environmental protection requirements.

4.2.2.2 Industrial processes

Industrial processes sector adjustment is consistent with the overall objectives of increasing external competitiveness and domestic productivity in terms of all production factors. In this respect, the following directions were addressed in the last period and will be pursued:

(a) extending the process of redesigning industrial capacity and structure, including development and promotion of co-operation with the EU partners, backed by consolidating the market economy, establishing a competitive environment, and stimulating potentially competitive small and medium-sized enterprises;

(b) sequencing the process of selection and rescaling the economic agents involved in the restructuring process for ensuring an appropriate business environment capable of fulfilling the increasing internal demand spurring significantly in the same time the export volume and efficiency for goods and services;

(c) completing the privatization of industrial companies and exposing the remaining state-owned industrial units to market conditions, on the basis of strengthening the legal discipline concerning competition issues (including the Bankruptcy Act);

(d) restructuring the energy and material-intensive sectors, as well as those with under-utilized capacities by diminishing losses and recording substantial productivity gains, promoting in the same time energy saving technologies;

(e) reviving and efficient deployment of the national research and technological development potential, including the microeconomic R&D;

(f) increasing the competition by promoting strategic alliances, holdings, and group companies in view of including the Romanian industry in the globalization process, considering also the development of complex exports;

(g) rapid developing, outsourcing and specializing of production-related services;

(h) accelerating growth in the volume and efficiency of exports by encouraging exports of high value-added manufactured products; setting a priority in supporting, within the limits provided by the international legislation, the globally expanding industries or high-tech industries insufficiently developed in Romania;

(i) taking advantage of Romania's geographic position by directing exports also to neighboring areas that may become strategic markets for EU.

A high level of environmental protection activity is the most important driver to sustainable development and increasing living standards and quality. Environmental protection activities are supported by a complex legal system, harmonized with the EU acquis communautaire. The Romanian Government considers environment as a natural resource, and the companies using it, must be prepared to pay for. Public authorities are assessing the price for this offer of environment resources and are taking care that it is not overused. The developing market for using the environmental resources, leads to the development of new instruments such as environmental permits and licenses, taking into account the „polluter pays” principle.

In this respect, the Government has taken some actions in recent years to grant necessary assistance to companies in developing environmental protection strategies and integrating „environmental friendly” technologies and products in the concept of designing, production and marketing. In order to decrease the pollution levels and, where possible to remove pollution, the Romanian Government will intervene at different companies, in geographic areas with severe pollution problems and where difficulties are noticed in complying with the environmental standards. This will be accomplished by observing the legislation in force, either by direct aid or by reducing taxes and duties or other measures having an equivalent effect. However, meeting the condition that the funds should be used in compliance with the harmonized legislation on state aids.

Two of the most important concerns of the Government in this field are: observing regulations on environmental protection and the wide promotion of „environmental friendly” technologies and services, as well as developing new production and consumption patterns. At the same time increasing performance in environmental protection activities by supporting the implementation of new environmental management systems (ISO 14000).

In this respect, the legislation was harmonized with the environmental acquis communautaire on industrial pollution control and risk management, developing and implementing programmes to reduce industrial activities that are harmful to the environment, simultaneously with ecological rehabilitation of the affected areas.

The Romanian Government considers instruments that are effective on general economic efficiency and also on pollution reduction and rational use of resources. Increasing the efficiency of electric energy, even if this will imply high costs for equipment updating, will have positive consequences both on companies' economic efficiency and on environment protection through limiting or reducing pollution.

Progress made for the implementation of the industrial policy

The most recent measures taken by the Romanian Government for achieving the objectives of the industrial policy are mainly the following:

Preparation and implementation of the new Industrial Policy Paper

- Establishing the Inter-ministerial Working Group for the co-ordination of the preparation and implementation of the Industrial Policy and the Action Plan related to the Governmental Decision no. 660/2001.

Improvement of business environment

- Setting up the Working Group for the preparation and monitoring of the Action Plan related to the improvement of the business environment - Governmental Decision no. 803/2001;
- Preparation and approval by the Romanian Government of the Action Plan for removing the administrative barriers related to the business environment - Governmental Decision no. 1189/2001 supplemented with the provisions of Governmental Decision no. 209/2002;
- Establishing the one-stop-shop, within the Chamber of Commerce and Industry, in order to eliminate the bureaucracy barriers in the process of setting up new business (authorization, setting up and registration of new companies), resulting in an important decrease of the entrepreneurs efforts and waiting time - Governmental Emergency Ordinance no. 76/2001 concerning the simplification of some administrative formalities for the registration and authorization of companies;
- Preparing a new fiscal code, aiming to ensure better coherence, transparency and flexibility in the financial field;
- Convening public procurement agreements through on-line auctions (Governmental Ordinance no. 20/2002), in order to enforce free competition, increase of the efficient use of public funds, transparency, equal treatment for all participants, commercial secret and intellectual property rights guarantee, as a way to avoid corruption;
- Modifying the Law no. 64/1995 concerning the legal system re-organization and bankruptcy procedure, through the Governmental Ordinance no. 38/2002;
- Strengthening Romania's private banking system by preparing for the privatization of the Romanian Commercial Bank in the coming years, according to the PSAL II program, this bank being the last and the most important state owned bank.

Accelerating the privatization process

In order to speed up the privatization process, the Romanian Government undertook the responsibility from the Parliament by Law 137 from March 2002 concerning the speeding up of the privatization process. This law supplements the existent privatization legislation, introducing some new elements, as follows:

- Establishing the „special administration during the privatization period” for the companies where the state still owns the share majority;
- Diversifying the methods whereby state involvement in the economy is diminished, by:
  - introducing the capital increase along with the sale of shares, and the transfer upon payment for the assets of social nature;
  - introducing the sale of state owned shares in unattractive companies at a symbolic price.
- Restructuring companies debts;
- Analyzing some problematic cases with priority for strengthening the privatization process;
- Limiting the Judicial Courts competences for awarding decisions based on legality and not on opportunity;
- Simplifying some privatization procedures;
- Shortening some procedural terms.

Attracting foreign investments

One of the important steps for attracting foreign investments was the establishment of the Romanian Agency for Foreign Investments, on March 2002, as the only institution for informa-

tion and promotion of foreign investment activities in Romania. This agency was set up and it is functioning under direct co-ordination of the Romanian Government. Another step was the approval of the Law no. 332/2001 concerning the foreign direct investments with a high impact on the economy (investments with a value exceeding 1 mil. USD).

The Investor's Code introduced by the Government as an useful instrument for investors, includes mainly the needed guiding elements regarding the legal and institutional framework for starting new business and the process for setting companies.

Making industrial products more competitive

The institutional framework adaptation in order to apply the provisions of the Law no. 608/2001, concerning the evaluation of product conformity law for the market surveillance and product certification has been seen as a driver for increasing the competitiveness in the industrial sector. At the same time the conditions for starting the negotiations with the European Union were created in the period 1998-2001 in order to conclude the product conformity evaluation protocols. In this respect, the Government has accelerated the process of transposing and/or implementing the European Union directives, decisions, rules and standards.

Supporting the small and medium size enterprises (SMEs) activity

Establishing the National Fund for SMEs credits guarantee, financed from the budget of the Ministry for SMEs - Governmental Decision no. 1211/2001 and setting up, through the Governmental Decision no. 1240/2001, the Selection and Training Center for the potential successful entrepreneurs (EMPRETEC/UNCTAD - Romania), meant also important steps promoted by the Romanian Government for this sector development.

Environmental protection

The Inter-ministerial Committee for the co-ordination of the environmental protection activities including the sectorial policies and strategies at a national level was established through the Governmental Decision no. 1097/2001 as a measure for integrating environmental protection in overall economical development.

The privatisation/restructuring process in this sector will continue with the following actions, as agreed with the World Bank in the framework of the PSAL I and II programmes:

- offering for sale of the companies SC ALRO and SC ALPROM Slatina (2 important actors in the aluminum production sector in Romania);
- continuing the privatization process, during the period 2002 - 2004, for the companies not yet privatized and included in the component „case-by-case privatization of the large state-owned commercial companies with the assistance of investment banks;
- continuing the implementation of the restructuring programmes for companies included in the component „restructuring/liquidation of the large commercial companies”.

4.2.2.3 Transportation

The development of infrastructure, by taking into account both the National Programme for Territorial Planning and the connections with the European Union's infrastructure system, will play a major role in economic recovery and will create new working opportunities. Modernization, rehabilitation, and development of transportation infrastructures was started in recent years in the context of increased EU financial support (through the pre-accession instruments) and by attracting private resources. The priorities in this field are the following:

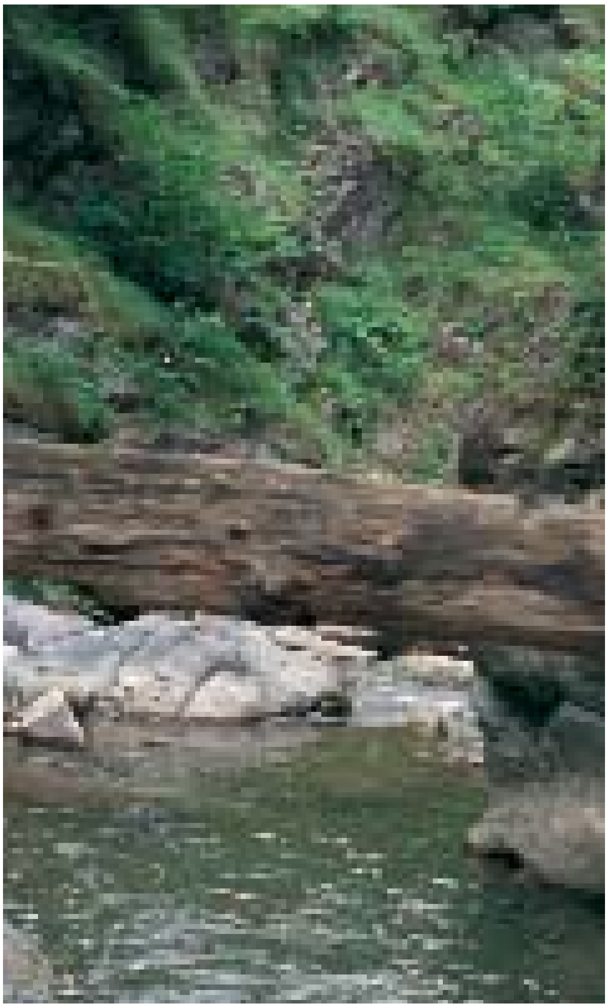
(a) starting the development of highways, in accordance with the provisions of the TINA Final Report, in order to integrate the Romanian transportation infrastructure into the Pan-European Transport Network;

(b) modernizing the railway and road infrastructure, building of bridges and beltways around cities along the Pan-European Transport Corridors no. IV and IX, in order to ensure an increase in the mobility of population, goods and services;

(c) changing the current tax and tariff systems regarding the railway and road transportation, in order to increase service accessibility, and to enhance the harmonization with the European Union standards.

Romania is facing a series of problems in the field of road infrastructure, and the following issues are among the most important ones:

- limited road capacity for absorbing the international and interregional road traffic, especially in the urban areas;
- important increase in the vehicle fleet in the last period;
- low quality of the road cover and minimal bearing capacity of the road infrastructure, except for the road sectors that have been rehabilitated and declared as such, which meet the EU standards;
- lack of bypass routes of the important towns and the existence of 400 level railways crossings, which constitute traffic bottlenecks.



In order to solve these problems, the road infrastructure policy takes into consideration the following priority objectives:

On short and medium term:
- completing the rehabilitation/modernization of the Pan-European transport Corridor IV and consequently increasing the transport supporting capacity on this corridor;
- continuing the rehabilitation/modernization of the Pan-European transport Corridor IX on Bucuresti-Marasesti-Galati/Iasi sector and Bucuresti-Giurgiu sector and consequently increasing the transport supporting capacity on this corridor;
- facilitating the traffic flows by building bypass routes to avoid the urban traffic jams, and modernization/construction of bridges and overpasses;
- starting the construction of motorways on the TINA backbone network, priority being given to the Northern branch of the Pan-European Corridor IV (Nadlac-Bucuresti-Constanta) and the Bucharest-Giurgiu sector (Pan-European Corridor IX).

On long term:
- rehabilitation of the whole national road network (14683 km) at European standards;
- construction of motorways and express roads on the whole TINA backbone network.

The main Romanian air carrier is the Air Transport National Company TAROM S.A. The registered capital of the company is owned by the Romanian State, who exercises all the rights derived from being a shareholder, through the Ministry of Public Works, Transportation and Housing. TAROM has one of the youngest fleets in the world with 14 airplanes working on one regular long-courier flight to New York, on regular courses to Europe, mid-Asia and internal routes.

Romania took the necessary steps in order to privatize the TAROM Company before the end of 2000. Therefore, in the autumn of 2000, the international bid for the privatization of the company had been launched, but no sale contract resulted.

The project entitled „The restructuring of the TAROM Company and its preparation for privatization” started in October 2001. Following the international bid, the selected consultant is LUFTHANSA CONSULTING.

The objective of the project is the restructuring of the company with a view to increasing its efficiency, aimed at restarting the privatization process.

4.2.2.4 Agriculture

Agriculture is one of the key sectors in the Romanian economy. The contribution of agriculture and forestry to the GDP was constantly significant during the period 1998-2002. Its share increased from 13.7% in 1989 to 18.6% in 1992. This share was maintained until 1996 and it decreased to 11.4% in 2000 and to 10.5% in 2002.

In the view of creating a competitive sector to meet the common market requirements, the priority objectives presented in the Governmental Program for the period 2001 - 2004 were: productivity and quality increase, maximizing the agricultural producers incomes and enhancing the sustainable development of rural areas, in compliance with the environmental protection requirements. Romania applied in the last years a policy aimed at privatizing and restructuring the agriculture sector, to support the agricultural production within the budgetary constraints and liberalize the trade in agricultural and food products.

The strengthening of private property represents the basis of structural reforms. The process has been initiated in 1991, by the adoption of Land Law no. 18, followed by Law no. 1/2000 regarding the restoration of property rights on agricultural and forestry land. Law no. 54/1998 regarding the legal procedure for circulation of lands facilitates the functioning of land market. The Emergency Governmental Ordinance no. 102/2001 for the modification and completion of Law no. 1/2000 regarding the restoration of property rights on agricultural and forestry land, and respectively of the Land Law no. 18/1991, was adopted in order to remove the problems in the implementation of the Law no. 1/2000.

The main provisions of the Emergency Governmental Ordinance are:

- restoring of property rights will be completed in former areas, if these are available and if not enough agricultural land is available, the restoration is completed from the agricultural land existing in the propriety of the respective locality;
- if the restoration of the property rights can not be entirely achieved, compensations is granted for the remaining agricultural land;
- regulating of the legal status of natural and artificial fish farming lakes, as well as of lands with greenhouses facilities or hops cultures, vineyards and orchards for which the restoration is performed on other areas, or compensations are granted;
- restoring of propriety rights on forest lands is completed only based on documentary proofs;
- regulating of the case when the same agricultural land is claimed by two applicants.

The National Office of Cadastre, Geodesy and Cartography has taken the following measures on short term in order to speed up the implementation of Law no. 1/2000 modified by Emergency Governmental Ordinance no. 102/2001:

- re-organizing the county offices of cadastre, geodesy and cartography in order to provide technical assistance and methodological guidance to the local commissions;

• elaborating the quantitative and qualitative inventory on administrative territories of land laws implementation;
• establishing and implementing a monitoring and reporting system on the whole activity of the county offices of cadastre, geodesy and cartography which should include indices regarding the accomplishments of Law no. 1/2000 provisions with subsequent modifications;
• identifying the necessities for changing the methodological framework in the application of Law no. 18/1991 and Law no. 1/2000 and elaborating a draft Order of the Ministry of Public Administration and Ministry of Agriculture, Food and Forestry regarding the application of Law no. 18/1991 and Law no. 1/2000 with subsequent modifications.

The Romanian Government approved a draft law simplifying the privatization procedures in order to speed up the privatization of state owned agricultural societies, the former IASs (State Agricultural Enterprises).

The agricultural production benefited in the last years of state support through the allocation of 1.0 million lei for each cultivated hectare of land, under the conditions of using certified seeds and complying with specific agricultural technologies. The financial support was 20.0 million lei for each cultivated hectare in greenhouses. Additionally, the State subsidized up to 50% of the purchase price of certified seeds and propagating material and 55% of the price of tractors, and other agricultural machines and equipments.

Other measures for supporting this sector refer to the exemption of private farmers from income tax, subsidized credit interests intended to finance agricultural production, support from the state budget to cover storage and conservation expenses for cereals, oilseeds and protein plants. In doing so, the state aid to agricultural producers has not exceeded 10% of the total agricultural production value, in compliance with the WTO provisions for the developing countries.

Investments in agriculture, in 2001, amounted to about 4,000 billion lei, out of which the private sector's share was 91.6%. The domestic trade with agricultural products was liberalized.

Romania faced difficulties due to competition with highly subsidized products of its trading partners, both on domestic and international markets. As a consequence of limited budgetary resources, Romania's possibilities to subsidize exports are very low. Under these circumstances, Romania applied in 1999 the safeguard clause within CEFTA Agreement for its imports of wheat and wheat flour from Hungary, and in 1999, 2000 and 2001, for its imports of pork and poultry meat from that country.

For solving problems in the agriculture sector the following measures were adopted:

•At macro economical level:
a) modification of the legal and institutional framework;
b) estalishment and development of some financial-economical levers, also financial perks - e.g. fee and tax reductions were adopted for those who replace dangerous substances from the manufacturing process or for those who invest in technological process or products resulting in the decrease of the negative impact on environment;
c) structural adjustment;
d) production structures reform.

•At micro economical level:

a) Adopting measures related to the economical agent, responsible of implementing some changes regarding the property, organization and management;
b) Introducing new technologies and modernizing the agricultural units.

Agricultural reform was structured on three pillars: re-organization, re-structuring and privatization.

In the recent past the Romanian agriculture was dominated by subsistence agricultural units, which are characterized by the using of traditional equipments, techniques and technologies. These traditional systems have similar characteristics with the ecological and biological types of agriculture, and the biggest advantage for Romania is just the opportunity to obtain ecological products based on recent clean practices in agriculture - the fertilizer and chemical substances consumption for the last 12 years show some values which are 10 times lower than the European countries' average.

4.2.2.5 Forestry

In Romania, the forestry area covers 6.6 million ha, representing about 28% of the country area. The distribution of forests on the relief is not uniform. Plains are poor in forests with a share of about 7% while 28% of the forests are spread on hills and 65% on mountain areas. Forests in Romania are predominantly composed of hard wood - 69% and soft wood - 31%. In relation to the total surface of forests, beech has the biggest share - 31% in the leaf-bearing wood species. Out of coniferous species the spruce fir tree has the main share - 23% followed by common fir - 5%.

The volume of wood on trunk has an overall value of 1,341 million cm^3, the average being 218 cm^3/ha, the average yearly growing rate is 5.6 cm^3/ha and the yearly output is 17 million cm^3. The whole forestland in Romania is administrated on the basis of management forestry projects (forests arrangements).

Currently, most of the forests are in state ownership, being administrated by the National Public Administration of Forests (RNP), only 10% of the total surface is private propriety. This share shall increase significantly, most probably around 30%, following the restitution process of forests to former owners.

The long-term government strategy for this sector has as a main objective to increase the afforestation rate at the national level, having in mind the large area of degraded lands which are improper for agricultural use.

Community regulations are partially transposed to the national legislation by:

- Decree of State Council no. 10/1986 concerning the setting up of the information system in forestry;
- Order of the Minister of Forestry for approval of Technical Instructions no. 10/1988 concerning the production, certification and genetic control of forestry planting materials;
- Law no. 124/1995 for the approval of Governmental Ordinance no. 47/1994 concerning fight against disasters;
- Law no. 212/1997 for the approval of Governmental Ordinance no. 60/1997 concerning fight against fires;
- Law no. 26/1996, the Forestry Code;

- Order no. 1654/2000 of the Minister of Water and Environmental Protection concerning the approval of the Norms for fire prevention and extinction in the forests;
- Order no. 269/2001 of the Minister of Agriculture, Food and Forestry for approval of the National Catalogue of sources for forestry propagating materials in Romania.

Concerning community forest protection against atmospheric pollution the Romanian Government ensured the implementation of the EU scheme concerning the protection of forests against atmospheric pollution (Regulation 3528/86) by the Ministry of Agriculture, Food and Forestry through the Institute of Forests Research and Arrangements (ICAS) under the subordination of the National Public Administration of Forests (RNP).

The forest regeneration programme developed in 2002, which was analyzed and approved by the Board of the National Public Administration of Forests, provided for the execution of regeneration works on 17,200 ha of forests. From which natural regeneration involves 8,200 ha and integral afforestation 9000 ha.

In the recent past Romania managed to implement regeneration activities on 20951 ha forests administered by the National Public Administration of Forests based on a specific coordination program. From the total regenerated forest area 9665 ha were natural regenerations and 11286 ha were based on reforestation. The regeneration works ensure the recovery of forest vegetation, the increase of forest efficiency for wood production and also the maximization of the protection actions provided by the forests.

The National Public Administration of Forests implemented the regeneration works with an important financial effort, with the total cost of the works being over 404,3 billion lei (11 million Euro). From the total value more than 345,3 billion lei have been taken from the Forests Conservation and Regeneration Fund established in accordance with the provisions of the Forestry Code, more than 33,9 billion lei were taken form the budgetary sources and external credits, and more than 24,8 billion lei being allocated from the land law fund for forest arrangements.

The National Public Administration of Forests actively involved in supporting the development of forest regeneration works implemented on other owners forestlands, the total value being 912

ha. Important support was also provided to other owners of forestlands by establishing 109 ha of forest belts.

4.2.2.6 Waste

In the last period, the waste sector represented one of the most acute problems of environmental protection in Romania. Large quantities of waste are produced annually, both due to the last 14 years of development, including the rise of production and consumption activities and due to the old industrial technologies and installations. All leading to intensive energy and raw materials consumption. The inadequate management of waste leads to numerous cases of contamination of soil and underground water and threatening human health.

Economical components of waste which can be reused, can be treated and recycled or transferred to a treatment plant (in order to diminish the hazardous degree) or to an incinerator (in order to reduce the volume). The unrecoverable wastes are usually stored.

Each step in waste management may pose a potential risk for the environment due to the different management methods involving the discharge of some pollutants in the environment. Agriculture, mining, industry and domestic activities are important waste sources as far as the quantitative and environmental impact. Waste management in Romania is based on the „polluter pays” principle. As a result waste management for both types of activity - industrial waste and municipal waste - is organized and operated on economic basis.

According to the provisions of the Law no. 462/2001, the Ministry of Water and Environmental Protection periodically elaborates the National Plan for Waste Management based on the county plans elaborated by the territorial authorities for environmental protection. The county waste management plans are established based on the plans set out by the local councils and the waste producers from every county. The county councils coordinate the elaboration of

the local councils plans and adopt the county plan elaborated by the territorial authority for environmental protection.

The present collection/transportation/storage practices for urban waste are inadequate, generating a negative impact on environmental factors and facilitating the spreading of pathogen agents and their borne vector diseases. In particular, industrial waste represents risk sources for human health and the environment, due to their toxic substances content, such as heavy metals (lead, cadmium), pesticides, waste oils.

Municipal waste landfills are counted on the list of sources recognized as impact and risk generators for environment and human health due to limited arrangements and to the improper exploitation.

The main forms of impact and risk generated by urban and industrial waste landfills are classified based on the population views as:

• Landscape change and visual discomfort;
• Air pollution;
• Surface water pollution;
• Modification in soil fertility and composition of the neighbouring lands;
• Increasing the global warming process.

During recent years, Romania concentrated its efforts in some important ways to protect the environment, one of them being the waste problem. Therefore, the Ministry of Water and Environmental Protection, through the Directorate of Wastes and Hazardous Chemicals Management, followed the harmonization of Romanian legislation with the European Union legislation and initiated the establishment and adoption of a national strategy. At the same time it supported the implementation of a national plan for industrial and urban waste management.

The following regulations were adopted in the waste management field in the last period:

• Law no. 426/2001 for approving the Governmental Emergency Ordinance no. 78/2000 on waste management;
• Governmental Decision (GD) no. 662/2001 regarding the management of exhausted oil (revised with GD no. 441/2002);
• Law no. 465/2001 for approving the Governmental Emergency Ordinance no. 16/2001 on the recyclable industrial waste management;
• Governmental Decision no. 1057/2001 on the management of batteries and accumulators containing dangerous substances;
• Law no. 139/2002 for approving the Governmental Emergency Ordinance no. 87/2001 regarding the local public services for sanitation;
• Governmental Decision no. 128/2002 regarding waste incineration;
• Governmental Decision no. 162/2002 regarding waste storage;
• Environment Minister Order no. 867/2002 regarding the criteria to be followed by waste in order to be recovered; on the specific list of landfills; and on the national list of waste types accepted in different storage class;
• Governmental Decision no. 349/2002 regarding package and waste package management;
• Environment Minister Order no. 1190/2002 regarding the package and waste package data reporting procedure;
• Governmental Decision no. 856/2002 regarding the waste management evidence and approval of waste types list, including hazardous wastes.

More legislation is necessary to encourage quantitative reduction of waste at sources, waste reutilization and recycling in order to reduce the waste impact on the environment. The regulations must establish ways and means for waste collection, treatment and storage in safety conditions both for human and environment, and encourage initiatives to recover the land contaminated by waste.

The essential principles presented below will be taken into account in order to establish the waste management strategy.

• Source prevention principle;
• Polluter pays principle (the costs related to wa-

ste treatment and discharge are supported by the waste generators);
- Precautionary principle (the measures taken have to anticipate the negative effects on environment);
- Proximity principle (the waste have to be managed near the generation source).

All the possible measures for an adequate waste management have to consider the main options in this field, having the following priorities:
- Waste minimization/reducing;
- Waste reusing, recovering, recycling;
- Waste treatment;
- Waste storage.

The national waste Strategy and the National Plan for Waste Management elaborated by the Ministry of Water and Environmental Protection, as well as all the recommendations regarding the adequate waste management consider the following options of waste policy:
- Waste reduction (product redesign, technological process improvement, replacing of some raw materials, restrictions regarding some products and packages);
- Material reusing, waste recovering and recycling (closing of material cycles, separate collection according with waste types, using the Best Available Techniques in technological processes);
- Elaboration of integrated management plans for waste from company, local and regional level to national level;
- Imposing some restrictions to waste storage, using the best techniques for waste treatment, imposing some thresholds for emissions resulted at waste incineration, obligations to monitor the waste landfills;
- Reducing the transboundary transport of hazardous wastes by respecting the Basel Convention conditions and other European Union Directives in the same field;
- Respecting all regulations referring to waste management.

The analysis performed in 2001-2002 from all existed and projected data resulted in the identification of the optimum number for non-hazardous waste landfills (50 landfills) necessary in Romania for the next 20 years. This task will be achieved by implementing the following investments:
- Finalizing the construction of those 3 landfills developed according to the EU Directive 99/31/EC provisions, which are now under construction;
- Conditioning of the 11 landfills, which follow to a great extent the EU Directive 99/31/EC provisions;
- Extension of the 9 landfills, which do not follow the EU Directive 99/31/EC provisions, by carrying out of some conforming zonal landfills in the respective establishments;
- Elaboration of documentation, identifying the financial sources, building and starting the exploitation of landfills, which are presented in the National Action Plan for Environmental Protection (ISPA projects in different preparing phases, priority projects, projects mentioned in the National Plan for Waste Management, other projects with international financing).

In 2002, 252 urban waste landfills were recorded, owned by cities and municipalities, representing 27% of the total waste landfills in the country.

The urban landfills cover 800 ha approximately, which represent about 7% of the total surfaces affected by the waste storage.

From the total number of landfills screened:

- 11 new waste landfills have free storage capacity, which are in accordance with the most part of the EU Directive 99/31/EC provisions, equivalent with the Governmental Decision no. 162/2000, regarding the waste storage which require operation improvements and monitoring for a total conformity;
- 238 urban waste landfills with variable free storage capacity, which do not follow the requirements of the EU Directive 99/31/EC and Governmental Decision no. 162/2000;
- 3 waste landfills were under construction in 2002.

The classification under the EU Directive for the total 252 landfills screened was performed according to the landfill owner and operator, to the type of waste stored, and to the type of industrial activities developed in the area. Hence, the result was that all the 252 landfills screened are classified in „b” storage class (landfills for non-hazardous wastes).

From the already mentioned 238 landfills that do not follow the EU Directive, 9 landfills have capacities larger than 500,000 m^3 and carry out the criteria referring to the distance from surface water, the distance from populated areas, the underground water depth. These establishments will be authorized for extension and they could be conditioned in order to become zonal landfills only the approval of the environmental evaluation (according to the provisions of the National Plan for Waste Management for the respective counties).

4.2.3. Joint Implementation in Romania

Joint Implementation (JI) is one of the three „flexible mechanisms” provided by the Kyoto Protocol, for achieving the greenhouse gas (GHG) emissions reduction commitments in a cost effective manner. Joint Implementation is based on the Kyoto Protocol's Article 6 and it is a project-based economic instrument.

GHG emission reductions require considerable investments and can be costly in the most industrially developed countries. The most developed economies of the world are normally quite energy efficient, so the cost of an emission reduction unit is high. GHG emissions reduction can however be much cheaper in less developed economies, for example in the countries of Central and Eastern Europe.

International legislation in the climate change field consists of 2 MEAs (UNFCCC and the Kyoto Protocol) and the relevant rules, decisions, modalities, guidelines and procedures adopted there under.

The EU legislation provides guidelines for implementing the 2 MEAs, some directions of action on GHG monitoring and inventories and a scheme for GHG emission allowance trading within the Community.

At present, the following EU regulations in the climate change field are:

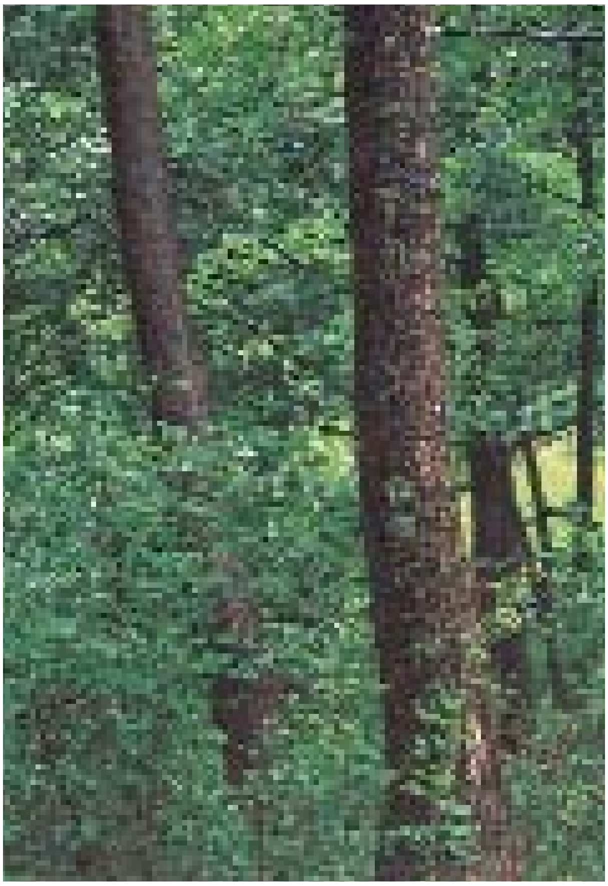
- Council Decision 1993/389/EEC on monitoring and reporting of CO2 and other greenhouse gas emissions amended by Decision 1999/296/EC;
- Council Decision 2002/358/EC, concerning the approval, on behalf of the European Community, of the Kyoto Protocol to the United Nations Framework Convention on Climate Change and the joint fulfilment of commitments thereunder,
- Council Directive 2003/87/EC establishing a scheme for GHG emission allowance trading within the Community and amending Council Directive 96/61/EC.

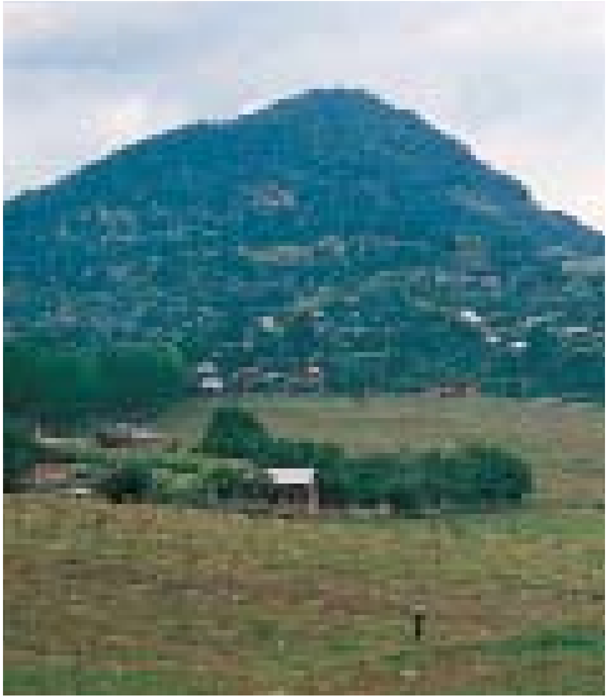
The corresponding Romanian legislation is referring to the following pieces of legislation:

- Law no. 24/1994 (Official Journal No. 119/ 12.05.1994) for the ratification of the United Nations Framework Convention on Climate Change, signed in Rio de Janeiro on 5 June 1992;
- Law no. 3/2001 (Official Journal No. 81/ 16.02.2001) for the ratification of the Kyoto Protocol to the United Nations Framework Convention on Climate Change, adopted on 11 December 1997;
- Governmental Decision no. 1275/1996 (Official Journal No. 326/06.12.1996) for establishing and functioning of the National Commission on Climate Change, a consultative inter-ministerial body in the coordination of the MEWM with the role to promote the necessary measures for unitary implementation in Romania of the objectives of the UNFCCC and Kyoto Protocol.

As mentioned before, the short term priority identified in the climate change sector is the elaboration of the Law or Governmental Decision for approving the National Strategy on Climate Change and National Action Plan on Climate Change.

There are also many legal documents and strategies that indirectly affect JI projects, in particular on setting baseline GHG emissions, which is not only crucial for eligibility testing as JI for a project but also determines the amount of ERUs that can be generated by the project. The most important circumstance in this respect is no doubt EU accession, and most relevant sectors to be examined are energy, environment (waste management in particular) and forestry (for sink projects). As these instruments generally promote higher energy efficiency and stricter environmental standards, they push baseline emissions downwards.





Romania was the first UNFCCC Annex I country (the developed countries and the transition to market economy countries) that ratified the Kyoto Protocol through Law nr. 3/2001, thus committing itself to reduce GHG emissions by 8% in the first commitment period 2008 - 2012, comparing with the base year (1989), with a view to harmonize the European Union's measures of reducing the same percentage. In realizing a sustained economic growth, Romania's GHG emissions are expected to increase slightly untill 2008, and also in the first commitment period unless Romania is able to preserve the reductions of emissions by implementing energy efficiency and other GHG emissions reduction measures, and also by decoupling economical development and GHG emis- sions trends. Following the signing of the Kyoto Protocol in 1997 Romania started to cooperate with different countries on preparing for the implementation of the protocol's flexible mechanisms. Romania was involved firstly in the Activities Implemented Jointly (AIJ) as a „pilot" stage for JI. The main objective of the cooperation between governments in this phase was the need to understand the possibilities of implementing this kind of projects for the further stages. Romania carried out 5 AIJ projects.

Emission Reduction at Power Plants (AIJ)

The project consists of three phases, the first of which started at the beginning of 1997. During the first phase of the project, a large number of power plants were visited, and then a selection was made at which plants the emission reductions would take place. The establishment of the baselines followed the first phase. After fact-finding was completed, a program of energy conservation and CO2 reduction was implemented for about two years. One of the activities within this project was the optimization of the management (periodical measurements and training and recommendations for policies and measures).

Improvement of Wastewater Infrastructure at Targu Mures (AIJ)

The project focused on the improvement of the technology used to collect and treat wastewater. Targu Mures municipal water company (RAGCL) had a sound strategy and vision with regard to its privatization. The most important elements of this strategy were the development of a cost and energy-effective water treatment system, the upgrading of technology and equipment and the training and education of staff. This project is meant to contribute to the realization of this strategy. Another part of the project provided for the opportunity to disseminate the new technologies and management techniques to other water companies.

Energy Efficiency in Drinking Water Supply (AIJ)

The project improved the drinking water supply system in the city of Targu Mures. The project contributes to the same objectives as the project above.

District Heating Project Bistrita and Tirgu Mures: Project identification and feasibility study (AIJ)

An identification mission took place for possible Swiss contributions to the improvement of district heating systems in the Romanian cities Bistrita and Tirgu Mures. In this project the assessment of technical, economic and environmental aspects was carried out, including the potential for Joint Implementation under the Kyoto Protocol and transfer of GHG emissions reduction units generated by the project.

Swiss Thermal Energy Project (STEP), Romania (AIJ)

The AIJ project proposed by Switzerland consisted in the retrofitting of two district heating systems in Romania. The tasks performed in the project included participation in the validation process, implementation of monitoring protocol, AIJ-related training of local counterparts. Switzerland proposed to modify the AIJ project in a Joint Implementation project.

Taking into account the possibilities identified in developing JI projects the first Memorandum of Understanding, creating the framework fro JI projects implementation was signed with the Switzerland in 1999, and the first JI project started in 2000 (initial as AIJ).

Romania signed recent years several Memoranda of Understanding with different countries like: the Netherlands, Norway, Denmark, Austria, Sweden and the World Bank's Prototype Carbon Fund. To date, a total of 11 JI projects have started being implemented or have already been finished in Romania, with the investments from some of the countries mentioned above, as presented in the table. These important investments will generate over 7.5 million ERUs in the first commitment period (2008-2012).

Concluding a bilateral Memorandum of Understanding (MoU) on JI co-operation between host and investing countries is not a requirement under the Kyoto Protocol, but it has become a common practice, or often regarded as pre-requisite by Central and Eastern European countries before implementing JI projects. MoUs are normally expected to serve as an alternative to official rules under the Kyoto Protocol at least until the Protocol becomes operational after its entry into force.

In other words, if both host and investing countries can allow the risk of the other party's inobservance of JI Project Agreement prepared on a project-by-project basis, then MoUs might not be absolutely necessary.

The objectives of MoUs are generally to pledge an expedited JI approval process in both host and investing countries, and to represent a governmental guarantee of ERU transfers from the host to the investing country under the MoU once the Kyoto Protocol enters into force and the official JI procedure starts functioning.

The approved 11 JI projects break down by project type as follows:

5 energy efficiency projects, of which
- 4 district heating, including 2 co-generation
- 1 industrial technology improvement (cement plants)

4 renewable energy projects, of which
- 2 hydropower
- 1 biomass (sawdust)
- 1 geothermal

1 landfill gas recovery project
1 afforestation project

All projects, especially hydropower ones, require considerable investments and bring revenues in addition to ERU sales. ERU sales are normally by far insufficient to cover the cost of abatement. Marginal cost of GHG emission abatement itself is very project specific and more importantly, it cannot be an indicator of project's cost effectiveness, which affects the eligibility as JI, since GHG abatement cost is only a part of whole project cost. Investment in clean technology leads not only to emission reductions, but also new technology, fuel cost reductions, and new or upgraded production facilities for electricity and heat.

ERU sales revenue is most important for co-generation, landfills and afforestation. Closing the old landfills is expensive and cannot be covered by disposal fees. Afforestation does not have much of commercial value, too. Co-generation appears to be the least commercially attractive part of energy efficiency projects in district heating.

Table 4.1. Joint Implementation projects in Romania

No	Project	Agreement
1.	Swiss Thermal Energy Project in Buzau and Pascani (AIJ/JI)	MoU Switzerland
2.	Development of the Municipal Utilities - Heating System in Fagaras	MoU Norway
3.	Modernization of 3 Hydro Units at Portile de Fier I Hydropower Plant	ERUPT 2 - the Netherlands
4.	Refurbishing of the Cement Factories Alesd and Campulung	ERUPT 2 - the Netherlands
5.	Modernization of 4 Hydro Units at Portile de Fier II Hydropower Plant	ERUPT 3 - the Netherlands
6.	„Sawdust 2000" Project	MoU Denmark
7.	Geothermal Energy Use in Oradea-Area II and Beius District Heating Systems	MoU Denmark
8.	Afforestation of 7000 ha Degraded Agricultural Land	Host Country Agreement - PCF
9.	Landfill Gas Recovery in 4 Major Cities (Baia Mare, Satu Mare, Oradea, Sf. Gheorghe)	ERUPT 4 - the Netherlands
10.	Municipal Cogeneration Targoviste	ERUPT 4 - the Netherlands
11.	Rehabilitation of Bucharest District Heating System*	MoU Switzerland

MoU - Memorandum of Understanding
* Project Agreement under negotiation

Swiss Thermal Energy Project in Buzau and Pascani (AIJ/JI)

The project rehabilitated a part of the district heating system in the two towns Buzau and Pascani as a demonstration project. The main components financed by Switzerland include: CHP units, thermal substations, electronic energy meters and all materials necessary to replace distribution pipes.

The investment amounts to EUR 70 million between 2000-2002, of which EUR 7 million was born by a Swiss national investment-facilitating agency (SECO). GHG emission reductions from the project will amount to 139,000 tCO_2 equivalent in the Kyoto Protocol's first commitment period.

Development of the Municipal Utilities - Heating System in Fagaras

The project is implemented based on the bilateral cooperation with Norway aims to rehabilitate the district heating system in Fagaras city. Eight zonal thermal plants with capacities ranging between 7.4 and 16 MW will replace a total of 25 old thermal plants and points. The new system consists of high capacity and efficient boilers and pre-insulated pipe system, and meters at each consumer. The total investment amounts to USD 13 million, of which the emission reduction accounts for USD 0.5 million.

The total emissions reductions for the first commitment period were estimated at 35,000 tCO_2 equivalent per year or 175,000 tCO_2 equivalent in total.

Modernization of 3 Hydro Units at Portile de Fier I Hydropower Plant

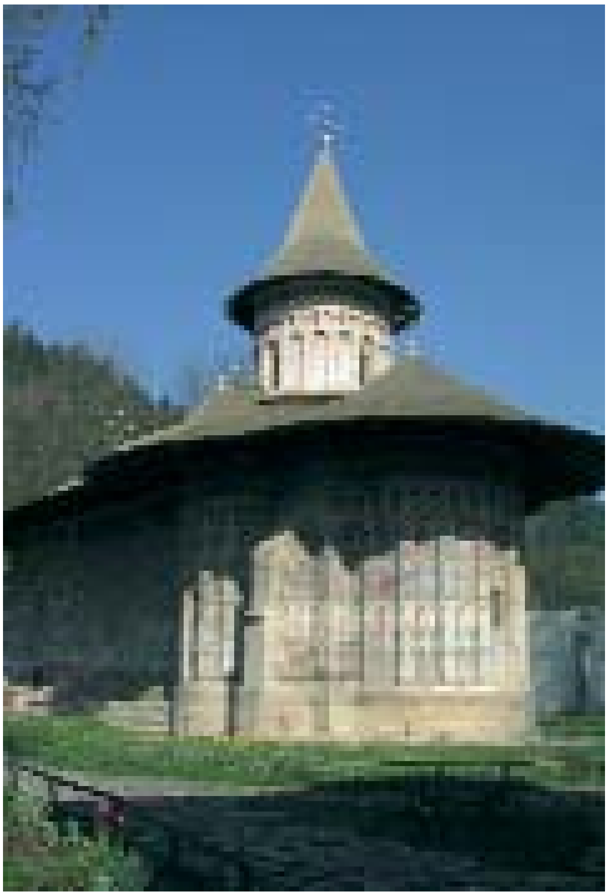
The project developed based on the cooperation with the Netherlands consists of the modernization of three hydro units (out of six) within the Portile de Fier I hydropower plant. The project aims to increase the unitary active power from 175 MW to 194.5 MW, to expand the ancillary services and to extend the hydro units life duration by 30 years. The project development benefits from the solution that has already been successfully applied for the modernization of the other three hydro units within the same plant.

The investment amounts to approximately EUR 200 million, which will come from the sources of the owner (Hidroelectrica) through energy sales, and the support from the Dutch government through ERUPT 2 programme. The expected ERUs are 1,674,000 tCO2 equivalent in total for the first commitment period (or 335,000 tCO2 equivalent per year in average).

Reduction of CO_2 Emissions at Alesd and Campulung Cement Plants

The project developed based on the cooperation with the Netherlands consists of the upgrading of two Holcim's cement plants in Alesd and Cimpulung in order to improve the energy efficiency of cement production process at these plants. The upgrading includes raw mill feed system, raw mill grinding, pre-heater tower, cooler and cement mills.

The total cost of the projects has been estimated at about EUR 30 million for Alesd plant and about EUR 5 million for Campulung plant, while ERUs are expected to account for 888,000 tCO_2 equivalent in total for the first commitment period (or 178,000 tCO_2 equivalent per year in average).



Modernization of 4 Hydro Units at Portile de Fier II Hydropower Plant

The project developed based on the cooperation with the Netherlands consists of overhauling and modernizing the 4 units out of the existing 8 within Portile de Fier II hydropower plant. The scope of the modernization is to increase the economic efficiency of the hydropower plant by improving its reliability, by raising the power reserve and the output of the plant, thus meeting the conditions required for aligning and including it into the ancillary service category. The supplementary installed power in these four hydro-units will be 22 MW, which will lead to a supplementary energy of 212.133 GWh/year.

The investment amounts to approximately EUR 200 million and the expected ERUs to be transferred are 850,000 tCO_2 equivalent in total for the first commitment period.

„Sawdust 2000" Project

The project will implement the technology for using sawdust for district heating as the fuel in the small to medium towns of Gheorgheni, Vatra Dornei, Vlahita, Huedin and Intorsura Buzaului, where the existing boiler systems consist of heat only boilers for production of hot water for space heating and for production of domestic hot water. The project will introduce new automatically controlled biomass boiler systems and a two track pre-insulated district heating network pipe system, construct new or renovate old boiler houses, and construct sawdust storage.

The overall project cost is over EUR 13 million, of which EUR 2.6 million (20%) is provided by the Danish Environmental Protection Agency through the JI mechanism. Total GHG emissions reduction until the end of the first commitment period is calculated at 720,000 tCO_2 equivalent. GHG emissions reductions are due to the classic fuel substitution and to the CH4 emissions decrease from the anaerobic digestion of sawdust in stock piles.

Geothermal energy

The project to be implemented under the bilateral cooperation between Romania and Denmark and it is a fuel-switching project addressing the district heating systems in the city of Oradea - Area II and in the town of Beius aiming to substitute fossil fuels (lignite, oil and natural gas) with local geothermal energy resources.

The project idea is to increase the use of geothermal energy resources in the city of Oradea by erecting a new geothermal heating plant and rehabilitation of existing DH system (pipe network, substation installations etc.) in Area II. In Beius the project idea is to increase the supply of geothermal energy from the new geothermal DH

system to public buildings in the town of Beius. The total investment amounts to about EUR 2.2 million and the estimated emissions reductions are 190.000 tCO_2 equivalent until the end of the first commitment period.

Afforestation of 7000 ha of Degraded Agricultural Land Project (JI)

The project is implemented on the basis of Romania's cooperation with the World Bank's Prototype Carbon Fund consists of the reforestation of approximately 7000 ha of degraded agricultural land (6,728 ha net area without roads and buildings etc.) and the location is spread across seven counties in the Southwestern and Southeastern Romania (Braila, Dolj, Galati, Mehedinti, Olt, Tulcea and Vaslui). The Romanian counterpart and the implementing organization is the National Public Administration of Forests. Estimated emission reduction is over 1 million tCO_2 equivalent over the period of 2002 - 2012.

Landfill Gas Recovery in Romania (JI)

The project to be developed under the cooperation with the Netherlands proposes to build and operate installations for the extraction of methane gas at four landfills in Romania. The extracted biogas will be converted into electricity by gas engines and will in the future be supplied to the public network or to local users. The investments will be made in gas collection network, permeable pipes, gas domes, gas engines and others. The project will be financed through the sales of ERUs and electricity generated from the collected biogas.

The approximate initial investment will amount to EUR 32 million, followed by EUR 12.5 million for annual operational cost. The ERUs estimated to be generated by the project will be 750,000 tCO_2 equivalent in total for the first commitment period (or 150,000 tCO_2 equivalent per year in average).

Targoviste Co-generation Project

The project is to be implemented under the bilateral cooperation with the Netherlands with the aim to build new co-generation facilities (6.5 MWe) and rehabilitate the existing heat-only boilers, the heat transport and distribution networks in the Municipality of Targoviste. The existing and rather old (around 25-30 years) heat production facilities that are scheduled to be replaced by the project have a very low thermal efficiency, leading to a relatively high consumption of natural gas for the heat produced. The project is based on a study carried out by the Municipality of Targoviste and the municipality-owned heat distributing company S.C. Termica S.A., together with Nuon, the Netherlands.

The total investment amounts to EUR 6,5 million. The project intends to reduce the GHG emissions by 400,000 tCO_2 equivalent until the end of the first commitment period.

District heating system rehabilitation - Bucharest (JI)

The project is to be developed based on cooperation with Switzerland and is to rehabilitate a part of the district heating system in Bucharest. This will be done by installing automation and control equipment, as well as pumps and frequency converters at around 600 thermal points, and by installing balancing valves for all final consumers connected to about 700 thermal points. The project implementation is expected to save approximately 237,400 Gcal/year of thermal energy, and 20,100 MWh/year of electric energy.

The total investment is EUR 51 million, of which EUR 7 million is provided by SECO through the JI mechanism. After full implementation of the rehabilitation program, achieved ERUs will be around 69,000 tCO_2 equivalent per year in average during the first commitment period. For the time being the project agreement is under negotiation.

All these measures demonstrate the strong will of the Romanian Government to comply with the commitments resulted from ratifying the UNFCCC and the Kyoto Protocol.

Projections and Asessment of Measures Effects to Mitigate Greenhouse Gas Emissions

5.1. Introduction

Emission projections in Romania are influenced by the uncertainties related to the privatization process and the continuous efforts for the harmonization of national legislation with the EU acquis communautaire. The assumptions for these projections are in accordance with the economical situation in the period 2000-2003, the „Road Map for the energy sector of Romania“ elaborated by the Romanian Government on July 2003 and the „Romanian Government strategy for the period 2004-2025“.

The evolution of the economic activity in the period from 1989 was very much influenced by the important changes at the political and social level that occurred when Romania entered into the transition period towards a market-orientated economy. Thus, all Romanian Governments after 1989 considered the deep economic reform as the first objective but the results were affected by the world economic crisis, the chosen liberalization policy, the lack of proper legislation, etc.

After 2000 the Romanian Government took appropriate measures to stop the negative economic trend. Since 2000, the economic environment has undergone a revitalization process through a slight increase in economic growth, a reduction in inflation and unemployment rates, an improvement of the main macroeconomic indicators and financial currency balances and an acceleration of the privatization process.

After 2000 the Romanian Government's policy was to support an accelerated growth of the GDP in the view of achieving the strategic objective of economic discrepancy reduction between Romania and the EU member states. In relation to this, two scenarios (base and alternative) are presented in Table 5.1 regarding the GDP growth for the period 2002-2015 in accordance with the „Road Map for the energy sector of Romania“.

Table 5.1. The GDP growth for the period 2000-2015

	GDP growth (%)				
	Achieved in the period 2000-2001	2002-2005	Forecast 2006-2010	2011-2015	2002-2015
Base scenario	5.2	5.1	6.0	5.2	5.4
Alternative scenario	5.2	4.4	5.5	4.8	4.9

Table 5.2. Macroeconomic and energy indicators of Romania for the period 1998-2020

	U.M.	1998	1999	2000
			Achievements	
1. Population	10^6 loc	22,5	22,5	22,4
2. Gross Domestic Product (GDP)	10^9 \$98	42,1	41,6	42,4
GDP/inhabitant	*\$98/inhabitant*	*1871*	*1852*	*1890*
3. Final energy consumption	10^6 tep	25,13	21,36	22,17
final consumption/inhabitant	*tep/inhabitant*	*1,1*	*1,0*	*1,0*
4. Final electricity consumption	TWh	42,23	38,74	39,78
final consumtion/inhabitant	*kWh/inhabitant*	*1877*	*1725*	*1773*
1. Population	10^6 loc	22,5	22,5	22,4
2. Gross Domestic Product (GDP)	10^9 \$98	42,1	41,6	42,4
GDP/inhabitant	*\$98/inhabitant*	*1871*	*1852*	*1890*
3. Final energy consumption	10^6 tep	25,13	21,36	22,17
final consumtion/inhabitant	*tep/inhabitant*	*1,1*	*1,0*	*1,0*
4. Final electricity consumption	TWh	42,23	38,74	39,78
final consumtion/inhabitant	*kWh/inhabitant*	*1877*	*1725*	*1773*

In the „Road Map for the energy sector of Romania“ the following important elements are observed:

- the base scenario takes into consideration the accelerated development of the economy, where industrial development has a key role, as well as the acceleration of privatization in electricity, gas and oil sectors but also accomplishment of the privatization in other sectors of the national economy;
- the alternative scenario takes into consideration the possible negative impact of the trend of the world economy on the Romanian market which can slow down some economic process;
- in the basic scenario as provided in the strategy for energy efficiency, the overall energy intensity has to be reduced by 30-50% until the year 2015, in a complex process which involves replacing technologies with high energy consumption and a structural adjustment of the economy.

The approval of the „National Strategy for privatization“ (1999), the „Energy Efficiency Law“ (year 2000), the „National Environmental Action Plan“ (year 2002), and the „Electricity Law“ (year 2003) ensured the suitable conditions for the achieved structural reforms.

	2001	2002	2003	2005	2010	2015	2020*)
					Forecast		
		Base scenario					
	22,4	21,8	21,7	22,2	22,4	22,6	22,8
	44,6	47,1	49,1	54,5	72,9	93,9	117,5
	1990	*2161*	*2259*	*2455*	*3254*	*4155*	*5154*
	22,44	23,37	23,80	24,50	29,10	34,20	37,50
	1,0	*1,1*	*1,1*	*1,1*	*1,3*	*1,5*	*1,6*
	41,13	40,78	41,71	44,14	50,99	57,59	63,58
	1835	*1871*	*1919*	*1988*	*2276*	*2548*	*2789*
		Alternative scenario					
	22,4	21,8	21,7	22,2	22,4	22,6	22,8
	44,6	47,1	49,1	53	69,3	88,4	110,1
	1990	*2161*	*2259*	*2387*	*3094*	*3912*	*4829*
	22,44	23,37	23,80	24,9	30,1	35,3	38,7
	1,0	*1,1*	*1,1*	*1,1*	*1,3*	*1,6*	*1,7*
	41,13	40,78	41,71	44,59	51,35	58,01	64,02
	1835	*1871*	*1919*	*2009*	*2292*	*2567*	*2808*

Note: *) Values are established in accordance with Romanian strategy for the period 2004 - 2025.

5.2. Projections of Greenhouse Gas Emissions

The economical development assessment up to 2020 is based on the following main considerations:

- structural change and modernization of the economy;
- different options for energy supply and for the development of electricity generation capacity as:
  - hydro energy (estimated as economically feasible at 500-900 MW);
  - nuclear energy (unit 2 and 3 at Cernavoda Power Plant to be finalized);
  - renewable energy;
  - new and rehabilitated coal-fired units with flue gas desulphuration (FGD) devices on low NOX burners (LNB);
  - new combined cycle units on natural gas.
- evolution of cogeneration;
- energy intensity reduction through:
  - losses reduction in heat networks and in the national power grid;
  - increase of efficiency for new generation units;
  - increase of thermal insulation of buildings;
  - promotion of new and efficient vehicles for freight and passengers transportation;
  - development of the public urban transportation;
  - increase of energy efficiency in households and service sectors, etc.

Macroeconomic and energy indicators of Romania for the period 1998-2020 were used in order to establish the reference scenario defined as „without measures“ scenario, and the scenarios „with measures“ and „with additional measures“ in accordance with the „Road Map for the energy sector of Romania“ (Table 5.2).

The projections are based on calculations carried out using the ENPEP (Energy and Power Evaluation Program) package program, developed by Argonne National Laboratory of US Department of Energy (DOE) and distributed to Romania by the International Atomic Energy Agency (IAEA). The main models used are MAED (Model for Analyses of Energy Demand), WASP (Wiener Automatic Simulation Program), BALANCE and IMPACT.

Table 5.3 presents the key assumptions taken into account in the „without measures“ scenario.

Table 5.3. Key assumptions used for the „without measures“ scenario

Parameter	Unit	2005	2010	2015	2020
GDP	10^9\$98	54.5	72.9	93.9	117.5
Population	10^6loc	22.2	22.4	22.6	22.8
GDP structure	%	100	100	100	100
• industry	%	26.4	26.4	26.4	26.4
• agriculture	%	12.8	12.8	12.8	12.8
• construction	%	4.8	4.8	4.8	4.8
• services	%	56.0	56.0	56.0	56.0

Figures 5.1 and 5.2 provide the forecasts of the final energy demand and the gross domestic energy consumption.

The adopted measures for the reduction of GHG emissions were estimated and the projections of GHG emissions for the period 2005-2020 were presented using the following scenarios:

- reference scenario – defined as „without measures“ scenario;
- low scenario – defined as „with measures“ scenario;
- high scenario – defined as „with additional measures“ scenario.

The starting point for the projections is the information included in the National GHG Inventory of Romania submitted in 2003 and provisional data for the year 2002.

5.2.1. Hypotheses for „Without Measures“, „With Measures“ and „With Additional Measures“ Scenarios

The possible evolution of the GHG emissions has been determined for both energy and non-energy sectors.

The following fields of activity have been studied for the non-energy sector:

- agriculture – CH_4 emissions from enteric fermentation and manure management and N_2O emissions from using natural and chemical fertilizers;
- industry – emissions resulting in industrial processes;
- forestry – atmospheric carbon sequestration options;
- solvents and other products – emissions have been determined in correlation with the economic and technological evolution;

Figure 5.1. Forecast of Final Energy Demand by Scenarios

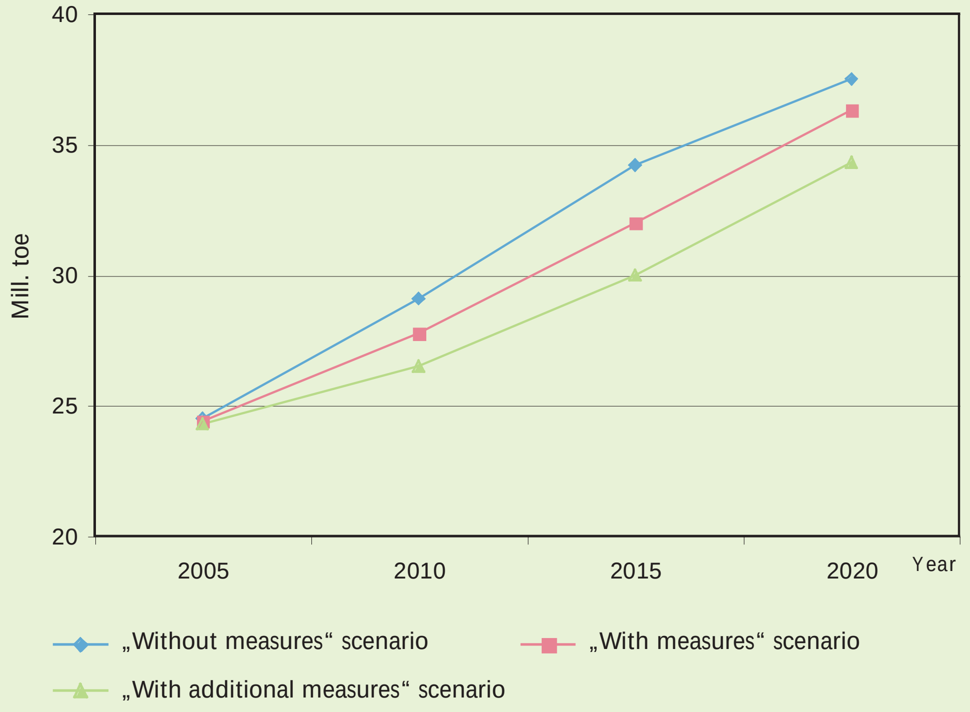


Figure 5.2. Forecast of Gross Domestic Energy Consumption by Scenarios

• waste – the management options for liquid and solid waste.

The following sub-sectors have been analyzed in the energy sector:
• energy supply from Romania and imports;
• energy conversion - refineries, coke factories, production of electricity and heat;
• energy consumers.

5.2.1.1. „Without Measures“ Scenario

The forecast of GHG emission has been determined taking into consideration the various hypotheses related to the evolution of activities in the energy sector, which is the most important in the overall GHG emissions in Romania, and the other non-energy sectors.

Energy sector

For the energy supply the following assumptions were made:
• total (maximum) domestic energy resources (including nuclear) are about 24 mil. toe per year for the period 2005-2015;
• the quantity of lignite used is about 6.1 mil. toe in the period 2005-2015;
• the quantity of used hard coal is about 1.2 mil. toe in the period 2005-2015;
• the renewable energy represents about 5% from the total energy resources;
• the import of crude oil and natural gas will be achieved in order to cover the consumers demand;
• the demand of oil products will be assured by refining both the Romanian and imported crude oil in the country;
• the imported quantity of natural gas will increase from 5.8 bill. m3 in 2004 up to 14.4 bill. m^3 in 2020;
• the nuclear energy program will be continued at Cernavoda Nuclear Power Plant by starting the operation at unit no. 2 in 2006-2007 and unit no. 3 up to 2015;
• the additional economically feasible hydropower generation capacity, estimated at 500-900 MW, will be put in operation in the period 2005-2020;
• the new electricity generation capacities will be built and the old capacities will be rehabilitated or retired;
• the modernization of cogeneration plants as well as the programme for achieving new capacities on natural gas.

The overall picture is presented in table 5.4, the installed power structure in the period 2005 -2020 is presented in table 5.5, and the gross electricity production structure for the period 2005-2020 is presented in table 5.6.

The assumptions for the consumption energy sectors are established based on the specific features of the consumers.

The assumptions for households are:
• the decrease of persons per dwelling to 2.445 in 2020;
• the reduction of useful energy consumption for house cooking of about 4% during 15 years due to the use of modern cooking methods by the gradual replacement of non-commercial fuels with industrial fuels allowing their utilization in higher efficiency dives;
• the increase of hot water consumption per dwelling by 11% until 2020;
• the increase of the electricity consumption per dwelling with about 100% until 2020 in comparison with the consumption in 2000;
• the improving of thermal insulation degree of residences which determines the reduction of average energy demand by 5% on the forecasted period.

The assumptions in the services sector are:
• the specific consumption reduction of electricity by 20% for old buildings and by 5% for new buildings;
• a specific consumption reduction for thermal energy in new buildings due to good insulation by about 20% compared to old buildings.

In the transport sectors the development of the activities (goods transport, passengers inter-

Table 5.4. Evolution of installed power for new capacities and retired capacities in MW

Sector	2003-2005		2006-2010		2011-2015		2016-2020	
	New capacities	Retired capacities	New capacities	Retired capacities	New capacities	Retired capacities	New capacities	Retired capacities
Hydro	129	-	200	-	200	-	500	-
• New	99		200		200		500	
• Rehabilitation	30							
Thermal	555	1280	3505	2185	710	-	1500	-
• New			1455		500		1500	
• Rehabilitation	555		2060		210		-	
Nuclear			707		707		-	
Total	**1284**	**1280**	**4412**	**2185**	**1617**	**-**	**2000**	**-**

Note: The figures given for the period 2003-2015 are presented in the Road Map for the energy sector in Romania.

Table 5.5. Installed power structure in MW

	2005	2010	2015	2020
TOTAL	**15,691**	**16,838**	**18,455**	**20,455**
Hydro power plants	6,181	6,381	6,581	7,081
Nuclear power plants	707	1,414	2,121	2,121
Thermal power plants, of which in units on:	8,803	9,043	9,753	11,253
• Lignite	4,264	4,064	4,064	4,064
• Hard coal	1,005	1,265	1,265	1,265
• Hydrocarbons	3,534	3,714	4,424	5,924

Note: The figures given for the period 2005-2015 are presented in the Road Map for the energy sector in Romania.

Table 5.6. Gross electricity production structure in TWh

	2005	2010	2015	2020
TOTAL	60.1	64.9	72.9	84.9
Hydro power plants	17.0	17.2	18.0	19.0
Nuclear power plants	5.34	10.68	16.02	16.02
Thermal power plants, of which:	37.76	37.02	38.88	49.88
• Lignite	17.8	18.0	18.0	18.0
• Hard coal	5.53	5.93	5.93	5.93
• Hydrocarbons	14.43	13.09	14.95	25.95

Note: The figures given for the period 2005-2015 are presented in the Road Map for the energy sector in Romania.

urban transport, passengers urban transport) is correlated with the increase of the value added in industry during the period 2005 - 2020, the population evolution, the mobility degree increase and the increase of car participation compared with the passenger transport. The assumptions in this sector are:

- the motor fuel consumption/ton*kilometer is considered to be reduced in the period 2005 - 2020 as following:
  - by 7% for trucks used for local transport;
  - by 10% for long distance transport;
  - by 20% for Diesel transport;
  - by 18% for electric transport;
- the average motor fuel consumption of a car will decrease in the period 2005 - 2020 by 5% for interurban transport and by 4% for urban transport;
- the average motor fuel consumption of a bus will decrease in the period 2005 - 2020 by 15% for interurban transport and by 8% for urban transport.

Non-energy sectors

The hypotheses taken into account in the agriculture sector are:

- the agricultural area is about 14.9 mil. ha, out of which 63% arable land, 23% pastures, 10% hayfields, 2% vineyards, 2% orchards;
- 60% of agricultural residues are incorporated in soil, 25% are used as animal food, 15% are used in industry;
- the amount of chemical fertilizers per land unit will increase progressively as following: about 280 thou. tons of nitrogenous fertilizers will be used in 2020 in comparison with 239 thou. tons used in 2002;
- livestock populations will increase in the following mode:
  - cattle from 2,878 thou. heads in 2003 at 4,600 thou. heads in 2020;
  - pigs from 5,058 thou. heads in 2003 at 8,000 thou. heads in 2020;
  - sheep and goats from 7,945 thou. heads in 2003 at 10,000 thou. heads in 2020;
  - poultry from 77,379 thou. heads in 2003 at 111,000 thou. heads in 2020.

The hypotheses in the forest ecosystems are presented below:

- the forest area is relatively constant, about 6.4 mil. ha until 2020;
- the harvested wood volume will increase from 16.4 mil. m^3 in 2002 to 18 mil. m^3 in 2020;
- afforestation and reforestation will increase from 16,448 ha in 2002 to about 200,000 ha in 2020;
- all works necessary to regenerate and clean forests shall be made including the following cutting wood areas:
  - about 55,000 ha regeneration of the cutting wood covered area;
  - about 80,000 ha for forest cleaning operations;
  - about 25,000 ha for attendance cuttings in young forests;
  - about 50,000 ha for accidental cuttings.

The assumptions in the industry sector are related to the evolution of the main industrial processes. Thus, the production parameters for cast-iron, steel, aluminum, other non-ferrous metals, chemical fertilizers, other chemical products, and cement represent the essential elements that were analyzed for the establishment of GHG emissions projections.

The quantity and quality of waste are determined in accordance with the increase of the living standard in the period 2005 - 2020. The main elements consist in the growth of the urbanization rate, the growth of water consumption per house by refurbishing the drinkable water network in places where it exists and extending it to other new areas, also raising the services standard by expanding the responsibility for cleaning the environment and the populated areas.

5.2.1.2. „With Measures“ and „With Additional Measures“ Scenarios

The measures for the GHG emissions reduction have been established on each activity sector taking into consideration various options, but different indirect measures to be developed in the future could have an important effect on Romania's GHG emissions.

Energy sector

The increase of natural gas imported, the development of the nuclear programme and the increase of hydropower and other renewable sources share in the energy production have been considered as alternatives in the energy supply and electricity generation sector.

The development of industrial and urban cogeneration plants by increasing the output with about 500 MW until 2020 were also taken into consideration in the conditions of heat loses reduction by about 20% in the same period.

In the consumption sectors an alternative was considered in the reduction of energy intensity in accordance with the Road Map for the energy sector in Romania. In the energy efficiency strategy, the overall energy intensity is to be reduced by 30 - 50% until the year 2015 in a complex process, which involves the replacement of high-energy consumption technologies in a structural adjustment of the economy.

Non-energy sectors

Two basic options were chosen in the forestry sector, considering the process of carbon sequestration, namely the increase of areas covered by forests with about 100 - 200 thou. ha until 2020 and the implementation of special measures in relation with forest management in order to create optimum structures.

Several activities were considered in order to reduce methane emission from enteric fermentation in the agriculture sector and the most important could be the improvement of the nutrition quality by increasing the protein share and the improvement of livestock performances. The decrease of nitrogenous fertilizers utilization is also considered in order to reduce the N_2O emissions due to concentrated agricultural land and the economically consolidated farms.

Using new and modern installations and investments for environmental protection are considered in the industrial processes sector in order to reduce the GHG emissions.

5.2.2. Projections of Anthropogenic CO_2 Emissions

Table 5.7. Summary of anthropogenic CO_2 emissions projections for „without measures“ scenario in Gg

	1998	1999	2000
Total emissions out of which:	**109.006,6**	**91.800,0**	**94.576,8**
Energy sector (fossil fuel combustion)	**93.122,3**	**80.326,6**	**82.452,6**
• Energy industries	52.413,5	46.009,8	46.122,3
• Manufacturing & Construction	20.046,5	17.776,5	18.752,4
• Transportation	10.783,7	8.510,2	9.286,8
• Other sectors	9.878,7	8.030,0	8.291,2
Industry processes	**15.884,2**	**11.473,4**	**12.124,2**
Agriculture	**0**	**0**	**0**
Waste	**0**	**0**	**0**

Table 5.8. Summary of anthropogenic CO_2 emissions projections for „with measures“ scenario in Gg

	1998	1999	2000
Total emissions out of which:	**109.006,6**	**91.800,0**	**94.576,8**
Energy sector (fossil fuel combustion)	**93.122,3**	**80.326,6**	**82.452,6**
• Energy industries	52.413,5	46.009,8	46.122,3
• Manufacturing & Construction	20.046,5	17.776,5	18.752,4
• Transportation	10.783,7	8.510,2	9.286,8
• Other sectors	9.878,7	8.030,0	8.291,2
Industry processes	**15.884,2**	**11.473,4**	**12.124,2**
Agriculture	**0**	**0**	**0**
Waste	**0**	**0**	**0**

The CO_2 emissions level of the base year 1989 will not be exceeded up to the year 2020 in all scenarios. So the emissions evaluated for year 2020 are 20% below the level of the base year 1989 in „without measures“ scenario, 25% below in „with measures“ scenario and 26% below in „with measures additional“ scenario. In this condition, the Kyoto Protocol commitment of 8% reduction for Romania will be met in the period 2008-2012 because at the 2010 level, the CO_2 emissions projections represent only about 65-70% of the base year level (1989).

It is worth mentioning that after 2000, a slight increase of the GHG emissions was observed in

5.2.2.1. Projections of CO_2 Emissions in the Energy Sector

	2001	2002	2005	2010	2015	2020
	98.759,3	**105.641,2**	**115.000,0**	**127.500,0**	**136.000,0**	**147.500,0**
	87.143,2	**92.775,4**	**102.050,0**	**113.520,0**	120.800,0	131.050,0
	49.251,5	49.972,4	55.400,0	59.600,0	63.100,0	67.600,0
	19.263,6	22.637,6	23.884,0	26.704,0	28.184,0	31.184,0
	10.799,4	11.890,6	13.422,0	15.922,0	17.222,0	18.922,0
	7.828,7	8.274,8	9.344,0	11.294,0	12.294,0	13.344,0
	11.616,1	**12.865,8**	**12.950,0**	**13.980,0**	**15.200,0**	**16.450,0**
	0	**0**	**0**	**0**	**0**	**0**
	0	**0**	**0**	**0**	**0**	**0**

	2001	2002	2005	2010	2015	2020
	98.759,3	**105.641,2**	**112.000,0**	**125.000,0**	**132.000,0**	**138.000,0**
	87.143,2	**92.775,4**	**99.100,0**	**111.520,0**	**117.560,0**	**123.050,0**
	49.251,5	49.972,4	54.000,0	59.000,0	61.860,0	63.600,0
	19.263,6	22.637,6	23.084,0	26.204,0	27.384,0	29.184,0
	10.799,4	11.890,6	12.822,0	15.422,0	16.622,0	17.922,0
	7.828,7	8.274,8	9.194,0	10.894,0	11.694,0	12.344,0
	11.616,1	**12.865,8**	**12.900,0**	**13.480,0**	**14.440,0**	**14.950,0**
	0	**0**	**0**	**0**	**0**	**0**
	0	**0**	**0**	**0**	**0**	**0**

all sectors. The most important CO_2 emitting source is the energy sector due to fossil fuel combustion. Within the energy sector, CO_2 emissions from the energy industries, the manufacturing industries and construction represent about 80% of the total CO_2 emissions.

Table 5.9. Summary of anthropogenic CO_2 emission projections for "with additional measures" scenario in Gg

	1998	1999	2000	
Total emissions out of which:	**109.006,6**	**91.800,0**	**94.576,8**	
Energy sector (fossil fuel combustion)	**93.122,3**	**80.326,6**	**82.452,6**	
• Energy industries	52.413,5	46.009,8	46.122,3	
• Manufacturing & Construction	20.046,5	17.776,5	18.752,4	
• Transportation	10.783,7	8.510,2	9.286,8	
• Other sectors	9.878,7	8.030,0	8.291,2	
Industry processes	**15.884,2**	**11.473,4**	**12.124,2**	
Agriculture	**0**	**0**	**0**	
Waste	**0**	**0**	**0**	

5.2.2.2. Projections of CO_2 Emissions in the Non-Energy Sectors

Emissions of CO_2 from industrial processes are calculated in correlation with industrial production development. The CO_2 emissions fromi ndustrial processes for the three scenarios are presented in tables 5.7 - 5.9 taking into consideration the various degrees of modernization for industrial technologies and the efficiency increase in the use of raw materials. Thus, the CO_2 emissions in the non-energy sectors represent only about 10-15% of the total CO_2 emissions.

5.2.2.3. Projections of Total Anthropogenic CO_2 Emissions

Projections for total anthropogenic CO_2 emissions are presented in the first line of the tables 5.7 - 5.9 and in the figure 5.3.

	2001	2002	2005	2010	2015	2020
	98.759,3	**105.641,2**	**110.000,0**	**120.000,0**	**130.000,0**	**134.400,0**
	87.143,2	**92.775,4**	**97.120,0**	**106.900,0**	**116.460,0**	**120.450,0**
	49.251,5	49.972,4	53.220,0	57.380,0	61.360,0	62.200,0
	19.263,6	22.637,6	22.684,0	25.004,0	27.184,0	28.784,0
	10.799,4	11.890,6	12.422,0	14.522,0	16.422,0	17.522,0
	7.828,7	8.274,8	8.794,0	9.994,0	11.494,0	11.944,0
	11.616,1	**12.865,8**	**12.880,0**	**13.100,0**	**13.540,0**	**13.950,0**
	0	**0**	**0**	**0**	**0**	**0**
	0	**0**	**0**	**0**	**0**	**0**

Figure 5.3. Summary of anthropogenic CO_2 emissions projections

Table 5.10. Projections of CH_4 emissions from fossil fuel combustion for „without measures“ scenario in $GgCH_4$/year

	1998	1999	2000	2001	2002	2005	2010	2015	2020
Total emissions out of which:	**40,44**	**37,65**	**36,40**	**28,93**	**30,54**	**33,00**	**37,00**	**40,50**	**43,00**
Energy industries	1,09	0,93	0,88	0,94	1,02	1,04	1,08	1,10	1,11
Manufacturing & Construction	1,83	1,66	1,73	1,73	2,11	2,66	2,92	3,15	3,29
Transportation	1,60	1,30	1,37	1,68	1,85	2,05	2,3	2,45	2,55
Other sectors	35,91	33,76	32,42	24,58	25,56	27,25	30,7	33,80	36,05

Table 5.11. Projections of CH_4 emissions from fossil fuel combustion for „with measures“ scenario in $GgCH_4$/year

	1998	1999	2000	2001	2002	2005	2010	2015	2020
Total emissions out of which:	**40,44**	**37,65**	**36,40**	**28,93**	**30,54**	**32,00**	**35,50**	**38,50**	**41,10**
Energy industries	1,09	0,93	0,88	0,94	1,02	1,02	1,03	1,06	1,09
Manufacturing & Construction	1,83	1,66	1,73	1,73	2,11	2,44	2,68	2,94	3,11
Transportation	1,60	1,30	1,37	1,68	1,85	1,95	2,12	2,25	2,4
Other sectors	35,91	33,76	32,42	24,58	25,56	26,59	29,67	32,25	34,5

Table 5.12. Projections of CH_4 emissions from fossil fuel combustion for „with additional measures“ scenario in $GgCH_4$/year

	1998	1999	2000	2001	2002	2005	2010	2015	2020
Total emissions out of which:	**40,44**	**37,65**	**36,40**	**28,93**	**30,54**	**31,50**	**34,80**	**37,90**	**40,10**
Energy industries	1,09	0,93	0,88	0,94	1,02	1,02	1,03	1,05	1,075
Manufacturing & Construction	1,83	1,66	1,73	1,73	2,11	2,4	2,61	2,78	3,01
Transportation	1,60	1,30	1,37	1,68	1,85	1,9	2,05	2,17	2,32
Other sectors	35,91	33,76	32,42	24,58	25,56	26,18	29,11	31,90	33,695

5.2.3. Projections of CH_4 Emissions

5.2.3.1. Projections of CH_4 Emissions from Fossil Fuel Combustion

Projections of CH_4 emission from fossil fuel combustion are presented in tables 5.10 - 5.12 for all the three scenarios.

5.2.3.2. Projections of CH_4 Fugitive Emissions from Fuels

The annual CH_4 fugitive emissions are calculated for the following activities:

- natural gas drilling, transportation and distribution;
- crude oil drilling and processing;
- underground coal mining.

Tables 5.13 - 5.15 present the values of projected emissions for „without measures“, „with measures“ and „with additional measures“ scenarios. The CH_4 emissions from oil and natural gas sector represents about 75% of the total fugitive emissions.

Table 5.13. Projections of CH_4 fugitive emissions for „without measures“ scenario in $GgCH_4$/year

	1998	1999	2000	2001	2002	2005	2010	2015	2020
Total emissions out of which:	**553,33**	**508,63**	**532,71**	**536,19**	**521,78**	**540,0**	**573,0**	**597,0**	**615,0**
Solid Fuels	128,05	111,86	141,16	158,65	145,90	148,6	152,4	157,5	163,6
Oil and Natural gas	425,28	396,77	391,55	377,54	375,88	391,4	420,6	439,5	451,4

Table 5.14. Projections of CH_4 fugitive emissions for „with measures“ scenario in $GgCH_4$/year

	1998	1999	2000	2001	2002	2005	2010	2015	2020
Total emissions out of which:	**553,33**	**508,63**	**532,71**	**536,19**	**521,78**	**535,9**	**562,0**	**585,0**	**605,0**
Solid Fuels	128,05	111,86	141,16	158,65	145,90	147,9	150,1	153,8	159,2
Oil and Natural gas	425,28	396,77	391,55	377,54	375,88	388,0	411,9	431,2	445,8

Table 5.15. Projections of CH_4 fugitive emissions for „with additional measures“ scenario in $GgCH_4$/year

	1998	1999	2000	2001	2002	2005	2010	2015	2020
Total emissions out of which:	**553,33**	**508,63**	**532,71**	**536,19**	**521,78**	**534,0**	**555,0**	**577,0**	**597,0**
Solid Fuels	128,05	111,86	141,16	158,65	145,90	147,1	149,2	151,9	154,8
Oil and Natural gas	425,28	396,77	391,55	377,54	375,88	386,9	405,8	425,1	442,2

5.2.3.3. Projections of CH_4 Emissions from Industrial Processes

The projections of CH_4 emissions from industrial processes were established taking into account the evolution of industrial production and outcomes of the models used are presented in table 16 for all the three scenarios.

5.2.3.4. Projections of CH_4 Emissions in Agriculture

The projections of CH_2 emissions in the agriculture sector are presented in table 17 for all scenarios.

Table 5.16. Projections of CH_4 emissions from industrial processes in $GgCH_4$/year

Scenario / Year	1998	1999	2000	2001	2002	2005	2010	2015	2020
"Without measures"	0,62	0,51	0,99	0,79	0,91	1,06	1,30	1,51	1,80
"With measures"	0,62	0,51	0,99	0,79	0,91	1,02	1,21	1,42	1,65
"With additional measures"	0,62	0,51	0,99	0,79	0,91	1,00	1,14	1,30	1,50

Table 5.17. Projections of CH_4 emissions in agriculture in $GgCH_4$/year

Scenario / Year	1998	1999	2000	2001	2002	2005	2010	2015	2020
"Without measures"	401,01	396,40	369,81	348,23	334,38	375,0	425,0	460,0	485,0
"With measures"	401,01	396,40	369,81	348,23	334,38	370,0	400,0	427,0	450,0
"With additional measures"	401,01	396,40	369,81	348,23	334,38	360,0	390,0	405,0	425,0

5.2.3.5. Projections of CH_4 Emissions from Waste Management

Projections of CH_4 emissions from the waste management sector were determined based on the new approach related to waste management and are presented in table 18 for all scenarios.

5.2.3.6. Summary of CH_4 Emissions Projections

The CH_4 emission projections are summarized in tables 5.19 - 5.21 and figure 5.4.

Table 5.18. Projections of CH_4 emissions from waste management in GgCH_4/year

Year / Scenario	1998	1999	2000	2001	2002	2005	2010	2015	2020
"Without measures"	278,13	281,99	284,73	280,82	270,20	286,0	296,0	300,0	305,0
"With measures"	278,13	281,99	284,73	280,82	270,20	285,0	295,0	299,0	302,0
"With additional measures"	278,13	281,99	284,73	280,82	270,20	282,0	291,0	296,0	299,0

Table 5.19. Summary of CH_4 emissions projections for „without measures" scenario in GgCH_4/year

	1998	1999	2000	2001	2002	2005	2010	2015	2020
Fuel combustion	40,44	37,65	36,40	28,93	30,54	33,00	37,00	40,50	43,00
Fugitive combustion	553,33	508,63	532,71	536,19	521,78	540,00	573,00	597,00	615,00
Industry processes	0,62	0,51	0,99	0,79	0,91	1,06	1,30	1,51	1,80
Agriculture	401,01	396,40	369,81	348,23	334,38	375,00	425,00	460,00	485,00
Waste management	278,13	281,99	284,73	280,82	270,20	286,00	296,00	300,00	305,00
Total	**1273,53**	**1225,18**	**1224,63**	**1194,97**	**1157,81**	**1235,06**	**1332,30**	**1399,01**	**1449,80**

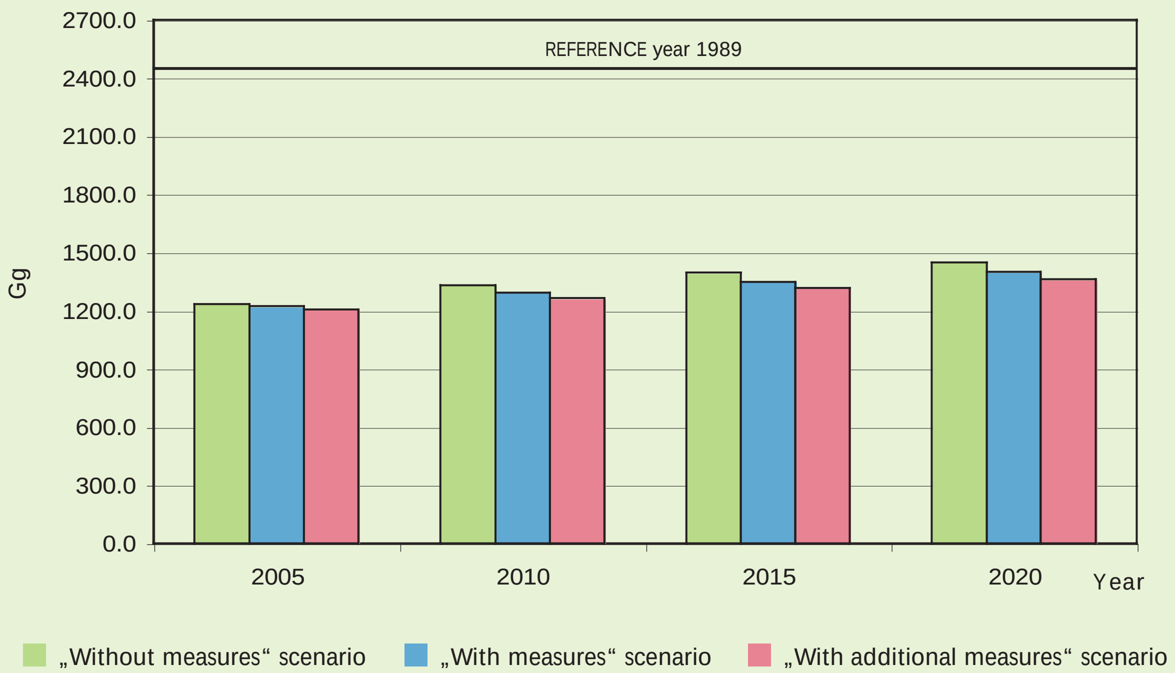
Table 5.20. Summary of CH_4 emissions projections for „with measures" scenario in GgCH_4/year

	1998	1999	2000	2001	2002	2005	2010	2015	2020
Fuel combustion	40,44	37,65	36,40	28,93	30,54	32,00	35,50	38,50	41,10
Fugitive combustion	553,33	508,63	532,71	536,19	521,78	535,90	562,00	585,00	605,00
Industry processes	0,62	0,51	0,99	0,79	0,91	1,02	1,21	1,42	1,65
Agriculture	401,01	396,40	369,81	348,23	334,38	370,00	400,00	427,00	450,00
Waste management	278,13	281,99	284,73	280,82	270,20	285,00	295,00	299,00	302,00
Total	**1273,53**	**1225,18**	**1224,63**	**1194,97**	**1157,81**	**1223,92**	**1293,71**	**1350,92**	**1399,75**

Table 5.21. Summary of CH_4 emissions projections for „with additional measures" scenario in $GgCH_4$/year

	1998	1999	2000	2001	2002	2005	2010	2015	2020
Fuel combustion	40,44	37,65	36,40	28,93	30,54	31,50	34,80	37,90	40,10
Fugitive combustion	553,33	508,63	532,71	536,19	521,78	534,00	550,00	577,00	597,00
Industry processes	0,62	0,51	0,99	0,79	0,91	1,00	1,14	1,30	1,50
Agriculture	401,01	396,40	369,81	348,23	334,38	360,00	390,00	405,00	425,00
Waste management	278,13	281,99	284,73	280,82	270,20	282,00	291,00	296,00	299,00
Total	**1273,53**	**1225,18**	**1224,63**	**1194,97**	**1157,81**	**1208,50**	**1266,94**	**1317,20**	**1362,60**

Figure 5.4. Summary of anthropogenic CH_4 emission projections



A continued increase of the overall CH_4 emissions is observed for all sectors by assessing the projections calculated in all scenarios. The most important emitting sources of CH_4 are oil and natural gas sector and agriculture.

5.2.4. Projections of N_2O Emissions

5.2.4.1. Projections of N_2O Emissions from Fossil Fuel Combustion

The projections of N_2O emission from fossil fuel combustion have been determined together with CO_2 emissions for all scenarios and are presented in table 5.22.

5.2.4.2. Projections of N_2O Emissions from Industrial Processes

The projections of N_2O emission from industrial processes are presented in table 5.23 for all scenarios.

5.2.4.3. Projections of N_2O Emissions from Agriculture

The projections of N_2O emission from the agriculture sector are presented in table 5.24 for all scenarios.

Table 5.22. Projections of N_2O emissions from fossil fuel combustion in GgN_2O/year

Scenario / Year	1998	1999	2000	2001	2002	2005	2010	2015	2020
"Without measures"	1,24	1,10	1,13	1,08	1,17	1,20	1,30	1,31	1,32
"With measures"	1,24	1,10	1,13	1,08	1,17	1,19	1,29	1,30	1,31
"With additional measures"	1,24	1,10	1,13	1,08	1,17	1,17	1,26	1,28	1,29

Table 5.23. Projections of N_2O emissions from industrial processes in GgN_2O/year

Scenario / Year	1998	1999	2000	2001	2002	2005	2010	2015	2020
"Without measures"	2,50	3,81	6,54	5,69	4,47	5,0	5,5	6,3	6,6
"With measures"	2,50	3,81	6,54	5,69	4,47	4,7	5,1	5,6	6,2
"With additional measures"	2,50	3,81	6,54	5,69	4,47	4,5	4,9	5,3	5,8

Table 5.24. Projections of N_2O emissions from agriculture in GgN_2O/year

Scenario / Year	1998	1999	2000	2001	2002	2005	2010	2015	2020
"Without measures"	14,36	15,28	12,43	14,79	12,91	14,1	15,9	17,0	17,8
"With measures"	14,36	15,28	12,43	14,79	12,91	14,0	15,5	16,5	17,0
"With additional measures"	14,36	15,28	12,43	14,79	12,91	13,8	15,0	16,0	16,8

5.2.4.4. Projections of N_2O Emissions from Waste Management

The projections of N_2O emission from the waste management sector are presented in table 5.25 for all scenarios.

5.2.4.5. Summary of N_2O Emissions Projections

The summary of N_2O emissions projections is presented for all scenarios in tables 5.26 - 5.28 and figure 5.5. The sector with the highest N_2O emissions level is agriculture.

Table 5.25. Projections of N_2O emissions from waste management in GgN_2O/year

Scenario / Year	1998	1999	2000	2001	2002	2005	2010	2015	2020
"Without measures"	1,06	1,06	1,06	1,06	1,03	1,04	1,06	1,08	1,10
"With measures"	1,06	1,06	1,06	1,06	1,03	1,03	1,05	1,07	1,09
"With additional measures"	1,06	1,06	1,06	1,06	1,03	1,03	1,04	1,06	1,08

Table 5.26. Summary of N_2O emissions projections for „without measures" scenario in GgN_2O/year

	1998	1999	2000	2001	2002	2005	2010	2015	2020
Fuel combustion	1,24	1,10	1,13	1,08	1,17	1,2	1,3	1,31	1,32
Industry processes	2,50	3,81	6,54	5,69	4,47	5	5,5	6,3	6,6
Agriculture	14,36	15,28	12,43	14,79	12,91	14,1	15,9	17,0	17,8
Waste	1,06	1,06	1,06	1,06	1,03	1,04	1,06	1,08	1,10
Total	**19,15**	**21,25**	**21,15**	**22,61**	**19,57**	**21,34**	**23,76**	**25,69**	**26,82**

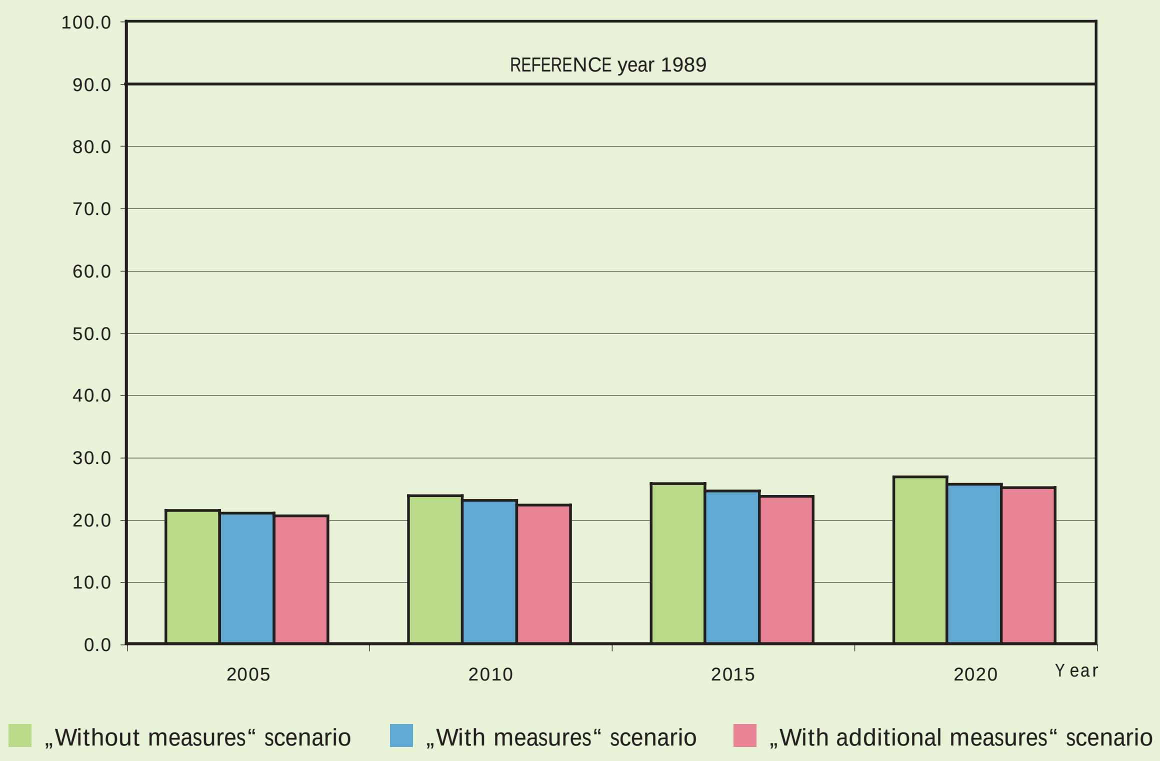
Table 5.27. Summary of N_2O emissions projections for „with measures" scenario in GgN_2O/year

	1998	1999	2000	2001	2002	2005	2010	2015	2020
Fuel combustion	1,24	1,10	1,13	1,08	1,17	1,19	1,29	1,30	1,31
Industry processes	2,50	3,81	6,54	5,69	4,47	4,7	5,1	5,6	6,2
Agriculture	14,36	15,28	12,43	14,79	12,91	14,0	15,5	16,5	17,0
Waste	1,06	1,06	1,06	1,06	1,03	1,03	1,05	1,07	1,09
Total	**19,15**	**21,25**	**21,15**	**22,61**	**19,57**	**20,92**	**22,94**	**24,47**	**25,60**

Table 5.28. Summary of N_2O emissions projections for „with additional measures“ scenario in GgN_2O/year

	1998	1999	2000	2001	2002	2005	2010	2015	2020
Fuel combustion	1,24	1,10	1,13	1,08	1,17	1,17	1,26	1,28	1,29
Industry processes	2,50	3,81	6,54	5,69	4,47	4,5	4,9	5,3	5,8
Agriculture	14,36	15,28	12,43	14,79	12,91	13,75	15,0	16	16,8
Waste	1,06	1,06	1,06	1,06	1,03	1,03	1,04	1,06	1,08
Total	**19,15**	**21,25**	**21,15**	**22,61**	**19,57**	**20,45**	**22,20**	**23,64**	**24,97**

Figure 5.5. Summary of anthropogenic N_2O emissions projections



5.2.5. Projections of Other Gases Emissions (HFC, PFC and SF_6)

The most important sources for other gases such as HFC, PFC and SF_6 are the chemical and manufacturing industries.

Unfortunately, the emissions of HFC in Romania were not quantified until recently due to the lack of useful data, but efforts are proceeding to provide information in the near future for these types of gases.

In accordance with the latest GHG inventory submitted, Romania has also a low level of PFCs emissions. The values achieved in the period 1989-2002 have been extrapolated for the projections of PFCs emission, taking into consideration the uncertainties related to the chemical industry. So the projections of PFCs emission are presented in table 5.29.

There are various types of power equipment that use as insulating medium SF_6. The analysis shows that the value of SF_6 emission is insignificant and the projections were not elaborated.

Table 5.29. Projections of PFC emissions for all scenarios in $GgCO_2$equivalent/year

Parameter	1998	1999	2000	2001	2002	2005	2010	2015	2020
PFC emission	488.69	477.06	503.23	508.08	525.06	550.0	570.0	590.0	600.0

5.2.6. Aggregated Emissions Projections of all Greenhouse Gases

The aggregated emissions projections of all GHG are presented in tables 5.30 - 5.32 and figure 5.6 for all scenarios.

It is obvious that the total GHG emission level in 2020 for all scenarios will not exceed the aggregated emission level of the base year (1989) of 259,914.04 Gg CO2 eq. although all projections show an increasing trend taking into consideration the Romanian Government's efforts regarding economic growth and harmonization with the EU acquis communautaire in the social and economic fields.

The small differences of about 7% and 10%, respectively, between the projections in the „without measures“ scenario and „with measures“ scenario, are presented in figure 5.6. These small differences can be explained, as the „without measures“ scenario is defined without any measures for the reduction of GHG emissions. The „without measures“ scenario reflects the progress of Romania towards a functional market economy through implemented reforms in order to respond to the requirements of the EU acquis communautaire.

If the „without measures“ scenario does not present the reorganization of the Romanian economy and is defined as an inertial scenario, which shows the evolution trends at the level of year 1996 without the structural adjustment of economy and the privatization, the differences between projections will be higher and will better reflect the effects of the adopted measures for the reduction of GHG emissions.

Thus, maintaining energy intensity at the value achieved in 1996, the total final energy consumption will be 58 mil. toe in 2010 and 108 mil. toe in 2020.

These values are about 2-3 times higher than the values presented in figure 5.1. The importance of economy reorganization for the reduction of GHG emission was identified as a first priority taking into account that the energy sector is the main source of CO_2 emissions.

The aggregated emissions projections of all GHG presented in tables 5.30 - 5.32 and in figure 5.6 have been calculated taking into account the CO_2 removals due to carbon sequestration.

Table 5.33 presents the CO_2 removals for all scenarios established on the base of the latest inventory submitted, taking also into consideration various measures for the increase of carbon sequestration potential. At this moment, the carbon sinks value represents only about 16% of the total aggregated emissions of GHG.

Figure 5.6. Aggregated emissions projections of all GHG

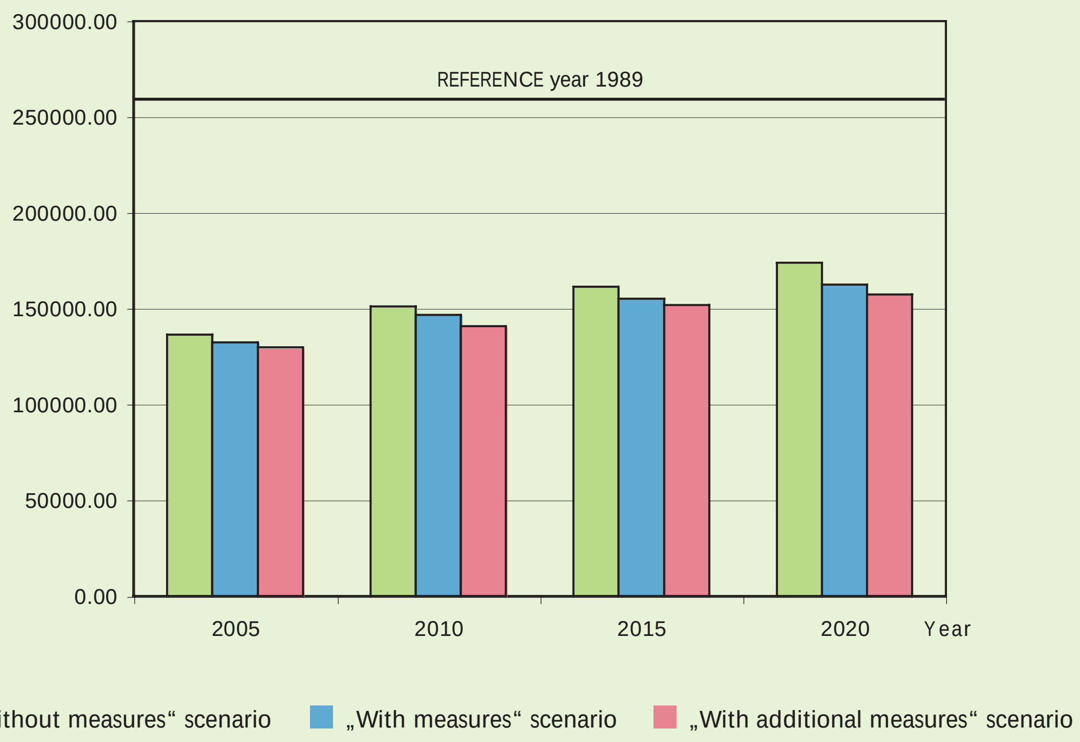


Table 5.30. Aggregated GHG Emissions (CO_2 eq.) for „without measures“ scenario

Parameter	1998	1999	2000
Total CO_2 emission	89487,59	73388,34	76891,86
Total CH_4 emission	31213,49	30028,92	30015,44
Total N_2O emission	6128,0	6800,0	6768,0
Total PFC emission	488,69	477,06	503,23
Total aggregated emissions	**127317,77**	**110694,32**	**114178,53**

Table 5.31. Aggregated GHG Emissions (CO_2 eq.) for „with measures“ scenario

Parameter	1998	1999	2000
Total CO_2 emission	89487,59	73388,34	76891,86
Total CH_4 emission	31213,49	30028,92	30015,44
Total N_2O emission	6128,0	6800,0	6768,0
Total PFC emission	488,69	477,06	503,23
Total aggregated emissions	**127317,77**	**110694,32**	**114178,53**

Table 5.32. Aggregated GHG Emissions (CO_2 eq.) for „with additional measures“ scenario

Parameter	1998	1999	2000
Total CO_2 emission	89487,59	73388,34	76891,86
Total CH_4 emission	31213,49	30028,92	30015,44
Total N_2O emission	6128,0	6800,0	6768,0
Total PFC emission	488,69	477,06	503,23
Total aggregated emissions	**127317,77**	**110694,32**	**114178,53**

Table 5.33. CO_2 Removals in Gg

Scenario / Year	1998	1999	2000
"Without measures"	19518,99	18411,67	17684,97
"With measures"	19518,99	18411,67	17684,97
"With additional measures"	19518,99	18411,67	17684,97

in Gg Carbon Dioxide Equivalent / year

	2001	2002	2005	2010	2015	2020
	80218,13 29288,77 7235,2 508,08	89669,69 28378,35 6262,4 525,06	98500,00 30270,98 6828,8 550,0	110000,00 32653,35 7603,2 570,0	117950,00 34287,75 8220,8 590,0	129000,00 35532,11 8582,4 600,0
	117250,18	**124835,50**	**136149,78**	**150826,55**	**161048,55**	**173714,51**

in Gg Carbon Dioxide Equivalent / year

	2001	2002	2005	2010	2015	2020
	80218,13 29288,77 7235,2 508,08	89669,69 28378,35 6262,4 525,06	95200,00 29998,5 6694,4 550,0	107200,00 31707,9 7340,8 570,0	113550,00 33108,8 7830,4 590,0	119200,00 34305,9 8192,0 600,0
	117250,18	**124835,50**	**132442,90**	**146818,70**	**155079,20**	**162297,90**

in Gg Carbon Dioxide Equivalent / year

	2001	2002	2005	2010	2015	2020
	80218,13 29288,77 7235,2 508,08	89669,69 28378,35 6262,4 525,06	93100,00 29620,3 6544,0 550,0	101950,00 31040,0 7104,0 570,0	111400,00 32283,4 7564,8 590,0	115350,00 33395,7 7990,4 660,0
	117250,18	**124835,50**	**129814,30**	**140664,00**	**151838,20**	**157396,10**

	2001	2002	2005	2010	2015	2020
	18541,20 18541,20 18541,2	15971,54 15971,54 15971,54	16500,0 16800,0 16900,0	17500,0 17800,0 18050,0	18050,0 18450,0 18600,0	18500,0 18800,0 19050,0

Climate Change Impacts, Vulnerability Assessment and Adaptation Measures

6.1. Introduction

The aspects presented in this chapter result mainly from the „Country Study on Climate Change in Romania - Vulnerability Assessment and Adaptation Options," which was developed with the strong financial and technical support provided by the U.S. Government in 1997. Some of this study's conclusions were presented in Romania's Second National Communication to the United Nations Framework Convention on Climate Change, prepared in 1998. During the last years, due to financial constrains, vulnerability and adaptation, related research activities were developed at a small scale for agriculture, water management and forestry to continue the work initiated in these fields. Thus, a part of the information presented in this chapter was taken from the study „Potential impact of climate change in Romania" (Cuculeanu V., Busuioc A., Simota C. and others - INMH Bucharest, 2002).

The consequences of global warming on a time scale can only be roughly estimated, especially on the regional level, due to still low performance of GCMs in simulating the complex characteristics of the climate system and the uncertainties related to emissions scenarios.

As the Third IPCC WG2 Assessment Report suggested, among other information needed, an important area for investigation is the use of observational evidence to detect impacts of observed climate changes on various ecosystems. Like in other regions of Europe, the change in the climate conditions may also affect Romanian agriculture, water management, forests, human life etc. In this respect, the conclusions derived from observations, research and studies are mainly presented in this chapter taking into consideration also the selection of the most suitable GCMs, impacts, vulnerability assessment and adaptation measures.

The shift in temperature and precipitation conditions may result in the modification of the vegetation periods and the displacement of the border-line between the grassland and the forest areas. The change in precipitation regime may also increase the erosion and the compaction of the soil. It was assumed that extreme weather related events (floods, drought) may appear more often and their associated risks and damages may become more significant.

Improvement of water management and irrigation systems, change in land use technologies, and hybrids use, together with other measures present an integrated approach in a future national adaptation strategy. These measures are expected to mitigate most of the negative effects of climate change in Romania's agriculture.

6.2. General Circulation Models in the Climate Change Analysis

General Circulation Models (GCMs) are the most widely used tools to generate climate change scenarios for impact assessments. The experts of the National Institute of Meteorology, Hydrology and Water Management - INMH Bucharest developed some studies concerning the validation of different GCMs on Romania's territory and the elaboration of several scenarios of climate change by using the results from a number GCMs experiments, including both equilibrium and transient ones. The Romanian data used in these studies were the time series of the monthly averages of air temperature and precipitation from 100 Romanian meteorological stations in the period 1961-1990. The data sets have been selected so that the time interval contains as few missing data as possible and the observation sites being uniformly distributed over the country's territory. The long term mean of the considered parameters over the observed interval represents the current climate which is usually called the „baseline" climate.

The GCM output data refer to multi-annual monthly mean data (temperature, precipitation) derived by assuming the present level of carbon dioxide ($1xCO_2$) and a doubling of actual carbon dioxide ($2xCO_2$), as well as to the monthly average data from several decades for one transient model runs. Four equilibrium GCMs were considered by the Romanian experts: GISS (Godard Institute for Space Studies), GFDL R-30 (Geophysical Fluid Dynamics Laboratory, GFD3), UK89 (United Kingdom Meteorological Office), CCCM (Canadian Climate Center Model) and as a transient GCM the GFDL (GFD1) has been used.

Current climate outputs from GCMs ($1xCO_2$) were compared with database of observed climate in order to select the models that best represent current climate, in two steps:

1. the geographical distribution of the monthly mean temperature and precipitation derived from CGM outputs as well as from the CLIM observed data set over a large area including Romania were compared (seasonal patterns and magnitudes of temperature and precipitation);
2. the area average derived from GCM grid points covering Romania was compared with the average baseline for Romania derived from observed data sets and from the CLIM data set (annual variation of the temperature and precipitation regime in Romania).

All the models showed the same climate signals of increasing the air temperature as a consequence of CO_2 doubling, but there are some differences between models regarding the warming intensity. The next table (Table 1) presents the variation of the air temperature in all the GCMs considered.

Table 6.1. Temperature differences between $1xCO_2$ and $2xCO_2$ scenarios in Romania

Model	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
CCCM	4.3	4.1	4.9	3.3	3.2	4.0	4.8	4.2	4.0	3.2	3.4	2.8
GISS	5.0	5.8	3.9	5.4	3.9	2.4	2.5	2.6	4.5	3.3	5.3	4.4
GFD3	2.4	6.1	3.9	4.5	3.8	5.1	5.8	4.1	3.4	3.6	4.3	5.0
UK89	3.2	6.6	6.0	5.4	4.1	6.7	7.1	7.4	6.6	6.0	5.2	4.2

Table 6.2. Precipitation differences between $1xCO_2$ and $2xCO_2$ scenarios in Romania

Model	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
CCCM	1.2	1.0	1.1	1.0	0.9	0.9	1.0	0.9	0.8	1.2	1.1	1.2
GISS	1.2	1.1	1.3	1.2	1.2	1.1	1.1	1.2	0.7	1.4	1.3	1.1
GFD3	1.2	1.5	1.1	0.8	1.0	0.6	0.8	0.7	1.0	1.0	1.1	1.2
UK89	0.8	0.8	0.8	0.7	0.8	0.6	0.5	0.5	0.6	0.7	1.1	0.9

The CCCM and GISS models reproduced best the climate in Romania, but the GISS model has a resolution which is too low compared to the Romanian territory. The UK89 and GFD3 models simulated a climate much colder than the baseline climate, except the GFD3 model which in some warm months simulated a warmer climate. The annual variation of the GCMs temperature was generally similar to the baseline with one exception in the GFD3 model which simulated a higher temperature in August than in July and the UK89 model which simulated a lower temperature in February than in January. In principle, all models simulated a climate more continental than the observed one.

From the precipitation point of view the problem is more complex. Some models simulated precipitation closer to the observed ones in some months and other models simulated better in other months. However, the highest differences were given by the UK89 model (for overestimation cases) and GFD3 model (for underestimation cases) even if the UK89 model simulated better the precipitation in summer. The annual variation of the precipitation in Romania was not well simulated by any model. Generally, all models overestimated the precipitation in the cold months and underestimated the precipitation in the warm months. The CCCM model provided the lowest differences against the observed climate.

Therefore it has been concluded that the CCCM model reflected best the current climate in Romania both from the temperature and precipitation point of view. This conclusion resulted also from other studies on Europe's climate using the same GCMs. All climate change related experiments carried out by using the four equilibrium GCMs showed that the doubling of CO_2 concentration will lead to the same climate consequences, meaning an increase of the air temperature in Romania. The magnitude of the warming is different from one model to another, the lowest being provided by the CCCM and the highest by the UK89 (especially in the summer).

From the precipitation point of view the climate signal is different from one model to another. The UK89 model presented precipitation decrease for all the months, especially during summer (up to 50%), which is consistent with the highest temperature increase simulated by the model in the same season. The GISS model showed in generally an increase of the precipitation for all months, with the maximum increase being noticed in October (40%). The CCCM and GFD3 models showed also an increase of precipitation in the cold month and a decrease in the summer period (Table 2).

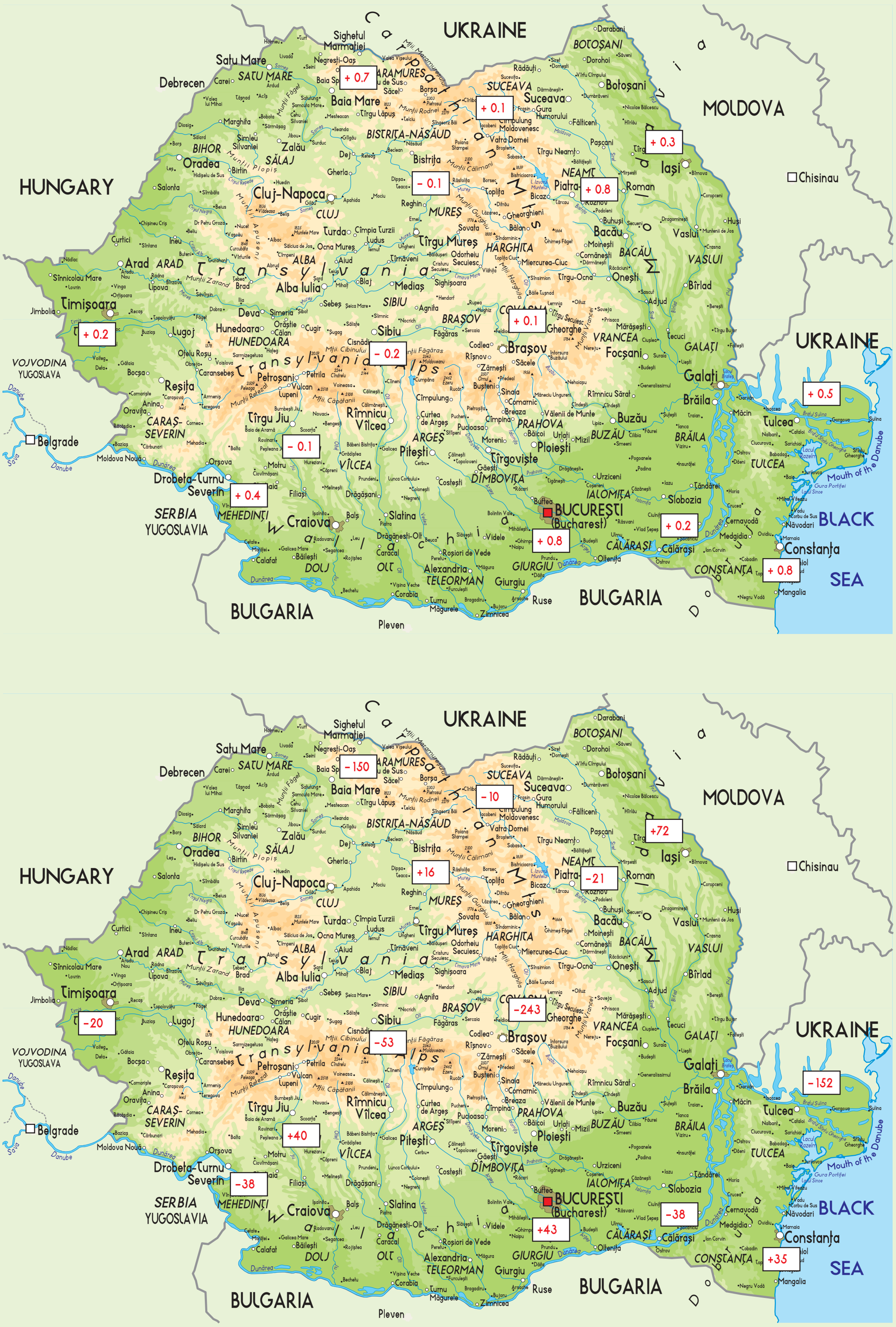
It was concluded that all the GCMs used have some limitations in simulating the current climate in Romania. This may be due in part to the relatively low resolution of the models, which limits their ability to simulate the complex topography such as that of Romania. Additionally, the models used were run assuming the changes only in the greenhouse gases concentrations. Some new developed GCMs showed that adding the sulfate aerosols in the greenhouse gases forcing result in a lower rate of average global warming in many mid-latitude areas of the globe compared with the case in which only the greenhouse gases concentrations were considered.

6.3. Changes in the Romania's Observed Climate over the Last Century

The changes in temperature and precipitation regime measured at long-term observational stations are periodically evaluated. The next figure (Figure 1) presents the linear trends of the annual mean temperature and precipitation amount in Romania over the last century (1901-2000).

A significant warming of about 0.8°C was identified at some stations in the extra-Carpathian region, showing the relief influence. On the seasonal scale the changes are highest in the winter season (reaching 1.9°C at Bucharest-Filaret station), and in autumn season a slightly downward shift in the western part was identified after 1969.

Figure 6.1. Linear trends of the annual mean temperature (°C) and precipitation amount (mm) in Romania over the last century 1901-2000



Visible anthropogenic effects were noticed at several observational stations (e.g. Bucuresti-Filaret), at these stations the warming being more significant. Other local factors influence is overlapped in the large-scale events. Similar conclusions resulted for mean maximum temperature. Taking into account this picture it is difficult to quantify the global warming contribution. Annual precipitation amount generally exhibits a decreasing trend, except for some stations where anthropogenic and local factors lead to a slightly increase (e.g. Brasov). Seasonal and spatial differences can be revealed.

A spatial extension of the surfaces affected by various degrees of dryness was identified in the last decades in Romania. Drought represents a re-

Figure 6.2. Temporal evolution of the annual mean temperature at Bucuresti-Filaret station over the period 1901-2000

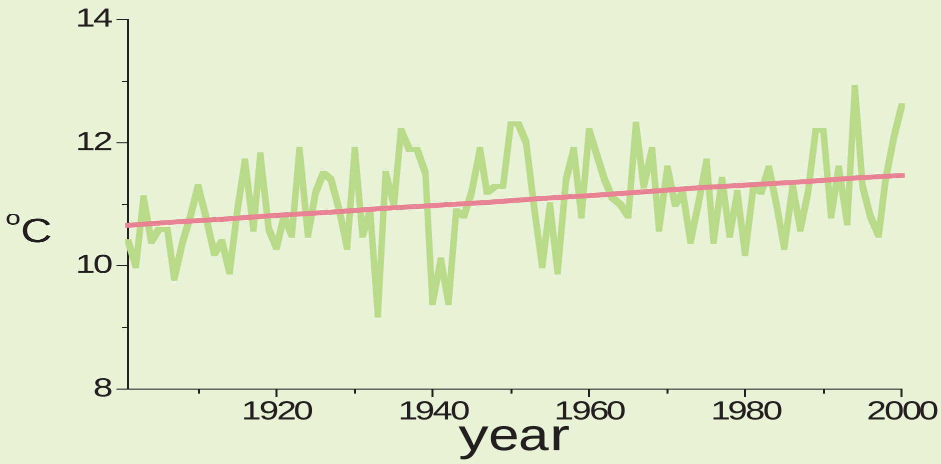
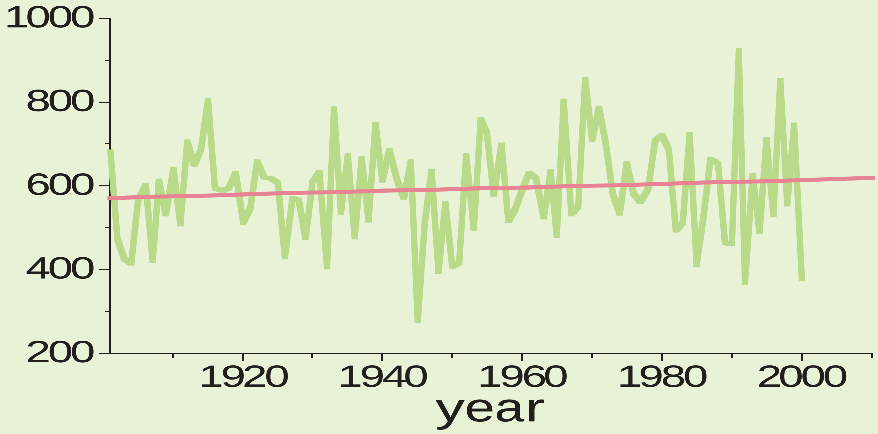


Figure 6.3. Temporal evolution of the annual precipitation amount at Brasov station over the period 1901-2000



lative frequent phenomenon in Romania, like many other countries in the south-eastern Europe. During history severe drought events have caused loss of yields, famine and even death from starvation. Most of the drought events affected only some parts of the Romanian territory and often in the same time there were areas with floods. The drought and the floods have occurred on the same territory, in the same year. The most drought sensitive area is the south-eastern part of the country, were the aridity index P/EPT is smaller than 0.65.

Figure 6.4. Temporal evolution of the annual precipitation amount at Baia Mare station over the period 1901-2000

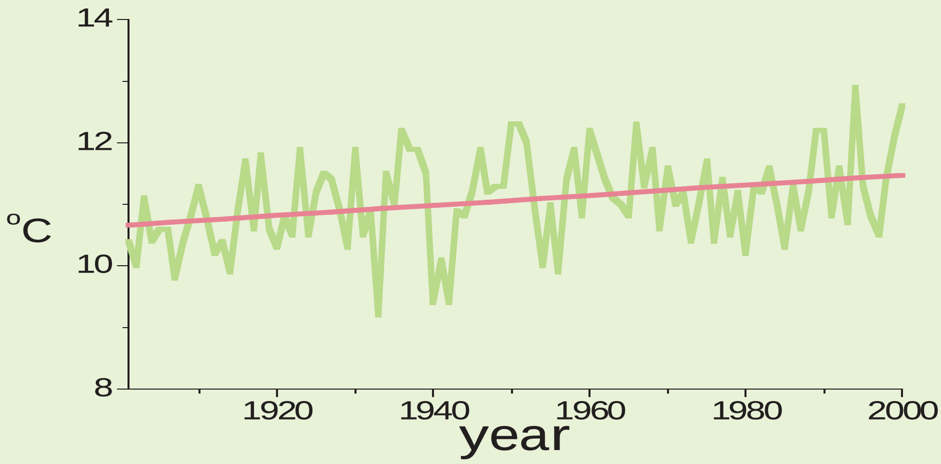
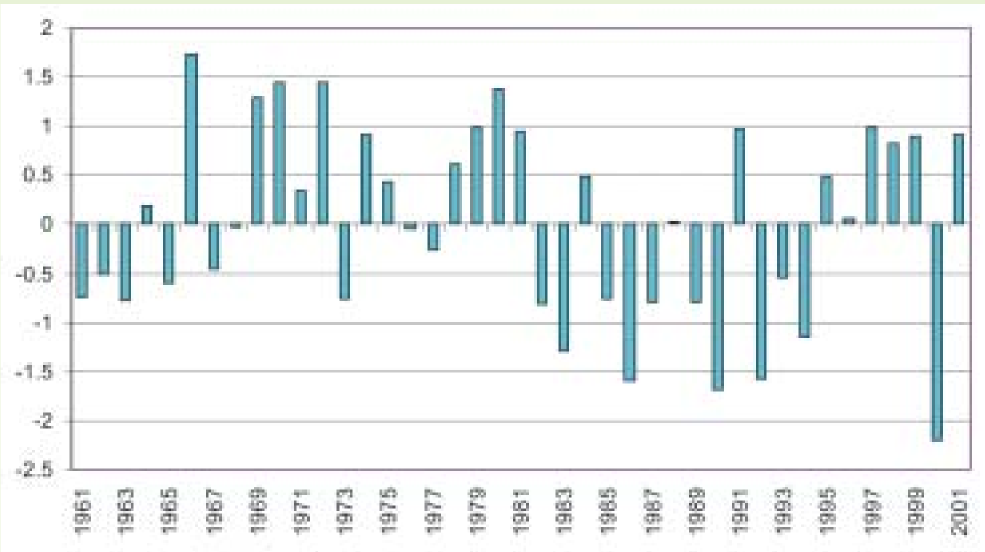


Figure 6.5. Annual SLP index for Romania



In the period 1980 - 2000 the drought event occurrence increased with more than half of the years having amounts of precipitation below normal on the entire Romanian territory (Figure 6). Within the same period the years 1986, 1990, 1992 and 2000 appear to be the most affected by drought, with a standardized precipitation index (SPI) below -1.5. In the year 2000, almost the entire country was affected by a prolonged drought event with high intensity as a result of a very hot and dry summer. (Figure 7).

As a confirmation of the frequent changes in Romania's climate conditions, important floods have affected the north-western part of Romania at the beginning of 2001. The most important excess of precipitation has been recorded in September over a large part of Romania.

The most drought affected areas (SPI index < -2.5) were located in the western south-western and central part of the country (Figure 8).

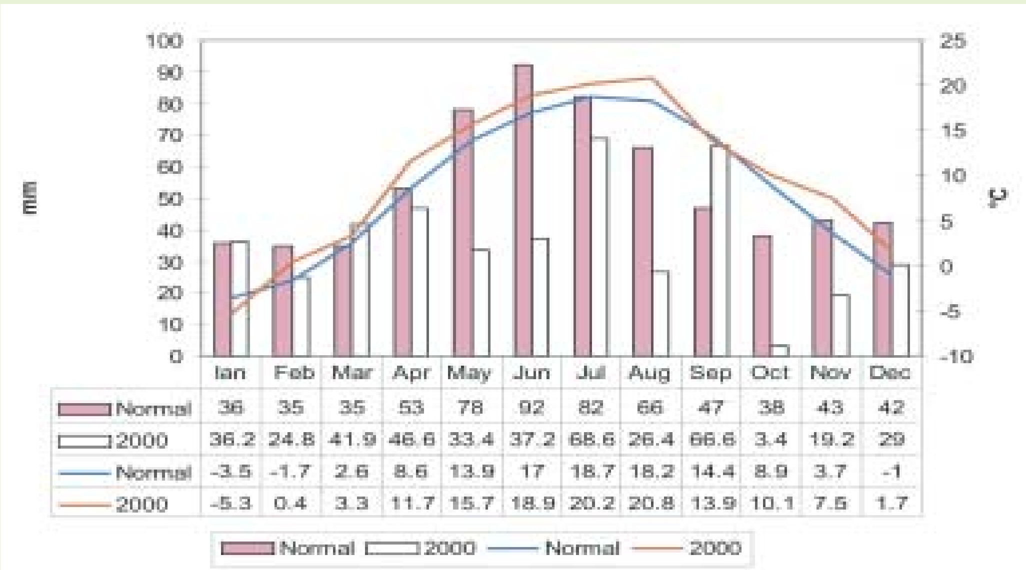
In terms of intensity, surface extension and duration, the drought which occurred in 2000 was the strongest one in the last century. Though a similar dry period was recorded in the period 1945-1953.

As mentioned above, in the last decades the Romanian climate was characterized by the occurrence of very short wet events (floods) within long dry periods, both of them producing a lot of economic and social damages (e.g. agriculture, transports, energy supply, water management, human health and life). For example, the 1970 floods affected 1,053,397 ha and 85,453 households.

The analysis of regional costs due to floods, storms and hail over the period 1992-1998 (taking into consideration the losses of 8,153 billion lei -equivalent to 326 million Euro at 2002 currency rate) showed that the most vulnerable areas, from a socio-economic point of view, are the intra-Carpathian region (35% above the country average) and the north-eastern part of Romania (12% above the country average).

A recent research study showed that the extreme wet events were most frequently in the second half of the 20th century. Therefore, the annual frequency of very wet intervals (one-two days) exhibits an increasing trend for some regions with an upward shift between 1990 and 2000.

Figure 6.6. Monthly mean air temperature and precipitation amount in Romania



	Ian	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Normal	36	35	35	53	78	92	82	66	47	38	43	42
2000	36.2	24.8	41.9	46.6	33.4	37.2	68.6	26.4	66.6	3.4	19.2	29
Normal	-3.5	-1.7	2.6	8.6	13.9	17	18.7	18.2	14.4	8.9	3.7	-1
2000	-5.3	0.4	3.3	11.7	15.7	18.9	20.2	20.8	13.9	10.1	7.5	1.7

Figure 6.7. SPI index distribution for Romania in the year 2000

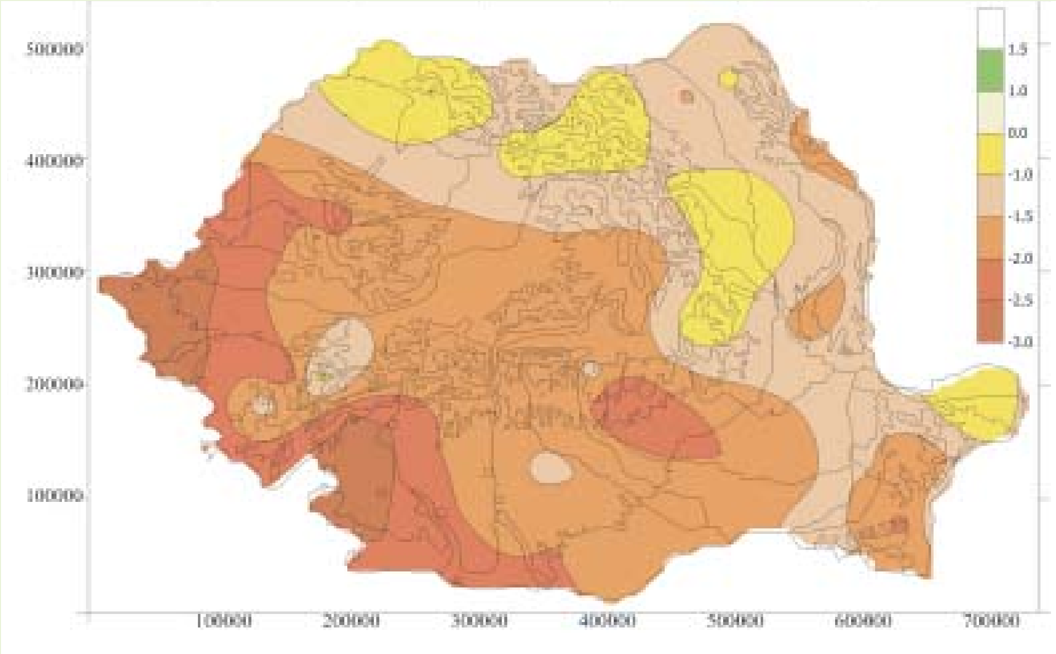
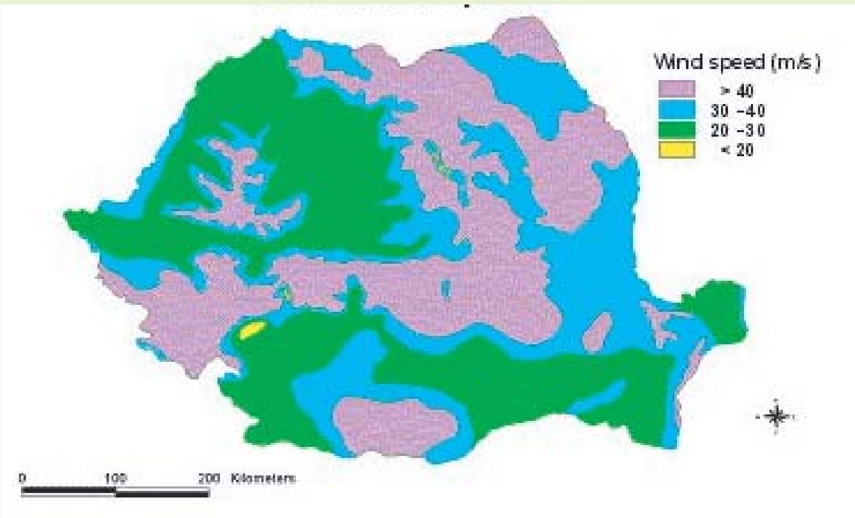


Figure 6.8. Territorial repartition of the maximum annual wind speed in Romania



On the seasonal scale (winter and summer), the frequency of very wet days started to decrease slightly in the same pace with the precipitation amount in the last part of century.

Over the last years a decreasing trend in wind speed is observed in Romania, possibly caused by the increased frequency and persistence of the anticyclone areas over Romania's territory. The most relevant example is the wind speed diminishing at Omu's Peak from 10 m/s (historical average) to 4 m/s in the period 1992-2002. This important decreasing trend of the wind speed is connected to the precipitation decrease trend and the increase of the sun shining period, both parameters confirming the maximization of the anticyclone areas frequency rate against the cyclone areas.

Meteorological Characterization of the year 2002 in Romania

In Romania, the year 2002 was warmer with 1.6°C with respect to the climatologically normal (1961-1990). It was the fifth consecutive year with positive anomalies of the average temperature, situated between 0.3°C and 1.8°C. The general thermal characteristic of the year was determined through 6 months, extremely warm (February, March, May, June, July and November), which recorded anomalies of 2.3°C - 5.8°C. The greatest anomalies were recorded in February, when these values exceeded 8°C in the southern and eastern part of the country. Records of maximum daily temperatures were observed and the highest minimum daily values were reached at various weather stations over the Romanian territory. The maximum temperatures in February ranged between 4.4°C (at above 2500 m altitude) and 23.8°C (in the Danube flood plain) and the minimum temperatures oscillated between -17.7°C on the highest tops of the Eastern Carpathians and -1.2°C along the Black Sea coast. Frosty nights (minimum temperatures: < -10°C) and winter days (maximum temperatures: < 0°C) were recorded only in the mountain area. In the summer months (July), the maximum temperatures frequently exceeded 35°C, with the highest maximum temperature of the summer (40°C) recorded at many weather stations in the southern part of the country. December had a special regime, being extremely cold, with recorded anomalies reaching 2.6°C.

Even if the mean annual precipitation amount at the country level (636.6 mm) was close to normal (647 mm), the precipitation regime showed a deficit in the first part of the year and an excess in the second part. The deficits in the first 6 months of the year situated between 7.4 % and 56.7 %. In the winter months, rainfalls accompanied by glaze were frequently recorded. In the second half of the year (July-October), the precipitation amounts over the entire country exceeded the normal values between 45% and 65%. Over this interval, down-pours, accompanied by hail, were recorded in most of the hydrographic basins, causing floods and landslides. Although December was, on average, extremely cold, the severe warming in the last days of the year and the rainfalls caused floods in the western, central and northern part of the country. The first snowfalls were recorded in September and October, in the north of the country, but a significant snow cover was recorded in November in the north of the country.

Severe wind gusts occurred over the year 2002, but the strongest storm-like wind gusts occurred at the end March, when in the the wind speed exceeded 145 km/h in the Eastern Carpathians and it gradually intensified to effect of the whole country. In this manner the wind gusts were extremely severe in its eastern half of the country. Significant material damages (forests grounding and fires) were recorded. On the night of August the 11th, during strong atmospheric instability, conditions in the east of the Romanian Plain (Facaieni locality - Ialomita county) produced a tornado phenomenon which was signaled between the hours 19:45 and 20:00. Over this restricted area, a severe storm with a strong vortex, caused significant material damages, the loss of 3 human lives, trees grounding, damaged residences and significant agricultural damage.

Over the year 2002, the severe meteorological phenomena in Romania caused 23 deaths and material damages of more than 2,043.3 billion lei (equivalent to 81.5 mil Euro at the 2002 currency rate). The phenomena affected or destroyed more than 3,700 residences and dependencies, 40,700 ha agricultural land, 228 socio-economic objectives and 22,615 m^3 forest wood.

6.4. Climate Changes Impacts on Agriculture

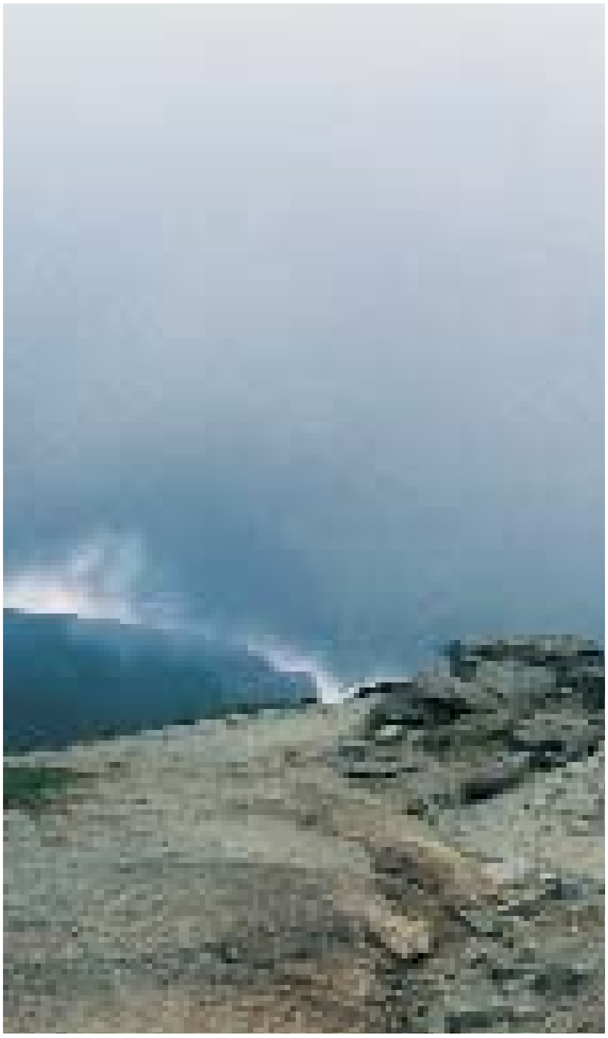
As mentioned in the previous sub-chapter, drought related periods (regarding intensity, duration and spatial extension) became more frequent and severe in the last decade having a very negative effect upon crop yields. Some of drought years may by considered as catastrophic concerning the impacts upon the mean yield of winter wheat and maize crops - the most important crops in Romania.

Some research studies have shown that the decline in crop yields reached 40-60%, especially in the southern part of the Romanian Plain. In the excessive drought years main crop yields were partially or entirely compromised in the areas without irrigation systems.

The critical development stage of these crops (formation of the reproductive organs during flowering and grain filling) very often coincides with almost total depletion of the available water supply in the soil and with the maximum evapotranspiration demand. The chances of plants being subject to water shortage at this time are high, especially if the days of scorching and low atmospheric humidity are followed by tropical nights.

A significant impact of climate conditions on maize was identified by analyzing yields for the period 1988-1999, which was the driest period of the last century in Romania. Therefore, the maize yields for 1992, 1993 and 1998 were entirely compromised in some areas in the southern part of Romania.

In order to identify the most extreme dry/wet year, precipitation data at Calarasi agro-meteorological station from 1961-2001 were analyzed. It is noticed that there is a large variation in precipitation during the maize growing season (April-



September) from 164 mm to about 490 mm. In 18 years out of 41 the precipitation was below normal, in 15 years out of 41 years the precipitation was over the normal and in 8 years was more or less close to normal. Over the analyzed 41 year period, the year 2000 was identified as having the most extreme dry year (by 43% below the normal) and 1997 was the most extreme wet year (by 69% above the normal).

Examination of the monthly rainfall during the maize growing season (April-September) in all three analyzed years shows considerable variations from month to month (Figure 10). In the dry year 2000, the monthly precipitation varies from 3 mm in August to about 80 mm in September and in the wet year 1997, from 140 mm in April to 20 mm in September, respectively.

More important, the pattern of distribution within the season varies considerably from year to year. The severity of extreme climatic events depends on various other factors, such as air temperature, the stage of plant development, soil properties, etc. For example, in the year 2000, low rainfalls during the maize growing season associated with high temperatures (maximum temperature over 32°C have represented the major restrictive factors to the maize growth.

Effects on evapo-transpiration

The next figure (Figure 11) shows the results simulated with the CROPWAT model for daily evolution of reference evapo-transpiration, water requirements, actual crop evapo-transpiration, and irrigation requirements (Irr.Req.) during the rainfed maize growing seasons, in both the dry year 2000 and the wet year 1997. Generally, maize water requirements follow the slope of a typical Kc curve and it rises above the reference evapo-transpiration curve when the crop coefficient is greater than 1.0. The effective precipitation makes the difference between crop water requirement and irrigation need. The largest water shortages in conjunction with high temperature during the months of June, July and the first half of August, which corresponds with the silking-grain filling phase with maximum water requirements determined significant yield reduction (e.g. the year 2000). The daily values of the three parameters (ETo, WR and Irr.Req.) are higher in 2000 than in 1997, especially irrigation requirements. Low values of the daily actual evapo-transpiration during the maize growing season in 2000 indicate a large soil moisture deficit, as compared to 1997.

The next table (Table 3) summarizes the output of the CROPWAT model and changes in the rainfed maize variables for the dry and wet year versus normal climate conditions.

Table 6.3. Cumulative values of maize variables simulated with CROPWAT model on the whole vegetation period in the rainfed conditions at Calarasi site. ETo: reference evapo-transpiration; CWR: crop water requirement; Eff. Rain: effective rainfall - the amount of rainfall that enters the soil; SMD: soil moisture deficit or irrigation requirement; ETc: actual crop evapo-transpiration; Yield red.: the estimated yield reduction due to crop stress; Change from normal year is shown as a percentage.

Years	Eto (mm)	CWR (mm)	Total Rain (mm)	Eff. Rain (mm)	SMD (mm)	ETc (mm)	Yield red. (%)
Normal year	718	606	242	220	386	259	52%
2000	+9.3%	+5.3%	-48.3%	-52.3%	+32.9%	-35.5%	+73.1%
1997	-10%	-13.5%	+34.7%	+39.1%	-40.9%	+52%	-51.2%

Figure 6.9. Variation in the daily rainfall distribution and maximum air temperature at Calarasi station during 2000 (top) and 1997 (bottom), with similar seasonal totals

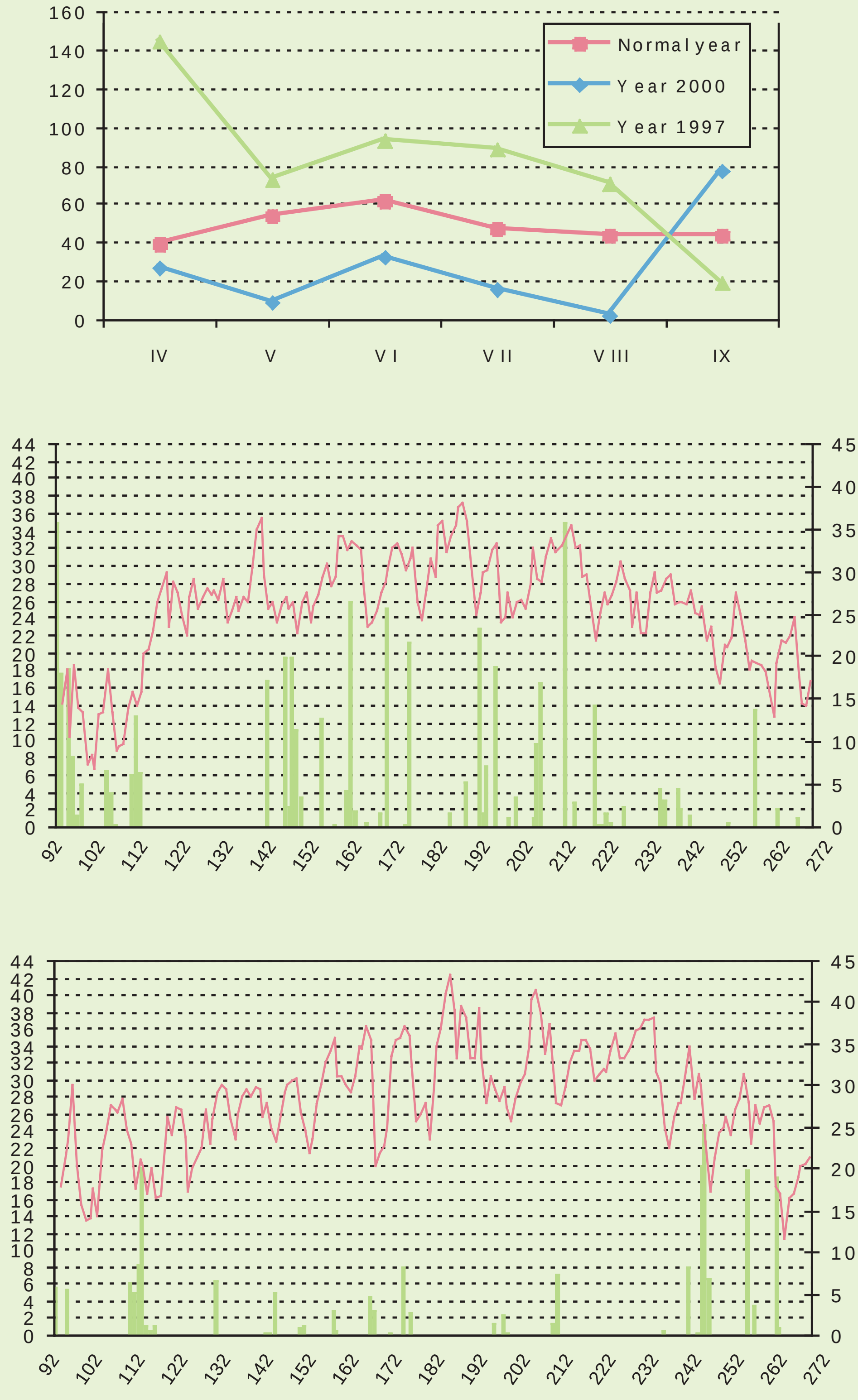


Figure 6.10. Daily evolution of the of the reference evapo-transpiration (ETo), water requirement (WR), irrigation requirement (Irr. Req.) and actual evapo-transpiration (ETc) simulated with CROPWAT model during maize growing season, in 2000 and 1997 at Calarasi station

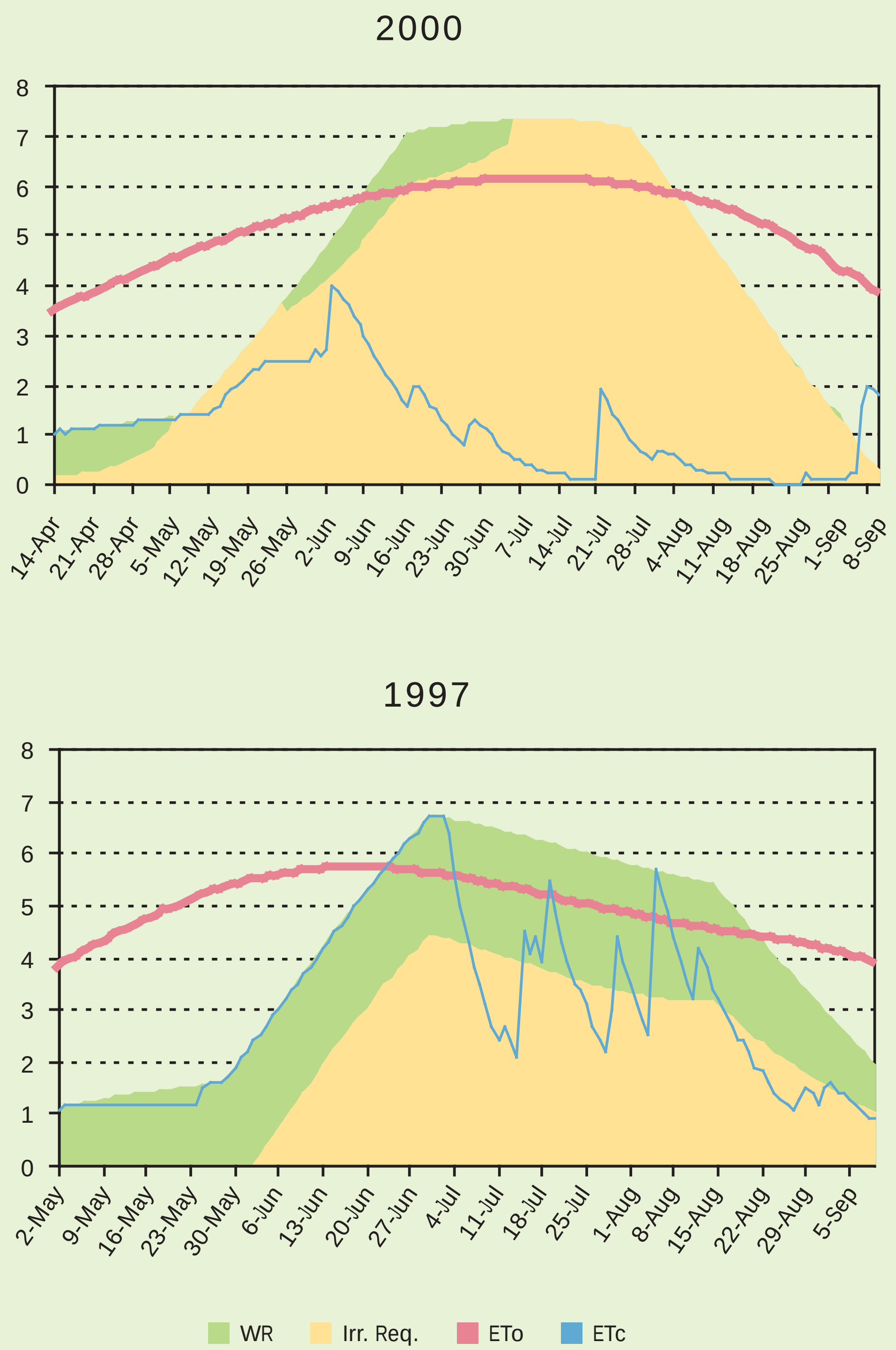


Figure 12 shows the total amount of reference evapo-transpiration, maize water requirements and actual maize evapo-transpiration simulated with the CROPWAT model on the whole vegetation period in the three analyzed years. The reference evapo-transpiration and maize water needs decrease by 10% and 13.5%, respectively in the wet year and slightly increased by about 9% and 5% in the dry year, as compared to the normal year. The actual maize evapo-transpiration greatly increases by 52% in 1997, while in 2000 it decreases significantly by 36%, comparing to the same values from the normal year (Table 3 and Figure 12).

Low values of the actual crop evapo-transpiration (less than 200 mm) and precipitation (less than 150 mm) indicate a large soil moisture deficit during the maize growing season in 2000 and in this case the estimated total yield reduction increases by 73% over the normal year.

Figure 6.11. The total amount of the reference evapo-transpiration (Eto), crop water requirements (CWR) and actual crop evapo-transpiration (ETc) simulated with CROPWAT model, on the whole maize vegetation period, in the all three studied years

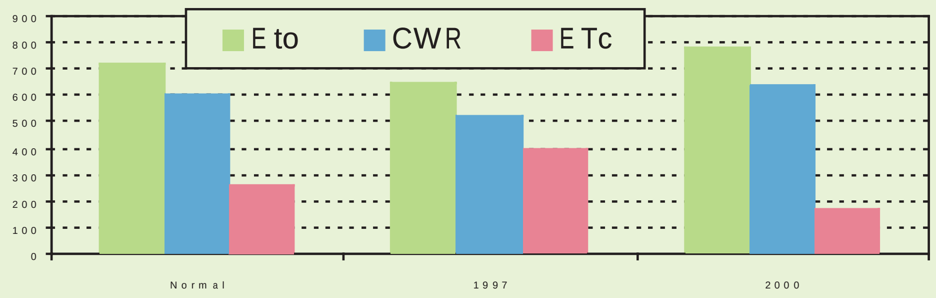


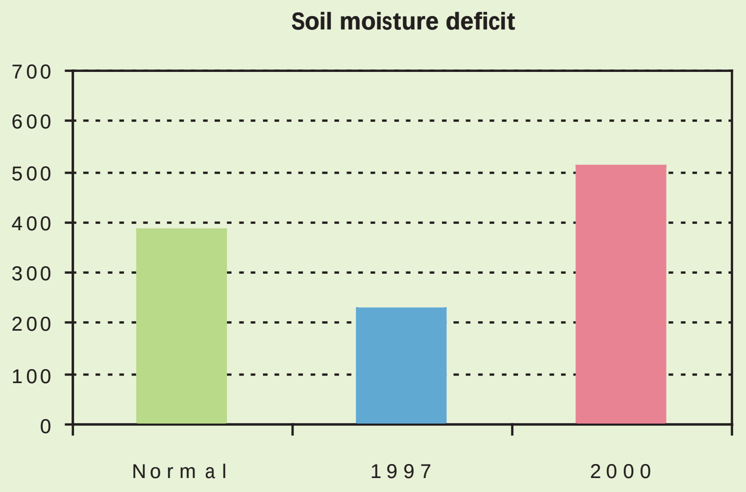
Figure 6.12. Comparison of the total and effective precipitation during the maize-growing season in the all three studied years

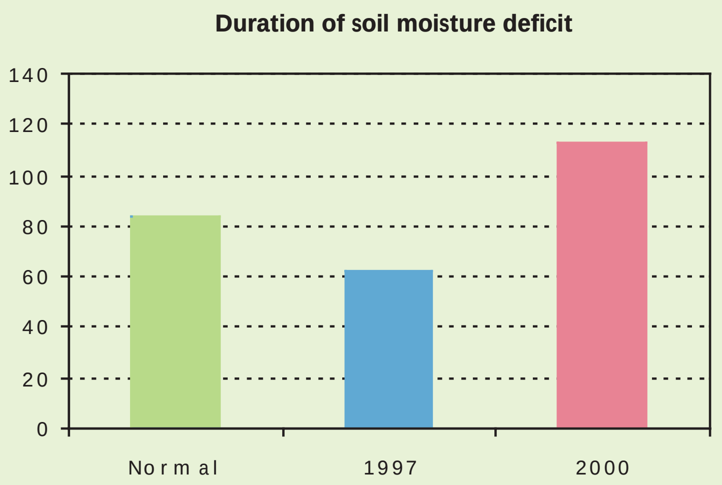
Effects on soil moisture deficit

The next figure (Figure 14) illustrates the comparison of the difference in the amount and duration of soil moisture deficit during the vegetation period, in the all these three analyzed years.

The results of soil moisture balance analysis showed that rainfed maize suffered from a lack of soil water during the growing season on all these three studied years, but with different strengths according to the specific climate conditions of each year. In the mean climate conditions (normal year) the total water deficit was about 386 mm for 84 days (days when the soil moisture falls below the readily available moisture). In the dry year 2000, the soil moisture deficit was higher by 33% and 29 days longer than during a normal year, due mainly to the decreased effective rainfall by 52%. In the wet year 1997, the soil moisture deficit was lowered 41% and 22 days shorter as presented in the figure below.

Figure 6.13. Comparison of difference in amount and duration of soil moisture deficit at the normal, dry and wet year in Calarasi station





The effects of extreme dry conditions on maize yields were also analytically detected with the CERES model. Experts have found that the drought effects depend on the local condition of each area, the severity of extreme dry conditions and the crop vegetation phase in which temperature and precipitation stress occurred.

High temperature in conjunction with decreased precipitation during the vegetation phases (end leaf growth, began grain filling and grain filling) lead to significant yield losses, from 4 to 90%. This is a consequence of the shortening of crop duration associated with the decrease in total seasonal evapo-transpiration and precipitation, as compared to the normal condition.

6.5. Vulnerability Assessment

Among the reasons for relevant vulnerability assessments is the fact that climate changes are likely to happen and many anticipatory measures that would be taken in response to climate changes are „no regret actions“ that will produce benefits even if the climate does not change.

6.5.1. Agriculture

During the vegetation season, crop vulnerability with respect to the impact of meteorological parameters as risk factors, increases proportionally with water and temperature requirements, which reach the highest values during the maximum sensitivity period.

Vulnerability was quantified in various vegetation phases depending on the crop response to the frequency and intensity of risk factors, expressed through the deterioration of the vegetation state, the unusual short length of the vegetation phases' duration and the degree of the crop yields decline.

During the emergence vegetation phase, barley and winter wheat are particularly vulnerable to air and in-soil humidity deficit, but also to precipitation excess. The highest vulnerability is displayed by crops in the Vallachian Plain and Dobrudja. The lowest vulnerability is associated with the northern and central parts of the country, where the covering degree of precipitation necessary in autumn is optimum.

During the maximum sensitivity period (heading-flowering-grain filling) of winter cereals (wheat, barley) and of the weeding crops (maize, sun flower) which take place in Romania in May-July interval, crop vulnerability increase in the south and east of the Vallachian Plain. This is due to the fact that the negative impact of drought is enhanced by the simultaneous effects of other risk factors like: bright sunshine, excessive maximum temperature, and severe air humidity deficit.

The strongest droughts affecting the crops in Romania are those occurring in the autumn and summer. In the years with severe droughts, very small yields (below 1000kg/ha) were obtained, with a reduction of 60-70% of the productive potential of the areas, and sometimes the yields were totally damaged.

Researchers from INMH analyzed the potential climate change impacts on development, grain yield and water balance for the key agricultural crops at 6 typical sites located in one of the most vulnerable zones in Romania (the south region). The vulnerability assessment focused on winter wheat and maize due to the particular importance of these crops in the cultivated areas and the difference of their genetic type, reflected in their distinct physiological response to different CO_2 concentration level (winter wheat is a C3 crop, while maize is a C4 crop).

Output from 2 equilibrium 2xCO_2 general circulation models (CCCM and GISS) was used to develop climate change scenarios. According to the climate predictions for the south region of Romania the annual temperature is likely to rise by 3.9 - 4.4^{o}C and monthly variation of precipitation ranges from -47% to +81%. Generally, precipitation will increase during the autumn and winter and decrease during the summer, depending on the scenarios, sites and crop seasons. The CCCM scenario provides a higher temperature increase and a more pronounced decrease in the amount of precipitation. As a result the projected

climate changes will cause positive and negative impacts.

The crop growth simulation models used to evaluate the effects of climate change scenarios on the crops cultivated in the southern Romania (winter wheat, maize, soybean, sunflower) were: ACCESS for winter wheat and maize; ARFCWHEAT2 for winter wheat; CERES family for winter wheat, maize and soybean; EPIC for all crops; MAIZE for maize; and SOS for all crops.

Models ARFCWHEAT2, MAIZE and SOS were validated for the specific soil and climate conditions of Romania. Due to the fact that CERES and EPIC models were validated only for few crops, soil, climate and management conditions specific to Romania, the output of ARFCWHEAT2, MAIZE and SOS models was used to check the information obtained from the CERES and EPIC models. The crop yields outputs of the simulation models were compared for two sites (Fundulea and Craiova) for a 30 year climate sequence with experimental crop yield data with two crops considered: winter wheat and maize. Experimental data were derived from long time experiments on the effect of mineral fertilizers on crop yields.

The simulation models estimated the crop yields corresponding to different hierarchical levels of the crop system reflected in the crop stress factors considered during the crop yield formation. Therefore three levels of management practices were considered:

- no fertilizer stresses are allowed (potential yield). Water and temperature stresses are the only factors decreasing the crop yields;
- „medium“ technology, allowing nitrogen and phosphorus stresses up to values that are compensated by fertilizer amounts currently applied in average farms for the region of interest;
- „low“ input technology with no fertilizer application.

CERES-type, EPIC and ARFCWHEAT2 models were used for all the three hierarchical levels. ACCESS, MAIZE and SOS were used to estimate only the potential yields.

For winter wheat in both locations and for all hierarchical levels, the EPIC simulation model predicts crop yields which have statistically significant different means than the experimental values. The variance of the EPIC-winter wheat yield sample differs from the one of the experimental yield sample mainly for medium and low input management systems.

For maize no statistically significant differences can be noted between the crop yield samples derived using various simulation models and the sample consisting in measured crop yields.

The results of crop simulations under 2xCO_2 equilibrium GCM scenarios have revealed the fact that climate change effects on development, grain yield and water balance for winter wheat and maize depend on local conditions of each site, the severity of changes in climate and the direct physiological effects of double CO_2 concentration. Wheat and maize crops have different photosynthetic pathways, so their response to increased CO_2 is different.

Winter wheat could benefit from the double CO_2 concentration with higher temperatures, while maize appears to be a vulnerable crop to climate change, especially in the case of a warm and dry scenario (such as CCCM). Wheat yields increased at all sites for both climate change scenarios as a result of large direct effects of doubling CO_2 on photosynthesis and water use. The negative effect of the temperature increase that causes a shorter growth period would be counterbalanced by the positive effect of the doubling CO_2 concentration.

In the case of winter wheat for medium input agricultural technologies (allowing nitrogen and phosphorus stress factors up to 50 %) simulation results show that:

- both climate change scenarios used (CCCM, GISS) induce an increase of grain yield. The increases are about 0,7 t ha-1 for CCCM, and 0,4 t ha-1 for GISS scenario;
- the grain yield percentage increases are higher for sites were the yields for the actual climate are lower due to higher water stresses;
- no statistical differences were detected between the standard deviation of the yields for current climate and that for climate scenarios. Therefore, the year to year variations of the yields will be more or less the same for future doubling CO_2 conditions and corresponding climate changes;
- the length of the growing season decreased with about 16-27 days;
- the water use efficiency increases with 47-57% than the actual conditions, due mainly to the increased CO_2 assimilation rate;
- the economical risk analysis gives as dominant the non-irrigated agro-technology, for actual and changed climate;
- no significant changes in yield levels for climate change conditions were detected if the sowing date were altered by +/-30 days as the actual conditions;
- all the selected sites show the same trend of simulated parameters.

The impact on maize is different according to the scenario and the management practices used:

For rainfed maize:

- CCCM scenario resulted in an increase in the grain yield by 1.4-2.1 t ha-1 d.m., than the baseline. For GISS scenario the increase is 3.5-5.6 t ha-1 d.m. These data show that for GISS scenario the CO_2 assimilation rate (AMAX) reaches its maximum value. The data are consistent with the AMAX values obtained in controlled climate chambers.
- the growing season length decreases by 4-32 days for CCCM and by 2-26 days for GISS;
- as compared with the baseline climate the amount of precipitation during the vegetation period decreases by 2-19% in the CCCM scenario and increases by 1-18% in the GISS scenario;

- the total evapo-transpiration during the growth period slightly decreases at all sites for both scenarios (0-19%);

For irrigated maize:

- the average grain yield of irrigated maize decreases by 4-15% depending on the location, for CCCM scenario. For GISS scenario, the yield increases up to 18% at 3 sites or slightly decreases by 2-5% at the other 3 sites;
- water used for irrigation in the locations where climate changes induce an evident change of the maize yield (Fundulea, Alexandria and Craiova) increases from 17% to 52%, in the case of CCCM, due to water stress development especially in the grain filling phase. For the GISS scenario water used for irrigation decreases almost in all sites with an average of 14-29% than the base and thus irrigation use efficiency increases (the opposite situation as for CCCM scenario).

In summary, for rainfed maize the grain yield increases significantly for both scenarios while in the case of the irrigated maize the grain yield decreases for CCCM and increases or slightly decreases depending on the sites, for GISS scenario. Yield decreases are a result of increasing temperatures that shorten the season length associated with the water stress during the grain filling, as well as the physiological effect of CO_2 double (maize is a C4 crop and therefore benefits little from CO_2 doubled). For both crops the cumulative evapo-transpiration during the growth season generally decreases, as a result of growing season shortening, but with different strengths according to the crop type and management practices. Also, under climate change conditions the water is more efficiently used by the two crops.

Referring to the crop rotations, simulation results indicate:

- as a general trend the benefit increases for all the crop rotations used in southern Romania, in the case of climate change scenarios corresponding to doubling CO_2 concentrations;
- the greatest percentage increases correspond to the short crop rotations (single crop of wheat, wheat-maize), but these crop rotations have the smallest absolute values of the benefit;
- the mineral fertilizer amount increases with about 15-20% for climate change conditions in the case of using the same stress factors for fertilizer application;
- no notable changes in the hierarchy of the crop rotations according to their benefit was detected in the case of climate change scenarios considering as reference the actual climate;
- the values of the benefit in the best rainfed management systems for climate change conditions were about the same with the benefit values computed for the best irrigated technologies for the baseline climate condition.

The assessment of the direct effects of CO_2 on crop production remains an important research question. Although many studies have confirmed the beneficial effect of CO_2 on the mean responses of crops (especially for C3 plants, including winter wheat), variation in responsiveness between plant species persists.

Evaluation of the direct effects of CO_2 on crop production is an open research issue. Although many studies have confirmed the favorable effect of CO_2 upon crops (particularly upon the C3 type plants, such as winter wheat), uncertainties regarding the intensity of this effect for different plants persist. Also, the assessment of other adaptation options requires further studies.

6.5.2. Forests

With a surface of about 238,000 km^2, Romania offers very good natural conditions for different kinds of forest ecosystems. Following the climate conditions, the structure and species composition of the forest depend mainly on elevation. Subsequently, of the forests existing in the plains and hills the dominated species are broadleaf, and in the mountains resinous species dominate.

From the above mentioned surface nowadays only 26.7% represent forested areas with an uneven distributed over the surface of the country (58.5% of mountain area, 27.3% of hill area, and 6.7% of plain area). In the last two centuries clearings have produced a severe decrease in the surfaces covered by forests especially in the plains and hill. As an example the share of forested area held by main forest species has, in the period 1950-1992, diminished for beech occupied areas by 144,000 ha, and the oak occupied areas by 79,000 ha.

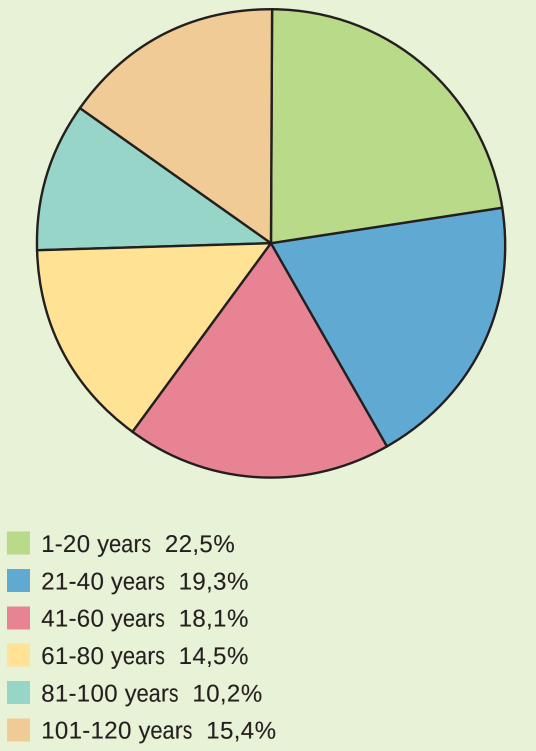
The varied ecological conditions within these areas and stages show a rich forest flora (with over 700 forest plant species) together with the formation of a wide number of forest ecosystem types (more than 150). The biodiversity of Romanian forests is still large, ranking among the firsts in Europe in this respect.

During the last 50 years, some mixture deciduous (broadleaf) species have occupied an ever narrower surface, some of them vanishing almost completely (the beech, elm, maple and common maple species).

The country's forest stock surface is 6,366,888 ha, 6,249,236 of which occupied by forest and 117,652 ha allocated to forestry culture production and management. In regards to forest surface, Romania ranks 17th in Europe, with a smaller forest share as compared to other temperate climate European countries (30-40%).

One of the basic principles to sustainable forestry is that of ensuring continuity to the woodmass production to be harvested from exploitable stands, usually older than 100 years of age. To this aim, it is desirable that the structure by age classes should be normal with the forested surfaces in each class being even. The present day structure of Romanian forests is presented in the next figure (Figure 15). It can be seen that at present in Romania, young age classes (1-60 years) are in excess, while the middle age class (61-80 years), the exploitable stands (over 100 years) and mostly the pre-exploitable stand class (81-100 years) show a deficit.

Figure 6.14. Repartition of forests by age classes



One of the simplest ways to relate vegetation pattern to climate changes is the climate vegetation classification. By assuming that broad-scale patterns of vegetation are at equilibrium with present climate conditions, the distribution of vegetation types can be correlated with the main features of the climate. The Holdridge model relates vegetation to climate variables of bio-temperature, mean annual precipitation and the ratio of potential evapo-transpiration to precipitation. The life zones are depicted by a series of hexagons in a triangular coordinate system. This model is suitable for examining, on one hand, broad-scale patterns of vegetation as they relate to climate and on the other hand, the influence of climate change on the suitability of a region to support different vegetation/forest types.

The Holdridge life zone method does not take into account the specific vegetation processes and as such it cannot be used to predict the temporal dynamics of species composition and stand productivity. Thus, this approach has limitations of principles and its use has to be considered as a first approximation. The current forest distribution is quite similar to the life zones described by the Holdridge life zones. Taking into account different climate change scenarios, the change of life zones should also be considered. The outputs of four GCMs were used to relate vegetation to the possible future climate conditions the results being relevant. The migration of the existing life zones to higher altitudes was observed and also the lower altitudes becoming available for life zones nowadays existing in Minor Asia and in the south of the Balkan Peninsula.

Complementary to Holdridge model, the Jabowa model, taking into account local conditions and species characteristics, was used to predict the dynamics of species composition and productivity in the climate change scenario. While the Holdridge model incorporates equilibrium models of climate change, Jabowa model should incorporate a transient model of Global Circulation Model. For the research study concerning forests experts used outputs from GFD1 model, interpolated in three points of the Romanian territory: Bistrita in the hill area, Predeal in the mountains and Bucharest in the middle of the plain. For Bistrita station situated in north of the Transylvanian Plateau beech (Fagus sylvatica) forest is dominant. According to the climate evolution two kinds of biomass evolutions are considered: the first for a normal climate evolution, the second for transient GFD1 climate.

The sharp decrease of biomass after 2040 is due to the enhanced desertification as a result of temperature rise and precipitation decrease, especially during the summer season. Predeal station located at 1000 meters elevation in the middle of the spruce (Picea excelsa), and fir (Abies alba) forests seems to be less affected by the climate changes.

For mountain areas, under both climate scenarios, the forest evolution seems to be practically the same. As it may be seen, the biomass slightly increases during for the analyzed period (2000-2070). More sensative to climate changes seems to be the oak (Quercus sp.) forest near Bucharest.

The forest in the plain area seems to be as sensitive to the climate changes as the forest in the hill area. The oak forest near Bucharest, appear to be affected by the temperature increase, especially after 2040. Even under current climate condition, a negative tendency of the forest should be expected after 2030.

6.5.3. Water management

In view to estimate the impact of climate change on the hydrological resources due to a double amount of CO_2 in the atmosphere a mathematical rainfall-runoff model is used and applied to three pilot basins, representing mountain, hill and plain zones. These zones of relief are found in all the analyzed basins (Siret, Arges and Tarnave) which have been selected for the assessment of the vulnerability of water resources in these catchments and corresponding adaptation measures.

The mathematical model is applied in two cases: present regime (actual climate) and modified regime (2xCO_2 scenario). The climate scenario adopted in the assumption of a double amount of CO_2 in the atmosphere was determined with

Figure 6.15. Trend in growth at beach forests in Bistrita area

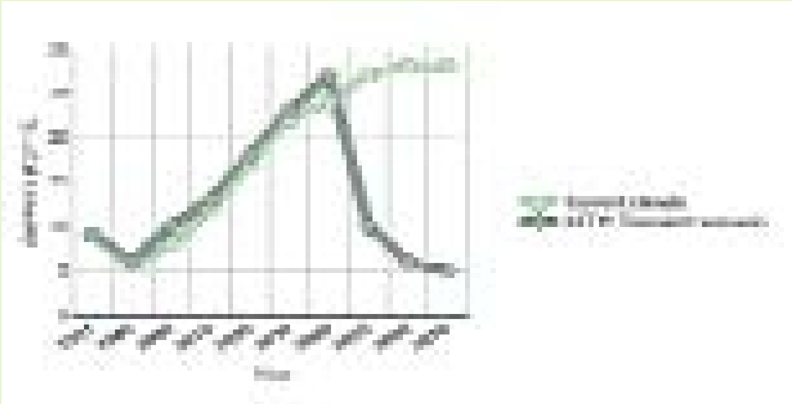


Figure 6.16. Trend in growth at coniferous forests in Predeal area

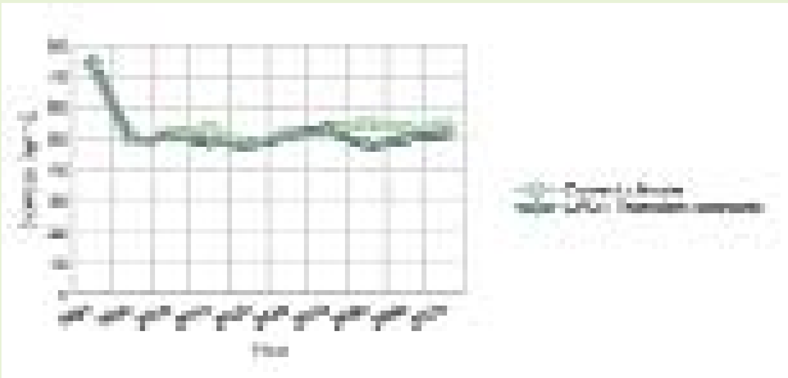
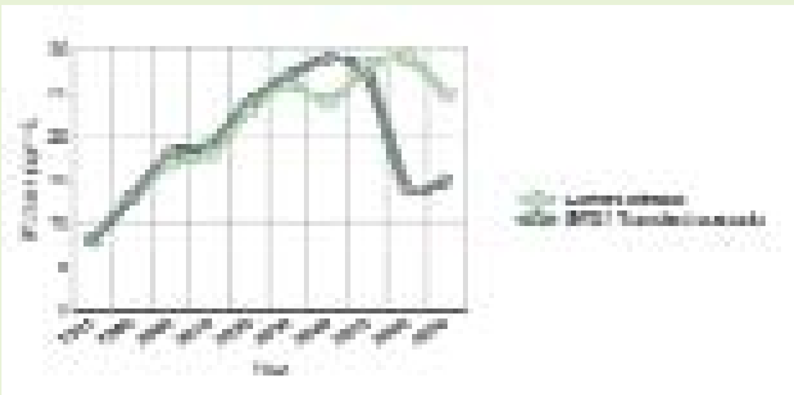


Figure 6.17. Trend in growth at oak forests near Bucharest



the CCCM (Canadian Climate Center Model), which has been considered the most suitable for the climate and relief conditions of Romania.

The river flows at the outlets of the pilot basins simulated by the model for both scenarios which are then transferred to several river sections in the analyzed basins by an up-scaling procedure.

The Romanian VIDRA model was used to simulate the runoff for the three pilot river basins (Siret, Arges and Tarnava) (Figure 19).

The VIDRA rainfall-runoff model used for the simulation of river flow in both scenarios (actual climate and $2xCO_2$) is a lumped type model. Consequently, the input meteorological data (precipitation and temperature) and the model parameters should be considered as average values over the basin area. The application of the VIDRA model as a first step in estimating the climate change impact on the hydrological resources has been performed on three representative small basins, named pilot basins.

Three small basins (200-350 km^2) were selected as pilot basins, each of them being located respectively in representative mountain, hill and plain areas. The daily flows over the period 1971-1988 were simulated in order to calibrate the model on the pilot basins.

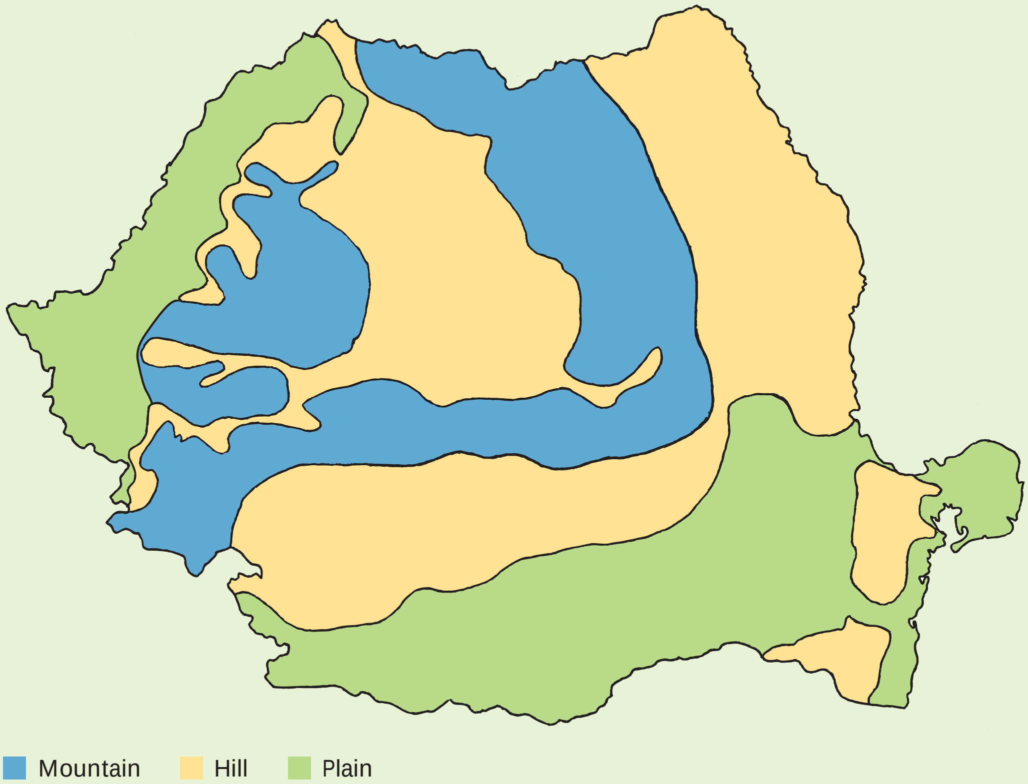
The analyzed basins, Siret and Arges, encompass two main zones with different hydrological behaviour:

- Contributing zone which supplies most part of the total flow volume of the catchment. The corresponding basin of this zone is mainly hilly and mountainous.
- Routing zone where the contribution of the basin is minor although its area is significant.

In Tarnava basin the runoff is gradually formatted over the whole catchment area.

The reference basin is the catchment corresponding to the contribution zone.

Figure 6.18. The spatial relief distribution of Romania



An up-scaling procedure of transferring the model outputs from the pilot basins to the reference basin stations took into consideration the relief configuration of the reference basins, which show a quasi-gradual variation of the area with the altitude. For these basins which have a significant relief, the mean altitude represents a morphometric characteristic which integrates the influence of all climate and physiographic factors upon runoff formation. The river and basin slopes, hydrographic network density, soil permeability, vegetation as well as main climate factors (temperature and precipitation) reveal an obvious variation in the altitude. Thus, the multi-annual specific runoff, defined as the ratio between the multi-annual discharge and the basin area, is strongly correlated with the mean altitude of the basin. Also, there is a good correlation between the mean altitude of the basin and the multi-annual mean specific discharge for a given month.

By coupling the hypsographic curves of the reference basins with the above correlation, the multi-annual monthly mean specific runoffs for each zone of relief from a reference basin were integrated to obtain the total runoff.

It should be mentioned that the pilot basins are not located inside the reference basins but they represent typical relief configurations (mountain, hill and plain) which are similar with the landscape of them later. Consequently, the meteorological input data (temperature and precipitation) of the model applied for the pilot basins should reflect the climate scenario foreseen for the reference basins under the circumstances of doubled CO_2 in the atmosphere.

In order to assess these meteorological input data, the daily temperature and precipitation values have been corrected with the absolute differences in temperature and the percentage variation of precipitation, respectively, as indicated by the CCCM model for the reference basins. The computation of the corrections for the reference basins have been performed by averaging the values determined by CCCM model in certain points for each zone of relief.

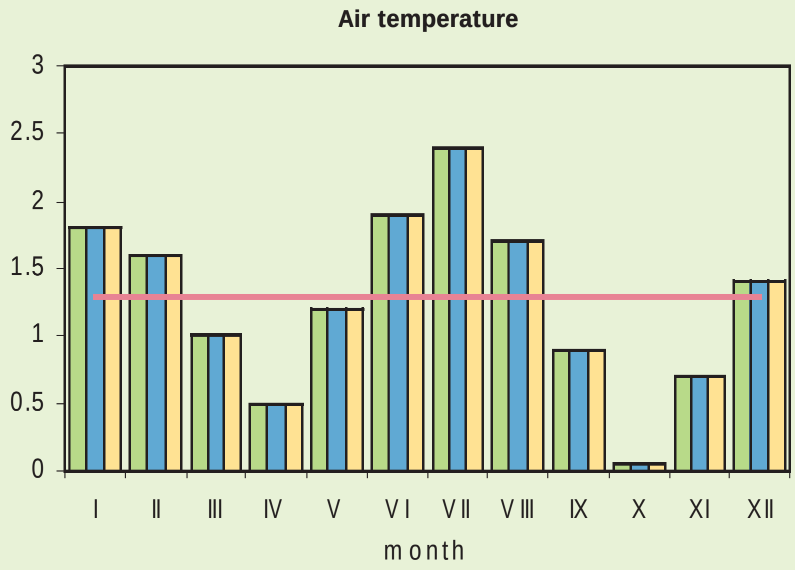
The monthly discharge hydrographs at the outlets of the reference basins have been assessed by applying the model in the pilot basins and by using the up-scaling procedure. The following main conclusions resulted:

- For the climate scenario 2xCO_2, a decrease of runoff occurs as compared to the present one. This is explained by the fact that, although the precipitation is higher in case of 2xCO_2 scenario, due to the marked increase of the air temperature a significant increase of the evapotranspiration occurs, leading to the decrease in runoff.
- For 2xCO_2 climate scenario, a redistribution of the monthly mean runoff is noticed, with an increase of the variation coefficients of the monthly mean discharges as compared to the multi-annual monthly discharges, specific to the mean year.
- In four of the five analyzed basins the variation domain of the monthly mean discharges decreased in case of 2xCO_2 climate scenario, as compared to the actual situation.
- The analysis of the monthly frequency of the discharges above the multi-annual mean has revealed the fact that the most affected month is April, when the most pronounced decrease of maximum runoff occurs. It is also noticed that September is characterized by minimum ru-

noff. Because this implies a possible lack of water, the necessity for proper water management is obvious.

• From the analysis of runoff distribution during the year in the case of the 2xCO_2 climatic scenario the following conclusions may be drawn:
- the maximum monthly mean discharges shifts from the spring - summer months to the winter ones, due to the temperature increase causing the snow cover melting at a different phase than precipitation (generally specific for April-July period);
- the minimum monthly mean discharges shifts during the period October-January towards August-October, due to the temperature increase (leading to the evapo-transpiration increase and the soil moisture decrease) as well as the marked decrease of the precipitation in September.

Figure 6.19. The changes in the mean temperature and precipitation overages the three types of relief presented in Figure 19, derived by using the CCCM (2xCO_2 scenario)



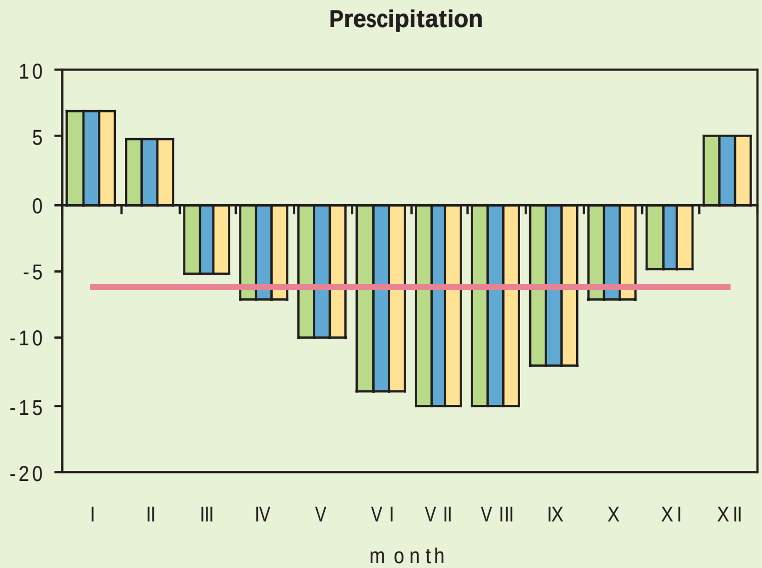
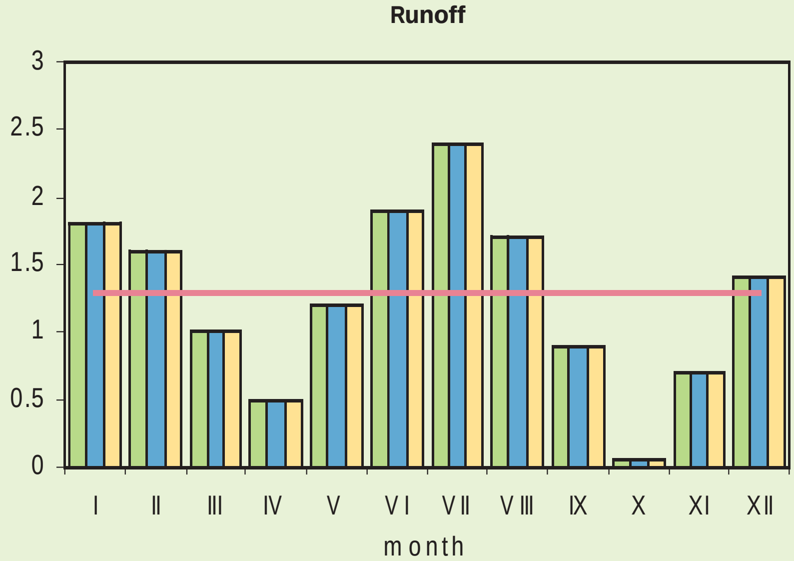


Figure 6.20. The impact of climate change derived through the CCCM model (2xCO_2) upon runoff corresponded to the three types of relief



The expected changes in monthly mean temperature and precipitation amount are presented in Figure 20 and the resulted runoff changes are presented in the following figure (Figure 21).

In order to assess the vulnerability of water resources under the climate change conditions, the series of mean monthly discharges in several points of the analyzed basins were needed. These points refer to the locations of the water reservoirs, diversion and restitution works where the water resources demands budgets are to be performed. The assessment of the monthly flows in these points has been done by means of a correlation function between the stations at the outlets of the reference basin and other gauging stations in the analyzed basins. The correlation function has been determined on the basis of the recorded data over a 40-50 year period at the gauging stations located in the analyzed basins. It was assumed that the correlation function between discharges in different points of the analyzed basins, determined for the current climate, maintains in the 2xCO_2 scenario.

Taking into account the monthly flow estimated as trends of demands in future for agriculture, industry and water supply under the circumstances of the climate change, a water balance „resources-demand“ model was applied. This model allows the simulation of some storage reservoir exploitation according to some pre-established scenarios. For each step the model applies the balance equation for each storage reservoir in the cascade from upstream to downstream.

The application of this model results in the assessment of the vulnerability for the analyzed basins: Arges River, Siret River and Tamava River.

Taking into account the existing water management works, the climate change impact is sensitive only for the Arges River Basin, one of the most important for the economic and social development and environmental issues. The capital of Romania - Bucharest (about 2,000,000 inhabitants) is located within the Arges River Basin. The adaptation measures proposed in this basin refer to:

- Non structural measures: Newly proposed operational rules for the strategic reservoir Vidraru (live storage 420.106 m^3) according to the time development of the user demands combined with a gradual reduction of the water losses in the water supply network.

- Structural measures: From a certain number of reservoirs and water diversion works possible to be built in the future 15 combinations of the most economical ones have been analyzed. On the basis of an economic analysis 3 sets of combinations have been selected.

6.6. Adaptation Measures

The adaptation measures to mitigate the effects of climate changes on agriculture and water management in Romania can be roughly classified in two groups.

The first group is related to the national decision level and it refers to various governmental laws regarding the protection, conservation and improvement of soil and water resources and, therefore, indirectly refers to drought, desertification and soil degradation. One of the most important is related to the United Nations Convention to Combat Desertification, which was ratified by Romania through the Law no. 111/1998.

A particular aspect of agriculture in drought-affected areas is connected with the social security of the local people. Farmers cannot cover the losses by themselves in years of extreme drought, and especially since insurance companies do not cover the effects of drought, so there is a need for considering some kind of support actions in these situations.

The second group of strategies refers to those derived from research studies. In this way, in the agriculture field it was suggested that for unfavorable years the dominant strategy to minimize water stress during sensitive development phases has to be the use of irrigation while simultaneously increasing applied nitrogen levels up to 120-160 kg/ha. Irrigation has a maximum beneficial effect on yields when it is used during the development of the floral organs (in the late shooting, heading and flowering stage).

Results of the vulnerability assessment on winter wheat and maize crops presented in the previous sub-chapter showed that maize productivity in southern part of Romania can be affected by future climate change. Other measures are related to the using of some new more drought-tolerant hybrids with a high grain filling duration, and the sowing in the last 10 days of April using a density of 5 plants/m^2 (for maize).

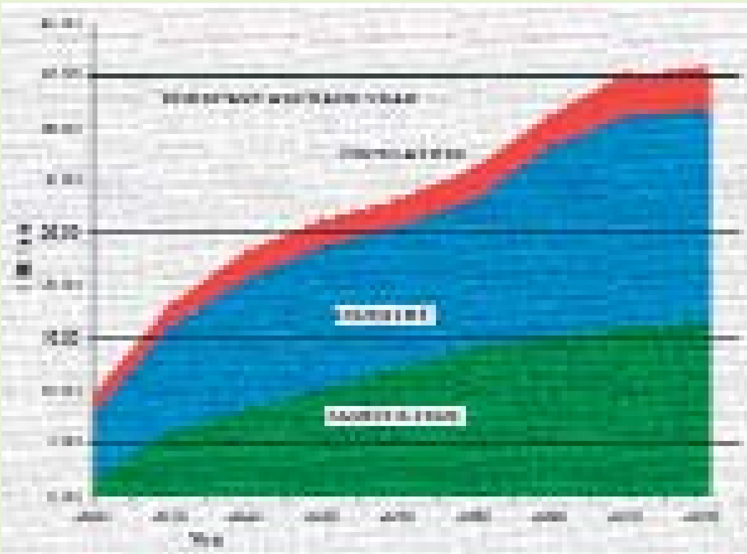
Effects of irrigation application

The negative impacts of climate changes on agricultural crops can be reduced by some technological measures such as the application of irrigation, being the most reliable tool of drought control, regardless of drought intensity and duration.

Table 6.4. The effect of the rainfed and different irrigation options simulated with CROPWAT model on estimated total maize yield reduction. Net Irr.: the irrigation depth applied; Yield red.: the estimated yield reduction due to crop stress

Years	Management options	Net Irr. (mm)	Yield red. (%)
Normal year	Rainfed	-	**52%**
	Irr. fixed int. & depth. (3 x 42mm)	126	36%
	Irr. fixed int. & depth. (3 x 70mm)	210	20%
2000	Rainfed	-	**90%**
	Irr. fixed int. & depth. (5 x 42mm)	210	49%
	Irr. fixed int. & depth. (5 x 70 mm)	350	26%
1997	Rainfed	-	**25%**
	Irr. fixed int. & depth. (1 x 42mm)	42	16%
	Irr. fixed int. & depth. (1 x 70mm)	70	10%

Figure 6.21. The evolution of water demand in Romania



The effects of different irrigation depths on the estimated total maize yield reduction were assessed by the comparison between rainfed and irrigated options and are summarized in the next table. The scheduling criterion was the irrigation at fixed intervals of 15 days and at fixed depths of 42 mm and 70 mm.

The year 2000 was a severe drought year and as a consequence, the yield loss was considerable in the areas without irrigation, the maize yield being practically compromised. In the wet year 1997, the crop stress was small and the estimated total yield reduction was not high, as compared to the normal year or dry year (Table 4).

Maize being a crop with high water requirements, by the application of irrigation the yield losses due to the crop stress can be significantly reduced, especially in extremely dry years. The simulation results showed that, in the dry year, irrigation decreased the percentage of the estimated total yield reduction in rainfed conditions from 90% up to 26% (by applying 5 irrigations of 70 mm), from 52% up to 20% in case of a normal year (by applying 3 irrigations of 70 mm) and in wet year from 25% up to 10% (by applying 1 irrigation of 70 mm). In the extremely dry year of 2000, maize was the seriously damaged by soil drought, which occurred as a result of low precipitation (125 mm) relative to crop water requirements (638 mm). In this case, the estimated total yield reduction due to crop stress was considerable (up to 90%) and the maize yield was practically compromised. The agricultural production growth and stabilization could be ensured by using many methods, in the conditions of the extreme climate events occurrence, such as severe droughts. The most important one being irrigation, while providing the environmental preservation and protection. Simulation result analysis suggest that in the case of extreme dry year, when maize water requirement exceeds the water supply, the application of irrigation the yield losses due to the crop stress can be significantly reduced from 90% to 26%.

In the field of water resources, the evolution of water demands for population, industry and agriculture (Figure 22) until 2075 were assessed on the basis of some particular socio-economic development scenarios and on the results obtained at the three pilot basins.

Adaptation measures and strategies for finding a balance between water use - demand and water supply could be established based on the presented information.

Regarding the water demand the adaptation measures refer to:

- conservation and improving efficiency;
- technological change;
- adaptation of lifestyle, crop variety, industrial recycling;
- market/price driven transfers to other activities.

For the water supply the adaptation options refer to:

- construction of a new infrastructure to transform hydrological resources into socio-economic resources;
- modification of the existing physical infrastructure;
- inter-basin water transfers;
- alternative management of the existing water supply systems.

Research and Systematic Observations

7.1. Introduction

Currently, research activities related to climate change are not as developed in Romania, as with other countries with economies in transition in the region due to the lack of financial resources. There are also problems with the communication and dissemination regarding research achievements like studies or reports that focus on different activities in the variety of climate change related fields. These aspects are important for development of the future national strategy on climate change. Some studies related directly or indirectly to climate change were elaborated in the last years by some interested research institutes or NGOs.

Science and technology research will contribute to the foundation of decision-making concerning climate change issues. The most important actors in the climate change related research are the Ministry of Environment and Water Management through its national research institutes (The National Research and Development Institute for Environmental Protection - ICIM Bucharest and the National Institute for Meteorology, Hydrology and Water Management - INMH Bucharest) and the Ministry of Education and Research. Additionally, some research work on climate change related activities was initiated by the Romanian Academy Institutes, the Academy of Agriculture and Forestry Sciences, the National Research and Development Institute for Marine Activities „Grigore Antipa“, the National Institute for Geography, National Institute for Statistics and Research Institute for Agriculture, Agro-chemistry and Soil. The National Committee for Global Environmental Changes, under the Romanian Academy, coordinates with several institutes and organizations and provides some opportunities for financial support of the research studies based on international co-operation and projects.

The systematic observation in Romania is developed on the basis of several projects implemented for addressing the reporting commitments made by Romania, but still not directly linked with climate change activities.

7.2. Research

The Ministry of Education and Research, the Ministry of Environment and Water Management, the Romanian Academy and the Academy of Agriculture and Forestry Sciences are financing climate research related activity in Romania.

The National Research and Development Institute for Environmental Protection - ICIM Bucharest is carrying out research activities regarding the elaboration of national GHG and sinks inventories, the establishment of national emission factors, and the assessment of possible technical measures for GHG emissions mitigation or removals fostering. The first two National Communications of Romania to the UNFCCC Secretariat were developed by the ICIM Bucharest in close co-operation with several institutes, since it is also the only institute to work for the estimation of GHG inventories using several methodologies (CORINAIR, IPCC).

In December 2002, Romania submitted the National GHG Inventory for the period 1992-

2000 for the first time in the requested format. The next National GHG Inventory was submitted in May 2003, according to schedule, and comprising the period 1992-2001. This inventory has been reviewed by an expert review team (ERT) sent by the UNFCCC Secretariat in Romania in the period 29 September-3 October 2003. The ERT identified some problems that should be addressed by the next submission. Romania also committed itself to submit the national GHG inventories for the entire period 1989-2002 by the end of May 2004, and improving the NIR at the same time. The main conclusions of this review are very important for the future development of Romania's GHG inventories, in accordance with the IPCC methodology.

In the next couple of years, ICIM Bucharest will be involved in research activities for the calculation of some national emission factors to be used for the GHG emissions inventories. This is based on the fact that the Revised 1996 IPCC methodology establishes a general framework for using as much national emission factors possible for all activities and until now Romania used default emission factors for almost all the activities. The results of these studies will support the future calculation of the national GHG emissions inventory for which ICIM will use the national emissions factors as determined in the research studies.

The climate related research in Romania is mainly developed by the National Institute of Meteorology, Hydrology and Water Management - INMH Bucharest, which has a long history of weather related activities behind it.

Meteorological scientific research

INMH focused upon the main fields selected as being of national interest and in accordance with European Community demands: atmospheric and pollutant transport modelling, physics of the atmosphere, ozone layer, climate studies (climate variability, climate change and impacts on crops, climate prediction), studies based on satellite, remote sensing and GIS techniques. The research activity is mostly financed by the state budget and within the themes and grants provided by the Romanian Academy and the Ministry of Education and Research. Other research studies were achieved through projects financed by NATO and the European Union. The number of these projects is quite small compared to the scientific potential of the institute. One of the main strategies of INMH is to encourage this activity within the 6th Framework Program (COST and LIFE) and other international programs. It is worth mentioning the developing activity for the preparation of the book entitled „Romanian Climate“, which will include a great volume of work referring to the climatic parameters processing over the interval 1961-2000 and the elaboration of the auxiliary graphic material.

The main research directions approached in climate variability and the climate change field refer to a better understanding of the mechanisms controlling regional climate variability, extreme climate events analysis and climate change caused by anthropogenic activities (increase of the greenhouse effect gas and aerosols concentration).

INMH continues the analysis operation of the climate series homogenization, which began in previous years in order to obtain qualitative data useful for carrying out climate research studies.

In 2002, the issue of the mean seasonal and annual temperature data homogenization was approached. Thus, the mean monthly temperature data files, coming from a number of 118 weather stations with full-time observation series were prepared, for the period 1961-2000 and the intercomparison of the data sets coming from many other sources were achieved.

Remote sensing applications

Were used to determine the water reserve in the snow cover during the winter-spring season of 2002 in the following basins: Arges, Bistrita, Lotru and Doftana. The water reserve in the snow cover, on altitude levels and vegetal cover types, was calculated by using the snow cover depth values collected in fast flux from the meteorological weather stations and gauging stations. This was done during the winter time and in the spring months until the thawing of snow. Thus, the experts achieved assessments for the three hydrographic basins of interest, in January, February and March.

Agro-meteorological studies

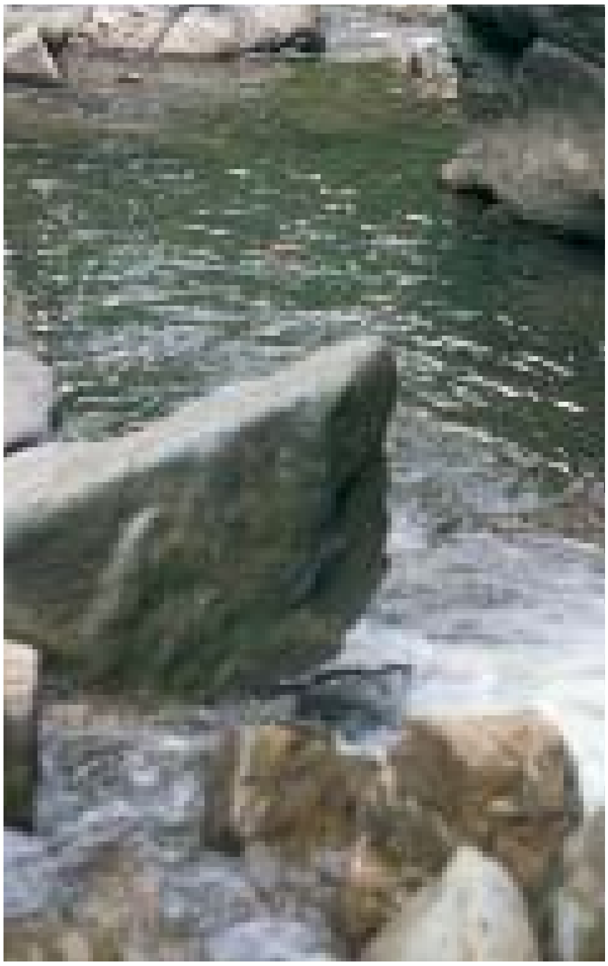
The daily agro-meteorological parameters and the changes in the soil moisture content at the level of plant root systems are monitored in order to establish the plant favorableness degree in different growing and developing stage of crops. The periods and the agricultural areas affected by extreme events (droughts, intense heat, excess/deficit of water in soil, frost, etc.) are also identified.

The agro-meteorological bulletins including the agro-meteorological forecast for the next interval, warnings regarding the occurrence of agro-climatic hazard factors, are elaborated every week and month in order to have a current assessment of the agro-meteorological parameters effects upon the soil condition and agricultural crops vegetation. Information is accompanied by useful recommendations, advising farmers in choosing the corresponding technological solutions to prevent and mitigate severe weather effects in different critical vegetation stages of the crops. Longer-range agro-meteorological forecasts (based on long-range meteorological forecasts) are also elaborated allowing a perspective view of the influence of agro-meteorological conditions evolution (ex. air and soil hydro-thermal regime) upon plants growth, development and productivity.

The agro-meteorological information are disseminated towards governmental decision-making offices, District Agricultural Agencies, Regional Meteorological Centres and mass-media. This is done in order to make optimal decisions for agriculture in due time (e.g. performing ploughing, choosing the optimal epochs and the seeding depth, irrigations and rational fertilizing, introducing the most efficient species acclimatized to the soil-climate conditions available at local or regional level).

Romanian climate in the 20th century

In order to identify the climate characteristics of Romania for the previous century, the variation



trends over the period 1901-2000 were analyzed by INMH. The analysis focused on mean annual/seasonal air temperature and annual/seasonal precipitation amounts, using the climate series from 14 weather stations which provide complete data for the mentioned period. Significant warming trends were identified, especially in the extra-Carpathian region, Bucharest-Filaret and Baia Mare stations proving anthropogenic influences. In the case of the annual precipitation amounts, a decreasing tendency was identified, which became stronger after 1970, and some light increasing tendencies were also identified in the south-west.

Extreme climate events

Taking into account the damages caused by extreme climate events occurrence and the results presented by the IPCC Assessment Reports regarding the increase of extreme climate events intensity and frequency over the past decades, INMH initiated in 2002 the development of evaluation studies for these events variation tendencies in Romania. Due to the fact that continuous daily data series were unavailable over long periods, this analysis was performed over shorter periods. Thus, the experts analyzed the temporal evolution of the maximum precipitation amounts, fallen in 24, 48 and 72 hours at 8 weather stations, in the period 1926-2000. In the case of air temperature, the annual frequency of the days with extreme winter and summer temperatures, for 100 stations over the period 1961-2000, showed a decrease of the extreme winter temperatures frequency and a rising of the extreme summer temperatures frequency. This occurrence became more evident starting with the 1970.

In order to understand the mechanisms controlling the regional climate variability, the experts analyzed large scale atmospheric circulation and ocean-atmosphere interaction influence upon the climate anomalies in Romania. It was concluded that there is an important link between changes in the frequency of the days with extreme precipitation amounts in Romania and the large scale atmospheric circulation changes, being more significant in the winter and summer seasons. Thus, the decrease of the extreme precipitation amounts frequency, during the winter seasons after 1970 is determined by a decrease of the south-western circulation frequency over Romania.

Climate change scenarios

The climate change scenarios, due to the increase of the greenhouse gases and aerosols concentra-

Figure 7.1. Variation trend of the annual mean temperature at Bucuresti-Filaret station

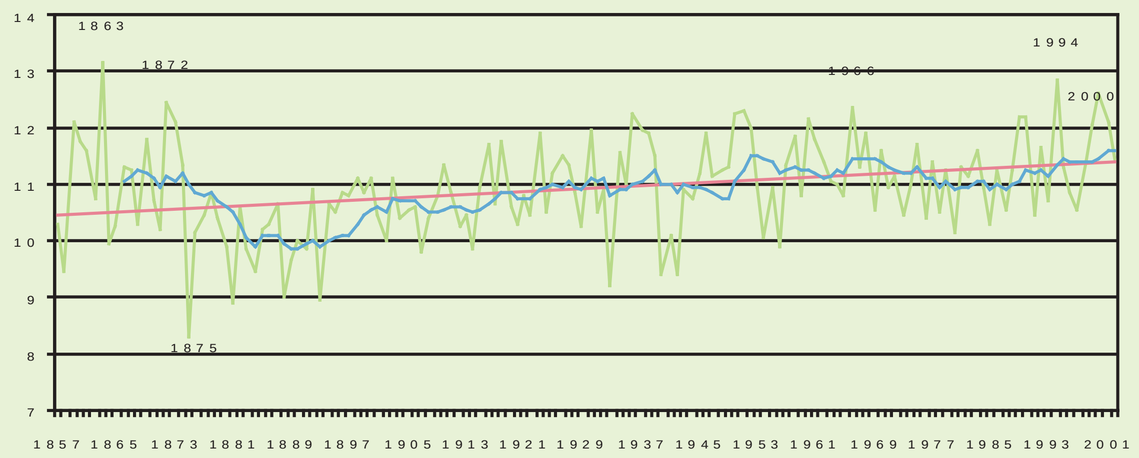
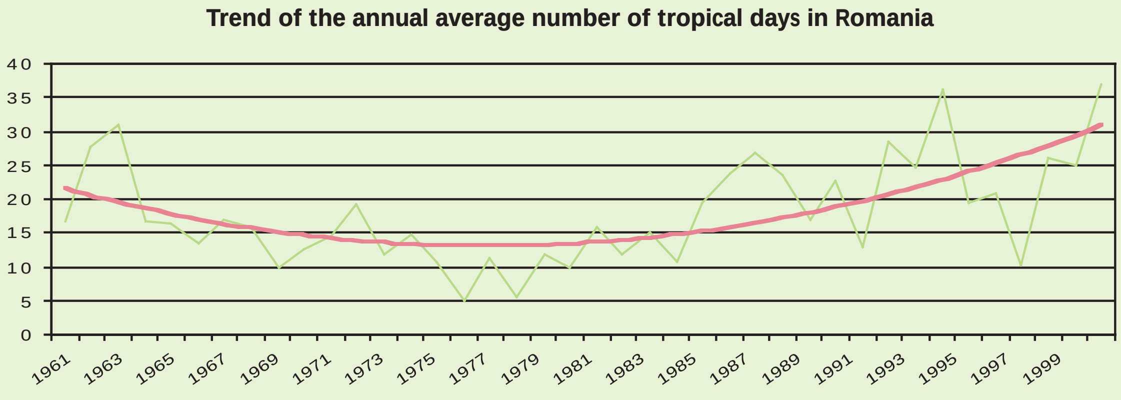
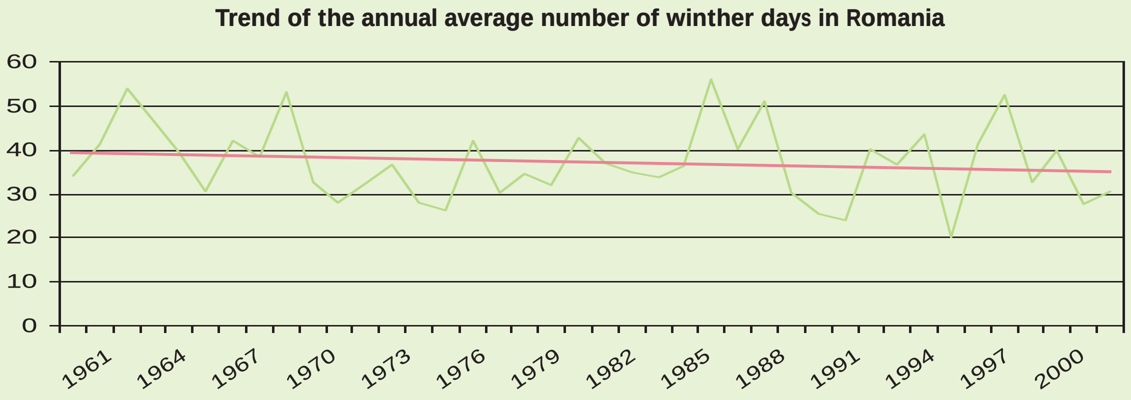


Figure 7.2. Trend of the annual average number of tropical and winter days in Romania





tions were attentively approached. In the last years, where attention was drawn upon the extreme precipitation events frequency in the south of the country. Through the use of downscaling statistic models, based on the link to atmospheric circulation at the European scale, the changes in the mentioned events frequency were determined for the next 100 years using the climate change scenarios elaborated by Hadley Center (HadCM3-A2). Significant changes have also been estimated for the autumn (increase) and summer (regional increases and decreases). For the preceding version of the model (HadCM2), the INMH experts analyzed the changing trends in the mean seasonal air temperature conditions (winter and summer) and the precipitation amounts in the Atlantic-European area, resulting directly from the HadCM2 model integrations, using 3 experiments: control, greenhouse gases effect without aerosols and greenhouse gases effect in the presence of sulphate aerosols.

In assessing regional climate change uncertainty and in order to improve the downscaling statistic models, in 2002, a stochastic model conditioned by large-scale atmospheric circulation was achieved in order to generate daily precipitation amounts.

The model was tested for Bucharest-Filaret station and by comparing the results obtained and the unconditioned stochastic model variant. The results indicated that the conditioned stochastic model is more suitable for use within climate change studies, because it manages to reproduce the linear technique induced by the circulation changes at a large scale.

Connection between Romanian climate and ENSO/NAO

INMH experts identified the key areas in the SST field in the Atlantic Ocean, influencing the atmospheric circulation at the European level and some preliminary results were obtained regarding the ENSO influence upon the thermal and precipitation regime in Romania. Thus identifying certain months in which this influence is more significant from the statistical point of view. The North Atlantic Oscillation (NAO) role upon the lower Danube basin discharge characteristics was also pointed out, in connection with the atmospheric circulation and the sea surface temperature anomalies at a global scale.

Climate predictability

The NAO variability and predictability study has continued over the last three years in order to develop prediction methodologies for anticipating winter season severity in Romania. Significant results have been obtained, such as including the snow cover expansion in Eurasia amongst the predicting elements of the North Atlantic Oscillation phase.

The tests regarding obtaining prediction information referring to the thermal and precipitation anomalies in Romania, with an anticipation of up to 3 seasons, were also continued using a statistic model based on the canonical correlation analysis. In 2002, the spring and autumn models were carried out and tested.

In order to verify the conditioned probabilities method performance in estimating the thermal and precipitation anomalies in Romania, INMH began the reconstruction of the climate conditions over the independent interval 1981-2000 and the comparison with real data. The testing was performed for the Timisoara weather station. A quite large number of uncertain situations were observed and in certain cases the achieved forecasts percentage was significant.

Impact studies of climate variability upon crops

In the last years, INMH has continued research regarding the development and improvement of methods for assessing and predicting the climate variability impact (including extreme events) upon crops growth, development and formation. Using the CropWat 4 model, the irrigation demand was determined during the maize vegetation season in the Teleorman-Vlasca area by using different climate conditions, for a wet (rainy) year (1997), a dry (droughty) year (2000) and a normal one (2001). Thus using different agricultural management options: rainfed and irrigated with different watering norms, in order to quantify the drought effect upon production. The crop losses in rainfed and critical irrigating conditions were assessed in the same time with the stress upon the irrigation techniques efficiency in the maize productivity growth. The exceeding precipitation amounts frequency for the Moldova region was also analyzed in the active vegetation season. Critical periods characteristic to the main agricultural species and also the moisture dynamics available to the winter wheat and maize crops over the vegetation season - case study for the Moldavian agricultural areas - were analyzed.

In order to assess the vegetation phases for different agricultural crops, the PROGFENO statistical model was used for elaborating the flowering phenophase forecast of the sun-flower crop and the appearance of the first mulberry leaves, in climate conditions from the year 2002. A study regarding the cultivating technologies substantiation within the mulberry agro-ecosystem was carried out within the RELANSIN national research-development and innovation program, and also within the AGRAL program. The study focused upon the forecast of honey production at the sun-flower hybrids through the integration of the biological, ecological and technological factors.

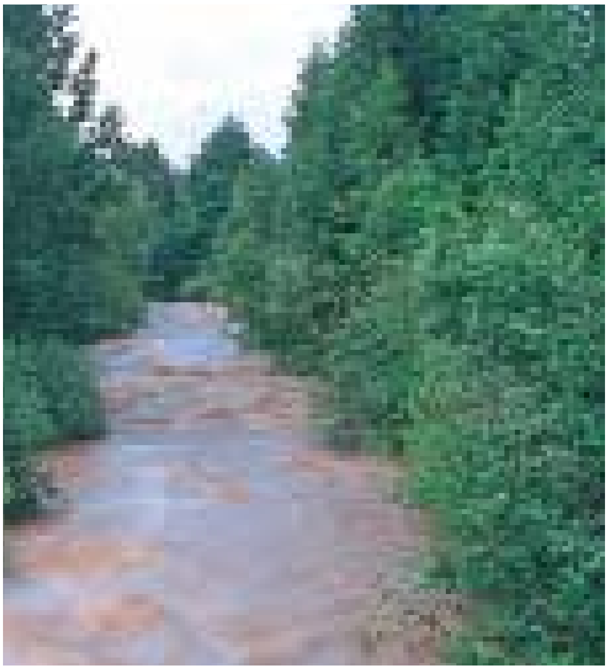
Research activities in Romania cover also a wide range of climate processes and climate system studies included in the framework of the Climate Variability and Climate Prediction Project (CLIVAR) of the World Climate Research Programme (WCRP) and the International Geosphere-Biosphere Programme (IGBP), focusing especially on studies guided on regional scale. The research activities are characterized by participating in national research studies and international through cooperation.

The following sections describe each of these elements and provide a brief overview of relevant research activities. More details about the observational network and the Romanian contribution to the systematic observation are described further on.

7.2.1. National Research Programs

The most important national research programs, which include climate change related studies, are briefly described below:

- ORIZONT 2000 - funded by the Ministry of Education and Research and coordinated by the ICIM (The National Research and Development Institute for Environmental Protection). This program includes the following main themes:
  - air pollution monitoring;
  - climate change impacts on floods control in Romania;
  - variability of climate extremes;
  - regional predictability of climate risks.
- RESEARCH GRANTS - financed by the Romanian Academy its Institutes and the Ministry of Education and Research. This program includes high-level research for small research teams and some of the climate related fields are addressed.
- METEOROLOGICAL AND HYDROLOGICAL RESEARCH PROGRAM - financed by the Ministry of Environment and Water Management. This program, coordinated by INMH includes research on, among others:



- climate monitoring system;
- climate variability, climate changes, scenarios and strategies;
- climate impacts on agricultural crops and water resources;
- variability of hydrological and hydro-geological processes;
- water management and mitigation measures for floods and droughts control.

• COST ACTION 718: „Meteorological Applications for Agriculture" (2000-2005) - is an inter-governmental framework for European Co-operation in the field of Scientific and Technical Research and is supported by the European Science Foundation (ESF). The main objective of the Action is to improve the meteorological applications to agriculture and environmental protection identifying and defining the requirements in terms of scale and time resolution and end-users' needs.

7.2.2. International co-operation

One of the most important issues in the international co-operation between the Romanian scientists and other international research centers is related to the development of regional climate change scenarios. Scientists from the INMH were involved in this activity, which includes mainly the developing of mathematical techniques to project the global climate changes on regional scale and to validate global climate models (GCMs) on regional scale. The GCM simulations elaborated by the international centers with high research and technical potential in establishing various IPCC (Intergovernmental Panel on Climate Change) scenarios were used in the Romanian research studies.

This fruitful international co-operation is the result of the participation of INMH in the international projects (such as „U.S. Country Studies") in the bilateral activities (Max Planck Institute for Meteorology, GKSS Research Center in Germany, and Laboratoire de Meteorology Dynamique in France) or by using international data distribution centers (DKRZ, Hadley Center). Romanian researchers collaborated also as experts in other projects such as Swedish project SWECLIM in the field of regional climate change scenarios construction.

The conclusions resulting from the „Country Study on Climate Change in Romania. Vulnerability Assessment and Adaptation Options" supported by the U.S. were presented in Romania's Second National Communication to the United Nations Framework Convention on Climate Change. It should also be mentioned that the models available in the U.S. Country Studies Program were operated assuming changes only in greenhouse gas concentrations. Other studies were also elaborated using ECHAM3 doubling CO_2 concentration scenario. The results are different, especially for precipitation. Generally, it is known that there are uncertainties in climate change scenarios related both to GCM performance and emission uncertainties as well as to the method used for construction of regional climate change scenarios (statistical or dynamical downscaling). The Romanian climate change scenarios are based on the statistical downscaling technique.

Recent GCM models show that adding sulphate aerosols to greenhouse gases results in a lower rate of average global warming in many mid-latitude areas compared to the case in which only the greenhouse gases were considered, but the aerosols lasting time in the atmosphere is shorter. Studies about the projection of climate change scenarios regarding Romania have started based upon the last version of the coupled ocean-atmosphere model elaborated by the Hadley Center (HadCM3-A2), and some impact assessment studies will be developed in the near future. The mean temperature changes are more realistic than those resulted from the older UK89 model. Thus, one of the conclusions using the statistical downscaling models was that the winter temperature could increase with about 2°C around the year 2100 against the 1990 level. During the summer the increase could be about 4°C.

International co-operation is an important component of the meteorological activity, through which INMH participates in both the world observations and measurements system and international scientific research. The main activities can be grouped into 3 categories:

- International scientific collaboration programs;
- Bilateral scientific collaboration programs;
- Data Exchange programs within international organizations.

International scientific collaboration programs:

- LIFE ASSURE Project (1999-2002) within the LIFE - ROMANIA Program of the European Commission - General Agency for Environment, was developed in international partnership with METEO-FRANCE, having an innovating character in approaching the environmental issue at national and international level. The LIFE ASSURE project builds a pilot system for estimating the environmental impacts on the air and hydro fields at the urban

level, in the benefit of the local environmental authorities.
- LIFE AIRFORALL Project (2002-2005), also established in international partnership with Meteo France. The project will approach, for the first time in Romania, the air quality forecasts issue in „hot-spot“ areas of the national territory, providing a feedback instrument upon polluters in the industrial sector with possible negative impact, and warning the decision-making factors at urban level.
- COST Project - ACTION 718 - Meteorological Applications for Agriculture (2000-2004) has as general objectives, the improvement of the meteorological applications for agriculture, through identifying the demands for the operational agro-meteorological models development and their use for optimizing the agricultural management and environmental protection, for the remote sensing data integration, in order to improve the performance of these models.
- ARENA („A Regional Capacity Building and Networking Program to Upgrade Monitoring and Forecasting Activity in the Black Sea“), led by the Oceanographic Institute of Varna, Bulgaria, to which INMH participates in the Black Sea area research activities together also

with other institutes from different countries. The objectives of the project are to exploit and initiate a preliminary prediction system for the Black Sea, through developing interdisciplinary models coupled with data assimilation schemes.

- NATO Project (Science for Peace) - „Monitoring of the extreme floods in Romania and Hungary, using EO data“ (2001-2004). The partners of the project are: Dartmouth Flood Observatory (SUA), Meteorological Service in Hungary, VITUKI Institute (Budapest), Water Management Authority, Civil Protection Authorities. The objective of this project is to achieve a detection, analysis and mapping system for the areas affected by floods, through integrating new satellite and GIS technique data and developing advanced rain-runoff models. This system will improve the present operational floods forecasting and warning system at local level in Romania and Hungary.
- Collaboration with METEO-FRANCE within the ALADIN Project. The ALADIN model constitutes the basis of the forecasting model used in INMH.

Bilateral scientific collaboration programs

- ADEMA Project - bilateral collaboration with CNES/SCOT/FRANCE regarding the achievement of a support system for flood management in Romania (2000- 2002).
- Bilateral collaboration between CEN, METEO FRANCE and INMH: „Developing forecast methods of the snow cover evolution in mountain areas for the avalanche hazard forecast and hydrological effects“.
- IAP Project (Integrated Action Projects) - Brancusi, achieved in partnership with Meteo France, has as a main objective the use of the satellite data integrated to an agro-meteorological model for assessing the nitrogenous pollution effects, due to agriculture.
- Collaboration with the University of Vigo, Spain, on the theme „European predictive potential of the North Atlantic Oscillation“.

Data exchange program within international organizations

World Meteorological Organization's Programs:

- Global Atmosphere Surveillance - atmospheric turbidity, total ozone and solar radiation-related data;
- World Weather Watch (WWW) - synoptic and climatic data patterns;
- Voluntary Co-operation Program (VCP) - bilateral exchange of hydro-meteorological data and specialists between Romania and the Republic of Moldova, Romania and Yugoslavia, under the concluded collaboration protocols and also another bilateral protocol of hydro-

meteorological data exchange has been concluded between Romania and Bulgaria;
- RMDCN (Regional Meteorological Data Collecting Network).
- EUMETSAT - The access agreement of INMH to the new generation satellites was renewed through a corresponding licence.

7.2.3. Overview of the main research themes

As mentioned above, research efforts in climate change related fields in Romania cover a wide range of activities. The main research topics are:
- Monitoring and systematic observation - focuses on data collection at national level and data validation procedure.
- Climate processes and climate system - involves research studies about the main features of the observed climate including the understanding of physical mechanisms controlling the large scale and regional scale climate variability.
- Climate changes - includes statistical downscaling modelling in order to project global climate change at regional level, validation of the global climate model at regional level, and other statistical techniques to identify changes in the large scale climate variability in the view of the future possible GHG concentrations increase;
- Research on climate change impacts - involves research on water management, agriculture crops and ecosystems, in order to choose the best adaptation measures for mitigating the adverse effects of climate change.

7.3. Systematic observation

INMH coordinates the National Meteorological Observations Network which includes: 151 stations, 3 aero-logical stations, 7 radar centers, 729 pluvial-metrical stations, 60 agro-meteorological stations and 8 actinometrical stations.

The National Hydrological Observations Network, coordinated by the National Administration „Romanian Waters“, includes 956 hydrometrical stations, 300 precipitation stations and 57 hydrological stations.

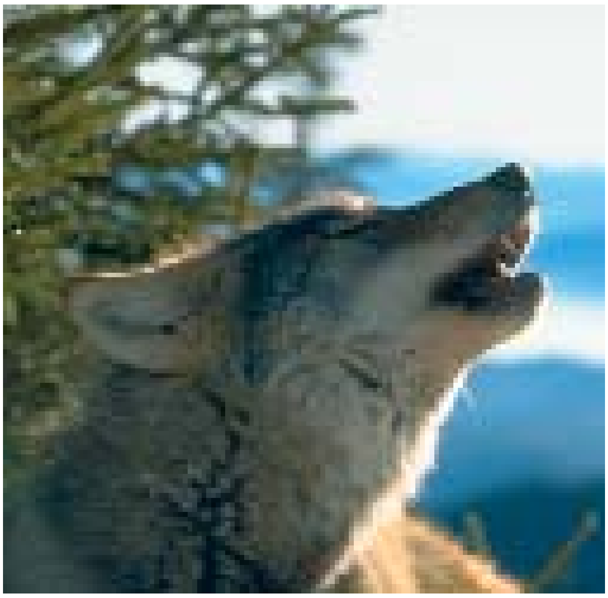
Observation system

The year 2002 celebrated the implementation of the new National Integrated Meteorological System (SIMIN), through installing new equipment for real and likely meteorological data observation, processing and displaying (automatic weather stations, radars, satellites, lightning detection network). These equipment were installed both at the headquarters of INMH and at Regional Forecasting Centers. First of all, SIMIN means collecting a great amount of data in fast flux at the working place of meteorologist forecasters offering them, at the same time, multiple options for analyzing the already mentioned data.

The national observation network is managed by 7 Regional Meteorological Centers (RMCs). The Meteorological Methods Laboratory (MML), Bucharest also brings its contribution to the network co-ordination.

Surface network

In 2003, the national network was composed of 150 weather stations and 290 rain gauge stations. The number of the rain gauge stations continued



to decrease, so that, at the end of 2001, 16 of them did not exist any longer. In exchange, the number of the automatic weather stations increased in 2002 from 15 to 60. From the 150 weather stations, 130 are full-time operational and 20 are part-time operational; 52 weather stations have a special agro-meteorological measurements program and 7 stations perform solar radiation measurements. In addition to this, at the Atmospheric Physics Observatory on the Afumati platform, several measurements are performed like the limit layer and air-electric measurements as well as temperature and wind speed gradients in the 0-10 m layer. Fundata station is a GAW (Global Atmospheric Watch) one, whose specific program is under completion. Within the GAW program, Bucharest station has an associated station status with respect to the total ozone measurements.

The meteorological products and geo-physical parameters obtained using the satellite reception stations are available for the Forecasting Service, through the local computer network. The Meteosat satellite provides digital images (MSG-type reception station) and analogical images (WEFAX) METEOSAT/SDUS and the NOAA passage satellite also provides digital images (NOAA/HRPT-type reception station). The main products obtained through the images received from the NOAA satellite are the following: the Black Sea surface temperature, cloud top temperature, cloud cover, clouds analysis, vegetation index, snow cover, soil surface temperature, active fire detection and fire hazard detection.

Communication system

The collection and dissemination of primary and processed meteorological data and information, in national and international fast flux, are achieved within the National Center of Communications. Over the year 2002, this unit has brought an essential contribution to setup the operational equipment within the SIMIN Project. The Automatic Meteorological Message Switching System provides the connection between INMH and the Regional Meteorological Data and Communication Network (RMDCN), in accordance with the WMO standards. Once installed and operating the Integrated Meteorological Radar System will covering the whole Romanian territory. A connection to the specific communication system was developed to process and transmit in real time both radar and other meteorological data. The Central Communication System is responsible for the real time supply of meteorological data belonging to the database systems.

At this moment, the meteorological and hydrological system of Romania is improved through the following projects:

- LIFE-MOSYM Project - was established in 2002 and improves the hydrological and environmental data system. Some methods for processing the satellite images of the visible and radar domain were established, to map the flooded and floodable areas. A support system for the decision-making factors in flood management was achieved, through an application in GIS environment, collecting forecasts and real river discharge data at the gauging stations placed in the test area and interactively representing them.
- MEDHYCOS Project - within the World Hydrological Cycle Observing System (WHYCOS), has the objective to develop an automatic satellite transmission network for the hydro-meteorological stations;

- SIMIN PROJECT - developed in collaboration with Lockheed Martin Company, imposing a modernization of the basic infrastructure technologies within INMH, improving the meteorological data sources and integrating the data automatically.
- DESWAT Project (Destructive Waters) - aims to achieve the modernization of the hydrological data system and to integrate its infrastructure in the SIMIN Project;
- WATMAN Project (Water Management) - will result in the integration of data resulted from SIMIN and DESWAT projects for applying the national water management strategy in case of disasters.

In order to prevent and mitigate the effects of the natural disasters (floods, dangerous meteorological phenomena, droughts, accidental pollution, accidents at the hydro-technical structures), the Ministry of Environment and Water Management together with the National Administration „Romanian Waters“ has taken into account the elaboration and implementation of a national strategy based on the development of these projects (SIMIN, DESWAT and WATMAN).

These three projects regarding the modernizing of the Meteorological National System and of the Water Management National System are in the implementation phase and have the following features:

Integrated Meteorological National System (SIMIN)

SIMIN Project was developed with the aim to modernize the national meteorological infrastructure, so that the data provided by this new system together with those from the existed systems in Romania, provides the possibility for the meteorological and hydrological experts to detect and monitor related phenomena in Romania. It also provides the means of elaborating high quality forecasts and of disseminating all this information through a communication infrastructure.

In the framework of the project the following items were developed:

1. National surface measurements network: establishing 60 automatically meteorological stations;
2. National meteorological radar's network: establishing 5 Doppler radar in „S“ band in: Bucharest; Craiova; Barnova; Timisoara; Tarnaveni and Medgidia;
3. National detected lightning network: establishing 8 detected lightning stations;
4. Reception system of data from meteorological satellite METEOSAT 7.

In addition, SIMIN has an „external component" for developing and modernizing the services and interfacing with the most important client-systems, in order to disseminate data and specific meteorological products. In this respect a number of 96 terminal stations were established at the following beneficiaries:

- Ministry of Environment and Water Management;
- Ministry of Defence;
- Ministry of Administration and Interior;
- Ministry of Transports, Constructions and Tourism;
- The Civil Aeronautical Authority;
- National Administration „Romanian Waters";
- Meteorological Service Moldova.

SIMIN project is by far the greatest project in the meteorological field in Romania (approx. USD 55 M) being a very complex investment from the technical point of view (IT&C) as well as the quality of human resources involved.

SIMIN project assures a great variety of meteorological data and products, necessary in the development of specific activities of each organization, both to the meteorological and hydrological experts in the forecasting field and to the common beneficiaries.

SIMIN provides specific meteorological data and products which can be utilized for specialized processes in the DESWAT project.

In 2002, some INMH experts working in the operative field were trained in order to use the hi-tech equipment acquired within the SIMIN Project. In this sense, an „on-the-job" training course was held in Bucharest in August 2002 for the benefit of the forecasters. Prof. Leslie R. Lemon, from the National Severe Storm Laboratory, Norman, Oklahoma, lectured on the American experience in radar use, hail and tornados detection and prediction, with direct application for the event in Facaieni, Romania dated 11th August 2002. The American specialists from Lockheed Martin also performed a number of training courses, referring to the implementation of the new SIMIN products.

DESWAT Project

DEStructive WATers - Abatement and Control of Water Disasters - its main goal is the modernization of the informational - decisional system in the hydrology and water pollution field.

The goal of the DESWAT project will be addressed by taking into consideration the collection of data through:

- 600 automatically stations situated on rivers;
- 250 automatically stations for precipitation;
- 64 automatically stations for water quality;
- development of the River Basin Centers and of the National Center for hydrological forecast.

Primary data processing will be semi-automatically using program products of spatial representation based on a GIS system. The package of hydrological forecast programs which will be modernized and enlarged, and will include semi-automatic processing of warnings, forecasts and information products necessary for decision- makers, mass media and population.

A pilot project was realized in the period 2001-2002, in the Lapus River Basin through the implementation of 5 automatic stations, from which 4 were for hydrological data and one for water quality.

The DESWAT Project will be developed and implemented at the national level in the period 2003-2007 at a total cost of USD 45 millions.

WATMAN Project

The WATer MANagement project will apply the national water management strategy in case of disasters, issued by the Ministry of Environment and Water Management and the National Administration „Romanian Waters“. This project will integrate the data resulted from SIMIN and DESWAT projects, making it possible to achieve an Integrated Informational and Decisional System in case of water hazards.

The general objective of the WATMAN project is to rehabilitate the water resources management system from Romania based on the Water Framework Directive 2000/60/EU and National Hazard Protection Program.

The objectives of the project are:

- establishment of 11 Quick Intervention Centers;
- modernizing the existing water informational system and interconnecting with local and central administration systems;
- establishing a fixed intervention sections in case of accidental pollution;
- establishing an expert system for water resource allocation.

Implementation period for the project at the national level is 2004 - 2007.

In the period 2004 - 2006 there will be developed a pilot project in Arges River Basin.

The final achievement is to integrate the three projects: SIMIN, DESWAT and WATMAN into one expert system which will represent the foundation for the water decisional system and will offer a continuous control of reservoir maintenace and operation, dam operation, and other hydrotechnical works. The cost of this project is about USD 87 millions.

7.4. Relevant publications

The amount of research on climate related activities has increased over the last couple of years, where one of the most important aspects is the co-operation between Romanian experts and international experts for developing research studies at both the national and regional scale.

The following publications are very important for this research activity in Romania, the publications are in chronological order:

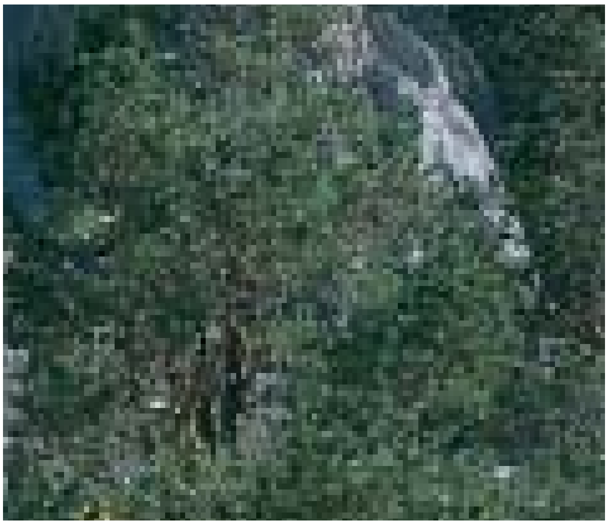
- Bojariu R. (1997): Climate variability models due to ocean-atmosphere interaction in the central Atlantic. Tellus.
- Stanescu V. Al., Corbus C. and Simota M. (1997): Upscaling procedure for the assessment of the potential impact of climate change upon water resources, XXII General Assembly of the European Geophysical Society, Vienna, Austria.
- Adler M. J., Busuioc A., Mageanu C., Ghioca M. and Nistor G. (1997): The tendency of decreasing of the winter water resources in the Balkan region, European Geophysical Society, Annales Geophysicae, part II, vol. 15.

- Bojariu R. (1998): Tropical variability Models Related to North Atlantic Oscillation, Romanian Journal of Meteorology, Vol. 5, No.1-2, 9-16.
- Busuioc A., von Storch H. and Schnur R. (1999): Verification of GCM generated regional seasonal precipitation for current climate and of statistical downscaling estimates under changing climate conditions, Journal of Climate, vol. 12, 258-72.
- Busuioc A, and Tomozeiu R. (1999): Connection between maximum temperature variability in Romania and the large scale circulation, Romanian J. Meteor vol. 5 no. 1/2, 29-38.
- Adler M. J., Busuioc A. and Stefan S. (1999): Atmospheric processes leading to droughty periods in Romania, International Association of Hydrological Sciences Publication No 255, 48-60.
- Rimbu N., Boroneant C. (1999): Decadal climate variability over Europe during winter and its relation with the Atlantic sea surface temperature, Proceedings of the International Conference on Climate Change and Variability - Past, Present and Future.
- Stanescu V. Al., Corbus C. and Simota M. (1999): Modelling of the climate change impacts on water resources, ed. HGA Bucharest.
- Stephenson D., Pavan V. and Bojariu R. (2000): Is the North Atlantic Oscillation a random walk?. International Journal of Climatology, 20, 1-18, 2000.
- Tomozeiu R., Busuioc A., Marletto V., Zinoni F. and Cacciamani C. (2000): Detection of changes in the summer precipitation time series of the region Emilia-Romagna, Italy, Theoretical and Applied 67, 193-200.
- Busuioc A., (2001): Large-scale mechanisms influencing the winter Romanian climate variability, in „Detecting and modelling regional climate change“, (Brunet M. and Bonillo D. eds.), 333-344.
- Busuioc A., Chen D. and Hellstrom C. (2001): Temporal and spatial variability of precipitation in Sweden and its link with large-scale circulation, Tellus 53, 348-67.

- Busuioc A., Chen D. and Hellström C. (2001): Performance of statistical downscaling models in GCM validation and regional climate change estimates: Application for Swedish precipitation, International Journal of Climate 21, 557-8.
- Bojariu R., Paliu D. (2001): North Atlantic Oscillation projection on Romanian climate fluctuations in the cold season, in „Detecting and Modelling Regional Climate Change and Associated Impacts“ (Brunet M. and Lopez D. eds.), Springer-Verlag Berlin Heidelberg.
- Rimbu N., Le Treut H., Janicot S., Boroneant C. and Laurent C. (2001): Decadal precipitation variability over Europe and its relation with surface atmospheric circulation and sea surface temperature, Quart. J. Royal Met. Soc., vol. 127, no. 572, part B, 315-329.
- Cuculeanu V., Busuioc A., Tuinea P., Geicu A., Simota C., Marica A., Alexandrescu A., Patrascanu N., Stanescu V. Al., Serban P., Tecuci I., Simota M. and Corbus C. (2002): „Potential impact of climate change in Romania“, Bucharest.
- Bojariu R., Reverdin G. (2002): Large-scale variability modes of freshwater flux and precipitation over the Atlantic, Climate Dynamics, 18(5), pp. 369-381.
- Tecuci I. (2002): The evaluation of water demand in Romania, INMH (National Institute of Meteorology and Hydrology) Report.
- Tomozeiu R., Busuioc A. and Stefan S. (2002): Changes in seasonal mean maximum air temperature in Romania and their connection with large-scale circulation, International Journal of Climatology, 22, 1181-1196.
- Rimbu N., Boroneant C., Buta C. and Dima M. (2002): Decadal variability of the Danube river streamflow in the lower basin and its relation with the North Atlantic Oscillation, International Journal of Climatology, 22, 1169-1179.
- Boroneant C. (2002): „Anthropogenic Climate Influences“, in „Natural Resource System Challenge II: Climate Change, Human Systems and Policy“ (Ed. A. Yotova) - Encyclopedia of Life Support Systems, EOLSS Publishers, Oxford, UK.
- Busuioc A. and von Storch H. (2003): Conditional stochastic model for generating daily precipitation time series, Climate Research, vol.24:181-195.
- Busuioc A., Boroneant C. and Matei D. (2003): Analysis of the variability of extreme precipitation events frequency in Romania.
- Marica A. (2003): Assessment of the effects of climate variability on the main components of water balance and crop yield“, presented at the WMO-Regional Association VI Working Group meting on Agricultural Meteorology.
- Mateescu E., Tanislav N., Vatamanu V. (2003): The impact of drought conditions on the wheat and maize cultivation in the Romanian Plain.

Education, Training and Public Awareness

8.1. Introduction



In Romania climate change related activities are under the responsibility of the Ministry of Environment and Water Management which has undertaken a series of activities in this field in the last years in close co-operation with foreign partners like the Netherlands, Switzerland, Denmark and Norway and also with some NGOs. Some of the activities developed in this regard were related to distributing the Second National Communication to the UNFCCC, preparing the National GHG Inventory in the specified format (CRF and NIR), re-organizing the National Commission on Climate Change, publishing media articles on climate change issues, and raising awareness through the ministry web page. Awareness of the causes and effects of climate change is not yet widespread in Romania due to a lack of capacity and financial resources.

Article 6 of the UNFCCC refers directly to education, training, public awareness and access to information and international co-operation. Several activities in this field were initiated by the government and also by some Romanian NGOs in cooperation with the government. „TERRA Mileniul III" is probably the most active NGO in climate related activities in Romania working on information dissemination, public participation, training and publishing useful information on the matter.

Institutions Involved

- *Ministry of Environment and Water Management (MEWM)* is the main public administration authority responsible for climate change policy.
- *National Commission on Climate Change*, established in 1996, has to review the National Communications to the UNFCCC for approval, discuss national programs on the basis of UNFCCC provisions, approve Joint Implementation projects and promote flexible mechanisms, promote awareness activities under the UNFCCC and Kyoto Protocol, produce periodical surveys and inform the competent authorities and the public about its findings.
- *Environment Inspectorates* are local agencies operating under the authority of the Ministry of Environment and Water Management at the county level plus Bucharest.
- *Infoterra Romania* is an autonomous NGO hosted by MEWM, representing the focal point for environmental information.
- *Other Romanian NGOs* - associations and foundations focused on climate change issues or related issues, such as energy, transport, waste management, agriculture and forestry.

Legal Requirements

In Romania, the access to information and the public participation in environmental decision-making is well regulated through a set of national laws and ratified international conventions.

- *Law 137/1995 - Law for environmental protection*. The general principles provide for „training and education of population, as well as NGOs participation in the elaboration and implementation of decisions". It is also stipulated that „the state guarantees the access to information regarding the quality of the environment, as well as the right of public consultation in the decision-making process regarding the development of policies, legislation and environmental norms and regulations".
- *Law 84/2000 for the ratification of the Aarhus Convention*. Application norms for the Convention have not been issued yet.
- *Law 29/1990* guarantees the right to access environmental information and access to justice on environmental issues.
- *Order 1325/2000 of the MEWM Minister* regarding the participation of the public, through its representatives, at preparation of the environmental plans, programs, policies and legislation.
- *Law 544/2001 - Law regarding the free access to information of public interest*. This law was issued in October 2001 and entered into force 60 days latter.

8.2. Education

The highest authority involved in this field in Romania is the Ministry of Education and Research. The climate change process is not specifically addressed in the curricula, but it is presented in the broad framework of environmental protection and sustainable development education. Young people in the primary school are the key target for raising awareness and understanding of climate change process and it is very important to know how to present the causes and effects of the phenomena in an understandable manner.

At the level of secondary school, the pupils are encouraged to explore more on this field in the same time as outside activities addressing the need to protect the environment. Unfortunately, there are barriers in the climate change education area: the lack of trained teachers in this field and also the lack of teaching materials, and few special programmes that address climate change related activities.

Regarding higher education climate change activities are addressed at the environmental departments or faculties in state owned or private universities. In the period 1995-2002, several universities in Bucharest and in other important university centers like Timisoara, Brasov, Cluj, and Iasi established faculties or departments studying environmental science and in this respect the climate change process was addressed.

The most important universities involved are:
- Polytechnic University Bucharest - Faculty of Energy;
- Academy of Economical Studies - Economy and Management of Agricultural and Food Production - Environmental Dept.;
- Bucharest University - Faculty of Geography - Environmental Science Dept.;
- Bucharest University - Faculty of Biology - Ecology Dept.;
- Technical Construction University - Faculty of Hydromechanics;
- Agricultural Sciences University Bucharest - Faculty of Land Reclamation and Environmental Engineering;
- Ecological University Bucharest, private university.

NGOs - education in schools

The association Earth Friends from Galati prepared in 2000 a curricula for high school on „Energy and Environment“. The curricula was implemented in the Technical College „Paul Dimo“ from Galati for two years. In 2001, they also produced a manual for teachers which focused on the same topic, and probably in the coming years this kind of programmes will be replicated in other cities and at the state level.

8.3. Information and Public Awareness

The Ministry of Environment and Water Management use different channels for providing information to relevant target groups: mass media, NGOs, and the business sector. One of the instruments is the ministry's website - www.mappm.ro. The page contains legislative information, programs and projects developed by the ministry, contacts and other related links.

In the near future, climate change responsible experts in the ministry in cooperation with foreign partners will develop a specific Romanian web page especially dedicated to the climate change process.

The ministry organizes press conferences on a weekly basis. After UNFCCC negotiations (COPs and SB meetings), the results of the process are presented to the media. Also, details about Joint Implementation projects are disseminated to the large public via mass media.

Interviews and articles dealing with greenhouse gas emissions and the overall effects of climate change were published the last few years in several newspapers. Representatives of the relevant departments of the ministry have presented the issues of global warming and climate change in many radio transmissions and talk-shows, raising the awareness of the general public on these matters.

An important contribution to information dissemination, not only at the national level but also at the regional level, comes from the environmental NGO „TERRA Mileniul III“, which coordinates the regional NGOs network - Climate Action Network Central and Eastern Europe (CANCEE). TERRA Mileniul III produced informative materials such as „AIJ/JI List of Criteria“ and „Guidelines to Implement Joint Implementation Projects“, as well as the „CANCEE - Climate and Energy Bulletin“.

Unfortunately, the activities regarding information dissemination, public awareness and public participation are not so developed in Romania, due to the lack of funding for awareness campaigns. Nevertheless, funding for public awareness activities and other public orientated programmes will be addressed in the future on the basis of Romania's good co-operation in climate change activities (mainly on Joint Implementation Projects) with Denmark, the Netherlands, Switzerland and others.

Three NGO working groups on energy, transport and agriculture developed several national or small scale public awareness campaigns on related issues.

The Romanian Energy Working Group organized in the period 1998-2001 public awareness campaigns on energy efficiency and renewable energy at the national level. Between 2000 and 2002, the Romanian Group for Sustainable Transport conducted campaigns on raising awareness of the public and of the local authorities on the implications of road traffic at local level and evaluation of the external costs of road transport in six cities having as a main objective the development of an alternative sustainable national transport strategy. The Agriculture Working Group has been focusing on organic agriculture and demonstrative organic farming.

In 2002, the Romanian Society for Energy Conservation (SOCER) ran a large public awareness campaign called Environment - Energy - Consumer, regarding domestic use of energy and environmental protection.

The Romanian Energy Policy Association (APER) has an important involvement in this process by organizing different workshops and seminars like the APER Forums for dialog and exchange of experience among the specialists from the energy sector, representatives of public administration, international organizations and consulting companies from Romania, EU and USA. APER is and also involved in drawing the lines and involving decision makers in the elaboration of policies, while adapting strategies to international standards.

The activities organized by APER worth mentioning are:

- The Impact of Climate Change on Business & Industry. GEF Projects in Hungary and Romania, 1998;
- Success & Failure of Renewable Energy Policy; Lessons from Greece and Denmark, 1998;
- Developments of Biomass and Geothermal Energy Sources in Romania, 1998;
- Energy Sector and Romania's Commitment Related to Environmental Protection, 1999;
- Need of Correlating the Energy and Environmental Policies With the Investment Policy - Clean Energy Now, 2000;
- Kyoto Protocol - Presumable and Possible Influence on the Romanian Energy Sector, 2001;
- In depth review of energy efficiency and related environment aspects, 2002;

8.4. Training

Several training programmes and activities were developed in Romania based on direct cooperation between the government and NGOs and with international cooperation:

- LEAD (Leadership for Environment and Development) program organized in September 1999, a training session with representatives from Europe (including Romania), New Independent States and India, regarding Romanian-Swiss AIJ/JI project in the city of Buzau; LEAD Associates were selected from government, industry, commercial enterprises, NGOs, the academy and the media; MEWM contributed with lectors and experts in this training session.

- The Environmental Protection Agency and the Center for Clean Air Policy - USA organized in July 2000 a training session on Emission Trading for CEE representatives. Representatives from the Romanian Ministry and NGOs took part in this training.
- In the frame of the program Capacity Building in Balkan Countries to Address Climate Change, developed in Romania by the Greek Ministry for the Environment, Physical Planning and Public Works, a training session for enhancing skills to prepare national inventories was organized in April 2002.
- An invited expert from the MEWM participated in September 2002 in the in-country review of the GHG inventory of Hungary as an observer in the review. The review was organized by the UNFCCC Secretariat and provided a great opportunity for the invited experts to share views on the inventory preparation and submission process.

There is still an urgent need for training programmes in Romania in this field and for skilled experts to work side by side with Romanian experts, and also expert's participation in international courses and workshops.

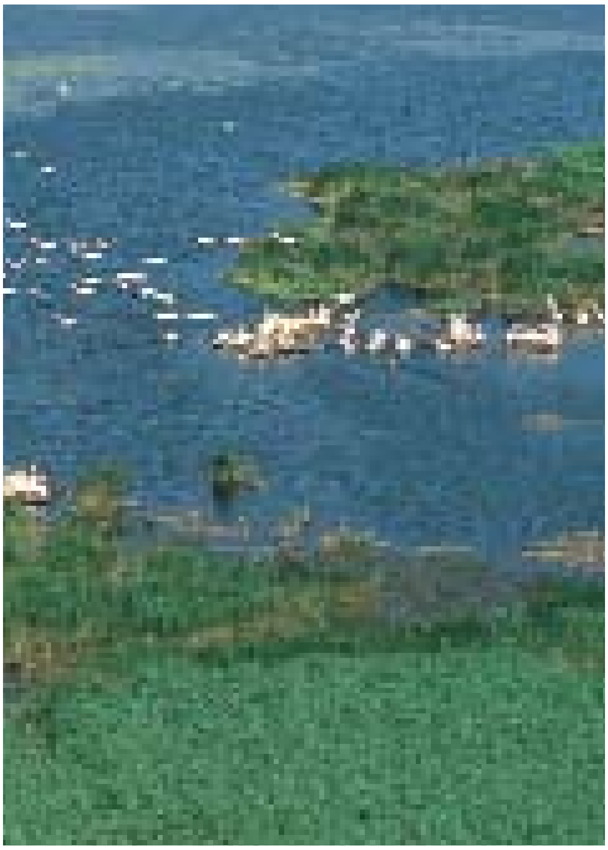
8.5. Public Access to Information

Access to Information and Public Participation in Decisions Affecting Climate Change

These activities were performed in the frame of the „Capacity for Climate Protection in Central and Eastern Europe“ project, developed by the REC/WRI partnership in 2001-2002. TERRA Mileniul III was the Romanian partner in the project and carried out the Romanian survey.

The objectives of the program were the following:

- Access to general information about greenhouse gases (GHG) emissions and compliance
  - information from national communications and inventories;
  - facility-level information on GHG emissions or fuel use.
- Participation in decision-making affecting climate change
  - sector policies, plans and programs;
  - participation in decisions on Activities Implemented Jointly (AIJ) and/or Joint Implementation (JI).
- Efforts to build the capacity of the public for meaningful participation in climate change-related decision-making
  - government efforts and investment to support understanding and participation in decision making affecting climate change
  - conditions and capacity of private sector to support understanding and meaningful participation in climate issues



- sources of general understanding of climate change issues by the public.

The target groups consisted of authorities (ministries, governmental agencies); business sector (state-owned and private companies, research institutes); non-governmental organizations.

Policies and Measures for GHG Emissions Reduction and Mitigation Strategies in Romania

The project was carried out by the NGO „TERRA Mileniul III“ in the period September 2000 - August 2001.

The aim of the project was to demonstrate the benefits of implementing policies and measures for the reduction and mitigation of greenhouse gases (GHG) emissions in the energy sector in Romania, within the context of transition to market economy.

The project had the following objectives:

a) to assess policies and measures for the energy sector and carry out a case study in order to demonstrate „good practices“ for GHG emissions reduction;
b) to contribute to the capacity building at individual and institutional level regarding climate change mitigation in this sector;
c) to disseminate information and compare the present status with the situation in other countries with economies in transition (from the region);
d) to facilitate regional sectoral cooperation and exchange of experience.

A seminar and a round table with all stakeholders were organized in the frame of the project.

8.6. Public Participation in addressing climate change

Public participation in addressing climate change is under the responsibility of the MEWM and in the last years increased on the basis of requesting public input on Joint Implementation projects. Some exercises have been developed through NGOs initiatives. One public hearing was run by „TERRA Mileniul III“ in 1999 regarding waste management in the district Giulesti - Sarbi, Bucharest.

In September 1999 the Romanian Group for Sustainable Transport organized a public debate regarding impact of the transport sector on the population. The event was attended by people from the „Tudor Arghezi“ street, representatives of the Bucharest City Hall and representatives of several NGOs.

A seminar with local authorities for identifying methods to involve civil society in decision making concerning urban transport was organized in September 1999 by the same Romanian Group for Sustainable Transport.

Two independent reviews of the First and Second National Communication (1998 and 2000) were made by „TERRA Mileniul III“ in the frame of a CANCEE program. In 1999, TERRA Mileniul III, on behalf of CANCEE, elaborated a set of criteria for approving AIJ/JI projects from the NGOs perspective. The documentation was widely circulated at the national and international level.

8.7. International cooperation

Romania has great potential to attract foreign investments through the Joint Implementation mechanism. The investment aim is to bring greater energy efficiency and cost-effective technologies to the power, industrial and transport sectors.

In this respect, Romania has already signed several Memoranda of Understanding with different Annex I country Parties (Switzerland, the Netherlands, Norway, Austria, Denmark, Sweden) and with World Bank's Prototype Carbon Fund - PCF which established the general framework for co-operation on the implementation of concrete JI projects. Based on these Memoranda, Romania has already 11 JI projects in different stages of development.

Romania is an active participant in international meetings like COPs, SB meetings, Annex I Expert Group meetings, and also all major international conferences and workshops in the climate change related fields. Romanian experts were invited to participate in regional or international training on Kyoto Protocol's flexible mechanisms-Joint Implementation and also in the in-depth reviews of National Communications and centralized in-country reviews of GHG inventories.

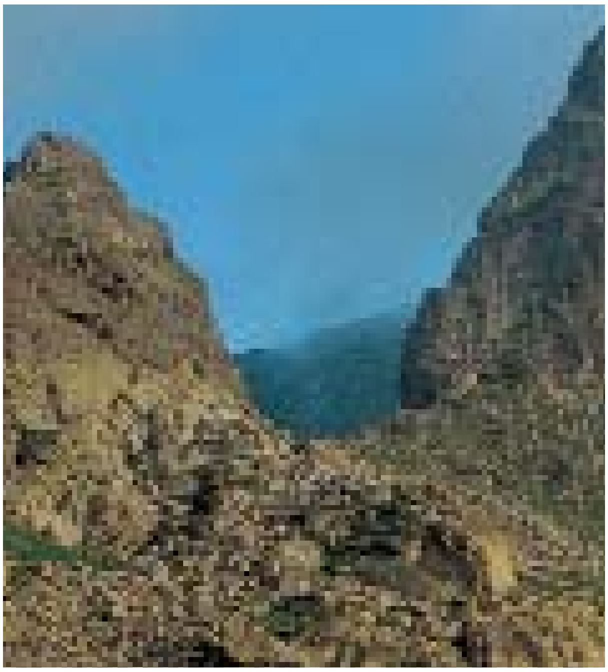
The Romanian NGOs also have an important participation in different international workshops and seminars. The regional CANCEE (NGO network) meeting developed a capacity building session in Romania in September 1999.

Capacity Building Program for Balkan Countries was an important project organized by the Greek Ministry of Environment, Physical Planning and Public Works in Albania, Bosnia-Herzegovina, Bulgaria, FYROM, Romania and Yugoslavia.

8.8. Conferences and Seminars organized in Romania

Green Light for Europe Summit on Environment and Sustainable Development in the Carpathian and Danube Region, April 29-30, 2001, Bucharest, Romania - The summit was organized by the Romanian Government with the support of the Romanian Chamber of Commerce and Industries and NGOs, with a special section „Business and NGOs Forum“, which addressed climate change issues and business opportunities.

Regional Summit on Sustainable Development, preparatory meeting for Rio+10, June 30, 2001 - Held by the Romanian Government, this summit brought together governmental and non-governmental representatives from most of the countries of the region. It represented a preparation session for the Johannesburg Summit on August 2002. The Summit also had workshop components on energy and climate change issues.



Capacity Building in Balkan Countries to Address Climate Change - April 30, 2002 - The National Research and Development Institute for Environmental Protection (ICIM Bucharest), Foundation TERRA Millennium III and the National Observatory of Athens organized this seminar in the frame of a regional project.

Romania GEF Country Dialogue Workshop - September 24-26, 2002 - The workshop was organized in partnership with the MEWM and specific working groups on climate change issues were organized, including a training session on writing project proposals.

SAVE II - Energy Efficiency Project Development in Romanian Municipalities 2000-2001 (organized by APER) - The aim of the activities were to offer a training program to Romanian municipal experts (engineers, economists and project managers), focusing on the municipal energy planning - municipal energy issues - project development process, including but not limited to energy audit approach, business planning, energy management.

SCORE - (Financed by SENTER) 2000-2001 and *MUNEE* - Municipal Network for Energy Efficiency 2001-2002 - 51 municipalities, including 73 experts and 57 decision makers (both programmes were organized in cooperation with APER).