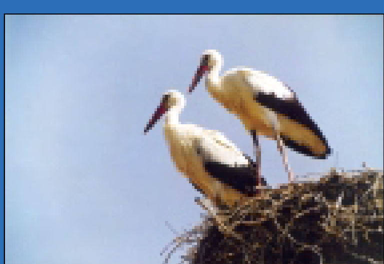
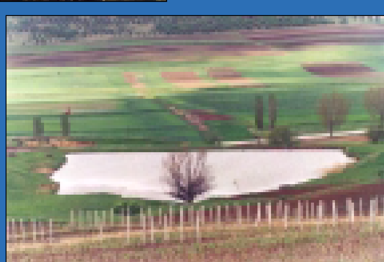
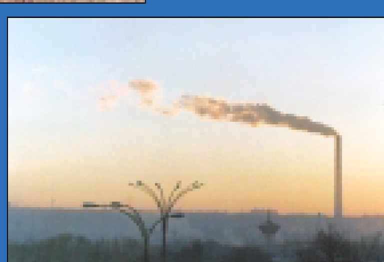
First National Communication of the Republic of Moldova

UNDER THE UNITED NATIONS FRAMEWORK CONVENTION ON CLIMATE CHANGE







2000

REPUBLIC OF MOLDOVA
MINISTRY OF ENVIRONMENT
AND TERRITORIAL DEVELOPMENT

First National Communication of The Republic of Moldova Under The United Nations Framework Convention on Climate Change

2000

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FOREWORD

The fact is well known that among the global ecological problems endangering the sustainable development of humankind climate change is not the last. Climate change problems may provoke different negative impacts following the rise of ocean level, flora ecosystems succession, impacts on human health, etc. This fact imposes to nations of the world the need to undertake a number of actions oriented both towards the climate change minimization and towards decreasing its potential consequences.

This Report was developed with the assistance of the Global Environmental Facility through the project "Enabling Moldova to Prepare its First National Communication in Response to its Commitments to the UN FCCC" managed by the United Nations Development Programme and the Ministry of Environment and Territorialy Development. It had systemised for the first time the research outputs of the Moldovan scientists in the area of air basin pollution, climate change tendencies at national and regional levels, vulnerability and adaptability to climate change of natural and man made ecosystems, etc. The fact is important that based on these outputs the climate change projections for the next century was made which was used as a lead to set of recommendations for the abatement of climate change negative impacts. These recommendations form a foundation for the National Action plan in the area. The development of the National Communication, as well as the compilation and implementation of the National Action Plan is the contribution of the country to the solution of the climate change problem at a global level.

Minister of Environment
and Territorial Development

Arcadie Capcelea

PREFACE

To various extents climate change affects all the people of the world. In ways yet unknown to science they are affecting newly married couples and old people, newborn children and young boys and girls, future children of today's toddlers. Most of the affected are in poor countries that have little or no means to do anything about it. Floods, hurricanes, torrential rains, draughts carry away people's lives, their shelter and their everyday bread. We are in debt to the future generations and are obliged to work so that people who will bear our names and values into the next centuries will have their share of life's gifts too. Thus, a common effort of all nations is needed to overcome at least some of the climate change problems and for adapting to the factors that have no solution today.

The United Nations Framework Convention in Climate Change is an international instrument developed for a common action by many countries for the mitigation of the greenhouse gas emissions and for adaptation to those climate changes, which cannot be avoided. The signing of the Convention by the Republic of Moldova on June 9, 1995 was a step of courage aimed at assuming a high responsibility to become a part of a global process committed to address climate change issues. As signatory party to the Convention the Republic of Moldova has prepared its first National Communication in order to honour its commitments under the Framework Convention on Climate Change, and to provide to the local decision makers and to the people of the country the knowledge on climate change so that it can be taken into account at all levels of political, social, economic and cultural activity. The Global Environment Facility through the UNDP assisted Governmental agencies, academic institutions, NGOs and individuals who worked together for the preparation of this document which is the first attempt for the Republic of Moldova to contribute to the global effort on addressing climate change issues in a constructive way.

We are here today – but it's still a long way.

UN Resident Coordinator
UNDP Resident Representative

Soren Tejno

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SUMMARY

NATIONAL CIRCUMSTANCES

The Republic of Moldova is situated in the Southeastern part of Europe. In the North, East and South it borders with Ukraine, in the West – with Romania. The surface of the country is 33.8 thousand square kilometres and its population is 4.3 million inhabitants. The territory of the country stretches from North to South on a distance of 350 kilometres and from West to East - 150 kilometres.

The relief is represented by plains and elevations, the latter being concentrated mainly in the central part of the country. The altitudes vary between 5 and 429 meters.

The climate of the Republic of Moldova is moderate-continental. The mean annual temperature varies in the range of 8–10°C. The amount of precipitation is 450–620 mm per year.

The most important natural resources of the country are: soils, water resources, forests and mineral ores. Soils are also the main natural wealth of the country. The chernozems occupy two thirds of the country's surface.

The hydrographical network occupies 2.7% of the country's surface and has a total length of about 16 thousand kilometres. The main rivers are Dniester and Pruth. On a small stretch, in the South, there is an outlet to the Danube river. Thus, the country is situated in the Black Sea basin.

On the territory of the country steppe and forest vegetation prevails.

The forests are represented by deciduous (97.8%) and resinaceous (2.2%) species. In the deciduous forests oak, ash, hornbeam and elm species dominate. The forest cover degree is 9.6%. The steppe vegetation has maintained only in form of isolated fragmented spots.

The territory of the Republic of Moldova shows a high biologic diversity. The flora comprises about 5,513 species, while fauna – 14,800 species, 641 of the latter being vertebrates. There are 5 natural reserves in the country: "Codru", "Plaiul Fagului" ("The Beech Region"), "Iagorlic", "Prutul de Jos" ("Lower Pruth"), "Padurea Domneasca" ("The Royal Wood"), as well as a big number of nature monuments protected by the state.

The most important mineral ores are: limestone, granite, bentonitic and sandy clays, diatomite, gypsum, and chalk.

Starting in the 90-ties the process of transition to market economy was initiated. The transition period showed a dramatic decrease of all economic and social indicators. The GDP has decreased by 66%, the consumption of primary energy resources – by 71%, industrial production – by 68% and the agricultural production – by about 49% *(Figure 1)*.

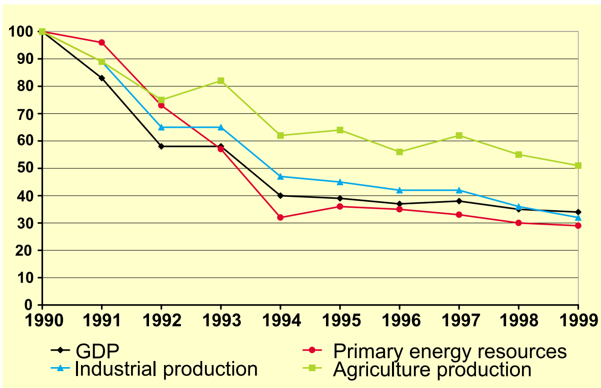


Figure 1 The progress of the main economic indicators in the Republic of Moldova during the 1990–1998 period

INVENTORY OF GREENHOUSE GAS EMISSIONS

The assessment of the greenhouse gases (GHG) for the period 1990–1998 was carried out based on the guidelines of the Intergovernmental Panel in Climate Change (IPCC) and CORINAIR methodology. According to the recommendations of the United Nations Framework Convention in Climate Change the year of 1990 was proposed as base year for the GHG inventory. The inventory includes emissions of the following gases: CO_2,CH_4, N_2O, NO_x, CO, NMVOC, SO_2 *(Table 1)*.

CO_2 Emissions

The main source of CO_2 emissions is the fossil fuels combustion which amounted to 91% of the total anthropogenic CO_2 emissions in 1990, 94% – in 1994 and 85% – in 1998. Over the period 1990–1994 the amount of emissions has dropped by approximately 57%, while during the 1990-1998 period – by about 71%.

CH_4 Emissions

In 1990 the main sources of CH_4 emissions were: agriculture (52.4%), fugitive emissions resulting from the transportation and distribution of natural gas (26.6%), waste (18.9%) and fossil fuels combustion (1.4%). The structure of these emissions has not changed significantly. Over the period 1990-1994 the total amount of CH_4 emissions has decreased by about 30%, while over the 1990-1998 period – by about 42%.

N_2O Emissions

In 1990 the sources of emissions were the energy sector (77%) and agriculture (23%). In 1994 the share of these emissions has considerably changed, the emissions from agriculture growing to 59%, while the ones from the energy sector – decreasing to 41%. Over the 1990–1994 period the total amount of N_2O emissions has reduced by about 85%. The amount of N_2O emissions registered in 1998 was only about 15% of the ones of the base (1990) year.

Emissions of Gases with Indirect Greenhouse Effect

In 1998 the emissions of gases with indirect greenhouse effect such as: nitrogen oxides (NO_x) carbon monoxide (CO), non-methane volatile organic compounds (NMVOC) and sulphur dioxide (SO_2) have registered values which were lower than the amounts of the base year. NO_x emissions have decreased by about 71%, CO – by 68%, NMVOC – by about 53% and SO_2 – by about 88%.

Structure of Total Greenhouse Gas Emissions Expressed in CO_2 Equivalents

Total greenhouse gas emissions estimated using the global warming potential (GWP) for 100 years and expressed in CO_2 equivalents have decreased over the 1990–1998 period by about 68% as opposed to the base year level. In the base year the structure of total emissions was as follows: CO_2 – 85.1%, CH_4 – 12.2%, N_2O – 2.7%. In 1990 81.8% of the total greenhouse gas emissions originated from the energy sector, followed by agriculture with 8.4%, industrial processes – 7.6%,

Table 1. Anthropogenic greenhouse gas emissions, Gg

Land use	Surface	
	km²	%
Agricultural land, including:	2,556.6	75.5
arable land	1,809.9	53.5
orchards	179.8	5.3
vineyards	176.9	5.2
pastures	373.7	11.0
hayfields	2.3	0.1
other	14.0	0.4
Forests	325.4	9.6
Water surfaces	93.5	2.8
Other lands	408.9	12.1
Total	3,384.4	100

waste – 2.3% and solvents – 0.02%.

In 1994 and 1998 the CO_2 emissions amounted to 79.9% and 76.5%, respectively, the CH_4 emissions – 18.9% and 22.2%, while N_2O emissions – 1.3% and 1.2% of the total emissions. The share of emission sources has changed in 1998, so that 71.0% of emissions were registered in the energy sector, 12.7% – in agriculture, 11.6% – in industrial processes and 4.7% – in waste. The emissions from solvents were consi-dered insignificant and amounted in 1990–1998 period to 0.02 – 0.05% of the total greenhouse gas emissions.

The total greenhouse gas emissions expressed in CO_2 equivalents amounted in the Republic of Moldova to the following per capita figures: in 1990 – about 7.6 tons, in 1994 – 3.5 tons, in 1998 – 2.5 tons. Out of them carbon dioxide (CO_2) amount per capita was about 6.6 tons in 1990, 2.8 tons in 1994 and 1.9 tons in 1998.

Carbon Sequestration by Forests

The forests in the Republic of Moldova occupy about 325 thousand hectares. They present an important potential for CO_2 emissions sequestration. Although the amount of GHG removals by forests has stayed practically at the same level throughout the 1990–1998 period, the amount of CO_2 emissions stored by forest ecosystems equalled about 6% in 1990, about 11% in 1994 and about 16% in 1998 of the total amount of direct greenhouse gas emissions expressed in CO_2 equivalents. This evolution is due to the fact that in 1990–1998 a significant (about threefold) reduction of total direct GHG emissions occurred as a result of the crisis in the national economy.

PROGNOSIS OF THE GREENHOUSE GAS EMISSIONS

The prognosis of the greenhouse gases emissions was carried out based on the indicators of the models for macroeconomic development of the country using the statistical data and the forecast calculation for the economic development of the Republic of Moldova as initial data. The first macroeconomic model considered was the inertial one (I), which forecasts for the period 2000–2010 an annual GDP growth of 1.5% and a minimal level of external funding for the main sectors of the national economy. The second model (II), which was consi-dered to be the basic one, provides for an annual GDP growth of about 6.7% and an amount of external funding oriented expressly towards the sector of services.

Based on the two macroeconomic models, other two models were developed for the prognosis of the direct GHG emissions (CO_2, CH_4, N_2O). Each model comprises three scenarios: basic, minimal and maximal. The basic scenario provides the prognosis of GHG emissions and it does not include the abatement actions. The minimal scenario gives the prognosis of the GHG emissions with moderate abatement actions. The maximal scenario shows the prognosis of GHG emissions based on maximal actions for their abatement.

Prognosis of CO_2 Emissions

The prognosis of CO_2 emissions until the year of 2010 was developed taking into account the following: restructuring and mo-dernization of the national economy sectors, different options for the supply of energy from imported sources and the development of energy producing capacities at the national level, the growth of the energy efficiency in the energy producing sectors and in industry, reduction of energy losses, increase of vehicles performance.

The scenarios of the first model are considered as being the most realistic. For the case of these scenarios, by the year of 2010, the CO_2 emissions per capita will amount to only about 29-41% of the respective emissions level in the base year, while the total CO_2 emissions will amount, depending on the scenario used, to 8,436–11,820 Gg. For the scenarios of the basic model (II), the 2000–2010 period will show a continuing tendency towards GHG emissions increase per capita, while the total CO_2 emissions will amount in 2010, depending on the used scenario, to about 41–64% of the level of this gas emissions in 1990.

Prognosis of CH_4 Emissions

In the year of 2010 the CH_4 emissions originating in the agricultural, industrial processes and waste sectors will vary, depending on the scenarios of the models used (I or II), in the range of 52–80% and, respectively, 55–90% as opposed to the 1990 levels of this gas emissions.

Prognosis of N_2O Emissions

N_2O emissions originate, as a rule, from the energy and agriculture sectors. These sectors still remain the main sources of this gas emissions. Over 2000–2010 the N_2O emissions will vary, depending on the scenarios of the models applied (I or II), in the range of about 17–23% and, respectively, 24–37% as opposed to the levels of this gas emissions in the base year.

Total Greenhouse Gas Emissions

The total greenhouse gas emissions will not attain in 2010 the level of the base year (1990), although the period 2000-2010 will show a general trend towards direct GHG emissions growth, which, depending on the scenarios of the applied models (I or II), will vary in the range of 32–46% and 42–67% of the respective emissions level of the 1990 year. Energy will remain the sector with the greatest share in the total amount of these gases emissions.

CO_2 Emissions Storage

By the year of 2010 the sequestration capacity of direct GHG by forests expressed in CO_2 equivalents, depending on the scenarios of the used models (I or II), will increase by about 7–26% and, respectively, 12-36% as opposed to the level of total GHG emissions in the base year .

GREENHOUSE GAS EMISSIONS ABATEMENT

In the Republic of Moldova no specific strategy has been adopted on the GHG emissions abatement. The actions that are currently in the process of implementation and were stipulated in the plan of actions of the Government of the Republic of Moldova regarding the improvement of the legal framework, restructuring and modernization of the economic sectors, the increase of energy efficiency and conservation will contribute to greenhouse gas emissions abatement. To this end, over the last years, several important documents were developed in the area of environmental protection. With the support of the World Bank the National Strategic Action Plan in Environmental Protection (1995) and the National Plan for Short Term Activities in the Area of Environmental Protection (1996) were developed and approved. This National Communication is the first fundamental document dedicated to the assessment of greenhouse gas emissions, estimation of climate change impacts, development of activities for emissions abatement and measures for adaptation to climate change.

Energy Sector

The priority objectives of the national energy policy are included in the “Energy Strategy of the Republic of Moldova and the Action Plan until the year of 2010” approved by the Resolution of the Government No. 360 of April 11, 2000. This strategy includes a number of actions directly or indirectly pertaining to the GHG emissions abatement in the sector, such as: increase of the energy efficiency and conservation, implementation of effective energy technologies with minimal impact on environment, introduction of renewable energy resources in the consumption balance in case they prove economically competitive, promotion of an active energy conservation policy with the consumer, observing the international standards and norms for prevention of environmental pollution.

Transport Sector

The following actions are foreseen: utilisation of electrical urban transportation to a greater extent and the electrification of the railway transportation of route Ungheni-Razdelnaia, operations with a view of improvement of vehicles technical state, establishment of technical control stations and centres using modern equipment, systematic control of fuel quality, limitation of old vehicles import, application of differential taxes, depending on pollution degree.

Industrial Processes Sector

The development strategy for the Industry sector which is currently being worked out, takes into account the need for the decrease of the industrial activities impacts on environment, including the need for GHG emissions abatement. The GHG emissions abatement actions are listed only for branches with major contribution in the total amount of direct GHG emissions:

a) Metallurgical Industry

Actions foreseen: reduction of emissions originating from technological processes, use of control equipment and equipment with automatic switching off in case of the technological cycle violation, improvement of the technological processes in view of rational use of resources.

b) Industry of Building Materials

Actions foreseen: replacement of old equipment, improvement or replacement of some polluting technological processes.

Agriculture Sector

The draft Strategy of the Republic of Moldova in the area of agriculture is based on sustainable agricultural principles capable of improving the efficiency in the sector and of GHG emissions abatement. GHG emissions abatement in the area of agriculture is based on actions for reducing such sources of emission as the burning of vegetal residues in the field and utilisation of technologies for capturing the methane originating from livestock waste decomposition.

Waste Sector

The waste handling is a prior problem; it is included in the "National Action Plan in Environmental Protection" and, as a special item, in the "National Plan for Utilization of Industrial and Domestic Waste" approved by the Resolution of the Government No. 606 of June 28, 2000. According to these documents, the prior activities of these programs are as follows: utilization and neutralization of existing waste, implementation of separate collection of domestic waste and its re-introduction in the technologic cycle, building of new waste disposal sites in conformity with the norms coordinated with similar international requirements, giving up the utilization of raw materials containing toxic substances, decrease of waste toxicity.

Land Use Change and Forestry Sector

The utilization of the potential for forests extension for the amelioration of the ecologic condition, including greenhouse gas emissions sequestration, is an important component of the ecological policy of the state. In this respect, the following actions are foreseen: afforestation of river and water basins protection zones, afforestation of degraded surfaces, establishment and extension of seed resources for production of reproductive seeding material of local species.

VULNERABILITY ASSESSMENT AND ADAPTATION ACTIONS

Risk Factors Conditioning Vulnerability

The severity of the predicted climate changes depends much on the current state of cenoses and ecosystems. The greater the biological diversity and the capacity for ada-ptation to new conditions of the environment, the lesser the impacts consequences and vice versa. For these reasons, some distinctive features were revealed in natural and artificial ecosystems (agrophy-tocenoses), which were named risk factors and which could later determine the climate change related vulnerability degree of ecosystems.

The current distinctive features which could affect the vulnerability degree are as follows:

For Natural Ecosystems:

– Reduced surfaces, degraded state, fragmented distribution;

– Insufficient soil humidity, uneven distribution of precipitation.

For Agrophytocenoses:

– Insufficient soil and air humidity; essential fluctuations of air temperature, especially during critical periods of development;

– Uneven distribution of atmospheric precipitation over the vegetation period.

For Human Health

Some of the basic climatic factors which may affect the human health, are the precipitation, the air temperature and the excessive environmental pollution.

Reaction of Natural and Artificial Ecosystems to Various Climate Change Scenarios

Climate Change Scenarios

Three climate change models (CSIROMk2, HadCM2, ECHAM4) and the paleontological method were used for vulnerability evaluation.

The slowest and the most favourable evolution is described by model CSIROMk2. The other two models make projections for a pronounced aridity with a longer duration already in the first evaluation period (2010-2039).

The Reaction of the Natural Ecosystems to Climate Changes

a) Forests

According to model CSIROMk2, until the middle of the 21st century a productivity growth is predicted, the timber amount increasing by 10–20%. At the end of next century, along with the intensification of the climate aridity degree, a decrease of the general productivity of forests will be registered by about 25%.

According to ECHAM4, by the end of the 21st century the forests productivity will diminish by 50–70% in comparison with the reference period (1961–1990). Simultaneously, a considerable decrease of forests socio-economic significance (by 60% and of their protection function (by 40%) is forecasted.

b) Water Resources

The user water supply needs may be assessed by comparing the demand for water with the available resources. According to different climate change scenarios the available water resources will vary in the range of 4.16 and 7.06 km^3. In order to fill the needs of the consumers difficulties will have to be overcome dealing with the uneven territorial and seasonal distribution of the water resources and with the degradation of its quality indices.

c) Soils

According to the performed evaluations for the next century, the landslides and wind erosion may intensify.

Adaptation Actions

A wide range of adaptation actions is offered for the minimization of the climate change impacts on different systems and areas of activity. The most important of them refer to the following activities: development and implementation of programs for repair and extension of forests; adaptation of natural resources management to the principles of sustainable development of the national economy sectors.

COSTS EVALUATION OF ABATEMENT AND ADAPTATION ACTIONS

In the cost-benefit analysis of the abatement and adaptation actions the most relevant climate change related social and economical costs were taken into account: damage and GHG abatement and adaptation actions. The analysis was carried out for the 2000–2010 period based on models I and II for country's macroeconomic development. The net benefit was calculated by comparison of the two alternatives: with no abatement actions and in case of implementation of the proposed actions, minimal and maximal.

Cost-Benefit Analysis of the Abatement Actions

The analysis of the total costs and benefits of the abatement actions for all considered sectors of activity showed that if they are implemented in their entirety, over the 2000–2001 period, a growth of the energy efficiency of about 6–14% will be attained for model I scenarios and a respective 8–17% growth will be achieved for model II scenarios. According to the scenarios analysed in models I and II, the GHG emissions abatement will reach the amount of 4–9% and, respectively, 6–11% of the total direct GHG emissions. The costs of these actions are close to about 1.1–5.8% and 1.3–9.2% of the GDP for the 2000–2010 period.

Cost-Benefit Analysis of the Adaptation Actions

Based on the vulnerability evaluation, options were formed regarding the adaptation actions for: biologic diversity conservation, potable and irrigation water resources, floods danger elimination for human settlements. The period planned for implementation of adaptation actions is 10 years.

SYSTEMATIC RESEARCH AND OBSERVATION

Research and Observation in the Area of Climate Change

The systematic observations of the climatic indices in the Republic of Moldova were initiated in 1886 and they continue up to date by the Hydrometeo Service of the Ministry of Environment and Territorial Development. The first prognosis of the climate for the Republic of Moldova for the beginning of the 21st century was developed based on the analysis and generalization of geological data (including paleoclimatic ones), on statistical analyses of meteorological observations sets, on data obtained through direct measurements and through physical-mathe-matical modelling.

Within the project which provided the basis for this Communication, prognoses were made of possible climate changes for the Republic of Moldova, taking into account both the global fluctuations of the climatic indices and the amount of GHG emissions.

The estimation of the dependence between the fluctuation rate of the local, global climatic indices and the indices for the North Hemisphere was carried out based on the climatic data observed at the Chisinau meteorological station. As a result, it was stated that 8.1% of the fluctuation share of air temperature annual average data in the Republic of Moldova depend on global fluctuations of the respective index, while 11.1% – on the fluctuations of the North Hemisphere ones.

The following models were tested for model-ling and development of climate change scenarios, which could account for the local climatic data fluctuations probable for the conditions of the Republic of Moldova: HadCM2, ECHAM4, CGCM1, GFDL-R15, CSIROMk2. Finally three models were selected for the evaluation:

HadCM2, ECHAM4 and CSIROMk2.

Research in the Area of Greenhouse Gas Inventory

Currently, the IPCC and CORINAIR Guidelines do not provide methods for evaluation of CO_2 emissions from arable soils. A special methodology was developed for estimation of CO_2 emissions from arable soils which is based on the carbon flux balance going into the soil and the carbon flux going out of the soil. According to this methodology, the CO_2 emissions from arable soils were calculated for the whole surface of the country.

Research in the Area of Vulnerability and Adaptation Assessment

Research for the evaluation of the climate change related vulnerability degree in different fields was carried out in the areas of public health (three case studies) and soil erosion (one case study). Due to these estimations, both the vulnerable environmental components with maximal share in abovementioned areas and the zones vulnerable from the viewpoint of these factors impact were revealed.

During the research works, databases were created for the current and for the preceding periods. Interactive software was developed for the utilisation and processing of the databases which allowed for their analysis starting at a local level and ending at the national one.

EDUCATION, TRAINING AND AWARENESS BUILDING

The specialists in the area of environmental protection are being prepared by the State University, the University for Politology and Ecology, the Technical University and the Ecological College. Ecology hours are included in the curricula of secondary schools, lyceums and gymnasiums. Over the last years, specialised courses in environmental protection were included in the curricula of the secondary technical schools and universities. The Academy of Sciences of the Republic of Moldova, the Ministry of Environment and Territorial Development, Ministry of Health, Ministry of Education and Science, research institutions in the area of ecology, geography, pedology, waters, botany, zoology made a significant contribution in the organisation of regular training events in various areas of environmental protection. For the time being, there are no programs for training and education in climate change in the Republic of Moldova. The UNDP/GEF “Climate Change” Project has initiated events for special education and training in the area. The first such activity was the translation, publication and dissemination among all Moldovan schools of the brochure “Understanding Climate Change: A Beginer’s Guide to the UN Framework Convention”. The experts that worked in the abovementioned project have actively participated in the awareness building in climate change through direct involvement in seminars, conferences, workshops, presentations in radio and TV programs, publications, etc. A big number of NGOs have also participated in the building of public awareness in climate change issues. Within a small grants program initiated by the aforementioned project, the NGOs have published articles in mass media, installed instruction posters in the city, organised meetings, round tables, seminars, etc.

INTRODUCTION

The Republic of Moldova has adhered to the United Nations Framework Convention in Climate Change (June 9, 1995), thus recognizing the significance of the climate change related problems for humanity.

As a developing country and Party to the Convention, the Republic of Moldova has undertaken the commitment to contribute, as far as possible, to the international efforts to moderate the anthropogenic impact on global climate. In this respect, activities in various areas were implemented: preparation of the greenhouse gas inventory, estimation of different sectors' vulnerability to climate change, development of actions for abatement and adaptation to climate change, as well as education, training and awareness building among the population, especially the younger generation.

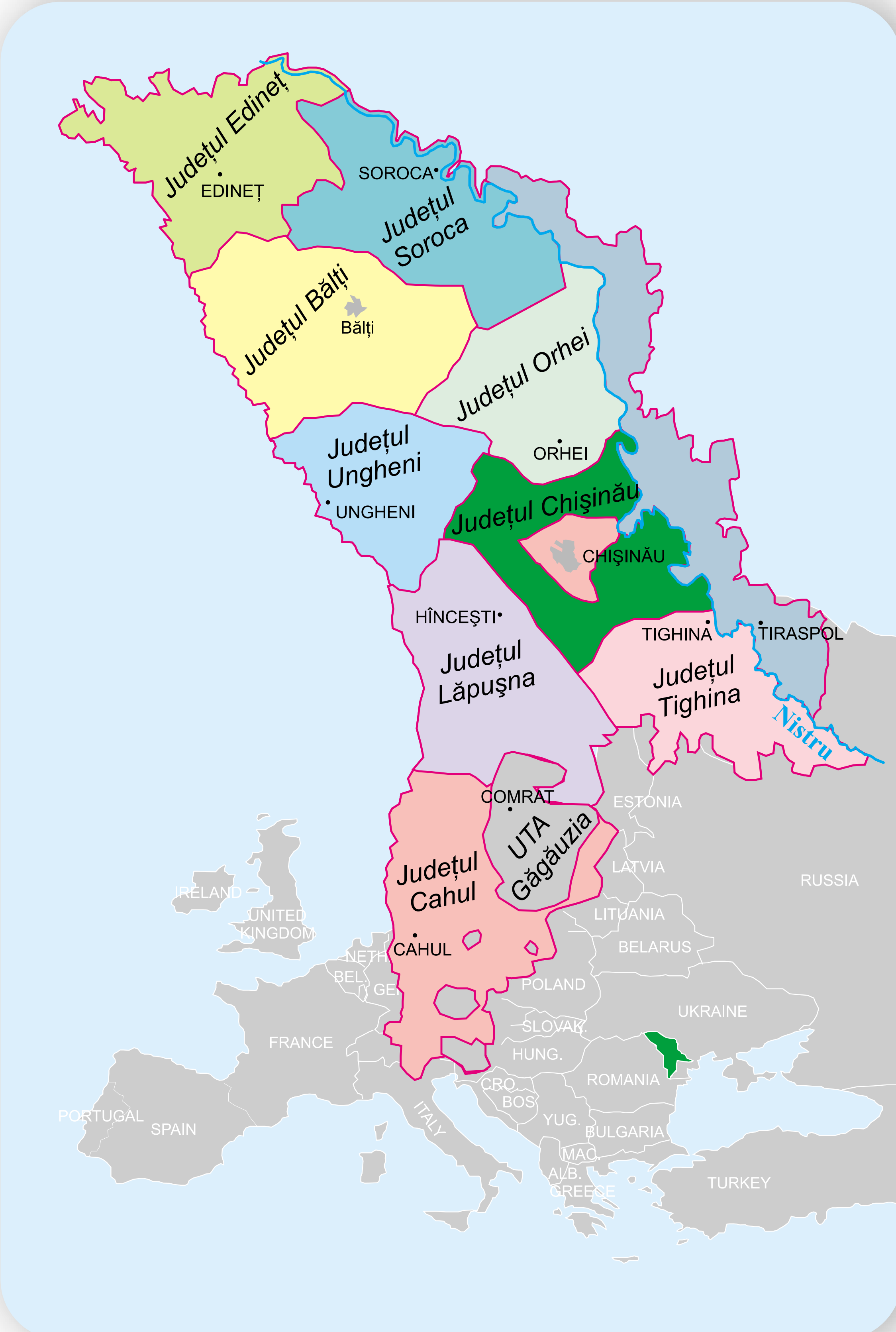
The National Communication is a first voluntary report of the country reflecting the extent to which the special provisions of the aforementioned Convention are observed. The work is based on the outputs of the Project "Enabling Moldova to Prepare its First National Communication in Response to its Commitments to the UN FCCC" which has outlined a number of measures in the above listed areas while showing directions of work for future and creating a basis for efficient partnerships.

As a country, which is Party to the Convention, the Republic of Moldova studies the possibilities for adhering to the Kyoto Protocol and with the continuation of the negotiation process currently taking place internationally.

The wide dissemination of climate change related information has contributed to greater awareness of the public, scientific community and decision makers of our country. Thus, it may be stated that the Republic of Moldova has all the necessary potential both for the evaluation of the climate change impact and for promotion and implementation of strategies, policies, programs and technologies focused on the attenuation of these changes impacts.

The continuity in this aspect is an imperative need; it will not only make possible an important contribution of the Republic of Moldova to the global efforts of climate change abatement, but will also ensure an opportunity to involve the research and technical potential of the country along with qualified professionals in this activity.

This Communication will serve as a basis for taking future decisions dealing with the application of Climate Change Convention provisions and as an useful guideline for taking climate change issues into consideration in the development strategies of the country.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TURKEY

1. NATIONAL CIRCUMSTANCES

The Republic of Moldova is situated in the Southeastern part of Europe. In the North-east and South it borders with Ukraine, in the West – with Romania. The surface of the country is 33.8 thousand square kilometres and its population is 4.3 million inhabitants. The capital of the country is Chisinau certified in 1436. Its population is 740 thousand people. The territory of the country is divided in different land use categories *(Table 1.1).*

Table 1.1 Structure of the land fund of the Republic of Moldova, 1998

Land use	Surface	
	km^2	%
Agricultural land, including:	2,556.6	75.5
arable land	1,809.9	53.5
orchards	179.8	5.3
vineyards	176.9	5.2
pastures	373.7	11.0
hayfields	2.3	0.1
other	14.0	0.4
Forests	325.4	9.6
Water surfaces	93.5	2.8
Other lands	408.9	12.1
Total	3,384.4	100

1.1 PHYSICAL-GEOGRAPHICAL CONDITIONS

The Republic of Moldova is located between 45^0 28' and 48^0 28' northern latitude and between 26^0 40' and 30^0 06' eastern longitude. The territory of the country stretches from North to South on a distance of 350 kilometres and from West to East – 150 kilometres. The relief is uneven with alternating elevations and plains, the altitudes varying between 5 and 429 meters. Being a part of the Central Eastern European Plain, the territory of the Republic of Moldova is situated mainly between Pruth, Dniester rivers and Danube stream; thus the territory of the country is in the Black Sea basin.

The Republic of Moldova is located in a seismic zone with the epicentre in Vrancea mountains of the Carpathians (Romania) situated at 60 kilometres distance from the Western border of the country. Recent seismic phenomena with the magnitude of about 7 degree on Richter scale were registered in 1990 (7.4), 1977(7.2), 1986 (6.9), 1990 (6.7).

The climate of the Republic of Moldova is moderate-continental. The mean annual temperature is 8-10^{0}C. The coldest month is January with the mean temperature: 2.8-5.3^{0}C below zero. The warmest month is July with the mean temperature 19-22^0 C. Moldova is characterized by a relatively high number of warm and sunny days, 160 to 190 annually. The atmospheric circulation shows a transfer of air masses from the Atlantic ocean zone towards East with the evacuation of the warm and humid air from the Mediterranean Sea. Sometimes relatively cold and dry air masses from the northern latitudes interfere.

The most frequent risks pertaining to the meteorological regime for human activities are temperature fluctuations (especially in the spring), frequent draughts, and high indices of minimal and maximal temperature values. The amount of precipitation is decreasing from Northwest to Southeast from 620 to 450 mm per year. In most cases the precipitations fall during the warm season in form of short-term shower rains and only 10% of the annual amount is in form of snow.

1.2 NATURAL RESOURCES

The most important natural resources of the Republic of Moldova are: soils, water resources, forests and mineral ores.

T*he Republic of Moldova* is situated at the confluence of three biogeographic zones – deciduous forests, silvosteppe and steppe. In the respective bioclimatic conditions three zonal types of soil were formed. On the Central Plateau of Codri in the common oak and beech forests, brown soils were formed, in hilly regions under oak and hornbeam - grey soils were formed, while in steppe conditions – chenozems were formed.

The soil is the main natural wealth of the country. The chernozems prevail; they occupy two thirds of the country's surface, being the principal resource of agriculture *(Table 1.2)*. These soils have a high productivity potential which, in some zones, is limited by the climatic conditions.

Table 1.2 Structure of soil types in the Republic of Moldova

Type of soil	Surface	
	thou. ha	%
Brown	27.2	0.9
Grey	319.6	10.6
Cernozems (clay-alluvial, leached, typical and carbonated)	2,235.8	73.9
Vertsols and vertic cernozems	13.6	0.4
Rendzins	14.7	0.5
Swamps	28.4	0.9
Solonetzs and solonchaks	6.5	0.2
Diluvial and alluvial soils	377.8	12.5
Total	3,023.6	100

Within the zonal soils there are fragmented intrazonal soils: in limy soils – the rendzines, in heavy clays – the vertisoils, in zones with excessive humidity – swamps. The presence of soluble salts made for the formation of solonetzs and solonchaks. When no ameliorative actions are taken in respect to these soils, they show reduced productivity. In valleys and meadows diluvial and alluvial soils are formed which are frequently saline.

The variety of soils, offers the possibility of their exploitation for different purposes. The degradation processes, especially erosion, reduce the productive potential of soils.

The efficient exploitation and soil protection are imperative needs both for the economy of the country and welfare of the population, and for the conservation of the biologic diversity and maintenance of the ecological balance.

The water resources of the country include: surface water, phreatic water and underground water. About two thirds of the water resources of the country are formed by the transboundary rivers Dniester and Pruth. The average annual debit of Dniester is 10.4 km^3, that of Pruth is 2.9 km^3.

The regime of the surface and phreatic waters varies depending on the season. The hydrographical network occupies 2.7% of the country's surface and has a total length of about 16 thousand kilometres. Over 3,260 rivers and rivulets traverse the territory of the country. The average debit of the interior rivers is 1.14 km^3.

There are 57 natural lakes with a total surface of 62.2 km^2 and about 3000 accumulation lakes and other artificial water reservoirs with a total surface of about 33 km^2 in the country. The exploitable reserves of the underground water amount to 2,724 thousand m^3 during 24 hours.

Potable water supply, especially in rural areas, depends much on the level of phreatic water. Phreatic waters have an uneven distribution across the country and they vary according to the season. In this respect, the most heavily affected region both for the quantity and the quality of water is the South and Southeast of the country.

The territory of the Republic of Moldova boasts a high *biologic diversity*. The flora comprises about 5,513 species, while fauna – 14,800 species, 641 of them being vertebrates. The reason for the relatively high diversity lies in the fact that the country's territory is situated at the intersection of three bio-geographical regions: Central European, Euro Asiatic and Mediterranean.

As far as fauna goes, the Republic of Moldova borders with the Balkan region and forms a transition zone between the elements of continental Asia steppe fauna and the European silvosteppe fauna. The natural ecosystems do not exceed 25% of the territory and belong to the following groups: meadow (1.5%), aquatic (2.7%), steppe (about 10%) and forest (9.6%) ones. The forest distribution in the Republic of Moldova is uneven, most of the forests being situated in the central zone, about 58% (forest cover degree 13.1%). The Northern and Southern regions are extremely poor in forests with 25% (forest cover degree 7.2%) and 17% (forest cover degree 6.7%) of the total forests, respectively.

The forests of the Republic of Moldova are represented by deciduous forests, 97.8%, the resinaceous amounting to only 2.2%. The main woody formations are oak, acacia, ash and hornbeam forests. The distribution of forests by age groups is unbalanced, the young plantations covering 26.3%, medium age ones - 43.7%, close to exploitable age ones – 17.5% and exploitable ones – 12.5% of the total forest area. Forests with the age of over 100 years occupy only six thousand hectares.

The most important *mineral ores* are: limestone, granite, clays (including bentonitic and sandy ones), diatomite, gypsum, and chalk, which are useful for building, production of cement and glass and for the alimentary industry.

There is a total of 330 known plots with mineral ores distributed all over the country, about 180 of them being exploited.

In the South of the country oil and gas deposits (in insignificant amounts) were found.

1.3 CURRENT STATE OF THE NATIONAL ECONOMY

Starting in the 90-ties the process of transition to market economy was initiated. Over the transition years the country was confronted by great difficulties in the task of establishing a modern economy.

The period of reforms may be divided into two stages: first, comprising the years 1991-1994 and the second, starting in 1995 and up to date. The first stage showed a catastrophic decrease of all economic and social indicators (the GDP has decreased by 60% as opposed to 1990). The second stage shows a deep and stable depression, which has worsened following the regional financial crisis of the end of 1998. Although at a smaller rate than in the first stage, the economic fall has continued through the second stage so that the GDP has fallen to 34% of its 1990 level.

The GDP and the industrial production amount to only one third of the respective data of 1990, while the agricultural production has decreased twofold *(Table 1.3)*.

The investments, consumption and exports have decreased. The purchasing power of the national coin has reduced. In 1999 the average nominal salary was covering the minimal consumption basket only in the amount of 46%.

The energy sector is almost entirely (98%) based on energy-imported resources. Both electricity and the fossil fuel for power and heat production are imported. Their consumption has decreased about three times *(Table 1.4)* as opposed to 1990, which correlates well with the GDP fall of the period *(Figure 1).*

The production of electricity and thermal power is expensive due to the low productivity of the equipment that is old and allows high energy losses (from 10% in 1990 up to about 25% in 1998) in the processes of production and transportation.

The transportation in the Republic of Moldova has the following structure: automobiles, railway, air and river transport means with various shares in the total transportation of commodities and passengers *(Table 1.5)*.

Table 1.3. Dynamics of the main indicators of the Republic of Moldova for the 1991-1999 period as percentage of the preceding year

Name of macroeconomic indicators	1991	1992	1993	1994	1995	1996	1997	1998	1999
Gross Domestic Product (GDP),	82.5	70.9	98.8	69.1	98.6	94.1	101.6	93.5	95.6
Amount of industrial production	89	73	100.3	72	96	94	100	85	88
Agricultural production	90	84	110	75	102	88	111	88	92
Investments in fixed assets	91	74	55	49	84	92	92	110	78
Retail sales in officially registered entities	82	53	75	58	97	95	96	89	80
Paid services to population per officially registered entity	81	55	67	52	102	78	95	92	89
Index of consumer goods prices (annual average)	198	1209	1284	587	130	124	112	108	139
Export	-	-	103	117	132	107	110	72	73
Import	-	-	98	105	128	128	109	87	56
Budget deficit (% of GDP)	-	-	7.5	5.8	5.8	9.8	7.5	3.5	4.9
External debt (end of the year), mill. $US	-	-	255	633	840	1068	1273	1452	1462
Exchange rate, MDL/1$US:									
end of the year	-	-	3.6	4.3	4.5	4.7	4.7	8.3	11.6
annual average	-	-	1.4	4.1	4.5	4.6	4.6	5.4	10.5
Real income of the population	-	-	71	81	123	101	101	88.2	82
Real salaries	-	-	69	59	102	106	105	106	88

All the transportation and communication activities account for about 7.2% of the country's GDP (1999).

The network of roads has the length of 9.2 thousand kilometres, 95% of them being roads with stiff cover. The railway network has a 1.14 thousand kilometres length; it is double lined only along 178 kilometres. Currently the automobile car park of the country comprises 290 thousand units, 20% of them being trucks, while the railways of Moldova own about 190 engines.

Table 1.4. Indices of energy consumption in the Republic of Moldova in 1990, 1994 and 1998

Indices	Years 1990	1994	1998
Population, thou. inhab.	4,361.6	4,352.7	4,304.7
Total consumption of primary energy, resources, thou. t.c.e.	1,4269	4,636	4,218
Total consumption of electricity, thou. kWh	1,2647	5,558	4,624
Consumption of primary energy resources per capita, t.c.e.	3.3	1.1	1.0
Consumption of electricity per capita, thou. kWh	2.9	1.3	1.1

Agriculture is an important branch of the national economy. Currently, it produces 22.3% of the GDP, 62.5% of the exports and employs 42% of the labour fit population.

The pedoclimatic and geomorphologic conditions allow the cultivation of a high diversity of agricultural crops. The main groups of agricultural plants cultivated in the country are as follows: cereals (wheat, corn, bar-

Table 1.5. The share of different transportation means

Transport type	Transportation, % of total: Commodities, 1990	Commodities, 1998	Passengers, 1990	Passengers, 1998
Auto	29.1	28.3	49.9	35.5
Railway	69.3	71.6	16.1	21.8
Air	0.1	0.1	23.3	10.5
River	1.5	-	0.2	-
Electric (trolleybuses)	-	-	10.5	32.2

ley, etc.), vegetables (tomatoes, cabbage, pepper, cucumber, etc.), technical crops (sunflower, sugar beet, tobacco, soybean), orchards and vineyards *(Table 1.6)*.

Table 1.6. Structure of surfaces under the main agricultural crops

Category of crops	Year		
	1990	1994	1998
Cereals	836.9	830.1	937.4
Tehnical crops	277.3	263.5	309.1
Potatoes and vegetables	140.9	140.4	117.8
Fodder crops	462.3	481.5	162.6
Vineyards	215.8	202.6	180.9
Orchards	224.5	208.3	189.8
Total	2,157.7	2,126.4	1,897.6

The agricultural sector has undergone many changes over the transition period. Most of the agricultural plots are privately owned. The economic situation of the country does not allow the utilisation of advanced technologies in the area of plant and animal production. The factors of agriculture intensification are used to a small extent. As a result, in 1998 the agricultural production has decreased by 48% and the animal production by 64% as opposed to 1990 levels.

Industry is an important component for the economic stability of the country and it amounted to 16.2% of the GDP (1999). The main sectors of the industrial production structure are represented by the alimentary industry (50.3%), electricity and energy production (27.2%) and light industry (4.9%). Over 1990-1999 the industrial production has decreased by 66%. The decisive factors that determined this fall in the industry were the utilisation of old technologies with excessive consumption of energy and raw materials.

The alimentary industry is famous for the traditional production of wines and cognacs. An important contribution to the sector is made by production of fruit and vegetable cans and by sugar and tobacco industries. The high moral and physical ageing of the energy equipment and installations has led to a low degree of the services rendered by the industry and to the decrease of the energetic efficiency.

2. NATIONAL GREENHOUSE GAS INVENTORY

In accordance with Articles 4.1 and 12 of the United Nations Framework Convention in Climate Change (UNFCCC) the Parties undertake the commitment to develop, periodically update, publish and present to the Conference of Parties the national inventories of anthropogenic greenhouse gas emissions by sources and removals by sinks. The Republic of Moldova is a Party to the Convention as a developing country and as a non-Annex I country. According to the Resolution of the Second Session of the Conference of the Parties to the Convention, 1990 is recommended for use as base year for the inventories of greenhouse gas emissions.

2.1. METHODOLOGIES

The inventory of the direct and indirect GHG for the period 1990-1998 is carried out based on the 1995 IPCC Guidelines. For the sectors “Industrial processes” and “Solvents and their use” the emission indices of CORINAIR methodology were applied.

The inventory of emissions comprises data for the following gases: CO_2, CH_4, N_2O, NO_x, CO, NMVOC, SO_2 (Annex A). The sources of greenhouse gas emission are grouped into six categories: Energy sector, Industrial processes, Solvents and their use, Agriculture, Waste, Land Use Change and Forestry. Applying the global warming potential for one hundred years (GWP_{CO_2} = 1, GWP_{CH_4} = 21, GWP_{N_2O} = 310 in accordance with the IPCC Guidelines) the greenhouse gas emissions were expressed in CO_2 equivalents.

The greenhouse gas emissions were calculated based on primary data on fuel use submitted by the Department for Statistical and Sociological Analyses, as well as based on the data submitted by the Ministry of Agriculture and Processing Industry, the Ministry of Environment and Territorial Development, the Ministry of Internal Affairs, the Ministry of Transport and Communications and the State Forestry Service.

The assessment of the CO_2 emissions, the gas with the greatest share in the total amount of greenhouse gases emissions, was done by two methods: the reference method and the detailed method. The first method allows the calculation of the greenhouse gas emissions by sector of national economy and category of emission, while the second – the estimation of emissions by type of fuel used and by technology. The calculations prove the difference between these two methods to be about 3.1% for the period 1990-1993 and about 10.1% for the period 1994-1998 (due to partial lack of statistical data for the localities on the left bank of Dniester).

Since the data of the Statistical Annual Reports for 1995–1998 differed from the data of the fuel – energy balance, the emissions assessment was based only on the aforementioned balance, which is considered to be more complete and more detailed.

The emissions from fossil fuels combustion in transportation, industry and small sources of combustion for the localities on the left bank of Dniester were omitted for the years 1995–1998 due to the lack of data.

The statistical data on the ferrous and non-ferrous industry were, to some extent, approximate due to incompleteness. The data on the emissions from domestic solid state waste are also inaccurate since for the years 1990–1995 only the data for the authorized waste disposal sites are taken into account, while for the period 1996-1998 the data for the unauthorized waste disposal sites are also included in the statistical data.

2.2. THE EMISSION OF GASES WITH DIRECT GREENHOUSE EFFECT

The category of gases with direct greenhouse effect comprises: the water vapours, carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), ozone (O_3), chlorofluorocarbons (CFCs) and hydrochlorofluorocarbons (HCFCs) and others. The emission of these gases takes place through fossil fuels combustion in energy and transportation, during the mechanized agricultural works, in industrial processes, in the processes of enteric fermentation and in liquid animal waste handling in the livestock sector, in processing of domestic and industrial waste, etc.

2.2.1. CO_2 Emissions

In 1990 the human induced carbon dioxide emissions amounted to about 28,323 Gg. The main emission sources were the fossil fuels combustion and industrial processes *(Figure 2.1)*.

The CO_2 emissions registered in 1994 were in the amount of about 12,086 Gg, which constituted approximately 43% of the 1990 total amount of emissions. The reduction of CO_2 emissions was typical for the whole of the 1990–1998 period, amounting in 1998 to only about 29% of the base year emissions. The reduction is accounted for by the decrease of the total consumption of primary energy resources.

CO_2 Emissions in the Energy Sector

In 1990 most of the CO_2 emissions in the Energy sector were generated by sources producing electricity and heat, by small combustion sources, transportation, as well as combustion processes in industry *(Figure 2.2)*.

The emissions resulting from combustion of all types of fossil fuels in 1990 had the following sources: 27% – combustion of coal, 26% – natural gas, 47% – liquid fuel, 24% – fuel oil, 12% – Diesel oil, 8% – gasoline, 2% – combustion of gasser liquefied gas, 1% – other sources. In the years following after 1990 the emissions resulting from solid and liquid fuel combustion have reduced, while the emissions resulting from gaseous fuel combustion have significantly increased.

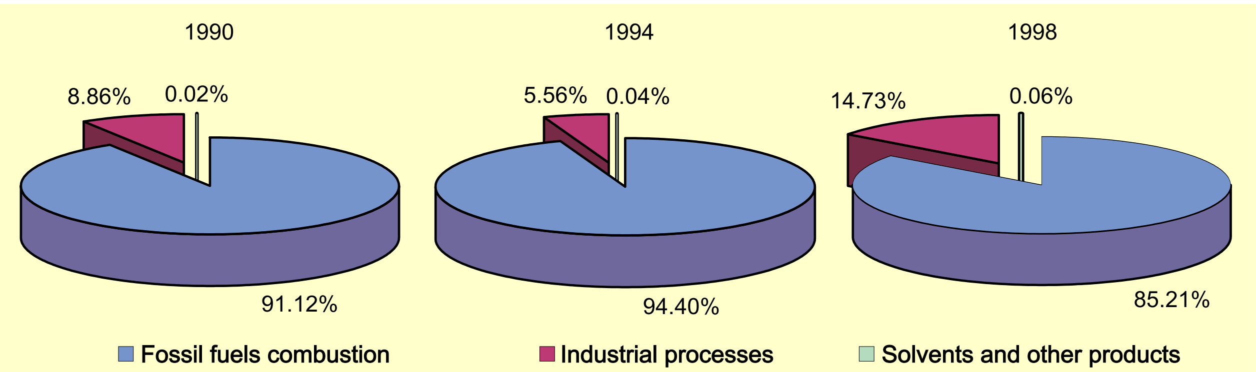


Figure 2.1. Structure of CO_2 emissions in 1990, 1994 and 1998

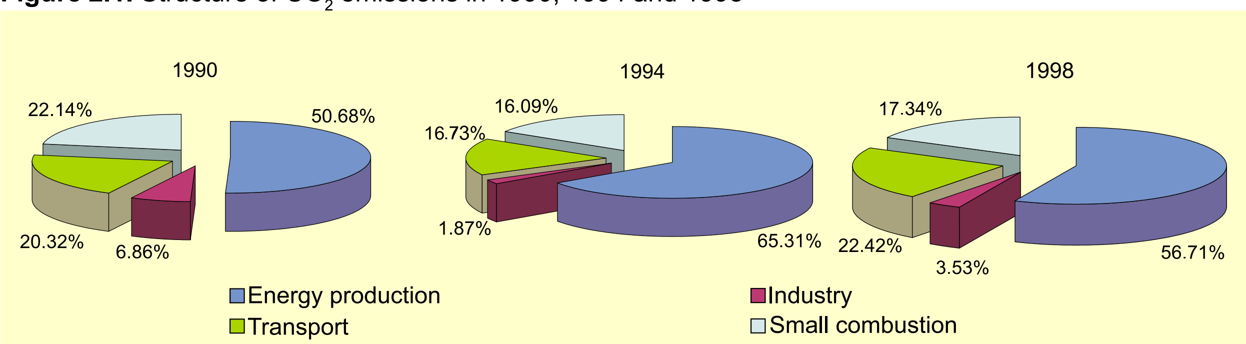


Figure 2.2 Structure of CO_2 emissions in the Energy sector in 1990, 1994 and in 1998

In 1994 CO_2 emissions coming from the fossil fuel combustion amounted to about 44%, while in 1998 the respective figure was only about 27% of the amount of emissions in the base year. Thus, as a result of the general decrease of fuel consumption, the emissions originating from their combustion have reduced by 3.7 times, including emissions from combustion of gasoline – 3 times, Diesel oil – about 4 times, fuel oil – about 10 times, natural gas – about 2 times.

CO_2 Emissions generated by Industrial Processes

In the period 1990-1998 the most important sources of CO_2 emissions in the Industrial processes sector were the following: metallurgical industry, the industry of building materials (cement, lime and mineral wool production) and the chemical industry *(Figure 2.3)*. Over the 1990-1992 period insignificant CO_2 emissions were registered in the production of building glass.

The period 1990-1998 showed a decrease of CO_2 emissions from the metallurgical industry and a continued decrease of emissions resulting from the chemical industry and the building materials sector.

2.2.2. CH_4 Emissions

CH_4 emissions in 1990 were estimated at about 193 Gg. The main sources *(Figure 2.4)* were: agriculture, fugitive emissions resulting from the utilisation and distribution of natural gas, Waste and Energy sectors (fossil fuels combustion).

In 1990 in agriculture about 43.0% of the total CH_4 emissions resulted from the processes of enteric fermentation, about 7.6% – from livestock waste handling and about 1.8% – from burning of organic residues in agricultural fields.

CH_4 emissions resulting from the incineration of solid waste were not estimated, since most of them come from unauthorized waste disposal sites.

In the conditions of the Republic of Moldova the only technology for solid waste storage is the filling in of waste disposal pits. This source accounted for about 18% of the total CH_4 emissions registered in 1990. Emissions resulting from the waste water purification were estimated based on the biochemical consumption of oxygen used for

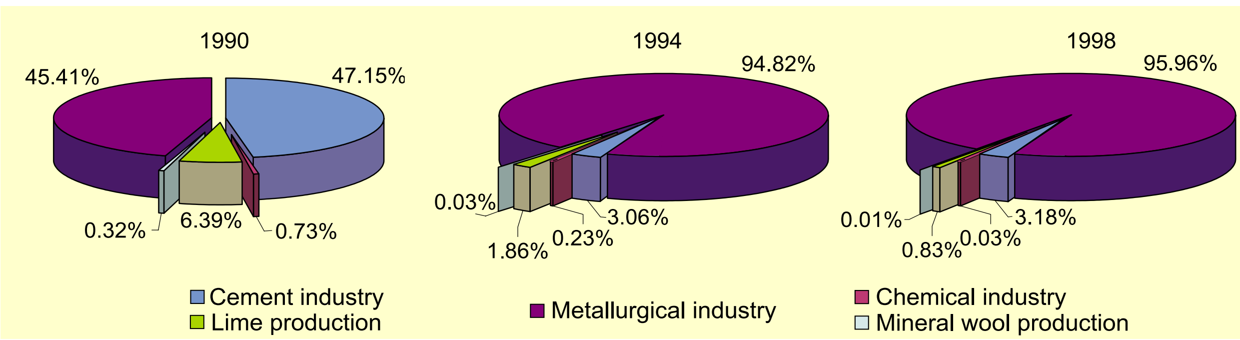


Figure 2.3 Structure of CO_2 emissions in the Industrial processes sector in the years 1990, 1994 and 1998

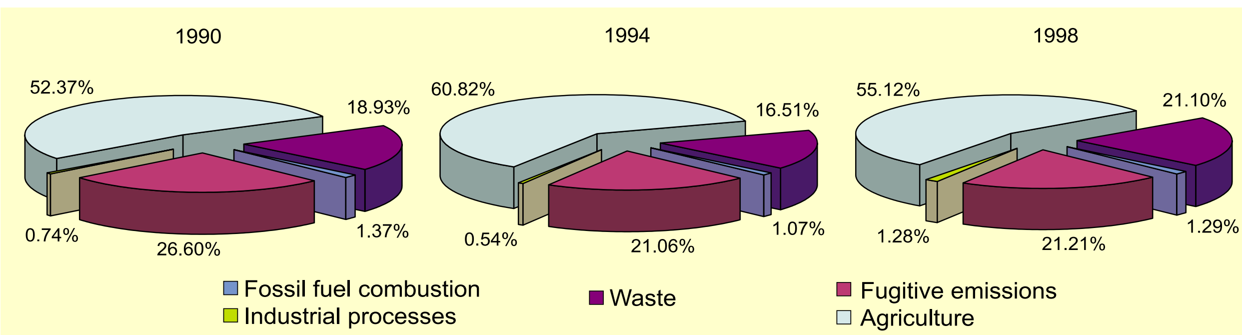


Figure 2.4 Structure of CH_4 emissions in the years 1990, 1994 and 1998

the treatment of domestic and industrial waste water; in the base year they amounted to 1% of the total CH_4 emissions.

The share of CH_4 emissions resulting from fossil fuels combustion in 1990 was only 1.4% of the total emissions. The structure of these emissions by source was as follows: combustion of coal – 37%, gasoline – 20%, Diesel oil – 14%, liquefied natural gas – 12%, fuel oil – 7%, natural gas – 5%, gasser liquefied gas – 5%. The CH_4 emissions amounted in 1994 to about 70%, while in 1998 – to about 58% of the emissions registered in 1990. The percentage of the emission sources changed only slightly over that period.

2.2.3. N_2O Emissions

N_2O emissions estimated in 1990 amounted to about 2.87 Gg. The main sources of emissions were agriculture and fossil fuels combustion in the Energy sector *(Figure 2.5).*

N_2O emissions from agriculture come mainly from surfaces fertilized with nitrogen mineral nutrients. The lack of funds has conducted to a significant decrease of their use. Consequently, N_2O emissions from agriculture have decreased significantly. In 1994 they were 9 times less than the ones of the base year.

Following the decline in the industrial sector and reduction of fossil fuels consumption in the Energy sector in 1994 the N_2O emissions decreased twice as opposed to 1990. N_2O emissions registered in 1990 in the energy sector came from combustion of: coal (39%), Diesel oil (15%), fuel oil (14%), gasser liquefied gas (12%), natural gas (3%), gasoline (1%) and other sources (16%). The emissions from the combustion of lignite and liquefied natural gas were insignificant.

The total N_2O emissions in 1994 amounted to 21.6%, while in 1998 – to 14.8% of the base year (1990) ones.

2.3. EMISSIONS OF GASES WITH INDIRECT GREENHOUSE EFFECT

The gases with indirect greenhouse effect are: NO_x, CO, NMVOC and SO_2.

2.3.1. NO_x Emissions

In 1990 total NO_x emissions were estimated at about 138 thousand tons (Gg). The gases of the NO_x group react easily with oxygen forming new compounds. About 99% of these gases emissions originate from combustion of fossil fuels used for the production of heat and electricity and for transportation. In 1990 the emission of NO_x group gases in the energy sector originated from the combustion of: Diesel oil – 45%, gasoline – 17%, coal – 15%, natural gas – 13%, fuel oil – 9%, other types of fuels – 1%. In 1994 the NO_x emissions were estimated at approximately 42%, while in 1998 – at about 29% of the total 1990 emissions.

In 1990-1998 the structure of these gases emissions has changed insignificantly *(Figure 2.6)*.

2.3.2. CO Emissions

CO emissions amounted to approximately 308 Gg in 1990. The main sources of CO emissions were the fossil fuels used in the

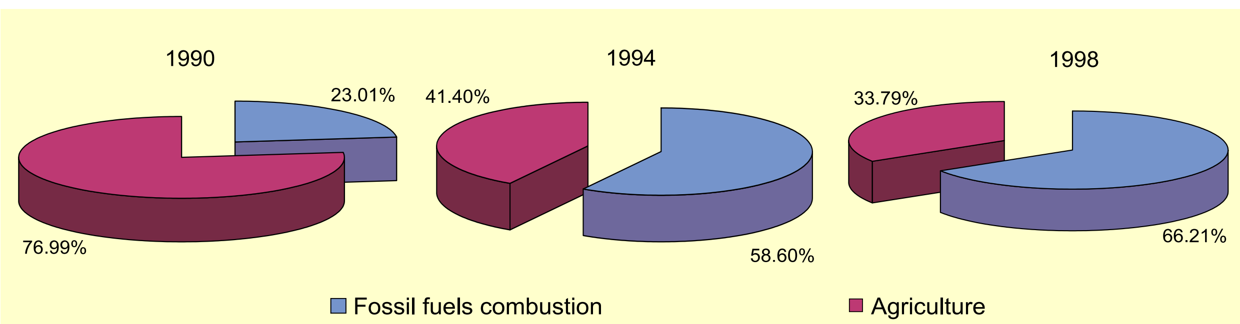


Figure 2.5 Structure of N_2O emissions in the years 1990, 1994 and 1998

Energy sector (94.5% in transport) and the agricultural residues disposed of through burning. The emissions from the Industrial Processes were insignificant *(Figure 2.7)*.

In 1990 the CO emissions resulting from the use of fossil fuels in the energy sector originated from the combustion of: gasoline – 86%, Diesel oil – 8%, coal – 4%, natural gas – 1%, other types of fuels – 1%.

CO emissions registered in 1994 and 1998 were estimated at about 105 and 99 Gg, respectively, amounting respectively to the approximate figures of 34% and 32% of this gas emission in 1990.

2.3.3. NMVOC Emissions

The emission of the volatile organic non-methane compounds (NMVOC) were estimated at 93.6 Gg in 1990. The share of NMVOC sources of emission in the 1994-1998 period showed a considerable decrease of these gases emission as opposed to 1990 levels *(Figure 2.8)* .

NMVOC emissions through fossil fuels combustion in the energy sector were registered only in transportation and they originated from combustion of gasoline – 96%, Diesel oil – 3% and gasser liquefied gas – 1%.

For 1994 and 1998 the NMVOC emissions were estimated at 64.4 and 60.8 Gg, respectively, which represented 68% and 65% respectively of the 1990 NMVOC emissions.

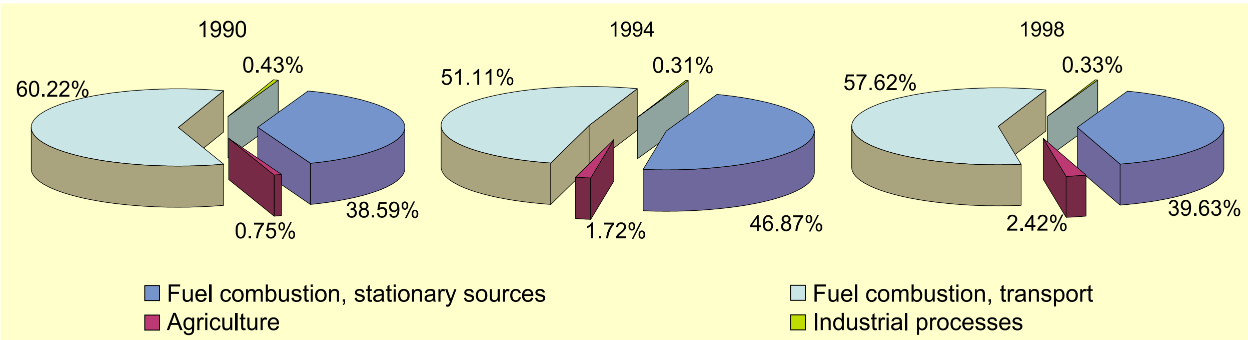


Figure 2.6 Structure of NO_x emissions in 1990, 1994 and 1998

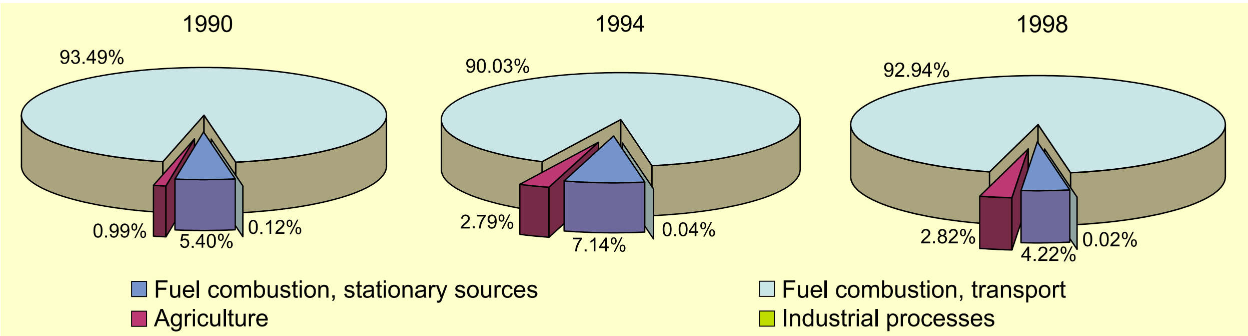


Figure 2.7 Structure of CO emissions in 1990, 1994 and 1998

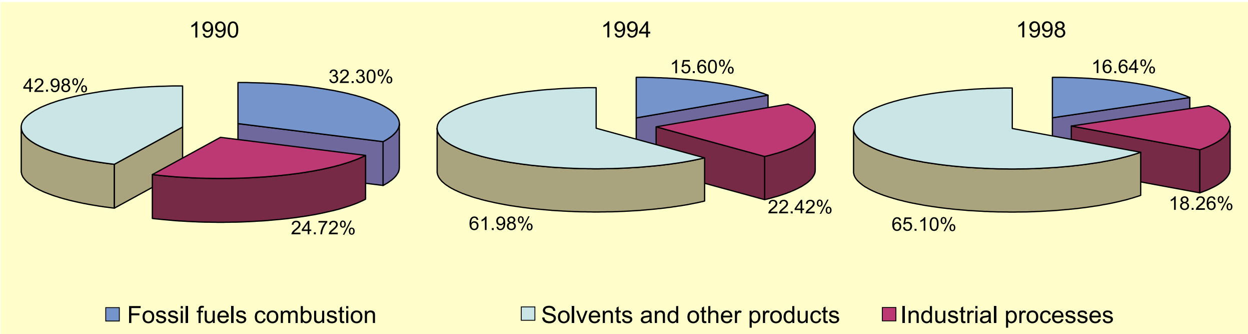


Figure 2.8 Structure of NMVOC emissions in 1990, 1994 and 1998

2.3.4. SO_2 Emissions

SO_2 is considered as a pollutant with an especially grave impact on the environment and it is a subject of a number of regional and global conventions. Due to the fact that this noxious agent is included as an entry in the GCM (Global Circulation Models) program, SO_2 emissions were also calculated for the period 1990–1998. Thus, in 1999 these emissions were estimated at about 266 Gg *(Figure 2.9)*.

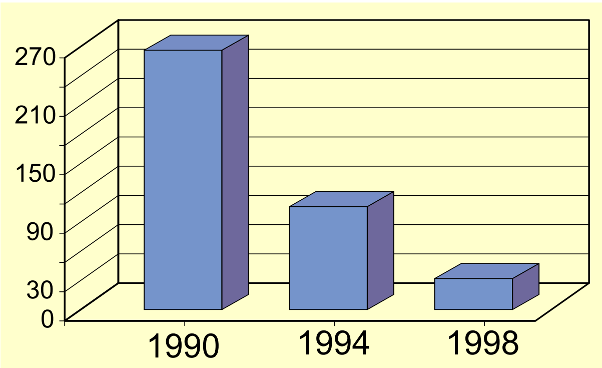


Figure 2.9 SO_2 emissions in 1990, 1994 and 1998

In 1994 and 1998 SO_2 emissions amounted respectively to only about 38% and 12% of the emissions registered in the base year (1990).

2.4. TOTAL GREENHOUSE GAS EMISSIONS EXPRESSED IN CO_2 EQUIVALENTS

Total greenhouse gas emissions estimated using the global warming potential for 100 years and expressed in CO_2 equivalents amounted to 33,273; 15,359 and 10,621 Gg in 1990, 1994 and 1998, respectively. Over the period 1990–1998 the total greenhouse gas emissions have decreased by about 68% as opposed to the base year (Annex B). The total greenhouse gas emissions expressed in CO_2 equivalents amounted in the Republic of Moldova to the following per capita figures: in 1990 – about 7.6 tons, in 1994 – 3.5 tons, in 1998 – 2.5 tons. Out of them carbon dioxide amount per capita was: 6.6 tons in 1990, 2.8 tons in 1994 and 1.9 tons in 1998. The greatest share among sources of emission over the period 1990-1998 were the energy, agriculture and industrial processes *(Figure 2.10).*

The period 1990–1998 showed a continuing tendency towards the reduction of total greenhouse gas emissions *(Figure 2.11)*.

The ratio of the main three gases with direct greenhouse effect (CO_2, CH_4, N_2O) of the total emissions expressed in CO_2 equivalents showed a decrease of the carbon dioxide share and the increase of the share

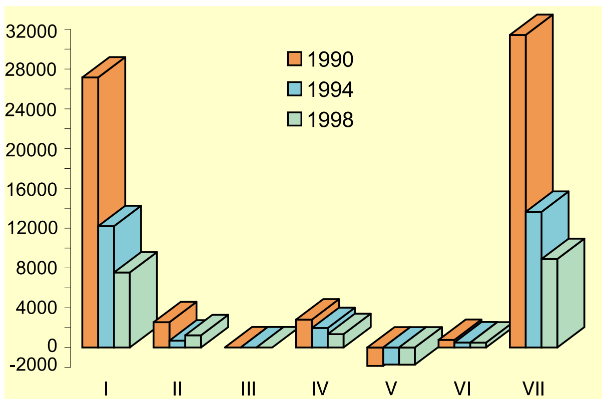


Figure 2.11 Total direct greenhouse gas emissions expressed in CO_2 equivalents

I – energy sector; II – industrial proceses; III – solvents and other products; IV – agriculture; V – land use change and forestry; VI – waste; VII – net emissions.

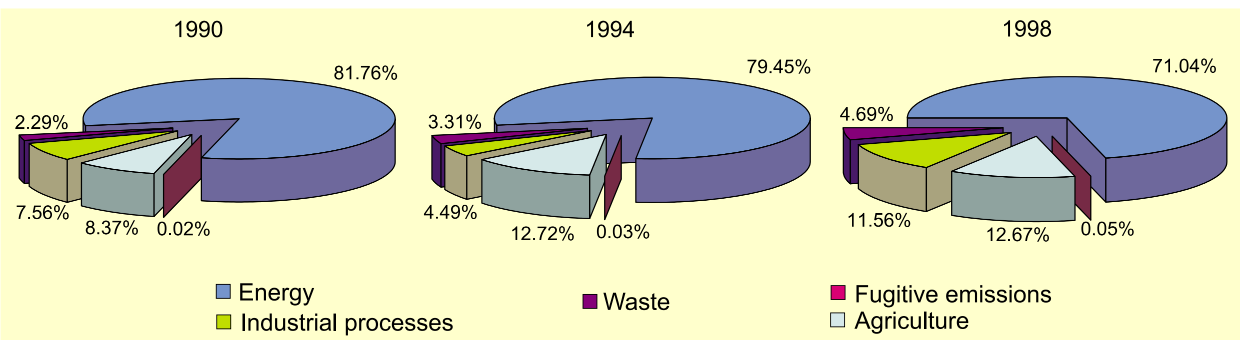


Figure 2.10 Total emissions expressed in CO_2 equivalents by sources

of methane emissions *(Figure 2.12)*.

Over the period 1990-1998 the total emissions of the gases with direct greenhouse effect expressed in CO_2 equivalents showed a triple decrease in the Republic of Moldova as a consequence of the economic crisis: they amounted to about 45% in 1994 and 32% in 1998 of the emissions registered in the base year. The ratio of emission sources has changed: a considerable reduction occurred of the emissions originating from fossil fuels combustion in the industry sector and from the use of solvents and other products, while the percentage of the emissions originating in agriculture, waste management and the percentage of volatile emissions has increased. The distribution of the greenhouse gas emissions expressed in CO_2 equivalents through the global warming potential for one hundred years has changed as opposed to the base year and showed a continuous tendency towards reduction of CO_2 emissions and increase of CH_4 emissions.

2.5. CARBON STORAGE

The capacity for GHG emission abatement and, respectively, the annual CO_2 removal amount has stayed practically at the same level throughout the period 1990-1998. However, the amount of CO_2 emissions stored by forest ecosystems equalled about 6% in 1990, about 11% in 1994 and about 16% in 1998 of the total amount of greenhouse gas emissions expressed in CO_2 equivalents (Figure 2.13). This evolution is due to the fact that in 1990-1998 a significant (about threefold) reduction of total direct GHG emissions as a result of the crisis in the national economy occurred.

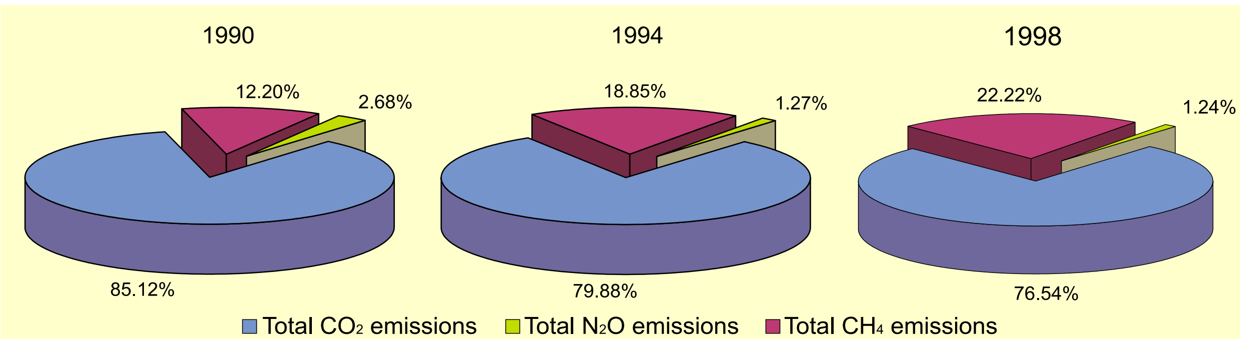


Figure 2.12 Total greenhouse gas emissions expressed in CO_2 equivalents in 1990, 1994 and 1998

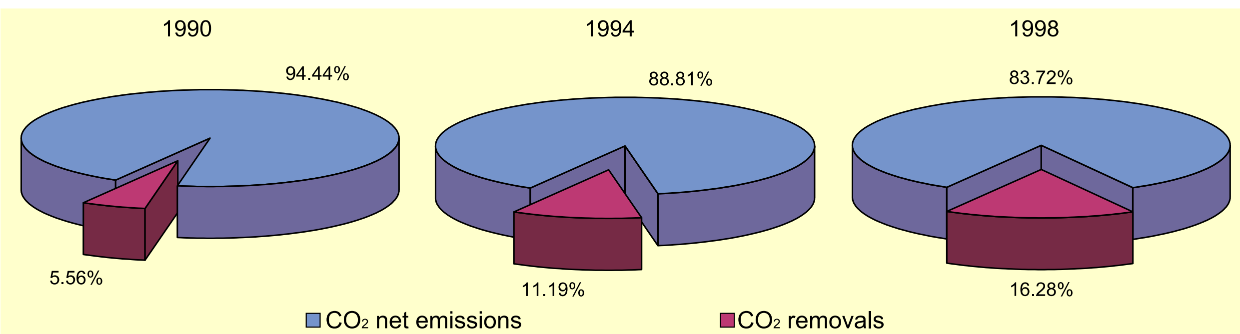


Figure 2.13. Storage potential of CO_2 emissions by forests in 1990. 1994 and 1998

3. PROGNOSIS OF THE GREENHOUSE GAS EMISSIONS

3.1. PROGNOSIS OF THE SOCIAL-ECONOMIC DEVELOPMENT OF THE REPUBLIC OF MOLDOVA UNTIL THE YEAR OF 2010

The prognosis of the greenhouse gases emission was carried out in accordance with the draft "Strategy for Social Economic Development of the Republic of Moldova until the Year of 2010" developed by the Ministry of Economy and Reforms. The project was based on the Resolution of the Government No. 1107 of November 6, 1998 "On the Strategy for Social-Economic Development of the Republic of Moldova until the Year of 2005" and on the updated data of the Ministry of Economy and Reforms in coordination with other ministries, departments and research institutions in correspondence with the situation as of June 1, 2000. The document operates with the indicators resulting from the macroeconomic development until the year of 2010. The first macroeconomic model considered was the inertial one (I), which forecasts for the 2000–2010 period an annual GDP growth of 1.5% and a minimal level of external funding for the main sectors of the national economy. The second model (II) which was considered as the basic one, forecasts an annual GDP growth of about 6.7% and an amount of external funding oriented expressly towards the sector of services.

The main macroeconomic indicators *(Table 3.1)* were used for the evaluation of GHG emissions according to the abovementioned models.

Table 3.1 The progress of the main macroeconomic indicators in accordance with the draft "Strategy for Social-Economic Development of the Republic of Moldova until the Year of 2010"

Index	Measuring units	Real estimation		2000 models		2005 models		2010 models	
		1994	1998	I	II	I	II	I	II
GDP in real terms	bill.lei	4.7	9.1	15.4	16.1	26.5	33.3	40.0	63.2
-as opposed to preceding year	%	69.1	93.5	97	101	102	107	102	108
-consum. prices index, annual average as opposed to preceding year	%	587	108	131		106		104	
Average exchange rate of the national currency	lei/1US	4.1	5.4	12.7		19.2		23.8	
Commercial balance amount	$USmill.	-94	-392	-200		-220		-205	
Agricultural production as opposed to preceding year	%	76	89	95	101	104	108	104	107
Industrial production as opposed to preceding year	%	72	85	100	105	104	108	104	108
GDP, structure of expenses by chapters:	%	100	100	100	100	100	100	100	100
a. Agriculture	%	27	26	23	23	23	24	27	23
b. Industry	%	31	17	17	17	19	18	22	19
c. Construction	%	5	3	3	3	3	3	3	3
d. Transport and communication	%	6	7	6	6	6	5	4	5
e. Other sectors	%	24	32	41	40	38	39	34	40
f. Net taxes per product and imports	%	7	15	11	11	11	11	10	10

The prognosis of the GHG emissions for the Energy sector until 2010 was carried out taking into account the documents "Energy Strategy of the Republic of Moldova" and "Action plan in the energy sector" which were approved by the Resolution of the Government No. 360 of April 11, 2000. Among the objectives of the strategy were the following: increase of the productive potential of the energy sector, identification and application of more effective technologies for utilisation of the energy resources which provide for the reduction of the greenhouse gas emissions in the sector as well.

The prognosis of the electricity consumption was made taking into account the general prognosis of GDP evolution as well as based on the evolution of the share of national economy sectors using the models described above.

According to models I and II of macroeconomic development of the country by the year of 2010 the electricity consumption will amount to about 54% and 83%, respectively as opposed to 1990 *(Table 3.2).*

Table 3.2 The electricity needs until the year 2010, million KWh

Real consumption			Prognoses			
1990	1994	1998	Models	2000	2005	2010
12,647.2	5,557.8	4,623.6	I	4,464.5	5,378.9	6,831.2
			II	4,679.6	7,046.4	10,542.6

According to the calculations, over the period 2000-2010 the fuel consumption will not reach the level registered in 1990 and will amount, depending on the model used, to only 44.5-70.5% of the base year *levels* *(Table 3.3)*. Thus, depending on the social-economic model used, the consumption of fuel oil will be about 17-26%, coal – about 31–48%, natural gas – about 75–118%, liquid fuel used in transportation: gasoline – about 44-75%, Diesel oil – about 37-63%, gasser liquefied gas – about 14–23%, liquid natural gas – about 59–109% of the amount consumed in the base year.

Table 3.3 Prognosis of the fuel consumption until the year of 2010, PJ

Real consumption			Prognoses			
1990	1994	1998	Models	2000	2005	2010
352.15	162.86	130.82	I	108.61	127.13	156.86
			II	113.85	187.81	248.10

3.2. PROGNOSIS OF THE ANTHROPOGENIC GREENHOUSE GAS EMISSIONS UNTIL THE YEAR OF 2010

The prognosis of emissions was calculated in accordance with the main macroeconomic indicators *(Table 3.1)*. Based on the two macroeconomic models other two models were developed for the prognosis of the direct GHG emissions (CO_2, CH_4, N_2O). Each model comprises three scenarios: basic, minimal and maximal. The basic scenario provides the prognosis of GHG emissions reflecting the tendency for economic growth in the prior sectors, but it does not include the abatement actions. The minimal scenario gives the prognosis of the GHG emissions with moderate abatement actions and based on the same tendencies for economic growth. The maximal scenario shows the prognosis of GHG emissions based on maximal actions for their abatement.

In the prognosis of GHG emissions only the sectors with the greatest share in the total amount of GHG direct emissions were taken into account.

The scenarios of the first model are considered to be the most realistic. In these scenarios, by the year of 2010, the total GHG emissions per capita will amount to only 33–46% of the respective emissions of the base year *(Figure 3.1)*, while the total GHG direct emissions will amount to a figure between 10,722 and 15,284 Gg, depending on the scenario used *(Table 3.4)*.

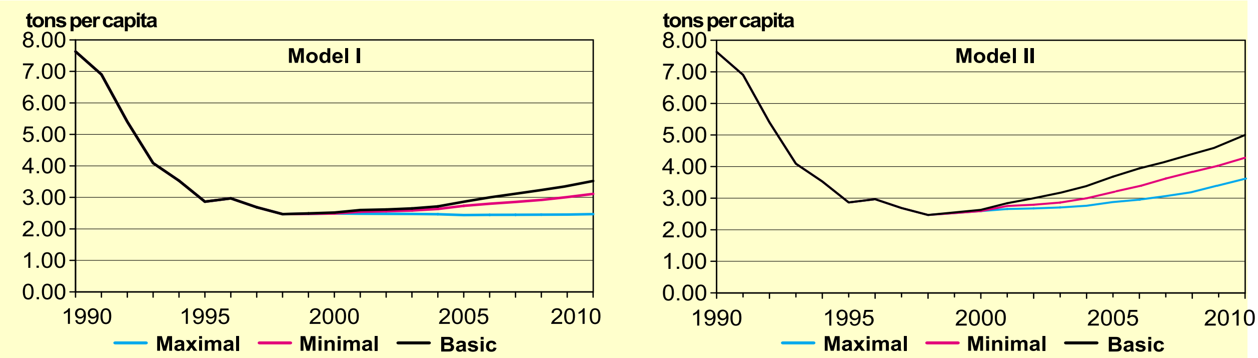


Figure 3.1. Progress of the total emissions of gases with direct greenhouse effect per capita

For the scenarios of the basic model (II) the period 2000–2010 will show a continuous tendency towards increase of GHG emissions per capita *(Figure 3.1)*, while total GHG direct emissions will amount in 2010 to about 42-66% of the base year emissions depending on the scenario used *(Table 3.4)*.

3.2.1. Prognosis of Direct Greenhouse Gas Emissions for the Energy Sector

The prognoses are based on the analyses carried out using RASTR program, which calculates complex regimes of the energy systems and simulates the prospects for the sector development. This program optimises the power of sources and all the parameters of the system depending on their configuration by connecting and disconnecting the system nodes *(Annex C)*.

The prognosis of the direct GHG emissions until 2010 in the Energy sector was carried out taking into account the following actions:

- Structural changes and modernization of the national economy sectors;
- Different options for imported energy supply and development of national capacities for energy production;
- Extension of energy production capacities through modernization and building of power stations and heating stations;
- Reduction of electricity losses in the power distribution network.

According to prognoses for the scenarios of models I and II until 2010, the total GHG emissions expressed in CO_2 equivalents will not exceed the emissions registered in the base year. They will amount to only about 29–41% and 42–65% of the 1990 levels, respectively *(Table 3.5)*.

Table 3.4. Scenarios of the GHG direct emissions prognoses until 2010

Index	Measuring unit	1990	2010					
			Model I scenarios			Model II scenarios		
			basic	minimal	maximal	basic	minimal	maximal
Population	mill.	4.36	4.34			4.42		
GDP as opposed to 1990	%	100	40.3			68.8		
Total GHG emissions	Gg	33,273	15,284	13,849	10,722	22,112	18,909	14,114
Total CO_2 emissions	Gg	28,323	11,820	10,344	8,436	18,138	15,739	11,689
Total CH_4 emissions, in CO_2 equivalent	Gg	4,059	3,253	2,957	2,130	3,643	2,881	2,216
Total N_2O emissions, in CO_2 equivalent	Gg	891	211	189	156	330	289	210
Total GHG emissions per capita	tons	7.63	3.52	3.11	2.47	5.00	4.28	3.19
CO_2 emissions per capita	tons	6.50	2.72	2.38	1.94	4.10	3.56	2.64

3.2.2. Prognosis of Direct Greenhouse Gas Emissions for the Industrial Processes Sector

In conformity with the prognosis, the total amount of direct GHG emissions expressed in CO_2 equivalents in the Industry sector will amount to about 45-67% of the base year levels for the scenarios of models I and II *(Table 3.6)* in 2010. The metallurgical industry, the industry of building materials and the chemical industry will remain the main sources of emissions. Carbon dioxide will continue to maintain the main share of the total direct GHG emissions registered for the sector.

3.2.3. Prognosis of Direct Greenhouse Gas Emissions for Agriculture Sector

The main sources of emission in the Agriculture sector are the following:

– Livestock sector (processes of enteric fermentation in cattle and the liquid animal waste management);

– Mineralization of soil organic matter;

– Incineration of organic residues in agricultural fields.

According to prognoses, in 2010 the total direct greenhouse emissions in agriculture will amount, for scenarios of models I and II, to about 52–79% of the base year levels *(Table 3.7)*.

In 2010 the share of CH_4 and N_2O emissions in agriculture will amount to about 95% and 5%, respectively. In 1990 the proportion was about 76% and 24%, respectively.

3.2.4. Prognosis of Direct Greenhouse Gas Emissions for Waste Sector

In the prognosis of the direct greenhouse gas emissions from waste only CH_4 emis-

Table 3.5 Prognosis of the direct greenhouse gas emissions for the Energy sector, Gg CO_2 equivalent / year

Year	Real emissions	GHG emissions, prognoses						
		Year	Model I scenarios			Model II scenarios		
			basic	minimal	maximal	basic	minimal	maximal
1990	27,150	2000	7,750	7,672	7,669	8,128	8,047	8,047
1994	12,203	2005	9,071	8,627	7,594	11,986	11,120	9,926
1998	7,545	2010	11,134	9,660	7,794	17,651	15,274	11,369

Table 3.6 Prognosis of direct greenhouse gas emissions originating in the Industrial processes sector, Gg CO_2 equivalent / year

Year	Real emissions	GHG emissions, prognoses						
		Year	Model I scenarios			Model II scenarios		
			basic	minimal	maximal	basic	minimal	maximal
1990	2,539	2000	1,344	1,301	1,296	1,356	1,308	1,306
1994	689	2005	1,438	1,357	1,274	1,563	1,489	1,418
1998	1,228	2010	1,539	1,387	1,133	1,707	1,520	1,218

Table 3.7 Prognosis of direct greenhouse gas emissions for Agriculture sector, Gg CO_2 equivalent / year

Year	Real emissions	GHG emissions, prognoses						
		Year	Model I scenarios			Model II scenarios		
			basic	minimal	maximal	basic	minimal	maximal
1990	2,811	2000	1,366	1,366	1,366	1,453	1,414	1,414
1994	1,953	2005	1,621	1,540	1,409	2,068	1,951	1,634
1998	1,345	2010	2,095	1,938	1,450	2,215	1,748	1,176

sions are taken into account *(Table 3.8)*. In this sector the GHG emissions originate mainly from the solid waste stored in waste disposal pits, from domestic and industrial waste water. The actions for reducing direct greenhouse gas emissions in the sector will allow for the decrease of their amount by the year of 2010 depending on the scenarios of the used models by about 172–187 Gg.

3.3. PROGNOSIS OF TOTAL DIRECT GREENHOUSE EMISSIONS

According to prognoses, during the 2000-2010 period the total direct GHG emissions expressed in CO_2 equivalents will not exceed their respective registered levels of the 1990 year *(Table 3.9)*, amounting depending on the scenarios of the used models (I or II) to about 32-46% and, respectively to 42–66% of the base year levels *(Figure 3.2)*.

Depending on the scenarios of the applied models (I or II), CO_2 emissions will vary in the range of 30-42% and, respectively, 41-64% *(Figure 3.3)*, CH_4 emissions – in the range of 52–80% and, respectively, 55–90% *(Figure 3.4)*, N_2O emissions – in the range of 17–24% and, respectively, 24–37% *(Figure 3.5)* of their respective levels registered in 1990.

According to the scenarios of model I, over the 2000-2010 period, the structure of direct GHG emissions will show insignificant change *(Figure 3.6)*.

According to the scenarios of model II, the structure of GHG direct emissions will change: the share of CO_2 in the total emissions will grow, while the share of CH_4 will decrease. By 2010 the structure of GHG emissions for the scenarios of model II will be close to the one registered in 1990.

Over the period 2000-2010 the sources of

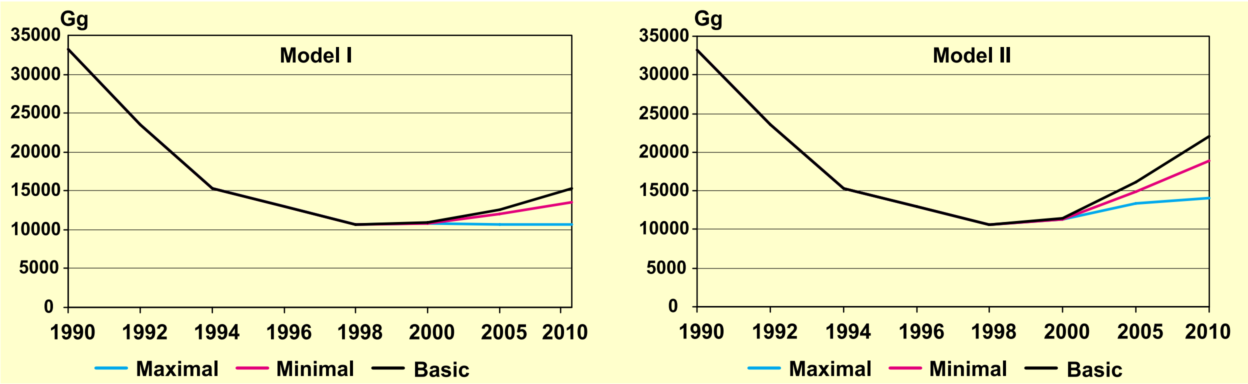


Figure 3.2 Prognoses of total direct greenhouse gas emissions expressed in CO_2 equivalents

Table 3.8 Prognosis of direct greenhouse gas emissions for Waste sector, Gg CO_2 equivalent / year

Year	Real emissions	CH_4 emissions, prognoses						
		Year	Model I scenarios			Model II scenarios		
			basic	minimal	maximal	basic	minimal	maximal
1990	768	2000	498	498	498	499	498	498
1994	509	2005	504	499	338	514	348	338
1998	498	2010	512	500	341	534	363	347

Tabel 3.9. Prognosis of total direct greenhouse gas emissions, in Gg CO_2 equivalent / year

Year	Real emissions	GHG emissions, prognoses						
		Year	Model I scenarios			Model II scenarios		
			basic	minimal	maximal	basic	minimal	maximal
1990	33,273	2000	10,963	10,842	10,834	11,441	11,271	11,269
1994	15,359	2005	12,640	12,098	10,618	16,136	14,913	13,322
1998	10,621	2010	15,284	13,489	10,722	22,112	18,909	14,114

emissions with the greatest share of total direct GHG emissions will be found in the activities dealing with power and heat production, as well as the fuel consumed in transportation, followed in a decreasing order by the activities specific to the Agriculture, Industry, Waste and Solvents sectors. According to the scenarios of the first model, as opposed to 1990, the share of emissions originating from the Energy sector will decrease, while the percentage of emissions for the Industry, Agriculture and Waste sectors will increase *(Figure 3.7)*.

The scenarios of model II for the period 2000-2010 forecast a reduction of the share of the emissions originating from Agriculture as opposed to 1990.

3.3.5. Prognosis of CO_2 Sequestration by Forests

For the prognosis of CO_2 sequestration by forests, the land use changes were taken into account for agricultural land, pastures and forests *(Figure 3.8)*.

By the year of 2010 the sequestration ca-

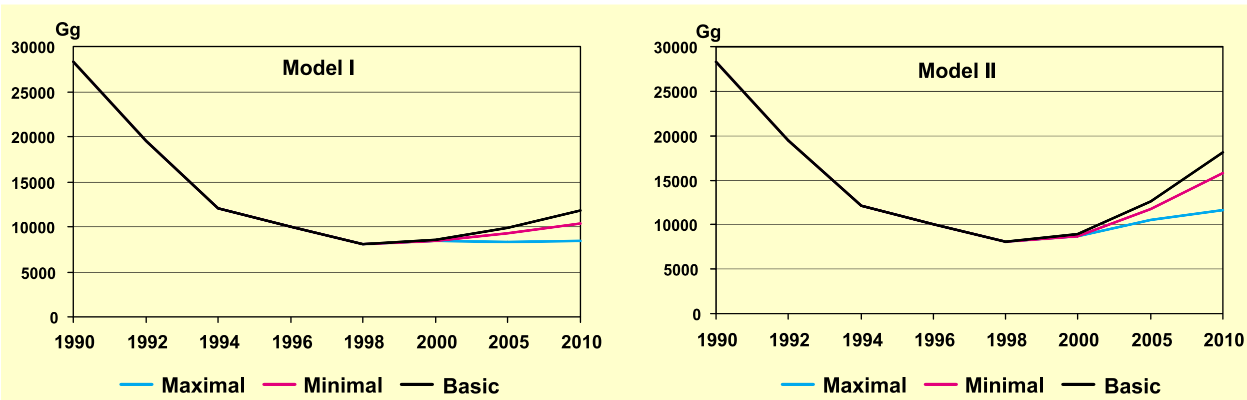


Figure 3.3 Prognoses of CO_2 emissions until 2010

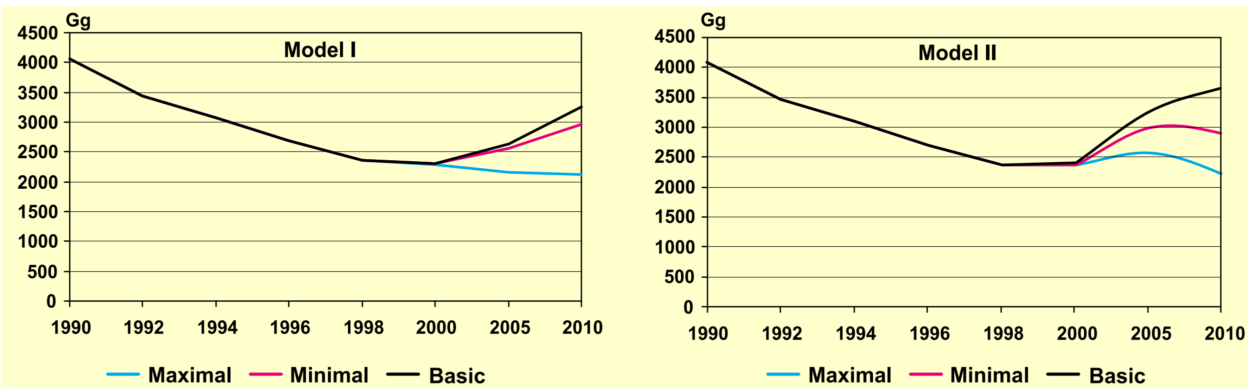


Figure 3.4 Prognoses of CH_4 emissions expressed in CO_2 equivalents until 2010

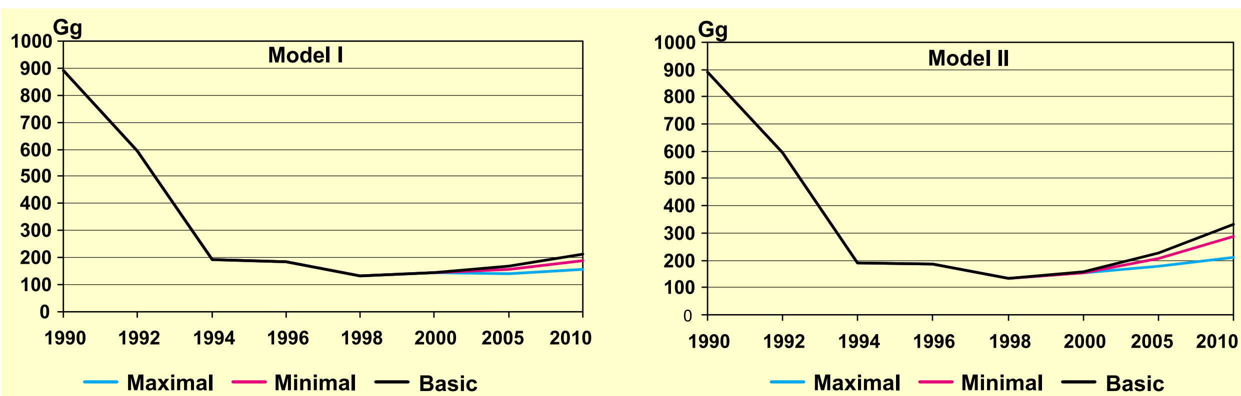


Figure 3.5 Prognoses of N_2O emissions expressed in CO_2 equivalents until 2010

pacity of direct GHG by forests expressed in CO_2 equivalents will increase depending on the scenarios of the used models (I or II) by 7-18% and, respectively, by 4–12% as opposed to the storage level for total GHG emissions in the base year (1990).

The total net emissions expressed in CO_2 equivalents will amount for the scenarios of models I and II, respectively, to only about 27-42% and 37-64% of the base year levels *(Figure 3.9)*.

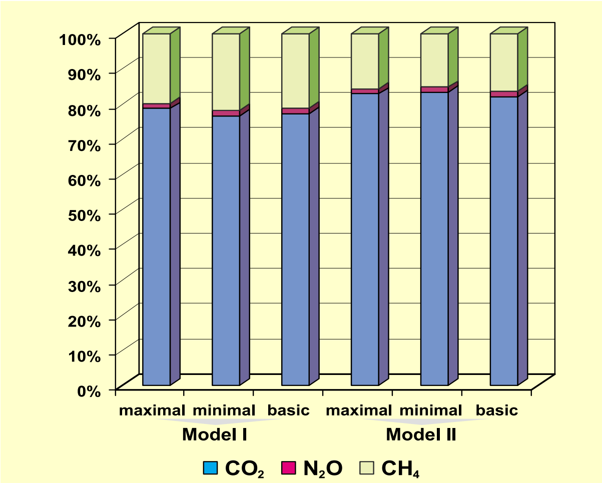


Figure 3.6 Prognoses of the structures of total direct GHG emissions expressed in CO_2 equivalents in 2010

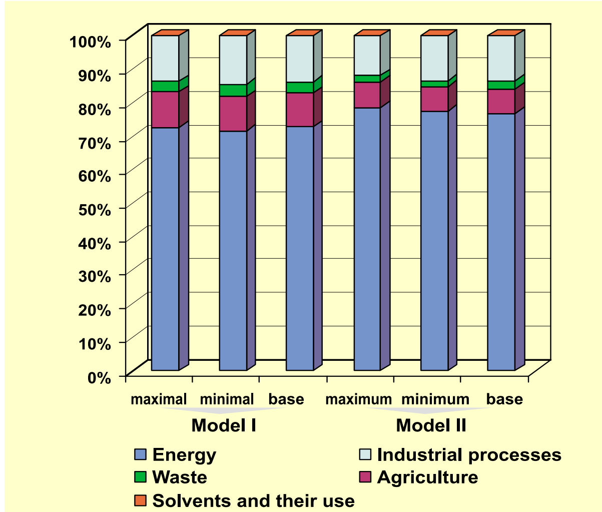


Figure 3.7 Prognoses of total direct GHG emissions expressed in CO_2 equivalents (depending on sources) in 2010

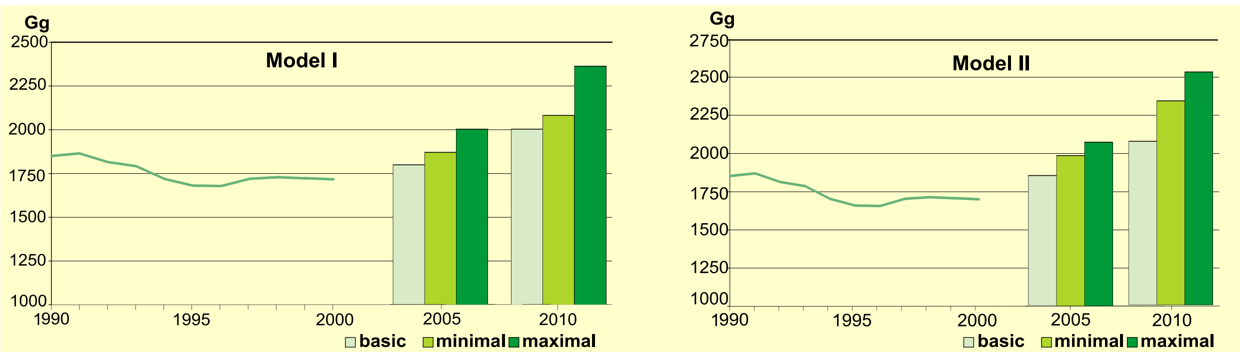


Figure 3.8. Prognosis of CO_2 reduction resulting from agricultural land use change and forestry, Gg

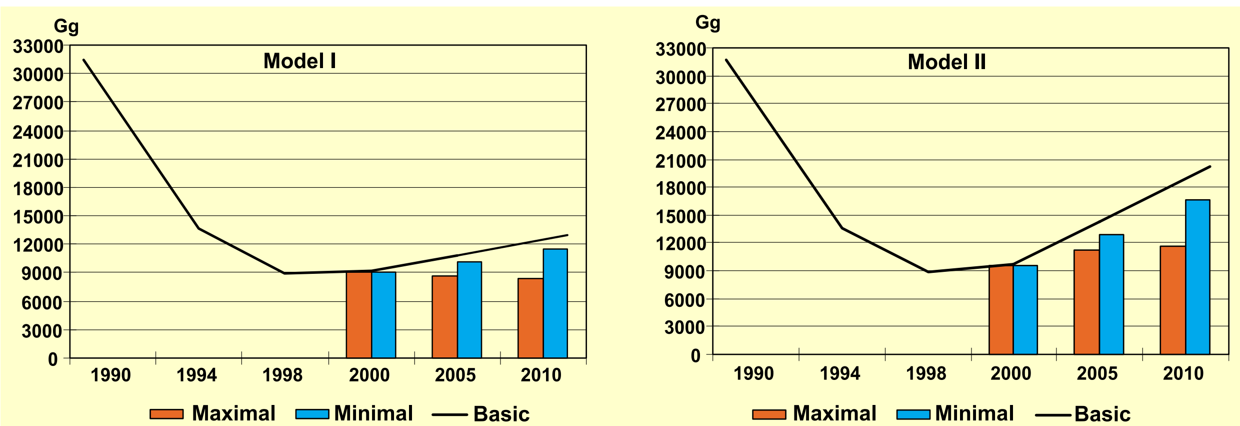


Figure 3.9. Prognosis of net direct greenhouse gas emissions expressed in CO_2 equivalents

4. GREENHOUSE GAS EMISSIONS ABATEMENT

In the Republic of Moldova no specific strategy has been adopted on the abatement of greenhouse gas emissions. The actions that are currently in the process of implementation regarding the improvement of the legal framework, restructuring and modernization of the economic sectors, the increase of energy efficiency and energy conservation, will indirectly contribute to greenhouse gas emissions abatement. To this end, over the last years, several important documents were developed in the area of environmental protection. Thus, in 1995, the central environmental protection authority has published with the support of the World Bank the National Strategic Action Plan in Environmental Protection. Another important document is the National Plan for Short Term Activities in the Area of Environmental Protection. This National Communication is the first fundamental document dedicated to the assessment of greenhouse gas emissions, estimation of climate change impacts, development of activities for emissions abatement and measures for adaptation to climate change.

4.1 LEGAL FRAMEWORK

The legal document regulating the protection of the environment in the Republic of Moldova is the Law No. 1515-XII of June 16, 1993 on Environmental Protection. This law directly addresses the ecological security of the population, the rational use of natural resources, as well as nature conservation and environmental protection. A special chapter is dedicated to the protection of the atmospheric air. According to Article 55, the standards for air quality should be established by the central environmental protection authority in coordination with the Ministry of Health and the Academy of Sciences and they are subject to approval by the Parliament.

In compliance with the Law No. 851-XIII of May 29, 1996 “On the Ecological Expert Evaluation and the Assessment of Impacts on Environment”, the air quality is the main index in the impact estimation.

The Law No. 1422-XIII of December 17, 1997 “On the Protection of the Atmospheric Air” specifies the exact norms in this area. In order to prevent the air basin pollution the observance of some norms is required both in respect to the admissible pollution indices and regarding the air quality indices. The abovementioned norms prescribe the maximal admissible concentrations for a number of atmospheric pollutants for certain zones and periods of time.

In conformity with Article 16 of the Law on the Sanitary-Epidemiological Security of the Population, the sources emitting noxious substances should be separated from residential areas by sanitary zones.

The economic tool for air basin protection is based on air pollution taxes. The methods for these taxes calculation are prescribed by Law No. 1540-XIII of February 25, 1998 “On Environmental Pollution Taxes”. The taxes vary depending on the type of pollution sources (stationary or mobile) and on the degree of pollution.

4.2 INSTITUTIONAL FRAMEWORK

The Ministry of Environment and Territorial Development is the central public professional authority designated to manage the activities dealing with the implementation of actions recommended by the United Nations Framework Convention in Climate Change. The respective ministry reports on the observance of the Convention provisions in the Republic of Moldova. The National Communication builds the awareness in policies and measures applied both for the GHG emissions abatement and for the evaluation and adaptation of local systems to climate change.

4.3 ACTIONS FOR GREENHOUSE GAS EMISSIONS ABATEMENT

4.3.1 Energy Sector

The strategic objectives of the national energy policy until the year of 2010 will be reached through the following actions:

- Increase of the energy efficiency and energy conservation;
- Implementation of efficient energy technologies with minimal impact on environment
- Introduction of renewable energy resources in the consumption balance in case they prove economically competitive;
- Promotion of an active energy conservation policy with the consumer;
- Observing the international standards and norms for prevention of environment pollution.

The achievement of these objectives will conduct to the GHG emissions reduction and to the improvement of environment state. In case of abatement actions implementation provided for in the scenarios for macroeconomic development number I and II *(Table 4.1)*, a growth of the energy efficiency and a substantial reduction of GHG emissions will be achieved.

4.3.2 Transport Subsector

For the Transport sector the strategic objectives in view of greenhouse gas emissions abatement will be implemented through some short-term (2000–2010) actions *(Table 4.2)*. The short term actions are oriented towards activities which need no major investments and no significant modifications in the technologies used. The implementation of such actions will have no essential GHG emissions abatement effects. The medium term actions need substantial investments dealing with the modification of some vehicles share in the total transport and with their modernization. The implementation of such set of actions over the 2000–2010 period will result in a substantial abatement of GHG emissions originating in the sector, namely, a decrease of about 426–1,066 Gg for model I scenarios and 816–1,470 Gg for model II scenarios.

4.3.3 Industrial Processes Sector

The development strategy for the Industry sector which is currently being worked out, takes into account the need for the decrease of the industrial activities impacts on environment, including the need for GHG emissions abatement. The GHG emissions abatement actions are listed only for branches with major contribution in the total amount of direct GHG emissions *(Table 4.3)*. If these actions are implemented in their entirety the country will benefit from GHG emissions abatement in the amount of 585-1,180 Gg for the scenarios of model I and, respectively, 712–1,4565 Gg for the scenarios of model II.

4.3.4 Agriculture Sector

The strategy of the Agriculture sector in respect to the GHG emissions abatement is based on sustainable agricultural practices capable of effectively using the waste produced in the agricultural farm. The GHG emissions abatement in the area of agriculture is based on reducing such sources of emission as the burning of vegetal residues in the field, livestock waste handling, mineralization of organic matter in soil. The growth of the biologic productivity of the natural and agricultural ecosystems with high photosynthetic potential that increases carbon dioxide sequestration will contribute to the GHG emissions abatement.

Table 4.1. Actions Plan in the Energy Sector for Energy Resources Conservation and GHG Emissions Abatement for the 2000–2010 Period

Abatement actions	Model I				Model II			
	Minimal scenario		Maximal scenario		Minimal scenario		Maximal scenario	
	Energy conservation, thou.t.c.e.	GHG emission abatement, Gg	Energy conservation, thou.t.c.e.	GHG emission abatement, Gg	Energy conservation, thou.t.c.e.	GHG emission abatement, Gg	Energy conservation, thou.t.c.e.	GHG emission abatement, Gg
Energy producing sector:	3184.9	3706.1	6226.6	6673.0	4662.5	4806.6	9044.9	8047.9
– Growth of natural gas share at the expense of coal by a minimum of 2.5% and a maximum of 5% of the total fuel consumption in the energy producing sector;	0.0	871.7	0.0	1307.5	0,0	1228.8	0.0	1843.2
– Growth of the energy efficiency by at least 2.5% and maximally by 5% in the energy producing sector;	2234.8	1472.7	4469.6	2945.4	2993.7	2345.7	5987.4	3511.6
– Extension of the energy producing capacities through building of heat generation stations and replacing condensation turbines with gas ones;	588.9	832.5	1034.7	1461.9	1170.7	1651.9	2061.2	2911.2
– Growth of the energy efficiency by minimally 5% and maximally 10% in the small combustion subsector;	300.8	445.5	601.5	890.9	410.1	675.1	820.3	1350.3
– Growth of the energy efficiency by minimally 5% and maximally 10% in the industrial processes subsector.	60.4	83.7	120.8	167.3	88.0	133.9	176.0	267.8
Renewable sources of energy:	72.0	101.6	387.2	648.3	156.6	221.5	969.4	1371.8
– Utilization of available capacities of solar energy, a 1,300 KWh/m^2 collector per year, application of minimally 0.1 mill. of solar collectors and a maximum of 0.6 mill. solar collectors;	72.0	101.6	144.0	304.8	144.0	203.2	432.0	610.4
– Examination of some feasibility studies regarding the optimal sites for the extension of water power potential of the country by maximally 180 mill. kWh/year;	0.0	0.0	204.3	288.6	0.0	0.0	459.6	651.6
– Utilization of biomass energy resources through implementation of technologies for obtaining and utilization of biologic gas (the available capacity of energy originating from biomass is estimated at about 532 thousand t.c.e./year).	0.0	0.0	38.9	54.9	12.6	18.3	77.8	109.8

Table 4.2. Action plan in transport sector in view of greenhouse gas emissions abatement for the 2000-2010 period.

Short-Term Objectives, 2000-2005

- Traffic control for avoidance of roads congestion;
- Adequate management of the park of automobiles through limitation of engines idle work, especially Diesel ones;
- Building of urban transportation networks and of underground passages for pedestrians in order to avoid pollution;
- Use of non-ethylated gasoline, natural gas and gasser liquefied gas;
- Application of differentiated taxes: smaller – for vehicles which avoid city roads and larger – for using the urban ones;
- Limitation of old automobiles import, which do not comply with the environmental protection norms.

Medium-Term Objectives, 2000-2010

- Modernization and replacement of vehicles;
- Electrification of the Ungheni-Razdelnaia railway line;
- Reconstruction of city roads, creation of zones forbidden for transportation;
- Building of loop-like roads, avoiding cities;
- Increase of railway and fluvial transportation potential;
- Reconstruction of national roads and improvement of their maintenance quality according to international standards;
- Establishment of some transportation services equipped with containers and terminals for commodities dispatch assisted by computer technologies.

Table 4.3. Action plan in the industry sector in view of GHG emissions abatement until the year of 2010

Metallurgical Industry:

- Emission abatement through better management of installations and equipment of the production entities and energy networks;
- Observance of a ratio between scrape metal raw material and the necessary additions of auxiliary substances;
- Installation of monitoring equipment and tools for automatic disconnection of electrical power in case of necessity;
- Reducing costs for energy distribution and use, increase of the energy-economic efficiency;
- Introduction of automated control procedures to avoid overheating of high voltage connectors for fixing the electric heaters and the gases emitted in ovens in the process of water cooling in closed circuit;
- Maintenance of an established ratio between water and gases emitted in the process of metal smelting in furnaces prior to their release into the atmosphere;
- Training of the staff responsible for technological processes;
- Rational use of natural and energy resources;
- Automation of basic parameters control.

Cement Industry:

- Modernization of equipment and technologies;
- Assurance of more efficient production from ecologic and economic perspectives through automated control systems and disconnection in case of failure;
- Installation of automated control systems for set technological parameters;
- Implementation of procedures for natural gas and fuel oil desulphuration;
- Recycled combustion of gases;
- Limitation of refuse through observation of set parameters in preparation of mixtures.

Table 4.4 Action plan in the agriculture sector in view of GHG emissions abatement until the year of 2010

In plant production:
- Development of organic agriculture;
- Promotion of a strategy for agriculture orientation towards a sustainable system of development;
- Utilization of modern technologies and extension of irrigated surfaces;
- Growth of the photosynthetic capacity of crops;

In livestock farming:
- Increase of livestock productivity through application of genetic amelioration technologies, livestock optimization;
- Reduction of the fodder used through improvement of ration quality;
- Recovery of methane originating from livestock waste decomposition.

The strategic objectives of GHG emissions abatement in the Agriculture sector will be achieved through the actions listed in *Table 4.4*. According to scenarios of the considered models (I and II), the direct GHG emissions over the period 2000–2010 will abate by 798–1,802 Gg and by 2,469–4,923 GG, respectively.

4.3.5. Waste Sector

The annual amount of domestic waste in the country is estimated at about 700 thousand tons. As a rule, the domestic and industrial waste is deposited in waste disposal sites. The total surface of these sites is about 1,144 ha. The waste handling is a prior problem; it is included in the "National Action Plan in the Area of Environmental Protection" and, as a special item, in the "National Plan for Utilization of Industrial and Domestic Waste" approved by the Resolution of the Government No. 606 of June 28, 2000. The prior activities of these programs are as follows:

- Utilization and neutralization of existing waste;
- Minimization of waste generating sources;
- Giving up the utilization of raw materials containing toxic substances;
- Decrease of waste toxicity until its elimination;

Table 4.5 Action plan in waste sector in view of GHG emissions abatement until the year of 2010

Solid domestic waste
- Waste storage management;
- Waste recycling through its use as secondary raw material;
- Organization and improvement of the system for waste accounting;
- Promotion of ecologically pure production in companies and implementation of non-polluting technologies.

Waste from purification plants for domestic and industrial residual water:
- Technology improvement and assurance of continuous operation of existing systems for residual water treatment with organic components observing the requirements of the normative acts for their exploitation;
- Construction of methane tankers and other installations based on a feasibility study for treatment of mud and utilization of methane;
- Feasibility study for utilization of biologic gas from mud treatment at the purification plants of big cities.

– Separate collection of domestic waste.

The actions needed for the utilization of the domestic and industrial waste are listed in Table 4.5. The implementation of this set of actions in its entirety will contribute to the abatement of GHG emissions from this sector by about 51–1,338 GG for the model I scenarios and by 828–1,449 Gg for model II scenarios.

4.3.6. Land Use Change and Forestry Sector

The current forest cover degree of the country is far from optimal yet. The utilization of the potential for forests extension for the amelioration of the ecologic condition, including greenhouse gas emissions sequestration, is an important component of the ecological policy of the state.

The actions needed in this respect *(Table 4.6)* are included in the draft "Strategy for Sustainable Development of the Forest Sector of the Republic of Moldova".

Table 4.6. Action Plan in the Land Use Change and Forestry Sector until the Year of 2010

- Extension and amelioration of actions for protection of forests against diseases and pests, including
  - a) forest pathology supervision;
  - b) implementation of actions for air and terrestrial fighting of pests;
- afforestation of water basins protection zones (about 20 thousand hectares);
- planting of forest belts for protection of water basins (about 9 thousand hectares);
- afforestation
  - c) in Southern regions – about 50-60 thousand hectares;
  - d) in Northern regions – about 40-50 thousand hectares;
  - e) in Center regions – about 45-55 thousand hectares;
- establishment and extension of seeding bases for cultivation of reproduction material of local species.

5. VULNERABILITY ASSESSMENT AND ADAPTATION ACTIONS

The evaluation of natural ecosystems and artificial phytocenoses vulnerability degree, depending on the eventual rate of climate change, was carried out in two stages.

First, taking into account the current state of these systems, some aspects were revealed which could determine the vulnerability degree depending on the new climatic conditions. These aspects of the current stage were accounted for as risk factors which could, in the future, substantially affect the vulnerability degree of the system.

Secondly, upon the estimation of these factors, the vulnerability degree of the systems was evaluated depending on the new climatic conditions evaluated in conformity with models for climatic indices evolution.

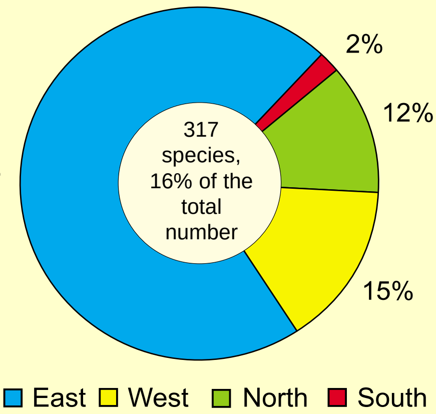
5.1. RISK FACTORS CONDITIONING VULNERABILITY

5.1.1. Natural Ecosystems

The severity of the climate change impacts on the natural ecosystems depends, to a great extent, on the current state of flora and fauna. The greater the biological diversity and the capacity for adaptation to new conditions of the environment, the lesser the impacts consequences and vice versa. For these reasons, currently the need exists to reveal those flora and fauna features, which could later determine the climate change related vulnerability degree of ecosystems. The current features which could affect the vulnerability degree are as follows:

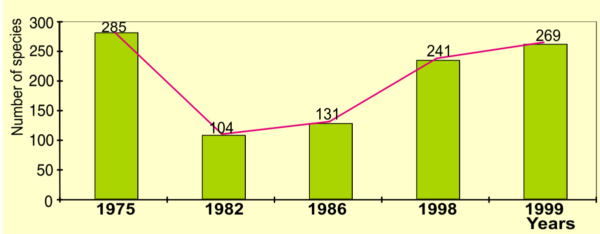
For flora:

- a high percentage of species with marginal placement or located at the border of their habitats *(Figure 5.1)*
- the increase, especially over the last years, of the number of species qualified as rare and disappearing species *(Figure 5.2)*



317 species of higher plants of the spontaneous flora are at the borders of their habitats. The highest percentage of this number refers to the species with habitats farther to the East (71%) and to the West (15%). A number of 1,341 plants are located at the border of their habitats. Most of these species refer to the Asteraceae (234), Fabaceae (126) and Poaceae (142) families.

Figure 5.1. Percentage of higher plant species of the spontaneous flora of the Republic of Moldova located at the borders of their habitats.



Currently, 117 species of plants of the spontaneous flora of the Republic of Moldova are included in the Red Book. Out of the total number of rare species, 48 species are typical for forest ecosystems, 32- for steppes, 19 are petrodophilous and 18- meadow specific ones.

Figure 5.2. Progress of rare and disappearing species of the flora in the Republic of Moldova

– reduced share and fragmented distribution of natural ecosystems.

For fauna:

– High and differentiated risk of decrease of vertebrate species numbers. The mammals and the predatory birds are the most affected from this viewpoint;

– Localization in limited, isolated and dispersed spaces. About 80% of the fauna species live in forest ecosystems with limited surfaces.

For ecosystems:

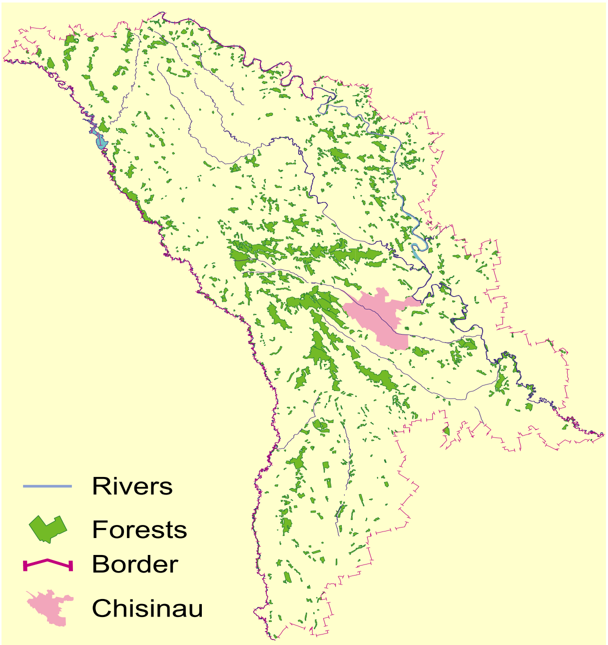
Forests

– Uneven and dispersed distribution of forest areas *(Figure 5.3)*;

– Extremely small share of occupied surfaces;

– Very high dependence on the limitative factor, the soil humidity, the factor becoming more severe;

– Prevalence of older age trees with reduced viability;



Surfaces covered with forest vegetation amount to 325 thousand hectares. The territory distribution comprises about 800 forest formations with surfaces from 5 to 1,500 hectares.

Figure 5.3. Distribution of forest surfaces in the Republic of Moldova

– Extension of zones with high degree and rate of drying;

– Increase of surfaces affected by pests and diseases.

Steppes

– Advanced dispersion of highly degraded habitats;

– Extension of a considerable number of basic species of phytocenoses to the habitats borders;

– Prevalence of phytocenoses with a reduced number of species (secondary ecosystems) within steppe ecosystems;

Meadows and Humid Zones

– Advanced misbalance of cenoses caused by the anthropogenic factor;

– Degradation of water and saline regimes;

– Frequent fluctuation of phreatic water levels

Water Resources

– Uneven distribution across territory;

– High dependence on the amount and seasonal distribution of atmospheric precipitation;

– Lack or unsatisfactory state of water protection zones;

– Severe mudding of accumulation lakes and reduced capacity for water debit control;

– Substantial increase of the mineralization degree and the pollutants contents in the surface water in dry seasons;

Soils and Land Resources

– High dehumification rates. Humus contents decrease by 30-40% over the last 100 years *(Figure 5.4)*;

– Erosion intensity (annual soil loss is 18.5 tons per hectare);

– Landslides intensity, especially over the last years (the affected surface is 24 thousand hectares;

– Physical, biological and chemical degradation conditioned by dehumification and erosion processes.

5.1.2. Artificial Ecosystems. Agricultural Ecosystems

In 1998 in the Republic of Moldova a number of 511 varieties and hybrids representing 74 plant species were homologised and recommended for use in agriculture; however, about 35% of the agricultural surface of the country was occupied by only three species: winter wheat, corn and vineyards. This situation may conduct to the danger of so-called "genetic vulnerability", in which on large surfaces the number of species is continuously decreasing, while the varieties and hybrids have a high kindred degree. In such cases the projected climatic changes may substantially affect the crops productivity and the food security of the country.

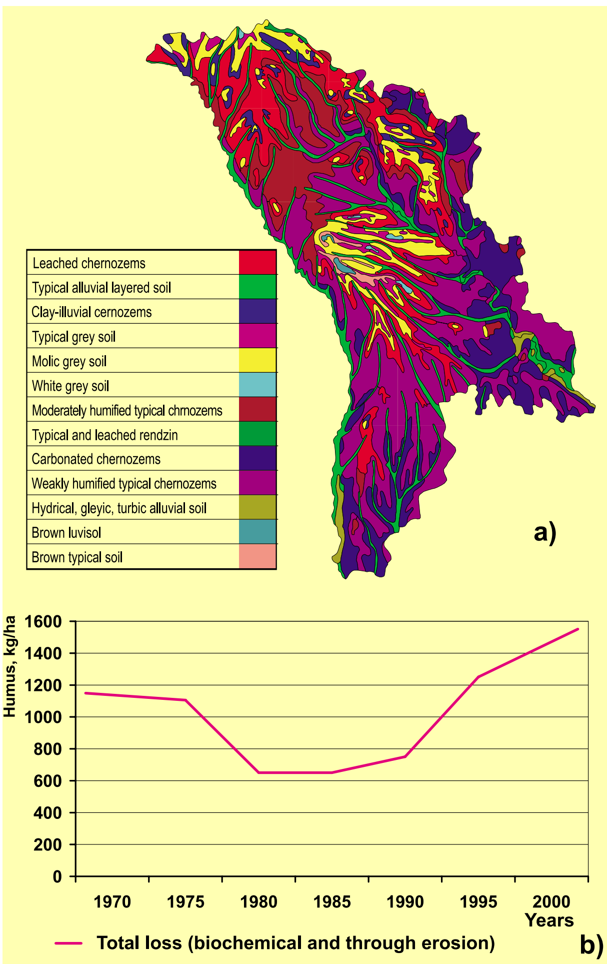


Figure 5.4. Territorial distribution of soil types (a) and the progress of their modification through humus losses (b).

Other reasons which may increase the vulnerability degree of phytocenoses of the Republic of Moldova are the frequency and range of the climatic changes. The parental forms from which the current varieties and hybrids originate were adapted to a slow rate of change in the features of the environment. Thus, the current vegetal organisms have a respective "phyllogenetic and ontogenetic memory" (slow rate of climate factors modification). The climatic features of the second part of the 19th century within frequent modifications and fluctuations with large ranges have suddenly misba-lanced this coevolution rhythm, thus increasing the vulnerability of phytocenoses.

In the conditions of the Republic of Moldova, the risk factors which may condition instability and a high degree of vulnerability in the main agricultural crops are as follows:

– Insufficient soil and air humidity;

– High temperatures during the reproductive phase (pollination period);

– Uneven distribution of atmospheric precipitation over the vegetation period;

– Severe temperature fluctuations (for winter and perennial crops - dramatic temperature falls in autumn and temperature rise during winter; for annual crops – sudden temperature rise or fall in spring for short periods of time, or early frosts in autumn);

– Rate and degree of pests and diseases development.

5.1.3. Public Health

Some of the basic climatic factors which may in conditions of the Republic of Moldova affect in an obvious way the human health, are the atmospheric precipitation and the air temperature. This impact is especially forceful in the periods of extreme manifestations of climatic phenomena. The human health may be subjected to direct effects (heat stress, abundant precipitation) and indirect ones conditioned through the modification of ecosystems, sanitary regime and food security.

The risk factors for the human health originating from the air temperature and precipitation are:

– Heat stress which increases morbidity (a high number of patients with respiratory diseases) and mortality (in case of cardio-vascular pathologies – the infarction, in case of cerebral-vascular diseases – the ictus);
– Extreme climatic events (floods, storms, hail, landslides) may have such consequences as: deceases, traumas, increase of infectious pathologies risks;
– Degradation of natural and artificial systems which leads to worsening of sanitary conditions, may favour emergence of infectious diseases and increase food security dangers.

5.2. REACTION OF NATURAL AND ARTIFICIAL ECOSYSTEMS TO VARIOUS SCENARIOS OF CLIMATIC CHANGE

5.2.1. Climate Change Scenarios

Three climate change models were used for the assessment of sector systems (ecosystems and cenoses) vulnerability: CSIROMk2, HadCM2, ECHAM4.

The analysis of several climate features (average annual data) intended to form a general conclusion in respect to probable climate change leads to the following findings *(Table 5.1)*:

1. According to CSIROMk2 and HadCM2 models (taking into account only the greenhouse gases impact) a stable average annual temperature rise will occur: a 1.4-1.5 ^{0}C rise by '20, a 2.3-2.4 ^{0}C rise – by '50 and a 3.3-3.6 ^{0}C rise by the 80' of the 21st century.
2. Changes in maximal and minimal air temperatures will be very close to the changes in the average air temperatures.
3. The general modifications in precipitations will be more complex: from de-

Table 5.1 Climate Change Scenarios for the Republic of Moldova (annual average values as opposed to reference period, 1961-1990)

Parameter	Models and periods								
	2010-2039			2040-2069			2070-2099		
	CSIROMk2	HadCM2	ECHAM4	CSIROMk2	HadCM2	ECHAM4	CSIROMk2	HadCM2	ECHAM4
Average air temperature, °C	1.4	1.5	2.1	2.3	2.4	3.4	3.7	3.3	4.6
Maximal air temperature, °C	1.4	1.5	1.8	2.3	2.5	3.2	3.6	3.3	4.9
Minimal air temperature, °C	1.5	1.6	1.6	2.5	2.6	3.2	3.8	3.5	4.9
Precipitation, mm/month	47.8	-5.6	-14.4	64.7	-14.6	48.1	60.1	8.4	33.9
Solar radiation w/m^2	-3.8	-	13.1	-6.9	-	5.5	20.8	-	60.3
Absolute humidity, hPa	-	0.7	-	-	1.2	-	-	1.8	-
Wind speed, m/sec	-	0.0	-0.1	-	0.0	0.0	-	0.1	0.0

Note: "-" was not evaluated.

crease according to HadCM2 up to an essential increase, according to model CSIROMk2.

4. A fall in the solar radiation may be presumed over the following fifty years and its rise by the end of the 21st century.

Upon the analysis of the average seasonal evolutions of air temperature and precipitation by season (Table 5.2), the following was found:

1. The winter months have the main contribution to the warming process in the Republic of Moldova.
2. Over the summer period a moderate air temperature warming is expected (a 5-8% rise at the beginning of the century and a 15-20% rise by the century's end.
3. For the winter period a growth in the amount of precipitation is foreseen. Thus, in the future warmer and more humid winters and drier summers are to be expected.

The analysis of the seasonal humidity changes in form of climate diagrams has lead to the conclusion that currently an insignificant period may be estimated as a semi-arid one (end of summer-beginning of autumn), while the intervals between arid climate are lacking *(Figure 5.5)*.

In accordance with the stated climatic indices the scenarios of the projected climate changes on the territory of the Republic of Moldova were developed. The prognoses of the three models applied show the extension of semi-arid periods on the territory of the country and the emergence of the arid climate. The slowest and the most favourable evolution is described by model CSIROMk2; according to this model more significant modifications are to be expected by the 80' of the 21st century. The other two models make projections for a very pronounced aridity with a longer duration already in the first evaluation period (2010-2039). More obvious modifications are predicted according to model ECHAM4, which shows a high draught intensity. The ECHAM4 model reveals extreme events (a well defined trend towards aridization process intensification, *Figure 5.6*). From this viewpoint, the ECHAM4 model was considered as an alternative to model CSIROMk2.

Making an analogy between the trends of the climatic change evolution on the territory of the Republic of Moldova (evaluated

Table 5.2 Prognosis of changes in average air temperature and precipitation by season (%, as opposed to the reference period, 1961-1990)

Season	Models and periods								
	2010-2039			2040-2069			2070-2099		
	CSIROMk2	HadCM2	ECHAM4	CSIROMk2	HadCM2	ECHAM4	CSIROMk2	HadCM2	ECHAM4
Average air temperature									
Winter	66,0	86.4	122	124	143	224	211	210	265
Spring	15.8	11.4	21.8	23.3	15.2	34.3	32.9	22.9	46.2
Summer	5.7	7.3	8.7	10.1	11.8	13.6	15.1	15.9	20.3
Autumn	17.3	17.4	19.0	24.4	29.8	32.3	38.7	37.2	46.6
Annual average	15.3	16.3	22.1	24.7	26.0	37.1	38.5	35.9	49.7
Precipitation									
Winter	15.2	5.4	3.7	26.5	11.7	36.7	32.7	10.3	34.3
Spring	11.3	12.5	-11.9	15.2	9.2	6.1	31.3	21.5	8.9
Summer	6.1	-7.6	-11.4	5.9	-11.6	-13.3	0.6	-13.3	-18.0
Autumn	7.5	-7.5	15.1	8.8	-11.4	27.5	-5.9	3.0	23.0
Annual average	8.7	-1.0	-2.6	11.8	-2.7	8.8	11.0	1.5	0.1

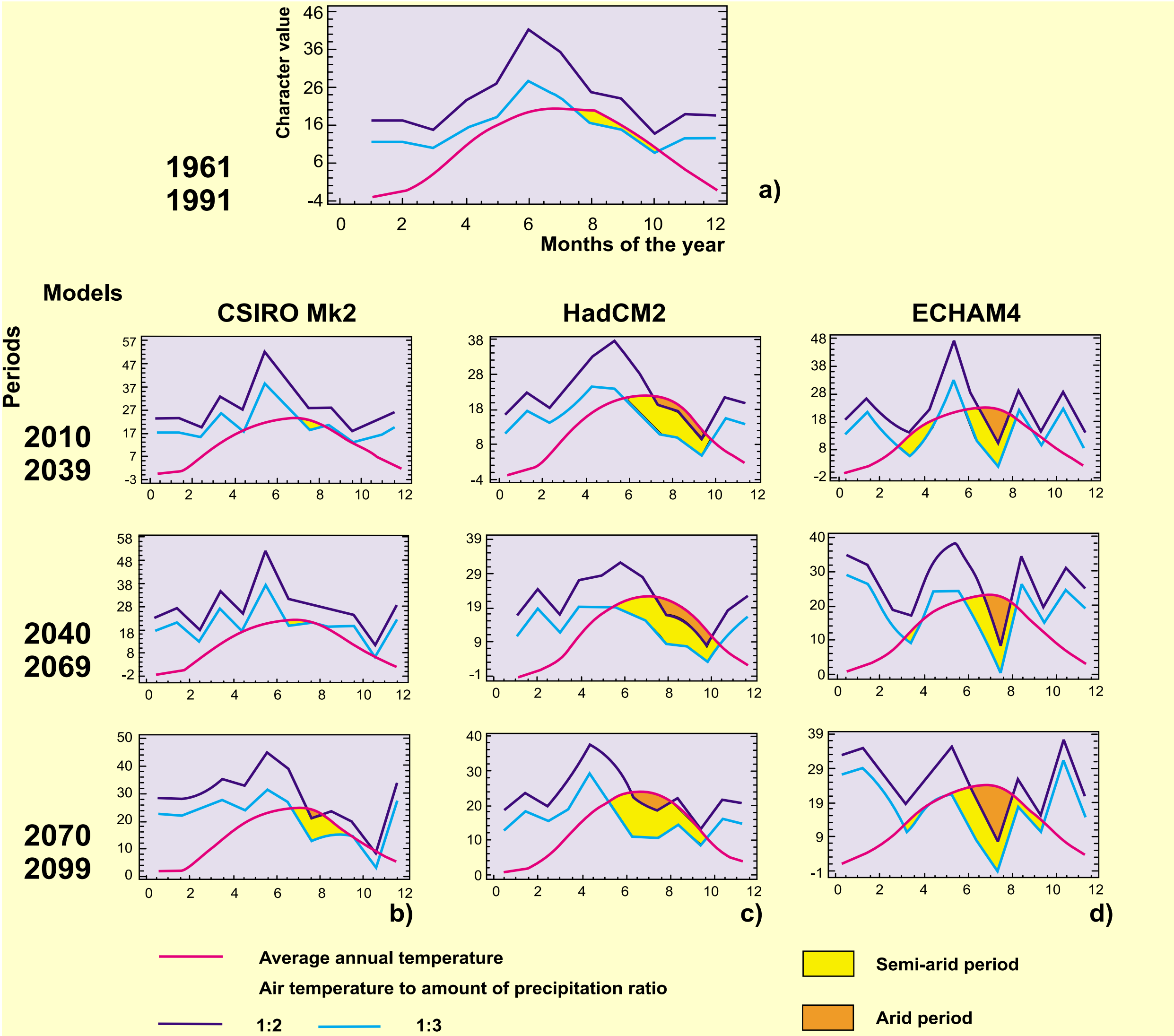


Figure 5.5 Climate diagrams for various climate change scenarios on the territory of the Republic of Moldova

in conformity with paleontological methods) and the results of these changes prognoses (estimated according to the climate models), the fact may be stated that already by the years 2040-2060 (model ECHAM4) the average annual air temperature will reach values equivalent to the respective index for the "Tiraspol" period (Inferior Pleistocene, the period registered approximately 500-600 thousand years ago). According to the most moderate climate change model (CSIROMk2) in the conditions of the Republic of Moldova such values could be registered by the 2070-2099 period.

5.2.2. The Reaction of the Natural Ecosystems to Climate Change

Forests

The prognosis of climate chage impact on forests was carried out based on the evolution of climatic conditions for the forest habitats. As input data for the determination of types of climate for forest habitats climatic indices (total of the atmospheric precipitation for the months with positive totals of average monthly temperatures) were used of the respective climatic models *(Figure 5.7)*. According to model CSIROMk2, the "migration" towards North through the considerable limitation of optimal climatic conditions for forest habitats – 2e, 2f, *(Figure 5.7)* by

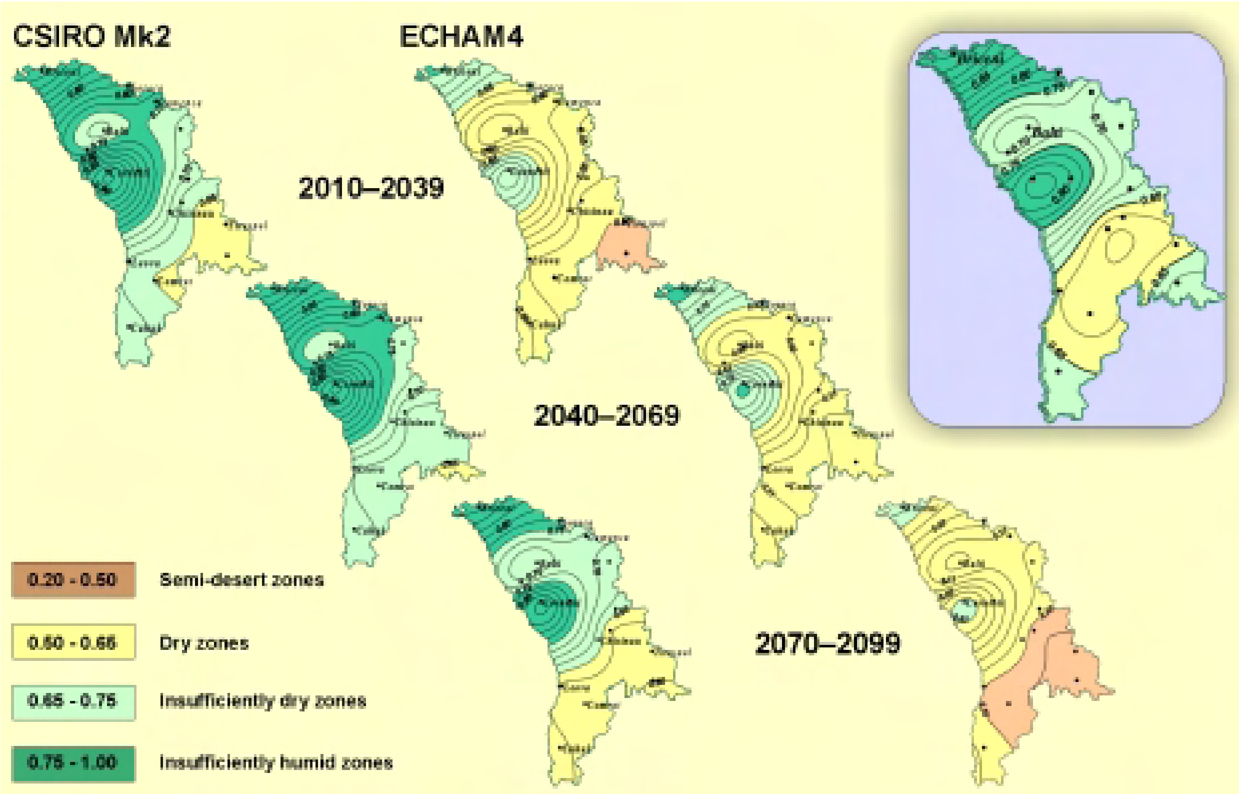


Figure 5.6. Change of Aridity Degree on the Territory of the Republic of Moldova according to CSIROMk2 and ECHAM4 Scenarios

the end of the century will occur. The respective prognosis in accordance with the other models applied shows a similar state by the 50' of the 21st century.

The changes of the forest habitats evaluated according to the strategy drawn from the climatic scenarios may have the following consequences:

1. Essential restructuring of the forest ecosystems at all levels starting with physi-

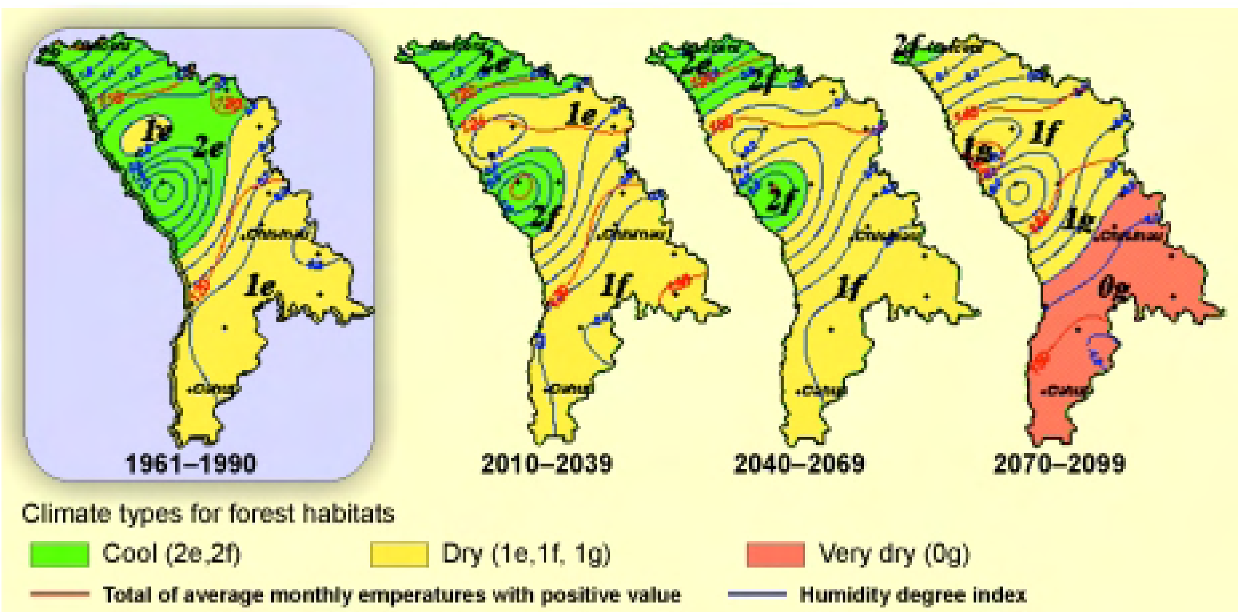


Figure 5.7. Climatic conditions evolution for the forest habitats of the Republic of Moldova according to CSIROMk2 scenario

ological processes which determine the biologic productivity and ending with the phytocenotic modifications.

2. Modification of ecological groups ratios in the direction of percentage growth of xerophytes species. The diversification in habitats and in the number of populations with species habituating to the South and Southeast with the decrease of the populations with a Northern and Western habitation.

3. Modification of forest habitats capacity for biologic diversity maintenance, environmental protection and provision of specific socio-economic functions (habitats supplying energy resources, raw materials, serving as site for recreation and as source of alternative foodstuffs).

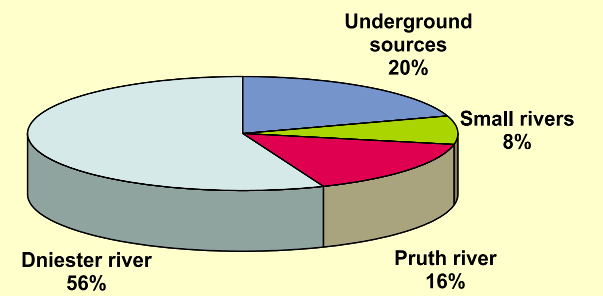
As CSIROMk2 model shows, a 10-20% productivity growth of forests in timber is predicted until the middle of the 21st century. Over this period heat loving species will be favoured. By the years 2070-2099, along with the aridity increase, an average 25% fall of this index will be registered.

According to ECHAM4 model an insignificant growth of timber productivity is foreseen only till the 30' with essential 20-40% fall by the 50'. By the end of the 21st century significant productivity changes will occur with a 50-70% fall as opposed to base period (1961-1990). A considerable decrease of the protection (by 40%) and socio-economic (by 60%) functions of forests is foreseen.

Water Resources

Currently, in the Republic of Moldova, the water supply comes from three categories of sources: surface, phreatic and underground water. The accounting of water debit is being carried out only for surface and underground water *(Figure 5.8)*; for phreatic water partial quality monitoring is performed. Phreatic water is used mainly in the rural area and covers about 80% of the potable water consumption in these localities. The annual water consumption has increased till 1990 and it attained the amount of 3,827 mill. m^3 (out of them 312 mill. m^3 is underground water). During the period of maximal consumption water was supplied to the most important beneficiaries as follows: 2,523 mill. m^3 for production needs, 898 mill. m^3 for irrigation of agricultural land and 217 mill. m^3 for potable and household needs. Starting in 1991, the water consumption was steadily decreasing due to the deep economic crisis. By the end of 1997 surface water consumption has reduced 3.5 times, including 7 times for irrigation purposes.

The most vulnerable water resources from climate change perspective are the surface and phreatic waters. According to estimations, it was found that climate change will substantially affect both the amount and the territorial and seasonal distribution of water.



Annual water resources of the Republic of Moldova are 4.9-6.3 billion m^3, depending on the amount of precipitation

Figure 5.8. Water resources of the Republic of Moldova

In conformity with CSIROMk2 model, the climate change will lead to a 27% increase of Dniester and Pruth rivers debit and to a 30-50% increase of the interior rivers one as opposed to average debits of the reference period (1961-1990*, Table 5.3*) According to model HadCM2, a possible 2-16% debit fall is possible for big rivers and a 4-20% fall – for small rivers. ECHAM model shows that at the beginning of the century the average annual debits of Dniester and Pruth trasboundary rivers will decrease by approximately 14%, which will be followed by a growth of about 23%. Similar changes are also foreseen for internal rivers debits. Their fall by about 19-21% at the beginning of the prognosis period will be followed by a 16-29% increase over the following periods.

The future water supply may be assessed through the comparison of water needs with the available resources. According to various climate change scenarios the surface water resources available for use in the next century amount to 4.12-7.06 km^3 (*Figure 5.9a)*. The comparison of the water amount consumed in 1990, the maximal consumption year from all preceding period, with the water resources available in the future, shows a relatively good water supply situation till the end of the prognosis period.

However, upon a more detailed estimation which takes into consideration the seasonal distribution of water resources, their quality and the possibilities for water distribution across the country, the fact is stated that water supply will still be a priority problem of the country. From this viewpoint the most vulnerable is the Southern region which has limited phreatic water resources, a small network of surface water distribution and smaller underground water reserves in comparison with the Northern zone (*Figure 5.9b)*. The water supply problem will still be severe for the rural localities of the whole country.

Soil

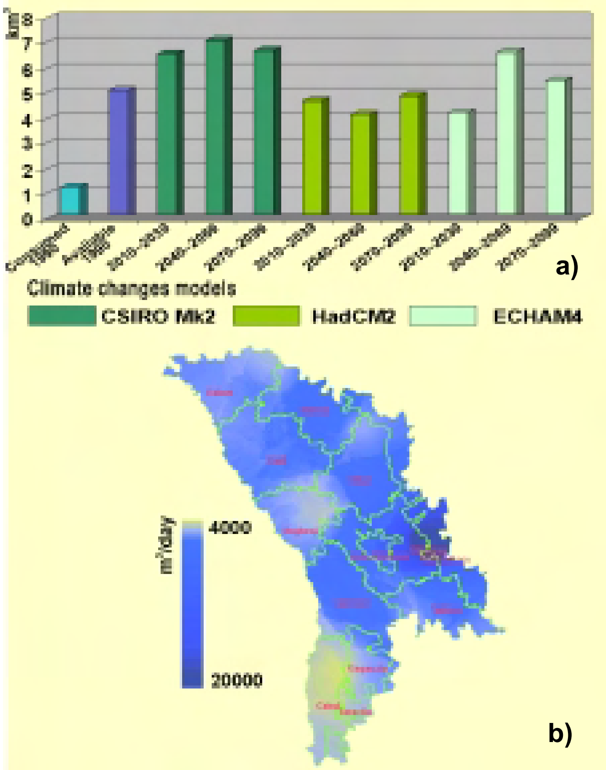
The vulnerability of the soil cover quality depending on the possible climatic changes was estimated for two restrictive factors: wind erosion intensity and danger of landslides.

The evaluation of the climate change impact on wind erosion intensity (C) shows that in the future, in case adaptation actions are not undertaken, these processes may intensify *(Table 5.4)*. The absolute values of the wind erosion intensity index for various periods and models show a moderate or high danger of this phenomenon.

The CSIROMk2 model allows for an intensification of landslides due to growth of precipitation amounts by 8.4-11.4%.

Table 5.3. Debits Modification of the Main Rivers of the Republic of Moldova through Climate Change (%, as opposed to reference 1961-1990 period)

River name	Model								
	CSIRO Mk2			Had CM2			ECHAM4		
	2010-2039	2040-2069	2070-2099	2010-2039	2040-2069	2070-2099	2010-2039	2040-2069	2070-2099
Dniester	22	29	24	-6	-13	-2	-12	23	6
Pruth	24	36	26	-8	-16	-7	-15	24	6
Ciugur	30	43	32	-11	-17	-4	-19	25	17
Sarata	43	50	40	-14	-20	-5	-21	29	22
Ialpug	43	50	40	-14	-20	-5	-21	29	22
Iagorlic	42	48	38	-13	-19	-5	-21	28	21
Raut	41	45	34	-12	-18	-4	-20	26	16
Cubolta	41	45	34	-12	-18	-4	-20	26	16
Cainar	41	46	36	-12	-19	-5	-21	27	18
Bic	41	45	34	-12	-18	-4	-20	26	16
Botna	43	50	40	-14	-20	-5	-21	29	22



a. changes of the available surface water amount according to various climate change scenarios
b. amount and distribution of underground water resources

Figure 5.9 Water reserves of the Republic of Moldova (surface and underground) and the modification of the available amount of surface water

5.2.3. The Reaction of Agrophytocenoses to Climate Change

For most agrophytocenoses the most important climate factors are the air temperature, precipitation and the total of effective temperatures (total of temperatures over 10 ^{0}C during the vegetation period), the latter parameter being very important for evolution of pests and diseases.

Annual Agrophytocenoses

For the reference period (1961-1990) it was found that in conditions of the Republic of Moldova the interactions between air temperature and the amount of atmospheric precipitation determine about 75% of the average values of the annual crops for the winter wheat and about 40% of the crop for corn. For these reasons, it was deemed that the reaction of these agrophytocenoses to the said climate change parameters would be essential. Two concepts were used as starting points for the evaluation of annual agrophy-tocenoses to future climate change.

The first is based on the idea of "accepting losses" (passive adaptation actions). This means that no adaptation actions to climate change are offered. In conformity with this concept it is assumed that the role of the climate components and the effects of their interactions, as well as the principles of plants interaction with environmental factors, will stay the same as the ones registered in the reference period (1961-1990).

For winter wheat and corn (basic crops for which the estimates were made) the heat factor in current conditions is close to the physiologic maximum (especially in the most important development phases). For these reasons, the growth of the temperatures without a compensation on the part of other factors (primarily, atmospheric precipitation) will have a negative impact

Table 5.4. Possible changes in the wind erosion potential in the Republic of Moldova depending on climate change

Climate models	Period of time					
	2010-2039		2040-2069		2070-2099	
	C	ΔC,%	C	ΔC,%	C	ΔC,%
HadCM2	67.1	38.3	79.0	62.9	85.2	75.7
ECHAM4	79.6	64.1	80.6	66.2	84.9	75.0
The basic value of the potential is 48.5						

Table 5.5. Possible productivity changes in cereal crops (% as opposed to reference period, 1979-1983) in accordance with the "accepted losses" strategy.

Climate models	Period of time								
	2010-2039			2040-2069			2070-2099		
	T	P	T+P	T	P	T+P	T	P	T+P
Winter wheat									
CSIROMk2	-25.4	2.2	-17.6	-36.6	6.2	-24.4	-52.3	3.9	-39.0
HadCM2	-25.1	1.0	-21.6	-46.7	0.7	-38.7	-62.1	5.9	-50.5
ECHAM4	-32.6	0.8	-28.2	-47.9	5.3	-38.4	-71.8	3.3	-58.8
Corn									
CSIROMk2	-0.7	0.4	-0.2	-2.4	0.5	-1.3	-8.9	4.0	-5.0
HadCM2	-5.1	2.2	-2.6	-7.8	0.9	-6.4	-12.5	3.7	-8.4
ECHAM2	-3.2	-0.5	-2.0	-5.6	2.5	-0.8	-8.2	2.6	-4.5
T - air temperature					P - atmospheric precipitation				

on the productivity of the respective phytocenoses *(Table 5.5)*. In case the current varieties and technologies are maintained in agriculture, the evolution of temperatures according to prognoses may moderately affect the corn crops but will have a significant impact on winter wheat.

The second concept is based on the implementation of some adaptation actions depending on climate change.

For corn, among adaptation actions the utilisation of hybrids with longer vegetation periods (with a higher productivity potential) and of technologies reducing soil humidity losses were proposed. It was estimated that these actions could conduct to essential favourable changes of climate change impacts. For the conditions of all climatic models, the growth of this crop productivity is predicted *(Table 5.6).*

Perennial agrophytocenoses

One of the most widely used type of perennial agrophytocenoses in the Republic of Moldova are the vineyards. The most sensitive characters of this crop to possible climate change are productivity and sugar content in grapes. Upon analysis of climate change projections for these characters *(Table 5.7)* it was found that if no adaptation actions are taken, a trend will be seen towards productivity decrease. However, the rise of effective temperatures will improve the quality of the crop (considerable growth of sugar content). In the future this situation may substantially change quality of the wines. The future climatic conditions will allow in case of need the modification of the ratio of table to sparkling wines.

The climate changes will allow for the extension of the cultivation area for this species, which will reach the Northern border

Table 5.6. Corn crop change according to climate change scenarios upon utilisation of tardy hybrids (%, as opposed to reference period, 1979-1983)

Climate models	Period of time					
	2010-2039		2040-2069		2070-2099	
	tons/ha	%	tons/ha	%	tons/ha	%
CSIROMk2	7.97	15.0	8.29	19.6	8.62	24.4
HadCM2	7.84	13.1	8.30	19.8	8.70	25.5
ECHAM4	8.11	17.0	8.71	25.7	9.39	35.5

of the country. In the South favourable conditions will exist for the cultivation of high quality table varieties (for fresh consumption of grapes).

The general analysis of the climate change impacts on pests and diseases of agricultural crops shows that the eventual warming in winter may increase the number of harmful species (pathogens, pests, weeds), their density and the degree of damage to crops. In the future, along with the existing species of pests favourable conditions will exist in the Republic of Moldova for the emergence of new diseases and pests, which are currently either absent or of quarantine types. Unless adequate adaptation actions are taken, this general trend may lead to a considerable decrease of crops and to food security degradation.

5.3. ADAPTATION ACTIONS

In order to minimize the negative impact of climate change on socio-economic domains, ecosystems and public health, the following actions are proposed for the conditions of the Republic of Moldova:

For Natural Ecosystems:

– Diversification and extension of protected areas for the conservation of ecosystems which are most vulnerable to climate change;

– Creation or recovery of interconnexion zones (creation of the ecological network) between fragmented and dispersed ecosystems;

– Organisation of the monitoring aimed at evaluating species and ecosystems stability from climate change perspective. Orientation of their evolution towards higher resistance to the changes;

– Development and implementation of programs for restoration and extension of forests;

– Restoration of humid zones.

For Water Resources:

– Improvement of the accumulation lakes state and increase of their number;

– Restoration and creation of dams in areas with flood danger;

– Reduction of water loss in irrigation and water consumption decrease in industry through implementation of closed cycle water use.

For Soils and Land Resources:

– Implementation of agricultural systems adequate to the relief conditions that could reduce soil erosion;

– Efficient use of local organic matter for compensating the humus losses from soils;

– Soil quality improvement works in agricultural surfaces with reduced productivity.

For Agroecosystems:

– Creation, diversification and study of ample sets of vegetal resources in order to find new plant species and varieties with higher resistance to elevated temperatures and insufficient humidity;

Table 5.7. Influence of climate change on productivity and quality of grapes in the Republic of Moldova

Reference period 1961-1990	Model and period								
	CSIRO Mk2			HadCM2			ECHAM4		
	2010-2039	2040-2069	2070-2099	2010-2039	2040-2069	2070-2099	2010-2039	2040-2069	2070-2099
Productivity (kg/bush)									
5.74	4.81	4.46	4.10	4.96	4.44	4.01	4.66	4.00	3.26
Sugar content (gr/cm^3)									
15.53	16.16	16.35	16.55	16.08	16.36	16.60	16.25	16.60	17.01

- Improvement of local agricultural crop varieties which are well acclimated and resistant to draughts aiming at productivity growth;
- Development of varieties, hybrids and technologies allowing separation in time of critical development phases from the limitative environmental factors affecting productivity at the respective phase;
- Increasing the share of those agricultural varieties and hybrids which have a maximal potential for solar radiation utilization and show minimal consumption of assimilation products aiming at their adaptation and protection;
- Wider range application of natural properties of C_4 photosynthesis type plants achieved within agrophytocenoses;
- Development and implementation of complex (hydro- and agrotechnical) systems for accumulation and efficient use of atmospheric precipitation;
- Adaptation of the natural resources utilization processes in agriculture to sustainable development principles;
- Creation of socio-economic conditions for profitable work of agricultural companies based on private property on land and production means;
- Finalisation and implementation of the strategy for medium- and long term development of the industries based on agricultural production.

6. COST ASSESSMENT OF SOME ABATEMENT AND ADAPTATION ACTIONS

The cost-benefit analysis of abatement and adaptation actions was carried out taking into consideration the most relevant social and economical costs associated with global climate change: damage, adaptation & abatement costs. The analysis was performed for those abatement and adaptation actions for which available data existed. The stages of the analysis: first, the possible impact caused by climate change was reviewed; then the current and future GHG emissions were estimated and a preliminary evaluation was made of the potential GHG emissions abatement in the Energy, Industrial processes, Agriculture, Waste sectors taking into account the land use change and the surface of forests.

6.1 COST-BENEFIT ANALYSIS OF THE ABATEMENT ACTIONS

The cost-benefit analysis covers the 2000–2010 period and it was carried out based on models I and II described in the Chapter "Prognosis of greenhouse gas emissions". The net benefit was calculated through comparison of the following alternatives: with no abatement actions and in case of application of the proposed minimal and maximal actions.

6.1.1. Abatement Actions in the Energy and Industrial Processes Sectors

According to the data of the National Agency for Energy Conservation (ANCE) the country has a potential for energy efficiency growth for the year of 2000 of about 5% (220 thousand tons of coal equivalent (t.c.e). The energy efficiency in the main sectors of the national economy, which are major energy consumers, will increase significantly by the year of 2010. The greatest specific energy consumers are currently registered in the industry of building materials. In case of power supply technology modernization along the lines of the technologies used in the European Union, energy consumption could be decreased: in the cement industry – by about 24–35%, brick production – by 5–37%, glass production – by 47–87% *(Table 6.1)*.

Table 6.1. Comparative data on the need for energy consumption reduction for attaining European standards in the industry of building materials

Sector	Measuring unit	Needed amount of energy, 1997		
		Moldova	EU	PEEI*, %
Cement	kg c.c./t	205	137	33.2
	kWh/t	170	130	23.5
Glass	kg c.c./t	690	366	47.0
	kWh/t	585	76	87.0
Bricks	kg c.c./thou units	295	187	36.6
	kWh/thou units	127	120	5.5

* – Potential for Energy Efficiency Improvement

For the following ten years in macroeconomic development programs a number of energy conservation actions were taken into account. It should be noted that the technological and technical modifications in the Energy and Industrial processes sectors described in Chapter "Policies and strategies for greenhouse gas emissions abatement" contribute not only to a significant growth of energy efficiency, but also to GHG emissions abatement.

The final data obtained for these sectors showed that through the implementation of minimal cost abatement actions a benefit will be obtained for each monetary unit invested, since they do not require dramatic modification of technologies and are less costly. The data obtained for the case of implementing the maximal sets of abatement actions are based on the application of modern technologies with a high amortization period which would be economically justifiable over a longer timeframe *(Table 6.2)*.

6.1.2. Abatement Actions in Agriculture Sector

The analytical cost-benefit calculations of actions for the GHG abatement and reduction in Agriculture sector and for the increase of energy conservation potential showed for both scenarios a benefit of US$4 for each invested monetary unit *(Table 6.3)*.

Table 6.2. Cost-benefit analysis of GHG emission abatement actions for the Energy, Industry and Renewable sources sectors

Index	Model I				Model II			
	Minimal scenario		Maximal scenario		Minimal scenario		Maximal scenario	
Energy and Industrial processes								
Necessary investments	163.9 mill. $US		823.2 mill. $US		244.4 mill. $US		1804.3 mill. $US	
Energy conservation potential	3589.6 thou. t.c.e.	179.5 mill. $US	7206.1 thou. t.c.e.	360.3 mill. $US	5116.1 thou. t.c.e.	255.8 mill. $US	10326.9 thou. t.c.e.	516.3 mill. $US
Potential for GHG emission abatement	4721.6 Gg	42.0 mill. $US	9019.0 Gg	80.3 mill. $US	7171.4 Gg	63.8 mill. $US	12817.1 Gg	114.1 mill. $US
Net benefit	57.6 mill. $US		-382.6 mill. $US		75.2 mill. $US		-1173.9 mill. $US	
Cost-benefit ratio US$/1 invested unit	1.4 $US		0.54 $US		1.3 $US		0.35 $US	
Net present value of benefit (NPV)	35.4 mill. $US		-234.9 mill. $US		46.2 mill. $US		-720.7 mill. $US	
Renewable energy sources								
Necessary investments	0.8 mill. $US		33.8 mill. $US		2.6 mill. $US		74.6 mill. $US	
Energy conservation potential	72.0 thou. t.c.e.	3.6 mill. $US	387.2 thou. t.c.e.	19.4 mill. $US	156.6 thou. t.c.e.	7.8 mill. $US	969.4 thou. t.c.e.	48.5 mill. $US
Potential for GHG emission abatement	101.6 Gg	0.9 mill. $US	648.3 Gg	5.8 mill. $US	221.5 Gg	2.0 mill. $US	1371.8 Gg	12.2 mill. $US
Net benefit	3.7 mill. $US		-8.7 mill. $US		7.2 mill. $US		-13.9 mill. $US	
Cost-benefit ratio US$/1 invested unit	5.6 $US		0.74 $US		3.8 $US		0.81 $US	
Net present value of benefit (NPV)	2.24 mill. $US		-5.32 mill. $US		4.42 mill. $US		-8.54 mill. $US	

Table 6.3. Cost-benefit analysis of GHG emission abatement actions for the Agricultural sector

Indices	Model I				Model II			
	Minimal scenario		Maximal scenario		Minimal scenario		Maximal scenario	
Necessary investments	5.3 mill. $US		12.0 mill. $US		16.4 mill. $US		32.8 mill. $US	
Energy conservation potential	319 thou. t.c.e.	16.0 mill. $US	721 thou. t.c.e.	36.1 mill. $US	988 thou. t.c.e.	49.4 mill. $US	1969 thou. t.c.e.	98.5 mill. $US
Potential for GHG emission abatement	798 Gg	7.1 mill. $US	1802 Gg	16.0 mill. $US	2469 Gg	22.0 mill. $US	4923 Gg	43.8 mill. $US
Net benefit	17.8 mill. $US		40.1 mill. $US		54.9 mill. $US		109.5 mill. $US	
Cost-benefit ratio US$/1 invested unit	4.4 $US		4.3 $US		4.4 $US		4.3 $US	
NPV	10.9 mill. $US		2.6 mill. $US		33.7 mill. $US		67.2 mill. US	

6.1.3. Abatement Actions in the Waste Sector

The cost-benefit analysis of GHG emissions abatement actions and of the increase of energy conservation potential in the Waste sector showed that the cost-benefit ratio for the scenarios of the analysed models is about US$5.0 and US$4.3 per monetary unit invested for the scenarios of model I and, respectively, about US$4.4 and US$4.3 per monetary unit invested for the scenarios of model II *(Table 6.4)*.

6.1.4. GHG Emissions Abatement Actions through the Land Use Change and Forests Extension

The advantages of land use change and forests extension are reflected in the growth of the capacity for carbon sequestration and in the social benefits. The material products of this approach are: medicinal herbs, hunting, forest fruits, firewood, timber, etc. The economic value and benefits of afforestation are well known in the Republic of Moldova. In this case for the cost-benefit analysis a number of factors was taken into account: cost of investment and research & development management, the cost of the sequestered carbon, of the firewood and timber amounts, other forest products *(Table 6.5)*.

By comparing the net costs and benefits of the two alternative I and II models, depending on the growth of afforested surfaces over ten years, net benefits were obtained of about US$249 million and US$259 million at the prices of the year of 2000.

The cost-benefit ratio for both considered models is respectively US$7.43 and US$7.68 per monetary unit invested.

The total cost-benefit analysis of the GHG emissions abatement actions in all sectors of activity for the case of two alternative development scenarios, minimal and maximal, for the period 2000–2010 shows: if these actions are to be implemented in their entirety, the Republic of Moldova will benefit from a growth of energy efficiency of about 6-14% for the scenarios of model I and of about 8–17% for the scenarios of model II. In accordance with the scenarios of the examined models I and II, GHG emission abate-

Table 6.5. The cost-benefit analysis of GHG emissions abatement due to land use change and forest extension for the period 2000-2010

Indices	Model I	Model II
Necessary investment, mill. $US	38.70	38.74
Total NPV cost, mill. $US	29.95	29.98
Benefits, mill. $US	287.38	297.43
Net NPV benefits, mill. $US	248.68	258.69
Cost-benefit ratio, $US/1 invested unit	7.43	7.68

Table 6.4. Cost-benefit analysis of GHG emissions abatement actions for the Waste sector

Indices	Model I				Model II			
	Minimal scenario		Maximal scenario		Minimal scenario		Maximal scenario	
Necessary investments	0.3 mill. $US		8.9 mill. $US		5.5 mill. $US		9.7 mill. $US	
Energy conservation potential	20.5 thou. t.c.c.	1.0 mill. $US	535.1 thou. t.c.c.	26.8 mill. $US	331.3 thou. t.c.c.	16.6 mill. $US	579.7 thou. t.c.c.	29.0 mill. $US
Potential for GHG emission abatement	51.2 Gg	0.5 mill. $US	1337.7 Gg	11.9 mill. $US	828.3 Gg	7.4 mill. $US	1449.2 Gg	12.9 mill. $US
Net benefit	1.2 mill. $US		29.8 mill. $US		18.4 mill. $US		32.2 mill. $US	
Cost-benefit ratio US$/1 invested unit	5.0 $US		4.3 $US		4.4 $US		4.3 $US	

ment will attain 4-9% and, respectively, 6–11% of the total direct GHG emission for the whole period. The costs of these actions were assessed at about 1.1-5.8% and 1.3–9.2% of the GDP for the analysed period, 2000–2010 *(Table 6.6a and b)*.

Upon comparison of the cost-benefit ratio of the two scenarios (minimal and maximal) of abatement actions implementation, the fact was revealed that, along with the rate growth of the country's macroeconomic development, which implies the total modernization of technologies, big investment with long amortization period, no benefits will be registered per monetary unit invested. The positive effects of the capital investment will come later. The conclusion may be made that over the period 2000–2010 the country will have benefits only in case of minimal scenarios of emission abatement actions in accordance with the development models examined *(Table 6.7)*.

6.2. COST-BENEFIT ANALYSIS OF ADAPTATION ACTIONS

Based on the vulnerability assessment for ecosystems, flora and fauna, options were developed for some adaptation actions to climate change. The actions developed for the negative tendencies mitigation for a 10 year period will require an amount of funding of about US$3.2mill. The adhering annual allocations for priority actions will equal about US$0.4mill. The need for allocations in the area of biologic diversity maintenance was calculated taking into account the impact of all environmental factors on biologic diversity. The impact dealing with climate change is estimated at 10% of the total allocations for this sector of the environment.

In the area of potable water supply the amount of necessary funding for the same ten year period was estimated at about US$168.2mill. Currently, the qualitative potable water offer through water supply networks covers only 50% of the demand (82% of the urban and 18% of the rural population). In the area of potable water supply the share of funds needed through climate change impacts allevation is 5% of the total.

For the irrigation sector actions are planned

Table 6.6 Potential for energy conservation, GHG emission abatement and the costs of abatement actions for models I and II of socio-economic development of the country for the period 2000-2010.

a)

Development models	Scenarios	Indices	Total potential
Model I	min	Energy conservation, thou. t.c.e.	4001
	max		8849
	min	CO_2 emisiion abatement, Gg	5673
	max		12807
	min	Necessary investment, mill. $US	170.3
	max		877.9
Model II	min	Energy conservation, thou. t.c.e.	6592
	max		13845
	min	CO_2 emisiion abatement, Gg	10690
	max		20561
	min	Necessary investment, mill. $US	268.9
	max		1921.4

b)

Indices	Model I		Model II	
	min	max	min	max
Total demand for primary energy resources, thou. t.c.e.	62444		80801	
Saving of energy resources % of total	6.4	14.2	8.2	17.1
Total direct GHG emissions, Gg	141941		181026	
Direct GHG emissions abatement, % of total	4.0	9.0	5.9	11.4
Total GDP, mill. %US	15224		20802	
Total investment, % of GDP	1.12	5.77	1.29	9.24

which, according to estimations for the examined period, amount to US$287.6mill. The implementation of these actions will contribute directly to obtaining additional agricultural production and fodder as follows: wheat – 216 thousand tons (benefit of about US$25.9mill.), corn – 360 thousand tons (benefit of about US$28.8mill.), ve-getables – 738.5 thousand tons (benefit of about US$121.9mill.), silo – 778.5 thousand tons (benefit about US$7.8mill.), hay – about 2,848 thousand tons (benefit of about US$13.1mill.). The present analysis shows that 20% of the amount of US$287.6mill. will be oriented towards the minimization of climate change effects.

The expenses dealing with the water supply are needed both for the building of new water pipes and for the repair and diversification of the existing ones. The analysis of the needs for adaptation actions in order to avoid the danger of floods in localities showed that the costs will amount to US$84.4mill. The net benefit due the irrigation sector is about US$18mill. The average net benefit in the case of flood danger avoidance actions is about US$13.1mill. *(Table 6.8)*. Only 5% were allotted to this sector from the total of funds planned for adaptation to climate change phenomenon. Each dollar invested in this area may come with a benefit in the ratio 1:4.

The possible funding sources for the actions in the area of ecosystems, flora and fauna protection may include: state and local budgets, ecological funds, landowners contribution, assistance of international financial institutions and donors. The maximal benefit to be obtained as a result of adaptation actions implementation within the assessed sectors is about US$425.2mill.

Table 6.7. Cost-benefit ratio of the minimal and maximal scenarios of GHG emission abatement for models I and II of macroeconomic development of the country

Sectors	Scenarios of models I		Scenarios of models II	
	min.	max.	min.	max.
Energy (including transport), and Processing	1.4	0.54	1.3	0.35
Renewable energy	5.6	0.74	3.8	0.81
Agriculture sector	4.4	4.43	4.4	4.43
Waste sector	5.0	4.3	4.4	4.3
Land use change and forestry sector	7.43		7.68	

Table 6.8. Cost-benefit analysis of the actions for adaptation to climate change for the 2000-2010 period in US$mill.

Sectors	Costs	Benefits	Net benefits
Protection of ecosystems, flora and fauna	0.32	-	-
Water supply	8.4	438.5	430.1
Irrigation	57.5	39.5	-18
Flood danger prevention	4.4	17.5	13.1
Total	70.6	495.5	425.2

Note: "–" – was not estimated

7. RESEARCH AND SYSTEMATIC OBSERVATION

7.1 RESEARCH AND OBSERVATIONS IN THE AREA OF CLIMATE CHANGE

Currently in the Republic of Moldova both observations and research are being carried out. The systematic observations of climatic indices were initiated in 1886 and they continue up to date being carried out by the Hydrometeo Service of the Ministry of Environment and Territorial Development. The prognosis of the Republic of Moldova climate for the beginning of the 21st century was developed based on the analysis and generalization of geological data (including paleoclimatic ones), on statistical analyses of meteorological observations sets, on data obtained through direct measurements and through physical-mathematical modelling.

Within the project which provided the basis for this Communication, prognoses were made of possible climate changes for the Republic of Moldova taking into account both the global, regional and local fluctuations of the climatic indices and the amount of GHG emissions.

The estimation of the dependence between the fluctuation rate of the local, global climatic indices and the data for the North Hemisphere was carried out based on the climatic data observed at the Chisinau meteorological station *(Figure 7.1)*. As a result, it was stated that 8.1% of the fluctuation share of the air temperature annual average data in the Republic of Moldova depend on global fluctuations of the respective index, while 11.1% - on the fluctuations of the Northern Hemisphere.

The following models were selected for modelling and development of climate change scenarios, for the conditions of the Republic of Moldova:

HadCM2 - The United Kingdom Hadley Centre for Climate Prediction and Research;

ECHAM4 - The German Climate Research Centre, Deutches Klimarechenzentrum;

CGCM1, - The Canadian Centre for Climate Modeling and Analysis;

GFDL – R15 - The United States Geophysical Fluid Dynamics Laboratory;

CSIROMk2 - The Australian Commonwealth Scientific and Industrial Research Organisation.

In order to select the most appropriate models for climate change prognosis accounting for the climatic indices local fluctuation, the modelling outputs for the air temperature and precipitation monthly average evolutions of the study period (1961-1990) were compared to the respective data of the meteorological stations. This showed that the prognosis closest to the air temperature and precipitation data was the one of the CSIROMk2 model, which was taken as a basis for the climate change prognosis in the Republic of Moldova. According to this model, in the next century, by the years 2039 a 1.4 ^{0}C

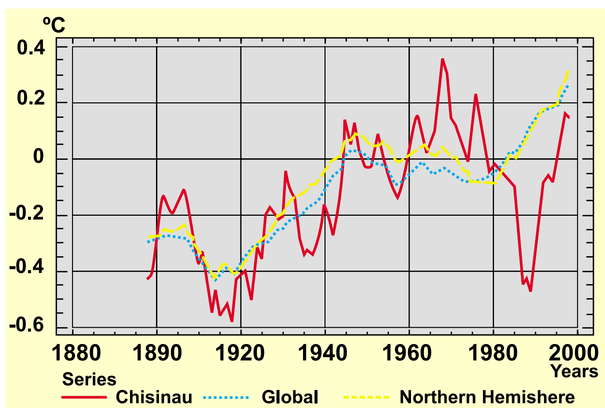


Figure 7.1. Average air temperature fluctuations as compared with the reference period, 1961-1990

rise of the mean annual temperature is foreseen, by the 2069 – a 2.3 ^{0}C rise is expected and by the 2099 – a 3.7 ^{0}C rise is forecasted. HadCM2 and ECHAM4 models were used as alternatives. There are some uncertainties regarding the change in annual precipitation, the models showing data from decrease – to a considerable growth.

7.2. RESEARCH IN THE AREA OF GREENHOUSE GAS INVENTORY

Currently, the IPCC and CORINAIR Guidelines do not provide methods for evaluation of CO_2 emissions from arable soils. A mathematical model, an algorithm and an interactive model were developed for the estimation of CO_2 emissions from agricultural soils as a function of climatic indices, soil texture, crop, amount of nutrients used and technology applied. The estimation method is based on the carbon flux balance going into the soil (humification of vegetal residues and organic nutrients) and the carbon flux going out of the soil (mineralization of organic matter). The interactive model allows the map drawing of emissions from soil starting with plot level maps and ending with the map for the whole surface of the country for any period of time.

According to assessments carried out for a 10 year period (1990–1999) for the whole country, the carbon cycle in arable soils of the Republic of Moldova showed considerable time variation. Thus the 1990–1992 period showed carbon storage in soil (216–289 Gg annualy); the value per hectare is about 0.2 tons. The phenomenon was determined by application of technologies increasing agrophitocenoses productivity. The maximal amount of total CO_2 emissions from arable soils was registered in 1997 and equalled 2,323 Gg (1.77 tons per hectare, *Table 7.1)*.

7.3. RESEARCH IN THE AREA OF VULNERABILITY ASSESSMENT AND ADAPTATION

Research for the evaluation of the climate change related vulnerability degree of different sector components was carried out in the areas of public health (three case studies) and soil erosion (one case study), water ecosystems (one case study). For the water supply software, algorithms and interactive models were developed which were used for the assessment of the underground and surface water reserves and their territorial distribution depending on their utilization and quality. The objectives of these assessments was both to reveal the climatic components with maximal impact on studied areas and to find the zones vulnerable from the perspective of potable water and technical water supply.

Table 7.1. CO_2 Emissions from Arable Soils of the Republic of Moldova

Year	Carbon going into soil, Gg	Carbon going out of soil, Gg	Carbon balance, Gg	Total	
				CO_2 storage, Gg	CO_2 emission, Gg
1990	941	862	-79	289	0
1991	868	789	-79	289	0
1992	629	570	-59	216	0
1993	721	1,165	444	0	1,629
1994	387	659	272	0	998
1995	515	918	403	0	1,479
1996	370	724	354	0	1,299
1997	553	1,886	633	0	2,323
1998	397	845	448	0	1,649
1999	516	1,129	613	0	2,099

7.3.1. Research in the Area of Impact Assessment of Climate Change Indices on Public Health

The respective studies were aimed at revealing the climate indices impacts on the health of the population. To this end, three case studies were made, which assessed both the direct and the indirect effects on the climate change factors on the morbidity and mortality of the population.

The first study was dedicated to the analysis of the excessive precipitation impact, such precipitation being assessed as extreme event with direct impact on public health. The assessment was made for 34 rural localities most affected by the 1994 floods. Based on this study, the conclusion was made that a pronounced growth of gastro-intestinal and infectious pathologies occured following the floods. Thus, the pathologies provoked by determined pathogen agents have grown by 25% as opposed to the annual average, the undetermined pathogens provoked pathologies – by 50%, while the dysentery cases have tripled *(Figure 7.2)*. The study outputs also revealed the fact that the severe sanitary epidemiological condition of 1994 has negatively influenced the epidemiological background for the next few years.

The second case aimed at the assessment of the correlation between public health (estimated according to morbidity degree of the population provoked by helminth pathologies and a high degree of soil infestation with geohelmonths eggs) and the climate features. The geohelminths are human parasites with one development phase (egg phase) highly dependent on the climatic indices, since the eggs are stored in the soil. Thus, the impact of the climatic parameters on health is believed to be indirect. The analysis comprised the whole surface of the country for a 30 year period (1970–1990).

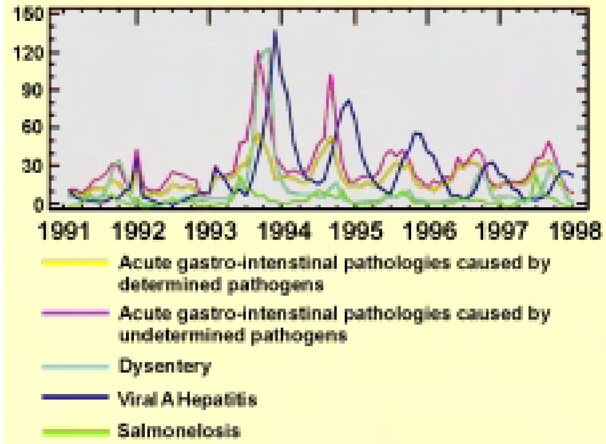


Figure 7.2. Morbidity (in 100,000 people) for gastro-intestinal and infections pathologies in zones affected by 1994 floods

A conclusion on the geohelminthiasis (ascaridiosis and tricocifalosis) was that these diseases correlate well with two climatic indices: total of annual temperatures over 10 ^{0}C and total precipitation of the months with mean temperature over 10 ^{0}C *(Figure 7.3a).*

Taking into account the correlations developed for the study period (1970-1990) and the climatic change indices resulting from different models a possible situation was forecasted in the described area *(Figure 7.3b)*. Thus, more favorable climatic conditions for one of the two geohelminth pathologies (Ascaridiosis) will emerge by the end of the next century (2070–2099 period).

The third case study refers to the modification of some cenosis components which have subsequently affected public health. The study is based on the analysis of clinical cases for a 21 year period (1979–1999). Over the last decades a big number of people have suffered from intoxications with forest mushrooms with severe, even lethal, effect *(Table 7.2)*. The medical files show that the patients consumed mushrooms which they knew as comestible. The medical observations showed that the phenomenon is more

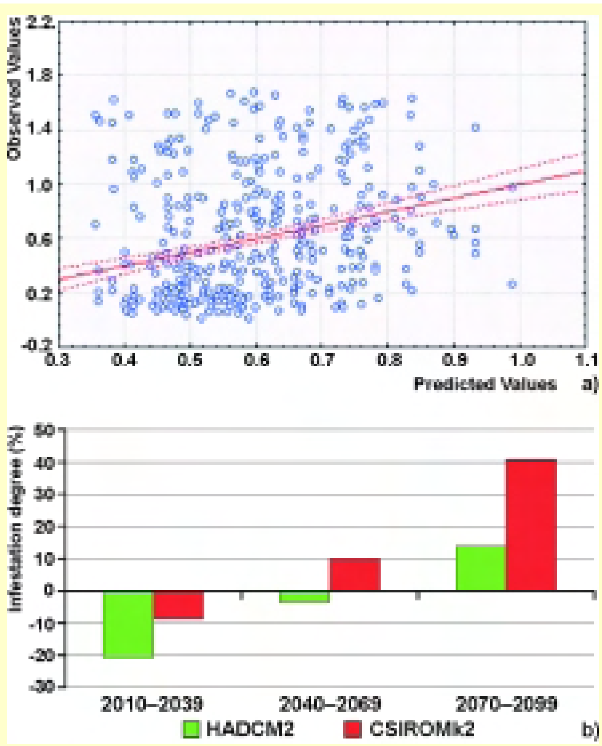
Table 7.2 Number of in-pations and deceased upon intoxication with comestible mushrooms in 1979–1999

Locality	In-patients			Deceased		
	Total	Adults	Children	Total	Adults	Children
Balti	150	132	18	10	10	0
Chisinau	2369	1782	587	59	37	22
Total	2519	1914	605	69	47	22

highly pronounced in droughty periods. For these reasons, it was assumed that given unfavourable conditions some comestible mushrooms may undergo metabolic modifications thus accumulating toxins. We named these mushrooms “modified comestible mushrooms”.

Upon a minute analysis aimed at revealing the relationship between the number of intoxications with modified comestible mushrooms and the climatic indices, the conclusion was drawn that this phenomenon for the zones where it was identified was a function (r = 0.6) of the amount of precipitation in August-September period and of the mean temperature for September.

By summarising the results of the three case studies we may state the existence of both a direct and an indirect impact of climatic indices on human health. A comparison of the identified correlations for the researched cases with the tendencies of the climate change models predicted indices leads to the conclusion that these phenomena will persist in the future. Depending on the climatic indices rate of change, it is possible that their impact on public health may become in some cases more accentuated.



a) Dependence of population infestation degree with geohelminthoses on the climatic indices

b) Prognosis of the ascaridiosis infestation risk in climatic conditions determined by CSIROMk2 and HadCM2 models

Figure 7.3. Infestation and morbidity dependence though geohelminthoses on climatic indices

7.3.2. Research in the Area of Climate Change Impact on Land Resources

Following long term exploitation of agricultural soils, this natural resource is gradually losing some of its initial properties. The strongest and the most accentuated process conducting to soils degradation in the country is erosion. A determining factor in this respect is both the precipitation intensity and their amount. The process was assessed according to the erodibility index of rains intensity. As a result of the study the territory of the country was differentiated depending on the erodibility degree *(Figure 7.4)*.

In the process of the greenhouse gas inventory preparation and with the aim of vulnerability assessment and study of adaptation of and evolution of different sectors depending on climate change se-

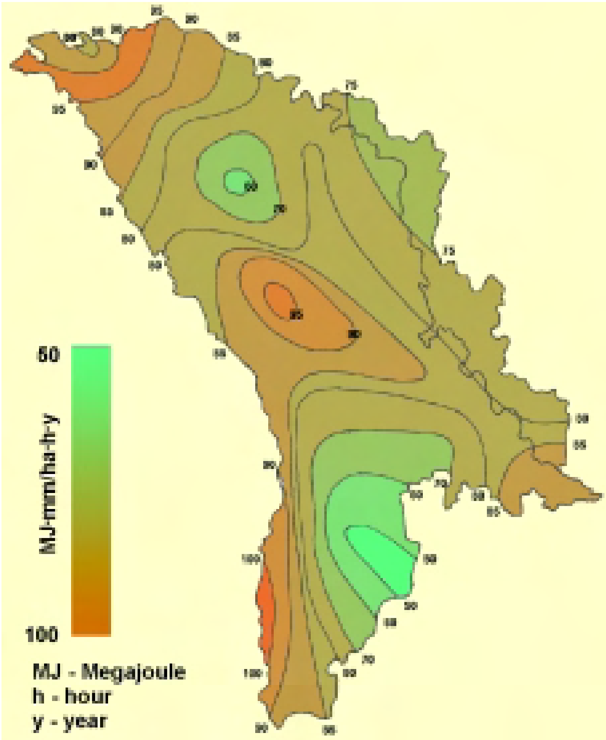


Figure 7.4. Soil erosion degree depending on erodibility index of rains intensity

veral important databases were created in different areas (agriculture, natural ecosystems, water resources. These databases present the current and the preceding state in most of the research fields for a period of approximately 30 years. Interactive software was developed for databases utilization and processing. This allowed for their analysis starting with local and ending with the national level. It is assumed that in the future the said databases will be completed, thus assuring the possibility for the monitoring of the studied phenomena and assessment of their impact at national, regional and global levels.

8.EDUCATION, TRAINING AND AWARENESS BUILDING

As a signatory Party to the Aarhus Convention on Access to Information, Justice and Public Participation in Environment Related Decision-making (1998), the Republic of Moldova is continuously trying to optimise and diversify the ways of public information. Ecology hours are included in the curricula of secondary schools, lyceums and gymnasiums, which allow to inform the students about the problems of the country's environment and the opportunities for their solution. The specialists in the area of environmental protection are being trained by the State University, the University for Politology and Ecology, the Technical University and the Ecological College. Over the last years, specialised courses in environmental protection were included in the curricula of the secondary technical schools and universities. These courses are useful due to the provision of minimal knowledge in environmental protection, including climate change. The Academy of Sciences of the Republic of Moldova, the Ministry of Environment and Territorial Development, Ministry of Health, Ministry of Education and Science, research institutions in the area of ecology, geography, pedology, waters, botany, zoology, etc., made a significant contribution in the organisation of regular training events in various areas of environmental protection. These actions are especially appropriate for efficient awareness building on site through the assistance of researchers from different localities of the country. A number of important environmental protection strategy and policy documents developed by governmental agencies in conjunction with the above listed organizations reveal the specific areas of activity for other governmental and non-governmental structures.

For the time being, there no programs for training and education in climate change in the Republic of Moldova. The UNDP "Climate Change" project has initiated events for special education and training in the area. The first such activity was the translation, publication and dissemination among all schools of Moldova of the brochure "Understanding Climate Change: A Beginner's Guide to the UN Framework Convention".

During training workshops in GHG emission inventory and abatement, vulnerability and adaptation to climate change an important number of researchers, representatives of governmental, public agencies, non-governmental organizations, mass media have obtained sufficient knowledge and training materials in the above listed areas. The experts that worked in the aforementioned project have actively participated in the awareness building in climate change through direct involvement in seminars, conferences, workshops, presentations in radio and TV programs, publications, etc. The nongovernmental organizations were informed about climate change issues at a special national workshop. Two issues of the project bulletin were published and the Web site was prepared on the evolution of the project activities and studies developed within its framework; the page may be accessed on the Internet.

The nongovernmental organizations show an increasing participation in training actions in environmental protection, in promotion of strategies, policies and ways of life in harmony with the environment. The NGO community has made its contribution in the building the public awareness in climate change issues throughout the country by publication of articles and launching programs in mass media, installation of instruction posters in the city, organization of tree planting campaigns, clearing of public spaces, organization of and active participation in meetings, round tables, seminars, etc., within a competitive small grants program implemented by the aforementioned project.

These activities were organized by the "Flux" press group, "Natura" magazine, "Ave Natura" club, Chisinau territory organisation of the Ecological Movement of Moldova, the "Ecoterra" Association of eco-radio-reporters, "Moldova Suverana" newspaper and the "SunInform" publicity agency.

ABBREVIATIONS

ANCE – National Agency for Energy Conservation
ASM – Academy of Sciences of the Republic of Moldova
CET – Heat Producing Power Plant
CGCM1 – The Canadian Centre for Climate Modelling and Analysis
CORINAIR – Joint EMEP/CORINAIR Atmospheric Emission Inventory Guidebook
CSIROMk2 – The Australian Commonwealth Scientific and Industrial Research Organisation
ECHAM4 – The German Climate Research Centre, Deutches Klimarechenzentrum
GHG – Greenhouse Gases
GFDL-R15 – The United States Geophysical Fluid Dynamics Laboratory;
GSM – Global Circulation Models
GWP – Global Warming Potential
HadCM2 – The United Kingdom Hadley Centre for Climate Prediction and Research
IPCC – Intergovernmental Panel in Climate Change
M I – Inertial Model (1) of Socio-Economic Development of the Country
M II – Basic Model (2) of Socio-Economic Development of the Country
NPV – Net Present Value
NGO – Nongovernmental Organisation
GDP – Gross Domestic Product
PEEI – Potential for Energy Efficiency Improvement
UNDP – United Nations Development Programme
RASTR – Program for Calculation of Regimes in the Energy Systems and Simulation of Future Development
RM – Republic of Moldova
CC – Climate Change
EU – European Union
MU – Measuring Units
UNFCCC – United Nations Framework Convention in Climate Change

CHEMICAL SYMBOLS

CH_4 – Methane
CO – Carbon Monoxide
CO_2 – Carbon Dioxide
CFC – Chlorofluorocarbons
HCFC – Hydrochlorofluorocarbons
NMVOC – Non Methane Volatile Organic Compounds
N_2O – Nitrous Oxide

NO_x – Nitrogen Oxides
O_3 – Ozone
SO_2 – Sulphur dioxide

MEASURING UNITS

°C – Degrees Centigrade
cm^3 – Cubic centimetres
Gg – Gigagrams (10^9g)
g – Grams
ha – Hectares
kg – Kilograms
kg c.f. – Kilograms of Conventional Fuel
km – Kilometre
km^2 – Square kilometre
km^3 – Cubic kilometre
kWh – Kilowatt per Hour
MDL – Moldovan Leu
Mill. – Million
m – Metre
m^2 – Square metre
m^3 – Cubic metre
mm - Millimetres
MW – Megawatt
PJ – Petajoul
$ US – Dollar of United States of America
s – Second
t.c.e. – Tone of Coal Equivalent
t – Tons
W – Watt
% – Percent
‘ – Minute

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ANNEXES

ANNEX A. GREENHOUSE GASE INVENTORY IN 1990-1998 ACCORDING TO TABLE 7A OF THE IPCC GUIDELINES

Table 7A. Summary report for national greenhouse gas inventories, year 1990

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 Emissions	CO_2 Removals	CH_4	N_2O	NO_x	CO	NMVOC	SO_2
Reference Approach	29119.00							
Total National Emissions and Removals	28323.25	-1849.85	193.27	2.87	138.40	308.20	93.55	266.14
1 Energy	25809.45		54.05	0.66	136.76	304.78	30.08	264.84
A Fuel Combustion (Sectoral Approach)	25809.45		2.65	0.66	136.76	304.78	30.08	264.84
1 Energy Industries	13080.45		0.35	0.10	40.58	6.95	0.00	
2 Manufacturing Industries and Construction	1770.27		0.06	0.01	2.91	0.53	0.00	
3 Transport	5227.14		1.31	0.10	83.35	288.15	29.96	2.14
4 Small combustion	5713.69		0.93	0.45	9.68	8.05	0.00	
5 Other (please specify)	17.90		0.00	0.00	0.24	1.10	0.12	
B Fugitive Emissions from Fuels			51.40					
1 Solid Fuels								
2 Oil and Natural Gas			51.40					
2 Industrial Processes	2508.62		1.42	0.00	0.60	0.36	23.24	1.30
A Mineral Products	1351.35				0.57	0.36	10.01	1.27
B Chemical Industry	18.23		0.00	0.00	0.00	0.00	5.96	0.00
C Metal Production	1139.04		1.42	0.00	0.02	0.00	0.02	0.03
D Other Production	0.00		0.00		0.00	0.00	7.25	0.00
E Production of Halocarbons and Sulphur Hexafluoride								
F Consumption of Halocarbons and Sulphur Hexafluoride								
G Other (please specify)								
3 Solvent and Other Product Use	5.19						40.23	
4 Agriculture			101.21	2.21	1.04	3.06		
A Enteric Fermentation			83.06					
B Manure Management			14.66	0.00				
C Rice Cultivation								
D Agricultural Soils				2.18				
E Prescribed Burning of Savannas								
F Field Burning of Agricultural Residues			3.49	0.03	1.04	3.06		
G Other (please specify)								
5 Land-Use Change & Forestry		-1849.85						
A Changes in Forest and Other Woody Biomass Stocks	475.45	-2325.30						
B Forest and Grassland Conversion								
C Abandonment of Managed Lands		0.00						
D CO_2 Emissions and Removals from Soil								
E Other (please specify)								
6 Waste			36.57	0.00				
A Solid Waste Disposal on Land			34.60					
B Industrial Wastewater Handling			0.78	0.00				
C Domestic Wastewater Handling			1.19	0.00				
C Waste Incineration								
D Other (please specify)								
7 Other (please specify)								
International Bunkers*	218.00		0.06	0.00	0.89	0.37	0.06	0.00
Aviation	218.00		0.06	0.00	0.89	0.37	0.06	0.00
Marine	0.00		0.00	0.00	0.00	0.00	0.00	0.00
CO_2 Emissions from Biomass**	424.48		1.37	0.01	0.43	14.29	0.00	0.00

NOTE:

Empty cells mean not applicable

Zero cells mean not estimated

*CO_2 emissions from biomass burning are not included in national totals

**CO_2 emissions from International Bunkers are not included in national totals

Table 7A. Summary report for national greenhouse gas inventories, year 1991

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 Emissions	CO_2 Removals	CH_4	N_2O	NO_x	CO	NMVOC	SO_2
Reference Approach	26469.57							
Total National Emissions and Removals	25485.53	-1763.34	183.76	2.57	130.69	315.42	89.27	261.13
1 Energy	23399.33		46.36	0.58	129.15	312.25	29.40	260.07
A Fuel Combustion (Sectoral Approach)	23399.33		2.29	0.58	129.15	312.25	29.40	260.07
1 Energy Industries	11894.52		0.31	0.09	38.66	6.52	0.00	
2 Manufacturing Industries and Construction	1328.03		0.04	0.01	2.25	0.41	0.00	
3 Transport	5152.18		1.03	0.10	80.28	284.19	29.30	2.28
4 Small combustion	5009.60		0.90	0.38	7.31	6.16	0.00	
5 Other (please specify)	15.00		0.00	0.00	0.20	0.94	0.10	
B Fugitive Emissions from Fuels			44.07					
1 Solid Fuels								
2 Oil and Natural Gas			44.07					
2 Industrial Processes	2081.57		1.25	0.00	0.55	0.27	19.77	1.06
A Mineral Products	1071.06				0.52	0.26	10.14	1.03
B Chemical Industry	13.71		0.00	0.00	0.00	0.00	4.47	0.00
C Metal Production	996.80		1.25	0.00	0.03	0.01	0.02	0.03
D Other Production	0.00		0.00		0.00	0.00	5.14	0.00
E Production of Halocarbons and Sulphur Hexafluoride								
F Consumption of Halocarbons and Sulphur Hexafluoride								
G Other (please specify)								
3 Solvent and Other Product Use	4.64						40.10	
4 Agriculture			99.66	1.99	0.99	2.91		
A Enteric Fermentation			81.90					
B Manure Management			14.43	0.00				
C Rice Cultivation								
D Agricultural Soils				1.96				
E Prescribed Burning of Savannas								
F Field Burning of Agricultural Residues			3.32	0.03	0.99	2.91		
G Other (please specify)								
5 Land-Use Change & Forestry		-1864.91						
A Changes in Forest and Other Woody Biomass Stocks	469.39	-2334.30						
B Forest and Grassland Conversion	100.08							
C Abandonment of Managed Lands		0.00						
D CO_2 Emissions and Removals from Soil								
E Other (please specify)								
6 Waste			36.50	0.00				
A Solid Waste Disposal on Land			34.68					
B Industrial Wastewater Handling			0.63	0.00				
C Domestic Wastewater Handling			1.19	0.00				
C Waste Incineration								
D Other (please specify)								
7 Other (please specify)								
International Bunkers*	233.25		0.01	0.00	0.96	0.38	0.06	0.00
Aviation	233.25		0.01	0.00	0.96	0.38	0.06	0.00
Marine	0.00		0.00	0.00	0.00	0.00	0.00	0.00
CO_2 Emissions from Biomass**	422.60		1.24	0.01	0.45	14.03	0.00	0.00

NOTE:
Empty cells mean not applicable
Zero cells mean not estimated
*CO_2 emissions from biomass burning are not included in national totals
**CO_2 emissions from International Bunkers are not included in national totals

Table 7A. Summary report for national greenhouse gas inventories, year 1992

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 Emissions	CO_2 Removals	CH_4	N_2O	NO_x	CO	NMVOC	SO_2
Reference Approach	**18742.28**							
Total National Emissions and Removals	**19494.82**	**-1816.25**	**164.19**	**1.92**	**92.68**	**175.62**	**71.01**	**168.29**
1 Energy	18359.62		40.64	0.50	91.29	172.39	16.59	167.96
A Fuel Combustion (Sectoral Approach)	18359.62		1.85	0.50	91.29	172.39	16.59	167.96
1 Energy Industries	10372.63		0.28	0.07	32.32	5.34	0.00	
2 Manufacturing Industries and Construction	864.35		0.02	0.01	0.39	0.34	0.00	
3 Transport	3288.47		0.68	0.07	53.40	161.95	16.53	2.10
4 Small combustion	3824.77		0.88	0.35	5.05	4.29	0.00	
5 Other (please specify)	9.40		0.00	0.00	0.13	0.47	0.06	
B Fugitive Emissions from Fuels			38.79					
1 Solid Fuels								
2 Oil and Natural Gas			38.79					
2 Industrial Processes	1130.39		1.31	0.00	0.33	0.10	14.32	0.34
A Mineral Products	78.25				0.31	0.10	7.61	0.31
B Chemical Industry	6.70		0.00	0.00	0.00	0.00	2.20	0.00
C Metal Production	1045.44		1.31	0.00	0.02	0.00	0.02	0.02
D Other Production	0.00		0.00		0.00	0.00	4.49	0.00
E Production of Halocarbons and Sulphur Hexafluoride								
F Consumption of Halocarbons and Sulphur Hexafluoride								
G Other (please specify)								
3 Solvent and Other Product Use	4.81						40.09	
4 Agriculture			97.51	1.42	1.07	3.13		
A Enteric Fermentation			80.29	0.00				
B Manure Management			13.64					
C Rice Cultivation								
D Agricultural Soils				1.39				
E Prescribed Burning of Savannas								
F Field Burning of Agricultural Residues			3.58	0.03	1.07	3.13		
G Other (please specify)								
5 Land-Use Change & Forestry		-1816.29						
A Changes in Forest and Other Woody Biomass Stocks	513.91	-2330.20						
B Forest and Grassland Conversion	176.20							
C Abandonment of Managed Lands		0.00						
D CO_2 Emissions and Removals from Soil								
E Other (please specify)								
6 Waste			24.73	0.00				
A Solid Waste Disposal on Land			23.01					
B Industrial Wastewater Handling			0.54	0.00				
C Domestic Wastewater Handling			1.18	0.00				
C Waste Incineration								
D Other (please specify)								
7 Other (please specify)								
International Bunkers*	94.69		0.00	0.00	0.41	0.16	0.02	0.00
Aviation	94.69		0.00	0.00	0.41	0.16	0.02	0.00
Marine	0.00		0.00	0.00	0.00	0.00	0.00	0.00
CO_2 Emissions from Biomass**	385.12		1.17	0.01	0.41	12.85	0.00	0.00

NOTE:
Empty cells mean not applicable
Zero cells mean not estimated
*CO_2 emissions from biomass burning are not included in national totals
**CO_2 emissions from International Bunkers are not included in national totals

Table 7A. Summary report for national greenhouse gas inventories, year 1993

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 Emissions	CO_2 Removals	CH_4	N_2O	NO_x	CO	NMVOC	SO_2
Reference Approach	14731.87							
Total National Emissions and Removals	**14455.37**	**-1791.90**	**144.37**	**0.94**	**70.37**	**111.71**	**69.21**	**152.77**
1 Energy	13574.59		25.65	0.39	69.05	108.83	10.49	152.42
A Fuel Combustion (Sectoral Approach)	13574.59		1.78	0.39	69.05	108.83	10.49	152.42
1 Energy Industries	8773.43		0.23	0.06	28.77	4.70	0.00	
2 Manufacturing Industries and Construction	444.35		0.01	0.01	0.59	0.16	0.00	
3 Transport	2264.59		0.68	0.04	36.91	101.07	10.43	
4 Small combustion	2082.82		0.85	0.29	2.67	2.44	0.00	
5 Other (please specify)	9.40		0.00	0.00	0.13	0.47	0.06	
B Fugitive Emissions from Fuels			23.87					
1 Solid Fuels								
2 Oil and Natural Gas			23.87					
2 Industrial Processes	876.00		1.00	0.00	0.38	0.10	18.74	0.35
A Mineral Products	75.78				0.36	0.10	12.57	0.33
B Chemical Industry	3.58		0.00	0.00	0.00	0.00	1.18	0.00
C Metal Production	796.64		1.00	0.00	0.02	0.00	0.01	0.02
D Other Production	0.00		0.00		0.00	0.00	4.97	0.00
E Production of Halocarbons and Sulphur Hexafluoride								
F Consumption of Halocarbons and Sulphur Hexafluoride								
G Other (please specify)								
3 Solvent and Other Product Use	4.78						39.98	
4 Agriculture			93.27	0.55	0.94	2.77		
A Enteric Fermentation			77.81					
B Manure Management			12.30	0.00				
C Rice Cultivation								
D Agricultural Soils				0.52				
E Prescribed Burning of Savannas								
F Field Burning of Agricultural Residues			3.16	0.03	0.94	2.77		
G Other (please specify)								
5 Land-Use Change & Forestry		-1791.90						
A Changes in Forest and Other Woody Biomass Stocks	615.90	-2407.80						
B Forest and Grassland Conversion	279.18							
C Abandonment of Managed Lands		-18.11						
D CO_2 Emissions and Removals from Soil								
E Other (please specify)								
6 Waste			24.45	0.00				
A Solid Waste Disposal on Land			22.86					
B Industrial Wastewater Handling			0.41	0.00				
C Domestic Wastewater Handling			1.18	0.00				
C Waste Incineration								
D Other (please specify)								
7 Other (please specify)								
International Bunkers*	61.55		0.00	0.00	0.26	0.10	0.02	0.00
Aviation	61.55		0.00	0.00	0.26	0.10	0.02	0.00
Marine	0.00		0.00	0.00	0.00	0.00	0.00	0.00
CO_2 Emissions from Biomass**	386.06		1.11	0.01	0.42	12.80	0.00	0.00

NOTE:

Empty cells mean not applicable

Zero cells mean not estimated

*CO_2 emissions from biomass burning are not included in national totals

**CO_2 emissions from International Bunkers are not included in national totals

Table 7A. Summary report for national greenhouse gas inventories, year 1994

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 Emissions	CO_2 Removals	CH_4	N_2O	NO_x	CO	NMVOC	SO_2
Reference Approach	13099.50							
Total National Emissions and Removals	12085.80	-1718.73	146.83	0.62	58.27	105.14	64.42	105.68
1 Energy	11408.90		32.46	0.36	57.09	102.16	10.05	105.51
A Fuel Combustion (Sectoral Approach)	11408.90		1.57	0.36	57.09	102.16	10.05	105.51
1 Energy Industries	7451.08		0.18	0.05	24.27	4.30	0.00	
2 Manufacturing Industries and Construction	213.22		0.01	0.01	0.24	0.12	0.00	
3 Transport	1897.72		0.55	0.04	29.78	94.65	9.98	
4 Small combustion	1836.14		0.83	0.25	2.65	2.47	0.00	
5 Other (please specify)	10.75		0.00	0.00	0.14	0.62	0.07	
B Fugitive Emissions from Fuels			30.90					
1 Solid Fuels								
2 Oil and Natural Gas			30.90					
2 Industrial Processes	672.41		0.80	0.00	0.18	0.04	14.44	0.17
A Mineral Products	33.26				0.16	0.04	8.32	0.15
B Chemical Industry	1.56		0.00	0.00	0.00	0.00	0.51	0.00
C Metal Production	637.60		0.80	0.00	0.02	0.00	0.01	0.02
D Other Production	0.00		0.00		0.00	0.00	5.60	0.00
E Production of Halocarbons and Sulphur Hexafluoride								
F Consumption of Halocarbons and Sulphur Hexafluoride								
G Other (please specify)								
3 Solvent and Other Product Use	4.48						39.93	
4 Agriculture			89.22	0.26	1.00	2.93		
A Enteric Fermentation			74.94					
B Manure Management			10.93	0.00				
C Rice Cultivation								
D Agricultural Soils				0.23				
E Prescribed Burning of Savannas								
F Field Burning of Agricultural Residues			3.35	0.03	1.00	2.93		
G Other (please specify)								
5 Land-Use Change & Forestry		-1718.73						
A Changes in Forest and Other Woody Biomass Stocks	615.90	-2333.90						
B Forest and Grassland Conversion	241.30							
C Abandonment of Managed Lands		-58.87						
D CO_2 Emissions and Removals from Soil								
E Other (please specify)								
6 Waste			24.35	0.00				
A Solid Waste Disposal on Land			22.93					
B Industrial Wastewater Handling			0.25	0.00				
C Domestic Wastewater Handling			1.17	0.00				
C Waste Incineration								
D Other (please specify)			0.00	0.00	0.00	0.00	0.00	0.00
7 Other (please specify)								
International Bunkers*	37.88		0.00	0.00	0.16	0.06	0.01	0.00
Aviation	0.00		0.00	0.00	0.00	0.00	0.00	0.00
Marine	37.88		0.00	0.00	0.16	0.06	0.01	0.00
CO_2 Emissions from Biomass**	378.56		1.10	0.01	0.41	12.56	0.00	0.00

NOTE:

Empty cells mean not applicable

Zero cells mean not estimated

*CO_2 emissions from biomass burning are not included in national totals

**CO_2 emissions from International Bunkers are not included in national totals

Table 7A. Summary report for national greenhouse gas inventories, year 1995

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 Emissions	CO_2 Removals	CH_4	N_2O	NO_x	CO	NMVOC	SO_2
Reference Approach	10803.58							
Total National Emissions and Removals	9449.27	-1494.28	134.26	0.60	49.48	128.61	69.10	64.33
1 Energy	8771.28		26.58	0.33	48.57	126.27	12.65	64.19
A Fuel Combustion (Sectoral Approach)	8771.28		1.38	0.33	48.57	126.27	12.65	64.19
1 Energy Industries	5231.26		0.13	0.03	16.39	2.87	0.00	
2 Manufacturing Industries and Construction	244.89		0.01	0.00	0.20	0.10	0.00	
3 Transport	2026.56		0.44	0.03	30.23	121.12	12.60	1.30
4 Small combustion	1260.67		0.81	0.26	1.63	1.74	0.00	
5 Other (please specify)	7.90		0.00	0.00	0.11	0.45	0.05	
B Fugitive Emissions from Fuels			25.20					
1 Solid Fuels								
2 Oil and Natural Gas			25.20					
2 Industrial Processes	673.15		0.80	0.00	0.13	0.04	16.45	0.14
A Mineral Products	34.61				0.11	0.04	8.90	0.12
B Chemical Industry	0.93		0.00	0.00	0.00	0.00	0.31	0.00
C Metal Production	637.60		0.80	0.00	0.02	0.00	0.01	0.02
D Other Production	0.00		0.00		0.00	0.00	7.23	0.00
E Production of Halocarbons and Sulphur Hexafluoride								
F Consumption of Halocarbons and Sulphur Hexafluoride								
G Other (please specify)								
3 Solvent and Other Product Use	4.84						40.00	
4 Agriculture			82.70	0.27	0.78	2.30		
A Enteric Fermentation			70.17					
B Manure Management			9.90	0.00				
C Rice Cultivation								
D Agricultural Soils				0.25				
E Prescribed Burning of Savannas								
F Field Burning of Agricultural Residues			2.63	0.02	0.78	2.30		
G Other (please specify)								
5 Land-Use Change & Forestry		-1494.28						
A Changes in Forest and Other Woody Biomass Stocks	854.74	-2349.02						
B Forest and Grassland Conversion	261.85							
C Abandonment of Managed Lands								
D CO_2 Emissions and Removals from Soil								
E Other (please specify)								
6 Waste			24.18	0.00				
A Solid Waste Disposal on Land			22.79					
B Industrial Wastewater Handling			0.22	0.00				
C Domestic Wastewater Handling			1.17	0.00				
C Waste Incineration								
D Other (please specify)								
7 Other (please specify)								
International Bunkers*	34.72		0.00	0.00	0.17	0.07	0.01	0.00
Aviation	34.72		0.00	0.00	0.17	0.07	0.01	0.00
Marine	0.00		0.00	0.00	0.00	0.00	0.00	0.00
CO_2 Emissions from Biomass**	391.68		1.41	0.01	0.38	13.40	0.00	0.00

NOTE:
Empty cells mean not applicable
Zero cells mean not estimated
*CO_2 emissions from biomass burning are not included in national totals
**CO_2 emissions from International Bunkers are not included in national totals

Table 7A. Summary report for national greenhouse gas inventories, year 1996

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 Emissions	CO_2 Removals	CH_4	N_2O	NO_x	CO	NMVOC	SO_2
Reference Approach	11544.66							
Total National Emissions and Removals	9984.14	-1585.26	128.19	0.60	50.31	106.42	64.74	66.71
1 Energy	9303.94		29.64	0.31	49.27	103.63	10.09	66.61
A Fuel Combustion (Sectoral Approach)	9303.94		1.53	0.31	49.27	103.63	10.09	66.61
1 Energy Industries	5766.60		0.13	0.03	18.37	3.00	0.00	
2 Manufacturing Industries and Construction	187.78		0.01	0.00	0.20	0.08	0.00	
3 Transport	1815.99		0.57	0.03	28.42	97.63	10.01	1.21
4 Small combustion	1520.67		0.82	0.25	2.11	2.14	0.00	
5 Other (please specify)	12.90		0.00	0.00	0.17	0.79	0.08	
B Fugitive Emissions from Fuels			28.11					
1 Solid Fuels								
2 Oil and Natural Gas			28.11					
2 Industrial Processes	674.87		0.80	0.00	0.10	0.02	14.61	0.09
A Mineral Products	36.49				0.08	0.02	7.76	0.07
B Chemical Industry	0.78		0.00	0.00	0.00	0.00	0.26	0.00
C Metal Production	637.60		0.80	0.00	0.02	0.00	0.01	0.02
D Other Production	0.00		0.00		0.00	0.00	6.57	0.00
E Production of Halocarbons and Sulphur Hexafluoride								
F Consumption of Halocarbons and Sulphur Hexafluoride								
G Other (please specify)								
3 Solvent and Other Product Use	5.33						40.05	
4 Agriculture			73.91	0.29	0.94	2.77		
A Enteric Fermentation			61.92					
B Manure Management			8.83	0.00				
C Rice Cultivation								
D Agricultural Soils				0.26				
E Prescribed Burning of Savannas								
F Field Burning of Agricultural Residues			3.16	0.03	0.94	2.77		
G Other (please specify)								
5 Land-Use Change & Forestry		-1585.26						
A Changes in Forest and Other Woody Biomass Stocks	733.19	-2318.45						
B Forest and Grassland Conversion	318.74							
C Abandonment of Managed Lands		-122.61						
D CO_2 Emissions and Removals from Soil								
E Other (please specify)								
6 Waste			23.84	0.00				
A Solid Waste Disposal on Land			22.47					
B Industrial Wastewater Handling			0.21	0.00				
C Domestic Wastewater Handling			1.16	0.00				
C Waste Incineration								
D Other (please specify)								
7 Other (please specify)								
International Bunkers*	34.72		0.00	0.00	0.17	0.07	0.01	0.00
Aviation	34.72		0.00	0.00	0.17	0.07	0.01	0.00
Marine	0.00		0.00	0.00	0.00	0.00	0.00	0.00
CO_2 Emissions from Biomass**	412.30		1.51	0.01	0.40	14.07	0.00	0.00

NOTE:
Empty cells mean not applicable
Zero cells mean not estimated
*CO_2 emissions from biomass burning are not included in national totals
**CO_2 emissions from International Bunkers are not included in national totals

Table 7A. Summary report for national greenhouse gas inventories, year 1997

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 Emissions	CO_2 Removals	CH_4	N_2O	NO_x	CO	NMVOC	SO_2
Reference Approach	10767.76							
Total National Emissions and Removals	9016.45	-1720.34	117.91	0.50	47.07	122.95	63.85	35.10
1 Energy	8303.43		29.51	0.29	46.10	120.43	12.28	34.96
A Fuel Combustion (Sectoral Approach)	8303.43		1.51	0.29	46.10	120.43	12.28	34.96
1 Energy Industries	4600.53		0.11	0.02	15.51	2.22	0.00	
2 Manufacturing Industries and Construction	244.35		0.01	0.00	0.15	0.07	0.00	
3 Transport	1917.85		0.58	0.03	28.60	115.83	12.19	0.73
4 Small combustion	1532.11		0.81	0.24	1.72	1.77	0.00	
5 Other (please specify)	8.60		0.00	0.00	0.11	0.55	0.09	
B Fugitive Emissions from Fuels			28.00					
1 Solid Fuels								
2 Oil and Natural Gas			28.00					
2 Industrial Processes	708.38		0.80	0.00	0.12	0.03	11.88	0.14
A Mineral Products	70.65				0.11	0.03	6.20	0.12
B Chemical Industry	0.13		0.00	0.00	0.00	0.00	0.10	0.00
C Metal Production	637.60		0.80	0.00	0.02	0.00	0.01	0.02
D Other Production	0.00		0.00		0.00	0.00	5.56	0.00
E Production of Halocarbons and Sulphur Hexafluoride								
F Consumption of Halocarbons and Sulphur Hexafluoride								
G Other (please specify)								
3 Solvent and Other Product Use	4.63						39.69	
4 Agriculture			63.87	0.21	0.85	2.49		
A Enteric Fermentation			53.10					
B Manure Management			7.92					
C Rice Cultivation								
D Agricultural Soils				0.19				
E Prescribed Burning of Savannas								
F Field Burning of Agricultural Residues			2.84	0.02	0.85	2.49		
G Other (please specify)								
5 Land-Use Change & Forestry		-1720.34						
A Changes in Forest and Other Woody Biomass Stocks		-2339.47						
B Forest and Grassland Conversion	238.70							
C Abandonment of Managed Lands		-190.89						
D CO_2 Emissions and Removals from Soil								
E Other (please specify)								
6 Waste			23.74	0.00				
A Solid Waste Disposal on Land			22.37					
B Industrial Wastewater Handling			0.20	0.00				
C Domestic Wastewater Handling			1.17	0.00				
C Waste Incineration								
D Other (please specify)								
7 Other (please specify)								
International Bunkers*	64.39		0.00	0.00	0.32	0.11	0.02	0.00
Aviation	64.39		0.00	0.00	0.32	0.11	0.02	0.00
Marine	0.00		0.00	0.00	0.00	0.00	0.00	0.00
CO_2 Emissions from Biomass**	412.30		1.51	0.01	0.40	14.08	0.00	0.00

NOTE:

Empty cells mean not applicable

Zero cells mean not estimated

*CO_2 emissions from biomass burning are not included in national totals

**CO_2 emissions from International Bunkers are not included in national totals

Table 7A. Summary report for national greenhouse gas inventories, year 1998

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 Emissions	CO_2 Removals	CH_4	N_2O	NO_x	CO	NMVOC	SO_2
Reference Approach	8094.89							
Total National Emissions and Removals	8129.32	-1729.40	107.43	0.42	39.58	99.44	60.84	31.83
1 Energy	6926.85		25.29	0.28	38.50	96.61	10.12	31.70
A Fuel Combustion (Sectoral Approach)	6926.85		1.45	0.28	38.50	96.61	10.12	31.70
1 Energy Industries	3928.36		0.09	0.01	13.73	1.82	0.00	
2 Manufacturing Industries and Construction	244.35		0.01	0.00	0.15	0.07	0.00	
3 Transport	1545.42		0.55	0.03	22.81	92.41	10.07	0.59
4 Small combustion	1200.82		0.81	0.24	1.70	1.77	0.00	
5 Other (please specify)	7.90		0.00	0.00	0.10	0.54	0.05	
B Fugitive Emissions from Fuels			23.83					
1 Solid Fuels								
2 Oil and Natural Gas			23.83					
2 Industrial Processes	1197.69		1.44	0.00	0.13	0.02	11.11	0.13
A Mineral Products	48.12		0.00		0.10	0.02	5.85	0.10
B Chemical Industry	0.31		0.00	0.00	0.00	0.00	0.10	0.00
C Metal Production	1149.26		1.44	0.00	0.03	0.00	0.02	0.03
D Other Production	0.00		0.00		0.00	0.00	5.14	0.00
E Production of Halocarbons and Sulphur Hexafluoride								
F Consumption of Halocarbons and Sulphur Hexafluoride								
G Other (please specify)								
3 Solvent and Other Product Use	4.78						39.60	
4 Agriculture			57.08	0.14	0.96	2.80		
A Enteric Fermentation			46.66					
B Manure Management			7.22	0.00				
C Rice Cultivation								
D Agricultural Soils				0.12				
E Prescribed Burning of Savannas								
F Field Burning of Agricultural Residues			3.20	0.03	0.96	2.80		
G Other (please specify)								
5 Land-Use Change & Forestry		-1729.40						
A Changes in Forest and Other Woody Biomass Stocks	612.00	-2341.40						
B Forest and Grassland Conversion	278.24							
C Abandonment of Managed Lands								
D CO_2 Emissions and Removals from Soil								
E Other (please specify)								
6 Waste			23.63	0.00				
A Solid Waste Disposal on Land			22.28					
B Industrial Wastewater Handling			0.20	0.00				
C Domestic Wastewater Handling			1.15	0.00				
C Waste Incineration								
D Other (please specify)								
7 Other (please specify)								
International Bunkers*	64.07		0.00	0.00	0.29	0.12	0.02	0.00
Aviation	64.07		0.00	0.00	0.29	0.12	0.02	0.00
Marine	0.00		0.00	0.00	0.00	0.00	0.00	0.00
CO_2 Emissions from Biomass**	412.30		1.51	0.01	0.40	14.07	0.00	0.00

NOTE:
Empty cells mean not applicable
Zero cells mean not estimated
*CO_2 emissions from biomass burning are not included in national totals
**CO_2 emissions from International Bunkers are not included in national totals

ANNEX B NATIONAL GREENHOUSE INVENTORY OF THE TOTAL EMISSIONS OF THE REPUBLIC OF MOLDOVA IN CO_2 EQUIVALENT FOR 1990-1998 YEARS PERIOD

	1990	1991	1992	1993	1994	1995	1996	1997	1998
CO_2 ,Gg									
Fuel combustion	25809.45	23399.33	18359.62	13574.59	11408.90	8771.28	9303.94	8303.43	6926.84
– Stationary sources	20564.41	18232.15	15061.75	11300.60	9500.43	6736.46	7475.05	6789,28	5373.52
– Transport	5245,04	5167,18	3297,87	2273,99	1908,47	2034,46	1828,89	1926,45	1553,32
Industrial processes	2508.62	2081.57	1130.39	876.00	672.41	673.15	674.87	708.38	1197.69
Solvent and other product use	5,19	4.64	4.81	4.78	4.48	4.84	5.33	4,63	4.78
Total emissions	**28323.26**	**25485.54**	**19494.82**	**14455.37**	**12085.79**	**9449.27**	**9984.14**	**9016.44**	**8129.31**
CH_4, Gg CO2 equivalent									
Energy sector	1135.15	973.46	853.47	538.68	681.73	558.23	622.44	619.63	530.99
- Fuel combustion	55.70	48.10	38.88	37.33	32.89	29.05	32.11	31.63	30.48
- Fugitive fuel emissions	1079.44	925,37	814,59	501,35	648,84	529,18	590,33	588,00	500,51
Industrial processes	29.90	26.17	27.44	20.91	16.74	16.74	16.74	16.74	30.17
Agriculture	2125.47	2092.82	2047.67	1958.69	1873.67	1736.60	1552.16	1344.24	1300,68
Waste	768.22	766.58	519,39	512,42	508,64	507,26	500,01	497,95	497,83
Total emissions	**4058.74**	**3859.03**	**3447.97**	**3030.70**	**3080.78**	**2818.83**	**2691.41**	**2475,56**	**2359,67**
N_2O, Gg CO2 equivalent									
Fuel combustion	204.91	179.61	156.48	120.81	112.62	101.80	96.69	88.75	87.11
Agriculture	685.66	617.33	439.43	170.22	79.58	85.16	89.00	65.88	44.45
Total emissions	**890.57**	**796.95**	**595.89**	**291.03**	**192,20**	**186.95**	**185.69**	**154.63**	**131.56**
TOTAL, Gg CO_2 equivalent									
Energy sector	27149.50	24552.51	19369.55	14234.08	12203.25	9431.31	10023.07	9014.81	7544.94
- Fuel combustion	26070.06	23627.04	18554.96	13732.73	11554.41	8902.13	9432.74	8423.81	7044.43
- Fugitive fuel emissions	1079,44	925.37	814,59	501,35	648,84	529,18	590,33	588,00	500,51
Industrial processes	2538.52	2107.74	1157.83	896.91	689.15	689.89	691.61	725.12	1227.86
Solvent and other product use	5.19	4.64	4.81	4.78	4.48	4.84	5,33	4.63	4.78
Agriculture	2811.13	2710.15	2487.10	2128.91	1953.25	1821.76	1641.16	1365,42	1345.13
Waste	768.22	766.58	519,39	512,42	508,64	507,26	500,01	497,95	497,83
Total emissions	**33272.57**	**30141.62**	**23538.68**	**17777.10**	**15358.77**	**12455.06**	**12861.18**	**11604.9**	**10620.59**
Land use Change and Forestry	-1849,85	-1864,91	-1816,25	-1791,91	-1718,73	-1494,28	-1585,26	-1720,34	-1729,4
Net emissions	**31422.72**	**28276.71**	**21722.43**	**15985.19**	**13640.04**	**10960.78**	**11275.92**	**9884.59**	**8891.19**

ANNEX C CONFIGURATION OF ENERGY SYSTEM REGIMES MODELING IN THE REPUBLIC OF MOLDOVA