THE FIRST

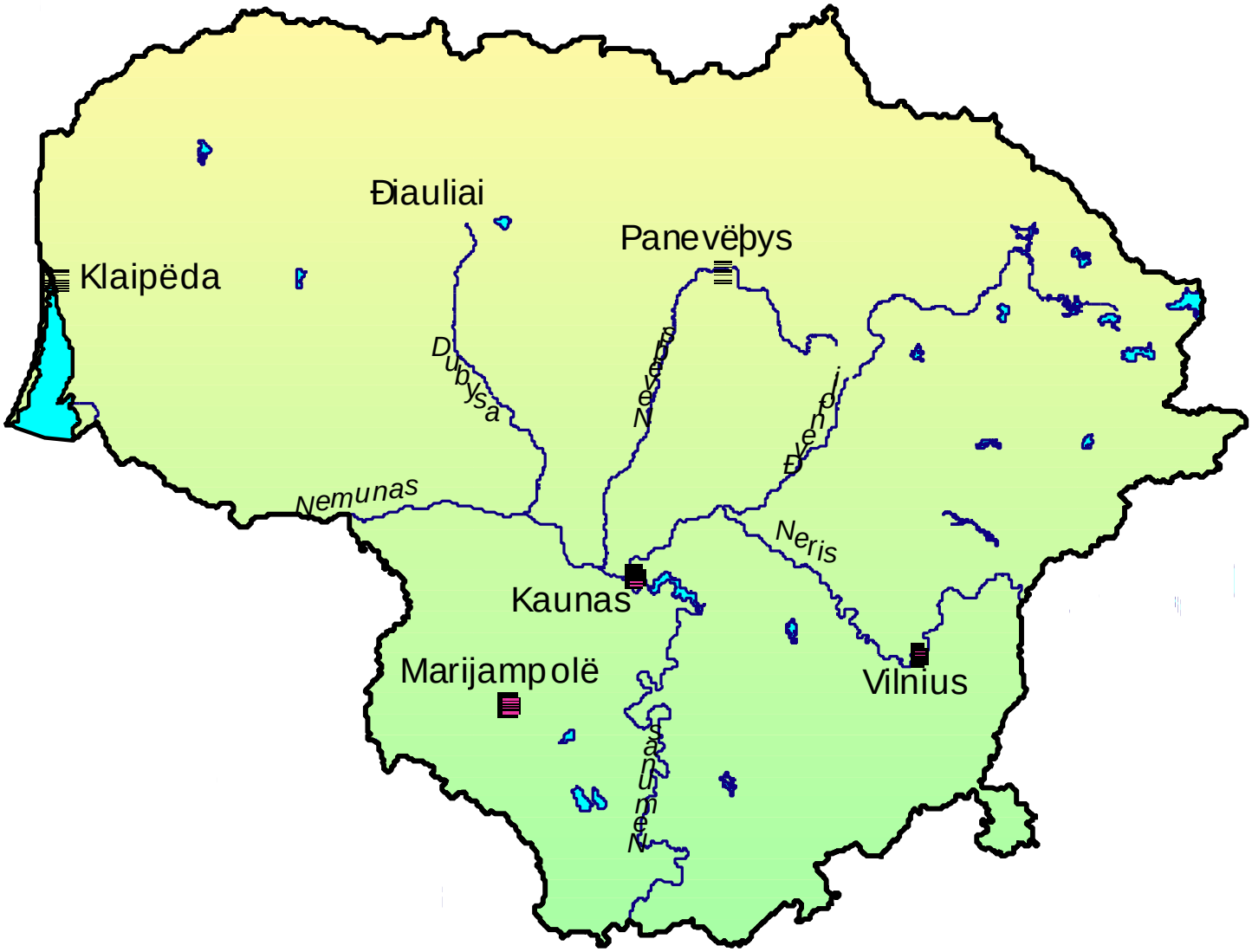
NATIONAL COMMUNICATION

OF THE REPUBLIC OF LITHUANIA

ON CLIMATE CHANGE

EXECUTIVE SUMMARY

THE FIRST NATIONAL COMMUNICATION ON CLIMATE CHANGE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Vilnius
Nemunas

1. INTRODUCTION

The Republic of Lithuania signed the United Nations Framework Convention on Climate Change together with the rest of 154 states in Rio de Janeiro in June 1992. The Convention was ratified by the Seimas (the Parliament) of the Republic of Lithuania on 23 February 1995 and entered into force for our state since 22 June 1995.

The First National Communication on Climate Change of the Republic of Lithuania is based on the National Implementation Strategy of the United Nations Framework Convention on Climate Change.

The First National Communication on the UNFCCC was prepared by a country team, consisting of specialists from:

- Ministry of Environmental Protection,
- Ministry of Transport,
- Ministry of Economics,
- Ministry of Agriculture and Forestry,
- Ministry of Health,
- Hydrometeorological Service,
- Vilnius University,
- Lithuanian Academy of Sciences,
- University of Agriculture,
- Institute of Ecology,
- the Green Movement of Lithuania.

2. BASIC DATA ON LITHUANIA

The Republic of Lithuania lies in the centre of Europe, on the eastern coast of the Baltic Sea (the length of the Lithuanian coastline is 99 km).

Lithuania lies on the western fringe of the East European Plain, in the middle and lower basin of the River Nemunas. The relief is a meridian-oriented alternation of lowland plains and hilly uplands. The mean absolute surface altitude is 100 m above the sea level; the highest point (293.6 m) is in the east of the country.

The territory of Lithuania is situated in the northern part of the moderate climate zone. The distance of the territory from the equator (6100 km) and from the pole (3900 km) decides the amount of the general solar energy -- it is 3600 MJ/km^2 per year.

At the beginning of 1990 the population of Lithuania was 3 million 723 thousand, of which 1 million 173 thousand or 32 % reside in the country.

The largest increase in the population in post-war Lithuania was in the seventh decade when the average growth rate was 46 thousand per year (1.2-1.3 %). At the beginning of the eighth decade the growth rate stabilized and it comprised 0.8-0.9 % a year.

3. INVENTORY AND PROJECTIONS OF GREENHOUSE GAS EMISSIONS AND REMOVALS

Inventory of greenhouse gas emissions has been carried out according to the IPCC methodology. Emissions of carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), nitrogen oxides (NO_x), carbon monoxide (CO) and non-methane volatile compounds (NMVOC) have been estimated. Due to the lack of local methodology, the proposed factors of the IPCC methodology for estimation of CO_2, CH_4 and N_2O emissions were mainly used.

Energy and transport sectors are termed to be the most extensive sources of greenhouse gas emissions in Lithuania. This sector comprises the full cycle of fuel consumption, production, transportation, storage, delivery, recycling and burning. CO_2 is regarded to be the dominant ingredient of emissions discharging during the power production process from fossil fuel.

Along with burned fuel consumed in international air, railway, sea and road carriages as well as with emitted ingredients of the combustion processes the country owner's responsibility of the means of transport shall be taken into the balance sheet.

Methane emissions prevail in agricultural sector due to fermentation process in alimentary canal of cattle, due to agricultural waste, manure, biogas. Fertilizer usage in great amounts leads to nitrous oxide emissions from soils.

GHG emissions from land use and forestry sectors are diverse. Carbon dioxide emissions are induced here because of the forest felling and land use change, but newly grown-up forests uptake huge amounts of CO_2.

Waste remains one of the major sources for methane emissions. Anaerobic bacterium decompose organic substances from waste into methane. Methane emissions from sewage waters come off due to the processes of very similar nature.

GHG source and sink categories	*CO_2 emissions*	*CO_2 removals*	*CH_4*	*N_2O*	*NO_x*	*CO*	*NMVOC*
Total emissions and sinks	**42338**	**11651**	**377.95**	**13.15**	**178.29**	**644.1**	**93.65**
1. All energy	*37332*		*31.35*	*0.95*	*17789*	*644.1*	*81.36*
A. Fuel combustion	37332		5.25	0.95	177.89	644.1	72.76
1. Energy & transformation activities	16352		0.73	0.36	58.63	43.8	0.74
2. Industry	5379		0.44	0.14	10.90	18.4	0.44
3. Transport	5791		1.42	0.19	71.69	492.3	65.03
4. Residential heating	6313		0.73	0.16	30.16	42.1	3.84
5. Other	2882		0.43	0.09	6.02	11.0	0.43
Biomass for energy purposes	615		1.50	0.01	0.49	36.5	2.28
B. Fugitive fuel emission			26.1				8.6
1. Solid fuels							
2. Oil and natural gas			26.1				8.6
2. Industrial processes	2203		0.2	1.4	0.4		1.2
3. Solvent and other product use							11.1
A. Paint application							
4. Agriculture			180.7	10.8			
A. Enteric fermentation			157.3				
B. Animal waste			23.4				
C. Agricultural soils				10.8			
5. Land use change and forestry	2803	11651					
A. Changes in forest other biomass stocks		10375					
B. Forest and grassland conversion	2803						
C. Abandonment of managed lands		1276					
6. Waste			165.7				
A. Landfills			162.0				
B. Wastewater			3.7				

Table1. GHG emissions in Lithuania in1990 (Gg)

4. POLICIES AND MEASURES FOR CLIMATE CHANGE MITIGATION AND ADAPTATION TO IT

The standards and norms adopted in Lithuania are conditioned by national policy as well as by obligations after having signed international conventions and agreements. Moreover, Lithuania has participated in the main conventions on environment policy development. They are as follows: Convention on the Protection of the Marine Environment of the Baltic Sea Area (Helsinki Convention); Convention on the Long-range Transboundary Air Pollution, Convention on Climate Change, Convention on Biological Diversity, Convention for the Protection of the Ozone Layer etc.

A list of the conventions that have been ratified by Lithuania is presented below:

1. Convention on the Protection of the Marine Environment of the Baltic Sea Area (1992)
2. Convention on the Long-Range Transboundary Air Pollution(1993)
3. Framework Convention on Climate Change (1995)
4. Convention on Wetlands of International Importance Especially as Waterfowl Habitat (Ramsar Convention) (1993)
5. Convention on the Conservation of European Wildlife and Natural Habitat (Bern Convention) (1993)
6. Convention on Fishing and Conservation of the Living Resources in the Baltic Sea and the Belts (Gdansk Convention) (1992)
7. Convention on the Future Multilateral Cooperation in the North - West Atlantic Fisheries (Ottawa Convention) (1992)
8. Convention on the Protection of the Ozone Layer (Vienna Convention) (1994)
9. Protocol on Substances that deplete the Ozone Layer (Montreal Convention) (1994)

The majority of environment standards and norms applied in Lithuania fully satisfies the requirements of European Union, and some of them present themselves to be even more stringent.

Environment protection system for European Union by 2000 has been legalized at the fifth program "Stability". The general and specific environment protection goals have been set out and the actions proposed in support of landscape protection and biological diversity upholding.

The following laws regulating environment protection have been approved by 1990:

1. Code on Territorial Waters of the Republic of Lithuania, 1978.
2. Code on the Entrails of the Soils of the Republic of Lithuania, 19977.
3. Law on Fauna Protection and Regulation , 1981.
4. Law on Atmosphere Protection, 1981.
5. Code on Administrative Law Violations of the Republic of Lithuania, 1984.

Legislative system on environment protection mainly based on "The Law on Environment Protection" is being developed and shall have to be expanded in quality and quantity in the nearest future. At present it is of vital importance to work out and adopt laws, regulating the usage of various raw materials and their protection as well as to ensure the implementation of the regulations of environment protection laws, setting out unified system of laws on economic activities, environment protection and natural resource usage.

Among the most important trends of response to climate change the following are worthwhile mentioning:

- reduction of fertility of soils and crop capacity of agriculture;
- reduction of forest productivity (although increase of CO_2 in the atmosphere may evoke increment of timber; it is quite a complicated process);
- reduction of productivity of water basins;
- change and degradation of ecosystems of the Baltic Sea coast and littoral zone.

Possible means and measures to mitigate climate change and adapt to it are presented in Chapters 4.4 and 5.10.

5. PROJECTIONS

The economical development in Lithuania is conditioned by the market and its factors. In order to simplify the transition to the market economy, the Government is expected to work out the strategies for different sectors of economy to foresee the priorities. New strategies have been worked out for the following sectors:

- industry (different sectors),
- energy,
- transport,
- communications and information,
- agriculture,
- services, tourism included.

Long- and short term projections enable us to conclude that an economic upsurge has already started. Each coming year is expected to have 4,2% growth in national product. Newly developed projections for Lithuanian industry indicate that fuel and food industries are the most significant for Lithuanian economy. It is expected that machine building capacities would be reduced. Energy, transport and environmental protection are three priority sectors for state investments. By 2000, environmental protection is expected to remain a priority sector open for state investments.

The projections for greenhouse gas emissions by 2000 and 2010 have been based on "Projections of Economic Development in the Republic of Lithuania" prepared by the Ministry of Economics and development programs of different sectors of industry.

GHG	***1990***	***2000***	***2010 (Scenario I)***	***2010 (Scenario II)***
CO_2	42338	29914	36282	53035
CO_2 removal	(-11651)	(-11891)	(-12046)	(-12046)
CH_4	377.95	309.37	330.53	333.86
N_2O	13.15	4.31	5.56	5.94
NO_x	178.29	126.52	161.71	221.52
CO	644.08	528.17	680.12	724.93
NMVOC	93.66	136.86	97.64	99.24

Table 2. Projections of GHG emissions in 2000 and 2010 (Gg)

6. FURTHER DEVELOPMENT OF LITHUANIA'S NATIONAL PROGRAM

The national implementation strategy of the UNFCCC is the first step in evaluating country's impact on climate change, adaptation to it and foreseeing means and measures for climate change mitigation. Still there are some unsettled questions. Therefore, in future when new information and broader scientific knowledge on climate change is acquired and means and mitigating means and measures on climate change are adopted, the national program should be revised and enhanced. Further development of the Program will depend on how fast new data is gained and how the UNFCCC itself will advance.

7. PUBLIC AWARENESS AND EDUCATION

The key priority in Lithuania is to form a public comprehension of climate change issues, factors encouraging climate change, possible negative impacts on Lithuania and the world, possible mitigation means and measures.

A part of the state funds for the implementation of the UNFCCC and a part of the environmental funds of the MEP and municipalities for public education and awareness on climate change issues should be allocated. NGOs activities, related to public education and awareness on climate change should be financed by these funds as well.

1. INTRODUCTION

The First National Communication on Climate Change of the Republic of Lithuania is based on the National Implementation Strategy of the United Nations Framework Convention on Climate Change (UNFCCC).

Lithuania cannot hold atmosphere protection and GHG emission policy other than the requirements submitted in Climate Change Convention. Gases tend to spread widely and quickly in the atmosphere without any boundaries, and therefore contribution of each state to the problem in question should be reflected globally, expanding throughout other territories. It is quite evident that worldwide policy on the reduction of GHG emissions should be obligatory and uniform for all the states. Large majority of generally coordinated activities should exhibit favorable results. With this in view, the Republic of Lithuania signed the United Nations Framework Convention on Climate Change together with the rest of 154 states in Rio de Janeiro in June 1992. The Convention was ratified by the Seimas (the Parliament) of the Republic of Lithuania on 23 February 1995 and entered into force for our state since 22 June 1995.

As an Annex I country to the Convention, Lithuania is fully responsible for the implementation of its obligations. The main obligations to the UNFCCC are acceptable and can be translated into reality in Lithuania. But as a country with economies in transition, for the resolution of the set tasks Lithuania needs help from developed countries.

2. NATIONAL CIRCUMSTANCES

2.1. Basic data

2.1.1. Geography

The Republic of Lithuania lies in the centre of Europe, on the eastern coast of the Baltic Sea (the length of the Lithuanian coastline is 99 km). The northernmost point of Lithuania is 56° 27' and the southernmost 53° 54' N; the westernmost point of Lithuania is 20° 56' and easternmost 26° 51' E. In the north Lithuania boarders on Latvia (610 km of the boarder line), in the east and south on Belarus (724 km), in the southwest on Poland (110 km), and the Kaliningrad region of the Russian Federation (303 km). The area of Lithuania is 65.3 thousand sq. km.

Lithuania lies on the western fringe of the East European Plain, in the middle and lower basin of the River Nemunas. The relief is a meridian-oriented alternation of lowland plains and hilly uplands. The mean absolute surface altitude is 100 m above the sea level; the highest point (293.6 m) is in the east of the country.

The longest rivers are the Nemunas (length is 937.4 km) and the Neris (length is 509.5 km).

Figure 2.1. Lithuania in Europe

2.1.2. Climate

The territory of Lithuania is situated in the northern part of the moderate climate zone. The distance of the territory from the equator (6100 km) and from the pole (3900 km) decides the amount of the general solar energy -- it is 3600 MJ/km^2 per year.

The average annual temperature in the territory of Lithuania varies from 6,5 - 7,1^o C at the sea-side to 5,5^o C in the north east. January is the coldest month of the year almost in the whole of Lithuania except the sea-side. The lowest temperature in January is in the East and drops to -6,5^o C while in the Western part it is about -3^o C. February is the coldest month at the sea-side (-3,2^o C). July is the warmest month in Lithuania (only at the sea-side and in Curonian Spit (Kurðiø Nerija) August is the warmest month of the year). The average temperature in July is 16,5 - 17,5^o C.

2.1.3. Population

At the beginning of 1990 the population of Lithuania was 3 million 723 thousand, of which 1 million 173 thousand or 32 % reside in the country.

The largest increase in the population in post-war Lithuania was in the seventh decade when the average growth rate was 46 thousand per year (1.2-1.3 %). At the beginning of the eighth decade the growth rate stabilized and it comprised 0.8-0.9 % a year. Since 1990 the population growth rate began slowing down and in 1992 the population size started to decrease. It was subject to re-emigration of part of the population to the former USSR republics. Besides, mortality rate exceeded fertility rate.

In 1992 the population decreased by 10 thousand, in 1993 - by 12 thousand, in 1994 - by 6 thousand. During the same period the number of rural population after a long period of decreasing, started to grow: in 1992 it increased by 9 thousand, in 1993 - by 3 thousand, and in 1994 by 700.

Till 1992 natural increase was the most significant. In 1960-1990 it comprised 77 % of the total increase of population. The largest natural increase was 1960 and after it began to decrease. Birth rate and mortality rate in 1993 were the same, birth rate was higher only by 620.

Different political status, essential changes in social and economic spheres called forth new types of migration: returning of deportees, repatriation of some ethnic minorities, Russians in particular. Beginning with 1989 a reverse process took place - the number of incoming people diminished and the number of outgoing increased. In 1989-1994 99 thousand of Lithuanian population moved to the former USSR republics and 51 thousand came to Lithuania from there. Since 1989 the number of incoming people was decreasing and the number of outgoing persons is stabilizing.

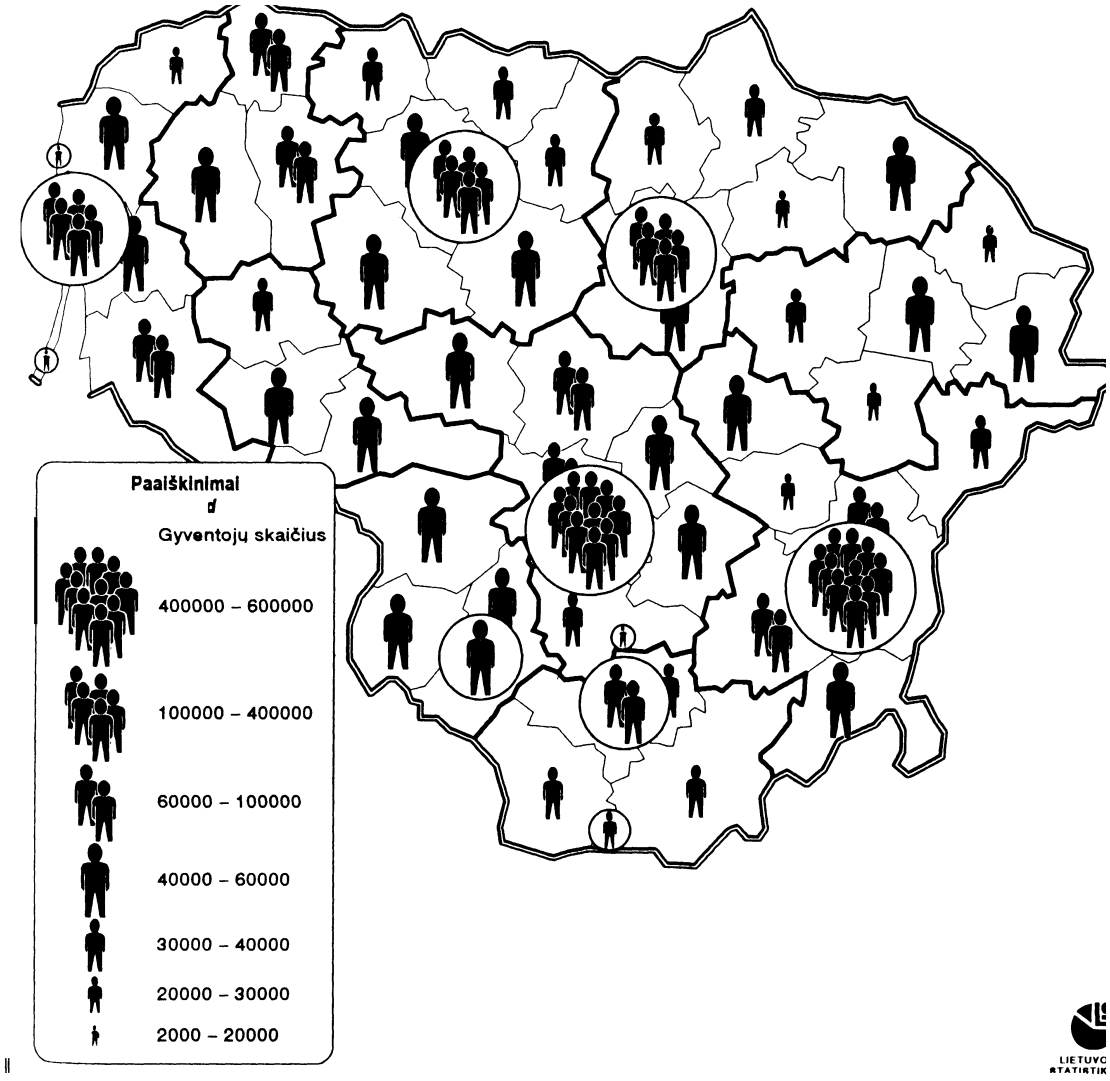


Figure 2.2. Population in towns and regions at the beginning of the 1995 year

2.1.4. Economic Structure

Lithuania beholds the transition from the centralized planning to the market economy. The decentralization of the governing system comprises the background of this period. Starting 1991, economy is in a recession. Raw material shortage, increase of energy prices, losses of former market possibilities exhibit the recession in process.

In 1992, Lithuania experienced the foremost crisis when the gross domestic product was brought to the point of 36 %, the productivity in industry was cut down to 52 %, inflation rate was 1160 %. In 1993, the gross domestic product was reduced by 27 %, in 1994 3,5 % was added to that reduction. During the period of 1993-1994, productivity of the total production capacities was reduced by 32 %. Such industrial sectors which were based on the imported raw materials and energy resources as well as their output, exported to the

Community of Independent States (CIS), namely building materials, wood-processing and paper, machine-building industries occurred in the most ruinous situation. The gross domestic product of agriculture dropped to 27.5 % during 1990 and some more 11.2 % in 1993.Productivity in agriculture was lowered to 28 % in 1994.

The privatization of the former state-owned enterprises has been nearly finished. In 1994 the Ministry of Economics kept a record of 22 thousand private companies. The most typical feature of private sector development is the process of founding of enterprises and holding companies with minor enterprises and subdivisions being embodied.

2.1.5. Energy

In accordance to the Lithuanian primary energy balance sheets for 1994, energy resources for 1994 comprised 12087 ktce (thousand tons of coal equivalent) or 90 % the quantities of resources obtained for 1993, but 58 % for 1990, including 5565 ktce of oil products (94 % compared to 1993 and 55 % in 1990), natural gas - 2462 ktce (115 % and 37 %), coal - 400 ktce (69 % and 34 %), wood, peat, the other indigenous fuel resources -600 ktce (119 % and 88 %), nuclear energy -2869 ktce (63 %), hydroenergy - 56 ktce (117 %). Wood, peat, the other types of indigenous fuel and hydroenergy comprised 5.4 % in 1994 primary energy balance (in 1993 - 4.1 %, in 1990 - 3.3 %).

Nearly the same quantity of energy has been produced from wood, peat and other types of indigenous resources during the last three years. However the input on the general energy consumption in the country with energy resources mentioned above has increased, though total fossil fuel consumption has decreased: electrical energy export has been reduced 80 %, heat and electricity consumption in Lithuania has been reduced 45 %. Disregarding the general reduce of energy consumption, total energy efficiency has not been changed greatly. Moreover this particular reduction of energy production capacities has diminished the pollution and emissions in energy sector twice in comparison with 1990.

In this country electrical energy produced comprise 35 % of the energy totally consumed. Nuclear fuel make 93 % of the energy resources obtained and intended for electricity production.

In general 55 % of the total number of buildings and structures in Lithuania are connected to the district heating systems, in cities there is more than 70 % structures connected. Heat is being delivered from CHP and boiler stations, heavy fuel oil and natural gas are being burnt. To heat 1 m^2 is needed 450 kWh/m^2 (this is twice more than in Denmark). The main reason conditioning the situation is poor insulation possibility in residential apartment houses. Heat losses in the network are also great and for most part the consumers have no possibilities to regulate heating. In 1994 consumers have consumed heat that made 49 % of final expenses on heat energy.

.	***Installed capacity***	***Consumed in 1990***	***Country's input in 1990***
Capacity of plants, GW	5.7	5.1	3.1 (45 %)
Production of electric power, TWh	35*	28.1	16.4 (47 %)
Oil refinery, Mt	12	9.6	6.4 (53 %)
Oil import (by oil pipeline), Mt	16	9.6	6.4 (40 %)
Heavy fuel oil export, Mt	9	6.4	3.5 (39 %)
Gas import, Gm^3	12.4	6.2	6.0 (48 %)

* A possible maximum production (load factor is 70 %)

Table 2.1. Energy indicators of Lithuania in 1990

2.1.6. Industry

When restructuring its economic structure from the centralized planing to the market economy, Lithuania encounters with great difficulties. These difficulties are much greater than those in the countries of Eastern or Central Europe, because Lithuania was much closer integrated into the economics of the former Soviet Union. After the downfall of the Soviet Union, the decline of the Lithuanian economic structure was far deeper than in the states belonging to the former Council of Reciprocal Economic Aid and a bit deeper than in Latvia or Estonia which are less dependent on the trade with Russia and other states of the CIS.

The structure of the Lithuanian economy has undergone considerable changes: only during the period from 1992 to 1994, the share of industry decreased from 35,5 % to 20,4 % of GDP, the share of agriculture - from 11,6 % to 8,1 %, but in trade the share went up from 4,5 % to 23,5 %.

Together with the economics, the consumption of energy has started decreasing from 1992, but its decrease was slower than that of the GDP. Therefore the energy demand in the economics has also increased during the period. It is evident that production volume is different from sector to sector of industry. The industries of electronic equipment, metal processing and machinery have suffered the greatest decline, and therefore their prospects to return to the former production capacity are extremely vague. But the production of chemicals, bicycles, refrigerators, leather and textile is recovering.

2.1.7. Transportation

Having assessed that the level of transport infrastructure has a direct impact on the growth of the state economy, the government has recognized transport as a priority sector of the national economy. In 1993, the contribution of transport to the gross domestic product

(GDP) reached 10 %, in 1994 - 12 %. It is estimated that before 1997, when the role of transit transport will have grown, the transport share of the GDP will reach 17-18 %.

Early in 1994, the Government of the Republic of Lithuania approved the National Transport development Program up to the year 2010, and later the same year, it approved the schedule for the implementation of its main points for the period of 1995-1997. These strategic documents define the main aspects of the state transport policy:

- the integration of the Lithuanian transport system into the European transport network and transport service market, taking advantage of the county's favorable geopolitical location for international economic and tourist relations;
- adjustment of the fundamental transport law to comply with the transport legislation and standards of the European Union and other Western countries;
- active participation of the state in ensuring the stable activities of strategic transport infrastructure objects, their reconstruction and updating, making the necessary investment for that purpose;
- breaking up of state-owned monopolies and privatization of the state transport sector providing commercial services; promotion of private investment in the transport sector.

The network of roads in Lithuania consists of more than 21,000 kilometers of motorways and regional roads, 50 % of them with bituminous surfaces. Despite financial difficulties, attempts are being made to maintain the technical state of this rather dense network. The new "wet salt" technology for the ice and snow removal in winter has been implemented. New machinery for hot and cold regeneration of surfaces has been acquired, light reflecting road signs are being produced and replaced, the quality of road marking has improved.

The period of decrease in traffic density on Lithuanian roads due to the economic reform and a considerable rise of the price of energy resources has ceased and the tendency of growth of car flows has been prominent since 1994 (Fig. 15). Research conducted on motorways shows that the heaviest loads of traffic have been observed on international corridors Via Baltica and IXB (according to the international method of loading by standard 8.2 t. axles).

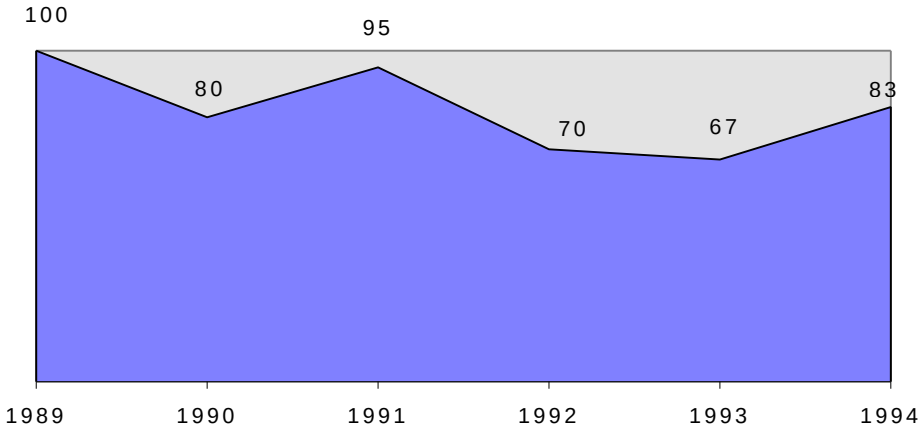


Figure 2.3. *Dynamics of traffic intensity change in 1989-1994*

At the UN/EEC Committee for Domestic Transport, Via Baltica was given the status of European International Motorway E67. In 1994, the average intensity of traffic fluctuated from 2,000 to almost 9,000 vehicles per day in certain sections of the motorway (compared to 1993, it has increased by 25 %). The study of the implementation possibilities of the Via Baltica project anticipates that vehicle flow will have grown to 13,000-14,500 vehicles by the year 2000.

2.1.8. Agriculture and Forestry

In total the territory of the Republic of Lithuania occupies 6530,1 thousands of hectares (1995.01.01), including 3328,6 thousands of hectares of land for agricultural use and 1979,6 thousands of hectares of forests. Farming lands occupy 3513,3 hectares and ploughed of them are 2958,3 thousands of hectares.

In the Republic of Lithuania 3041,5 thousands of hectares have been land - improved, 2616,4 thousands of hectares of them by drainage.

In 1994 the sown areas in all farms were estimated 2560,7 thousands of hectares (in 1993 - 2681,9 thousands of hectares). The composition of the crops was as follows: cereals cultures and leguminous plants - 1221,8 thousands of hectares (1288,9), sugar beets - 27,9 thousands of hectares (94,7), flax - 10,4 thousands of hectares (4,5), rape - 12,1 thousands of hectares (2,1), potatoes - 118,0 thousands of hectares (121,9), field vegetables - 27,5 thousands of hectares (25,0), fodder cultures- 141,5 thousands of hectares (1203,8), pure fallow lands - 89,5 thousands of hectares (41,3).

In 1994 the structure of the crops was a follows: cereals cultures and leguminous plants - 47,5 % (in 1993 - 48,1 %), cultural for technical purposes - 2,0 % (1,6 %), potatoes - 4,6 % (4,5 %) vegetables - 1,1 % (0,9 %), fodder cultures - 44,6 % (44,9 %).

Before the beginning of the agricultural reform the number of farms in the Republic of Lithuania was 1245 (at the end of 1988) and they had about 7500 centers of production. In the eighth decade and in the beginning of the ninth decade 33 big swine breeding complexes had been built (having the capacity from 12.000 to 14.000 pigs per year). The number of cattle in the farms of all types in 1989 was 1892,2 thousands (in 1994 - 718,9 thousands). Among them the number of cows was 337,4 thousands (233,0), pigs - 2214,5 thousands (666,0), sheep and goats - 26,3 thousands (2,2), horses - 72,0 thousands (42,5), poultry - 11429,1 thousands (6176,9), families of the bees - 66,6 thousands (14,2).

Since 1956, Lithuania has started taking state forestry inventories every five years. The last inventory was made in 1993 with the help of a computerized database 'Forests in Lithuania'. The data is updated every year.

Land attributed to the fund of the forests	2123 thous. ha
Land under the forests	1920 thous. ha
Land overgrown with forests: of them:	1860 thous. ha
Forest culture	424 thous. ha
Total volume of timber	334,0 mil. m^3
Average volume of timber per 1 ha	180 m^3
Average volume of mature stands	244 m^3
Total volume of mature stands	43,6 mil. m^3
Annual increment of timber	11,9 mil. m^3
Average increment of timber	6,3 m^3/1 ha
Part of increment accumulated per 1 ha of stands	3,7 m^3
Afforestation, %	30,1 %
Forest area per unit of population	0,51 ha
Volume of timber per unit of population	89 m^3

Table 2.2. The main data on forests in Lithuania

In accordance with the statistical data of the Ministry of Forestry the condition of the forests within the recent decade has worsened considerably. The reason for it are unfavorable conditions of nature: strong winds, draughts, spreading of the forest pests, contamination of the air, harm done by the hoofed animals.

2.1.9. Water Management

In the Republic of Lithuania there are 29,1 thousands of rivers, streams and channels having the total length of 63,700 kilometers. Also there are almost 3000 lakes having the area over 0,5 hectare. Such lakes occupy the territory of about 880 square kilometers. Besides there are about 14000 lakes having the area of less than 0,5 hectares occupying the territory of 16,2 square kilometers. Even 76 % of all lakes are artificial.

The territory of the Republic of Lithuania is situated in the zone of surplus humidity and has therefore comparatively much water resources. In the average annually through the surface of the territory of the Republic of Lithuania flow down about 15-16 cubic kilometers of water. Considering the transit flowing from the neighboring countries this figure grows up to 26 cubic kilometers (in the average year of 50 % probability). When the year is dry the amount of water flowing by rivers of the Republic of Lithuania reduces to 8 cubic kilometers.

The major part (about 60 %) of the underground water bodies are connected with the river. In the process of their exploitation up to 60-80 % of the debit of a water intake is formed up from the water of a river.

The thickness of the zone of drinkable underground water in the Republic of Lithuania is from 50-100 up to 400 meters, Mineralized water the amount of salts in which exceeds 1 g/l is accumulating below. The exploitation resources of drinkable underground water are

estimated 3,2 million of cubic meters per day. It makes up 25 % from the total amount of the resources of underground waters forming up in a natural way. It is estimated that exploitation resources exceed the demand for drinkable water forecast for the period of 2000-2010 by 0,5 million of cubic meters per day.

To meet most varied demands of the Republic of Lithuania in the year 1992, 3980 million of cubic meters of water had been taken from the water sources. In this figure 480 cubic meters of water makes up the underground water. Compared with 1991 the amount of water taken reduced by 527 cubic meters. The amount of residential and industry related waste waters that got into the basins of the surface waters is estimated 3540 million of cubic meters (in 1991 - 3880). Of them about 3170 million of cubic meters were conditionally clean, that is, needed no cleaning (in 1991 - 3490). 366 million of cubic meters of waters that got into the basins of the surface waters needed treatment yet about 70 million of cubic meters of water (19 %) remained untreated (in 1991 - 85 million or 21,7 %). 96 million of cubic meters of waste water treated did not exceed the norms of maximum permissible contamination (26,1 % from all contaminated waste waters). Yet the amount of water taken in 1993 exceeded that in 1992 by 600 cubic meters of water. The reason is that the hydroaccumulation electric power plant of Kruonis was put into operation. The biggest amount of water - 3800 million of cubic meters - was used to meet the needs of the energy producing industry. The Ignalina nuclear power plant alone which is using the water of the Druksiai lake for the purposes of cooling their reactors needed 2900 million of cubic meters of water. The amount of underground water consumed for drinking and to satisfy various needs of the life in 1993 is estimated 259,8 million cubic meters or 35 % less than in the period of 1989-1990. This process was probably influenced by the increasing prices for the water.

2.2. General Processes of National Policymaking and Legislation

Lithuania takes aim at integration into the European Union (EU), and sets its sights on becoming the real EU member by 2000. In June 12, 1995 Lithuania signed Treaty of Associate Membership to the European Union and after the transfer period expired it would become full and equal member of the European Union. One of the preconditions for the membership is the conformity of environment policy and relevant laws to the legal forms in use of European Union documentation.

The standards and norms adopted in Lithuania are conditioned by national policy as well as by obligations after having signed international conventions and agreements. Moreover, Lithuania has participated in the main conventions on environment policy development. They are as follows: Convention on the Protection of the Marine Environment of the Baltic Sea Area (Helsinki Convention); Convention on the Long-range Transboundary Air Pollution, Convention on Climate Change, Convention on Biological Diversity, Convention for the Protection of the Ozone Layer etc.

A list of the conventions that have been ratified by Lithuania is presented below:

1. Convention on the Protection of the Marine Environment of the Baltic Sea Area (1992)
2. Convention on the Long-Range Transboundary Air Pollution(1993)

3. Framework Convention on Climate Change (1995)
4. Convention on Wetlands of International Importance Especially as Waterfowl Habitat (Ramsar Convention) (1993)
5. Convention on the Conservation of European Wildlife and Natural Habitat (Bern Convention) (1993)
6. Convention on Fishing and Conservation of the Living Resources in the Baltic Sea and the Belts (Gdansk Convention) (1992)
7. Convention on the Future Multilateral Cooperation in the North - West Atlantic Fisheries (Ottawa Convention) (1992)
8. Convention on the Protection of the Ozone Layer (Vienna Convention) (1994)
9. Protocol on Substances that deplete the Ozone Layer (Montreal Convention) (1994)

The majority of environment standards and norms applied in Lithuania fully satisfies the requirements of European Union, and some of them present themselves to be even more stringent.

Environment protection system for European Union by 2000 has been legalized at the fifth program "Stability". The general and specific environment protection goals have been set out and the actions proposed in support of landscape protection and biological diversity upholding.

When developing the National Environmental Strategy, short-, mid-, and long-term environmental goals were envisaged. The goals, formulated in the National Environmental Strategy, correspond the goals and tasks of the European Union and the 1992 Conference of the UNCED, as well as the requirements of international conventions. The key attention in the Strategy is paid to prioritized goals. Alongside with the Strategy, short- and mid-term action plans to achieve environmental goals were developed.

2.2.1. Policies Adopted Before the Base Year

The following laws regulating environment protection have been approved by 1990:

- Code on Territorial Waters of the Republic of Lithuania, 1978.
- Code on the Entrails of the Soils of the Republic of Lithuania, 19977.
- Law on Fauna Protection and Regulation , 1981.
- Law on Atmosphere Protection, 1981.
- Code on Administrative Law Violations of the Republic of Lithuania, 1984.

Legislative system on environment protection mainly based on "The Law on Environment Protection" is being developed and shall have to be expanded in quality and quantity in the nearest future. At present it is of vital importance to work out and adopt laws, regulating the usage of various raw materials and their protection as well as to ensure the implementation of the regulations of environment protection laws, setting out unified system of laws on economic activities, environment protection and natural resource usage.

3. INVENTORY AND PROJECTIONS OF GREENHOUSE GAS EMISSIONS AND REMOVALS

Inventory for 1990

3.1. Introduction

Inventory of greenhouse gas emissions has been carried out according to the IPCC methodology. Emissions of carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), nitrogen oxides (NO_x), carbon monoxide (CO) and non-methane volatile compounds (NMVOC) have been estimated. Due to the lack of local methodology, the proposed factors of the IPCC methodology for estimation of CO_2, CH_4 and N_2O emissions were mainly used. Hydrofluorocarbons (HFC), chlorofluorocarbons (CFC), and perfluorocarbons (PFC) were not assessed in the inventory only due to the lack of statistical data on the consumption of these substances and their emissions into the atmosphere by different industries or types of production. Estimates for the rest of pollutants were not complicated as all the statistical data on the emissions were available.

The information on the CO_2 emission and uptake due to the change of land-use during the latest 20-year period is not very accurate, as the statistical data on the topic are not abundant. The assessment of the previous situation 20-50 years ago was not carried out because of the same reason mentioned above.

Carbon dioxide (CO_2), one of the main gases causing greenhouse effect, tends to emit during all the combustion processes, it cannot be avoided in burning organic fuel as well. Due to the adverse anthropogenic activities, half amount of CO_2 emissions remain in the atmosphere, the other half is uptaken by soil and the sea. However, CO_2 remains in the atmosphere for 50-200 years, the after effects are to be felt through many centuries to come.

While modeling climate change, the greenhouse gas emissions based mainly on CO_2 effect are taken into consideration. In that case "double' concentration of CO_2 does not mean that the amount of CO_2 has been doubled. Generally accepted is the fact that the degree of general climate change corresponds to the effect of double CO_2 concentration.

Each time it is compulsory to assess the impacts of the entire amount of converted gases.

The greenhouse gas emissions for 1990 are presented in Table 3.1.

GHG sources	*CO_2*	*CH_4*	*N_2O*	*NOx*	*CO*	*NMVOC*
TOTAL	**42338**	**377.9**	**13.2**	**178.3**	**644.1**	**93.7**
1. Energy	37332	31.4	1.0	177.9	644.1	81.4
2. Industry	2203	0.2	1.4	0.4		1.2
3. Solvent and other product use						11.1
4. Agriculture		180.7	10.8			
5. Land use change and forestry	2803 (-11651)					
6. Waste		165.7				

Table 3.1 GHG emissions in Lithuania in 1990 (Gg)

Energy and transport sectors are termed to be the most extensive sources of greenhouse gas emissions in Lithuania. This sector comprises the full cycle of fuel consumption, production, transportation, storage, delivery, recycling and burning. CO_2 is regarded to be the dominant ingredient of emissions discharging during the power production process from fossil fuel.

Along with burned fuel consumed in international air, railway, sea and road carriages as well as with emitted ingredients of the combustion processes the country owner's responsibility of the means of transport shall be taken into the balance sheet.

Methane emissions prevail in agricultural sector due to fermentation process in alimentary canal of cattle, due to agricultural waste, manure, biogas. Fertilizer usage in great amounts leads to nitrous oxide emissions from soils.

GHG emissions from land use and forestry sectors are diverse. Carbon dioxide emissions are induced here because of the forest felling and land use change, but newly grown-up forests uptake huge amounts of CO_2.

Waste remains one of the major sources for methane emissions. Anaerobic bacterium decompose organic substances from waste into methane. Methane emissions from sewage waters come off due to the processes of very similar nature.

3.2. CO_2 Emissions

In 1990, the emissions of carbon dioxide in Lithuania were the greatest (if investigated by gases) and amounted to 42398 Gg. The largest source of carbon dioxide emissions is energy sector together with transportation (see Table 3.2).

Sectors	***Emission/removal***
1. Energy	37332
2. Industry	2203
5. Land use change and forestry	2803
TOTAL	**42338**
5. Land use change and forestry	(- 11651)

Table 3.2. CO_2 emissions in 1990 (Gg)

3.2.1. CO_2 Emissions fro m Energy Sector

The accumulated potential on energy production in Lithuania by 1990 greatly amounts to the present potentials possessed and even the future demand expected. Energy sector is considered to be one of the major sources of CO_2 emissions into the atmosphere. The calculated amounts of CO_2 according to the type of fuel used are submitted in Table 3.3.

Consumers and type of energy	***PJ***	***CO_2 emissions(Gg)***
1.A. Fuel combustion		
TOTAL	**512.74**	**37332**
1.A.1. Energy and transformation activities	247.85	16425
1.1. Oil	103.72	8072
1.2. Gas	140.34	7985
1.3. Solid fuels	3.79	368
1.A.2. Industry	68.70	5396
1.1. Oil	37.71	2919
1.2. Gas	12.37	704
1.3. Solid fuel	18.62	1773
1.A.3. Transport	78.89	5791
1.1. Oil	78.89	5791
1.A.4. Commercial heating	21.37	1750
1.1. Oil	4.91	366
1.2. Gas	4.95	282
1.3. Solid fuel	11.51	1102
1.A.5. Residential heating	41.41	3330
1.1. Oil	11.58	823
1.2. Gas	9.23	525
1.3. Solid fuel	20.60	1982
1.A.6. Agriculture	23.07	1730
1.1. Oil	19.91	1474
1.2. Gas	1.15	65
1.3. Solid fuel	2.01	191
1.A.7. Other	31.45	2910
1.1. Oil	4.02	309
1.2. Gas	0.20	12
1.3. Solid fuel	27.23	2589

Table 3.3. CO_2 emissions from fuel combustion activities in 1990 (Gg)

3.2.2. CO_2 Emissions from Industry Sector

Industry as such tends to emit CO_2, but the type of emissions has nothing to do with the combustion processes as they have already been included into the emissions from energy sector. Cement, lime and brick production processes are the main CO_2 sources.

Total CO_2 emissions from industry amount to 2 203 Gg.

Emission sources	*Amount of production (Gg)*	*CO_2 emission (Gg)*
2. Industry		
2.E.1. Production of cement	3400	2069
2.E.2. Production of lime	171	134

Table 3.4. CO_2 emissions from industrial processes in 1990 (Gg)

3.2.3. CO_2 Emissions in Forestry and Agriculture

Quite great amounts of CO_2 emissions are due to land use change, as well as meadow and forest transformation.

5. Land use change and forestry	
5.A. Forestry	
Total CO_2 sequestration (Gg)	12882
CO_2 emissions from felling (Gg)	(- 2508)
Net removals (Gg)	10375
5.B. Forest and grassland conversion	
CO_2 release from aboveground of biomass (Gg)	(- 36)
CO_2 from decay of aboveground biomass (Gg)	(- 54)
CO_2 from soil carbon release (Gg)	(- 2713)
Net emissions (Gg)	(- 2803)
5.C. Abandonment of managed lands	
Lands abandoned over the previous 20 years (Gg)	1276
Net removals (Gg)	1276

Table 3.5. Calculated CO_2 removals by land use change and forestry in 1990(Gg)

3.3. CH_4 Emissions

In 1992 the general amount of methane emissions in Lithuania comprised 378 Gg. The major sources of methane are agricultural sector and waste.

Sectors	***Emissions***
1. All energy	31.35
1.A. Fuel combustion	5.25
1.A.1. Energy and transformation activities	0.73
1.A.2. Industry	0.44
1.A.3. Transport	1.42
1.A.4. Commercial heating	0.22
1.A.5. Residential heating	1.80
1.A.6. Agriculture	0.21
1.A.7. Other	0.43
1.B. Fugitive fuel emissions	26.10
2. Industry	0.2
4. Agriculture	180.7
4.A. Enteric fermentation	157.3
4.B. Animal waste	23.4
6. Waste	165.7
6.A. Landfills	162.0
6.B. Wastewater	3.7
TOTAL	**377.95**

Table 3.6. CH_4 emissions in 1990 (Gg)

3.4. N_2O emissions

Nitrous oxide emissions are presented in Table 3.7. In 1990, total emission of N_2O included 13,2 Gg. Agricultural sector emitted the highest amount of N_2O.

Sectors	***Emission***
1. Energy	**0.95**
1.A. Fuel combustion	**0.95**
1.A.1. Energy and transformation activities	0.36
1.A.2. Industry	0.14
1.A.3. Transport	0.19
1.A.4. Commercial heating	0.04
1.A.5. Residential heating	0.09
1.A.6. Agriculture	0.04
1.A.7. Other	0.09
2. Industry	**1.4**
4. Agriculture	**10.8**
TOTAL	**13.15**

Table 3.7. N_2O emissions in 1990 (Gg)

3.5. NO_X, CO and VOC Emissions

Nitrogen oxides (NO_x), carbon monoxide (CO) and non-methane volatile organic compounds (NMVOC) discharge mainly from the energy sector when burning organic fuel and processing oil.

Sectors	***NOx***	***CO***	***NMVOC***
1. Energy	177.89	644.08	81.36
1.A. Fuel combustion	177.89	644.08	72.76
1.A.1. Energy and transformation activities	58.63	43.94	0.74
1.A.2. Industry	10.90	18.43	0.44
1.A.3. Transport	71.69	492.30	65.03
1.A.4. Commercial heating	3.27	5.13	0.24
1.A.5. Residential heating	4.77	46.00	2.51
1.A.6. Agriculture/ Forestry	22.61	27.27	3.37
1.A.7. Other	6.02	11.01	0.43
1.B. Fugitive fuel emission			8.6
2. Industry			1.2
3. Solvent use			11.1
3.A. Paint application			1.9
3.B. Degreasing and dry cleaning			2.3
3.C. Manufacturing/ processing of chemicals			4.9
3.D. Other			2.0
TOTAL	**178.29**	**644.08**	**93.66**

Table 3.8. NO_x, CO and NMVOC emissions in 1990 (Gg)

3.6. Global Warming Potential (GWP)

When estimating the equivalent contribution of greenhouse gases, only direct radiative forcing of gases of global warming potential was taken into account.

Total GHG emissions (Gg)	***42338***	***377.95***	***13.15***	***Total***
GWP factors	1	21	290	
	CO_2	CH_4	N_2O	
Converted emissions (Gg)	42338	7937	3814	54089
Part in general emission,(%)	67	13	6	

Table 3.9. GHG emissions in 1990 and their equivalent contribution

3.7. Conclusions

Lithuania cannot hold atmosphere protection and GHG emission policy other than the requirements submitted in Climate Change Convention. Gases tend to spread widely and quickly in the atmosphere without any boundaries, and therefore contribution of each state to the problem in question should be reflected globally, expanding throughout other territories. It is quite evident that worldwide policy on the reduction of GHG emissions should be obligatory and uniform for all the states. Large majority of generally coordinated activities should exhibit favorable results.

In a general sense, ways should be found to reduce greenhouse gas emissions and to make long-term grounded forecasts to predict narrow gas spectrum and their low emissions in future. Action plans require reliable knowledge on the status of the environment, and accurate, comprehensive and operational information together with vast amount of data. Research and applied investigations on environment, energy, economy, biology and other sectors shall be developed. They shall include the following:

- setting priorities of industrial sectors;
- strategy on fuel consumption;
- rational use of natural resources;
- perfection of fuel combustion processes, technological equipment and treatment facilities;
- application of new advanced technologies
- alternative energy resources, etc.

To more accurately estimate the amounts of GHG gases, additional studies have to be carried out as well. This first of all concerns identification of national emission factors for CO_2, CH_4, N_2O gases, separate technologies or production and perfection of already initiated assessment of pollutants emissions of HFC, CFC, PFC.

As it has already been mentioned, the inventory of greenhouse gases has been carried out applying the IPCC methodology of UP-DOWN method, where the accuracy of the initial data is the main factor. The economical blockade in 1990, organized by Russia, inevitably caused the necessity to find out new means and unofficial ways of fuel supply for our industry, transport and population. Not all the fuel resources imported have been registered, evaluated and published. There are still a lot of doubts, concerning the reliability and accuracy of the statistical data for 1990.

It should be mentioned that unofficial fuel import resources that have appeared during the blockade remained, were perfected and became illegal resources of imported fuel. Such type of fuel is not included in the official statistical data and causes inadequacies in UN-DOWN calculation method for energy consumption. Especially it was obvious in recent years when statistical data do not coincide with the submitted data from the governmental institutions, consuming primary energy resources.

In order to have a more realistic view on Lithuania's contribution on the global climate change process, it is necessary to continue and perfect data collection, compare and analyze more intensively the data by various institutions, continue inventory of greenhouse gases applying other methods as well as comparing the received data with the results of other projects (e.g., CORINAIR), to update and correct data in accordance with the local conditions and available equipment and emission factors of combustion products. More accurate data will be needed for evaluation of the situation when Ignalina nuclear power plant is stopped and search of alternative energy resources mainly influencing the quantities of GHG emissions. This is the general task as the emissions have no borders and their accumulation is hazardous globally.

Projections for 2000 and 2010

3.8. Introduction

The economical development in Lithuania is conditioned by the market and its factors.

In order to simplify the transition to the market economy, the Government is expected to work out the strategies for different sectors of economy to foresee the priorities. New strategies have been worked out for the following sectors:

- industry (different sectors),
- energy,
- transport,
- communications and information,
- agriculture,
- services, tourism included.

Long- and short term projections enable us to conclude that an economic upsurge has already started. Each coming year is expected to have 4,2% growth in national product. Newly developed projections for Lithuanian industry indicate that fuel and food industries

are the most significant for Lithuanian economy. It is expected that machine building capacities would be reduced. Energy, transport and environmental protection are three priority sectors for state investments. By 2000, environmental protection is expected to remain a priority sector open for state investments.

The projections for greenhouse gas emissions by 2000 and 2010 have been based on "Projections of Economic Development in the Republic of Lithuania" prepared by the Ministry of Economics and development programs of different sectors of industry.

GHG	*1990*	*2000*	*2010(Scenario I)*	*2010 (Scenario II)*
CO_2	42338	29914	36282	53035
CO_2 removal	(-11651)	(-11891)	(-12046)	(-12046)
CH_4	377.95	309.37	330.53	333.86
N_2O	13.15	4.31	5.56	5.94
NO_x	178.29	126.52	161.71	221.52
CO	644.08	528.17	680.12	724.93
NMVOC	93.66	136.86	97.64	99.24

Table 3.10. Projection of GHG emissions in 2000 and 2010 (Gg)

3.9. CO_2 Emissions and Sinks

Energy sector remains the main source of CO_2 emissions. The total ultimate energy demand in all analyzed cases is less than the baseline demand (in 1990) due to implemented energy conservation measures.

Sources of emissions	*1990*	*2000*	*2010 (Scenario I)*	*2010 (Scenario II)*
TOTAL	**42338**	**29914**	**36282**	**53035**
1. Energy	37332	26486	32574	49327
1.A. Fuel combustion	37332	26486	32574	49327
1.A.1 Energy and transformation activities	16425	9855	12812	29565
1.A.2 Industry	5396	3561	4479	4479
1.A.3 Transport	5791	4980	6544	6544
1.A.4 Commercial heating	1750	2257	2555	2555
1.A.5 Residential heating	3330	2797	3230	3230
1.A.6 Agriculture	1730	796	917	917
1.A.7 Other	2910	2240	2037	2037
2. Industry	2203	661	969	969
5. Land use change and forestry	2803 (-11651)	2767 (-11891)	2739 (-12046)	2739 (-12046)

Table 3.11. Projection of CO_2 emissions in 2000 and 2010 (Gg)

CO_2 emissions by 2000 are expected to be 29% less than they were in 1990.

3.10. Expected Greenhouse Gas Emissions by 2000

Ignalina State Nuclear Power Plant capacities accounts for 47% from the total amount of capacities of all Lithuanian power plants. In 1994 the total capacity was 6324 MW. It is expected that two blocks of the nuclear power plant will continue to operate by 2000.

Until Ignalina State Nuclear Power Plant operates, the main fuel would remain the same, i.e. nuclear fuel, gas and heavy fuel oil only would add to it. The amount of heavy fuel oil will reduce while orimulsion fuel is increased. Orimulsion is to be burned in Lithuanian State Power Plant. New energy conservation means have to be introduced. Industry enables to save the largest amount of power (36%), in residential sector savings amount to (33%), in trade and services even less (24%). The major conservation means comprise administrative means requiring no additional expenditures.

GHG source and sink categories	*CO_2*	*CH_4*	*N_2O*	*NOx*	*CO*	*NMVOC*
Total emissions and sinks	**29914**	**309.37**	**4.31**	**126.52**	**528.17**	**136.86**
1. All energy	26486	31.81	0.69	126.26	528.17	128.76
1.A. Fuel combustion	26486	4.16	0.69	126.26	528.17	60.94
1.A.1. Energy & transformation activities	9855	0.43	0.22	35.18	26.36	0.44
1.A.2. Industry	3561	0.29	0.09	7.19	12.16	0.29
1.A.3. Transport	4980	1.22	0.16	61.65	423.38	55.92
1.A.4. Commercial heating	2257	0.28	0.05	3.21	6.61	0.31
1.A.5. Residential heating	2797	1.51	0.08	4.0	38.64	2.10
1.A.6. Agriculture	796	0.10	0.02	10.40	12.54	1.55
1.A.7. Other	2240	0.33	0.07	4.63	8.48	0.33
1.B. Fugitive fuel emission		23.49				6.88
2. Industrial processes	661	0.19	0.92	0.26		0.79
2.C. Inorganic chemicals			0.92			
2.D. Organic chemicals		0.19				
2.E. Cement, lime production	661					
2.F. Other						0.79
3. Solvent and other product use						7.31
3.A. Paint application						1.25
3.B. Degreasing and dry cleaning						1.52
3.C. Manufacture/processing of chemicals						3.23
3.D. Other						1.31
4. Agriculture		121.07	2.70			
4.A. Enteric fermentation		105.39				
4.B. Animal waste		15.68				
4.C. Agricultural soils			2.70			
5. Land use change and forestry	(-11891) 2767					
5.A. Changes in forest other biomass stocks	(-10531)					
5.B. Forest and grassland conversion	2767					
5.C. Abandonment of managed lands	(-1360)					
6. Waste		156.3				
6.A. Landfills		153.0				
6.B. Wastewater		3.3				

Table 3.12. GHG emissions in Lithuania in 2000 (Gg)

3.11. Greenhouse Gas Emissions by 2010.

When estimating future GHG emissions for 2000, only one scenario of economic growth (something in between slow and rapid) was taken into consideration, but for the projections of GHG emissions for 2010, there were 2 scenarios: rates of economic growth with Ignalina SNPP in operation (Scenario I) and when Ignalina SNPP is closed down (Scenario II).

Closing of Ignalina plant will have an immense influence on the work of cogeneration power plants. Cogeneration plants produce little power, consuming relatively less fossil fuel (see Table 5.13.) when two reactors operate.

After closing down Ignalina SNPP,. the consumption of heavy fuel oil is to increase. This is conditioned by higher prices for gas and the introduction of orimulsion. In order not to violate the environmental requirements, share of gas in the total amount of consumed fuel is to increase in future (see Table 5.14).

If Ignalina State Nuclear Power Plant idles, fuel consumption increases by 3 times if compared with the expected emissions in 2000.

GHG source and sink categories	*CO_2*	*CH_4*	*N_2O*	*NO_x*	*CO*	*NMVOC*
Total emissions and sinks	**36282**	**330.53**	**5.56**	**161.71**	**680.12**	**97.64**
1. All energy	32574	33.71	0.84	161.38	680.12	88.33
1.A. Fuel combustion	32574	5.00	0.84	161.38	680.12	79.30
1.A.1. Energy & transformation activities	12812	0.57	0.28	45.73	34.27	0.58
1.A.2. Industry	4479	0.36	0.12	9.05	15.30	0.36
1.A.3. Transport	6544	1.50	0.21	81.01	556.29	73.48
1.A.4. Commercial heating	2555	0.32	0.06	4.77	7.49	0.35
1.A.5. Residential heating	3230	1.75	0.09	4.63	44.62	2.44
1.A.6. Agriculture	917	0.20	0.02	11.98	14.45	1.79
1.A.7. Other	2037	0.30	0.06	4.21	7.70	0.30
1.B. Fugitive fuel emission		28.71				9.03
2. Industrial processes	969	0.20	1.16	0.33		0.10
2.C. Inorganic chemicals			1.16	0.33		
2.D. Organic chemicals		0.20				
2.E. Cement, lime production	969					
2.F. Other						0.10
3. Solvent and other product use						9.21
3.A. Paint application						1.58
3.B. Degreasing and dry cleaning						1.90
3.C. Manufacture/process-ing of chemicals						4.07
3.D. Other						1.66
4. Agriculture		133.72	3.56			
4.A. Enteric fermentation		116.40				
4.B. Animal waste		17.32				
4.C. Agricultural soils			3.56			
5. Land use change and forestry	(-12046) 2739					
5.A. Changes in forest other biomass stocks	(-10686)					
5.B. Forest and grassland conversion	2739					
5.C. Abandonment of managed lands	(-1360)					
6. Waste		162.9				
6.A. Landfills		160.3				
6.B. Wastewater		2.6				

Table 3.13. Scenario I. GHG emissions in Lithuania in 2010 (Gg)

GHG source and sink categories	*CO_2*	*CH_4*	*N_2O*	*NO_x*	*CO*	*NMVOC*
Total emissions and sinks	**53035**	**333.86**	**5.94**	**221.52**	**724.93**	**99.24**
1. All energy	49327	37.04	1.22	221.19	724.93	89.93
1.A. Fuel combustion	49327	5.72	1.22	221.19	724.93	80.04
1.A.1. Energy & transformation activities	29565	1.29	0.66	105.54	79.08	1.32
1.A.2. Industry	4479	0.36	0.12	9.05	15.30	0.36
1.A.3. Transport	6544	1.50	0.21	81.01	556.29	73.48
1.A.4. Commercial heating	2555	0.32	0.06	4.77	7.49	0.35
1.A.5. Residential heating	3230	1.75	0.09	4.63	44.62	2.44
1.A.6. Agriculture	917	0.20	0.02	11.98	14.45	1.79
1.A.7. Other	2037	0.30	0.06	4.21	7.70	0.30
1.B. Fugitive fuel emission		31.32				9.89
2. Industrial processes	969	0.20	1.16	0.33		0.10
2.C. Inorganic chemicals			1.16	0.33		
2.D. Organic chemicals		0.20				
2.E. Cement, lime production	969					
2.F. Other						0.10
3. Solvent and other product use						9.21
3.A. Paint application						1.58
3.B. Degreasing and dry cleaning						1.90
3.C. Manufacture/process-ing of chemicals						4.07
3.D. Other						1.66
4. Agriculture		133.72	3.56			
4.A. Enteric fermentation		116.40				
4.B. Animal waste		17.32				
4.C. Agricultural soils			3.56			
5. Land use change and forestry	(-12046) 2739					
5.A. Changes in forest other biomass stocks	(-10686)					
5.B. Forest and grassland conversion	2739					
5.C. Abandonment of managed lands	(-1360)					
6. Waste		162.9				
6.A. Landfills		160.3				
6.B. Wastewater		2.6				

Table 3.14. Scenario II. GHG emissions in Lithuania in 2010 (Gg)

4. LITHUANIA'S VULNERABILITY TO CLIMATE CHANGE AND POSSIBLE ADAPTATION MEASURES

Climate and Climate Change in Lithuania

4.1. Climate Fluctuations

Climate fluctuations in Lithuania can be regarded as an inseparable part of the processes taking part in the whole global system.

During the last century the global air temperature at the surface of the ground increased by 0,5°C. Warming by 0,8-1.0°C can be observed in the middle and high latitudes as well.

Marked climate fluctuations had been traced in Lithuania, too. Temperature measurements in Vilnius started in 1770 and precipitation in 1887. Possessing such data one can judge about climate fluctuations in Lithuania within the two recent centuries.

Average annual temperature in Lithuania has increased from the end of the 18th century by approximately 1°C (Fig. 4.1). Within this period winters and springs got warmer considerably (1,5-2.0°C) while temperature in summer and in autumn changed little.

From practical point of view it is quite important to assess the fluctuations of the amount of precipitation. After 1887, annual precipitation fluctuated in the range of 200 mm, there were three wet and three dry periods. Now average precipitation is somewhat equal to the amount of precipitation at the beginning of this century but less than in the 1920s, 1930s and 1950s. The following trend can be observed, viz., the amount of precipitation from middle of this century is uniformly increasing in the cold period of the year and decreasing in the warm period of the year, i.e. the annual distribution of precipitation is more regular. It can be regarded as expansion of characteristic features of marine climate in Lithuania. With the growth of winter temperatures increases moisture-holding capacity of the atmosphere and the conditions of precipitation formation become more favorable. Besides, it is established that cyclone activity gains force above the Baltic region. It means that in this respect climate of Lithuania is approaching that of West Europe.

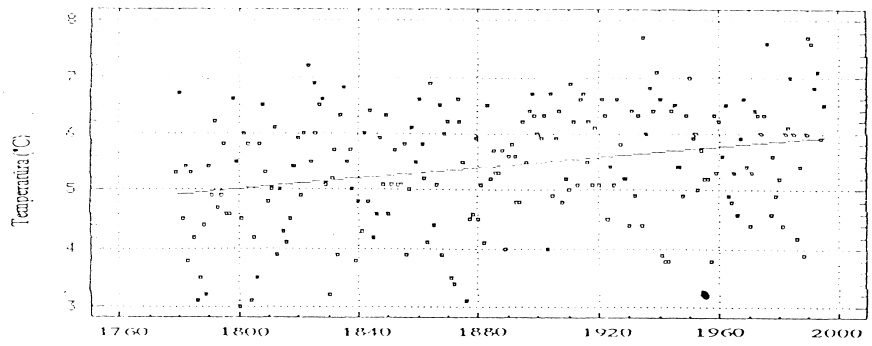


Figure 4.1. A linear trend of average annual temperature in Vilnius in the period of 1778-1994.

4.2. Scenarios of Future Climate Change

Since so far it is not possible to make accurate climate predictions for small territories, regional scenarios of climate change are employed in Lithuania. They can be used as a basis when assessing impacts of climate change on the development of the country. Before accurate climate predictions are created, methods and means for adaptation should be foreseen on the basis of such scenarios.

Contemporary models of global climate change (MGCC) consider and evaluate all possible emissions of greenhouse gasses, vulnerability of climate to increased concentrations of GHG in the atmosphere and also the likely impact of some natural factors on climate fluctuations. Emissions of greenhouse gasses are converted to the equivalent of CO_2 on the same basis of a climate model. Climate response to a doubled increment of converted CO_2 emissions is most often simulated. This model is compared to the pre-industrial period when concentrations of CO_2 in the atmosphere accounted for 0.028 %. According to the predictions built on the effectiveness of emission reduction measures it can take place in the years 2030, 2060 or 2090. Considering a possible vulnerability of climate system more rigid or moderate scenarios of changes in temperature and other climate parameters are developed as well.

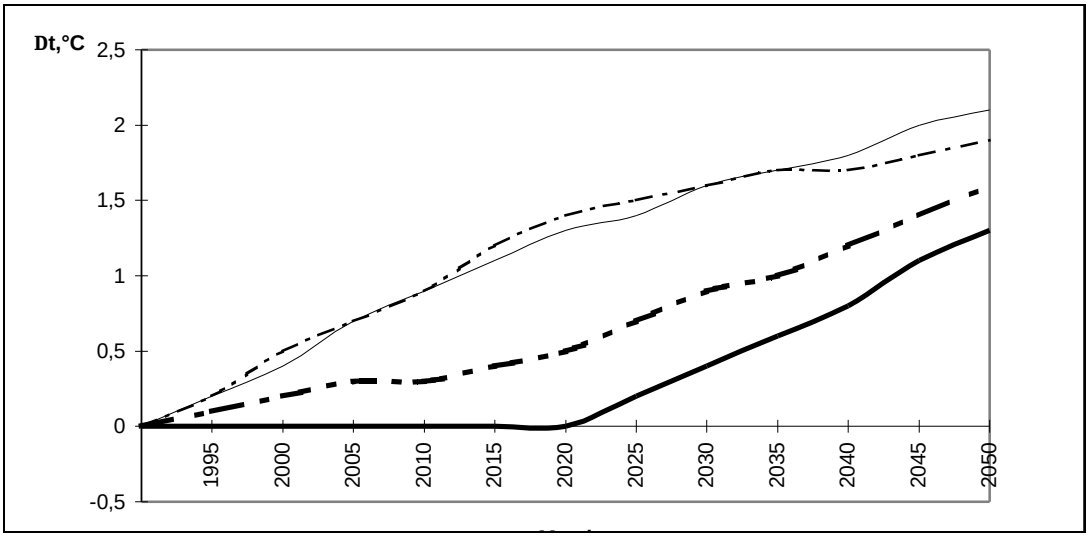
The scenario of climate change in Lithuania has been developed according to several MGCC created by research groups in different countries. Before their approval, these MGCC have been evaluated from the view point of their capability to reflect (simulate) the today's climate for the region of Lithuania.

Middle and high latitudes would respond to doubled converted emissions of CO_2 in the atmosphere most sensitively. According to predictions winter temperature would increase by 1.5-4^{o}C, spring temperature by 2-4^{o}C, summer temperature by 1-2^{o}C and autumn temperature by 1-3^{o}C in Lithuania. Such being the case, average annual temperature would exceed the current temperature by 1.5-3.5^{o}C.

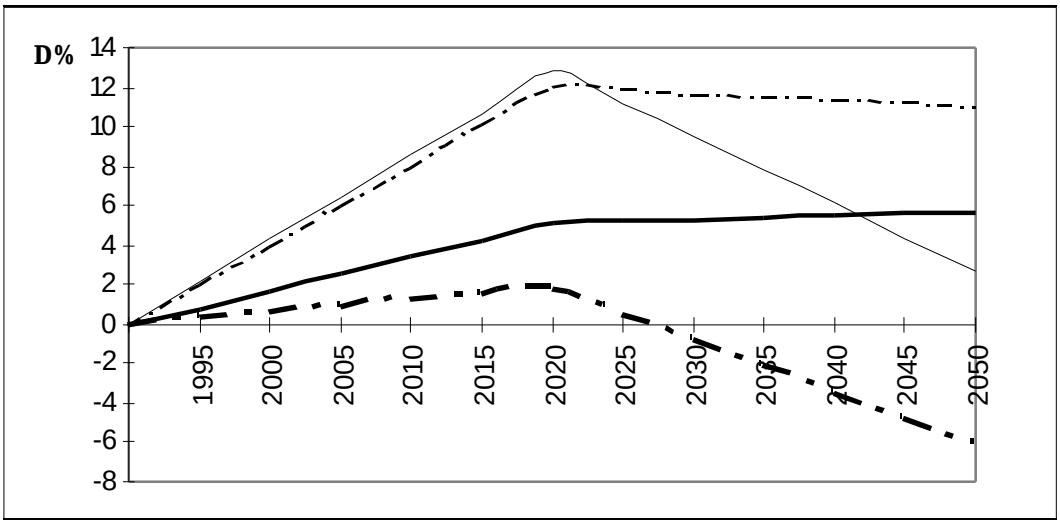
Climatic prediction of precipitation amount is an especially complicated matter. Here one must consider possible restructuring of circulation process in the atmosphere. According to the MGCC the change in the amount of precipitation in Lithuania should not be uniform. If the equivalent concentration of CO_2 is doubled, precipitation amount should increase by 5-20 % in winter, by 5-10 % in spring and in autumn, and in summer it could fluctuate from +6 to -6 %, i.e. increase in annual precipitation should account for 4-7 % per year. Thus considering changes in evapotranspiration conditions in spring and especially in summer would get worse. That means that humidity deficit may be felt, draught probability would increase. Period with snow cover would become shorter almost by half, mixed phase precipitation and rain would become predominant in winter.

The predictions of air temperature and precipitation amount in Lithuania during a year is presented in Figure 4.2. This prediction is based on the climate change model for the North Atlantic - European sector developed by the Laboratory of Dynamics of Geophysical Processes (LDGP) in Princeton, the USA. The model is based on the scenario of changes in the equivalent CO_2 concentrations in the atmosphere which predicts the doubled concentrations of CO_2 by the year 2060. By this time, the sea level will increase by 25 cm.

a



b



spring

summer autumn winter

Figure 4.2. Prediction in changes of average air temperature (a)and precipitation amount (b) for the territory of Lithuania in 1995-2050, based on the climate forecast model by Princeton Laboratory of DGP (the normal of 1961-1990)

4.3. Impacts of Climate Change on the Country

It is rather complicated to discuss the issue of a strictly differentiated impact of climate change on the development of a country when one lacks correct and objective research data. Furthermore, climate change indications on the development of a country is undoubtedly hidden by other side effects of our activity, i.e. various types of atmospheric pollution in different places, fertilization of soils, land reclamation and other economic activity. Changes of the Baltic Sea level and intensified destruction of the Baltic coasts accompanying it must be considered the most accurate manifestation of global climate change. As the result of the sea level rise blow-away plain of Curonian Spit and the littoral plain of the continental part of the coast may get swampy or even flooded, the composition of the ground waters and the dynamics of the Nemunas river mouth may be changed. Such changes may have a considerable influence on the changes of recreation potential of Lithuanian beaches and have a negative impact on tourism and recreation industry. Still a more accurate preliminary information is missing.

The influence of climate on the socio-economic development of a country may be both direct and indirect. The direct influence may be evaluated by studying response of various sectors of economy (e.g. agriculture, forestry, etc.) to climate change and to the increase of CO_2 concentrations. The effect of indirect influence stems from the attempts to reduce emissions of GHG from transport, energy and industry sectors. It is the most complicated to forecast the response of Lithuanian society to the general effect of direct and indirect impact. Such investigations in Lithuania are not numerous and therefore everything must be based on similar investigations by foreign authors. The socio-economic consequences of climate change are much more difficult to predict than possible changes in ecological systems. Besides, due to the increasing globalization of economics similar prerequisites must also be taken into consideration in countries which are the consumers or competitors of Lithuanian production.

Among the most important trends of response to climate change the following are worthwhile mentioning:

- reduction of fertility of soils and crop capacity of agriculture;
- reduction of forest productivity (although increase of CO_2 in the atmosphere may evoke increment of timber; it is quite a complicated process);
- reduction of productivity of water basins;
- change and degradation of ecosystems of the Baltic Sea coast and littoral zone.

4.3.1. Agriculture

Changes in the agro-climatic resources of Lithuania are predicted as follows:

- increase of the sums of active air and soil temperatures during the vegetation period;
- extension of vegetation period (duration of the period when the average air temperature is above 0 ^{o}C can noticeably extend);
- change of wintering conditions of biennial and perennial plants (air temperature might fluctuate around 0^{o}C, the snow cover might be shorter and thinner, etc.);

- increase in precipitation amount, yet the humidity conditions for plants should not change considerably because potential increase of evapotranspiration.

Climate change may have a noticeable influence on the spread of pests and diseases, cultural plants and animals. The warming would create favorable conditions for the penetration of new organisms from the south and also for the propagation and development of local pests.

Mild winters are not favorable to the wintering of winter crops. Because of frequent thaws the crops soak and steam and lose resistance to fungous diseases. Mild winters are especially unfavorable to gardens and winter crops because vegetation may renew when frost probability is still quite high. In such cases even the frosts of -10- -15^{o}C may be harmful.

In the recent decades the trend of instability of irrigation conditions has been evident. It is considered that this trend may also remain in the period of warming. Wet periods are considered to be especially unfavorable to haymaking and harvesting because work costs increase and part of the harvest may be lost. Now wet seasons appear every second-third year and every third-sixth year agriculture suffers from insufficient humidity. Sandy soils of South and South-East Lithuania are especially vulnerable to droughts. To reduce the negative impacts of this type both effective irrigation and land reclamation systems are necessary.

Simulation of the influence of different combinations of air temperature and CO_2 concentration in the atmosphere on wheat yields disclosed significant regularities. With the rise of air temperature yields may reduce because the time between flowering and ripening becomes shorter and the grains cannot reach maturity. According to the models, when air temperature and CO_2 concentration rise simultaneously, an insignificant increase of fertility is possible if humidity is redundant and a considerable increase of the harvest when the season is dry.

So far, almost no investigations on the possible impact of climate on agricultural technologies, market forces, spread of pests and diseases are made. Now the agriculture is influenced by neo-climatic factors, and their effects in developing the strategy for agriculture and cattle breeding should not be ignored. In view of this, deep investigations of this kind are necessary.

4.3.2 Forestry

Anthropogenic impact in the Baltic regions was evident two thousand years ago when wholesale eradication of forests and expansion of areas of pastures, arable, and other farming lands were started.

With the reduction of wooded areas the process of accumulation of phytomass has become slower and until the middle of this century, sustainability of ecological systems of the region was decreasing. The process was stopped when artificial planting of forests started in the post-war period and agricultural yields doubled or even trebled.

Thus it is possible to make a conclusion that by the middle of this century, the natural environment in the Baltic region was quite clean but when the amount of the biomass per

unit area reduced greatly, its ecological sustainability and the capability to recover from the effects of contamination and pollution of water, air and the soil reduced accordingly.

Chronology of tree rings shows that in the Baltic region as well as in the whole Northern hemisphere climatic conditions are changing. It seems that these changes shift the optimum of ecological conditions to the North or to the South. Taken as a whole, it has an influence on sustainability and productivity of ecological systems. Cyclic models, based on the increment of tree rings show that in certain periods conditions of growth either improve or get worse. Today, for example, if judged by many evident cyclic fluctuations (172-185; 90-93; 58-62 and 46-53 years) we live in the period of smaller tree productivity.

Judged by prediction models, natural growth conditions in our region will remain worse for about two decades. Yet according to short-term cycles which are typical to a quite humid Baltic region the minimum increment of trees is expected at around the year 2000. The minimum values of increment during short-term cycles as compared to the general worsening of ecological situation during long-term cycles may considerably worsen the functioning of systems, have a negative impact on crop yields, forest growth, sea productivity, etc.

Monitoring of the forest conditions has been performed in Lithuania since 1988 in accordance with internationally applied methods adapted to specific local conditions. It was discovered that only 21.2% of woods remained more or less healthy according to the 1993 data. 0.6% of woods withered in one year. The process slowed down in 1993, nevertheless the number of severely damaged trees almost doubled. The loss in increment of the Lithuanian forests constituted the loss of 0.64 million m³ of non-produced timber per year. According to the investigation data, the state of Lithuanian forests is better than in Central and Eastern Europe though worse than in Nordic countries. Damage done by nibbling insects to leaves and needles account for the major share of all the identified tree damage (as much as 45%).

Types of forests depending on predominant species	***Phytomass***	
	t/ha	***Total (mill.t)***
Pine	145.9	99.5
Fir	150.5	56.3
Birch	135.5	53.6
Other deciduous forests (species with soft timber)	90.9	25.2
Other foliage forests (species with hard timber)	178.1	13.6
Total (million of tons);	136.1	248.2

Table 4.1. Phytomass of Lithuanian forests

Climate change may cause following shifts:

- higher temperature and more abundant precipitation may stipulate growth of forests;
- as a result of warmer and more windy winters, number of wind-fallen trees may increase;
- as a result of the deficiency of cold winters, natural regeneration of pine may decrease;
- *picea abies* also grows worse under the conditions of mild winters. Besides, it may suffer from a small genetic variation;
- higher temperature results in abundance of pests and plant diseases;
- a shift towards deciduous and mixed forests may take place;

- planted forests and especially monocultures are more vulnerable to various changes, including climatic;
- forest plants with longer lifetime adapt less easily than organisms of agrocenosis. It means more rapid shifts in species composition in the forests;
- change of windiness, temperature, humidity may increase vulnerability of forests to acid rains causing pollutants;
- thus greenhouse effect may enhance other pollution-related problems.

Forest areas, density and vitality of the forests are very important to natural CO_2 cycle because CO_2 is accumulated by young growing forests. When forests reach maturity, this process stops, balance between the bound CO_2 and emitted CO_2 is established and additional CO_2 is no longer bound. Bound carbon by timber is emitted during destructive processes and can be used again. Still the ways of destruction are very different. They depend both on very specific local conditions and on the duration period.

4.3.3. Water Resources

Influence of the atmosphere warming on the contamination of basins is difficult to assess by generally acknowledged statistical methods. A method of mathematical simulation is used for these purposes. The selected mathematical model was developed by the USDA, Agricultural Research Service. It is called SWRRBWQ and is used for prediction of dispersed contamination of agricultural origin. The model contains hydrological, erosion and chemical parts. It can be used to predict the dispersed contamination of agricultural origin for a long period of 50-100 years because it involves a climate generator that enables to predict climatic conditions for quite a long period in the future.

Pertinence of the model to our climatic conditions was checked in a section the upper reaches of the Nevėþis River which begins at Panevėþys (the area of the basin is 1090 km^2). The results of the simulation are presented below.

	Prediction of run-off and water quality for 50-year period (1977-2077) under usual conditions	***The same, only the average air temperature being increased by 2 ^oC***
Precipitation, mm	674.5	674.5
Melt water, mm	149.34	117.46
Surface run-off, mm	23.47	18.07
Underground run-off, mm	98.22	99.87
Water percolation, mm	13.36	12.86
Evaporation from the basin, mm	540.50	544.50
Nitrogen consumed by vegetation, kg/ha	45.08	46.59
Nitrogen amount washed into surface waters, mm	1.25	0.97
Nitrogen amount washed into underground waters, kg/ha	5.63	4.46

Table 4.2. Simulations of water runoff and water quality

Yet the prediction data are only primary and reflect no more than trends.

High technogenic pollution of the atmosphere, and contamination of ground surface and rivers influence water quality in Curonian Lagoon, the Baltic Sea and - what is most important - the quality of drinking underground water.

The Ministry of Environmental Protection drafted the Program of Environmental Protection containing among other issues the program for the protection of water.

The main goals and tasks of the program are:

- to stop pollution and contamination by reducing both concentrated and dispersed contamination;
- to preserve the existing quality of water and improve it by legal regulation of water consumption, by more effective State control measures, by more ecological and economic waste water treatment, and by protecting the underground water from contamination;
- to rationally use water resources, improve the accounting system of water consumption and enhance economic mechanism.

The Program for Environmental Protection will be further improved with the assistance of foreign consultants in accordance with the PHARE program.

4.3.4. Coastal Resources

Due to the global sea level rise the following processes on the coast-line of Lithuania will be activated first of all:

- on the beaches: degradation, uncovering of moraines or peat on the main coast, intensive washing of protecting dunes;
- on the littoral lowlands (in Curonian Spit, Palanga - Ðventoji section, the Nemunas River delta): almost all territories on approximately sea level may be flooded, the level of the ground water will rise, processes of bog formation and falling of forests may start, etc.;
- in hydrographical network: with the rise of the baseline of erosion, hydrological properties of rivers falling into the Baltic Sea will change.

The priority of coast protection should prevail from the point of view of landscape management. Thanks to it, where possible, the consequences that are caused or may be caused by the following natural processes:

- increased frequency of abnormal storms,
- reduction of the total amount of washings in the littoral zone,
- rise of the Baltic Sea level,
- increase of enthrophication in the Curonian Lagoon,
- unregulated accumulation of washings in the Nemunas River delta

could be eliminated.

When formulating the concept of coast protection, the following ideas should be taken into consideration:

- formation of legal basis, regulating jurisdiction of the coast, the protection and utilization of nature,
- drafting a national program for coast research,
- drafting and implementation of monitoring,
- formation of basis for the coastal development, and
- drafting the program for design and implementation coast management projects.

Special research is needed to make a more detailed assessment of climate change impact on the dynamics of the Baltic Sea coast line.

4.3.5. Industry and Infrastructure

Industries of building materials, oil refining, and chemical industry are polluting the environment most of all. Industrial pollution has been caused mainly by:

- out-dated and inefficient production technologies,
- shortage of efficient treatment equipment,
- inefficient maintenance of the present treatment equipment.

Main difficulties in the environmental protection for these industries are as follows:

- in wood processing and furniture industries: solid particles, solvents, varnish waste, inefficiency in heat recuperation systems, formaldehyde etc.;
- in building material industry: dust, CO_2, SO_2 and NO_x, VOC, asbestos;
- in refrigerating equipment production: freons, CFC, solvents;
- in metal processing industry: oil products, heavy metals, solvents, CFC;
- in chemical industry: emission of nitrates, phosphoric compounds and acids etc.;
- in oil refinery: volatile organic compounds, oil leakage etc.

4.3.6. Construction and Building Maintenance

Climate impacts on the design and construction works are especially marked in the regions where the seasons of the year and seasonal prevalence are evident (the climate of Lithuania is a typical example of it). Technical requirements, costs of design works, type of constructions, choice and production of construction materials, maintenance of buildings and other constructions are extremely dependent on climate conditions.

According to the models climate warming will especially be marked in the cold period of the year. Therefore long-lasting periods, when air temperature fluctuates around 0^oC, can

cause an active frost-caused decay in the covering constructions of houses. Even more -- if during the cold season the rain-type and mixed phase precipitation prevail, moistening of wet surfaces will increase. It is expected that meteorological conditions causing freezing rain will become more frequent.

Many technological processes of construction depend on meteorological conditions too. It causes yet another problem. For example, concreting, asphalting, the work of column cranes, etc., are possible only under certain air temperature, wind speed, precipitation.

When designing and constructing air supports for power transmission and communication lines, constructions higher than 40 meters (chimneys, radio and television broadcast towers and other edifices), possible loads caused by wind, freezing rain and snow should be considered. Overestimation of such loads makes construction unreasonably more expensive, while underestimation may cause accidents.

Corrosion influences materials, exposed to the air, ground and water. The type and intensity of corrosion depend on climate conditions, environment pollution and the resistance of materials. Corrosion influences not only metals but all materials used for the construction of buildings, engineering underground networks, machinery and equipment, paints and lacquer covering, etc.

4.3.7. Human Health

Data submitted by Lithuanian oncology physicians indicate that cancer morbidity is mostly dependent on socio-hygienic risk factors, including working and living conditions, food and carcinogenic pollution.

Tests on the amount of benzopiren found in cereals and fruit grown along highways carried out by Cancer Prevention Laboratory of Lithuanian Oncology Center showed that amount of pollutants 3-10 times exceeded background amount of this particular pollutant.

The greenhouse effect being evident, bracing effect of meteorological factors on human body declines which in its turn weakens the immune system, i.e. ability to resist bacteria infections, pollutants, other health troubles causing factors. It is possible to state that human health indicators will get worse because of climate impact. In order to prevent the trend being spread it is necessary to take all the possible measures (economic, technological, legal, etc.) and try to reduce climate change both in our country and globally.

Climate fluctuations and changes of ecological situation related to it may have an inevitable impact on the human immune system and be the cause of its insufficiency. Various diseases, viz., immunodephicite, autoimmune, atopic and infectious diseases, tumors, immune complexes are related to insufficiency of immune system. However, knowledge on the causes of these diseases available today is still insufficient. It is important to further investigate relations between these diseases and environmental conditions. It would enable to predict the resistance capacity of human body as well as of other organisms.

Assessment of impacts of climate change on human community puts one more problem evident, viz., single out the most vulnerable environment. The results of investigations show that healthy organisms are very capable to adapt to climate change. Yet sick people, elderly persons and children are very vulnerable to climate change and unfavorable ecological conditions. Bearing in mind the fact that the population grows older, a rapid climate change would have a negative influence on a considerable part of the society. Therefore studies of climate change impacts and mitigation measures for human health should be planned in Lithuania. Financial resources for these studies should be economically and technically grounded.

4.3.8. Natural Ecosystems

Climate change may cause new trends for the selection process. The results of selection are absolutely unknown since the interaction of species in the ecosystem is a very complicated phenomenon. It is evident that during the adaptation process, stability of ecosystems will decrease. In these circumstances of new environment, species with a higher competitive capability will become evident both among fauna and flora as well as pests; ecosystems may be influenced by new pathogens. Temperature rise may shift areals of species to the North.

Interaction between various species is very complex. The term 'stability' has different meanings but in general it means invariability or capability to return to the former status after environmental changes have taken place. In natural communities the populations are the more stable, the more complex and diverse these communities are. The ecosystems are complex and most research is done by simulating the situation thus making it less complicated. Still investigation of model ecosystems, i.e., microcosms, is of great importance. Available climate forecast models have too small number of climate parameters at their disposal to make the description of species behavior under changing climate conditions possible.

The system of protected territories in Lithuania comprises:

- protective (conservation) territories. Attributed to them are reservations and reserves;
- preserving (preservation) territories;
- territories used to recuperate natural resources. Attributed to them are plots of natural resources under protection;
- multipurpose territories in which protective zones are joined together under a general program of landscape use and management. Attributed to them are state (national and regional) parks and the biosphere monitoring territories).

The system of protected territories was target-oriented and developed according to the preliminary plan for specially protected territories in Lithuania. The natural framework is formed on the basis of state, regional and local documents of territorial planning. It is especially important to return components of biota to the territories, i.e. to form field-grove-type complexes.

Swamps

Composition of swamp species depends on temperature, water and nutrients. The same processes decide biochemical processes, viz., primary production, disintegration, and accumulation. Due to the formation of peat, swamps can be attributed to that limited number of ecosystems in the earth which absorb carbon dioxide from the atmosphere. On the other hand, swamps emit methane and are considered the biggest source of natural atmospheric methane. It is difficult to predict how hydrological state of swamps may be influenced by climate change.

Increased amount of precipitation may cause larger emissions of CO_2 that in its turn increase the area of swamps. On the other hand, increase in temperature accelerates evaporation increases and therefore area of swamps may be reduced. This process would be accompanied by disintegration of peat and emission of CO_2 as a result of mineralisation. Higher temperature may result in a more rapid process of anaerobic disintegration and release of methane. Types of swamps and composition of their species may change. At the same time, new areas for cultivation of forests may appear. Manufacturing of peat enhances greenhouse effect due to CO_2 and CH_4 emission.

Bird Wintering Places and Wintering Areas

In recent decades great changes of populations of water birds, wintering and migrating in Lithuania, are taking place. For the most part they are caused by general warming of climate and especially by warm winters in the Baltic region.

In the winter of 1994, about 25,500 mergansers (or almost 17 % of all individuals of North-Western Europe) accumulated in the Curonian Lagoon. A change of wintering places of the regional population of the small merganser (*Mergus albellus*) has also been registered. If in 1977-1983 up to 90 % of all population of North-Western Europe used to winter in Holland, up to 86 % of all population accumulate in several wintering places in the East Baltic region (in the north-eastern part of Germany, Poland and Lithuania) in recent years. Similarly to the big merganser the wintering population of the small merganser has shifted almost by 5^o to the east.

4.3.9. Further Research and Information Needs

In order to assess climate changes, it is necessary to develop research investigations of climate in Lithuania. Such investigations should start with post-glacial period and reach our days. Climate fluctuations in the territory of Lithuania and the Baltic region on the whole during the last two millenniums require especially detail investigation. Mezoclimatic detalization of investigations requires extension of observation network of meteorological parameters and supplementing the program of meteorological monitoring. In recent years, the issue of development of regional climate change scenarios gained a special importance. Such scenarios would enable to solve the tasks of adaptation to climate change. As a component part of such scenarios, dendrochronological investigations should be started.

Already in the nearest future, it is necessary to define the trends of rise of the level of the Baltic Sea near the coasts of Lithuania and assess vulnerability of the Baltic Sea coastline to the rise of the sea level. In this context, an extension of monitoring of coasts and sea level and detailed morphometric and litological investigations are necessary. It is necessary to define the most sensitive and vulnerable coastal areas, classify them and draft a design of the Baltic coast of Lithuania according to the degree of vulnerability. The network of observations of the sea level has to be extended, measurement stations in Ðventoji (Bûtingë), Curonian Spit (near Nida) and Palanga have to be set up.

To draft the strategy for the forestry, it is necessary:

- to do scientific research to assess the possible impacts of climate change on ecological systems as well as forestry,
- to predict and evaluate the possible adaptation of ecological systems of forests and forestry,
- to provide for a complex of economic and technological measures of mitigation of impact on ecological systems thus increasing forest productivity, assigning a most important place to the assessment of damage caused by dendrophagus and identification of measures of its elimination.

Global climate change makes it more difficult to predict the change of biota. It has a direct influence on the preservation of biodiversity of birds, makes prediction of their life processes problematic. Available mathematical statistical models are inaccurate. They need improvement and perfection by including new environmental parameters, prediction of their change, trends and possible impacts of such changes. To do it, special research is necessary that could include not only birds but other elements of ecological systems and separate ecological systems as well.

Due to changes of climate conditions, hydrophysical and tropic parameters of the water basins in Lithuania are changed. To assess these changes, a more detailed research data are needed. Available information is sufficient only to determine the trends of changes but it is insufficient to make parameterization of interrelations and predictions. To assess and predict the intensity of possible changes, quantitative analysis of the trends of natural factors, interrelation of variability of populations and communities, as well as the synergetic activity of natural factors are essential.

It is necessary to monitor data collection on the response of biota to climate change. First of all, such investigations are to be made in reservations by measuring different parameters and trends of biota and climate change. It is necessary in order to determine impacts of climate change and separate short-term fluctuations from long-term trends.

The basic monitoring should first of all reveal the vulnerability of rare and disappearing species, populations and communities to climate change on the national and international scale. Later, a special system of monitoring should be applied to extremely sensitive and vulnerable species. Monitoring should be directed both at species, communities and ecological systems under protection and based on status of natural resources used and their prediction.

It is very important to clarify whether the processes taking place on the surface of the Earth eliminate the increase of CO_2 or, on the contrary, encourage changes on the global surface caused by human activity. The degree of undergoing transformations can be characterized by such features of biosphere as species of vegetation. Many processes of global importance

are more rapid in warmer environment. Especially it holds true to disintegration of organic substance and gas production while processes like photosynthesis in most cases get intensified due to the increase of atmospheric CO_2. The factors limiting photosynthesis will change in contemporary environment. Certain ecological systems and biomass will gradually be substituted by those which are capable to easier adapt to new conditions.

When predicting the dynamics of biosphere, the following issues should be given special consideration:

- what are the consequences of warming and increasing of CO_2 to the land,
- what is the response of climate to these changes.

The Government of Lithuania should continue backing up investigations of natural ecological systems and anthropogenic influence on them. Integration of separate sciences to analyze ecological systems is also required. In the course of investigation of land ecological systems the main attention should be paid to:

- forests;
- agrarian landscapes;
- industrial territories;
- environment of rivers and lakes.

Today, a number of international programs for climate change studies are implemented, the World Climate Research Program (WCRP) and the International Geosphere - Biosphere Program (IGBP) being among them. On the international scale, investigations of ecosystems of Lithuania are integrated into the UNESCO program "Man and the Biosphere".

It is also necessary to look for the ways of integration into other international programs for the assessment of climate change initiated by Western countries, viz., "Global Change and Terrestrial Ecosystems" (GCTE), IGBP and WCRP.

It is necessary to join the projects for assessing impacts of climate change on grasses under controlled circumstances and analyzing:

- vulnerability of the main Lithuanian agricultural varieties of plants and when making a comparison between them and the varieties used in Western countries for plant-breeding, examine vulnerability and fertility of the main plants to climate change;
- the main types of meadow communities and their competitive interaction;
- rare and disappearing species, especially vulnerable to change of temperature and humidity;
- the mechanism of plant metabolism under the conditions of the changed climate.

When implementing the national program on climate change it is necessary:

- to investigate the variety of species and their abundance as well as mutual interaction between various plants, plants and animals;
- to monitor rare, disappearing, resource and weed species in the communities of forests, agrocenoses and especially in protected territories, to evaluate the productivity of communities;
- to simulate the processes of climate change and to predict the most probable shifts of climate.

4.4. Possible adaptation measures to climate change in Lithuania

Title of the project	*Remarks*
I. ENERGY	
1. Energy and environmental protection: preparation of the program	
II. AGRICULTURE AND FORESTRY	
2. Development of seed-bank by selection and accumulation of most bioclimatically and protectively valuable species and genetic fund in view of regional peculiarities of Lithuanian nature	Improved forest stability and productive capacity by 5-30 %
3. Breeding and use of tree hybrids and species with greater assimilating capacity for creation of beneficial bioclimatic environment	Improvement of forest shielding functions
4. Influence of ecological factors on preservation and expansion of forest resources	Assessment of impact to forests, its loss caused by main biotic and abiotic factors; recommendations for forest preservation from pests, pathogens, fires, wild animals, climatic and anthropogenic factors, main means for forest preservation and enhancement possibilities of sanitary status
5. Studies in biotrophic relations between pest-insects and host- trees and their mutations caused by changing ecological conditions	Study and assessment of losses caused by dendrophagus; harmful effects to the dynamics of insect populations; trophic relations and influence of ecological factors Recommendation to abate losses caused by dendrophagus
6. Monitoring of forest status	Studies of dynamic changes of forest status, main factors causing defoliation, their impacts, predictions and means for abatement of defoliation
III. SCIENTIFIC RESEARCH	
7. Anthropoclimatic assessment of Lithuanian territory considering recreation and climatotherapy in the context of climate warming	
8. Research on climate change impacts on biodiversity in Lithuania: status, trends of changes and prediction	
9. Analysis, modeling and prediction of climate change in Lithuania	

10. Dynamics of coastline of the Baltic Sea and Curonian Lagoon caused by climate change: assessment of vulnerability and measures of adaptation	
11. Assessment of climate change impacts on land and aquatic ecosystems	
12. Assessment of adapting capacity and quality of main tree species' populations; reservation and use of genetic resources	
13. Interaction between forest ecosystems, climate change and pollution of the atmosphere	Chronological dynamics of timber increment caused by climate change, impacts of atmospheric pollution on forests and forest role in reconstruction processes of biosphere is to be examined. The strategy of economic response to biodiversity of forest ecosystems and enhancement of sustainability of biosphere is to be updated.
14. Dependence of characteristic features of Soil formation on climate change, relief peculiarities of soil-forming rocks and structure of phytocenosis	Main soil formation processes linked to climate, soil-forming rocks, relief and structure of phytocenosis is to be studied. The studies will enable to update genetic classification of Lithuanian soils.
15. Hydrological regime in the soil of wetlands and bogs and its effect on forest productivity in the global warming context	Influence of hydrological factors on forest functions is to be studied. Strategy of forest draining is to be prepared in the context of global warming processes.

5. POSSIBLE POLICIES AND MEASURES TO MITIGATE CLIMATE CHANGE

5.1. Introduction

Criteria for assessing mitigation options are as follows:

- cost-effectiveness (i.e. low or negative cost per ton of emission reduction),
- emissions reduction potential (estimated total tons of emission reduction),
- contribution to other national goals (e.g., generation of job vacancies, pollution prevention),
- technological benefit (potential to gain an early lead in new technologies),
- international cooperation (potential for GEF support, joint implementation, or regional cooperation).

5.2. Energy

5.2.1. Policies to Mitigate Greenhouse Gas Emissions

5.2.1.1. Energy Policy

The National Energy Strategy is based on the assumption that energy intensity (1 kg of oil equivalent 1,000 US dollars of GDP) is to decline by the year of 2015 if compared with the basic one in 1990:

- up to 51 % in case of the moderate reforms scenario is implemented;
- up to 71 % in case of the slow reforms scenario is implemented;

Such an effective energy consumption, production and supply will have a positive environmental effect and sufficiently reduce pollutant emissions into the atmosphere.

5.2.1.2. Consumption of Conventional Fuel

In 1996, the Government of Lithuania has approved the updated program on "Development of Efficiency in National Energy Consumption (DENEC)". A possible cut of current energy consumption by 20 % to 50 % in separate sectors of economy has been calculated. The greatest potential in energy conservation is in residential heating sector that would amount to a third of the consumed thermal energy (~ 1391 toe : 3 = 0,46 million toe or CO_2 emission would be reduced by 1,414 + 1,994 = 3,4 million tons of CO_2). But it is necessary to invest 22 billion of litas[1], the pay-back period being 29 years. Therefore, it is reasonable to think of implementation of only a part of cost-effective measures.

[1] 1 USD ≅ 4 litas

An example of such a measure could be modernization of heating systems that would pay back in 1-2.5 years and could save up to 4 Twh of thermal energy, or reduce CO_2 emissions up to 1 million tons.

The total annual potential of energy conservation in Lithuania's economy amounts to 19.4 Twh in consumers' sector (in 1994, 61.7 Twh has been consumed), and 5.3 Twh in production sector (in 1994, this figure was 24 Twh). That would reduce CO_2 emissions approximately by 6 million tons per year. It has been estimated that the consumption potential of indigenous and renewable energy resources is 15.3 Twh, while at present only 5.9 Twh is consumed. If converted to fuel combustion in oil equivalent, this would cut down CO_2 emissions by approximately 4 million tons.

5.2.1.3. Hydropower Engineering

All the possessed in Lithuania technological hydroenergy resources are estimated to have average annual capacities 407 MW or 3.6 billion kWh every year. From the total the Nemunas river alone has got 237 MW or 2.1 billion kWh/year, the Neris river has got 110 MW or 1.0 billion kWh/year, small rivers have got 60 MW or 0.5 billion kWh/year. The resources are economically grounded and make 1.5 billion kWh per year. In 1994, the hydropower plants in operation such as Kaunas HPP and 14 minor power plants produced 450 million kWh per year. This figure comprises only 10 % of all the technical energy resources and ~26 % economically aimed hydroenergy resources in Lithuania.

The river Nemunas complex energy utilization program should be initiated, because of a very perspective location from Kaunas to Druskininkai from the point of view of hydroenergy production.

5.2.1.4. Unconventional Technologies of Renewable Energy

Lithuania as a state has limited local resources. The primary objective of energy development here is to increase the efficiency of energy resources and energy consumption. In 1992, under the initiative of the Ministry of Energy the program on "Development of Efficiency in National Energy Consumption (DENEC)" was prepared. It estimated the way fuel and energy are consumed. Estimations have confirmed that implementation of saving measures of the primary energy resources in the nearest 10-15-years period would definitely save 1/4 of imported energy resources today.

The updated DENEC program and the main trends of its implementation in 1996-2000 have been approved by Resolution 940 of August 5, 1996 of the Lithuanian Government.

Solar Energy

Annual solar energy potential in Lithuania is estimated 1000 kWh/m^2 . This potential is equal to the solar radiation in similar latitudes in North Germany and Denmark. Here are presented the figures that rest on the supposition that solar energy could be used for preheating 30 % of domestic hot water (i.e. ~ 30 % from 5000 GWh, that makes 1500 Gwh

a year). Then solar energy could substitute 1.5 % of the total primary energy consumption for 1993 to be used for domestic hot water preheating.

Solar energy application in active heating systems, has been considered as having no practical implementation in Lithuania. This is proved by the fact that even now the system is not used as an active solar heating system.

Geothermal Energy

It is estimated that environmental pollution by SO_2, CO_2 and NO_x emissions is to be reduced due to the geothermal heat. Implementation of the pilot project on geothermal heat utilization in Western Lithuania (~ 10 PJ per year) would considerably reduce annual emissions of pollutants, i.e. ~ 0.9 million tons of CO_2, 5.8 thousand tons of SO_2 and 2.0 thousand tons of NO_x and annual savings will be 52 million US dollars.

5.2.1.5. Efficiency at the End-user Points (Industry, Construction)

The environmental and climate change mitigation effect is possible to achieve mainly by reducing expenditures on energy, energy reserves and perfecting the processes of energy consumption in industry and construction. The following means for implementing energy saving measures should be applied:

- reduction of losses when renovating buildings;
- upgrading and putting in order of heating and ventilation facilities;
- introduction of management and control on combustion processes of energy resources in boilers and other facilities;
- increase of efficiency in the facilities consuming energy resources and energy;
- technological upgrading of operational processes and implementation of new energy consuming technologies;
- utilization of secondary energy resources;
- conversion from liquid fuel to gas fuel or, possibilities permitting, conversion from liquid and gas fuel to indigenous energy resources;
- decentralizing of heat supply to enterprises by installing there efficient combined-cycle gas turbines;
- environmental audit in much energy consuming enterprises;
- introduction of the accountancy on consumed fuel and energy as well as control and regulation means and measures;
- implementation of neutralizing and cleaning technologies for combustion products emitted from boilers or other facilities.

5.2.1.6. Indigenous Wood Fuel and Biogas

Wood Fuel

Based on the "Forestry Development Program" as well as on the "Wood Fuel and Conversion Study" prepared by the Danish company "CarlBro Energy A/S" in 1994, an

assumption can be drawn that wood fuel reserves to be consumed in 2000 as well as their preparation for fuel, including transportation costs, would be less than 1.4 USD/GJ. It would make:

In the forestry sector	3 500 TJ/year
In the wood-processing industry	4 000 TJ/year
Total	7 500 TJ/year

It is possible to produce 300 MW for this amount of wood fuel consumed. The consumption of indigenous fuel (wood, agricultural waste, peat etc. included) is projected to 200,000 TJ per year. The capacity of boilers burning wood fuel amounts to approximately 60 MW. The mentioned HOBs burned heavy fuel oil and partially coal till now. Having in mind the fact that growing woods uptake much of CO_2, the emission of CO_2 alone in the atmosphere could be reduced by ~0.5 million tons annually if heavy fuel oil is converted by wood.

Biogas

It is possible to produce approximately 1 million tons methanol and/or high energy methanol (HEM) out of waste and biomass (wood and timber industry waste, straw). Lithuania can do without oil import for transport needs if she would utilize peat for the production of methanol. 1 ton of combusted gasoline in vehicles makes up ”2.8 tons of CH, CO and CO_2; and 1 ton of diesel fuel ”3.0 tons accordingly. If 1 ton of methanol is combusted, 1.4 tons of CO_2 is produced in a closed biological-production cycle according to a proposed technological scheme.

The chosen technology enables to recycle waste into methanol. There are two ways of methanol consumption: either as fuel for carburetors or diesel engines, or as raw material for further chemical recycling. It is extremely important for Lithuania to have an alternative fuel resource instead of oil products. Such fuel could be a mix of methanol and other higher alcohol (e.g. high energy methanol or HEM) which is formed during the catalytic synthesis of methanol. This fuel would be more environmentally friendly; environmental pollution by exhaust gases and hazardous substances could be reduced by tens of times and would enable to gain a double ecological benefit: waste would not be accumulated in landfill sites, environmental pollution by transport would be reduced.

The model enterprise could be located on sites where biomass is accumulated and connected with each other to achieve the desired capacity.

Lithuania could do with 50 model enterprises with output capacity of each being 1 million tons of methanol / HEM. This amount could be the equivalent for oil fuels and could satisfy ” 60÷80 % of Lithuania’s needs for transport fuels.

According to action plans 8.52 million tons of environmentally friendly fuel could be produced by 2010. Thus, we can state that having consumed ecologically friendly fuel instead of oil fuel, the GHG emission could be reduced in 1999-2010.

5.2.1.7. Nuclear power and CO_2

When making comparisons of nuclear power advantages against thermal power plants, burning heavy fuel oil with regard of CO_2, a striking result will be received. General input in 1994 for electrical energy comprised more than 11,000 GWh. In 1994, Ignalina SNPP produced ~7700 GWh, but capacities are for 15,000 GWh. Having applied all the production capacities of Ignalina SNPP for the production of heat energy, i.e. having eliminated the production of heat energy by burning heavy fuel oil with sulfur content of 2.0 %, it is possible to save ~ 1.4 million tons of heavy fuel oil annually (in 1994, 1.4 million tons of heavy fuel oil, 1.0 billion m^3 of natural gas, 0.17 million tons of LPG and 60.7 thousand tons of peat and 66.9 thousand tce of other fuel were used). The reduction of pollutants could be estimated in such a way : SO_2 by 83.0 kt/ yr.; NO_x by 120 kt/ yr.; CO_2 by 4.4 kt/ yr.

5.3. Industry

To the best of our knowledge food industry, oil produce manufacture and light industry are expected to comprise the same share in the general structure of industry and would continue so up to the year of 2000, except machine building industry, the significance of which would be decreased.

With due attention Lithuania aims at restructuring other progressive industries such as forestry and wood processing, flax growing and manufacturing, hides and fur processing, building materials.

To this effect it is important to improve skills and qualifications of employees, to perfect more efficient use of energy and raw materials, improve management of technological operations, execute better accountancy and administration at the enterprises. The investments into progressive clean technologies are required, causing reduced consumption of natural recourses and emissions of hazardous substances into the environment. Persistent actions are requested in evading trading barriers with other countries, introducing more flexible, production stimulating taxation system, expanding transfer of infrastructure, know-how and experience into Lithuania and etc.

Here are enumerated the main obstacles hindering the implementation of measures reducing waste and pollutants:

- lack of specific knowledge on means and measures of waste and pollutants reduction,
- inadequate control of pollution,
- insufficiency of technical equipment and means,
- shortage of funds for the investments on the environment,
- uncertainty about the industrial development in future,
- absence of the positive approval and obligations from the top authorities in respect to waste and pollutants reduction.

A great stress in national activity plans for environmental protection is laid on elimination of these obstacles and difficulties, including a possibility to introduce financial inducements if an enterprise makes an investment in low-cost waste and pollution reduction measures, technical assistance, education and public awareness.

Lithuania shall make provisions for mastering progressive know-how and experience in environmental policies and management of the European Community members, other European states, the USA and other countries. Reference should be made to the auditing scheme, ECO labeling scheme, ISO 14000 standard for international environment protection system on management put forward by the EU Ecomanagerial board. Introduction and adaptation of the above-mentioned systems and standards in Lithuania could meet the demand for a wide range of application of environment protection management in practice and help to develop the most reliable and safe production of environmentally-friendly goods. None the less the possible barriers could be destroyed and Lithuanian produce articles could get the access to overseas markets.

5.4. Transport

Transport is not considered to be one among the main consumers of fuel in Lithuania. The amount of fuel consumed in transportation comprised 15 % of the total fuel utilized in Lithuania in 1993. However, the experience of developed countries exhibits a greater amount utilized, e.g. in Ireland - 19 %, in the UK - 24 %.

The national strategies for 2010, as well as the program of strategy implementation for 1995-1997 have formulated the main requisites of the infrastructure intended to modernize and develop this branch to be able to integrate into the European transport network. The priorities are schemed for the international transport corridor development (Lithuania is crossed by 2 corridors of European significance directed East-West and North-South. The latter have been approved by the European Transportation Conference in Greece).

Local infrastructure, i.e. roads in rural areas, industrial districts, routes in street network has been developed satisfactory. But due to the lack of finances allocated to the maintenance and repair of separate objects of infrastructure certain difficulties come forth. The conditions of local infrastructure getting worse, the transport fuel expenditures increase as well. The situation is expected to be improved in 1996 when the law on the motor road fund, determining the financing procedure for new roads and city streets construction is enforced.

Motor road vehicles consume the most fuel (in 1990 - 74,3 %, in 1993 - 80,4%,) emitting the largest amount of greenhouse gases. The capacities of freight and passenger carriages are being reduced, motor car number being increased considerably - from 491.1 thousand cars in 1990 up to 615.7 thousand in 1993. Therefore, it is most significant here to maintain the purchase of the most efficient vehicles. This process could be regulated by various taxes such as customs duties imposed for imported vehicles.

The main document, analyzing transport impact on the environment is the State Program "Transport and Environmental Protection". Detailed analysis of GHG emissions by various means of transport is not included here, because the emissions were not taken into consideration when working on the Program. However, if certain activities were taken and various means used the emissions of greenhouse gases could be partially reduced.

They are the activities to be followed:

1. On motor road transport:

- rational distribution of traffic flows,
- perfection of means for selection and training of drivers,
- trolley-bus network development in Vilnius and Kaunas,
- optimization of fuel prices,
- construction of new biotransport routes.

2. On railway transport:

- electrification of Lithuanian railways,
- pipeline transport development for oil products transportation.

3. On Sea transport:

- power supply from the municipal power network to the ships in the port.

4. On the Entire Means of Transport:

- the formation of the fleet of various means of transport, taking into account the existing ecological requirements.
- development and implementation of national ecological standards.

5.5. Agriculture

In recent decades, a very intensive and highly chemical agriculture was developed in Lithuania. It was only in 1991 when crisis both in Lithuanian economics and agriculture started, consumption of chemicals for plant protection, growth stimulators, synthetic mineral fertilizers was considerably reduced. Yields in agriculture decreased accordingly.

Consumption of mineral fertilizers, especially of nitrogen and potassium, in Lithuania was increasing until 1990. If in 1973, agriculture of Lithuania received (in the form of active ingredient) 159.8 thousand tons of nitrogen fertilizers, in 1988 it was 267.5 thousand tons and in 1993 this figure dropped to 29.8 thousand tons. The amount of potassium fertilizers correspondingly was 154.5, 292.2 and 1.0 thousand tons and that of phosphorous 83.9, 141.5 and 12.9 thousand of tones.

A similar situation was observed in the application of chemical means for plant protection in Lithuania. If the amount of pesticides used in 1989 was 8822 tons, in 1993 the corresponding figure was only 490 tons.

Circumstances for positive restructuring of agriculture when implementing the strategy for climate change, are especially favorable today. In the recovery process of economics of Lithuania, it is possible to avoid the former chemical way of farming and exercise sustainable or bio-organic agriculture instead.

The demand for energy resources in Lithuania may and has to be reduced by restructuring agriculture into alternative forms of farming. Having restructured agriculture, pollution and contamination of the environment will be reduced both considerably and directly (when reducing consumption of pesticides and mineral synthetic fertilizers) and indirectly (due to the reduction of output of chemical industry).

Apart from the reduction of the consumption of chemical fertilizers mentioned above, the cutback of energy resources, and improved environmental protection, transition from the so called traditional to sustainable or bio-organic agriculture is extremely facilitated by search of agricultural markets (sale of agricultural products becomes easier) as well as abatement of social hardships (unemployment rate is reduced).

First significant transition measures were implemented. By Resolution 589 of December 24, 1991 of the Lithuanian Government on "Measures of Improvement of Ecological Situation in Karst Region of North Lithuania", a certain territory was chosen in which limited economic activity was introduced. The intensive zone covers the area of 29.4 thousand ha and the protective region 164.1 thousand ha. To implement the decisions of the Government, the pilot project for the protection of groundwater from contamination and implementation of the development of ecological agriculture in the intensive Karst Zone, was drafted in 1992 and approved by Resolution 719 of September 17, 1993 of the Lithuanian Government.

The program, implemented in the Karst Region by "Tatula" Fund, is a pilot project. Together with the recovery process of economics, reconstruction of agriculture in Lithuania is planned alongside with the first program implemented in the Karst Region and other similar programs in preserved areas to the development of sustainable and bio-organic agriculture in the whole of Lithuania. Possibilities of financing provided, the environmental program for the Karst Region can last for about a decade (until a breakthrough takes place in the region).

In order to cope with this issue, we have:

- to strengthen and develop international relations, and
- to look for the credits from international organizations and developed countries.

Implementation of the pilot project in the Karst Region which can be regarded as a promising model for agriculture is directly interrelated with the commitments of the United Nations Framework Convention on Climate Change. In the process of recovery of the economic potential of Lithuania but without alternative projects for agriculture approximately 600,000 - 700,000 tons of mineral synthetic fertilizers (in the form of active ingredient) and about 14,000 tons of pesticides would be used in the average annually again. This type of production would cause approximately 1.5 million tons of CO_2 emissions.

Possibilities to Develop Sustainable and Organic Agriculture in Lithuania

Sustainable and organic agriculture has to be developed by the year 2050 in:

- the Karst Region through the implementation of the environmental program, adopted and approved by the Government (not less than 5 %, or 20 thousand hectares of the land use by the end of the period).
- other regions, supported by the state as well (less of the land use than in the Karst Region).

In 2005-2015, development of sustainable agriculture (about 20 % of all agricultural land by the end of the period) and development of bio-organic agriculture (about 2 % of all farming land by the end of the period) in the whole territory of Lithuania.

The volumes of sustainable and bio-organic agriculture will depend to a considerable extent (and may be extremely extended) on the level of the National Implementation Strategy of the United Nations Framework Convention on Climate Change.

5.6. Land Use Change and Forestry

Forests

Possibilities of climate change mitigation in the forestry sector are based on the same policies and measures which are used to reduce GHG emissions in forestry as well as in the other fields of human activity which result in enhanced uptake of CO_2 by the forests and extension of life of wood products.

The following mitigation measures are available:

- preservation of current forests;
- expansion of forested areas;
- consumption of wood as renewable fuel instead of fossils.

With climate change in view, it is essential to review and make flexible assessment of:

- legal framework regulating forest felling,
- regulations of economic activity in preserved forests;
- forest recovery and sanitary protection of the forests,
- regulations of public and private forest management, forest fire prevention rules.

Forest cover of Lithuanian territory should be increased by 2-3% first of all by expanding afforested areas in hilly and infertile lands.

Land owners in private plots should be supported by means of land rent discounts, grants and supplies of saplings and seeds.

- development of selection and seed farming,
- exclusive utilization of selected saplings in the forests,
- preparation of the overall afforestation concept and reproduction presumptions.
- preparation of forest seed distribution by regions. Creation of a national forest seed bank based on local natural populations.

It is essential for expansion of large forests:

- to plant forests in new areas;
- to recover the felled forest by new planting and by natural reproduction of the forests;
- to promote reproduction of forests by increasing biomass density;
- to plant buffer zones along marginal areas of agricultural land to prevent wind-caused erosion; to utilize forest herb layer for forage;

- to develop urban tree planting, cultivate additional biomass in residential areas, on roadsides and marginal areas; to consume urban timber for residential heating;
- to improve fire and pest protection.

5.7. Waste Management and Sewage Treatment

It is important to point out that the major cities and towns of Lithuania (Kaunas, Klaipëda, Ðiauliai, Alytus, Palanga, a health resort on the Baltic Sea coast, regional centers like Anykðèiai, Birþai, Joniðkis, Pakruojis, Ðilutë, Zarasai) have no biological sewage treatment facilities. In all of the above places construction of such facilities was started but had impermissibly been delayed because of financing shortage. Having put into operation only the priority objects (sewage treatment facilities in Kaunas, Klaipëda, Ðiauliai and Palanga) the amount of pollutants emitted into water basins evaluating it by the BOD5 could be reduced by 60 % or by 21,000 tons in Lithuania.

Yet an ecological situation due to insufficient financing will remain very unfavorable in rural areas for an indefinite period of time. Among the biggest pollution and contamination sources in the country, animal breeding complexes, especially those 33 swine-breading farms with the out-put of 12,000-54,000 swine per year are extremely conspicuous. The level of production output in them was not reduced in the period of transition to the market economy and therefore their contamination capacities in the form of waste can be equaled to the contamination and pollution generated by a city with 5-million population (without industry). Animal-breeding farms and settlements (only every ninth of them is provided with sewage treatment facilities a part of which is, however, not functioning) are also among the most important sources of contamination.

The private sector has also started to finance the implementation of environmental protection measures.

The accounting organized by the Ministry of Environmental Protection showed that there were 1.55 million tons of household waste in Lithuania in 1995. Great volumes of paper and cardboard, glass, plastic waste are taken to landfills together with municipal waste. But great amount of it could avoid landfills if the system for the secondary raw materials collection and recycling were in operation. such collection systems start functioning in Kaunas, Vilnius, Klaipëda and Panevëþys. Municipalities should pay greater attention to the collection and recycling of secondary raw materials.

In order to regulate waste treatment in Lithuania the Ministry of Environmental Protection initiated the preparation of the draft law on Waste Treatment that was presented to the approval of the Seimas in 1994. This system of waste treatment is to be prepared and implemented according to purposeful programs and projects for waste treatment together with relevant institutions. Economic mechanism in the waste treatment sector should be created. Another significant document that has to be prepared without any delay is the Rules and Regulations on Landfill Design, Building Construction and Maintenance. All steps from landfill site selection to filter cleaning and silt treatment should be included here.

One of the most urgent environmental issues is treatment of hazardous waste. In 1995, there were accumulated 152 thousand tons of hazardous waste. At present galvanic slime, waste of oil by-products, photography production, accumulators and electrolytes of acid

accumulators are partially treated. But to tell the truth, a great volume of hazardous waste is not treated in the environmentally friendly way. Part of the materials polluted with oil products and pain, silt from vehicle cleaning and washing, soil contaminated by various chemicals, lubricants, etc. reach landfills and open dumps of municipal waste.

Having in mind the importance of hazardous waste treatment, the Program on Hazardous Waste Treatment that envisages regional sites for temporal storage of hazardous waste and central enterprise for hazardous waste treatment, was approved by Resolution 98 of February 22, 1993 of the Lithuanian Government. As the implementation of such a system would cost approximately 100 million US dollars, it is quite evident that in a current economic situation financial resources cannot be found. Therefore, alternative ways and means have to be investigated. When implementing the aforementioned program, sites for temporal storage of hazardous waste have been selected and designed in Alytus, Klaipëda and Ðiauliai. Sites were selected and design works are going on for Vilnius, Panevëþys and Marijampolë. Hazardous waste could be safely stored and controlled if the aforementioned sites were installed.

5.8. Economic Instruments

In the Law on Taxes of Environmental Pollution (April, 1991) it is stated that the goal of imposing pollution taxes is to "... serve as an economic element of environmental protection which stimulates pollution abatement and reduces the harmful impact on the environment." The goal of the legislation is therefore to influence the level of emissions by polluters. It should be noted that this is by no means the only goal which pollution charges can contribute to achieving. At least three alternative goals could be considered:

- *Financing environmental investments*. Pollution charges can be used to raise targeted levels of revenue which then may be earmarked for pollution abatement or cleanup activities; charge rates can be set to make a particular level of contribution to financing environmental investments;

- *Amelioration of the ecological tax system*. Pollution charges have the attractive property of creating incentives to reduce pollution and therefore improve the environment. Pursuing this goal offers the possibility to simultaneously improve the environment and the economy; this is the so-called "double dividend";

- *Emission reduction*. Because polluters may be expected to respond to the incentives for abatement provided by an appropriately designed system of pollution charges, it is possible to use charges to target an aggregate level of reduction in emissions. The advantage of using such an "economic instrument", as to opposed to merely directing each polluter regarding necessary pollution reductions or equipment to use, is that total pollution reductions are achieved much more cheaply.

For each charge level which the MEP sets, polluters will decide whether they prefer to reduce pollution by some amount or pay the tax on those emissions. If enforcement is effective and rates are high enough, polluters therefore will have strong incentive to seek out information regarding and then implement low-cost pollution abatement measures (i.e. those with extra costs less than the charge rate) so they can reduce their tax burdens.

5.9. Further Research and Information Needs

In future, it is necessary:

- to update the assessment methods and registration of eroded soils;
- to draft programs of agricultural conversion in eroded areas and raise relevant state funds for their implementation.

The design of landscape and reclamation management has to be renewed. On the basis of these designs, a part of the lands should regain natural status (land around lakes, peat-bogs, etc.), or allocate funds for the maintenance, repair and reconstruction of the rest of them. After the transition period, the ownership system has to be changed, i.e. part of the lands has to be privatized.

5.10. Climate Mitigation Measures

Title of the project	*Reference amount of energy being saved TJ/thous.t/yr. / CO_2 thous.toe*
I. ENERGY	
1. Investigation on implementation of energy saving programs	
2. Complete utility scheme of the Neris river for energy production	1600/40/122
3. Complete utility scheme of the Nemunas river for energy production	3600/90/276
4. Pilot project of Klaipëda geothermal energy plant	2400/60/184
5. Modernization program for burners, control of burning parameters	4000/100/306
6. Conversion of boilers for indigenous fuel	3200/800/2.454
7. Wind energy	800/20/61
8. Solar energy	200/5/15
9. Production of biofuel	800/20/61
10. Small hydroenergy	160/4/12
11. Use of local construction materials and technologies for construction and thermal insulation of residential, industrial, municipal and agricultural edifices	1600/400/1227
12. Possible employment of biogas reactors in water treatment stations and agriculture	1200/30/92
13. Quality standards of oil production	
II. TRANSPORT	

14. Study on dislocation of parking lots and rational transport organization in city centers	
15. Preparation of transport fuel standards and system of quality standards for exhaust gases from transport in accordance with the EU standards	
16. Assessment study of possible fuel option for road transport	
17. Development and modernizing of Klaipëda port infrastructure (Ro-Ro, container, passenger ferry friable freight terminals, rehabilitation of the gates to the port, development of the infrastructure on the crossing the borders, modernizing of the terminal for oil export)	240/5.1/16
18. The first stage of "Via Baltica" project (rehabilitation of separate routes and hard - surfaced coating - 117 km the layout of roundabout ways - 31 km)	130/2.8/9
19. Reconstruction of the rolling stock in urban and interurban coach fleets, purchasing of trolley - buses	150/3.2/10
III. INDUSTRY	
20. Introduction of stock-taking accounting and taxes for CO_2 emissions in industry and energy	
21. Hazardous waste treatment in Lithuania	
22. Utilization of secondary raw materials and waste	
23. Development of forestry and reconstruction of wood and timber industry	
IV. AGRICULTURE AND FORESTRY	
24. Implementation of pilot project for reconstruction of traditional agriculture to sustainable and organic in Karst Region of North Lithuania (Birþai, Pasvalys regions)	
25. Preparation of program on control and reduction of GHG emissions in agriculture in Lithuania	
26. Program on enhancement of afforested areas by greenery planting on long-fallow and other unused lands caused by the reform	

6. IMPLEMENTATION OF THE UNFCCC

6.1. Introduction

One of the most significant goals of the National Implementation Strategy of the United Nations Framework Convention on Climate Change is to lay the basis for the country's policies and measures in reference to climate change.

When working out the development plans for Lithuania and strategies for the basic sectors of economy (energy, transport, industry, agriculture, and forestry), institutions should integrate climate change issues into them.

6.2. Implementation of Policies and Measures

The strategy's action plans should be reviewed every year on the basis of:

- new development plans for the sectors of Lithuania's economy,
- changes in legislation framework,
- the state-of-art data on climate change,
- the environmental policy and directives of the EU,
- further development of the UNFCCC,
- the funds allotted for the implementation of the program,
- public awareness on environmental policy.

In addition to that, the country team will refer to the expert opinion.

On January 25,1995, the Government of the Republic of Lithuania approved the State Investment Program for 1995-1997. This program is annually updated and appended. The program presents general and investment priorities in sectors of Lithuania and directions for potential sponsors and donors, seeking to financially support Lithuania. Priority sectors for the state investments are sectors of energy, transport and environmental protection.

While preparing proposals for investment projects and making up the investment program, these requirements should be taken into consideration:

- project estimates should be economically well grounded,
- project proposals should be prepared in accordance with set procedures, indicating the objectives and the background of the project,
- projects should be prioritized, describing the criteria employed for the selection.

Important criteria in selecting projects for financing should be a considerable reduction in the emission of greenhouse gases, cost-effectiveness, etc.

Environmental strategy recommends to set up an investment fund for the environmental protection. This fund presents a financial support for enterprises that would enable them to invest into cost-effective measures for saving resources and decreasing pollution.

6.3. Building National Capacity and Institutions

For the effective execution of the National Implementation Strategy of the UNFCCC, it is necessary to ensure planning and coordination of the actions of all state and municipal institutions as well as feedback to specify and update the means foreseen by the strategy. That calls for resolved joint actions of state, municipal and research institutions and NGOs. The role of the Ministry of Environmental Protection in coordinating activities is unique, but it is necessary to enhance the actions of all state and municipal institutions in authority to deal with environmental protection matters and issues.

During the CC:TRAIN program, energy and transport specialists as well as representatives from environmental protection and research institutions participated in training seminars and workshops. They applied the acquired knowledge while working out the strategy. Further financial possibilities will be sought for participating in seminars and conferences. The acquired knowledge will be shared with local specialists during local seminars and workshops. Publications and reference on climate change are accumulated at the Ministry of Environmental Protection and can be available for everyone involved.

For the implementation of the strategy it is necessary:

- to prepare action plans on the basis of the strategy,
- to ground the amount of necessary capital to ensure the financing of the foreseen means and measures,
- to ensure the timely implementation of the foreseen means and measures,
- to choose executive authorities of the foreseen means and measures,
- to control the implementation of the program and the utilization of the funds.

The implementation of the actions will be coordinated by the National Committee for the implementation of the UNFCCC, and the working unit will be the country team, constituted of different ministries, research institutions and non-governmental organizations.

The country team shall control the implementation of the program. In future, the strategy would be regularly revised, taking into consideration the state-of-art information on climate change issues, and also seeking to adjust it to the changing environment, economic, political and social conditions.

6.4. Further Development of Lithuania's National Program

The national implementation strategy of the UNFCCC is the first step in evaluating country's impact on climate change, adaptation to it and foreseeing means and measures for climate change mitigation. Still there are some unsettled questions. Therefore, in future when new information and broader scientific knowledge on climate change is acquired and means and mitigating means and measures on climate change are adopted, the national program should be revised and enhanced. Further development of the Program will depend on how fast new data is gained and how the UNFCCC itself will advance.

The National Implementation Strategy on Climate Change was prepared by using the data and research carried out in Lithuania and strategy development methodology proposed by the UNITAR.

6.5. Public Awareness and Education

6.5.1. Role of NGOs and Private Sector

When implementing the national strategy of the UNFCCC in Lithuania, the Green Movement of Lithuania together with other non-governmental environmental organizations single out these fields of activities as priorities:

- green consumption, environmentally-friendly mode of life;
- ecological education and public awareness;
- transport;
- energy;
- management and development of coastal zones;
- water resources;
- ecosystems and animate nature;
- link between the UNFCCC and other environmental issues;
- formation and implementation of priorities of the Lithuanian National environmental policies.

6.5.2. Education

Lithuania still lacks programs on climate change issues for students of both higher, special high and secondary schools. Elementary knowledge on ecology is included into the curriculum of biology, chemistry, though not fully integrated and comprehensive.

When implementing the UNFCCC in the Lithuanian education system, first of all it is necessary to identify target groups, establish priorities, develop specially adapted curricula for schools as well as guidelines and manuals.

The main target groups may be prioritized as follows:

1. Research and education institutions:

teachers of ecology and environmental protection in senior forms of secondary, special high and higher schools; instructors of upgrading courses for teachers; instructors and teachers of upgrading courses for employees of governmental institutions and departments; students studying environmental sciences, forestry, energy, transport, management of economics, agriculture, biology, water management in higher and special high schools; pupils of senior forms of secondary schools where teaching of natural sciences is enhanced

2. State and management institutions of all levels (governmental/ county/ local administration):

state officials and employees, working in B category governmental/ county/ local administrative institutions in sectors for environmental protection, energy, transport, agriculture, forestry, water management and municipalities, as well as members of respective commissions in local municipal councils who prepare and make decisions.

3. Sector of economics:

environmental protection officials, working in all enterprises without respect to their ownership; bank employees and experts, analyzing and approving business plans for economic activities that influence the environment; employees of environmental consultancy companies, environmental experts.

6.5.3. Public Education and Awareness

The key priority in Lithuania is to form a public comprehension of climate change issues, factors encouraging climate change, possible negative impacts on Lithuania and the world, possible mitigation means and measures.

A part of the state funds for the implementation of the UNFCCC and a part of the environmental funds of the MEP and municipalities for public education and awareness on climate change issues should be allocated. NGOs activities, related to public education and awareness on climate change should be financed by these funds as well.

6.6. International (Regional) Cooperation

International cooperation of Lithuania with neighboring countries on climate change issues and considerations is an important means for the implementation of the UNFCCC commitments. Lithuania, being a small country with limited financial resources, at present needs foreign assistance. Lithuania possesses powerful research and practical capacities working on climate change issues. The fact that this strategy has been prepared by local specialists proves it. Still, there are weak points, e.g. modeling and simulations of climate change or preparation of GHG inventory, etc. where we lack experience. We could gain expertise at seminars and workshops organized by the US country studies program. Similar workshops are also organized in Czech Republic, Holland and Scandinavian countries.

Since the Baltic States are close in climatic, economic and social respect, it is necessary to promote cooperation among them. Present relations between appropriate responsible institutions are not sufficient. In future it is necessary to:

- organize workshops and seminars to consider regional problems,
- swap specialists to gain experience,
- arrange training seminars with visiting specialists from other regions of the world,
- prepare joint programs on climate change issues.

6.7. Participation in the UNFCCC Negotiations

Lithuanian participates in the UNFCCC negotiations. The country also took part in both Conferences of the Parties. We participated as observers in COP I (Berlin). The Convention Secretariat assists our participation in the UNFCCC negotiations by covering our costs from a special fund. Unfortunately, at present there is no financial possibility to fund the participation of several Lithuanian experts in the UNFCCC negotiations. Due to this reason, our participation in the talks is not full value, since the negotiations are arranged simultaneously on different topics and in separate working groups. In future, new possibilities for enabling more representatives from Lithuania to participate at the negotiations, for having at least a representative in a working group should be investigated.

6.8. International Financial Support

Lithuania has limited financial resources. Therefore, it is unrealistic to expect financing and , consequently, successful implementation of all policies and measures listed in the Strategy. Therefore, Lithuania should secure available international financial support. The main financial resource to cope with climate change issues is the Global Environmental Facility (GEF). There is a contact person for GEF at the Ministry of Environmental Protection. Projects for international financial support, approved by the National Committee for the implementation of the UNFCCC, are to be submitted to GEF through the coordinator.

The relationship between the country team and the GEF coordinator should be very close. The coordinator should inform the team about key GEF policies and documents, project presentation terms, etc. Country team through its representatives should inform respective state and non-governmental institutions. Country team is also responsible for the preparation of projects. Apart from GEF, other financial resources should be sought -- bilateral cooperation could be an example of such resource.

ANNEX 1

ABBREVIATIONS

CC	*climate change*
CC:TRAIN	*Joint program of the UNFCC/UNITAR for training and research on climate change issues*
CGC	*Center for Global Change*
CHP	*combined heat and power*
CORINAIR	*CORINE AIR Emissions Inventory (EU)*
DENEC	*Development of Efficiency in National Energy Consumption*
ECE	*United Nations Economic Commission for Europe*
EMEP	*Protocol to the 1979 Convention on Long-range Transboundary Air Pollution on Long-term Financing of the Co-operative Program for Monitoring and Evaluation of the Long-range Transition of Air Pollutants in Europe*
EMP	*Environmental Protection Ministry*
EU	*European Union*
GCTE	*Global Change and Terrestrial Ecosystems*
GEF	*Global Environmental Fund*
GHG	*greenhouse gasses*
GWP	*Global Warming Potential*
HOB	*heat boilers*
HPP	*hydropower plant*
IEA	*International Energy Agency*
IGBP	*International Geosphere-Biosphere Program*
INC/FCCC	*Intergovernmental Negotiating Committee under the FCCC*
IPCC	*Intergovernmental Panel on Climate Change*
ISO	*International Standard Organization*
MEP	*Ministry of Environmental Protection*
NEPP	*National Environmental Policy Plan*
NES	*National Energy Strategy*
NGO	*non-governmental organizations*
OECD	*Organization of Economic Cooperation and Development*
PSO	*Program on Cooperation with Eastern Europe*
SNPP	*state nuclear power plant*
SWRRBWQ	*mathematical simulation model for prediction of dispersed agricultural contamination*
UNCED	*United Nations Conference on Environment and Development*
UNDP	*United Nations Development Program*
UNEP	*United Nations Environment Program*
UNFCCC	*United Nations Framework Convention on Climate Change*
UNITAR	*United Nations Institute on Training and Research*
USSR	*the Union of the Soviet Socialist Republic*

ANNEX 2

CHEMICAL SYMBOLS

C	carbon
CH_4	methane
CO	carbon monoxide
CO_2	carbon dioxide
N	nitrogen
N_2O	nitrous oxide
NO_x	nitrogen oxides
NMLOJ	non-methane volatile organic compounds
O_3	ozone
SO_2	sulfur dioxide

ANNEX 3

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