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The Government of the Slovak Republic adopted the First National Communication on Climate Change on 23 May 1995.

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Slovak Republic

THE FIRST

NATIONAL COMMUNICATION

ON CLIMATE CHANGE

UN Framework Convention on Climate Change

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Contents

Contents

Executive summary

1. Introduction

Climate Change, caused by increasing anthropogenic emission of greenhouse gases (CO_2, CH_4, N_2O, CFCs, etc.), represents the most serious environmental issue in the history of mankind. The UN Framework Convention on Climate Change (FCCC) is the first binding international legal instrument to address this issue. The ultimate objective of this Convention is to achieve stabilisation of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system. Such a level should be achieved within a time-frame sufficient to allow ecosystems to adapt naturally to climate change, to ensure that food production is not threatened and to enable economic development to proceed in a sustainable manner.

The Convention entered into force for the Slovak Republic on 23 November 1994. The Slovak Republic accepted the particular obligations resulting from the Convention, including the commitment to take measures aimed at returning emissions of greenhouse gases to the base year (1990) level by the year 2000. The Slovak Republic will undertake all activities to achieve the "Toronto target" (20% CO_2 emission reduction in 2005 compared to 1988).

The First Slovakia's National Communication submitted contains all current information concerning FCCC implementation process in Slovakia. This Communication was elaborated according to the INC/FCCC guidelines.

2. National circumstances

The Slovak Republic is an independent state since January 1st, 1993 as a result of splitting the former Czech and Slovak Federal Republic. The new Constitution of the Slovak Republic was adopted on September 1, 1992. The President of the Slovak Republic is the head of the State. The Parliament is the supreme organ of State power and legislative authority. It has 150 deputies. The Government of the Slovak Republic is directed by the Prime Minister and it has 15 ministers. The legislative process is a combined effort of Ministries, Government and Parliament. The Slovak Ministry of the Environment, district environmental offices and municipalities are executive authorities concerning environment (Act 595/1990). Slovakia is one of the Central European Countries undergoing the process of transition from a central planned economy to a market economy. Transformation of the whole economy together with disintegration of the Common East European market have caused a deep depression of industrial production and substantial decrease in the Slovak GDP.

Slovakia lies at the heart of Europe. The area of the country is 49,036 km^2, including agriculture land (24,471 km^2), arable land (14,860 km^2), forest land (19,911 km^2), water area (940 km^2) and built-up areas (1,275 km^2). Slovakia is a mountainous country, 60% of its territory is over 300 m a.s.l. Slovakia is in the mild climate zone. The average annual precipitation for the whole country of Slovakia is 743 mm, 65% of this is evaporated and 35% represents runoff.

A temperature increase of about 1°C and precipitation decrease of about 10-15% were observed during the last 100 years.

The population of Slovakia has grown from 3 million inhabitants in 1920 to 5.3 million in 1992. The highest natural population increment (over 1.7%) occurred in 1950, while in 1992 it was 0.4%.

Slovakia is an industrial country. The industry and construction share of GDP represented over 50% in 1991. High demand for energy and raw materials (production of iron, steel, aluminium, cement, fertilisers, plastic materials, etc.) is the characteristic feature of the Slovak economy. However, there is a shortage of domestic sources of high-quality raw materials (excluding non-ore material and magnesite).

Agriculture and forestry in Slovakia employed about 250,000 people in 1992, which is equivalent to 4.7% of the population. The per capita acreage of 0.46 ha of farmland is relatively small. During the first years of economic transformation no significant changes in crop production were registered, but all forms of animal production dropped significantly. The forest is one of Slovakia's most important natural resources and is the basis for the forest industry. In 1991, Slovak timber resources represented 352 million m^3.

Slovakia, a typical inland country, is situated on the "roof" of Europe. Therefore its natural water resources are limited. Average discharge of 405 $m^3.s^{-1}$ results from runoff. During the last several decades a significant decrease of Slovak rivers discharge has been observed. Several regions of Slovakia exhibit a considerable soil moisture deficiency. More than 800,000 ha of arable land need irrigation.

3. Inventory of greenhouse gas emissions

The Slovak Republic's share of global anthropogenic greenhouse gases emission is approximately 0.2%. Annual per capita CO_2 emission cca 11 tonnes in 1990 is lower than the OECD countries average, nevertheless it places Slovakia among the 15 states with the highest per capita emissions.

CO_2 emissions

The primary sources of atmospheric CO_2 in Slovakia is fossil fuel combustion. Cement (lime) production is another important source. Changes in land use and forestry generally act as a sink for CO_2. While the combustion of fossil fuels accounts for about 94% of total Slovak CO_2 emissions, CO_2 also results directly from industrial processes. Table 1 shows the total CO_2 emissions and removals in Slovakia in 1988 and 1990.

Approximately 83% of energy in the Slovak Republic is produced through the combustion of fossil fuels. The remaining 17% comes from other energy sources such as nuclear energy, hydropower or renewable sources.

Table 1

Total CO_2 emissions and removals in 1988 and 1990

	1988	1990
National CO_2 emissions (Gg)		
Total emissions	61 484	58 278
National CO_2 removals (Gg)		
Land use change	3 938	4 451

Table 2

Breakdown of energy balance and energy related CO_2 in 1990

Fuel combustion activities	(PJ)	CO_2 emission (Gg)
Energy		15 679
Commercial/Institutional		6 153
Residential		6 384
Industry		21 155
Transport		3 628
Agriculture/Forestry		2 034
Total	**764.93**	**55 033**
Solid	**344.35**	**32 184**
Liquid	**196.76**	**11 011**
Gaseous	**223.82**	**11 838**

Feedstocks and Carbon Storage
Total volume of carbon stored in products (pitch oil, tar, petrochemical crude oil products, industrial fertiliser) in 1990 was specified as 1064 Gg C according to the IPCC method, and 736 Gg according to the national method

CO_2 removals
The Slovak Republic's area is 49,036 km^2, including 41% forest land. The land use has remained fairly constant over the last century. In the same period, meadows and pastures have been converted to arable land. "Forestry and land use change" in our territory remains a sink of approx. 4,451 Gg of carbon dioxide/year.

Trends
It is rather hard to evaluate the CO_2 emission trends, because generally only data from 1990 are available. In general, CO_2 emissions were increasing until 1988, after 1990 they began to decrease. It is assumed that this trend will continue after 1993 as a consequence of economic depression.

CH_4 emissions

In Slovakia, the major sources of methane are represented by agriculture (livestock farming and manure), fuel extraction (brown coal), transport (natural gas network) and waste treatment.

N_2O emissions

A complete list of N_2O sources and emissions has not yet been developed for the Slovak region. It was not possible to quantify some of the sources and some remain hidden. N_2O emissions are caused by excess mineral nitrogen in the soil as a consequence of intense fertilisation and of unfavourable air regime of soil (the use of heavy machinery during cultivation).

Other gases

CFCs and HCFCs emissions are not known, only data on their consumption are available, their use is controlled within the Montreal Protocol. The major NO_x and CO sources are power engineering and transport. Metallurgy is also an important source of CO emissions. Anthropogenic emissions of NMVOC were specified within the implementation of the Protocol on NMVOC emissions reduction in the Slovak Republic. The application of paints and solvents together with extraction, transport, processing and use of crude oil and its products are the major sources.

Aggregated emissions

The values of aggregated emissions consider both primary and secondary contribution of greenhouse gases according to the IPCC methodology (IPCC 1994, GWP 100 yrs). CO_2 emissions contribute 81% of the total emissions, CH_4 emissions contribute 12% and N_2O emissions 7% (expressed as the CO_2 equivalent).

Table 3
CH_4 emissions (Gg) in 1988, 1990, 1993

	1988	1990	1993
Fossil fuel combustion		21	
Fugitive emissions		96	
Agriculture	188	172	112
Waste treatment	50	53	58
Forest ecosystems	(5)	5	(5)
Total		**347**	

Table 4
N_2O emissions (Gg) in 1988, 1990, 1993

	1988	1990	1993
Fossil fuel combustion		3.8	
Industrial processes	2.0	2.1	1.1
Agriculture	(10.0)	8.8	3.6
Water surfaces	1.3	1.3	1.3
Total		**16.0**	

Table 6

Aggregated emissions considering direct and indirect effects of CO_2, CH_4 and N_2O emitted in 1990

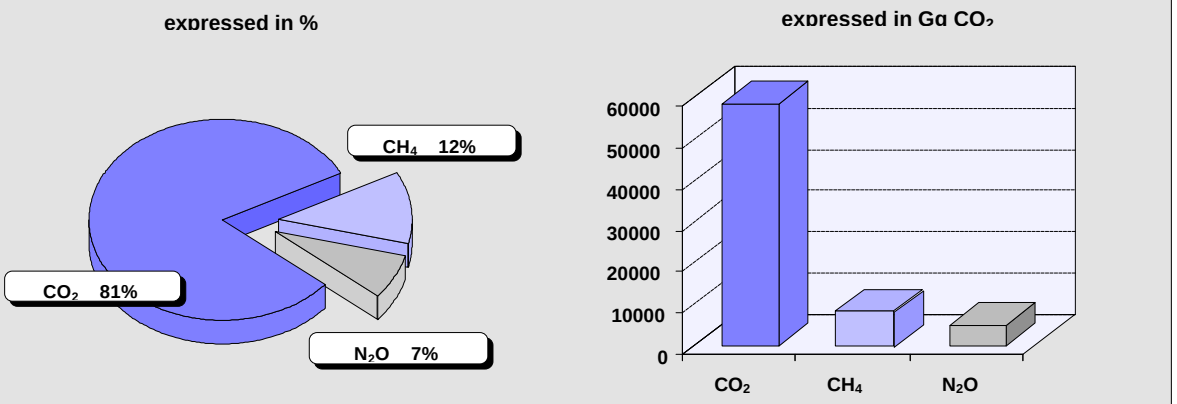
(aggregated emissions were calculated from emission data rounded to Gg)

	CO_2	CH_4	N_2O	Aggregated
	(Gg)	(Gg CO_2 equivalent)		
Energy/heat generation, Transport	55 033	515	1 216	56 764
Fugitive emissions	NE	2 352	NE	2 352
Industry	2 775	NE	672	3 447
Agriculture	NE	4 214	2 816	7 030
Forestry	(-4 451)[1]	122 [2]	416 [3]	538
Waste treatment	470	1 299	NE	1 769
Total	**58 278**	**8 502**	**5 120**	**71 900**

[1] *carbon sinks are not included in total CO_2 emission* [2] *emissions from wetlands* [3] *emission from watersurfaces*

Figure 1

Aggregated GHGs emissions



4. Programs and measures resulting in the reduction of greenhouse gases emissions

Climate change - Strategy and policy

The Slovak Republic has not yet adopted a national policy relevant to climate changes. Similarily there is no integral systematic program for the reduction of greenhouse gases emissions or enhancement of sinks. In a relatively short time during the period of political and economic transformation of the society and the development of a new state a range of acts, regulations and measures, indirectly related to greenhouse gases emissions reduction or enhancement of sinks, was adopted. In addition several research projects linked with climate change were finished or are being prepared.

The First National Communication introduces a survey of relevant activities originally devoted to other goals but indirectly linked to greenhouse gases emission reduction. It will represent an effective instrument for the implementation of the Framework Convention on Climate Change until the national policy directly related to greenhouse gases emissions is adopted.

Within the framework of the Slovak Republic´s Country Study, a proposal for climate change policy and an action plan will be developed. After its adoption by the Government of the Slovak Republic it will represent a consistent national policy on climate changes. This policy will be presented in the Second National Communication.

Strategy and measures to reduce CO_2 emissions

Because the historical development of the economy of the Slovak Republic has been energy intensive, the attention should be focused on seeking possibilities for the improvement of energy utilisation efficiency. Most of the important measures which result in energy savings are directly linked with CO_2 emissions reductions as a considerable share of energy in Slovakia is obtained from the combustion of low grade fuels.

The development of the economy of Slovakia before 1989 was substantially based on heavy industry with high energy intensity. The national economy restructuring needs an effective energy conservation policy.The following items should be taken into consideration:

- domestic energy sources to cover the total consumption represent only cca 10% (1990)
- the consumption of primary energy sources per capita is very high (178 GJ-1990).

The fundamental document for energy sector development is Energy Strategy and Policy of the Slovak Republic up to the year 2005. In this document the national target of CO_2 emissions reduction is defined directly, as follows

20% CO_2 emission reduction in 2005 compared to 1988

The Energy Policy is based on the following key assumptions:

- substantially higher use of natural gas for electricity and heat cogeneration in combined cycles,
- implementation of fuel and energy efficiency programmes,
- increasing use of renewable energy resources (mainly biomass and geothermal),
- reconstruction of the two largest Slovak fossil fuel power plants (fluid combustion, desulphurisation and denitrification),
- exploitation of the hydroenergetic potential of the Slovak Republic up to 65%,
- completion of all four units in the Nuclear Power Plant Mochovce (4 x 440 MW),
- to close V1 NPP operation in Jaslovské Bohunice (2 x 440 MW) within one year after commissioning and full power operation of the first two units of NPP Mochovce.

Fulfilment of the above assumptions will result in a significant decline in energy produced from the combustion of fossil fuels (mainly low grade coal), directly ensuring a significant CO_2 emission abatement.

Legislative instruments, economic tools and other measures with direct and indirect effects on GHGs emission are summarised in the following review. Details are given in Chapter 4.

I. Measures fully or partly implemented

Energy sector

- Act No. 89/1987 on production, distribution and consumption of heat
- Act No. 88/1987 and No. 347/1990 on Energy Inspectorate
- Act No. 316/1993 on consumption tax
- Price liberalisation of energy and fuels
- Information campaigns
- Training and education
- Demonstration projects
- Program supporting the economic activities resulting in savings of energy and imported raw materials

- Program supporting the building of renewable energy sources

Residential and service sectors

- Program of additional insulation and removal of defects in apartment houses
- Program of energy consumption reduction in apartment and family houses

Transport sector

- Act No. 316/1993 on consumption tax on hydrocarbon fuels and lubricants
- Act No. 87/1994 on road tax
- Inspection of vehicles in use (Act No. 309/ 1991)
- Establishment and development of combined transport (Governmental Decisions Nos. 833/1992 and 644/1991)
- Lowering of ineffective transport in municipal agglomerations
- Preference of electric to diesel railway transport
- Use of alternative fuels

Cross sectoral measures

At present the most important indirect legislative instrument to reduce the CO_2 emissions is represented by effective air protection legislation :

- Act No. 309/1991 on the protection of the air against pollutants
- Decree of the Slovak Commission for the Environment No. 407/1992 on emission standards
- Act No. 134/1992 on the state administration of air protection
- Act No. 311/1992 on charges for air pollution
- Act No. 128/1992 on state fund for the environment
- Decree No. 176/1992 on conditions for providing and use of the financial means from state fund for the environment
- Information materials - energy savings, renewable sources

II. Measures considered for the future

Energy sector

- Act on energy management
- Principles of regional energy policy
- Institutional building of project identification and implementation to reduce the greenhouse gases
- Establishment of a fund to increase energy efficiency
- Energy audits
- Demand side management
- Labelling of Appliances
- Legislative regulation on using of waste heat in industry

Residential and service sectors

- Standardisation of heat insulation of buildings

Transport sector

- Optimisation of motor-car traffic in cities
- Municipal charges
- Tax on motor-cars
- Preference for public transport
- Lowering of permissible speed
- Development of cycling
- Education

Measures to reduce the emissions of other greenhouse gases

I. Measures fully or partly implemented

METHANE

Waste management

- Program on waste management
- Act No. 239/1991 on waste
- Ordinance of the Slovak Government No. 605/1992 on keeping evidence on waste
- Ordinance of the Slovak Government No. 606/1992 on waste treatment
- Act of the Slovak National Council No. 309/1992 on charges for waste disposal
- Economic instruments to improve waste management

Agriculture

- Act No. 307/1992 on the protection of farmland
- Act No. 61/1964 on development of crop production

- Directive of Ministry for Agriculture and Nutrition of the Slovak Republic No.5001/ 1982 on manipulation with and utilisation of liquid manure and liquidation of ensilage juices
- Ordinance of the Government of the Slovak Republic No. 606/1992 on Waste Treatment

NITROUS OXIDE

Agriculture

- Act No. 307/1992 on the protection of farmland
- Act No. 61/1964 on development of crop production
- Directive of Ministry for agriculture and nutrition of the Slovak Republic No. 5000/ 1982 on water protection against agricultural contamination
- Directive of Ministry for agriculture and nutrition of the Slovak Republic No. 5001/ 1982 on manipulation with and utilisation of liquid manure and liquidation of ensilage juices.

II. Measures considered for the future

METHANE

Waste management

- Updating of legislative measures
- Technical standards implementation

Energy sector

- Implementation of measures to lower the leakage of natural gas from gas-piping system including local distribution network

NITROUS OXIDE

Agriculture

- Codex on quality assurance in agricultural practice
- Action plan for the reduction of water nitrate contamination
- Methodology of special agriculture practice in areas of hygienic protection of water sources and in polluted areas

Volatile organic compounds and carbon monoxide are not radiatively active gases but they indirectly support the greenhouse forcing. The Government of Slovak Republic decided to accede to ECE UNO Protocol on the reduction of volatile organic compounds emissions (30% reduction by the year 2000 compared to the year 1990). Ratification of this Protocol in the Slovak Parliament is expected during 1995. Further measures to reduce VOCs and CO result from effective air pollution legislation (emission standards, BATNEEC, charging of polluters, three-way catalytic converters, etc.).

Afforestation of 50,000 ha governmental non-forest land not suitable for agricultural utilisation is expected by the year 2000.

5. Projection and assessment of effects of measures

The estimation of future trends in greenhouse gases in a country with an economy in transition is complicated by the process of economy restructuring. In the First National Communication the largest emphases have been given on energy related CO_2 production. Non-energy related CO_2 projection is primarily based on the future development of lime and cement production. The other GHGs emission projection is estimated on the assumption of additional development of the agricultural and forestry sectors as well as on the future development of waste management.

Energy-related CO_2 emission projection

The energy-related CO_2 emission projection is based on the *Energy Strategy and Policy of the Slovak Republic up to the year 2005*. The following measures have been considered in this energy policy:

- The share of natural gas will increase for end use of energy as well as in the electricity generating process (the installation of new combined cycles facilities). The latter represents the impact of new environmental legislation.
- The 31.5 PJ decrease in fossil fuel consumption using energy conservation measures is considered for the year 2005.

- The new nuclear power plant Mochovce will be put in operation.
- The increasing share of renewable energy sources in national primary energy balance.

Considering these measures, the solid fuel consumption will decline between 1990-2005 by 36.1% and liquid fuels by 10.4%. This energy consumption decline will be offset by increasing gaseous fuels consumption by 38.1%, biomass consumption by 21.9% and by the increasing share of primary nuclear heat by 48.5%. Due to the decline in fossil fuel consumption as well as due to the change of fuel types a CO_2 decrease in the year 2000 of 15.7% from the base year is expected. This fact is important concerning meeting the FCCC requirements of GHGs stabilisation, because energy related CO_2 represents 94% of the domestic emission total in 1990. The total CO_2 projection, based on the *Energy Policy* is summarised in Table 7.

Table 7

Energy-related CO_2 emission projection [Gg/year]

Fuels	1990	1995	2000	2005
Solid	32 185	24 335	22 314	20 576
Liquid	11 010	10 219	10 518	11 060
Gaseous	11 839	11 669	13 541	16 351
Total	**55 033**	**46 223**	**46 373**	**47 987**

The National Target of Slovakia is to reduce the energy-related CO_2 emission in period 1988-2005 by 20%. The energy demand scenario from the *Energy Policy* projects a fossil fuel consumption increase in 2005 due to the national economic revival and a progressive increase of GDP in this period. In this case the projected CO_2 decline between 1988-2005 will be only 17.6%. In the *Energy Policy* only a minimal energy saving potential is considered (31.5 PJ). This document was prepared in 1993, therefore the new energy data from the transportation sector has not been incorporated in the energy balance. To achieve the National Target, the following scenarios of CO_2 emission have been assumed, considering the energy saving potential and new data from the transportation sector:

Scenario A Business as usual

Scenario B based on the *Energy Policy* (energy conservation 31.5 PJ in 2005) and the new data from transportation sector.

Scenario C Scenario B, 10% reduction of CO_2 emission in the transportation sector, energy conservation 50.2 PJ in 2005

Scenario D Scenario C, the energy conservation 126 PJ in 2005 (full energy saving potential).

Table 8

Energy-related CO_2 emission projection scenarios [Tg]

Table 9

Non-energy related CO_2 emission production [Gg]

	1988	1990	1995	2000	2005
Cement	2 005	1 853	1 467	1 565	1 956
Lime	473	451	303	316	355
Magnesite	522	471	362	385	472
Total	**3 000**	**2 775**	**2 132**	**2 266**	**2 783**

The individual scenarios are summarised in Table 8. It is obvious, that at assuming the business as usual energy consumption development, as represented by Scenario A, the CO_2 emission level in 2000 will not exceed the level 1990. It is important from the point of view of FCCC commitment to stabilise GHGs emission until 2000. The National Target will be achieved under Scenario B.

Non-energy related CO_2

Using the cement, lime and magnesite production data the non-energy related CO_2 emission projection was estimated (Table 9).

Emission of other GHGs

The emissions of other GHGs (CH_4, N_2O) have been balanced on the projected activity data from the power industry, industrial processes, agriculture, forestry and waste management (Table 10 and 11).

Table 10

CH_4 emission projection [Gg/year]

	1990	1995	2000	2005
Landfills	53	51	51	51
Agriculture	172	140	130	130
Combustion	21	18	18	18
Fugitive emission	96	88	94	102
Total	**342**	**297**	**293**	**301**

Table 11

N_2O emission projection

	1990	1995	2000	2005
Biomass combustion	3.8	3.2	3.2	3.3
Agriculture	8.8	3.6	8.8	10.0
Industry	2.1	1.2	2.1	2.1
Total	**14.7**	**8.0**	**14.1**	**15.4**

Table 12

Aggregated emission projection of GHGs expressed as CO_2 [Gg] (GWP-IPCC 1994, 100 years)

	1990	1 995	2 000	2005
CO_2 enegy related	**55 033**	**46 223**	**46 373**	**47 987**
CO_2 non-enegy related	**2 775**	**2 132**	**2 266**	**2 783**
CH_4	**8 502**	**7 390**	**7 295**	**7 495**
N_2O	**5 120**	**2 978**	**4 917**	**5 333**
Total	**71 430**	**58 723**	**60 851**	**63 598**

Aggregated emission projection

Table 12 illustrates the aggregated emission projection of GHGs (expressed as CO2). Scenario B for energy-related projection of CO2 emissions was applied. CO2 emissions from the waste incineration was not included.

6. Vulnerability to climate change and adaptive strategies

The climate in Slovakia is influenced predominantly by its position in Central Europe, by the topography of the Western Carpathian Mountains and the Alps and by preailing westerly zonal atmospheric circulation. The period from the 15th July to the 15th October is relatively dry in the South of Slovakia. Southern and southwestern Mediterranean cycloes cause heavy precipitation in the south and east half of Slovakia mainly from October to December and in May and June in some years. On the other hand, the western and north-western atmospheric currents bring preipitation predominantly to the mountains in western and northern Slovakia. Any change of atmospheric circulation may significantly affect the descried simplified scheme of climate conditions over the entire country of Slovakia. Projected waring of the climate may change the climate in Slovakia toward higher variability and this could change the limits for both natural ecosystems and socioeconomic activities.

From the historical climatic trends and variability analysist follow:

- trend of annual air temperature means from 1901 is significantly positive by about 1°C with maximum in the last 7-year period,
- trend of annual precipitation totals is significantly negative by about 90 mm in southern Slovakia with a minimum in the last 14-year period (decreasing trends of lesser magnitude have been found in Slovakia generally, but the trend is not significant in the northern mountains),
- trend of annual potential evaporation totals is significantly positive by about 125 mm in the south-west Slovakia with a maximum in the last 7-year period (trends from 10 to 15% have been found in other regions of Slovakia),
- trend of annual actual evaporation is decreasing in southern Slovakia with a minimum in the last 7-year period and increasing in the northern mountainous half of Slovakia where precipitation is comparable or higher than potential evaporation,
- values of calculated annual mean usable soil moisture is significantly decreasing mainly in south-western Slovakia by about 25% of the 1961-1990 means and by about 10-20% in the other regions,
- air temperature and precipitation trends are caused mainly by the change of climatic characteristics in the season from April to September,
- occurrence of exceptional monthly means and totals in the period 1981-1994 was more frequent than in the periods before 1981,
- in the mountainous part of Slovakia a great surplus of precipitation totals comparing potential evaporation occurred in the first three decades of this century, but after 1980 there was a similar deficiency of precipitation like the lowlands.

Assessments listed above clearly indicate trends toward higher aridity, predominantly in the southern part of Slovakia. The mean discharges of Slovak rivers have decreased by 10-30% (some smaller rivers in the South by more than 40%) since 1931.

Preliminary climate change scenarios

Scenarios of temperature rise by 1-2°C (in comparison with the means of the 1951-1980 period) are considered in accordance with GCMs (General Circulation Models) for the periods about the year 2025. Precipitation totals rise in winter and decrease in the vegetation period (April-September) by about 20% is expected (genenerally greater precipitation decrease is assumed in southern Slovakia). The mean relative air humidity will probably decrease year round (the greater decrease - about 6% - is expected in southern Slovakia in the spring months). Preliminary scenarios are presented in the Slovak National Climate Programme reports. More detailed development of climate scenarios is planned in the Country Study Project in 1995.

Climate change impacts and adaptation

Preliminary assessments, based on the present state of knowledge, existing climatic and hydrological trends and projected changes over the next decades have been estimated in the Slovak National Climate Programme Project and in other research projects in Slovakia. The results obtained are considered as a rough risk assessment only, but they are usable as a basis for framework strategies. Because of the progress of impact assessment in the hydrological cycle, forest ecosystems and partly in crop production, only these three sectors could be included into the First National Communication of FCCC implementation in Slovakia.

Hydrology, water resources and water management. According to simple model calculations (using preliminary climate change scenarios) the continuation of present trends (river discharges, ground water levels and spring yields decreases) is expected mainly in the southern half of Slovakia. This may negatively influence not only the water supply for the public, industry and agriculture, but also hydro-power plants and river transport systems use in Slovakia. Scenarios of about a further 20% decrease of

water resources were preliminary identified for the period 1990-2030.

Forest ecosystems. Based on regional climate scenarios (temperature, precipitation) as well as from concentrations of some gases in the atmosphere (greenhouse gases, photooxidants, etc.), it will be necessary to implement the following measures:

- acceleration of Norway spruce monocultures change to mixed stands of pine, oak, beech and the other broad leafed species,
- to preserve biodiversity of forest communities extensively in forest management,
- preparation of genetic material for the artificial regeneration to changed climate,
- reevaluation of forest management plans,
- to increase carbon dioxide fixation by afforestation of soils unused in agriculture.

Agriculture (crop production). Climate change impacts upon agriculture is very complex, partly positive, but mostly negative. Mitigation of negative impacts and utilisation of positive ones should be prepared for well in advance, because of the long-term nature of adaptation processes in agriculture systems and in agricultural ecosystems as well. The projected adaptive measures are as follows:

- change in crop cultivation technologies,
- change in agroclimatic regionalisation, and structure of crops and varieties cultivated,
- change in breeding objectives,
- change in plant protection,
- regulation of the water supply considering expected changes of the hydrological cycle,
- regulation of water and energy regimes of fields by mulching,
- improvement of soil fertility from the point of view of sustainable agriculture.

7. Joint implementation of FCCC commitments

Considering the joint implementation (JI) of the FCCC commitments, the position of the Slovak Republic is as follows:

- JI is economically effective as it allows the achievement of the maximum greenhouse gases emissions reduction at the lowest cost,
- the countries listed in Annex I should reach greenhouse gases emission stabilisation "at home", without the use of JI,
- JI is a voluntary activity under the responsibility of two or more Parties; such activity must be undertaken or accepted by the Governments concerned
- a three-year pilot phase, to gain experience, is recommended ,
- during the pilot phase, the credits do not yet apply,
- the criteria for the pilot phase should be flexible.

To ensure that the commitments of the Slovak Republic resulting from the Convention are meet effectively, a **National Panel for Collection, Evaluation and Implementation of Greenhouse Gases Emission Reduction Projects** is planned. In the Slovak Republic the joint implementation mechanism has not been applied to date.

8. Climate change research

Climate changes have been studied for a long time in research projects of the Slovak Hydrometeorological Institute, Department of Meteorology and Climatology at Comenius University and Geophysical Institute at the Slovak Academy of Sciences. Recently, the study of these issues has been initiated at the Institute of Hydrology of the Slovak Academy of Sciences, the Agriculture University in Nitra and the Forest University and the Forest Research Institute in Zvolen. National research programmes are listed below:

- National Climate Program of the Slovak Republic

- National Program of Greenhouse Gases Emission Reduction
- National Program to Reduce the Emission of Volatile Organic Compounds
- Hydrological regime changes as the result of global changes
- Slovak National Program to Stabilise And Reduce CO_2 Emissions in Transportation
- The Slovak Republic's Country Study to Address Climate Change (the 2nd round of US Country Study Programme)

These long-term programs were established and supervised by the Slovak Ministry of the Environment and are financed primarily from the state fund of the environment. More then twenty institutions are involved in this research. The Slovak Hydrometeorological Institute is the main research co-ordinator. Details can be found in Chapter 8. In the present economic situation costly technology research and development stagnates in Slovakia.Governmental funding is very limited and private sector interest is still absent.

9. Education and public awareness

Public awareness concerning climate change in the Slovak Republic is still low. An educational campaign, started in last three years, will be intensified. Great importance will be given to co-operation with non-governmental organisations. Special emphasis will be attached to communication among policymakers, researchers and the general public in order to improve general awareness, to support the feeling of political responsibility and to accelerate the FCCC implementation process.

CHAPTER 1

Introduction

Climate Change, the most pervasive and truly global of all issues affecting humanity, poses a serious threat to our environment. Potential impacts of the global warming on agriculture, water resources, energy, natural terrestrial ecosystems, and the social and economic sectors have generated calls for urgent responses by the international community to mitigate its effects. The UN Framework Convention on Climate Change (FCCC) is the first binding international legal instrument to address this issue. FCCC was signed in Rio de Janeiro in June 1992. The Convention entered into force the 21st of March 1994. FCCC represents the basis for further international co-operation in the field of global climate change. The ultimate objective of this Convention is to achieve stabilisation of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system. Such a level should be achieved within a time-frame sufficient to allow ecosystems to adapt naturally to climate change, to ensure that food production is not threatened and to enable economic development to proceed in a sustainable manner.

The Slovak Parliament ratified the UN Framework Convention on Climate Change in August 1994. The instrument of the ratification has been deposited on 25 August 1994 and thereafter the Convention came into force for the Slovak Republic on 23 November 1994. The Slovak Republic accepts the particular obligations resulting from the Convention, including the commitment to take measures aimed at returning emissions of greenhouse gases to the base year level by the year 2000.

This report sets out the Slovak Republic's approach for meeting the commitments under Articles 4 and 12 of the Convention. It represents the First Slovak National Communication to the Conference of the Parties. The communication contains all current information concerning FCCC implementation process in Slovakia and it was developed according to the INC/FCCC guidelines. The Communication expresses the political will of the Slovak Government to address the problem of Climate Change on the national basis. However, some special circumstances should be stressed:

- The Slovak Republic has been an independent state since January 1st, 1993, as a result of splitting the former Czech and Slovak Federal Republic. Therefore the economic transformation (started in the framework of the former Czech and Slovak Federal Republic before 1990) has occurring at the same time that the new state is being developed.

- The Slovak Republic is one of the Central European countries undergoing the process of transition from a central planned economy to a market economy. This transition is a unprecedented complex process involving a wide-range of legislative, administrative, financial, economic, technological and social restructuring activities. Since the beginning of the economic transition Slovak industrial production and consequently the GDP have decreased significantly. COMECON - the Common East European market has collapsed. In these non steady-state initial conditions all projections of the future contain a number of uncertainties.

- The transformation process in the Slovak Republic started before 1990. Therefore the data for 1990 do not reflect the realistic economic situation. In spite of this the Slovak Republic accepts 1990 as the base year. In this case Slovakia does not use its right to take advantage of a "certain degree of flexibility" mentioned in the Article 4.6 of the Convention.

- The Slovak Republic is the successor for all international environmental commitments ratified in the former Czech and Slovak Federal Republic.

- The Slovak Republic will initiate all activities to achieve the "Toronto target" (20% CO_2 emission reduction in 2005 compared to 1988).

- The Slovak Republic was included in the second round of US Country Study Programme to Address Climate Change.

The First National Communication of the Slovak Republic has been developed by the intersectorial committee with the assistance of other professional bodies and independent experts. This activity was co-ordinated by the Ministry of Environment of the Slovak Republic. The Slovak Government adopted the Communication on 23 May 1995.

Jozef Zlocha
Minister of Environment
of the Slovak Republic

CHAPTER 2

National circumstances

This Chapter contains a brief description of Slovak natural and economic conditions relevant to the presented Communication. It contains basic geographical data, climate profile, population development, economic characteristics and environmental information. The national legislative process and environmental policies adopted before the base year are outlined briefly.

2.1 Basic data

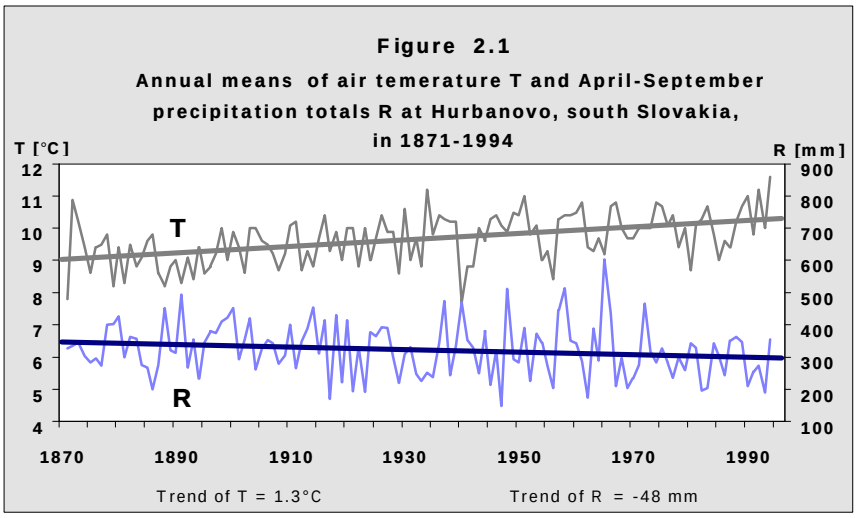
2.1.1 Geography

The Slovak Republic lies at the heart of Europe. It occupies the territory between the river Danube and the Tatra Mountains. The area of the country is 49,036 km^2 , including agricultural land 24,471 km^2 (50%), arable land 14,860 km^2 (30%), forest land 19,911 km^2 (41%), water area 940 km^2 (2%), built-up areas 1,275 km^2 (3%). Slovakia is a mountainous country. All Slovak mountains belong to the Carpathian system. The Danube and East-Slovakian lowlands are the northern parts of Panonian plains. 60% of Slovakia's surface is over 300 m, 15% over 800 m and 1% over 1,500 m a.s.l. The lowest point in Slovakia is 94 m a.s.l. and the highest (the Gerlach peak in the High Tatras) is 2,654 m a.s.l. The territory belongs to the Danube river drainage basin,only a small part in the north drains into the Baltic Sea. The Danube river is part of the boundary with Austria and Hungary. The major Slovak rivers are the Váh and the Hron. The capital of Slovakia, Bratislava, is located in the south-western part of the country close to the border with Austria and Hungary. Bratislava is the biggest Slovak city, the centre of political and cultural life and an important industrial centre and Danube river port.

2.1.2 Climate

According to the global climatological classification Slovakia belongs to the mild climate zone. A regular rotation of four seasons and variable weather throughout the year are typical for this country. Compared to the Czech Republic and Austria which lie more to the west, the climate in Slovakia has more continental features. Winters are colder by about 3 °C and summers are warmer by about 2°C. The above mentioned differences increase from the west to the east within the country. The average January temperature ranges from -1°C in the Danube lowlands to -12°C on the top of the Tatra Mountains. Average temperatures in July exceed 20°C in the Slovak lowlands, while at the elevations of 1000 m a.s.l. they reach about 14°C. Southern Slovakia receives about 2000 hours of bright sunshine each year, while the north-west of the country receives only 1600 hours. Average annual precipitation for the whole territory of Slovakia is 743 mm of which 65% is evaporated and 35% represents runoff. The smallest precipitation means (550 mm annually) are observed in the Danube lowlands, while in the highest elevations of the Carpathians it usually exceeds 1500 mm. Snow cover is not stable, and winters in the lower altitudes are usually without permanent snow cover.

Figure 2.1 illustrates the long-term trends of air temperature and precipitation in Slovakia. A temperature increase of about 1 C and precipitation decrease of about 10-15% were observed during the last 100 years. The year 1994 was the hottest one since the beginning of meteorological observation.



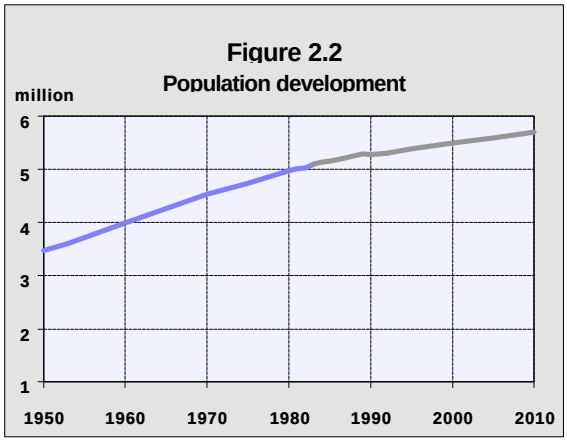
The current average population density in Slovakia is 109 inhabitants per km^2. The largest city in Slovakia is Bratislava (444,987 inhabitants in 1992), followed by Kosice (236,624 inhabitants in 1992). There are four other cities of more than 80,000 inhabitants. The average life expectancy at birth for men (66.5 years) is 6-7 years less and for women (73.5 years) 5-7 years less than in developed countries. Mortality, which increased by 2.2 per mille in 1960-1980, has since stagnated.

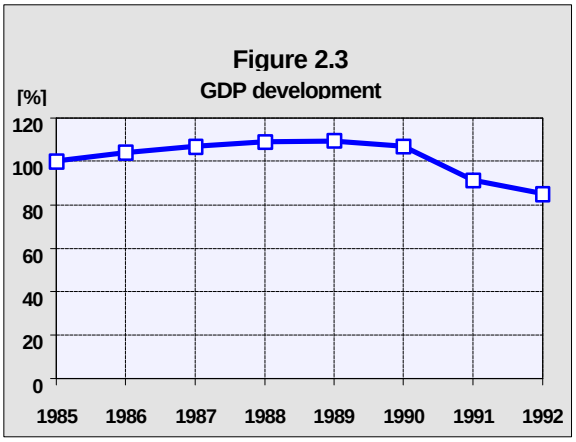
2.1.3 Population

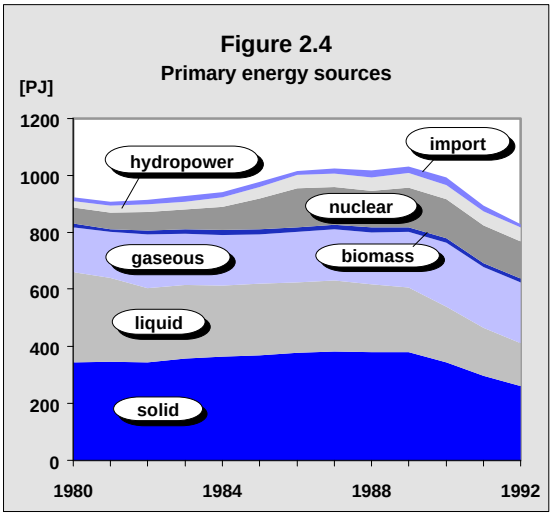
The population in Slovakia has grown from 3 million inhabitants in 1920 to 5.3 million in 1992. Figure 2.2 shows the population development between 1950 and 1992 as well as the expected population trend to 2010. The highest natural increase of population over 1.7% occurred in 1950. Since then a systematic decrease in the natural population increment has occurred. The natural population increase in 1992 was 0.4%. Net annual population increases were smaller because of population migration. Since the beginning of the economic transition process in Slovakia in 1989 the real average population of Slovak Republic stagnates. The effect of splitting the Czech and Slovak Federal Republic is fairly evident. Slovaks permanent living in the Czech Republic accepted Czech citizenship. The assumed official net population increase of about 0.3-0.4% to 2010 might be overestimated.

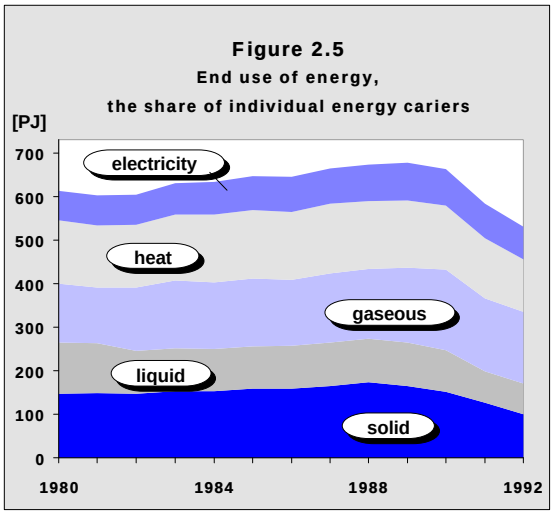
2.1.4 Economy profile

The Gross Domestic Product (GDP) at constant market prices (1984) in Slovakia amounted to 201 bill. Sk in 1985 and 215.4 bill. Sk in 1990. The average annual growth rate in the period between 1985-1990 was 1.39%. The political changes in central Europe, during this period, influenced the general social and economic situation in Slovakia. The decline of economic growth is obvious from Figure 2.3, illustrating the GDP development for the period 1985-1992 related to the year 1985 (in constant 1984 prices). The expected average annual growth rate between 1990-2000 is -1.2% (see Chapter 5).







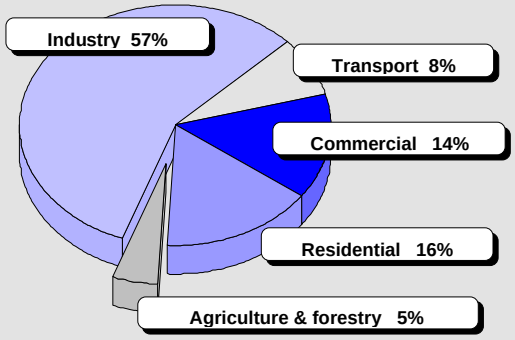


2.1.5 Energy structure

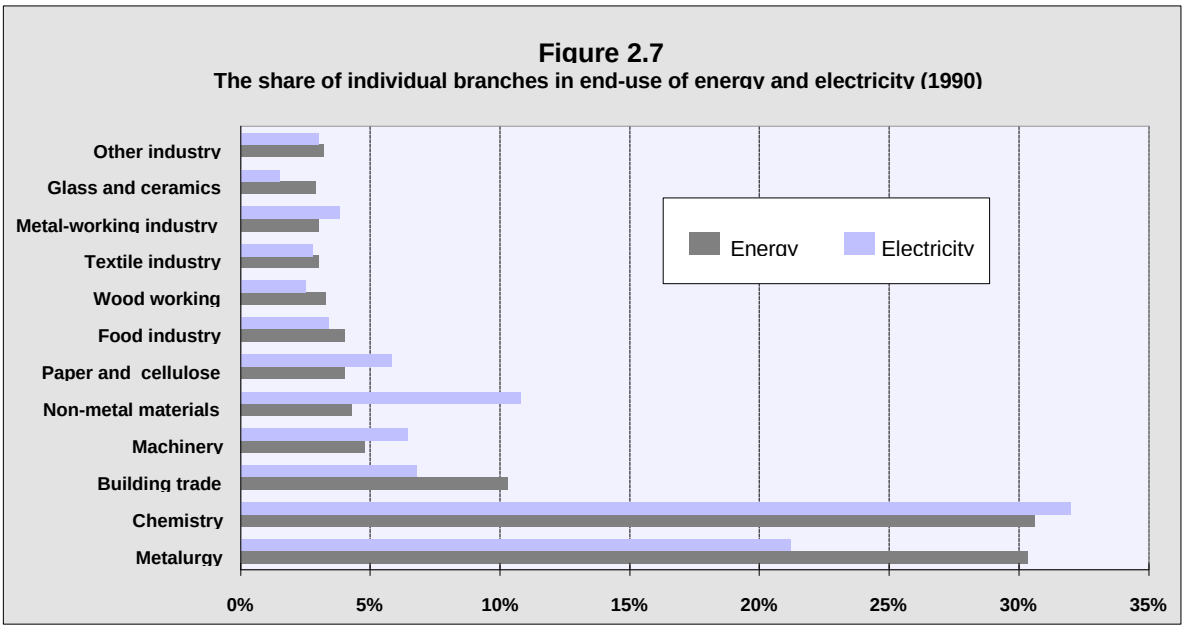
Figure 2.4 shows the structure of primary energy sources. Primary energy consumption increased during the period of 1987-1988. The decline in primary energy consumption began just prior to the political changes. The industrial production decline is accompanied by an impressive primary energy consumption decline in the period between 1990 and 1992. The energy demand increase in the period 1985-1990 has been predominately met by nuclear energy and its level (expressed as primary nuclear heat) is stable through the period of energy consumption decline (1990-1992). The share of nuclear energy consumption (as primary nuclear heat) represented 5.9% in 1980, 11.2% in 1985 and 14.1% in 1990.

The structure of end-use of energy is illustrated in Figure 2.5. It is obvious that the end-use of energy has declined in the same period (1990-1992) as in the case of primary energy consumption. The energy statistics used in former CSFR is not compatible with the OECD methodology. Energy distribution between end-use of energy and energy transformation and conversion processes cannot be expressed on the basis of available data for the 1980-1992 period. This new methodology has been used for the calculation of energy distribution and CO_2 emission in the base year 1990. The Figure 2.6 and 2.7 illustrate the end-energy distribution in individual sectors, using the OECD methodology.

Figure 2.6
The share of individual sectors in end-use of energy (1990)



	End-use of energy [PJ]				
	solid& biomass	liquid	gaseous	heat	electricity
industry	124	99	120	3	54
transport	0	51	0	0	4
commercial	35	7	41	8	9
residential	52	2	29	15	13
agriculture & forestry	5	20	3	1	4
total	**216**	**177**	**193**	**27**	**84**



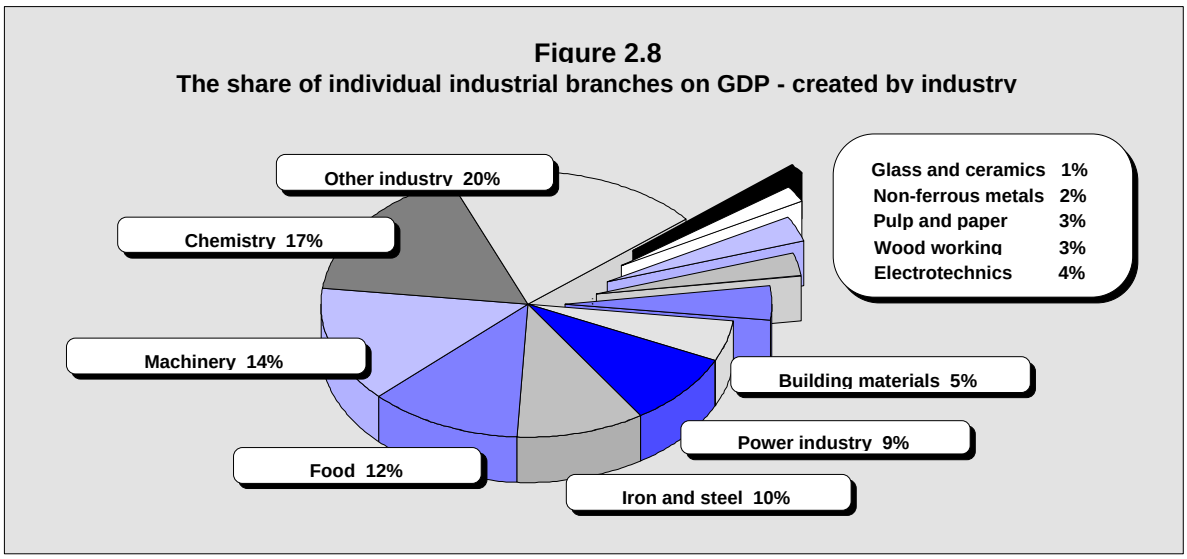
2.1.6 Industry

Slovakia is an industrial country. It documents the branch structure of gross domestic product at market prices (1991):

Material sphere, total		**80.9%**
of which	agriculture	4.9
	forestry	0.8
	water works and supply	0.9
	industry	51.8
	construction	7.4
	freight transport	5.8
	trade and catering	5.5
	other	3.8
Non-material sphere, total		**19.1%**

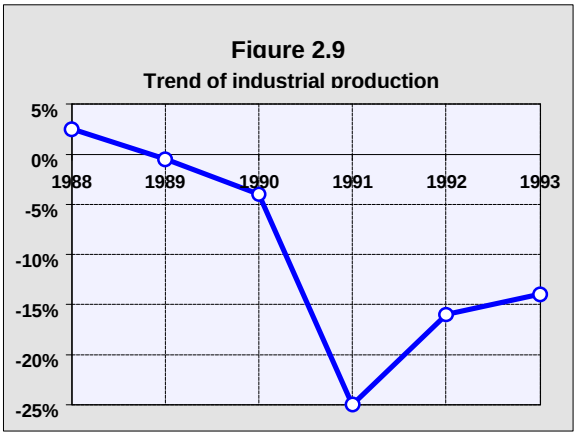
The share of individual industrial branches on GDP production (created by industry) in 1990 is illustrated in Figure 2.8. In 1992 the industrial sector employed 595,197 persons, representing 18.9 % of all Slovak registered labour sources.

High demand for energy and raw materials is the key feature of the Slovak economy. In 1990, the Slovak Republic produced: 3.6 million tons of pig iron, 4.7 million tons of steel, 30 thousand tons of aluminium, 0.5 million tons of plastic materials, 0.3 million tons of fertilisers, 3.7 million tons of cement, etc. However, there is a shortage of domestic sources of high-quality



raw materials (excluding non-ore material and magnesite). Expenditures for imported coal, fuel for nuclear power plants, iron ore and concentrates, processed ores and raw materials for the production of non-ferrous metals are relatively high in the Slovak economy. The result of this production orientation is that industry absorbs more than half of the energy and 63 % of electricity consumed. In terms of consumption the chemical industry is second behind the metallurgic industry followed by production of cement and construction materials. The thirty largest companies together account for more than 50% of industrial electricity consumption, the three largest ones (the Kosice iron smelters, aluminium production in Ziar n.H. and the petrochemical plant Slovnaft Bratislava) nearly 22%.

The transition of Slovak industry to full economic behaviour is a long-term process. Since its beginning in 1990 the industrial production has dropped dramatically (Figure 2.9). Disintegration of the East-European market, the drastic decrease in military production and increasing liquidation of non-effective economic activities have resulted in negative social consequences, such as increasing unemployment. Growing primary or secondary insolvency of enterprises requires temporary or long-term assistance through revitalisation programmes. The capital market is lacking and a chronic shortage of credit sources persists. Limited domestic sources and slow introduction of foreign capital have slowed the transformation of Slovak industry.



2.1.7 Transportation

Slovakia is among the smaller European countries. The density of its transportation network could be considered as appropriate, but investments during last decades were very low in the transportation sector. The entire Slovak infrastructure urgently needs extensive reconstruction and innovations. Because of its position in the centre of the European continent the improvement of the Slovak transport system includes a strong international aspect.

The total length of railway tracks represents 3,661 km, of which 1,373 km are electrified. The total length of roads and highways in 1992 was 17,880 km. The highway system is under construction and at present its share of road transport is still very low. The Danube is practically the only river used for water traffic. This international European flow forms the Slovak borders for a length of 172 km. Conditions of navigation on its Slovak-Hungarian sector were improved due to the erection of Gabcíkovo water dam.

From the beginning of the economic transformation process in Slovakia a decreasing trend of transportation activities has been observed. Taking the year 1988 as 100%, in 1992 railway freight transport was 58%, railway passenger transport 85%, road freight transport 72%, road passenger transport 94% and city transport 71%.

Individual transport is increasing, but public transport including city transport is still the dominant form. The number of automobiles, 0.2 car per inhabitant, is at a considerably lower level than in West European countries. Because of the low purchasing power of the population at present, full saturation of Slovak market is expected only after the year 2000. Since 1 October 1993 all new or imported second-hand cars have to be equipped by three-way catalytic converters. The performance as well as average transport distance of freight transport are going up. The number of motor vehicles as of end of year and fuel consumption for road transport in tonnes are given in Table 2.1.

Table 2.1

Number of motor vehicles and fuel consumption of road transport

	1987	1988	1989	1990	1991	1992	1993
Number of motor vehicles							
Passenger cars	767 769	796 806	837 221	875 550	906 129	953 239	994 932
Vans	20 677	21 408	22 026	22 893	22 989	17 752	17 061
Freight	64 078	64 863	67 722	69 101	72 347	84 543	84 491
Special	44 247	45 997	49 795	53 537	55 120	50 260	46 121
Buses	12 786	13 304	13 736	14 301	13 770	13 338	12 655
Tractors	64 053	65 709	66 162	67 056	67 642	64 713	65 150
Motorcycles	271 208	277 431	282 732	286 250	282 754	241 855	241 332
Total	**1 244 818**	**1 285 518**	**1 339 394**	**1 388 688**	**1 420 751**	**1 425 700**	**1 461 742**
Fuel consumption (in tonnes)							
Gasoline	405 660			437 460	434 100	443 870	499 740
Diesel fuel	1 020 670			1 058 600	906 720	680 700	627 240

2.1.8 Agriculture and Forestry

Agriculture and forestry in Slovakia employed about 250,000 people in 1992, which is equivalent to 12.1% of labour sources or 4.7% of the population. In Slovakia there are 2,447 thous. ha of land used for agricultural purposes, including 1,486 thous. ha of arable land. Per capita acreage is 0.46 ha of farmland and 0.28 ha of arable land.

Until 1989 agriculture was viewed as a branch of the national economy. By beaurocratic directives it was concentrated into large organisational units (co-operatives) with complicated systems of management, which often neglected specific soil, climate, geographic and regional factors. This led to ecologically irrational and economically inefficient agricultural and food production. The policy of “cheap “ food, based on increasingly subsidised consumer prices of foodstuffs, consequently resulted in the deformation of food production economy and food market. The privatisation and transformation process of co-operatives has already occurred (before 31 December 1992) by means of a special law. 986 successors asked for registration. 965 of them were transformed into a co-operative form of the company, 12 preferred to be join-stock companies and 9 limited liability companies. The majority of the transformed co-ops still did not perform an internal economic transformation and commercialisation of their production. At that time there were 8,727 private farmers registered, with an average farmland area of 7.6 ha.

Compared to the past there were no market changes in the crops production. An increase in the cereals acreage has been recorded, while sugar beet and bulky crop production has decreased. All species of animal production decreased. Compared to 1989, the inventory of slaughter animals in 1992 dropped by 21% due to the declining purchasing power of the population; inventories of slaughter beef cattle fell by 16.3%, pigs by 22.4%, slaughter poultry by 23% and milk production declined by 39.2%. In 1992 the number of heads was 1.2 million beef cattle, 2.3 million pigs, 0.5 million sheep and 13.4 million poultry.

Slovak’s agrarian policy will, in the near future, focus on the following strategic goals:

- state food security; availability of healthy, quantitatively and qualitatively balanced food for the population;
- economic stability, appropriate agricultural income and the balanced development of regions
- improvement and protection of farmland; ecological cultivation protecting landscape, and the prevention of food chain contamination with harmful substances;

- preserving agriculture also in the low-competitive, hilly areas, where it represents a basic condition for the development of landscape-forming, ecological and social functions of agriculture; maintaining rural settlement in the countryside.

Forests are one of Slovakia's most important natural resources and are the basis for the forest industry. Forest land covers 19,911 km^2, 41% of the country's surface area. Broad-leaved trees prevail in the forests of Slovakia (57%). Conifers represent 43% of forest inventory.

The general condition of forests in the Slovak Republic is positive. The comparison of forested land in 1920-1990 indicates that forested land increased by more than 20% mainly due to afforestation of farmland and acreage adjustments of agricultural crops. Positive changes were recorded also in the categorisation of forests. At present the managed forests represent approximately 76% of the total woodland area, with a marked increase of area of protective forests (13%). Also the area of specific-purpose forest increased (11%). This provides the basic conditions for a gradual emphasising of the public welfare function of forests.

The age composition of forest stands in the total forested area is also quite favourable. Forest stands up to the age of 40 years represent 33%, 41-80 year old trees about 43%, 81-120 year old trees 19% and the group of trees over 120 year of age approximately 5%. It may be concluded from the age structure of forest that by 2000 (2010) it is necessary to count with a stagnation and decrease of timber cropping in Slovakia. In comparison with 1950, Slovakia's timber resources went up in 1991 from 193.5 million m^3 to 352.2 million m^3. The timber-growing stock increased from 140 to 189 m^3/ha.

Besides the positive trends there are also negative ones. In the last decades the health condition of forests has markedly worsened. Rare and randomly found cases of forest damage occurred on a large scale after 1985 and were identified in severity as the first and fourth stage of forest damage severity. In 1989 the forest tree injury of that severity represented 85% of all damage. Present monitoring reveals a relative stabilisation of damage. However, regarding climatic condition in 1992-1993, further deterioration of health condition of forests in the following 5 years is expected.

Priority of tenancy relations, declared legally and institutionalised by the Forest Act No. 61/1977, resulted in total state tenancy of all forests in Slovakia until 1991. The equalisation of ownership rights and returning the tenancy of forests to original owners represent a qualitatively new situation, where the correct forestry management procedures and protection of forest ecosystems as a component of the environment have an immense importance. In realisation of these tasks, it will be necessary to respect the specifics of the transitory period. A harmonisation of public welfare and productive functions of forests is important.

Important principles of the State Forestry Policy in Slovakia are inter alia gradual afforestation of farmland area unsuitable for agricultural purposes and overall ecologization of forestry.

2.1.9 Water management

Slovakia, a typical inland country, is situated on the roof of Europe. Therefore its natural water resources are limited. This fact underlines the importance of Slovak water management branch.

The water areas of Slovakia covers only about 2% of the territory. The length of water courses is 8,437 km, of which 3,156 km is regulated.On the basis of 1931-1980 average data the following annual is the water balance for Slovakia:

Precipitation	36,848	million m^3
Runoff	12,784	million m^3
Evaporation	24,214	million m^3

The average discharge from runoff is 405 $m^3.s^{-1}$. During the last decades a significant discharge decrease has been observed in Slovakian rivers.

Except for the Southwest Danubian region, Slovakia suffers a sizeable deficiency in utilizable stocks of underground water.

The useable capacity of the Danube alluviums represents about 23 $m^3.s^{-1}$ of drinking water. Protection of this highly valuable natural source against anthropogenic pollution is one of the most important goals of the state environmental policy. Most of the Slovak territory uses the surface waters. The volume of water reservoirs increased from about 300 million m^3 in 1975 to 1,618 million m^3 in 1992. Several regions of Slovakia exhibit a considerable soil moisture deficiency, mainly during the vegetation period. More than 800,000 ha of arable land need irrigation systems. At present only 328,000 ha can be irrigated.

The general principles and major goals of Slovak state water management policy are documented in the Master Water Management Plans. Most activities are executed by four river basin agencies. In March 1994 the Slovak Government accepted the new water management policy of the Slovak Republic.

2.2 National policymaking and legislative processes, and present environmental strategy

The President of the Slovak Republic is the head of the State. He is elected by the Slovak Parliament for a period of 5 years. The Parliament is the supreme organ of state power and legislative authority. It has 150 deputies. The government of the Slovak Republic is directed by the Prime Minister and has 15 ministers. From an administrative point of view the territory of Slovakia is subdivided into 38 districts, 121 town districts and 2 826 communities. The legislative process is a combined effort of Ministries, Government and Parliament. All legislative instruments are published in The Bulletin of Acts.

The Slovak Ministry of the Environment, district environmental offices and municipalities are executive authorities concerning the environment (Act 595/1990 on state administration for the environment).

National environmental policy is based on the 1st September 1992 Constitution of the Slovak Republic, proclaiming the right of any citizen to a favourable environment and to timely and complete information on the state of the environment and the causes and consequences of that state. All citizens are required by the Constitution to preserve and protect their environment and cultural heritage. No one may endanger or damage the environment, natural resources, or historical artefacts beyond the limit specified by the law. The State is required by the Constitution to ensure environmental balance, conservation of natural resources, and effective environmental protection.

The Slovak Parliament (Resolution 339 of November 18, 1993) approved the Draft Strategy, Principles and Priorities of the National Environmental Policy, in which inter alia short-term, medium-term and long-term objectives are formulated (Table 2.2). This table gives those objectives that could affect the greenhouse gases emission directly or indirectly. Some of the long-term objectives aim at reaching the basic positive improvements for the environment as well as permanently sustainable development. The Slovak Parliament requested the Government to complete the distribution of responsibilities of individual sectors to implement the strategy of the national environmental policy.

The Ministry for the Environment in co-operation with other Ministries is responsible for the implementation of the Draft Strategy, Principles and Priorities of the national environmental policy.

Table 2.2

Objectives of national environmental policy

Short-term objectives

In air protection

- substantial reduction in the emissions of basic substances polluting the atmosphere (SO_2, NO_x, CO, C_xH_y, solids) and concentrating on the worst polluters and twelve areas most affected by air pollution;
- introduction of a ban on the use of halons after 1994 and a ban on fully halogenated hydrocarbons, carbon tetrachloride, 1,1,1-trichloromethane, and partially halogenated bromhydrocarbons from 1996;
- a cap on the consumption of methylbromide from 1995 and reduced consumption of partially halogenated hydrocarbons;
- development of national programmes aimed at reducing anthropogenic emissions of CO_2 and other greenhouse gases not covered by the Montreal Protocol on Substances Depleting the Ozone Layer, as well as reduction in emission of VOCs, POPs, and heavy metals;

In protection and rational use of water

- to reduce utilisation of groundwater for technological purposes to 5-10 % of the current level in areas where water can be substituted for groundwater;

In waste management

- expanded collection and utilisation of secondary raw materials, economic incentives, and introduction of separated collection with reduction in the volume of municipal waste designated for disposal by 20 % of the 1992 level;
- undertaking the construction of a network of regional medical waste disposal facilities, including eight incinerators;
- evaluation of the possibilities for and initiating the re-use of suitable materials (heavy metals, construction materials, etc.) from the waste accumulated in landfills;
- implementation of legal and economic instruments for the disposal, utilisation, and reduced production of waste in individual fields;

In soil and forest conservation

- preferential re-forestation of areas of great to extreme environmental damage;
- implementation of the Principles of National Forestry Policy and the Strategy and Concept of Forestry in Slovakia;
- in accordance with the principles of environmental policy to complete the bill on soil and the bill on inspection of fertilisers, soil, and fertilising practices;

Concerning the whole environment

- implementation of a financial return on resources spent on the environment (the Revolving Fund) and their gradual orientation towards solving environmental problems on a national scale;
- preference for projects and investment focusing on conservative and rational energy and raw material use, recycling and utilisation of waste, greater reliance on environmentally safe forms of energy (hydro, solar, wind, etc.), expended use of biological processes in agriculture, and elimination of the release of contaminants into drinking water and the food chain;

Medium-term objectives (for the year 2000-2010)

In air protection

- reduction of SO_2 emission by more than 50 %, of NO_x emission by more than 35 %, of solids by 65 %, and of other emissions of harmful substances (C_xH_y, dioxins, etc.);
- implementation, compliance with, and enforcement of the ban on production and use of materials depleting ozone layer;
- reduction of the consumption of partially halogenated hydrocarbons by 35 %;
- implementation of national programmes reducing CO_2 and other anthropogenic greenhouse gas emissions not covered by the Montreal Protocol on Substances Depleting the Ozone Layer, as well as reduced VOCs, POPs, and heavy metal emissions;

In protection and rational use of water

- reduction of the technological use of underground water to 3-5 %, with exceptions for the use of geothermal waters;

In waste management

- processing of at least 80 % of biodegradable waste to organic fertilisers;
- economic incentives for expanded collection and utilisation of secondary raw materials (for example used oils, glass, metals, paper, etc.);
- construction of a network of waste sorting equipment for separating out secondary raw materials;
- increased use of waste for economic purposes, in particular ash and cinders from power and heating plants, mine tailings, and waste from the lumber, paper, metallurgical, rubber, and chemical industries, utilising modern low waste or waste-free technologies, recycling;

In soil and forest conservation

- landscaping measures, especially windbreaks, vegetation on banks and slopes, terracing, and changing appropriate vegetation, reduction of the area of great to extreme soil erosion by one half;
- re-forestation of approximately 60-80,000 hectares of the least productive meadowland as well as inaccessible or otherwise unprofitable plots of land, taking into account the protection of certain rare ecosystems;

Long-term objectives

- reduction of environmental pollution to an acceptable level not exceeding the limit of tolerable stress on the land in individual regions and eventually in all of Slovakia;
- 80% reduction in SO_2,NO_x and dust emissions, reduction of VOCs, POPs, heavy metals, CO_2 and other greenhouse gas emissions in accordance with international conventions;
- minimising coal combustion and more effective and rational coal utilisation;
- introduction of the ban on the production and consumption of partially-halogenated hydrocarbons, by the year 2030;
- higher utilisation of alternative fuels and transportation means reducing environmental pollution (gas, electricity, public transportation, bicycles);
- reducing the specific electricity consumption in production and distribution of water to the average of European Union;
- minimising the negative impact of waste on the environment and public health and maximal valuation of waste as secondary raw material;
- establishment of managed landfills and incinerators for the disposal of unusable waste;
- elimination of damaging compounds synergetic effect on forest ecosystems, and an overall increase in the resistant potential of forest wood;
- optimising of forest harvesting, renewal of natural composition of forest and use of less-disruptive harvesting and re-planting methods;
- completion of the integrated environmental monitoring and information system of the Slovak Republic;

2.3 Policies adopted before the base year

No specific policies in the matter of climate change were adopted before the base year. Executive authority in the field of environment was spread over several sectors. Public awareness with regard to climate change issue was poor. While control laws for water, territorial planning and building order achieved the appropriate international level, the Act 35/1967 on the measures against air pollutants, based upon the "high stack" principle, did not correspond to existing international European standards and no waste control law had been adopted. The independent governmental administration for environment (ministry, district environmental offices, municipalities) was established in 1990. A new legislative process was initiated in the same year and new environmental control laws have been gradually adopted.

CHAPTER 3

Inventory of greenhouse gas emissions

This chapter provides a summary of the inventory of greenhouse gas emissions in the Slovak Republic. Estimation of emissions quantities are calculated according to the IPCC Guidelines.

3.1 Introduction

Greenhouse gases include carbon dioxide (CO_2) methane (CH_4), nitrous oxide (N_2O) and ozone (O_3). Chlorofluorocarbons (CFCs), a family of human made compounds, its substitute hydrofluorocarbons (HFCs), and other compounds, such as perfluorinated carbons (PFCs), are also greenhouse gases. In addition there are other gases photochemically important, such as carbon monoxide (CO), oxides of nitrogen (NO_x) and nonmethan volatile organic compounds (NMVOCs).They are not greenhouse gases, but contribute indirectly to the greenhouse effect. There are commonly referred to as tropospheric ozone precursors, because they influence the rate at which is O_3 created and destroyed in the atmosphere. Sulphur dioxide (SO_2) and aerosols are believed to contribute negatively to the greenhouse effect.

Although CO_2, CH_4 and N_2O occur naturally in atmosphere, their recent atmospheric build-up appears to be largely the result of human activities. This build up has altered the composition of the Earth's atmosphere and may affect the future global climate.

This chapter provides a summary of the inventory of greenhouse gas emissions in the Slovak Republic. Estimates of emissions quantities are calculated according to the "IPCC Draft Guidelines for National Greenhouse Gas Inventories" (IPCC,1994). The emissions of CO_2, CH_4, CO, N_2O, NO_x, NMVOC, HFCs and PFCs will be discussed. Appendix presents summary tables of emissions, activity data and aggregated emission factors for sources and gases included in this chapter. All emissions are expressed in full molecular mass (e.g. Gg CO_2). GWP (Global Warming Potential) figures used are from "The 1994 Report of the Scientific Assessment Working Group of IPCC".

3.2 CO_2 emissions

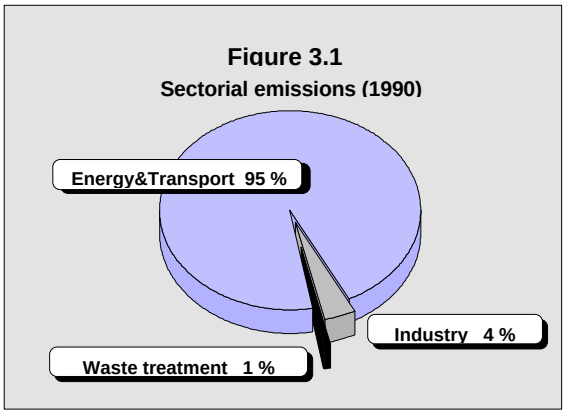
The global carbon cycle is made up of large carbon flows and reservoirs. Two primary sources of the observed increase in atmospheric CO_2 are fossil fuel combustion and changes in land use. Cement (lime) production is another important source. Changes in land use and forestry activities both emit carbon dioxide (forest clearing) and can act as a sink for CO_2.

Table 3.1 shows the total CO_2 emissions and removals in Slovakia in 1988 and 1990. The following section provides more detailed infor-

Table 3.1

Total CO_2 emissions and removals in 1988 and 1990

	1988	1990
National CO_2 emissions (Gg)		
Energy&Transport	58 244	55 033
Industry	(3 000)	2 775
Waste treatment	(240)	470
Total emissions	61 484	58 278
National CO_2 removals (Gg)		
Land use change	3 938	4 451



mation on CO_2 emission from various economic sectors. Information with respect to the uncertainty of emission estimates and on emission trends is also included. While the combustion of fossil fuels accounts for about 96% of total Slovak CO_2 emissions, CO_2 also results directly from industrial processes.

3.2.1 CO_2 emissions from the energy sector

Approximately 83% of the energy in the Slovak Republic is produced through the combustion of fossil fuels. The remaining 17% comes from other energy sources such as hydropower, nuclear energy or renewable sources. Combustion of fossil fuels is the most important source of carbon dioxide in Slovakia. Emission estimates are based on fuel consumption recorded in the REZZO National Inventory System and on the data published in "Energy Strategy and Policy of the Slovak Republic up to the year 2005" (Ministry of Economy, 1994) . The approach followed is the aggregated fuel approach derived from the IPCC methodology. The Inventory includes all fossil fuel combustion as well as oil and gas production and storage. This balance includes coke production and CO_2 emissions from aluminium production. Average emission factors recommended by the IPCC methodology were used.

Table 3.2
Break down of energy balance and energy related CO_2 in 1990

Fuel combustion activities	(PJ)	CO_2 emission (Gg)	mean EF (kg CO_2 / GJ fuel)
Energy		**15 679**	**81.0**
Solid	143.07	12 772	
Liquid	19.44	1 164	
Gaseous	31.11	1 743	
Commercial/Institutional		**6 153**	**74.4**
Solid	35.26	3 355	
Liquid	6.68	512	
Gaseous	40.79	2 286	
Residential		**6 384**	**80.2**
Solid	49.51	4 686	
Liquid	1.51	95	
Gaseous	28.60	1 603	
Industry		**21 155**	**64.2**
Solid	111.88	10 934	
Liquid	98.57	4 190	
Gaseous	120.19	6 031	
Transport		**3 628**	**71.1**
Liquid	51.05	3 628	
Agriculture/Forestry		**2 034**	**74.7**
Solid	4.63	437	
Liquid	19.51	1422	
Gaseous	3.13	175	
Total	**764.93**	**55 033**	**72.0**
Solid	**344.35**	**32 184**	
Liquid	**196.76**	**11 011**	
Gaseous	**223.82**	**11 838**	

Feedstocks and carbon storage

The IPCC methodology assumes that part of the carbon in fossil fuels is not oxidised but stored in products such as plastics and bitumen. The volume of carbon was identified which was not oxidised directly during the production process but remained stored in the products.According to this method, the following types of stored carbon are included:

- carbon stored in tar and pitch oil
- carbon stored in petrochemical crude oil products (polyethylene, polypropylene, asphalt, lubricants etc.)
- carbon stored in industrial fertilisers.

The total volume of carbon stored in products in 1990 was identified as 1064 Gg C according to the IPCC method, and 736 Gg according to the national method (cf. Table A1 in Appendix).

3.2.2 Other categories of emissions

The industrial activities in Slovakia which are of most concern with respect to carbon dioxide in 1990 (1988) were cement, magnesite and lime production (Table 3.3). Carbon dioxide formed during the production of coke and aluminium, during crude oil processing and in metallurgy is included in Table 3.2. Applying the IPCC methodology for landfills, the CO_2 emission from communal waste produced in Slovakia in 1990 was estimated at 145 Gg. An estimation scatter of 20% is assumed. Emissions from incineration plants were estimated to be 470 Gg. This value should be considered as only preliminary.

Table 3.3

CO_2 emissions from non-energy sources in 1990

	Production (Gg)	Emission factor (kg/Gg)	CO_2 emissions (Gg)
Industrial processes			**2 775**
Cement	3 789	489	1 853
Lime	571	789	451
Magnesite			471
Waste			**470**
Waste incineration			470
Total			**3 245**

3.2.3 CO_2 removals

The Slovak Republic's area is 49,036 sq. km, including 41% forest land. The rest is arable land, pastures, natural grassland and urbanised areas. The land use has remained fairly constant over the last century. From the beginning of this century, there has been a conversion of agricultural land to forest area. Between 1950 and 1991, the volume of carbon stored in Slovak forests increased by approximately 48.8 Tg. This is the result of the area increase in forest and higher hectare storage of wood mass.

The carbon flux estimates in the forest area of Slovakia in 1990 are based upon a total accounting of biomass carbon stored in all forest ecosystems, surface (trees, plant cover) and subsurface (roots, soil, humus), including the evaluation of wood extraction and forest fires. As a result of biological processes and anthropogenic activities the net CO_2 flux is estimated to have been an uptake (sequestration) of 4,913 Gg CO_2. The results are to be seen as preliminary. In the same period, meadows and pastures have been converted to arable land. Between 1965-1990, this process affected 90,000 ha. Using the IPCC methodology, CO_2 emission from the conversion of grassy areas to arable land was equal to 462 Gg. In spite of this, the category "Forestry and land use change" in our territory a sink of approx. 4,451 Gg of carbon dioxide/year remains.

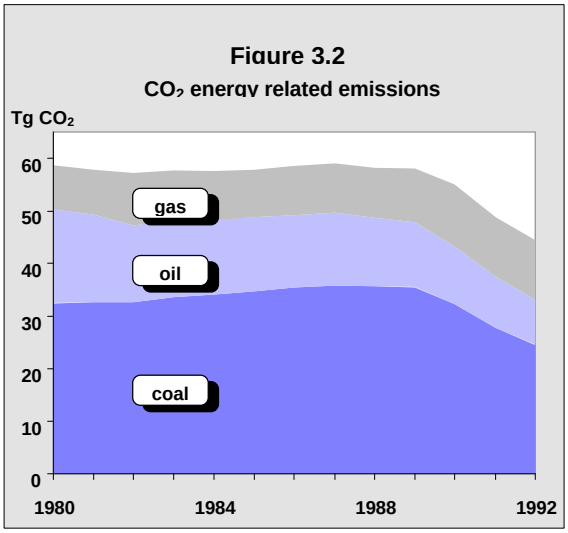
3.2.4 Trends

It is difficult to evaluate the CO_2 emission trends, as generally only data from 1990 are available. Table 3.4 gives the emissions from the activities for which the inputs could be obtained. The numbers in brackets are expert estimates. In general, CO_2 emissions were increasing until 1988, after 1990 they began to decrease (Figure 3.2). It is assumed that this trend will continue after 1993 as well, as a consequence of economic depression.

Table 3.4

Trends in CO_2 emissions and sinks for selected activities (Gg, rounded)

Activity	1985	1988	1990	1992	1993
Energy/heat generation, Transport	(54 734)	58 244	55 033		
Cement	1 836	1 067	1 853	1 650	(1 650)
Forest ecosystems	(-4 400)	(-4 400)	- 4 913	(-4 900)	(-4 900)



3.2.5 Uncertainty

The uncertainty in emission estimates from fossil fuel combustion results from varied statistic data on fuel consumption and energy balances. Other sources of inaccuracy can be in the default emission factors used. In the next stage of analysing the issue, the comparison of national and default emission factors is planned. The error during computing the other emissions is due to the fact that the methodologies used are not accurate enough, and we are not able to specify it. Due to the lack of time, uncertainty quantification according to the IPCC methodology has not yet been processed, and will be included in the next National Communication.

3.3 CH_4 emissions

Table 3.5 and Figure 3.3 show CH_4 emissions according to individual sectors. In Slovakia, the major sources of methane are waste handling, agriculture and fuel extraction and transport. CH_4 emissions are identified using the IPCC methodology (bottom-up). In our region, livestock farming in agriculture is the major anthropogenic source of methane emissions. CH_4 is formed as a direct product of the metabolism of herbivorous animals and as the product of organic degradation of animal waste. Calculations of emissions for the Slovak Republic come from the "Concept and principles of agricultural policy from 1993", the emission factors were modified according to specific national conditions. Between 1990 and 1993, the number of cattle decreased considerably as a result of the transformation from a planned economy to the market system and thus CH_4 emissions decreased considerably as well. Agricultural concepts assume that in 2000 the number of cattle will be approximately the same as in 1990. Detailed data are given in Tables A2 and A3 in Appendix.

The emissions from communal waste landfilling (open dumps) were calculated in a separate study, derived from the specific communal waste production per inhabitant and from the estimated volume of degradable organic carbon in the

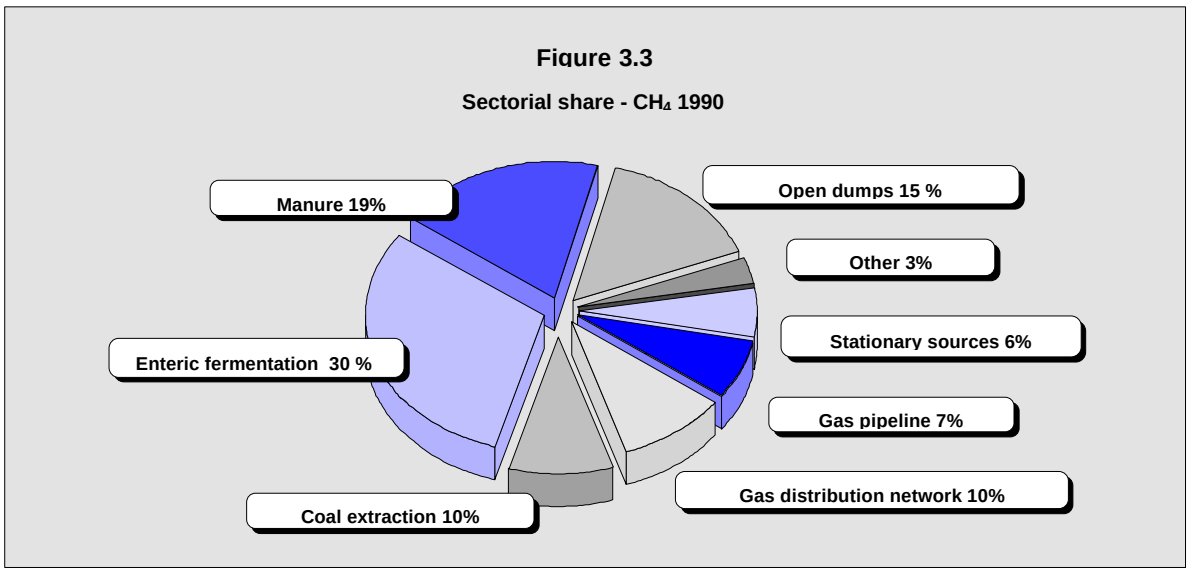


Table 3.5

CH_4 emissions (Gg) in 1988, 1990, 1993

	1988	1990	1993
Fossil fuel combustion		**21**	
Stationary sources		20	
Transport	1[3]	1	1
Fugitive emissions		**96**	
Gas extraction		4	
Gas pipeline (bunkers)[1]		24	
Gas distribution network	24	35	165[4]
Brown coal/lignite extraction	39	33	
Agriculture	**188**	**172**	**112**
Enteric fermentation	116	106	68
Manure	72	65	43
Waste incineration		1	1[2]
Waste treatment			
Open dumps	**50**	**53**	**58**
Forest ecosystems	**(5)**	**5**	**(5)**
Total		**347**	

[1] *emissions are not included in national total*
[2] *expert estimation* [3] *1987 value* [4] *1992 value*

Table 3.6

N_2O emissions (Gg) in 1988, 1990, 1993

	1988	1990	1993
Fossil fuel combustion		**3.8**	
Stationary sources		3.6	
Transport	0.2	0.2	0.2
Industrial processes	**2.0**	**2.1**	**1.1**
Agriculture	**(10.0)**	**8.8**	**3.6**
Agricultural land	10.0	8.8	3.6
Waste incineration	(0.02)	0.02	0.02[1]
Water surfaces	**1.3**	**1.3**	**1.3**
Total		**16.0**	

[1] *expert estimation*

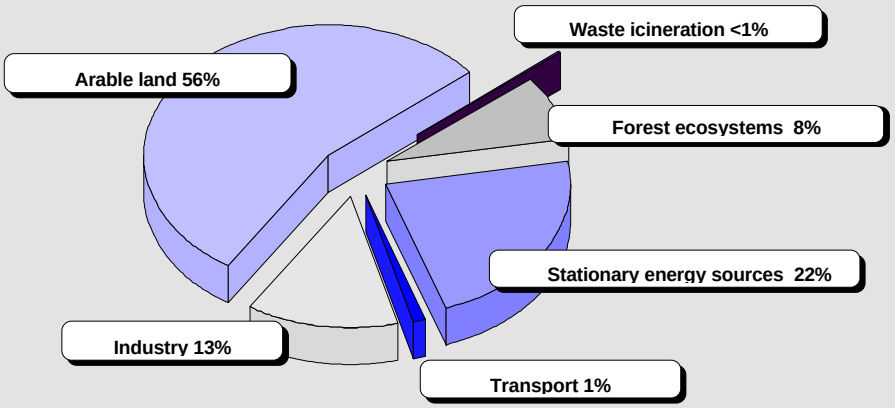
waste. IPCC methodology was used, applying a local factor of 0.5. Emissions from sewage water and sludge handling are not included. In the territory of Slovakia, fossil fuel extraction and transport are important sources of methane. The volume of methane liberated during brown coal and lignite extraction was calculated by applying the emission factor 7 kg CH_4 per Mg of extracted coal. These values might be too high. Methane emissions from losses during natural gas distribution are identified very roughly, according to statistically recorded natural gas losses in the distribution networks. These values will have to be calculated more precisely. Methane emissions from fossil fuel incineration were calculated on the basis of consumed fuel registered in the national Inventory system REZZO, applying the balance method. Emission factors according to (Veldt, 1991)

3.4 N_2O emissions

Compared to other greenhouse gases, the mechanism of nitrogen monoxide emissions and sinks has not been investigated completely. A complete list of N_2O sources and emissions has not yet been developed for the Slovak region so far. We are unable to quantify some of the sources yet,and some remain hidden.

Emissions in power engineering and transport were calculated on the basis of the fossil fuel consumption balance, applying emission factors from the literature. In the agricultural sector, nitrogen balance in arable land and in biomass was assessed, considering various types of soil and vegetation, as well as the application of mineral and organic fertilisers. N_2O emissions are caused by an excess of mineral nitrogen in the soil as a consequence of intense fertilisation and of unfavourable air regime of soil (the use of heavy machinery during cultivation). The method of indirect evaluation of the intensity of these processes was used (IPCC). From the early nineties, the average consumption of fertilisers decreased (in 1990 approx. 138 kg N per ha, 1993 approx. 60 kg of N per ha) as a result of the economic recession. It is assumed that in 2000 fertiliser consumption will again reach the level of 1990. Emissions from

Figure 3.4
Sectorial share - N_2O 1990



water surfaces were calculated by applying emission factors given in the literature (CORINAIR DEFAULT HANDBOOK, 1992) for 1990, and should not change significantly during the years.

Emissions occurring during waste handling are calculated roughly. Calculated emissions suggest a high inaccuracy which, however, is difficult to quantify - with certain emission factors even 100% are possible.

Table 3.7

Anthropoganic emissions of NO_x, CO and NMVOC (Gg)

	1988	1990	1993
NO_x	**198** [1]	**227**	**184**
Energy/Industry	138 [1]	158	131
Transport	60 [1]	69	52
CO	**457**	**489**	**480**
Energy/Industry	(330)	333	331
Transport	127	156	149
NMVOC	**(156)**	**147**	**116**
Energy/Industry		11	11
Transport	36 [1]	42	42
Solvents use		49	33
Crude oil processing and products		26	21
Other		19	9

[1] *data from 1987*

3.5 Other gases

Table 3.7 shows NO_x, CO and NMVOC emissions. CFCs and HCFCs emissions are not known; only data on their consumption are available (Table A4 in Appendix). They are not produced in Slovakia and their use is controlled in the Montreal Protocol and its appendices. From 1986 total consumption of controlled substances has decreased. Freons in cooling equipment are gradually being replaced by perfluorocarbons and it is assumed that their consumption will increase several times after 1996 (the Copenhagen Appendix allows their use until 2030).

Power engineering and transport are the major NO_x and CO sources. Metallurgy is also an important source of CO emissions (estimated with considerable degree of uncertainty). The emissions had reached their maximum during late eighties. After 1990, decreased effectiveness of the economy starts to be seen, and in 1993 emissions drop below the values of 1987. By 2000 they are assumed to increase again.

Anthropogenic emissions of NMVOC were calculated in the preparation of the ECE-UNO

protocol on NMVOC emissions in the Slovak Republic. The first inventory was processed for 1990. It is assumed that in 1988 the emissions were higher by approx. 0-5%. The application of paints and solvents together with extraction, transport, processing and the use of crude oil and its products are the major sources. A national program of NMVOC emission reduction has been prepared, with the objective reducing of emissions by 30% compared to 1990 by using a series of technical, economic and legislative tools.

3.6 Aggregated emisslons

This section gives the emissions in aggregated form in order to compare the contributions of individual greenhouse gases to the overall greenhouse effect. The emissions of individual greenhouse gases are based on the Global Warming Potential (GWP) for the time horizon of 100 years. Typical uncertainty is ± 35%. The values of aggregated emissions consider both primary and secondary contribution of greenhouse gases according to the IPCC methodology (Table 3.10). CO_2 emissions contribute 81% of the total emission (expressed as the CO_2 equivalent), CH_4 emissions contribute by 12% and N_2O emissions by 7% (Figure 3.5).

Global Warming Potential

	GWP 20 years	GWP 100 years
Carbon dioxide	1	1
Nitrous oxide	290	320
Methane	62	24.5

IPCC Report 1994

3.7 Conclusion

The Slovak Republic's share of global anthropogenic greenhouse gases emission is approximately 0.2 %. Annual per capita emission of 11 ton CO_2 in 1990, is lower than the average for OECD countries, nevertheless it places Slovakia among the 15 states with the highest per capita emissions. The data on greenhouse gases emissions presented in this report cannot be considered as final. In Slovakia, the first studies on these problems were started in 1993, identifying the GHGs emission sources in Slovak territory and calculating the first emission estimates. With respect to limited financial resources, more accurate information on sources and emissions can be obtained by the method of gradual steps only. At present, several projects are underway, financed from the Environmental Fund of the Slovak Republic, from the budget of the Ministry of Environment and from USA support within the project Country Studies. These projects should contribute more accurate information on sources, emissions and sinks of greenhouse gases in Slovakia.

Table 3.10

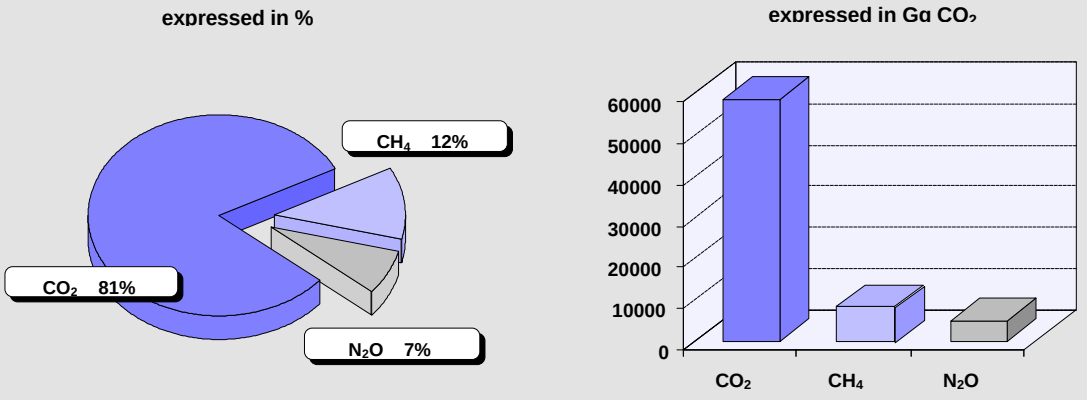
Aggregated emissions considering direct and indirect effects of CO_2, CH_4 and N_2O emitted in 1990

(aggregated emissions were calculated from emission data rounded to Gg)

	CO_2	CH_4	N_2O	Aggregated
	(Gg)	(Gg CO_2 equivalent)		
Energy/heat generation, Transport	55 033	515	1 216	56 764
Fugitive emissions	NE	2 352	NE	2 352
Industry	2 775	NE	672	3 447
Agriculture	NE	4 214	2 816	7 030
Forestry	(-4 451)[1]	122 [2]	416 [3]	538
Waste treatment	470	1 299	NE	1 769
Total	**58 278**	**8 502**	**5 120**	**71 900**

[1] *carbon sinks are not included in total CO_2 emission* [2] *emissions from wetlands* [3] *emission from watersurfaces*

Figure 3.5
Agregated GHGs emissions



CHAPTER 4

Programs and measures resulting in the reduction of greenhouse gases emissions

The introductory part of this chapter provides a general survey of strategies, legislation and measures to address the environment as a whole, climate changes and the production and sinks of greenhouse gases, adopted by the Slovak Republic primarily in the period following 1989. The second part presents the basic information on programs and important projects which are relevant to climate change policy. Because historically the economy of the Slovak Republic has been very energy intensive, the attention is focused on seeking ways to improve energy efficiency. Most of the important measures resulting in energy savings are directly linked with CO_2 emission reductions because of significant share of energy in Slovakia is obtained from the combustion of fossil fuels. This part also addresses further measures leading to the reduction of greenhouse gases emissions in compliance with the recommendations of INC "by gas and by sectors". Measures adopted as well as measures under consideration are presented. Very often it is not possible to divide the individual measures into discreet sectors, especially from measures which result in energy savings.

4.1 Environmental strategic and legislative framework

After the revolution in 1989, as a result of economic and political changes in the former CSFR, the process of gradual harmonisation of legislation including environmental legislation with the legislation of the EU countries has been initiated. Since 1993, following the establishment of the independent Slovak Republic, the trend to harmonise the legislation with the EU countries has been continued. An overview of the strategies and legislation with expressive impact on the environment follows. It is aimed at overall environmental improvement with a direct or indirect relationship to climate change.

4.1.1 Strategies and policies adopted

- **Strategy, Principles and Priorities of the Governmental Environmental Policy**

This document was approved by decision of the Slovak Government No. 619 of September 7, 1993 and the decision of the National Council of the Slovak Republic No. 339 of November 18, 1993. This material is based on the analysis of the environmental situation and its components and the overall environmental policy assessment, the orientation with respect to international relationships, determining the priorities of the state environmental policy and formulating the long-term (strategic), medium-term and short-term objectives. Detailed information is presented in Chapter 2.

- **Energy Strategy and Policy of the Slovak Republic up to the year 2005**

This document was approved by decision of the Slovak Government No. 562/1993.The strategic goal of energy policy is to provide all consumers with fuels and energy. At the same time energy should be produced at the minimum price and with minimum impact on the environment. From an ecological point of view the energy policy is aimed at environmental improvement and reduction of contaminating substances emissions in compliance with Slovak legislation and international commitments.

■ **Strategy and Policy of Forestry Development in the Slovak Republic**

This document was approved by decision of the Slovak Government No.8 of January 12, 1993. One of the strategic goals of forestry development in Slovakia is to preserve forests, i.e. to maintain and gradually increase the afforested area and forestry as an important contributer to ecological balance and landscape stability. This intention will be implemented also through further afforestation of land which is not suitable for agriculture.

■ **Waste Management Program in the Slovak Republic**

This document was approved by decision of the Slovak Government No.500 of July 13, 1993. The waste management program objective is to minimise the environmental risks of waste disposal and to develop a system of managed landfills and incinerators.

■ **Principles of Agricultural Policy**

This document was approved by decision of the National Council of the Slovak Republic of July 12, 1993. The policy concentrates on the fundamental measures to ensure ecologization of agricultural production, including rational consumption of fertilisers and the trend of further agricultural development.

4.1.2 Legislation

General evironment

- Act No. 17/1992 on Environment
- Act No. 127/1994 on Environmental Impact Assessment
- Act No. 248/1994 - Civil Code
- Act No. 140/1961 - Penal Code

Environmental administration

- Act No. 347/1990 on Organization of the Ministries and Other Central State Administration Authorities of the Slovak Republic
- Act No. 595/1990 on Environmental State Administration
- Act No. 134/1992 on the State Administration of Air Protection
- Act of the Slovak National Council No. 494/1991 on State Administration of Waste Management

Air protection

- Act No. 309/1991 on Protection of the Air Against Pollutants
- Measures of the Federal Committee for the Environment of October 1, 1991 to Act No. 309
- Decree of the Slovak Commission for the Environment No. 407/1992 adjusting the list of categorization of the sources of pollution and the list of pollutants and their emission standards
- Decree of the Ministry of the Environment of the Slovak Republic No. 111/1993 on expert licencing in the field of air protection
- Decree of the Ministry of the Environment of the Slovak Republic No. 112/1993 on establishing regions requiring special air protection, and the operation of smog warning and regulation systems

Waste management

- Act No. 238/1991 on Waste
- Ordinance of the Slovak Government No. 605 /1992 on Keeping Evidence on Waste
- Ordinance of the Slovak Government No. 606 /1992 on Waste Treatment

Territorial planning and building order

- Act No. 50/1976 on Territorial Planning and Building Order
- Decree of the Federal Ministry of Technical and Investment Development No. 83/1976 on general technical requirements for construction
- Decree of the Federal Ministry of Technical and Investment Development No. 84/1976 on the basis for territorial planning and territorial planning documentation
- Decree of the Federal Ministry of Technical and Investment Development No. 85/1976 on detailed provisions related to territorial proceedings and building order
- Decree of the Federal Ministry of Technical and Investment Development No. 12/1978 on protection of forest land in territorial planning activities
- Regulation of the Ministry of Transport,Communications and Public Works No. 14/1994 of October 1, 1994 on procedure and technical conditions for additional insulation and removal of defects in residential buildings.

Energy management

- Act No. 79/1957 on Production, Distribution and Consumption of Electricity
- Act No. 67/1960 on Production, Distribution and Utilisation of Gaseous Fuels
- Act No. 89/1987 on Production, Distribution and Consumption of Energy
- Act No. 88/1987 and No. 347/1990 on Energy Inspectorate
- Act No. 44/1988 on Protection and Use of Mineral Resources

Economic instruments

- Act No. 128/1991 on State Fund for the Environment of the Slovak Republic
- Decree of the Slovak Commission on Environment No. 176/1992 on conditions for providing and use of the funds from State Fund for the Environment of the Slovak Republic
- Act No. 311/1992 on Charges for Air Pollution
- Act No. 309/1992 on Charges for Waste Disposal
- Act No. 222/1992 on Value-Added Tax
- Act No. 286/1992 on Income Tax amended by Act No. 326/1993
- Act No. 316/1993 on Consumption Tax on Hydrocarbon Fuels and Oils
- Act No. 87/1994 on Road Tax

4.2 Climate change strategy and policy

In the Slovak Republic no consistent national policy relevant to climate changes has been approved and also no integral systematic program for the reduction of greenhouse gases emissions or enhancement of sinks has been developed. As is apparent from the previous chapters, it can be ascertained that in Slovakia in a relatively short time of political and economic transformation of the society and development of a new state a range of acts, regulations and measures, directly or indirectly related to greenhouse gases emissions reduction or enhancement of sinks, has been adopted. In addition several programs and research projects, linked with climate change, were finished or are being completed.

The First National Communication introduces a survey of relevant activities originally devoted to goals differing from greenhouse gases reduction. In spite of this, after the approval by the Government of the Slovak Republic, it will be an effective instrument for the implementation of the Framework Convention on Climate Change until the national policy directly related to greenhouse gases emissions is adopted.

Within the framework of the Slovak Republic´s Country Study, a proposal for policy and an action plan will be developed. After its adoption by the Government of the Slovak Republic it will represent a consistent national policy on climate change. This policy will be presented into the Second National Communication.

4.2.1 Research programs

National Climate Program of the Slovak Republic

The main objectives of the National Climate Program include the analysis of regional trends and climate variability, regional interpretation of global climate change scenarios and the assessment of vulnerabilities to climate change impacts on natural environment and socio-economic activities as well as the development of mitigation and adaptation strategies.

National Program of Greenhouse Gases Emission Reduction

The objectives of this program include a detailed inventory of emissions and sinks of greenhouse gases and the preparation and assessment of technical measures to mitigate greenhouse gases emissions.

Slovak National Program to Stabilise and Reduce CO_2 Emission in the Transportation

The aim of this project was to develop the inventory of CO_2 emissions from transport to project their development up to the year 2000 and to specify measures with respect to the stabilisation and reduction of CO_2 emissions from transport in the Slovak Republic.

■ The Slovak Republic´s Country Study to Address Climate Change

Because of the lack of financial resources for research projects, the Ministry of the Environment of the Slovak Republic in co-operation with the Ministry of Foreign Affairs decided to apply for U.S. Government Support for Country Studies to Address Climate Change. Slovakia is participating in the second round of this program. The objective of this program, co-financed from the financial resources of the Ministry of the Environment of the Slovak Republic and USAID, is to develop a proposal for an action plan for greenhouse gases emission abatement and the implementation of adaptation strategies to mitigate the climate change consequences. The project "The Slovak Republic´s Country Study" is supervised by US EPA officers.

4.2.2 Energy intensity and potential of energy savings

The development of economy Slovakia before 1989 was based substantially on high energy intensity heavy industry. The national economic restructuring needs an effective energy conservation policy. The following items should be taken into consideration:

- domestic energy sources to cover the total consumption represent only cca 10% (1990)
- the consumption of primary energy sources per capita is very high (178 GJ - 1990).

■ Energy intensity

The energy policy of the Slovak Republic up to 2005 shows that in spite of the fact that the energy required to produce GDP (gross domestic product) is several times higher in comparison with developed countries, but it is not a simple process to reduce it within a short period of time. Change in energy demands could be influenced by:

- changes in volume of the total production and consumption of goods and services
- structural changes among the sectors and within the economic sectors
- changes in energy and material efficiency of production and consumption
- measures influencing of GDP formation

Influence of structural changes on GDP formation

The share of industrial production in GDP formation in the Slovak Republic is high (more than 50% in Slovakia compared to 30% in OECD countries), and the share of energy intensive industrial branches (metallurgy, chemical industry, pulp and paper industry, cement production, etc.) is also high. Therefore it is necessary to support those structural changes that will bring the structure of GDP formation in Slovakia nearer to a standard typical for smaller European countries. This should result in a relative decline in GDP contribution by industry as a whole. On the other hand, the share of GDP contributed by the commercial and service sectors should rise.

■ Potential of energy savings in industrial sector

The potential of economically effective savings in the industrial sector after the input of indispensable investments for their implementation was evaluated to 10-15 PJ in primary energy sources for the year 2005. The possible savings of electricity in industry for the year 2005 was estimated at 880 GWh.

The most frequently proposed rationalisation measures included:

- modernization and innovation of production technology
- utilization of renewable and secondary energy resources including waste heat
- measurement and regulation of electrical consumption
- utilization of electricity saving appliances and devices
- modernization and reconstruction of heat transmission facilities
- thermal insulation of buildings.

The savings can be estimated approximately at 60% for solid fuels, 5% for liquid and 35% for gaseous fuels depending on the type of measure. Up to the present time several studies dealing with instruments of energy policy, especially policy relating to energy savings suitable for application in the Slovak Republic, have been developed by domestic and foreign experts.

■ **Potential of renewable sources**

One of the possibilities for fossil fuels savings is through the utilisation of renewable and secondary resources of energy

- solar, wind and geothermal energy,
- biomass as a fuel,
- production and utilization of biogas from waste,
- waste heat from condensing power plants and industrial plants,
- small hydro-power plants,
- heat pumps.

The usable potential in renewable sources is estimated at 28.8 PJ, mainly from biomass, geothermal and solar energy, biogas from waste and waste heat. The renewable resources share of primary energy sources accounts for only 2.5% (1990). The usable potential of waste heat in industrial plants represents about 4.5 PJ in Slovakia. The most effective use is within its own technology or elsewhere on site and only after these possibilities have been exhausted should off site use be considered. Analysis of the usable potential of individual types of renewable and secondary resources shows that under Slovak conditions they are only of local importance, but they represent options for the improvement of energy balance of concrete enterprise, operation, district or household. The main problem preventing the wider exploitation of renewable sources is relatively long payback time.

4.2.3 Strategy and measures to reduce CO_2 emissions

4.2.3.1 Energy sector and industry

The fundamental document for energy sector development in the Slovak Republic is the above-mentioned Energy Strategy and Policy of the Slovak Republic up to the year 2005. It defines the basic goals of development for the energy sector. One of the goals is to produce energy at the lowest price, with the lowest possible impact on the environment and promote the rational consumption of energy. In the environmental area the energy policy is aimed at the rehabilitation of the environment and the abatement of contaminating substances emissions in compliance with national legislation and international commitments.

The national target of CO_2 emissions reduction is specifically defined in the *Energy Policy* namely

20% CO_2 emission reduction in 2005 compared to 1988

The *Energy Policy* is based on the following key assumptions:

- substantially higher use of natural gas in combined production of electricity and heat in cogeneration steam-gas cycles
- implementation of fuel and energy efficiency programmes
- increasing use of renewable energy resources (mainly biomass and geothermal)
- reconstruction of the two largest Slovak fossil fuel power plants (fluid combustion, desulphurisation and denitrification)
- exploitation of the hydroenergetic potential of the Slovak Republic up to 65%
- completion of all four units in Nuclear Power Plant Mochovce (4x440 MW)
- to close the V1 NPP operation in Jaslovské Bohunice (2x440 MW) within one year after the commissioning and full power operation of the first two units of NPP Mochovce.

Pursuant to the decision of the Slovak Government No. 562 of August 17, 1993 the Minister of Economy is obliged to implement the *Energy Policy*. Consistent implementation of the recommended measures will result in a significant decline of the share of energy production from the combustion of fossil fuels, mainly of low grade brown coal, therefore ensuring a significant abatement of CO_2 emissions.

I. Measures fully or partly implemented

⇨ **Act No. 89/1987 on Production, Distribution and Consumption of Heat**

The Act requires the preparation, verification and control of heat consumption efficiency or technical and economical indicators.

Act No. 88/1987 and No. 347/1990 on Energy Inspectorate

The Energy Inspectorate was established in 1987 under the supervision of the Ministry of Economy for inspecting the efficiency of energy production and consumption and providing information on modern technologies and energy management.

Act No. 316/1993 on Consumption Tax

Tax exemptions can support efficient energy use. The operators of small hydropower plants, cogeneration cycles for common production of electricity and heat, wind power plant, solar facilities, thermal pumps, equipment for biogas production, geothermal energy use are exempted from taxation for a period of 5 years.

Liberalization of energy and fuels price

Prices represent one of the most important instruments in energy policy. Consumer prices have to reflect world prices and where these are not available, e.g. electricity, they must include in marginal costs of energy supply. At present energy prices in Slovakia do not reflect the costs (mainly inhabitants consumer prices). The intention of the energy policy defined in the *Energy Policy* is an attempt to gradually remove the fuel and energy price subsidies. The price of domestic coal is a particular problem in Slovakia.

Information campaigns

Organized by the Ministry of Economy

For the chiefs and managers of the energy departments in industry regular working meetings and professional seminars are organised, gradually involving all industrial sectors. During the seminars, domestic and foreign firms, which deal with development, trade and services in the energy sector, with an emphasis on fuel and energy consumption rationalisation are introduced. The real contribution of these measures cannot be estimated.

Organized by Slovak Energy Inspectorate - Energy Agency

The activity of Energy Consulting and Informaion Centres is focused mainly on advising with respect to energy savings in households and on the reduction of energy consumption in builings.

Organized by electricity companies

The direct contact with the client enables the energy companies to provide information with respect to the energy savings possibilities. Their information is generally considered more reliable than that provided by most other sources. During recent years, a great deal of work has been done in Slovakia, mainly due to good co-operation between the Canadian firm POWER SMART INC. and SE as well as energy distributing companies.

Training and education

A long tradition exists in training workers in the industrial energy sector. These activities are carried out by the Energy Institute SEI-EA. Recently, EI has organised the following courses:

- effective combustion
- effective utilization of fuels and energy in schools
- energy advisors and auditors.

Demonstration projects

The governmental financial support of new technologies through demonstration projects is a very useful instrument of energy policy. With respect to energy savings Slovakia has had several demonstration projects, mainly involving insulation and regulation technics.

Programs in energy savings

The Government and the relevant ministries have expressed their view of the issue of energy savings by means of program development focused on energy conservation.

Program Supporting the Economic Activities Resulting in Savings of Energy and Imported Raw Materials. By the end of the year 1993 support was provided to 53 projects with annual savings about 2.3 PJ and total contributions reaching about 100 mill. Sk. The government financial resources were spent in a very effective manner in this program. Projects for this program were chosen with an emphasis on savings and

payback. Investments to totalling a volume of 1.09 mld. Sk have been supported to date. For example, the saving of GJ of energy cost the state budget less than the usual subsidies for heat.

Program Supporting the Building of Renewable Energy Sources (as a part of the Program to reduce energy consumption in apartment houses). This program is an instrument for investment stimulation of projects focused on the construction of facilities using renewable energy sources. Within this program in 1994 the construction of small hydro-power plants with annual production 8570 MWh was supported. State support is provided in the form of:

- partial refund of interest on the loan (up to 70%)
- warrants on bank credit up to 75% of the maximum credit volume (12 mill. Sk).

II. Measures considered for the future

⇨ Act on Energy Management

According to the legislative plan of the Slovak Government a proposal for the act should be submitted for approval in December 1995. The Act on Energy Management will replace the current acts. The Act will set out the conditions of business activities in the area of production, transmission and distribution of energy and its rational consumption.

⇨ Set the principles of regional energy policy

This part of the regional policy should include gradual development of energy generels to the district level, in which all local energy sources, including waste heat and renewable energy sources, will be identified and quantified. Cogeneration should be taken into account.

⇨ Institutional building for project identification and implementation to reduce greenhouse gases

National Panel on Collection, Evaluation and Implementation of Projects to Reduce Greenhouse Gases will be established.

⇨ Establishment of a fund to increase energy efficiency

This fund should provide the necessary financial resources for the implementation of effective projects. A fund to increase the energy efficiency with subsidies from domestic financial resources and with the possible help of international financial organisations (e.g. EBRD, GEF or PHARE) could help the transforming Slovak economy to overcome the problem of the lack of sources of investment capital.

⇨ Energy audits

In accordance with the experience of developed countries, the obligation to carry out energy audits should be established as an effective instrument for the analysis of energy saving possibilities in existing facilities and newly constructed facilities. Foreign experience suggests the usefulness of governmental co-financing of these audits.

⇨ Demand side management

The project quantifying the possibilities of implementing DSM into the Slovak energy sector will proceed in co-operation with the Canadian company POWER SMART INC. The main technical and economic DSM potential has been identified and for Slovakia and two alternatives have been proposed.

The frst alternative: DSM of high intensity
This alternative is a high cost option including discounts and direct financial support as well as training, advancement, marketing and consulting with customers. Using this alternative 1059 GWh/year and 324 MW in peak output could be saved. The costs of electricity companies for implemented DSM projects are estimated at 2.4 mld Sk within a 15-year planning period.

The second alternative DSM of low intensity
This alternative does not use discounts or direct financial support. It is based only on advancement and information campaigns for electricity consumers. In this way 504 Gwh/year and 137 MW in peak output can be

saved, with costs of 509 mill. Sk within a 15-year period.

A wide range of energy savings programs was proposed:

- Lighting improvement in industry and services
- Optimisation of electricity consumed in industry and services
- Highly efficient motors speed control, peak load reduction
- Modernisation of building aimed at rationalisation of electrical consumption
- Decentralised hot water preparation in households
- Global household program
- Energy efficiency of electrical appliances in households
- Household lighting
- Electric heating rationalisation

⇨ **Labelling of appliances**
Appliance labelling is to a low cost instrument of energy policy with positive experiences abroad, but in Slovakia it has not been successfully applied.

⇨ **Legislative regulation on the compulsory use of waste heat in industry**

4.2.3.2 Residential and service sector

I. Measures fully or partly implemented

Pursuant to the decision of the Slovak Government No. 131/1991 a program supporting the energy efficiency "Principles of governmental participation in fuel and energy consumption abatement in apartment houses" was approved. In the years 1991 and 1992, 49 projects achieving annual savings of heat of about 830 TJ were supported (government contribution 103 mill Sk).

The Ministry of Transport, Telecommunication and Public Works of the Slovak Republic issued Directive No. 14/1994 on procedures and technical conditions for additional insulation and the removal of defects in apartment houses. The rules to determine governmental participation in the financing of the following programs were established:

⇨ **Program of Additional Salution and Removal of Defects in Apartment Houses**
Government subsidies are provided to owners of apartment houses for improvements of thermoinsulating properties of building structures. During the years 1992-1994 subsidies of more than 320 mill. Sk were provided and 3,432 flats were insulated. The assumed annual savings is approximately 120 TJ.

⇨ **Program of Energy Consumption Reduction in Apartment and Family Houses**
The program is designed for owners of apartments and family houses and their heat suppliers. The government financial support is provided in the form of:

- partial refund of interests from loans (maximum 70%), the maximum support for one project must not exeed 200 Sk for 1 GJ of heat saving per year, or 0.30 Sk for 1 kWh of electricity saved,
- the financial support is repayable within 3 years. This support is available only to legal persons and to a maximum amount 3 mill.Sk. Maximum support for one project is 300 Sk for 1 GJ of heat savings per year, or 0.50 Sk for 1 kWh of electricity saved.

In 1994, subsidies totalling of 20 mill. Sk (reonstruction of heat source and its measuring and regulation equipment) were provided in this program. Total annual savings are estimaed at 130 TJ (for the year 1994).

II. Measures considered for the future

⇨ **Standardization the Heat Insulation of Buildings - STN 730540**
Standards for coefficients of heat transmission in civil engineering were strengthened. Within a relatively short time, the levels

used in the EU countries will be reached. Table 4.1 presents the heat transmission coefficients and annual demand of heat for an average flat. The application of these standards alone since 1992 means that in newly constructed buildings the savings will amount to about 1.5 PJ by the year 2005. A great technical potential for energy savings exists in the residential sector (65%, 54 PJ). To date this potential has been exploited only minimally, while the costs for complex energy savings measures (heat insulation and regulation of heating-up system) are high in comparison with energy prices.They can be estimated at 1,500 Sk/m^2. Therefore, to date only about 1.5% of the flats built before 1984 (the flats with high energy consumption) were insulated.

Table 4.1

The heat transmission coefficients (W/m^2K) of buildings and annual energy demands E (MWh/flat.year)

	1966 - 1983	1984 - 1991	1992 -
windows	*xxx*	3.70 [x]	2.70 [x]
walls	1.45 [x]	0.89 [x]	0.46
roofs	0.79 [x]	0.51 [x]	0.32
E[xx]	12.60 [x]	9.30 [x]	7.30

[x] *for a temperature area A (-15°C)*
[xx] *for residential house* [xxx] *not specified*

4.2.3.3 Transport

The organisation use and convenience of transport plays an important role in relation to greenouse gases emissions. With respect to the decline of economic capacity a trend to lower traffic intensity was observed in the last period. An increase in capacity, mainly in the area of road transport and railways, is projected over the next 10 years. To avoid the undesirable trend toward road transport increases, it will be necessary to develop and apply measures giving preferential treatment to railway traffic. Public transport has been receiving subsidies. The transition to a market economy brought about significant price increases in transport tariffs. Fortunately, a relatively radical increase in fares did not significantly influence transport use. It is important to search for optimum solutions to continue to use of public transport at the present level.

I. Measures fully or partly implemented

⇨ Taxes

Consumption Tax on Hydrocarbon Fuels and Lubricants. The consumption tax (Act No. 316/1993).amounts to 10,800 Sk/t, or 9,390 Sk/t for gasoline. For diesel fuel there is the lower consumption tax, namely 8,250 Sk/t.

Road Tax (Act No. 87/1994). The road tax should be reconsidered in order to include the age of vehicles and swept volume. Currentlyapplied differentiation in combined transport stimulates the transporters, but not the producers of combined transport equipment.

⇨ Inspection of vehicles in use

Fuel consumption is substantially influenced by the technical state of the vehicles. The technical operating state of vehicles in use and their emissions are inspected at regular intervals. Therefore a network of inspection stations has been established and is being extended.

⇨ Combined transportation

Only one system of combined transportation based on large containers of the ISO 1C range is operated in the Slovak Republic. There are 1,380 km of the railway tracks in the Slovak Republic and there are reloading facilities in Bratislava, Zilina, Košice and Cierna nad Tisou which are included in the AGTC list as among the most important. The strategy of combined transportation is based on Slovak Government Decisions Nos. 833/1992 and 644/1991 in which measures (mainly legislative) to limit road traffic have been adopted.

⇨ Lowering of ineffective transport in urban agglomerations

The traffic control and information system in urban areas needs improvement. Measures like monitoring of parking place situation, parking limitations, extending of pedestrian

zones, shuttle traffic, preference of low emission transport means, etc. should be more widely implemented.

⇨ **Preference of electric traction to diesel railway transport**
At present 1,373 km of track, approximately one third of the total system, are electrified. The transport policy assumes the completion of electrification on the main railway tracks in Slovakia.

⇨ **Alternative fuels**
Commercial transportation using electrical or solar energy are exempted from road tax for 5 years. Vehicles powered by liquid propane gas or compressed natural gas have their taxes reduced by 50% for a period of two years. Economic incentives for the construction of the appropriate infrastructure (filling stations) will also be necessary.

II. Measures considered for the future

⇨ **Optimization of motor-car traffic in cities**
Optimisation of urban traffic systems (uninterrupted drives, green light waves, equable occupancy of municipal communications, enlargement of traffic lines and parking places, etc.).

⇨ **Municipal charges**
Charges for automobile traffic in city centres and subsidising mass transit can reduce traffic intensities in urban centres.

⇨ **Tax on motor-cars**
This tax should take into account the engine output, fuel consumption, emission, vehicle age, etc. and should be considered as an environmental tax.

⇨ **Preference of public transport**
Preference of mass transit to individual transit and railway traffic to road freight traffic should be given. These measures could reduce CO_2 emissions from transportation by 30%.

⇨ **Permissible speed**
A speed limit of approximately 80 km/h outside of built up areas would reduce CO_2 emissions.

⇨ **Cycling**
In Slovakia bicycles are used mainly for recreation. Every day mass bicycle use needs the construction of the appropriate infrastructure.

⇨ **Education**
Education of inhabitants to ecological behaviour will be supported. For example the driving mode can significantly (up to 15%) reduce of CO_2 emission.

4.2.3.4 Cross sectorial measures

At present the most important legislative instrument to lower carbon dioxide emissions is effective air protection legislation. The regulations are not directly linked with CO_2 , but the Air Protection Act established an obligation to apply the best available technologies not entailing excessive costs (BATNEEC) to new facilities. BATNEEC is characterised by emission standards. The present Slovak emission standards are comparable to German ones (TAL, 1986). The existing facilities must meet these standards within a strictly determined period. There is also an economic instrument - each operator pays the charges for air pollution. A survey of regulations follows:

⇨ **Act No. 309/1991 on the Protection of the Air against Pollutants**
Pursuant to paragraph 6(5) of the Act No. 309/1991 for the construction of new facilities or modernisation of existing facilities the best available technologies not entailing excessive costs must be applied.

⇨ **Decree of the Slovak Commission for the Environment No. 407/1992 on Emission Standards**
The emission standards for SO_2, NO_x, CO, particulate matter and other pollutants are determined for new air pollution sources. The existing sources must meet these standards before December 31, 1998.

⇨ **Act No. 134/1992 on the Governmental Administration of the Air Protection**
According to this Act the independent state administration operates at three levels: the Ministry of the Environment, district environmental offices and municipalities, as well as the air protection inspectorates have been established.

⇨ **Act No. 311/1992 on Charges for Air Pollution**
Pursuant to this Act every operator of a pollution source is obliged to pay charges for air pollution (particulate matters 3,000 Sk/t, SO_2 1,000 Sk/t, NO_x 800 Sk/t, CO 600 Sk/t, organic compounds 1,000-20,000 Sk/t; 100 Sk ≅ 3 US $). Although the charges for CO_2 were not specified, CO_2 emissions are indirectly affected.

⇨ **Act No. 128/1992 on Governmental Fund for the Environment, Decree No. 176/1992 on Conditions for Providing and Use of the Financial Means from Governmental Fund for the Environment of the Slovak Republic**
Pollution charges and government subsidies create the government fund for the environment. From this fund environmentally friendly activities are supported (fuel switching, natural gas powered buses, cogenerations, etc.).

⇨ **Information materials**
The non-governmental organisation Fund for Alternative Energy (a part of the largest ecological non-governmental organisation - the Slovak Union of Nature and Landscape Protectors) has issued a publication containing information on the possibilities of savings and use of renewable energy sources:
- Energy reserves in Slovakia
- Renewable energy sources - never-ending energy.

The fund video library provides the public and schools with its services free of charge. The centre for ecological education in Prievidza will be equipped with a small hydropower plant in 1995.

4.2.4 Measures to reduce the emissions of other greenhouse gases

4.2.4.1 Methane

Waste Management
Prior to 1991 there was no legal regulation for the landfilling of municipal waste. Waste had been dumped in unmanaged landfills which did not provide the appropriate conditions for anaerobic methane production. By the year 2000 an increase in methane released from landfills of municipal waste is expected, mainly due to
- building of landfills for municipal waste with respect to legislative requirements thus ensuring suitable conditions for methane generation in comparison with the situation before the legislation
- the fact that produced currently methane is not utilized or destroyed.

The increase in methane volume will be abated by
- extending the separate collection of paper
- increase in the share of organic components of municipal waste processed to compost
- abatement of the amount of municipal waste to be treated due to the charges for removal and landfilling, increase of ecological public awareness,
- gradual implementation of measures meeting the requirements of new legislation for retaining, utilization and destruction of methane from municipal waste landfills.

Prior to 2000 a level of methane emissions approximately equal to the present level is assumed. In the year 2005 a decline in methane emission by about 15% compared to 1995 can be expected. This decline is achieved by adjustments and amendments to legislative measures for managed landfilling of municipal waste, mainly in regional landfills and their completion for recovery, utilisation and destruction of methane.

I. Measures fully or partly implemented

In the Slovak Republic there were 7,204 landfills registered in 1992, but only 335 were licensed. The waste management program prior to 2000 contains goals related to methane emissions:

- to extend the collection and utilization of secondary resources, by implementation of separated collection to reduce the amount of municipal waste to be treated by 20% compared to 1992.
- utilization of at least 20% of biological waste as organic fertilizer
- destruction of 50% of all municipal waste in landfills meeting the technical requirements
- to start the sanation of unmanaged landfills
- to build new municipal waste incinerators or reconstruct the existing ones in Bratislava and Košice
- to build 10 composting facilities
- to build 9 high capacity regional landfills for municipal waste

Legislative measures

To support the goals for waste management regarding the problems of methane emissions from landfills for municipal waste, in 1991 several legislative measures have been adopted.

⇨ **Act No. 239/1991 on Waste** represents a fundamental legal norm in waste management. It establishes a duty to every waste generator to use the waste as a source of secondary materials or energy. Disposal of waste in landfills should be the last stage of waste treatment.

⇨ **Ordinance of the Slovak Government No. 605/1992 on Keeping Evidence on Waste** establishes the rules for landfill management. The building of new landfills where gas generation is assumed must include a gas drainage system. There is also an obligation to monitor the quantity and composition of gas at least twice a year.

⇨ **Ordinance of the Slovak Government No. 606/1992 on Waste Treatment** specifies the basic principles of keeping evidence on waste.

⇨ **Act of the Slovak National Council No. 309/1992 on Charges for Waste Disposal** determines the charges for municipal waste disposal in landfills and application of higher charges for waste disposal in dumps that do not meet the legislative requirements.

⇨ **Measure to the Act of the Slovak National Council No. 309/1991 on Charges for Waste Disposal** places the waste landfills into a list of air pollution sources.

The legislation effective does not force the owners or operators of landfills to utilise a gas, or to destroy it.

Economic Instruments

Implementation of separated collection and construction of large regional managed landfills for municipal waste are subsidies from the Governmental Fund for the Environment thus creating the prerequisites for future use of landfilling gases.

II. Measures considered for the future

Updating of legislative measures

Currently work on updating the waste management legislation has started. New legislation will take into account the recovery, destruction and utilisation of landfilling gases.

Technical regulations

Slovak technical standards for recovery, destruction and utilisation of landfilling gases will be adopted.

Information system

With respect to waste management legislation the information system will be completed. This system will contain sufficient input data to calculate the landfilling gases inventory.

Energy sector

Leakage from the natural gas distribution system is the most important emission source of methane in the energy sector. According to Slovak energy policy the increasing importance of

natural gas is assumed in the next decade. Therefore a general improvement of all gas distribution facilities including local distribution networks is needed.

Agriculture

- **Act No. 61/1964 on Development of Plant Production** specifies the principles of using fertilizers for field crops and indirectly the procedures for fertilizer and manure dumps.

- **Directive of Ministry for Agriculture and Nutrition of the Slovak Republic No. 5001 /1982 on manipulation with and utilization of liquid manure and liquidation of ensilage juices** states the principles of manipulation and utilization of liquid manure.

- **Ordinance of the Government of the Slovak Republic No. 606/1992 on Waste Treatment** asks the agricultural sector to develop the programs for systemic reduction of waste from consumer products and packages including the rest of agrochemicals and their packing.

4.2.4.2 Nitrous oxide

Agriculture

The increase of nitrous oxide emissions can be assumed as a result of agricultural production intensification, especially when the N-fertilisers are applied with higher intensity or in areas with damaged aeration regime in soils. The increase of mineral nitrogen surpluses in soils in Slovakia prior to 1988 was followed by a rapid decline. The decline in consumption of fertilisers is not a result of environmental farmers behaviour, but a consequence of the economic recession in agriculture. The expected improvement of economic conditions will bring about the rise of N-fertiliser consumption as follows:

Year 2000	138 kg N/ha (the year 1990 level)
Year 2005	155 kg N/ha (the year 1988 level)

I. Measure fully or partly implemented

- **Act No. 307/1992 on the Protection of Farmland.** Pursuant to this Act the user of farmland is obliged to use it in a way that the quality of other environmental components is not damaged (air, water). Changes in agricultural land use can be made only with the agreement of an authority for the protection of agricultural land.

- **Act No. 61/1964 on Development of Crop Production** specifies the principles of using fertilisers for field crops and indirectly the procedures for fertiliser and manure dumps.

- **Directive of Ministry for Agriculture and Nutrition of the Slovak Republic No. 5000 /1982 on Water Protection against Agricultural Contamination** outlines the principles of application of mineral nitrogenous and organic fertilisers in the Slovak Republic.

- **Directive of Ministry for Agriculture and Nutrition of the Slovak Republic No. 5001 /1982 on manipulation with and utilization of liquid manure and liquidation of ensilage juices** outlines the principles of manipulation and the use of liquid manure**.**

II. Measure considered for the future

- **Codex on Quality Assurance in Agricultural Practice in the Slovak Republic.** This codex should be developed in order to bring the legal regulations and directives in compliance with EU directives.

- **Action Plan of Reduction of Water Nitrate Contamination in Agriculture.** This program should be developed in accordance with the "EC Nitrate Directive 1991". This document introduces strict measures to limit the surpluses of nitrogen in soils and thus indirectly limits the nitrous oxide emissions from soil to the air.
- **Methodology of special agriculture practice in areas of hygienic protection of water sources and in polluted areas.** The methodology strictly formulates the require-

ments for correct use of N-fertilisers, thus indirectly influencing the reduction of nitrous oxide emissions from soil to the air.

4.2.4.3 Volatile organic compounds and carbon monoxide

Volatile organic compounds and carbon monoxide are not radiatively active gases but they indirectly support the greenhouse forcing. In the year 1993 an introductory study, National Program of VOCs Emissions Reduction, was established. An intersectorial working group composed of the representatives of state administration authorities, major industrial companies that contribute significantly to VOCs emissions and experts from professional institutions was established. The Government of the Slovak Republic decided (Decision No.929 of September 6, 1994) that the Slovak Republic accepts the Protocol on the Reduction of Volatile Organic Compounds Emissions to the Convention on Long-Range Transboundary Air Pollution, therefore accepting an international commitment to reduce the anthropogenic VOCs emissions by 30% by 2000 compared to 1990. Ratification of the VOCs Protocol in the Slovak Parliament is expected in 1995. The method of achieving this goal is the National Program of Volatile Non-methane Organic Compounds Emissions Reduction. This program should be submitted to the Slovak Government by June 30, 1995. Further measures to reduce VOCs and CO result from effective air pollution legislation (emission standards, BATNEEC, charging of polluters, three-way catalytic converters, etc.)

4.2.5 Measures to increase the greenhouse gases sinks

I. Measures fully or partly implemented

⇨ **Program of Afforestation of Agricultural Non-utilizable Land within the years 1994 -1996 with Projection to the year 2000**

This program assumes the afforestation of state non-forest land that is not suitable for agricultural utilisation with total area about 50,000 ha by the year 2000. Costs for the program are estimated at 2.2 mld. Sk.

CHAPTER 5

Projection and assessment of effects of measures

The emission projections in countries with economies in transition are influenced by the uncertainties accompanying the transition process. Considering the on-going transformation process, the extrapolation of historical data for energy demand cannot be used. At the time, when the First National Communication was prepared, energy projections were based on the "Energy Strategy and Policy of the Slovak Republic up to the year 2005" and the "Slovak National Program to Stabilise and Reduce CO_2 Emission in the Transportation".

5.1 Projection of CO_2 emission

5.1.1 Energy-related CO_2 emission

5.1.1.1 Basic consideration of CO_2 emission projection

The key assumptions used for emission projections, are provided in Chapter 4. To prepare a scenario of Primary Energy Sources (PES) consumption in period 1990-2005, the following input data has been used:

- Scenario of GDP development
- Scenario of energy intensity (EI) development
- Scenario of End-Use of Energy (EUE)

Energy balance in *Energy Policy* is based on the one GDP development scenario only. Table 5.1 as well Figures 5.1 and 5.2 summarises the above scenarios for the period

Table 5.1

Key assumption for scenario of PES demand

	1990	1995	2000	2005
GDP				
[bil. Sk]	232.1	178.3	204.8	238.6
Share of the 1990 level	100%	77%	88%	103%
Primary energy sources				
[PJ]	941	822	891	936
Share of the 1990 level	100%	87%	95%	99%
Fuels [PJ]	781	661	681	725
Share of PES	83%	80%	76%	77%
Electricity [PJ] [1]	28	26	13	14
Share of PES	3%	3%	1%	1%
Primary nuclear heat [PJ] [2]	132	135	197	197
Share of PES	14%	16%	22%	21%
Energy Intensity				
[PJ/bil.Sk]	4.05	4.61	4.35	3.92
[Toe/thousand USD] [3]	1.74	1.98	1.87	1.69
Share of 1990 level	100%	114%	107%	97%

[1] electricity import and hydropower, [2] heat released in primary circuit of nuclear power plant, [3] in constant prices of 1990

of 1990-2005.

The primary energy balance in *Energy Policy* considers these core measures:

- The share of natural gas will increase in the end-use of energy and in the energy sector.
- Implementation of energy conservation measures will result in a 31.5 PJ fossil fuel decrease in 2005.
- The new nuclear power plant will be in operation.

Figure 5.1

Development GDP, PES and EUE in period 1990-2005

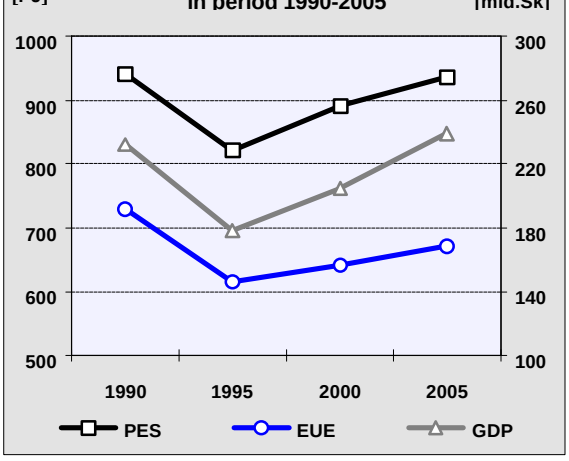
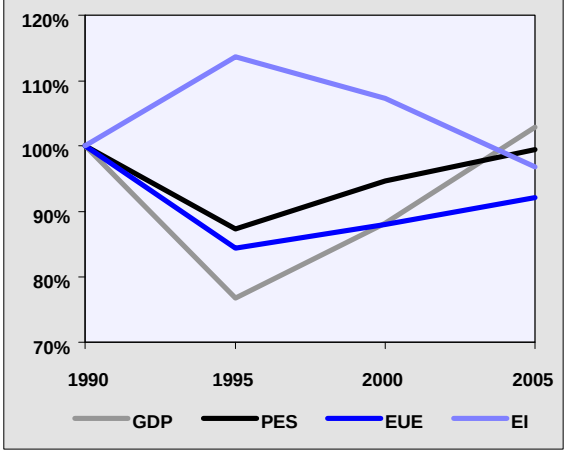


Figure 5.2

Relative development of GDP, PES, EUE and EI to the base year



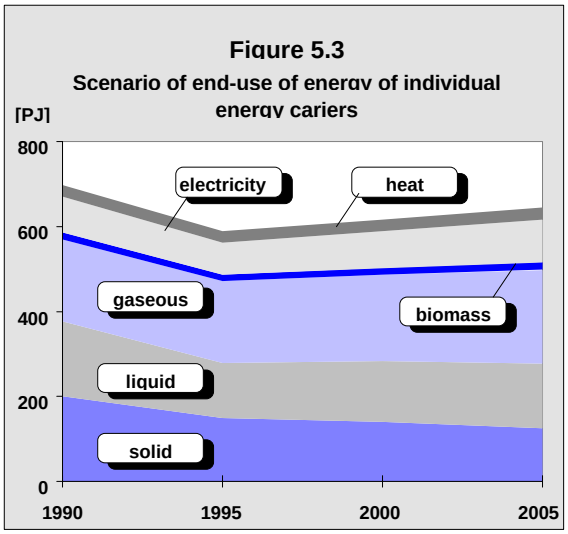
End-use of energy

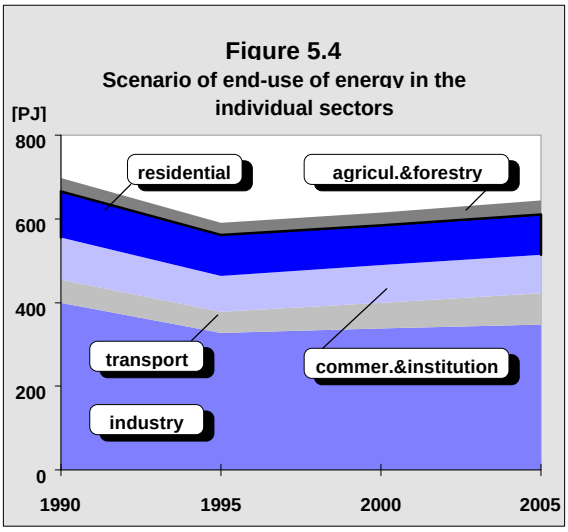
The scenario of end-use of energy is based on the assumptions of energy carriers demand in individual economic sectors and is illustrated in Table 5.2, Figures 5.3 and 5.4.

Table 5.2

End-use of energy by the individual sectors [PJ]

	1990	1995	2000	2005
Industry	**400**	**327**	**338**	**347**
solid	111	86	83	77
liquid	99	58	59	52
gaseous	120	119	126	137
biomass	13	12	14	16
electricity	54	49	54	60
heat	3	3	3	4
Transport	**55**	**51**	**62**	**75**
solid	0	0	0	0
liquid	51	47	58	70
gaseous	0	0	0	0
biomass	0	0	0	0
electricity	4	4	4	5
heat	0	0	0	0
Commercial & Institution	**99**	**86**	**88**	**91**
solid	35	25	22	19
liquid	7	6	7	7
gaseous	41	40	43	46
biomass	0	0	0	0
electricity	9	7	9	11
heat	8	7	8	8
Residential	**111**	**97**	**96**	**98**
solid	50	35	30	26
liquid	2	2	2	2
gaseous	29	28	30	33
biomass	3	2	3	3
electricity	13	14	16	18
heat	15	15	15	16
Agriculture& forestry	**33**	**29**	**31**	**34**
solid	5	3	3	2
liquid	20	17	20	22
gaseous	3	3	3	4
biomass	0	0	0	0
electricity	4	4	4	5
heat	1	1	1	1
End-use of energy	**698**	**589**	**616**	**645**
solid	200	150	139	124
liquid	177	130	145	153
gaseous	193	191	202	220
biomass	16	15	16	20
electricity	84	78	87	99
heat	27	26	27	29

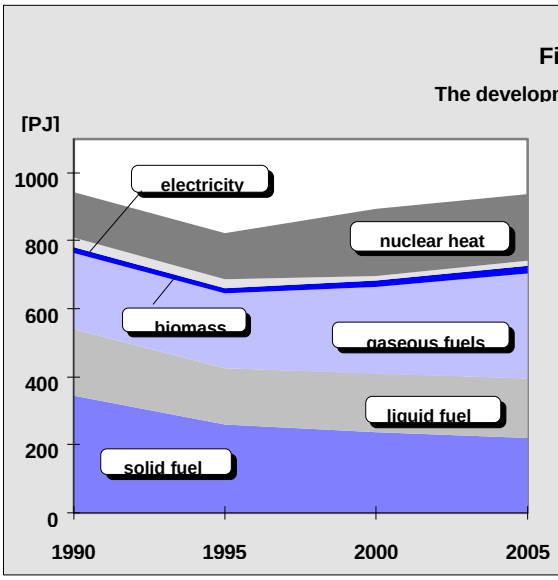




The structure of fossil fuel consumption in individual sectors will be influenced by the requirements of the new environmental legislation. Brown coal/lignite consumption will decrease by 55% in 2005, compared to 1990 and its share will be replaced by natural gas consumption. The consumption of coke and coking coal will decrease in 2005 by 20% from the base year 1990. Heavy fuel oil consumption will decrease in 2005 by 14% (from the 1990 level). On the other hand consumption of fuels for transport (gasoline, diesel oil) will increase by 25% in this period. From the CO_2 emissions point of view the increasing share of biomass is important since CO_2 emissions from biomass combustion is not incorporated in the total emission balance. The increase of direct use of heat and electricity will have a positive influence on the CO_2 emission balance.

Primary energy sources demand

In period 1990-2000 primary energy consumption will decrease with the decrease in GDP. The energy intensity will increase in this period as GDP is not in a linear relation with PES demand. After 2000 decrease in energy intensity is assumed. Figure 5.5 illustrates the development of individual primary energy source demand. In 1990-2005 solid fuel decline will be 36.1%, liquid fuel decline being 10.4%.



PES demand [PJ]

	1990	1995	2000	2005
solid fuel	343	260	238	220
liquid fuel	197	165	170	176
gaseous fuel	224	221	256	309
biomass	17	15	17	21
electricity	28	26	13	15
nuclear heat	132	135	197	196
total	**941**	**822**	**891**	**936**

The decline of both these fuels will be replaced by the increased consumption of the following primary energy sources: Natural gas by 38.1%, biomass by 21.9% and primary nuclear heat by 48.5%. The latter will be used primarily in the sector *Energy and Transformation*, where coal consumption will decrease by 30%.

5.1.1.2 CO_2 emission scenario based on *Energy Policy*

Using the IPCC methodology, the CO_2 emission scenario has been calculated. The proposed fossil fuels consumption from the *Energy Policy* has been used as input data. The fossil fuels consumption in individual sectors is presented in Table 5.3 and Figure 5.6. The CO_2 emission in individual sectors is presented in Table 5.4 and Figure 5.7. The total CO_2 emission scenario is illustrated in Figure 5.8.

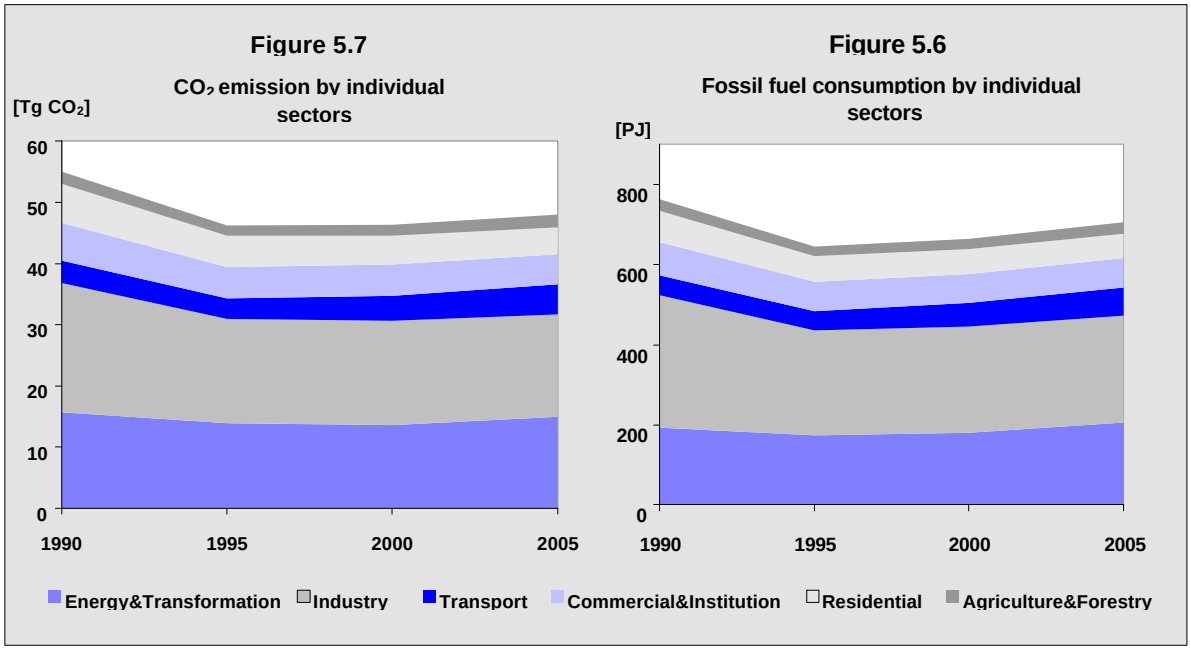
The CO_2 emission decline in the period 1990-1995 is related to the PES demand decline. After 1995 an increase in GDP is expected. This will be accompanied by a PES demand and CO_2 emission increase. Nevertheless, CO_2 emissions in the year 2000 will not exceed the 1990 level, a fact which is important from the FCCC requirement of CO_2 stabilisation point of view. The relative decrease of CO_2 emissions in

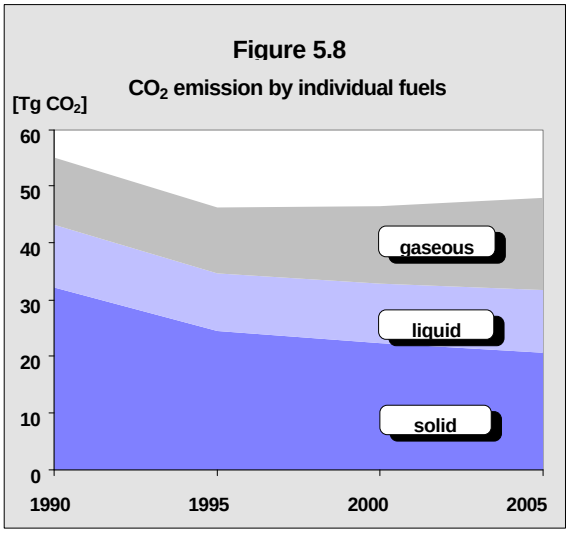
Table 5.3
Fossil fuel consumption by individual sectors [PJ]

	1990	1995	2000	2005
Energy& Transformation	**193.6**	**174.6**	**179.1**	**207.6**
solid	143.1	109.4	99.2	95.1
liquid	19.4	35.4	25.5	23.1
gaseous	31.1	29.8	54.4	89.5
Industry	**329.6**	**263.0**	**267.8**	**266.6**
solid	110.9	86.2	83.4	77.5
liquid	98.6	57.9	58.6	52.1
gaseous	120.2	119.0	125.8	137.0
Transport	**51.0**	**47.2**	**58.2**	**69.8**
solid	0.0	0.0	0.0	0.0
liquid	51.0	47.2	58.2	69.8
gaseous	0.0	0.0	0.0	0.0
Commercial& Institution	**82.7**	**71.4**	**71.4**	**72.5**
solid	35.3	25.4	22.2	18.8
liquid	6.7	5.6	6.6	7.2
gaseous	40.8	40.4	42.7	46.5
Residential	**79.6**	**65.5**	**62.2**	**60.4**
solid	49.5	35.3	30.4	25.7
liquid	1.5	1.9	1.9	2.1
gaseous	28.6	28.3	29.9	32.6
Agriculture& Forestry	**27.3**	**23.5**	**25.7**	**28.1**
solid	4.6	3.3	2.9	2.4
liquid	19.5	17.1	19.6	22.1
gaseous	3.1	3.1	3.3	3.6
Total	**763.9**	**645.2**	**664.4**	**704.9**
solid	343.3	259.6	238.0	219.5
liquid	196.8	165.0	170.4	176.3
gaseous	223.8	220.6	256.0	309.1

Table 5.4
CO_2 emission by individual sectors [Gg]

	1990	1995	2000	2005
Energy& Transformation	**15 679**	**13 874**	**13 554**	**14 971**
solid	12 772	9 701	8 742	8 358
liquid	1 164	2 499	1 835	1 769
gaseous	1 743	1 673	2 977	4 844
Industry	**21 155**	**17 107**	**17 128**	**16 693**
solid	10 934	8 546	8 289	7 733
liquid	4 190	2 589	2 528	2 086
gaseous	6 031	5 972	6 311	6 875
Transport	**3 628**	**3 341**	**4 108**	**4 914**
solid	0	0	0	0
liquid	3 628	3 341	4 108	4 914
gaseous	0	0	0	0
Commercial& Institution	**6 153**	**5 118**	**5 015**	**4 962**
solid	3 355	2 428	2 122	1 806
liquid	512	426	501	551
gaseous	2 286	2 264	2 392	2 606
Residential	**6 383**	**5 052**	**4 684**	**4 405**
solid	4 686	3 347	2 888	2 449
liquid	95	118	118	129
gaseous	1 603	1 587	1 677	1827
Agriculture& Forestry	**2 035**	**1 731**	**1 885**	**2 041**
solid	437	313	273	231
liquid	1 422	1 245	1 428	1 610
gaseous	175	174	183	200
Total	**55 033**	**46 223**	**46 373**	**47 987**
solid	32 185	24 335	22 314	20 576
liquid	11 010	10 219	10 518	11 060
gaseous	11 839	11 669	13 541	16 351





2000, compared with the 1990 level will be 15.7%. The National Target is an energy related CO_2 emission decrease of 20% in the period 1988-2005. This 20% CO_2 emission decrease will be achieved in the period 1990-2000. In the target year 2005, when the economic revival is assumed, the estimated CO_2 emission level would exceed the National Target target level. Table 5.5 illustrates the energy related CO_2 emission level and the difference between the individual years and the base year for the National Target (1988). As can be seen, the difference between the National Target (20% decrease) and emission level assumed from the input data from the *Energy Policy* is only 2%. After the correction, using the new data from transportation sector, it can be assumed, that the National Target will be achieved.

Table 5.5

CO_2 emission based on the *Energy Policy*

	1988	1990	1995	2000	2005
Δ CO_2	0.0%	5.5%	20.6%	20.4%	17.6%
Total CO_2 [Gg]	58 244	55 033	46 223	46 373	47 987

5.1.1.3 Assessment of effect of measures to mitigate CO_2 emission

As was stated above, the *Energy Policy* considers some measures having direct impact on the CO_2 emission level. The total effect of this policy has been divided into following steps:

Step 1 can be considered as *Business as usual*, and is characterised as follows: The primary energy demand will be met by non-fossil energy sources (nuclear primary heat, electricity from export and hydropower and biomass) in the same level as the base year 1990. The ad-

ditional energy demand will be met by fossil fuels.The share of individual fossil fuels will be the same as in the year 1990.

Step 2 The level of primary energy supply from non-fossil energy sources in each individual year is the same as in the *Energy Policy*. The share of individual fuels is the same as in 1990. CO_2 emission difference between Step 1 and Step 2 represents the introduction of the non-fossil energy source.

Step 3 In this step the impact of energy conservation measures is considered. Their total benefit will be in the year 2005 31.5PJ, 60% in solid fuels, 5% in liquid fuels, 35% in gaseous fuels. The CO_2 emission difference between Step 2 and Step 3 represents the impact of implementation of energy conservation measures.

Step 4 represents a projection based on the energy balance, considered in the *Energy Policy*. The shares of individual fossil fuels is influenced by the environmental requirements. The CO_2 emission difference between Step 3 and Step 4 represents the effect of environmental requirements.

The CO_2 emission in individual steps of analysis is illustrated in Figure 5.9. Emission has been calculated using activity data for solid, liquid and gaseous fuel and its aggregated emission factors $EFCO_2$ as follows:

$$\textbf{Emission } CO_2 = \Sigma\, act_i \times EFCO_{2,i}$$

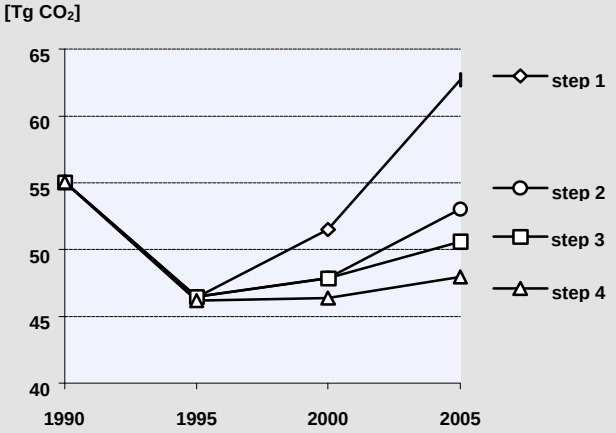
In the case of steps 1-3 the aggregated emission factors of solid, liquid and gaseous fuels from the base year 1990 have been used. The shares of individual fuels were the same. Step 4 represents the emissions according to the Energy Policy fuel balance. Figure 5.9 shows that CO_2 emission level approximates in individual steps to the level, calculated on the basis of energy balance from Energy Policy.

5.1.1.4 Energy related CO_2 emission scenarios

In 1995 document the Slovak National Program to Stabilise and Reduce CO_2 Emission in the Transportation was finished. Consequently data from the *Energy Policy* on fuel consumption in the transport sector were updated. On the basis of previous analyses and new input data from the transportation sector, the CO_2 emission scenario have been constructed using of IPCC methodology. The results of this balance and their comparison with the data calculated from the *Energy Policy* is in Table 5.6. The total

Figure 5.9

Assessment of effect of measures on the CO_2 emission



CO_2 emission [Tg]

	1990	1995	2000	2005
step 1	55	46	51	63
step 2	55	46	48	53
step 3	55	46	48	51
step 4	55	46	46	48

Table 5.6

CO_2 emission projection in transport

		1995	2000	2005
Energy Strategy & Policy				
Gasoline	[TJ]	22 394	30 903	39 998
Diesel	[TJ]	38 982	43 313	47 645
Total	[TJ]	**61 376**	**74 217**	**87 643**
Gasoline	[Gg CO_2]	1 536	2 120	2 744
Diesel	[Gg CO_2]	2 830	3 145	3 459
Total	[Gg CO_2]	**4 366**	**5 265**	**6 203**
Study of CO_2 emission in transportation				
Gasoline	[TJ]	21 615	25 293	27 638
Diesel	[TJ]	38 182	44 715	45 330
Total	[TJ]	**59 797**	**70 008**	**72 968**
Gasoline	[Gg CO_2]	1 483	1 735	1 896
Diesel	[Gg CO_2]	2 772	3 246	3 291
Total	[Gg CO_2]	**4 255**	**4 982**	**5 187**
Δ CO_2	[Gg CO_2]	**112**	**283**	**1 016**

amount of CO_2 emission is lower than that, based on the *Energy Policy*. The Ministry of Transport and Telecommunication is planning to implement measures to enable the CO_2 emission decrease in transport to reach 10% in 2005. The measures presented in paragraph 4.2.3.3 are considered. The highest effect is assumed from the measures presented in item I. Under this condition CO_2 emission of 4,668 Gg will be achieved in 2005. This represents CO_2 emission difference 1,535 Gg in the transport sector, compared to the balance based on the *Energy Policy*.

As stated above, in 2005 the energy balance in the *Energy Policy* assumes the minimal impact of energy conservation measures. Table 5.7 brings the balance of minimal and maximal impact of energy conservation measure as well as the possible potential of energy conservation.

Table 5.7

Energy conservation measures

Type of measures and sector of its application	Energy conservation [PJ] Min.	Max.	Potential
Industry	10	15	60
Construction	0.5	1.2	32
Conserv. programs	8	10	10
DSM	4	8	8
Restructuring	9	16	16
Total	**31.5**	**50.2**	**126**

Together with these measures the new data from transport sector has to be included in the energy balance. On the base of this energy balance analysis, it is possible to prepare the following CO_2 emission projection scenarios for individual years 1990, 1995 and 2005:

Scenario A represents *Business as usual*, (Step 1, Figure 5.9)

Scenario B is based on the energy balance from the *Energy Policy* (Energy conservation 31.5 PJ) including the new data from transportation sector. **Scenario B represents the most likely option of emission production development in Slovakia and all measures will be focused on its achievement.**

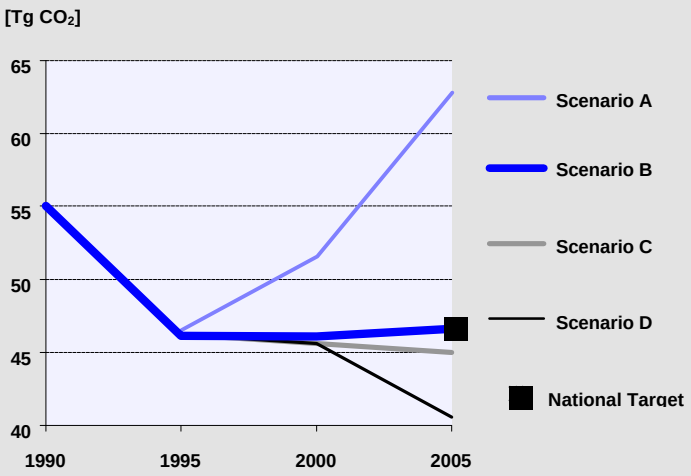
Scenario C Scenario B, 10% CO_2 reduction in the transport sector, Energy conservation 50.2 PJ in 2005

Scenario D Scenario C, energy conservation 126 PJ in 2005

The individual scenarios are illustrated in Figure 5.10.

Figure 5.10

Scenarios of CO_2 energy related emission



CO_2 emission [Gg]

	1988	1990	1995	2000	2005
Scenario A	58 24	55 033	46 452	51 481	62 716
Scenario B	58 24	55 033	46 111	46 090	46 971
Scenario C	58 24	55 033	46 111	45 592	44 995
ScenarioD	58 24	55 033	46 111	45 592	40 548
National Target					46 595

Table 5.8

Cement and lime production

	1988	1990	1995	2000	2005
Cement	4 100	3 789	3 000	3 200	4 000
Lime	600	571	384	400	450

Table 5.9

Non-energy related CO_2 emission from industrial sources

	1988	1990	1995	2000	2005
Cement	2 005	1 853	1 467	1 565	1 956
Lime	473	451	303	316	355
MgO [1]	522	471	362	385	472
Total	**3 000**	**2 775**	**2 132**	**2 266**	**2 783**

[1] *estimation on the basis of other MgO production in year 1990*

5.1.2 CO_2 emission from non-energy related industrial processes

The most important non-energy related CO_2 emission sources are cement and lime production. The MgO refractory bricks also play a role. Table 5.8 and 5.9 give the projected data for this material production. CO_2 production from waste incineration has not been included in this emission balance, because the level is comparatively low and it is very difficult to estimate the share of CO_2 from biomas waste and plastic materials.

5.1.3 The total CO_2 emission projection

Both projections of CO_2 emissions, energy related and non-energy related, are summarised in Table 5.10.

For energy related emissions the most likely scenario B was used. Slovakia's net emissions of CO_2 will be under such conditions 16% below 1990 level in 2000. Nevertheless, even if scenario A is considered CO_2 emissions in 2000 will be 7% below 1990 level (for scenario A see Figure 5.10).

The expected reduction of energy related CO_2 emissions in relation to 1988 are slightly lower in 2005 than 20% (i.e. National Target), in fact 19.2%. Taking into consideration high uncertainties of projection constructed, the scenario B is assumed as possible way for achieving of the National Target. Thus, in accordance with this conclusion, Slo-

Table 5.10

The total CO_2 emission projection [Tg]

	1988	1990	1995	2000	2005
Energy related (Scenario B)	58.2	55.0	46.1	46.1	47.0
Share of 1988 [%]	100.0	94.5	79.2	79.2	80.8
Non-energy related	3.0	2.8	2.1	2.3	2.8
Total	**61.2**	**57.8**	**48.2**	**48.4**	**49.8**
Share of 1988 [%]	100.0	94.4	78.8	79.1	81.4

vakia through its *Energy Policy* will have to enforce behaviour of CO_2 emissions sources appropriate for keeping trajectory of scenario B as a minimum.

5.2 Projection of other GHGs

5.2.1 Greenhouse gases combustion

There are IPCC Guidelines methods for the N_2O a and CH_4 inventory only for conventional biomass combustion. With the use of this method the N_2O a CH_4 emission has been balanced in the residential sector. The data of biomass combustion in the residential sector (energy balance for the *Energy Policy*) has been used as input data.

The total CH_4 and N_2O emission from combustion processes in 1990 was estimated using the data from the National Inventory (REZZO). The emission balance of these gases should be based not only on the amount of fuel consumed but also on the basis of the type of incineration technology used. Because the structure of the future technology units is not defined, the first approach is based on the linear relation of carbon emission in individual years and in 1990 and emission of CH_4 and N_2O in the year 1990.

5.2.2 Fugitive CH_4 emission

Projection of fugitive CH_4 emission from the gas distribution network is based on the assumption of the same level of gas leakage from the network system as in the year 1990. The input data of total NG consumption from the *Energy Policy* balance are used. The CH_4 emission from the gas pipeline and from the gas extraction is estimated in the period on the same level as in the year 1990. The result of this projection is in Table 5.13.

Table 5.11

The greenhouse gases emission from biomass combustion in residential sector [Mg]

	1990	1995	2000	2005
CH_4	1 292	1 182	1 306	1 577
N_2O	18	16	18	22

Table 5.12

GHGs emission from combustion [Gg]

	1990	1995	2000	2005
CH_4	21	18	18	18
N_2O	3.8	3.2	3.2	3.3

Table 5.13

CH_4 leakage from gas distribution network

		1990	1995	2000	2005
Consumption of NG	[TJ/year]	223 810	220 600	256 000	309 120
Leakage	[%]	0.76	0.76	0.76	0.76
Leakage	[Gg]	35	34	40	48
Gas pipeline	[Gg]	24	24	24	24
Gas extraction	[Gg]	4	4	4	4
Total	[Gg]	**63**	**62**	**68**	**76**

Table 5.14

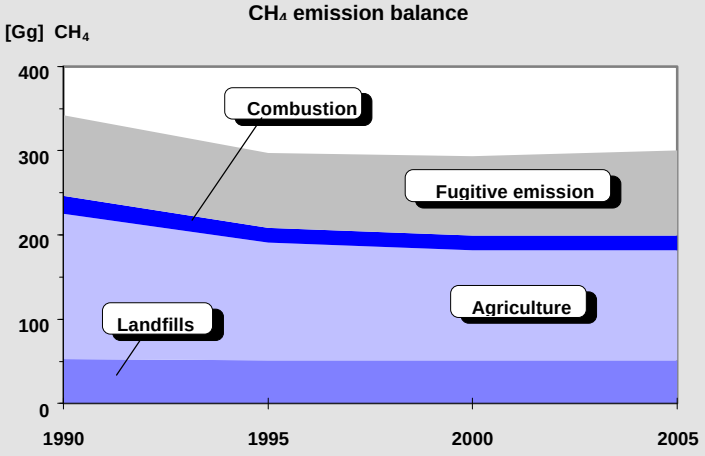
CH_4 from underground mining

		1990	1995	2000	2005
Coal production	[TJ/year]	54 046	41 900	41 900	41 900
LHV	[GJ/Mg]	8.82	8.82	8.82	8.82
Production	[Tg/year]	4.766	3.695	3.695	3.695
EF of mining	[Nm^3 CH_4 / Mg]	10	10	10	10
EF post mining	[Nm^3 CH_4 /Mg]	0.45	0.45	0.45	0.45
[mil Nm^3 CH_4 /year]		50	39	39	39
[Gg/mil.Nm^3 CH_4]		0.67	0.67	0.67	0.67
CH_4 emission	[Gg/year]	33	26	26	26

To calculate the balance of CH_4 emissions from underground mining the IPCC methodology has been used together with the activity data from the total energy balance (*Energy Policy*). The lower default value of emission factors was used. This approach was used in accordance with the opinion of specialist in mining facilities. Table 5.14 presents the results of CH_4 emission projections.

Figure 5.11

CH_4 emission balance



CH_4 emission [Gg /year]

	1990	1995	2000	2005
Landfills	53	51	51	51
Agriculture	172	140	130	130
Combustion	21	18	18	18
Fugitive emission	96	88	94	102
Total	**342**	**297**	**293**	**301**

5.2.3 Total CH_4 emission.

In order to estimate the total CH_4 emission, the emissions from the agriculture sector, biomass combustion and landfill must be added to the CH_4 fugitive emissions. Figure 5.11 shows the balance of total CH_4 emission.

5.2.4 Emission of N_2O

Emission of N_2O is represented as the sum of N_2O emission, arising at combustion processes,the emissions from agriculture and HNO_3 production As can be seen (Table 5.15), agriculture represents the largest N_2O emission source.

Table 5.15

N_2O emission projection

	1990	1995	2000	2005
Biomass combustion	3.8	3.2	3.2	3.3
Agriculture	8.8	3.6	8.8	10.0
Industry	2.1	1.2	2.1	2.1
Total	**14.7**	**8.0**	**14.1**	**15.4**

5.3 Summary of GHGs emission projection

In order to express the aggregated GHGs emission projection, the GWP values were used. These values, representing the values used by the IPCC in it's 1994 report, are presented in Table 5.16

Table 5.16

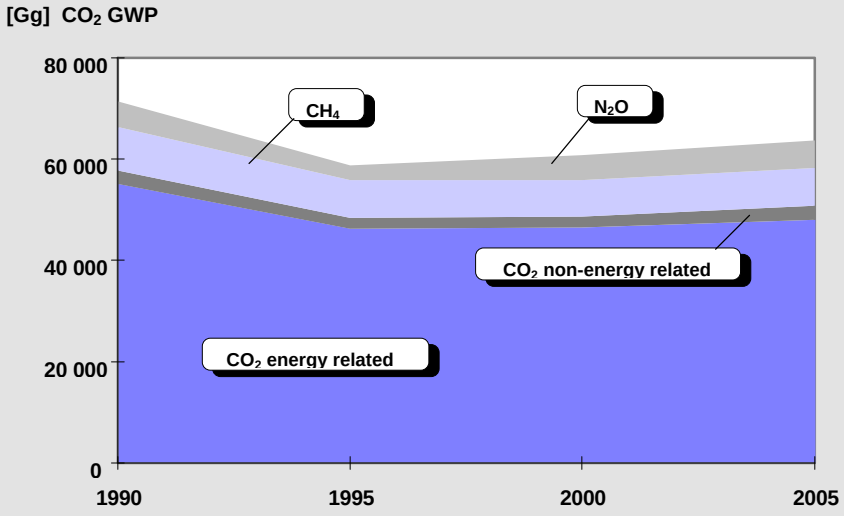
GWP values, used for aggregated emission projection

	20 years	100 years
CO_2	1	1
CH_4	62	24.5
N_2O	290	320

Using the GWP values for a 100 year time horizont the aggregated GHGs emissions was calculated (Figure 5.12). Together with the GWP values for N_2O and CH_4 calculated from the previous total balance the GWP potential from forestry also has been incorporated. As is obvious, that energy related CO_2 emissions is the main contributor to the aggregated GHGs emissions. The primary attention must therefore be focused on CO_2 mitigation in national energy and environmental policy.

Figure 5.12

Aggregated GHGs balance



CO_2,GWP [Gg]

	1990	1 995	2 000	2005
CO_2 enegy related	55 033	46 223	46 373	47 987
CO_2 non-enegy related[1]	2 775	2 132	2 266	2 783
CH_4	8 502	7 390	7 295	7 495
N_2O	5 120	2 978	4 917	5 333
Total	**71 430**	**58 723**	**60 851**	**63 598**

[1] *CO_2 emissions from the waste incineration not included*

CHAPTER 6

Vulnerability to climate change and adaptive strategies

Climate change analysis, climate change scenarios, vulnerability of hydrologic cycle, forest ecosystems and agriculture, and framework adaptive measures are the principal topics. Results presented there are adopted mainly from the Slovak National Climate Programme

6.1 Introduction

The climate in Slovakia is influenced predominantly by its position in Central Europe, by the topography of the Western Carpathian Mountains and the Alps and by the prevailing westerly zonal atmospheric circulation. The south-west and south part of the country belongs to the moderate C climate region with mild winters (according to Koppen) and the remaining part to moderate (boreal) D climate region with colder winters (January mean temperature T < -3°C). The annual distribution of monthly precipitation totals is equable with the maximum in June or July and the minimum from January to March. The period from middle of July to middle of October is relatively dry in the South of Slovakia. Southern and south-western Mediterranean cyclones cause heavy rains or snowfall in the south and east half of Slovakia mainly from October to December and in May and June in some years. On the other hand, the western and north-western atmospheric currents bring precipitation predominantly to the mountains of the west and north of Slovakia. Any change of atmospheric circulation may considerably affect the described simplified scheme of climate conditions on the all territory of Slovakia.

6.2 Climate change and variability in Slovakia

The majority of climate elements in this region is of high variability, mainly in the winter and spring seasons. The standard deviation (σ) of mean monthly air temperature (T) varies about 3°C in January and about 1°C in August, the σ at monthly precipitation totals (R) vary about 75% of monthly R means in October and about 50% in June (in the mountains about 60% in Winter and about 40% in June). The absolute daily maximum of T was 39°C and the minimum -41°C, mean daily maximum T in July is about 27°C in the lowlands and mean daily minimum T in January is about -10°C in the valleys. Annual totals of R in lowlands are 450 - 650 mm at 75% certainty (lower quartile) and 600 - 800 mm at 25% certainty (upper quartile). Daily totals of R above 100 mm occur rarely, but the absolute maximum in Slovakia was 232 mm at Salka in southern Slovakia on July 12, 1957. Hot and dry periods, similar to those in the Mediterranean region, are found in many parts of Slovakia from May to September in some years. Snowcover in Winter is stable for more than one month only in elevations above 300 m a.s.l. Snowcover (and stronger frosts as well) occurs in lower altitudes from the beginning of November to the middle of April, but uncertainty of snowcover for longer than two weeks is very high. The absolute maximum daily depth of snowcover is up to 100 cm in the lowlands and more than 300 cm in the mountains. Natural ecosystems have adapted to the climate changes and described variability for thousands of years. Socio-economic sectors have also adapted in the last

Table 6.1

Selected annual climate values at the station Hurbanovo, 115 m a.s.l., south Slovakia, representing lowlands in Slovakia (T is mean air temperature, R - precipitation totals, Eo - totals of the potential evaporation, E - totals of actual evaporation and W - mean calculated usable soil moisture in upper one meter soil layer [Lapin, 1994])

Period	T [°C]	R [mm]	Eo [mm]	E [mm]	W [mm]
1901-1931	9.5	586	735	480	95
1931-1961	9.9	572	773	469	88
1961-1990	10.0	253	806	451	81
1901-1990	**9.8**	**560**	**771**	**466**	**88**
25% certainty	**10.3**	**620**	**815**	**515**	**100**
75% certainty	**9.3**	**484**	**730**	**416**	**78**
1981-1990	10.1	496	835	437	75
1988-1993	10.5	498	860	414	75

decades. Expected warming of climate may change the climate in Slovakia toward higher variability and this could change the limit conditions for both natural ecosystems and socio-economic activities.

From the Table 6.1 it follows:

- trend of T is significantly positive by about 1°C in south Slovakia with the maximum in last the 7-year period, T = 11.7°C in 1994 - the absolute warmest year at Hurbanovo since 1871 (similar trends have been found in other regions of Slovakia as well),
- trend of R is significantly negative by about 90 mm in south Slovakia (17% of 1961-1990 mean) with the minimum in the last 14-year period (decreasing trends of lesser magnitude have been found elsewhere in Slovakia, but trends are not significant in the northern mountains),
- trend of Eo is significantly positive by about 125 mm in south Slovakia (16% of 1961-1990 mean) with the maximum in the last 7-year period (trends from 10 to 15% have been found in other regions of Slovakia),
- trend of E is decreasing by about 65 mm in south-west Slovakia (15% of 1961-1990 mean) with the minimum in the last 7-year period; this decrease is caused mainly by a decrease of precipitation in the warm season of the year (April to September); the rise of Eo caused a rise of E in the northern mountainous half of Slovakia where R is comparable or higher than Eo,
- values of W roughly represent the final impact of rising T and Eo and decreasing R; W was decreasing significantly mainly in south-western Slovakia by about 25% of 1961-1990 means and by about 10-20% in the other regions of Slovakia.

Figures 6.1 and 6.2 show trends, smoothed curves and values for individual years for annual and warm half-year's air temperature means (T), precipitation totals (R) of warm half-year and relative air humidity means (U) of warm half-year at the station Hurbanovo. It can be seen that trends T and R shown in the Table 6.1 are caused mainly by the change of climatic characteristics in the season from April to September, and that the decrease of U contributes considerably to rise of Eo. Occurrence of exceptional means and totals in the period 1981-1994 is more frequent than in the periods before 1981. Figures 6.3 and 6.4 show trends, smoothed curves and values of individual years for water balance elements R, Eo and E at Hurbanovo (115 m a.s.l.) and at the station Liptovský Hrádok (640 m a.s.l.) representing valleys in the northern mountainous part of Slovakia. Besides the facts mentioned above, it is clear that the mountainous part of Slovakia has a great surplus of precipitation totals comparing Eo which occurred in the first three decades of our century, but after 1980 there a similar

deficiency of precipitation like one in the lowlands exists.

The assessments listed above are considered preliminary, because of the simple methods used. In spite of this, it be seen clearly that thee is a trends toward higher aridity, predominantly in southern part of Slovakia, where the most important agricultural lowlands are. On the other hand, in the mostly mountainous northern regions, the rise of actual evaporation E causes a decrease of runoff. That is also why the mean discharges of Slovak rivers have decreased by 10-30% (at some smaller rivers in the South by more than 40%) since 1931.

Figure 6.1

Annual means of air temerature T and April-September precipitation totals R at Hurbanovo, south Slovakia, in 1871-1994

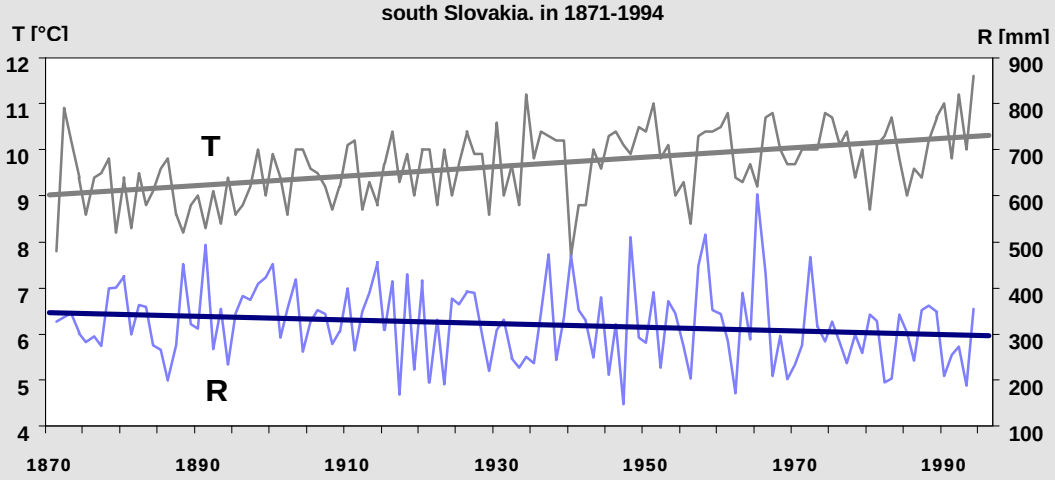


Figure 6.2

Trends and means of air temperature T and relative air humidity U at Hurbanovo in April-September seasons 1901-1994

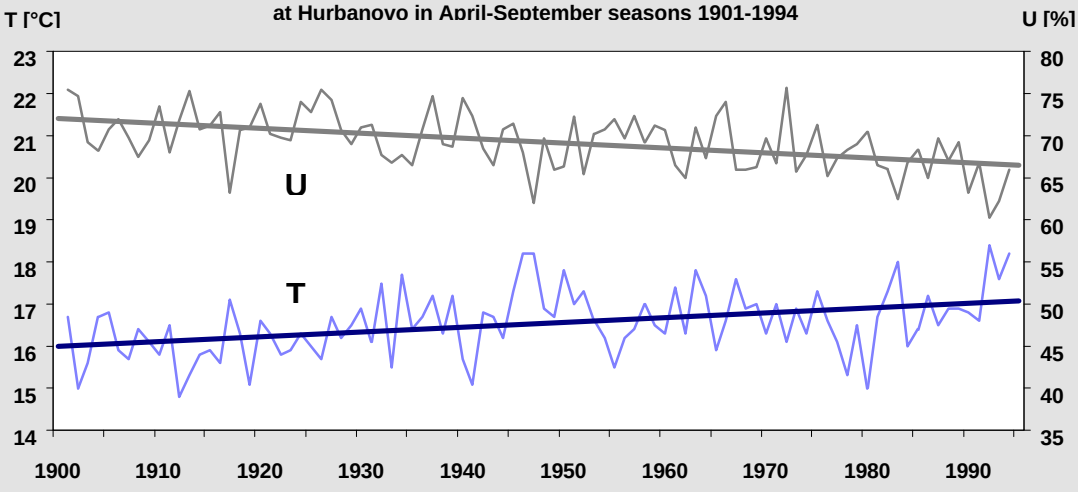


Figure 6.3
Linear trends of annual totals of potential evaporation Eo, precipitation R and actual evaporation E at Hurbanovo, south Slovakia, 1901-1994

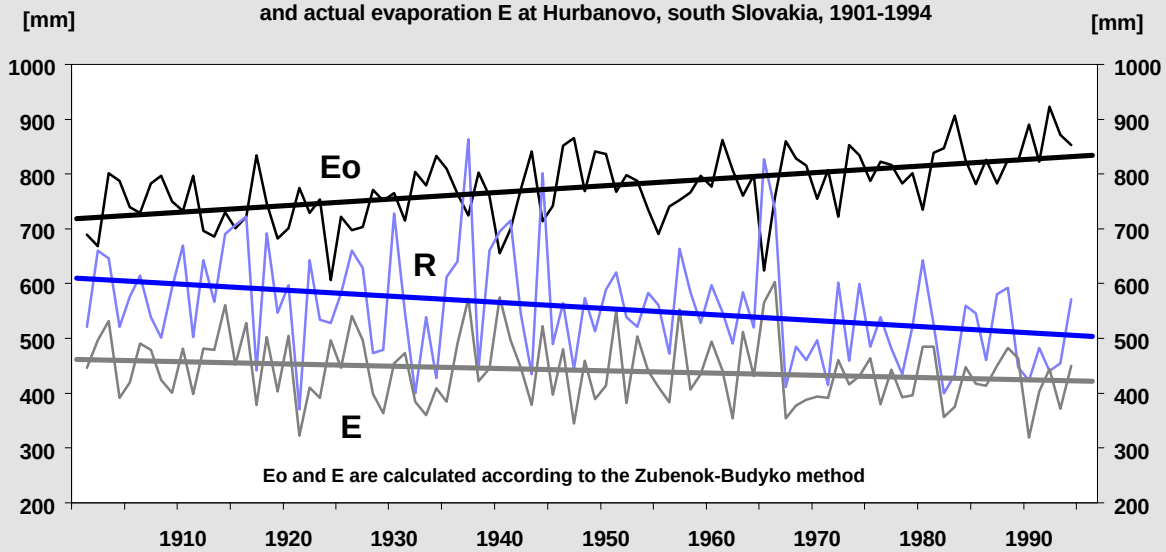
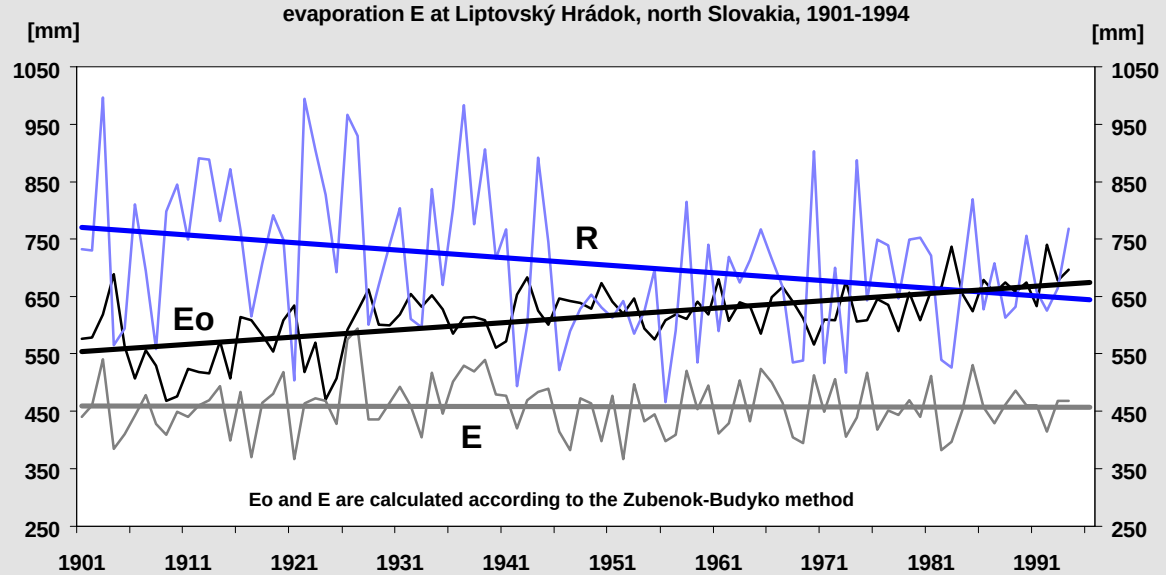


Figure 6.4
Linear trends of annual totals of potential evaporation Eo, precipitation R and actual evaporation E at Liptovský Hrádok, north Slovakia, 1901-1994



6.3 Preliminary climate change scenarios

Predicted global warming (connected with the greenhouse effect increase) will probably cause a change of atmospheric circulation and, from this, changes in precipitation, cloudiness, snowcover, air humidity and in other climatic elements all over the world. These changes can seriously influence the natural environment and socio-economic activities in many countries. Some results of the analysis and scientific assessments of temperature rise impacts upon precipitation, relative air humidity, daily range of air temperature and snow cover changes in Slovakia are presented in the Slovak National Climate Programme (NCP)

Table 6.2

Deviations (Δ)of preliminary mean climate change scenarios in periods about the year 2025 from normals calculated for the period 1951-1990 in Slovakia

	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
Mean monthly air temperature deviations in°C in all Slovakia (according to [Kalvová & Vanícek, 1991])												
ΔT1	1,5	1,4	1,2	1,0	0,8	0,6	0,5	0,6	0,8	1,0	1,2	1,4
ΔT2	3,0	2,9	2,5	2,0	1,5	1,1	1,0	1,1	1,5	2,0	2,5	2,9
Mean monthly relative air humidity deviations in% in mountainous areas of Slovakia												
ΔU1	0	0	0	0	0	0	0	0	0	0	0	0
ΔU2	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
ΔU3	-2	-3	-3	-3	-3	-2	-2	-2	-3	-3	-3	-2
Mean monthly relative air humidity deviations in% in lowlands of south-west Slovakia												
ΔU1	0	0	0	0	0	0	0	0	0	0	0	0
ΔU2	-2	-2	-3	-3	-2	-1	-1	-1	-2	-2	-2	-2
ΔU3	-3	-4	-5	-6	-5	-3	-2	-2	-3	-4	-3	-3
Mean precipitation totals (deviations in%) in southern half of Slovakia												
ΔR1	0	0	0	0	0	0	0	0	0	0	0	0
ΔR2	15	10	-15	-20	-10	10	5	0	-10	-10	0	5
ΔR3	0	0	-15	-20	-15	0	-15	-10	-10	-20	0	0
Mean precipitation totals (deviations in%) in northern half of Slovakia												
ΔR1	0	0	0	0	0	0	0	0	0	0	0	0
ΔR2	15	10	-10	-15	-5	15	10	5	-5	-5	5	10
ΔR3	10	10	-5	-10	-5	10	-5	0	0	-10	10	10
ΔR4	20	20	10	5	5	10	5	5	5	5	10	20

reports. Scenarios of temperature rise by 1-2°C (in comparison with the means of the 1951-1980 period) are considered in accordance with GCMs results for the periods about the year 2025. Preliminary temperature change regional scenarios based on GCMs (General Circulation Models) results (annual means) and historical analogues (annual course) have been prepared for the Czech and Slovak Republics in 1991, preliminary precipitation and relative air humidity change regional scenarios (Table 6.2) are based on projected air temperature change and historical analogues (only partly on GCMs scenarios). Calculations presented in NCP reports have been carried out using correlation and trend analysis (analogues methods of GCMs scenarios regional modification [Lapin et al., 1994]).

6.4 Impact of climate change on water management, agriculture and forest ecosystems

Preliminary assessments, based on the present state of knowledge, on existing climatic and hydrological trends and on projected changes in the next decades have been made in the framework of the Slovak National Climate Programme Project and other research projects in Slovakia. Results obtained are considered as a rough risk assessment only at present, but they are useful as a base for the preparation of framework strategies. Because of the greatest progress of impacts assessment in the hydrological cycle, forest ecosystems and partly in crop production, only these three sectors can be included into the First National Communication of FCCC (UN Framework Convention of Climate Change) implementation in Slovakia.

6.4.1 Hydrology and water economy

The mean river discharges (having been observed in Slovakia since 1931) are decreasing generally in Slovakia compared to long term means in the last several years. This decrease is different in the territory of Slovakia. The

highest one (by more than 40%) has been found in southern and south-eastern Slovakia (river basins: Ipel, Slaná, Bodva). The most significant decrease of discharges in annual course occurred in November and in the following months of the Autumn-Winter season. This decrease is significant mainly in the last 10-15 year period.

Results of the trend analysis confirmed the assumption with respect to decreasing monthly mean spring yields at about 80% of the gagging stations in Slovakia. The most significant decreases appeared in the central and southern part of Slovakia (app. 1.4-1.5% per year). In the crystalline range of mountains (predominantly in the north and north-west part of Slovakia) the decrease did not exceed 0.8% per year. In the relatively warmest and driest period 1988- 1993 spring yields decreased by 6-7% in some regions. Shorter periods of observations (not longer than since 1961) need reevaluation of results obtained by the analysis of the Slovak Hydrometeorological Institute for some Slovak regions. Evaluation of the ground water stages change depends on reliable and a long series of observations. Limited analysis showed significant decrease at the majority of stations from 1971 to 1993.

Analysing of the current areal water balance change in Slovakia it was stated by many experts, that in some localities where usable amounts of water were approved the significant decrease of the springs yields, respectively lowering of the ground water stages comparing to values assumed in calculation of supplies have occurred. It means, that there exist a decrease of the water supplies having been taken into account in the State Water Management Balance Plan. The estimated decrease of the approved water supplies represents 7.9% to 11.3%. For the more accurate estimation it is needed to analyse the extensive observations, to eliminate the anthropogenic effects and to avoid a possibility that this decrease is transitory, caused exclusively by the dry period only.

According to simple model calculations using preliminary climate change scenarios the continuation of present trends is expected. This may negatively influence not only the water supply for the general public, industry and agriculture, but also hydro-power plants and river transport systems in Slovakia. Scenarios of a further 20% decrease of water resources were calculated on a preliminary basis for the period 1990-2030.

6.4.2 Forest ecosystems

Nearly 38% of the territory of Slovakia is covered by forests, mainly deciduous and mixed stands. The current situation, which determines the adaptability of Slovak forests to the anticipated changes, can be described as follows:

- present species composition does not correspond fully with their climate demands (changed upper forest line, artificial planting of Norway spruce in lower locations, dominance of monotree species stable slightly),
- existence of large areas of forest stands affected by imissions (mountain coniferous forests especially),
- present uniform genotype and ecotype composition of the part of our stands.

Using the state and regional scenarios in the evolution of climate (temperature, precipitation) as well as concentrations of some gases in the atmosphere (greenhouse gases, photooxidants, etc.), an analysis of possible impacts of global changes upon the forests of Slovakia has been executed using the following factors:

- changes in species composition
- physiological aspects, changes in bioproduction
- forest soils
- injurious agents
- forest as a source and sink of greenhouse gases

Based on our own analyses and knowledge from the literature we came to the following conclusions:

- European fir and Norway spruce will be probably the most endangered tree species by the climate changes (in lower occurrence limit and outside of their natural range; favourable climate potential in upper limit will be limited by sensibility to imission activity)
- by lack of unimprovement of the vitality of mountain Norway spruce forests certain expansion of beech into upper locations can be expected
- expected intensity and a time scope of climate changes will cause such changes in forest ecosystems which they will not be able to be controlled autoregulatorly
- very unfavourable changes in soil moisture will occur in lower locations what will lead to physiological weakness of oaks and locally (carbonates) to considerable coming of xerophytes and forest steppe communities
- it is expected that a possible increase of production in the range of 10-30% in dependence on vitality and existence of stable and able stands productionally
- it is expected that the dynamization of nutrients circulation especially in upper altitudes from 6th forest altitudinal zone where production optimum of our forests will be probably shifted
- change of biotic and abiotic injurious agents is unknown, especially for insects where a very flexible adaptation to changing environmental conditions can be presumed

6.4.3 Agriculture (crop production)

Slovakia is a hilly country; only 39.7% of it's surface lies under 300 m a.s.l. elevation, 55.3% is identified as mountainous and 8.5% as high mountainous territory. The portion of arable agricultural fields is 30.4%, grasslands and pastures 17.0%, gardens, including vineyards account for 2.4% of the territory. Cereals, maize, potatoes and sugar beet are the principal agricultural products. Climate conditions influence agricultural crop production mainly through sun radiation, water and thermal certainty. Some plants are influenced by the variability of climate and by exceptional meteorological events (spring and winter frosts, high temperatures with low air humidity, hail, strong wind, intensive precipitation). The long vegetative period is limited by daily mean temperatures $T \geq 5.0°C$ and the main vegetative period by $T \geq 10.0°C$. Simple model calculations, using preliminary climate change scenarios, indicate that expected warming by 1-2°C and a small change in precipitation (increase in winter by 10% and decrease in long vegetative period by 10-20%) can cause an increase of certainty at air temperature by 7-11% and at sun radiation by 2-23%. Worse conditions are expected due to the evapotranspiration deficit Eo - E increase by 13-26% (Eo is potential and E actual evapotranspiration) and due to the decrease in snow cover occurrence and depth. Prolongation of vegetative periods is projected at 6-8%. Usable soil moisture will probably decrease by about 20% in the main agricultural fields in the south of Slovakia (this decrease is most important in the spring months from March to May).

Climate changes could lead to plant species selection pressure similar to other countries in Central Europe. The final results of such pressure cannot currently be predicted. During these adaptation processes, the stability of the ecosystem's structure can be negatively affected (for example, by the appearance of new competing species, new pests or increased pest abundance; by new pathogens; and by increased fire risk and soil erosion). As temperature rise, the natural range of tropical-disease pathogens spread northwards. Of critical importance among the direct effects of a change in atmospheric chemistry are the effects caused by the rise of CO_2 and change of oxidants content. All effects connected with the above mentioned processes are valid both for natural and man affected ecosystems and both for agricultural and forest ecosystems. Vulnerability of forests is much higher, because of the longer cycle of tree life. On the other hand, ecosystems in agricultural fields are more negatively affected by human activities.

Impacts of climate change in Agriculture can be briefly summarised as follows:

- Change of air temperature certainty
- Change of phenological conditions of plants
- Change of solar radiation certainty of plants for photosynthesis
- Change of agroclimatic production potential
- Change of water (soil moisture) certainty
- Change of winter condition of plants
- Change of CO_2 concentration and biomass production
- Change of soil physical and soil chemistry characteristics
- Change of diseases, pests and weeds occurrence

6.5 Adaptation strategies

Uncertainty of climate change impacts upon some socio-economic sectors was not enough cause for concern to result in the preparation of adaptive strategies prior to 1994. Because of the apparently negative impacts of the warm and dry period 1981-1993 upon water management, forests and crop production, the situation has changed remarkably and several reports providing preliminary strategies have been issued. A series of difficulties connected with the creation of Slovak Republic′s administration have restricted the attention to climate change based strategies within the Ministries of Economy, Transport, Health and others. There are projections of negative impacts upon winter tourism, the food industry, winter diseases etc. On the other hand positive impacts have been recognised in household heating and in energy consumption in cold period of the year.

6.5.1 Hydrology, water resources and water economy

Possible hydrological cycle and water balance changes in Slovakia due to expected climate change will need more detailed model evaluation under different geographical conditions. Further evaluations should be done in the stationarity of hydrological processes (continual decrease of river discharges and spring yields, as an example) and in low river water stages (magnitude, frequency and duration of low river discharges). These changes can seriously influence the routine utilisation of measured hydrological data and calculated characteristics (projects, norms etc.).

In the water management sector it is recommended that the generally binding regulations be issued (water law and corresponding legislative) which would ensure the collection of information needed for unambiguous identification and quantification of climate change impacts upon ground water resources and use with respect for:

- continual measurement of ground water consumption,
- continual measurement of utilised spring yields including unutilised portion returning to the natural environment,
- compulsory measurements of ground water stages in areas with water resources exploitation for disposable water amounts evaluation,
- modification of water quality measurement respecting needs and special circumstances,
- strict governmental inspection of water resources exploitation,
- establishment of the centre for ground water exploitation, for balancing of water amounts and quality and for consulting

With respect to water resources utilisation in Slovakia, either a very detail sample water management balance elaboration of selected region or concise water management balance elaboration of all Slovakia with selection of water surplus and deficiency regions needs to be prepared.

6.5.2 Forestry

Considering the serious risks connected with the expected climate change in Slovakia it is necessary to identify and to implement measures to minimise the negative impacts of global changes. In a short time it would be necessary to implement the following measures:

- acceleration of Norway spruce monocultures change to mixed stands of pine, oak, beech and the other broad leafed species,
- to preserve biodiversity of forest communities extensively in forest management
- preparation of genetic material for the artificial regeneration to changed climate conditions,
- revaluation of forest management plans,
- to increase carbon dioxide fixation by afforestation of soils not used for agriculture.

6.5.3 Agriculture

Climate change impacts upon agriculture are expected to be complex, partly positive and primarily negative. Mitigation of the negative impacts and utilisation of the positive ones should be prepared for long in advance, because of the long-term character of the adaptation processes in agriculture systems and in agricultural ecosystems as well. The projected adaptive measures are as follows:

Long term strategies in agricultural planning

- Change in crop cultivation technologies,
- Change in agroclimatic regionalisation, and structure of crops and varieties cultivated,
- Change in breeding objectives,
- Change in plant protection.

Agricultural practice

- Regulation of the water supply considering the expected changes of the hydrological cycle,
- Regulation of water and energy regimes of fields by mulching,
- Improvement of soil fertility from the point of view of sustainable agriculture.

6.6 International activities

The Slovak Republic's activities in research and application of climatological research results in the three sectors described above (water management, agriculture and forestry) are relatively broadly based. The environment is a new topic related to the problems of climate change issues (especially forest, field and water ecosystems). Several institutions and many experts with intensive international collaboration are involved in this field of work. The long term monitoring of climate changes as well as the monitoring results analysis have a long history in Slovakia. The Slovak Hydrometeorological Institute, Institutes of the Slovak Academy of Sciences and several universities have several long standing contacts with the World Meteorological Organisation (WMO), International Association of Hydrological Scientists (IAHS), UNEP, UNESCO, FAO and other UN organisations. International co-operation within the Central European Initiative (CEI) countries and the four Vishegrad countries (V-4) has increased recently.

CHAPTER 7

Joint implementation of FCCC commitments

The UN Framework Convention on Climate Change includes a rule according to which "efforts to address climate change may be carried out co-operatively by interested Parties" (Article 3, Paragraph 3). Article 4, Paragraph 2 a, b gives a more specific presentation of joint implementation (JI) options.

With respect to the mechanism of joint implementation of FCCC commitments, the viewpoint of the Slovak Republic is as follows:

- JI is economically effective because it allows the achievement of the maximum emissions reduction of greenhouse gases at the lowest cost.
- The countries listed in Annex I should ensure greenhouse gases emission stabilisation "at home", without the use of JI.
- JI is a voluntary activity under the responsibility of two or more Parties; such activity must be undertaken or accepted by the Governments concerned
- An initial three-year pilot phase is recommended to accept, to gain experience.
- During the pilot phase, the credits will not apply yet. Credits will apply during the phase following 2000, i.e. further commitment related to possible greenhouse gases reduction.
- The criteria for the pilot phase should be flexible.

To ensure the Slovak Republic effective meet its commitments resulting from the Convention, it is planning to establish a **National Panel for Collection, Evaluation and Realisation of Greenhouse Gases Emission Reduction Projects,** with the following tasks:

- Retrieval and identification of projects.
- Preparing an offer of top quality projects.
- Retrieval of sources to finance project realisation
- Evaluation of projects following implementation from the viewpoint of generalising the experience from the joint implementation mechanism.

At present, the Slovak Republic does not have a project to be implemented through the joint implementation mechanism.

CHAPTER 8

Climate change research

This chapter provides a brief review of research projects in Slovakia related to climate change, possible climate change impacts, mitigation options and adaptation strategies.

During the development of science and research in Slovakia, climate changes have been studied only within the scientific and research projects of the Slovak Hydrometeorological Institute, the Department of Meteorology and Climatology at Comenius University and the Geophysical Institute at the Slovak Academy of Sciences. Recently, the study of these issues has also started at the Institute of Hydrology of the Slovak Academy of Sciences, the Agriculture University in Nitra, and the Forest University and the Forest Research Institute in Zvolen. Research with this orientation requires above all a climatological database, which can be provided only by the Slovak Hydrometeorological Institute. In present economic situation of Slovakia costly technology research and development stagnates. Governmental funding is very limited and private sector interests still absent. The Slovak Ministry of the Environment established the following long-term research programs:

National Climate Program of the Slovak Republic

With respect to the currently identified need to address the issues associated with the expected impacts of climate change, the federal minister of environment established the National Climate Program of the former Czech and Slovak Federative Republic (CSFR) in 1991. After the Czecho-Slovakia split into two independent countries, from 1993 independent National Climate Programs of the Slovak and Czech republics (NCP SR and NCP CR) were established.

NCP SR has the following basic goals:

- Development of activities in accordance with the aims of the World Climate Program co-ordinated by WMO and UNEP
- Development of background information for state authorities and other institutions with respect to meeting international commitments related to climate change issues (UN Framework Convention on Climate Changes, 21st Century Agenda).
- Co-ordination of activities and tasks including climate change issues within country as a whole.

The NCP SR is controlled by a committee consisting of representatives of the participating institutions and the Slovak Ministry of Environment as the main guarantor of activities. In 1993 and 1994 eighteen institutions have been participating. Slovak Hydrometeorological Institute is the main research co-ordinator.

The NCP Project tasks are as follows: design of observation networks for climate changes and the monitoring of impacts; analysis of regional changes (trends) and climate variability; regional interpretation of global climate change scenarios; estimation of possible climate change impacts related to natural environment components and socio-economic issues; preparing the framework design for adaptation measures to mitigate possible negative climate change impacts.

- **National Program of Greenhouse Gases Emission Reduction**

This program was established by the Slovak Ministry of the Environment in 1993. The objectives of this program include a detailed inventory of emissions and sinks of greenhouse gases and the preparation and assessment of technical measures to mitigate greenhouse gases emission or to enhance the GHGs sinks.

- **National Program to Reduce the Emission of Volatile Organic Compounds**

This program was established by the Slovak Ministry of the Environment in 1993. Its main objective is to prepare the proposal of measures to reduce VOCs emission by 30% in Slovakia before 2000. This is in accordance with the UN ECE Protocol on the reduction of VOCs. The National program to reduce the emission of VOCs will be submitted to the Slovak Government during 1995.

- **Hydrological Regime Changes as the Result of Global Changes**

In 1994, a scientific and research project of the Slovak Academy of Sciences titled "Hydrological regime changes in rivers and water regime changes in soil resulting from global changes in atmosphere and in human activities in relevant river basins" was started. The Institute of Hydrology at the Slovak Academy of Sciences is the main research site for this project. The goal is to identify how the expected climate changes in the atmosphere and in relevant river basins caused by human activities will be reflected in the changes of hydrologic regime in soil and surface runoff in the Slovak regions. The information obtained will serve as background data for the re-evaluation of water management systems functionality with respect to the climate changes.

- **Slovak National Program to Stabilise and Reduce CO_2 Emissions in the Transportation**

The objective of this project is to identify initial measures to stabilise and reduce CO_2 emissions from the transportation sector in the Slovak Republic so that the emissions in the target year (2000) will be lower that those in 1990. This program is financed by the Slovak Ministry of Transportation and Telecommunications.

- **The Slovak Republic's Country Study to Address Climate Change**

The Slovak Republic is participating in the second round of US Country Studies Program to Address Climate Change. The objective of this program, co-financed from financial resources of the Slovak Ministry of the Environment and USAID, is to developed a proposal for an action plan for greenhouse gases emission abatement and implementation of adaptation strategies to mitigate the climate change consequences.

CHAPTER 9

Education and public awareness

Global climate change represents one of the most serious environmental issues in the history of mankind. It seems however, that the Slovak public is not fully aware of the consequences of climate change. The important task of all relevant institutions is to support education and improve general public awareness, concerning these issues. Public awareness plays a key role in supporting governmental long-term climate change strategy and policy. The measures, which will have to be taken, require co-ordinated effort and assume co-operation of governmental and non governmental organisations.

9.1 Country study program

The objective of the fifth element of "The Slovak Republic's Country Study" is to provide information concerning climate change consequences to the public. The US Country Study partners put great emphasis on the presentation of the program's results to non governmental organisations and individuals, which guarantee the objectivity and accurate dissemination of information. The Country Study results will be presented to the public via seminars, professional literature, educational video and the mass media.

Seminars

It is expected that a series of seminars will be organised for managers from the state administration, legislation, industry and research sectors. The aim of these seminars is to explain the gist of the issue, the possibilities for technical solution and to discuss the costs needed for greenhouse gas emission reduction, as well the adaptation measures in the national economy and the field of environment protection.

Professional literature

An information booklet summarising the results of the Country Study Program will be issued. This booklet will be provided to governmental and non governmental organisations.

Educational video film

A professional film will be made emphasising global warming of the atmosphere and climate changes in co-operation with experts in various fields. This film will be distributed free of charge via TV, non governmental organisations and schools.

Use of mass communication media

It is expected that a program including a series of lectures and TV and radio programs as well as articles and information in newspapers and magazines will be implemented.

9.2 Co-operation with non governmental organisations

At present more than 120 local environmental organisations, foundations and associations in the Slovak Republic are registered. The largest one is the Slovak Union of Nature and Landscape Protectors, involving more than 7,000 members in more than fifty local organisations. Most of these non governmental organisations do not pay enough attention to the issues of

global warming. The following organisations are involved in the issue:

- Fund for Alternative Energy Bratislava (anorganisation within the Slovak Union of Naure and Landscape Protectors).
- Love Mother Earth Movement Bratislava (an organisation within Slovak Union of Nature and Landscape Protectors). Activities connected with the issue of global warming and its consequences are the basis of their work.
- Global Releaf Banská Stiavnica. In the spirit of the US forest association "Green Traditions of Life" challenge this movement is engaged in the support of afforestation programmes.
- Tree of Life Bratislava, Banská Stiavnica, Kosice. Educational programmes and lectures.
- Children of the Earth Bratislava. Educational programmes and lectures.

Greenpeace, Community for sustainable development and other organisations of the Slovak Union of Nature and Landscape Protectors support measures which are in the spirit of Agenda 21. With respect to the energy policy of Slovakia, they severely criticise the idea of putting into operation the nuclear power plant in Mochovce, recommending the increase in efficiency of classical thermal power sourcesand the support of cogenerative productionof energy. However, thus approach would not result in greenhouse gas emission reductions corresponding to international commitments and recommendations.

9.3 Current activity

Co-operation with public mass communication institutions and private mass media has started recently in order to publicise and increase general awareness about the issue of global warming. Several government officers and scientists have participated in Slovak radio and TV programs. A number of articles have been published in daily newspapers and professional periodicals. In 1994 the Ministry of Environment of the Slovak Republic in co-operation with the Slovak Hydrometeorological Institute started to issue the periodical publication National Climate Programme (two volumes have been published so far). Information leaflets for the general public are being published periodically within the framework of the National Climate Programme. Several scientific conferences and seminars, devoted to various aspects of global climate change and their consequences, have taken place recently.

Appendix

Table A1

Comparison of carbon stored balance calculated according IPCC methodology and domestic approach

Product	Feed stock	Chemical composition	Carbon fraction	Production [Gg]	Carbon stored [Gg]	
					Approach	IPCC
Urea	NG	$(NH_2)_2CO$	0.200	29	5.6	192.3
Plastic material	crude oil	C_nH_{2n+2}	0.857	482	404.8	650.8
Men-made fibres	crude oil	C_nH_{2n+2}	0.857	124	104.6	
Bitumen	crude oil				210.3	210.3
Lubricants	crude oil				10.7	10.7
Coal Oils and Tars	coking coal				0.1	0.1
Total					**736.1**	**1064.2**

Table A2

CH_4 emissions from livestock farming - enteric fermentation

	Heads (in 1000 hd)	Emission factor (kg CH4/hd/year)	Emission (Gg CH4)
Cattle total	**1 492**		**99.1**
Cows	526	100.0	52.6
Young cattle	531	31.5	16.7
Heifers	361	62.0	22.4
Other	76	98.0	7.4
Sheep total	**456**	**8.0**	**3.6**
Young shep	287	8.0	2.3
Swine total	**2 254**	**1.5**	**3.4**
Total	**4 202**		**106.1**

Table A3

CH_4 emissions from livestock farming - manure

	Animals heads (in 1000 hd)	Excrement prod. (10^6 t liquid manure)	Emission factor (kg CH_4/hd/yr)	Emission (Gg CH4)
Cattle total	**1 492**	**34.9**		**43.6**
Cows	526	15.8	46.0	24.2
Other	968	19.1	20.0	19.4
Sheep total	**456**	**0.4**	**0.28**	**1.8**
Swine total	**2 254**	**18.5**	**8.0**	**18.0**
Poultry total	**12 456**	**9.3**	**0.117**	**1.5**
Total	**16 658**	**63.1**		**64.9**

Table A4

Consumption of substances controlled by Montreal protocol in Slovak Republic

Group	ODP	1986/89		1993		1994	
		consumption	calculated consump.	allowed consump.	consump.	allowed consump.	consump.
		(Mg)		(Mg)		(Mg)	
A I							
CFC 11	1.0	457	457	457	150	457	
CFC 12	1.0	1249.6	1249.6	1249.6	833	1249.6	229.38
CFC 113	0.8	3.9	3.1	3.1	3.9	3.1	
CFC 114	1.0	0	0	0	0	0	
CFC 115	0.6	0	0	0	0	0	
Total		**1710.5**	**1709.7**	**1709.7**	**986.9**	**1706.7**	**229.38**
A II							
Hal 1211	3.0	0.75	2.3	2.3	0	2.3	
Hal 1301	10.0	0.75	1.5	1.5	2	1.5	
Hal 2402	6.0	7.2	43.2	43.2	0	43.2	
Total		**8.1**	**47.0**	**47.0**	**2**	**47.0**	**0**
B I							
CFC 13	**1.0**	**0.1**	**0.1**	**non-controlled**	**0.1**	**0.08**	
B II							
CCl4	**1.1**	**91**	**100.1**	**non-controlled**	**250**	**non-controlled**	**351.36**
B III							
metylchloroform	**0.1**	**200.1**	**20.0**	**non-controlled**	**180**	**20.0**	**136.74**
Total		**2009.8**	**1876.9**	**1756.7**	**1419**	**1776.78**	**717.48**

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