THE SIXTH NATIONAL COMMUNICATION OF THE SLOVAK REPUBLIC ON CLIMATE CHANGE

under the United Nations Framework Convention on Climate Change and Kyoto Protocol

Bratislava 2013

Ministry of Environment of the Slovak Republic
Slovak Hydrometeorological Institute

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LIST OF ABBREVIATIONS

Abbreviation	English
6NC SR	The Sixth National Communication of the Slovak Republic on Climate Change
APVV	Slovak Research and Development Agency
BR1 SR	The First Biennial Report of the Slovak Republic
CER	Certified emission reduction
CGCM3.1	Type of Global Circulation Model
CNG	Compressed natural gas
COST	Cooperation in Science and Technology
CRF	Common reporting format
CSEUR	Consolidated System of EU registries
CTF	Common tabular format
EBRD	European Bank for Reconstruction and Development
EF	Emission Factor
ECHAM5	Type of Global Circulation Model
ERU	Emission reduction units
EU ETS	European Union Emission Trading Scheme
GCM	Global Circulation Model
GDP	Gross Domestic Product
GHG	Greenhouse gas
GIC	Gross inland energy consumption
GWP	Global warming potential
CHP	Combined heat and power
IPCC	Intergovernmental Panel on Climate Change
ITL	Independent Transaction Log
KNMI	Type of Regional Circulation Model
LPG	Liquid petroleum gas
LULUCF	Land use, land-use change and forestry
MESRS	Ministry of Education, Science, Research and Sport of the Slovak Republic
MoE	Ministry of Environment of the Slovak Republic
MPI	Type of Regional Circulation Model
NA	Not applicable
NACE	The waste generation by classification of economic activities
NGO	Nongovernmental non-profits organization
ODA	Official Development Assistance
PaMs	Policies and measures
PV	Photovoltaic
QA	Quality Assurance
QC	Quality Control
RCM	Regional Circulation Models
REDD	Reducing Emissions from Deforestation and Forest
RISO	Regional Waste Information System
SEA	Slovak Environmental Agency
SHMI	Slovak Hydrometeorological Institute
SRES	Special Report on Emissions Scenarios (IPCC)
UNFCCC	United Nations Framework Convention on Climate
WAM	With additional measures
WEM	With existing measures

Chapter 2: National Circumstances

Population of the Slovak Republic as of December 31, 2012 was 5 410 836. Average residential density is 110.2 inhabitants per km^2. In the context of demographic development a very positive trend is the decrease in emissions per capita – in 2011 there were 8.38 tons of CO_2 equivalent compared to 1990 value of 13.55.

According to global climatologic classifications, the Slovak Republic is located in the mild climate zone with mean monthly precipitation totals equally distributed over the whole year. During the period 1881-2012, significant increase of annual air temperature by 1.8°C and insignificant decrease of annual precipitation totals by 1.3% were recorded on average in Slovakia.

In 2007, the Slovak economy reached historically the highest growth at 10.5%. During the years 2006-2008, GDP expressed in purchasing power increased compared to the EU average as many as 10 percentage points. Economic growth in this period was the most rapid among the EU countries. In 2009, the real GDP decreased by 4.9%. Thus Slovakia was ranked as the country with the highest GDP slump. The year 2010 marked the Slovak economy turnaround in the form of relatively strong recovery in economic growth – with 4.4% resulted in the SR being on the second place in the EU after Sweden.

The Slovak Republic has a balanced proportion of nuclear fuel, fossil fuels and renewable energy sources in gross inland energy consumption. Shares of primary energy sources in gross inland consumption in 2011 were as follows: natural gas 26%, coal 22%, nuclear fuel 22%, oil 21%, renewable sources, including hydropower 9%.

Gross inland energy consumption (GIC) has a long-term downward trend in the Slovak Republic along with the growth of GDP. GIC decline occurred mainly as a result of industrial restructuring with higher added value and wider application of the principles of energy efficiency.

The significant progress in energy intensity reduction was recorded in the years 2002-2009, when the Slovak Republic reduced energy consumption by 38%, which was the highest reduction among all OECD countries and EU Member States. This trend continued also in the period of years 2005-2010, when the reduction by more than 21% was the highest in the EU in that period.

Important role in the policy and decision making process with respect to climate change plays the High Level Committee for Coordination of Climate Change Policy chaired by the State Secretary of the Ministry of Environment. Other members are the State Secretaries of the Ministry of Economy, Ministry of Agriculture and Rural Development, Ministry of Transport, Construction and Regional Development, Ministry of Education, Science, Research and Sport, Ministry of Health, Ministry of Finance, Ministry of Foreign and European Affairs and the Head of the Regulatory Office for the Network Industries.

Chapter 3: Greenhouse Gas Inventory Information

Total GHG emissions in the Slovak Republic (without LULUCF) decreased by 36.9% from 1990 to 2011. The biggest relative change has been in the waste sector where the emissions of CH4 from managed waste disposal on land increased substantially. Major decrease in emissions was in agriculture sector due to the essential changes in management practice.

On average, since the year 2000, total GHG emissions (without LULUCF) were more than 30% below the emission level of 1990. The emission situation is similar as was described in the Fifth National Report of the Slovak Republic.

Emissions of total greenhouse gases decreased by 1.3% between 2010 and 2011; this was largely due to an emission decrease in energy and industry sectors. Milder winter conditions and the lower demand for heating can partly explain lower emissions in 2011 compared to 2010.

Significantly reduced CO_2 emissions, combined with strong GDP growth and low population growth rate, resulted in a sharp drop of the economy's carbon intensity as measured by CO_2 emissions per unit of GDP (using purchasing power parities). This was the sharpest decline in any OECD country.

The fall in emission per GDP observed in Slovakia during 2003-2008 is the highest decline of all EU-27 Member States, as result of a small fall in emissions despite a large increase in GDP. Slovakia project further decoupling of emissions and GDP but at a slower rate than the impressive rate observed during 2003-2008. Based on the trend observed in other Member States, it is fair to assume that Slovakia's emissions per GDP may not continue to fall at the same impressive rate observed in historic years.

Since the last National Communication of the Slovak Republic in 2007, emissions decreased with a sharp drop in 2009 when the economic downturn caused substantial emission reductions. In 2010, emissions increased again, partly driven by the economic recovery from the 2009 recession in many economical and industrial activities. In particular emissions from iron and steel production and other manufacturing industries increased significantly in 2010.

Chapter 4: Policies and Measures

Overall policy framework to tackle climate change in the Slovak Republic consists of European strategies and climate related policies complemented with specific national policies and measures focused on the most critical areas.

All relevant EU-level policies and measures are being strengthened to meet the targets for the year 2020 as agreed in the EU Climate and Energy Package – to reduce greenhouse gas emissions by at least 20% compared to 1990, to achieve 20% of energy from the renewable sources by 2020 (as a share on total gross final energy consumption), supplemented by a target to achieve a minimum of 10% renewable energy share on the fuel consumption in the transport sector and moreover the target of 20% reduction of total primary energy consumption by 2020, compared to projections in 2007. Slovakia is on the way to fulfil its commitments as it is seen from recent GHG emission inventories.

Legally binding target trajectories for the period of 2013-2020 are enshrined in both the EU-ETS Directive (Directive 2003/87/EC and respective amendments) and the Effort Sharing Decision (Decision 406/2009/EC).

The Slovak Republic as the EU Member State will contribute by its fair share to the emission reduction target 20% of the emission level from the base year 1990. Trajectory for GHG emissions from sectors not covered by the EU ETS for the Slovak Republic is defined by the Decision 162/2013/EC on determining Member States' annual emission allocations for the period from 2013 to 2020 as of March 2013 and its complementing Decision 634/2013/EC on the adjustments to Member States' annual emission allocations for the period from 2013 to 2020 as of October 2013.

With respect to still very high potential for increase in energy efficiency and necessity for better diversification of energy sources, specific policy tools such as the Action Plan for Energy Efficiency 2008-2010 (Resolution of the Government of the Slovak Republic No. 922/2007), its updated version Action Plan for Energy Efficiency 2011-2013 (Resolution of the Government of the Slovak Republic No. 301/2011), National Action Plan for Biomass Use (Resolution of the Government of the Slovak Republic No. 130/2008) and National Renewable Energy Action Plan (Resolution of the Government of the Slovak Republic No. 677/2010) have been adopted.

Chapter 5: Projections and the Total Effect of Policies and Measures

6NC SR presents results of GHG emission projections of up to 2030 for three scenarios: "with existing measures (WEM)", "with additional measures (WAM)" and "without measures (WOM)" reference scenario structured by sectors, by gases and as total aggregated form. The year 2010 was determined as the reference year for greenhouse gas emission projections.

Reduction impacts of evaluated policies and measures are quantified for cross years starting from 2010 up to 2030.

Projected data for total aggregate GHG emissions indicate that our reduction target under the second commitment of the Kyoto Protocol can be fulfilled with already implemented and adopted PaMs (WEM scenario).

With respect to the sectoral shares, for PaMs evaluated in the WEM and WAM scenarios we do not expect significant changes in sectoral contributions to the total GHG emissions up to 2030. To achieve further reduction or changes in sectoral shares we would have to apply specific and targeted sectoral policies.

Projected decrease in total aggregate GHG emissions (without LULUCF) in 2020 compared to 1990 for WEM scenario is around 27 289 Gg of CO_2 equivalents, for WAM scenario more than 29 000 Gg of CO_2 equivalents.

Projections show that with existing and additional measures GHG emissions in 2020 will decrease for all followed sectors except for transport and waste management.

Projections of GHG emissions per gas by 2020 relative to 1990 according to the WEM and WAM scenario indicate decrease of all greenhouse gases, except for F-gases. They are expected to peak by 2015 and only then, after implementing of specific measures, such as Regulation on F-gases, we can achieve their decrease by 2030. Although the relative increase of F-gases in 2015 seems to be substantial comparing with the other ones, their share on country's overall GHG emissions is very small (around 1%).

Chapter 6: Vulnerability Assessment, Climate Change Impacts and Adaptation Measures

In this Chapter is presenting a sample from the newest climate change scenarios as the table format of changes in several climatic variables for the time frame 2075 (2051-2100 average) compared to 1961-1990 average. Climate change scenarios suppose increase of air temperature by about 1.5°C to 4.5°C for growing period (Apr.-Sept.) in Slovak lowlands and no change or small decrease of relative air humidity. While temperature scenarios are very close for all Slovak localities, precipitation scenarios exhibit some regional differences. Higher increase of annual precipitation totals was obtained from the north of country; summer decrease of precipitation totals is more significant in the southern lowlands. Comparable increase (decrease) is projected also for daily maximum precipitation totals.

Adaptation consists of actions altering our behaviour to respond to current and future impacts and vulnerabilities. It means not only protecting against negative impacts, but also taking advantage of any benefits. The earlier we implement adaptation responses, the less it will cost and the better equipped we will be to cope with challenges stemming from climate variability, climate change and unsustainable socio-economic developments, i.e. to (global) environmental change.

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The magnitude of climate change impacts on human and natural systems in Europe calls for adaptation responses that both, reduce the vulnerability of these systems through technological solutions and so on, and further strengthen their resilience through ecosystem-based and managerial options and so on. This Chapter is focusing on the expected impacts of climate change, vulnerability and adaptation measures in several important sectors of Slovak economy such as Agriculture, Forestry, Biodiversity, Public Health, Hydrology nad Water Management, Tourism, Transport and Energy.

Chapter 7: Provision of Financial, Technological and Capacity Building Support to Developing Countries

Related activities were from projects implemented in the period 2009-2013 under the financial assistance granted by the SR to developing countries. Of the total portfolio, following activities were selected: activities in the field of climate change adaptation, mitigation projects, support and capacity building projects for water, waste management, ecological agriculture, food security, afforestation and renewable energy sources development.

The Slovak Republic has implemented more than 30 projects, mainly in the form of bilateral cooperation, by providing total sum nearing 9 million EUR. Most of them have been realized under the Official Development Assistance (ODA). In order to fulfil our fast-start finance mechanism commitment for climate change policy in developing countries in the years 2010-2012, there were projects financed and implemented also beyond the officially approved amount for ODA.

Currently in the Slovak Republic is being prepared a comprehensive information system for accounting and reporting of development financial flows of Slovakia, in accordance with the requirements of the OECD Development Assistance Committee which member is Slovakia since September 17, 2013.

Chapter 8: Research and Systematic Observation

The Slovak Republic has developed an Integral Conception of state scientific and technical policy. The Ministry of Education, Science, Research and Sport of the Slovak Republic (MESRS) is the authority with full competences and administration skills to manage research and development in Slovakia according to the Act No. 172/2005 Coll. on the organization of the state support of research and development. Similarly, ministries, central bodies of state administrations and the Slovak Academy of Sciences have developed their sector conceptions supporting research and development. Institutions involved in climate change oriented research include SHMI, universities and other institutions dealing with research.

In comparison with the previous period some increase in domestic and international activities has been registered. National projects in this field are as important as the international ones, their scope and results are mostly comparable with the European standards. It needs to be count among them also a large number of projects not dealing directly with climate change issues, but with physical, chemical and biological processes connected with comparable impacts like the climate change is. The list of projects includes the number of projects in the field of climatology, forestry sector, hydrology and water management sector and agriculture.

Slovakia has a long tradition in hydrological, meteorological and climatic observation. Decision 11/CP.13 adopted a separate decision with reporting requirements related to Global Climate Observing System. Detailed technical reports should be provided in conjunction with national communications. The hydrological and meteorological observations and measurements in Slovakia are guaranteed by the Act No. 201/2009 Coll. on the state hydrological service and the state meteorological service. These measurements and observations are carried out by the SHMI in Bratislava.

International activities in the field of the Earth's climate system research are also provided by several Slovak scientific institutions. As many as 23 institutions and other subjects participated in the Slovak National Climate Program activities.

The project implemented in Kenya can be considered as Slovak support to developing country to establish and maintain its climate monitoring system and to prepare the National Report on Climate Change. This project was coordinated by the Slovak State Department.

Chapter 9: Education, Training and Public Awareness-Raising

Education is generally a responsibility of the MESRS, for this issue, but also in training and in raising public awareness the MoE also contributes significantly directly or through its branches. Education and information on this subject are also provided by the selected university and scientific institutions, interest groups, as well as professional and non-governmental organizations (NGO).

Climate change is expertly challenging and cross-cutting theme that goes beyond the content of educational programs for elementary and secondary schools. The issue of climate change and its adverse consequences is a component of a wide spectrum of topics within the environmental education in primary and secondary schools. The activities include global education, training programs, national competitions as well as international activities. On the level of colleges and universities, its importance has increased recent years.

The other climate-related activities include conferences, seminars, festivals, exhibitions, trainings, source or information centres and involvement in international activities.

01
Introduction

Climate change has become one of the biggest, if not the biggest challenges of the environmental policy in the 21st century. The World Economic Forum Global Risks 2013 Report[1], which regularly assesses 50 biggest global risks according to their impacts, possibility and inter-connections with other issues identified this phenomenon as one of the top 5 risks that the world faces in 2013. The report criticises the lack of financial interest to solve environmental challenges such as climate change.

Although the impact of the climate change is different in different regions of the world, its socio-economic and environmental impact always needs an active solution. Necessary political measures have to stem from detailed analysis of the current greenhouse gas (HGH) emissions in every sector, emission projections and impact assessment of adopted or planned policy measures. Such a detailed analyses and a good starting point for any policy making is a national communication of a party prepared according to rules of the United Nations Framework Convention on Climate Change (UNFCCC).

To fulfil this obligation, the Slovak Republic also submits its 6th National Communication on Climate Change which contains the 1st Biennial Report of the Slovak Republic and Common Tabular Format (CTF) Tables, according to Article 12 of the UNFCCC and according to Article 7 of the Kyoto Protocol and Decision 2/CP.17.

The 6th National Communication on Climate Change, the 1st Biennial Report of the Slovak Republic and CTF Tables contain necessary information about all aspects of implementation of the UNFCCC and the Kyoto Protocol on the national level, gives a detailed analyses how our commitments are being fulfilled and provide information about important changes in the area of climate change policy since the submission of our last National Communication in 2009.

Since 2009, the most important achievements in the context of the fulfilment of goals of the UNFCCC and the Kyoto Protocol are as follows:

- Mitigation targets are being successfully fulfilled and at the same time economic growth is maintained and carbon intensity is being decreased;
- Climate and Energy Package approved in December 2009 on the EU level was successfully transposed into national legislation and is being implemented, which is the founding block for a successful implementation of the second commitment period of the Kyoto Protocol;
- Creation of an effective inter-ministerial mechanism for coordination of climate change policy making at the level of the state secretaries;
- Enhancement of cooperation between ministries and other state agencies in order to implement more effectively our climate change commitment including our Fast-start Finance commitment;
- Continuation of research programmes and projects related to clime change in various areas, such as forestry, hydrology, water man agement, agriculture sector and renewable energy sources;
- Connection of several Slovak scientific institutions into international activities of the Earth's climate system research;
- Improvements of educational programmes and climate change awareness of the general public, which also includes organisation of several international environmental events.

To sum up our mitigation commitments, under the first commitment period of the Kyoto Protocol, the Slovak Republic agreed to reduce aggregated GHG emissions by 8% compared to the base year 1990.

In 2011, total GHG emissions in the Slovak Republic without Land use, land-use change and forestry (LULUCF) were 36.9% below 1990. Between 2010 and 2011 emissions decreased by 1.3% (600 Gg of CO_2 equivalents).

Latest OECD Environmental Performance Review of the Slovak Republic summaries results in GHG emission reductions since 1990 as follows:

„Significantly reduced CO_2 emissions, combined with strong GDP growth and low population growth rate, resulted in a sharp drop of the economy's carbon intensity as measured by CO_2 emissions per unit of GDP (using purchasing power parities). This was the sharpest decline in any OECD country“.[2]

1 http://www.weforum.org/reports/global-risks-2013-eighth-edition
2 OECD Environmental Performance Reviews, Slovak Republic, 2011

In compliance with Decision 2/CP.17 the Slovak Republic also submits in the Annex 1 to this National Communication the 1st Biennial Report of the Slovak Republic, which contains:

- Information on GHG emissions and trends and the GHG inventory including information on national inventory system;
- Quantified economy-wide emission reduction target;
- Progress in achievement of the quantified economy-wide emission reduction targets;
- Projections of GHG emissions up to 2030 structured by sectors and gases.

Provisions of financial, technological and capacity building support to developing countries, including CTF tables are included in this National Communication.

Tabular information as defined in the CTF tables for the UNFCCC biennial reporting guidelines for developed country Parties[3] are enclosed as Annex 2 to this National Communication.

3 Decision 19/CP.18

02
National Circumstances

This chapter brings a brief overview of natural conditions relevant for the policy of climate change, including legal and institutional frame for its practical implementation. Chapter also includes a description of geographic, economic and climate profiles of the Slovak Republic (SR), including actual population development with emphasis on the most significant changes since 2009, when the Fifth National Communication of the Slovak Republic on Climate Change was submitted. Furthermore, this chapter brings basic characteristics of those economic sectors that contribute significantly to the emissions and sinks of greenhouse gases (GHG) respectively; this chapter also delivers an overview of trends in key indicators relevant to GHG emissions production.

2.1 INSTITUTIONAL AND LEGISLATIVE ARRANGEMENT

Since the establishment of the Slovak republic in 1993, the arrangement of state authority has not changed. The President – head of state is elected directly for a five-year period, the supreme legislative body is the National Council of the Slovak Republic with 150 members, elected for 4-year period and the Government of the Slovak Republic led by Prime Minister. The Government of the SR consists of 4 Deputy Prime Ministers and 14 ministers. The arrangement and responsibilities of central state administration bodies are governed by Act No. 575/2001 Coll. on the organization of the Government activities and central state administration bodies.

The Ministry of Environment of the Slovak Republic (MoE) is responsible for the development of a national environmental policy and measures regarding climate change and adaptation. The international legal context of climate change policy is determined by the UN Framework Convention on Climate Change (UNFCCC), adopted on May 9, 1992 in New York. On behalf of the Slovak Republic, UNFCCC was signed on May 19, 1993.[1] The Slovak Republic expressed its approval with UNFCCC by the Resolution of the National Council of the SR No. 555 of August 18, 1994.[2] The Kyoto Protocol was signed on behalf of the SR on February 26, 1999 in New York. National Council expressed its approval with the Kyoto Protocol by the Resolution No. 1966 of March 20, 2002.[3]

The Climate Change Policy Department of the MoE serves as the National Focal Point to the UNFCCC. This department, along with the Emissions Trading Dpt. performs the main coordinating role to ensure fulfilment of our international commitments within the UNFCCC and the Kyoto Protocol.

Given the scope and cross-cutting nature of climate change and adaptation, by the Resolution of Government No. 416/2008 of June 18, 2008 joint High Level Committee on Climate-Energy Package consisting of State Secretaries of selected ministries was created.

In 2011, according to the resolution of the Slovak Government No. 821/2011, the High Level Committee on Climate-Energy Package has been replaced by the High Level Committee for Coordination of Climate Change Policy (Coordination Committee).

The Coordination Committee is chaired by the State Secretary of the MoE. Other members include the State Secretaries of the Ministry of Economy, Ministry of Agriculture and Rural Development, Ministry of Transport, Construction and Regional Development, Ministry of Education, Science, Research and Sport, Ministry of Health, Ministry of Finance, Ministry of Foreign and European Affairs and the Head of the Regulatory Office for the Network Industries.

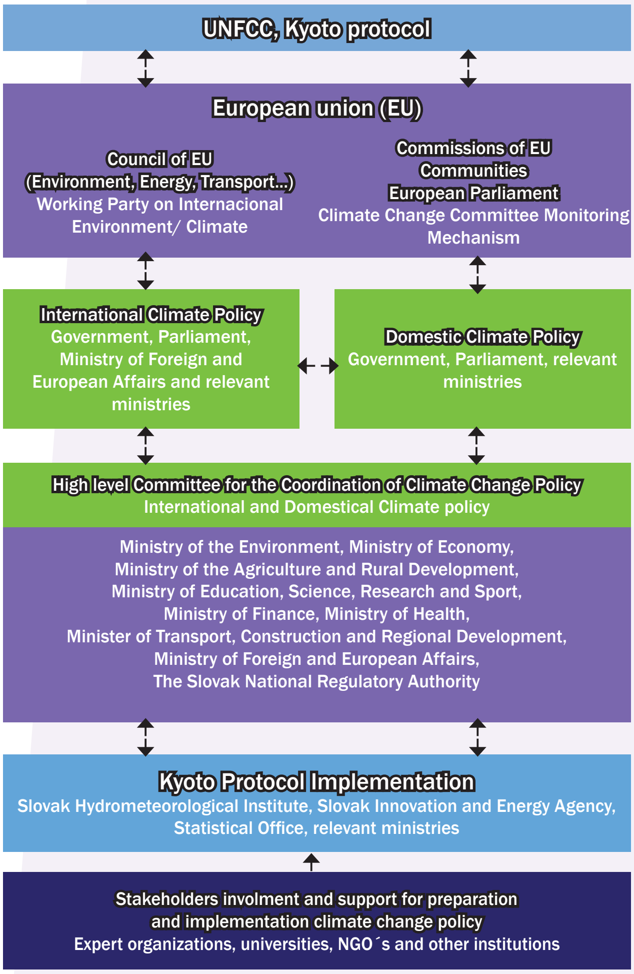
Main objective of the Coordination Committee is an effective coordination at developing and implementation of mitigation and adaptation policies and selection of appropriate measures to fulfil international obligations.

As an important output of its activities is also report titled "Report on the Current State of Fulfilment of the International Climate Change Policy Commitments of the Slovak Republic" ("Správa o priebežnom stave plnenia prijatých medzinárodných záväzkov SR v oblasti politiky zmeny klímy"), annually submitted to the Government, with aim to inform it on the basis of a detailed analysis of current progress on this issue. So far there were submitted two reports - the first in June 2012[4], another in April 2013.[5]

The Ad-hoc Expert Group for preparing Adaptation Strategy of the SR on Adverse Impacts of Climate Change and Ad-hoc Expert Group for preparing Low-Carbon Strategy of the SR were created under the Coordination Committee in 2012. These expert groups include experts from other relevant ministries, academic and university positions and all expert institutions.

1 Notice of the Ministry of Foreign Affairs of the Slovak Republic No. 548/2006 Coll.
2 The Act on Ratification was deposited at UN Depositary on August 25, 1994
3 The Act on Ratification was deposited at UN Depositary on May 30, 2002
4 http://www.rokovania.sk/Rokovanie.aspx/BodRokovaniaDetail?idMaterial=21144
5 http://www.rokovania.sk/Rokovanie.aspx/BodRokovaniaDetail?idMaterial=22264

Scheme 2.1: *Institutional arrangements concerning climate change policy and its implementation*



2.2 DEMOGRAPHIC PROFILE

Population of the Slovak Republic as of December 31, 2012 was 5 410 836. Average residential density is 110.2 inhabitants per km². Besides towns, the population is concentrated in lowlands and basins, highlands and mountains are populated very sparsely. Extensive settlement and landscape exploitation have influenced essentially the original landscape structure and ecosystems. Bratislava, the capital, is also the biggest city in the Slovak Republic with the population of 432 801.[6]

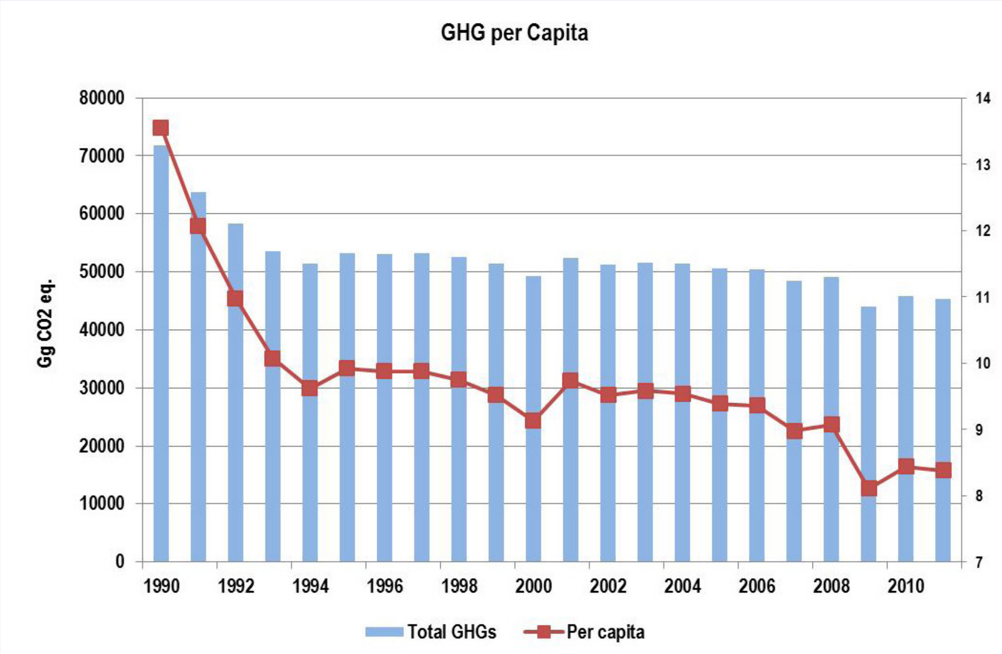
In 2011, 60 813 living children were born, i.e. 403 more than in 2010. Furthermore, in 2011 died 51 906 people, which is about 1 542 less than in 2010. These numbers therefore indicate a slight trend of the population increase, in spite of the recent years, where such a trend was halted.[7]

However, the major demographic trend is the increase of the share of the group over 65 years. The main reason is the change of reproductive behaviour, which caused that the Slovak Republic has dropped under the replacement level fertility rate.

In the context of demographic development a very positive trend is the decrease in emissions per capita – in 2011 there were 8.38 tons of CO_2 equivalent compared to 1990 value of 13.55.[8] This level of emissions per capita in Slovakia is below the EU-27 average level, which was 9.2 tons of CO_2 equivalents per capita[9] at that time.

6 As of 2011, Ministry of Finance of the Slovak Republic
7 All the statistic data from this paragraph are from the publication of the Statistical office of the Slovak Republic “Trend in population in the Slovak Republic, 2011,“ December 2012
8 Background data for preparation of the SVK NIR 2013
9 Greenhouse gas emission trends and projections in Europe 2012, EEA Report No 6/2012, p. 92

Figure 2.1: *Aggregated GHG emissions per capita in the Slovak Republic from 1990 to 2011*[10]



2.3 GEOGRAPHIC PROFILE

The information on geographic profile of the Slovak Republic is provided in the Fifth National Communication of the Slovak Republic on Climate Change, Chapter 2.3.[11]

2.4 CLIMATE PROFILE

According to global climatologic classifications, the Slovak Republic is located in the mild climate zone with mean monthly precipitation totals equally distributed over the whole year. The Atlantic Ocean more impacts the west part of the country and the continental influence is more typical for the east part. The Mediterranean climate influences mainly the south of the central part of Slovakia by higher precipitation totals in autumn. A regular rotation of spring, summer, autumn and winter seasons is typical for the country.

During the period 1881-2012 (good quality of meteorological observations at several stations and precipitation totals at 203 stations), significant increase of annual air temperature by 1.8°C and insignificant decrease of annual precipitation totals by 1.3% were recorded on average in Slovakia. Annual precipitation totals increased up to 3% in the north and decreased also more than 10% in the south of the country. Relative air humidity decrease up to 5% in the south-west and snow cover decrease up to altitude 800 m were recorded (moderate snow cover increase in the highlands, above 1 000 m a.s.l.). There is the evidence of gradual desertification, particularly in the south of the country (increase of potential evaporation and decrease of soil moisture), but the year 2010 and the cold half-year 2012/2013 were the wettest since 1881. Significant increase in regional and flash floods was recorded after 1995. Sun radiation characteristics changed insignificantly, except the temporal decrease in 1965-1985. Figures 2.2 and 2.3 show seasonal mean temperatures in Slovakia in 1980-2012 and areal mean precipitation totals in Slovakia in 1881-2012. It can be seen that the temperature increase is even more significant than in the whole 1881-2012 period and that the precipitation totals started slightly to increase since 1994 (extreme year 2010 is exceptional).

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10 National Inventory Report of the Slovak Republic 2013
11 http://unfccc.int/resource/docs/natc/svk_nc5.pdf

Figure 2.2: *Deviations of warm and cold half-years mean temperatures from the 1961-1990 normal in Slovakia in 1980-2012 (by the SHMI data)*

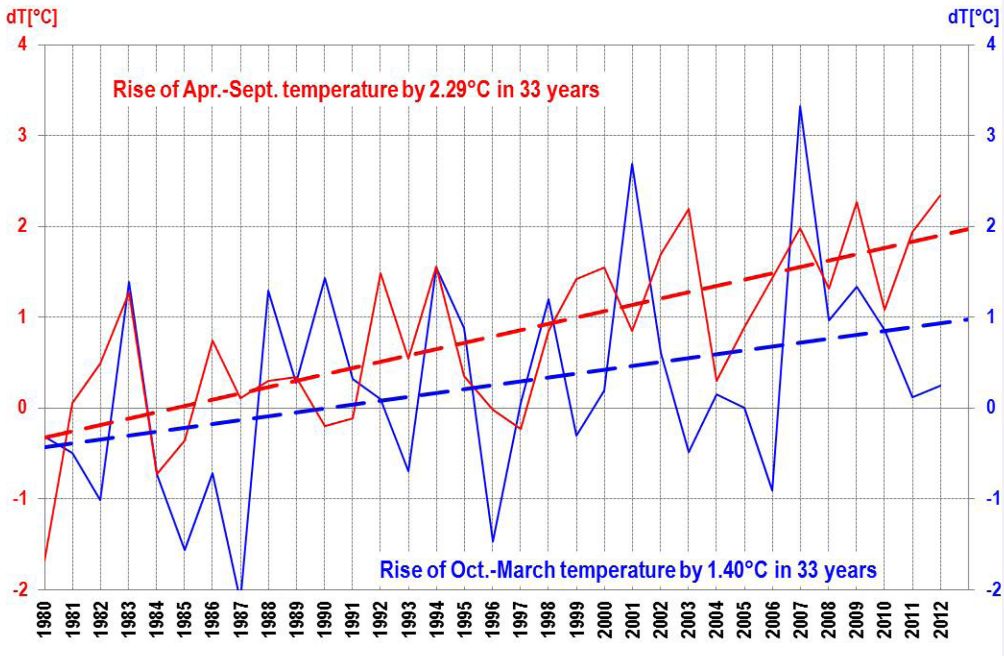
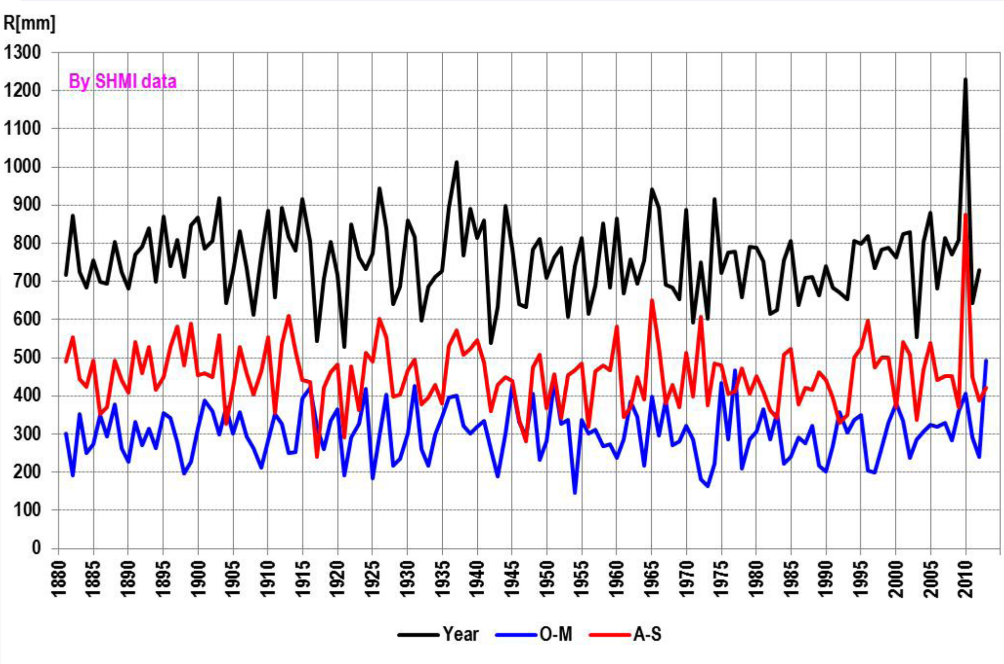


Figure 2.3: *Annual (Year), warm half-year (Apr.-Sept.) and cold half-year (Oct.-March) areal mean precipitation totals in Slovakia in 1881-2012/2013 (by the SHMI data)*



Particular attention needs to be paid to the climate change and variability, in particular to precipitation totals and hydrologic cycle. Over the last 20 years, a significant increase in the occurrence of extreme daily precipitation totals as well as several day heavy rain events have been observed, mainly compared to period 1975-1993. This trend has resulted in higher risk of local floods in several localities of the Slovakia. On the other hand, local and regional droughts caused by long periods of relatively warm weather and low precipitation totals in some part of growing seasons, have been recorded in the period of 1989-2012. Particularly strong droughts were in 1990-1994, 2000, 2002, 2003, 2007, 2009, 2011 and 2012. Based upon the indicators of air temperature, precipitation totals, evapotranspiration, snow cover and some other elements, the decade 1991-2000 and mainly 2001-2010, have approached the conditions expected in about 2030 with respect to climate change scenarios designed for Slovakia.

Evaluation of extreme weather events till 2013

Extreme weather events in relation to temperature, precipitation, air humidity, sunshine duration, evaporation and snow cover have been evaluated. In case of temperature we consider daily temperature means above 24 °C and 27 °C and below -5 °C, daily maximum temperature above 25 °C and 30 °C, daily minimum temperature below -10 °C etc. Important for heat waves and cold waves are both individual days and series of several such days with synoptic analysis. In case of periods with low precipitation totals, we consider series of 15 days at least with 1 mm of precipitation at the most. Daily precipitation totals above 100 mm cause usually local flash flood at least, change of such events number in Slovakia seems a good indicator. The number of days with muggy weather (water vapor pressure above 18.7 hPa), and number of days with 1 cm, 10 cm, 50 cm or 100 cm snow cover have been evaluated similarly. These results proof different climate change evolution in lowlands and mountainous regions. More details in decades from 1951-1960 to 2001-2012 can be seen in Tables 2.1, and 2.2 and in Figure 2.4. Climate change scenarios anticipate significant increase in number of certain weather extremes.

Tables 2.1 and 2.2 show that significant changes occurred at some climatic characteristics and extreme values, mainly in 2001-2012, compared to 1901-1990 or 1951-1990 periods (Hurbanovo is one of the best stations with unchanged observing conditions since 1901): number of days with average temperature 27 °C and more and tropical nights with minimum temperature 20 °C and more increased about 5-times, number of tropical days with maximum temperature 30 °C and more increased by about 2-times, number of days with average relative humidity below 50% by about 3-times, number of muggy days (average water vapor pressure above 18.7 hPa) increased by about 2-times, summer average saturation deficit increased by 31%, number of days with harmful saturation deficit 10 hPa and more increased by 80%, number of daily precipitation totals above 10 mm increased in the whole Slovakia by about 15%, but number of all days with precipitation slightly decreased, precipitation totals decreased in the South, but increased in the North of Slovakia (at Oravská Lesná by about 10% compared to 1951-1990 period).

Table 2.1: *Some climatic characteristics of mean and extreme weather elements for Hurbanovo (SW Slovakia, 115 m a.s.l. in decades from 1951-1960 to 2001-2012 (2001-2010*) compared to published values for the period 1901-1950 (*1901(1951)-2010)*

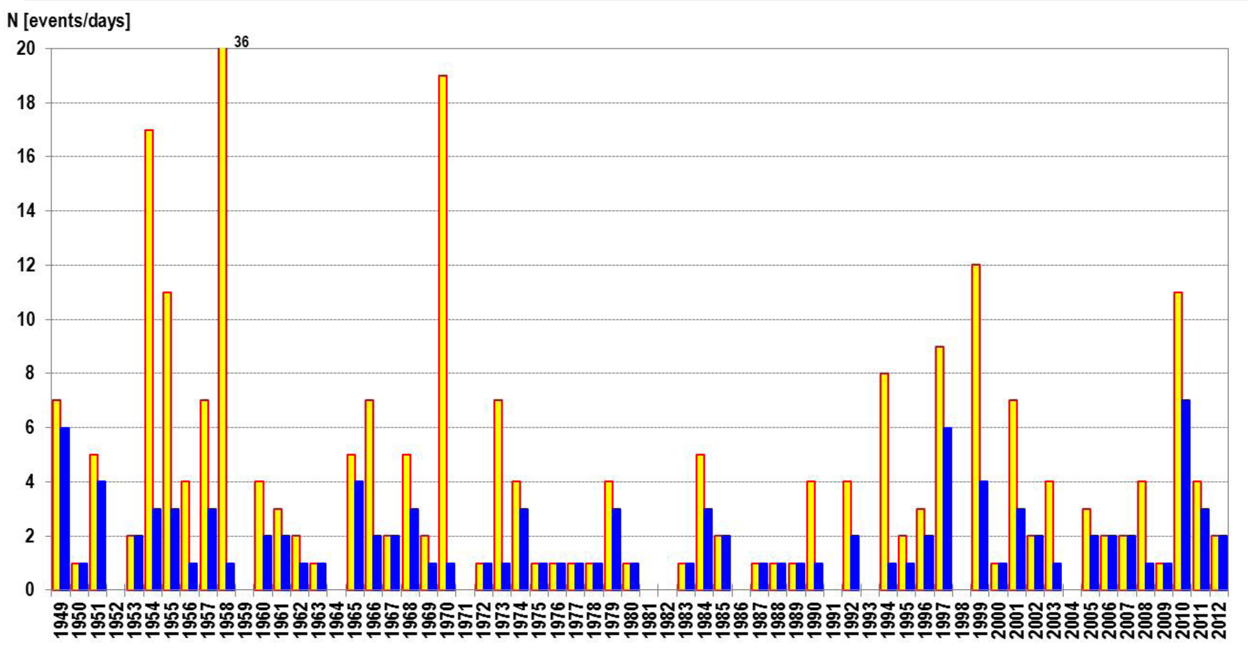
	1901-1950	1951-1960	1961-1970	1971-1980	1981-1990	1991-2000	2001-2012
Annual average temperature (T). °C	9.7	9.9	9.9	10.0	10.1	10.7	11.1
Means of maximum aver. daily T in Summer. °C	N	26.9	27.0	26.3	27.3	27.8	29.1
Number of daily aver. T 24 °C and more. Days	N	9.2	12.2	8.4	11.4	17.6	23.9
Number of daily aver. T 27 °C and more. Days	N	1.2	1.0	0.2	1.0	3.6	5.8
Number of daily aver. T below 0 °C. Days	N	46.3	56.6	40.0	48.0	44.3	45.2
Number of daily aver. T below -5 °C. Days	N	12.2	17.0	7.8	13.5	9.6	9.5
Mean daily max. temperature in Summer. °C	25.4	N	26.1	25.6	26.0	27.2	27.6
Number of daily max. T 25 °C and more. Days	67.8	N	76.5	71.6	75.7	86.0	93.0
Number of daily max. T 30 °C and more. Days	14.8	N	22.9	14.5	21.2	27.8	35.3
Mean daily minimum temperature in Winter. °C	-3.7	N	-4.7	-2.1	-3.1	-2.6	-2.6
Number of daily min. T below 0 °C. Days	96.7	N	103.5	88.5	90.5	90.0	86.3
Number of daily min. T below -10 °C. Days	14.2	N	15.1	6.4	10.4	7.5	8.3
Number of daily min. T 20 °C and more. Days	1.0	N	0.6	1.2	1.9	3.2	4.7
Annual mean relative humidity (RH). %	75.6	76.1	74.4	74.2	72.4	73.1	72.2
Number of days with aver. RH below 50%	N	5.2	8.8	11.2	15.5	16.2	20.3
Summer mean water vapor pressure (WVP). hPa	15.4	16.2	15.4	15.1	14.8	15.8	16.3
Number of days with aver. WVP above 18.7 hPa	N	17.5	14.1	11.9	9.7	16.8	21.5
Summer mean saturation deficit (SD). hPa	6.6	6.9	7.6	7.4	8.1	8.8	9.2
Number of days with aver. SD 10 hPa and more	N	20.8	30.5	24.6	34.4	42.8	49.8
Annual mean sum of sunshine duration (SSD). hours	1987	1850	1774	1831	1951	1979	2118
Number of days with 10 hr SSD and more	N	N	55.5	62.8	66.2	71.4	88
Annual mean precipitation totals (PPT). mm	581	567	556	518	497	555	554
Number of days with 10 mm PPT and more	16.3	15.7	15.8	15.1	12.8	15.0	17.2
Number of days with snow cover 1 cm and more	37.7	34.1	50.4	27.2	32.9	34.0	34.0
Number of days with snow cover 10 cm and more	13.5	12.4	22.2	6.1	12.8	14.3	5.3
Average annual potential evaporation sum. mm *	N	692	730	742	773	782	791
Average annual actual evaporation sum. mm *	N	445	432	417	417	442	460
Number of ≥15-day dry periods in GP *	1.66	1.9	2.2	2.0	1.5	1.9	1.7
Number of days in ≥15-day dry periods in GP *	33.8	38.1	46.4	40.1	29.6	37.8	36.8
Annual number of ≥30-day dry periods *	0.86	1.3	1.4	1.4	1.2	1.1	0.9
Annual number of days in ≥30-day dry periods *	32.6	47.6	50.5	53.5	43.4	42.7	33.6

Potential evaporation (also potential evapotranspiration) increased in the whole Slovakia, more in the South (at Hurbanovo by about 100 mm since 1951), but actual evaporation was determined by soil moisture (decreased in the South up to 1990, Table 2.1). No significant change was recorded in number of “dry periods” (less than 1 mm precipitation in ≥15-day dry period and less than 5 mm precipitation in ≥30-day dry period, GP is growing period). Because of warmer climate and higher potential evaporation the periods with low precipitation were more dry and longer since 1990 than before. Snow cover days number decreased slightly in the whole Slovakia, in lowland decreased significantly number of days with snow cover depth 10 cm and more, but in the mountains increased number of days with snow cover depth 100 cm and more by about 3-times (at Oravská Lesná, Table 2.2).

Table 2.2: *Some climatic characteristics of mean and extreme weather elements for Oravská Lesná (NW Slovakia, 780 m a.s.l. in decades from 1951-1960 to 2001-2012 compared to published values for the period 1901-1950 (*1951-2010)*

	1901-1950	1951-1960	1961-1970	1971-1980	1981-1990	1991-2000	2001-2012
Annual mean precipitation totals (PPT). mm	1 109	1 045	1 155	1 059	1 071	1 170	1 200
Average annual potential evaporation sum. mm *	N	448	452	437	461	467	492
Average annual actual evaporation sum. mm *	N	421	434	416	440	434	461
Number of days with snow cover 1 cm and more	N	126.9	139.3	126.5	120.6	132.6	125.8
Number of days with snow cover 10 cm and more	N	107.7	114.5	104.1	95.6	106.7	113.3
Number of days with snow cover 50 cm and more	N	30.4	51.7	30.6	42.5	29.1	42.3
Number of days with snow cover 100 cm and more	N	4.2	3.1	4.1	6.0	3.4	10.8

Figure 2.4: *Number of events (yellow) and days (blue) with measure daily precipitation totals 100 mm and more at about 700 stations in Slovakia in 1949-2012*



Heavy and intense precipitation events play very important role in flash flood events, evidence of such cases is based on measurements at about 700 station since 1949 and decreasing number of stations since 1881 (more than 200 stations in Slovakia in 1900). From Figure 2.4 some increase of such events can be seen since 1994, but in 1949-1970 there were as many or even more heavy rains than in the last 20 years (36 events/stations on June 29, 1958).

2.5 ECONOMIC PROFILE

This chapter brings short analysis of the economic development of the Slovak Republic in the period 2000-2012. Beside the basic macroeconomic indicators as GDP, GDP per capita, foreign and domestic trade development, inflation, employment, there are also mentioned the data on the amount of investment in environmental protection and activities in the area of science and research, without specifying their orientation. The economic crisis that began in 2008, has brought a significant weakening of the external demand, causing a decreasing dynamics of the Slovak export, manufacturing, labour market and total domestic demand. The debt crisis in the Eurozone that broke out in 2012, again caused a decline in external demand.

Table 2.3: *GDP development*

Indicator	2004	2005	2006	2007	2008	2009	2010	2011	2012
GDP at curr. price (million EUR)	45.16	49.31	55.00	61.45	66.84	62.79	65.87	69.11	71.46
GDP at const. PPY (million EUR)	42.67	48.17	53.43	60.77	64.98	63.54	65.55	67.99	70.51
GDP at const. pr. 05 (million EUR)	46.24	49.31	53.43	59.04	62.43	59.35	61.95	63.95	65.25
GDP per capita at curr. pr. (thousand EUR)	8.39	9.15	10.20	11.39	12.36	11.59	12.13	12.70	13.22
GDP per capita at const. PPY (thousand EUR)	7.93	8.94	9.91	11.26	12.02	11.73	12.07	12.50	13.04
GDP per capita at const. pr. 05 (thousand EUR)	8.59	9.15	9.91	10.94	11.55	10.95	11.41	11.75	12.07

Source: SLOVSTAT
Note: ESNÚ 95 methodology, according to quarterly national accounts

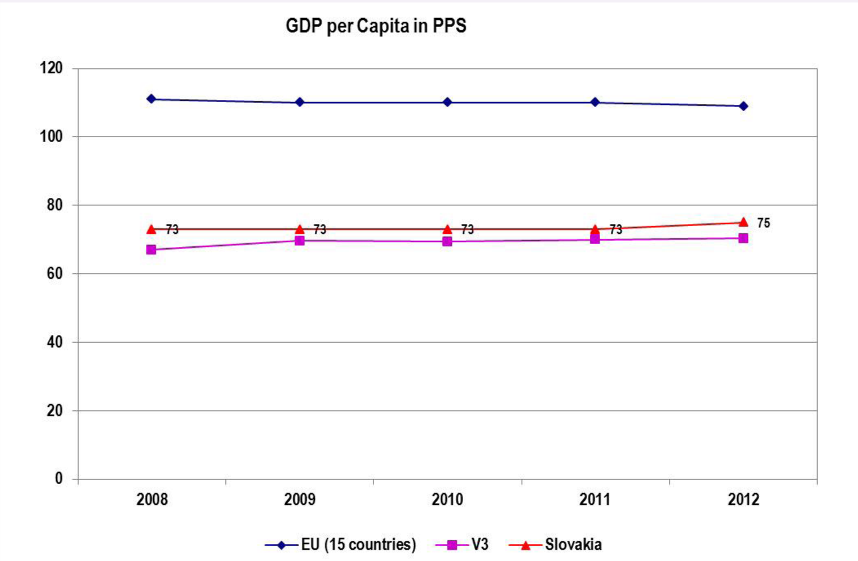
Table 2.4: *Foreign Trade development (million EUR)*

Indicator	2004	2005	2006	2007	2008	2009	2010	2011	2012
Total	31.3	35.4	43.7	48.1	50.3	38.8	47.5	55.8	59.3
Total	29.6	32.9	41	47.4	49.6	39.8	48.3	56.8	62.9
Balance	-1.7	-2.5	-2.6	-0.8	-0.8	1	0.8	1.1	3.7

Source: Statistical Office of the Slovak Republic

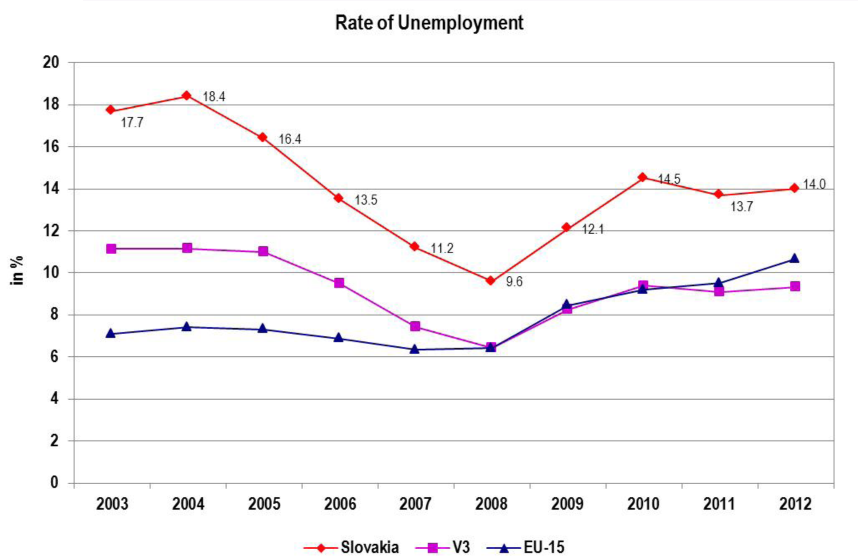
Note:
Index - the corresponding period last year = 100; values of FOB type, at current prices; data are processed according to country of origin / destination, possible differences at the last place are due to rounding
1) data calculated according to methodology effective from 1. 1. 2005
2) data on value of imported and exported electricity were estimated on the base of data on physical flows of electricity
3) data calculated according to methodology effective from 2007 (without indirect imports and exports)
4) data 2004-2008 were converted by exchange rate EUR 1 = SKK 30.126

Figure 2.5: *GDP per capita in purchasing power standard (PPS)*



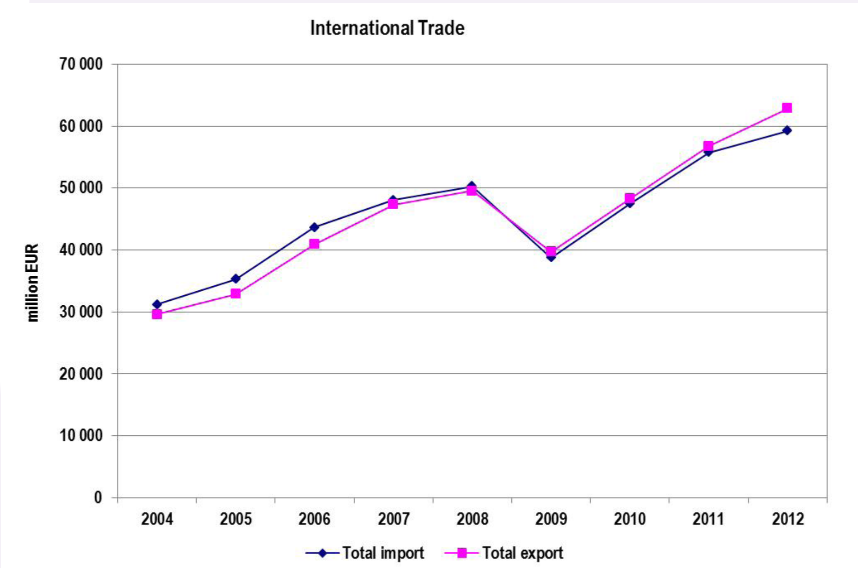
V3 = Hungary, Poland, Czech Republic; Source: Eurostat

Figure 2.6: *Rate of unemployment*



V3 = Hungary, Poland, Czech Republic; Source: Eurostat

Figure 2.7: *International trade*



Source: Statistical Office of the Slovak Republic

In 2007, the Slovak economy reached historically the highest growth at 10.5%. The growth was the result of the co-operation of the foreign direct investment, the positive developments in the external environment, the structural reforms and the accession to the EU in 2004. During the years 2006-2008, GDP expressed in purchasing power increased compared to the EU average as many as 10 percentage points. Economic growth in this period was the most rapid among the EU countries.

Economic growth was also accompanied by a significant decline in unemployment. According to LFS[12], unemployment between 2004-2007 showed a positive downward trend and in 2008 for the first time during the existence of an independent Slovakia it reached the single-digit value of 9.6%. Along with the decline in unemployment it was accompanied by an increase in wages and thus the living standard of the population was growing. Labour productivity growth in this period, however, outpaced wage growth, therefore these developments have not threaten the competitiveness of the Slovak industry.

12 http://portal.statistics.sk/showdoc.do?docid=1801

In 2009, the real GDP decreased by 4.9%. Thus Slovakia was ranked as the country with the highest GDP slump. The economic crisis has brought a significant weakening of external demand, causing a decreasing dynamics of the Slovak exports, manufacturing, labour market and total domestic demand. The decline in external demand for the Slovak exports was immediately reflected in the labour market. Employment grew rapidly until 2009 and then declined by 2.8%.

The year 2010 marked the Slovak economy turnaround in the form of relatively strong recovery in economic growth - with 4.4% resulted in the SR being on the second place in the EU after Sweden. Boosting growth has not been translated into the labour market - still falling employment and a decline in gross disposable income of households contributed to a decline in household consumption. The debt crisis in the Eurozone that broke out in 2012 again caused a decline in external demand. Slovakia managed to avoid recession due to the new investments in the automobile industry, which supported the export and due to which Slovakia finished with a historical trade balance surplus.

The labour market reacted to the production side of the economy with a delay. Thus in 2010 the decline in employment continued, which declined by 2.0%, and the unemployment rate jumped up and down to 14.4%. In 2011, the situation on the labour market improved as a result of renewed growth, although unemployment lagged far behind the pre-crisis level. With the outbreak of the debt crisis in 2012, there was another slow-down and unemployment in 2012 ended at 13.9%.

As described in the Table 2.5, looking at economic growth broken down by output, its main drivers were industry and services. The construction sector remained in recession.

Table 2.5: Branches of activity structure of GDP development (SK NACE Rev. 2) (in %)

Indicator	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Economy in total	100	100	100	100	100	100	100	10	100	100	100	100	100
A Agriculture. forestry and fishing	3.1	3.6	3.8	3.8	3.6	3.2	3.2	3.3	3.5	3.6	3.0	3.5	3.2
B. C. D. E Industry total	20.4	21.0	21.1	23.9	26.5	26.1	28.4	28.9	28.5	25.2	27.7	28.3	30.6
C Manufacturing	14.6	16.1	15.7	17.6	19.9	20.7	21.7	22.0	22.4	20.1	23.2	23.9	26.5
F Construction	7.0	6.1	7.2	5.8	6.0	6.1	6.8	7.0	7.9	7.7	7.3	7.4	6.2
G-U Services	60.8	61.5	59.7	56.8	53.4	53.3	51.7	51.2	50.8	54.1	52.9	51.5	51.5
Net taxes on products	10.0	8.9	9.2	10.0	10.5	11.2	909	9.7	9.2	9.0	9.0	9.5	8.4

Source: SLOVSTAT
Note: ESNÚ 95 methodology, according to quarterly national accounts

Table 2.6: Environmental expenditures (million EUR)

Indicator	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Environmental investments	128.7	170.8	296.9	176.5	245.3	281.4	332.5	292.2	321.3	279.6	260.1	269.5
Investments covered by state budget	29.9	39.7	35.6	29.6	26.5	34.1	38	28.5	33.9	23.5	23.4	37.7
Investments covered by foreign investor	12.6	4.5	71.9								56.3	73.8
Current expendi-tures total	221.4	305.7	381.3	378.1	461	501.3	772.7	579.3	479.2	448.6	474.1	515.9
Incomes from the protection of envi-ronment together	31.6	38.3	58.7	81.8	210.3	261.1	265.8	268.9	396.3	355.4	449.1	528.2
Incomes from sales of products. instruments and environmental components	-21.4	22	23.6	3.5	3.7	1.8	2.2	2.9	1.6	6.1	5.8	16.1
Incomes from sales of environment technologies	0.063	0.54	0.037	0.001				D	D	3	1.7	
Incomes from provided services on protection	10.2	15.9	35.1	49.8	149.3	186.4	149.6	191.2	264.7	275.5	326.4	329.4

Source: SLOVSTAT

Table 2.7: *Gross domestic expenditure on R&D (GERD) (million EUR)*

Indicator	2003	2004	2005	2006	2007	2008	2009	2010	2011
Gross domestic expenditure on R&D	232.9	231.3	249.1	267.7	282.7	316.5	303	416.4	468.5

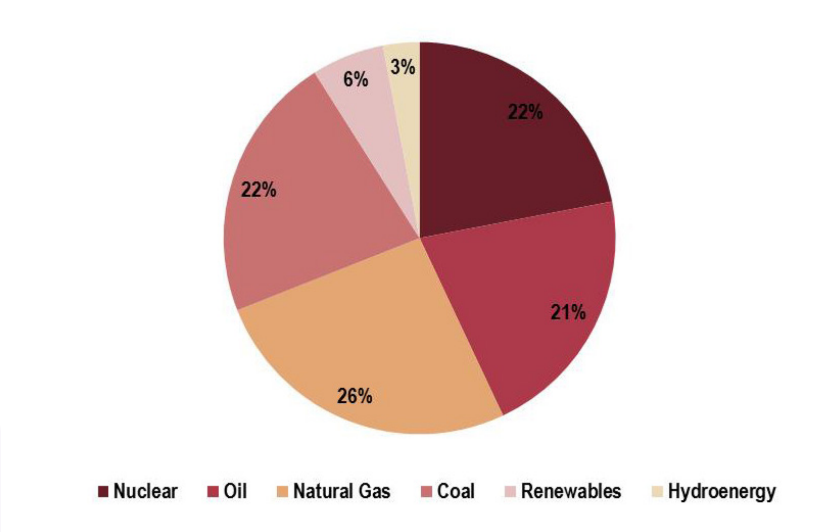
Source: SLOVSTAT

As results from the Table 2.7 figures, the total expenditure on R&D without taking into account inflation has been continuously increasing since our accession to the EU and more than doubled in the monitored period.

2.6 ENERGY SECTOR

The Slovak Republic has a balanced proportion of nuclear fuel, fossil fuels and renewable energy sources in gross inland energy consumption. Shares of energy sources in gross inland consumption in 2011 were as follows: natural gas 26%, coal 22%, nuclear fuel 22%, oil 21%, renewable sources, including hydropower 9%. The concept of energy development is focused on optimizing the energy mix in terms of energy security.

Figure 2.8: *Energy mix in the Slovak Republic in 2011*



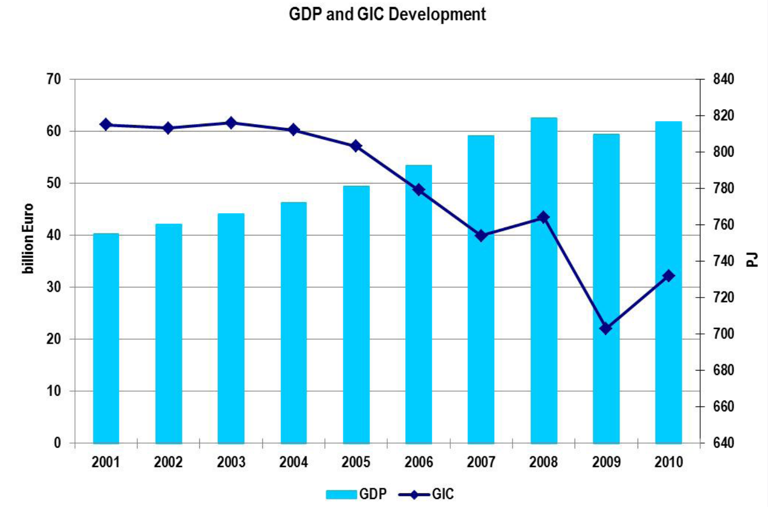
Source: Statistical Office of the Slovak Republic

2.6.1 Development of Energy Consumption

Gross inland energy consumption (GIC) has a long-term downward trend in the Slovak Republic along with the growth of GDP. GIC decline occurred mainly as a result of industrial restructuring in the 1990s of the 20th century, the arrival of investors in sectors with higher added value and wider application of the principles of energy efficiency by introducing modern production technologies with lower energy consumption, building insulations, consumers switching to low-energy appliances and savings as a result of price deregulation.

The decrease in GIC from 2001 to 2011 is 12%. Long-term downward trend of GIC was also maintained in 2011 (716 PJ) (Figure 2.9). In 2009 the GIC reached the lowest value (702 PJ) throughout the year. This sharp decline was caused by the economic crisis and it reached a value of 743 PJ in the next year with decreasing tendency.

Figure 2.9: Development of GDP and GIC



Statistical Office of the Slovak Republic, Ministry of Economy of the Slovak Republic

2.6.2 Development of Energy Intensity of the Slovak Republic

Energy intensity as the ratio of gross domestic consumption and gross domestic product is an important economic indicator of the national economy. It has had a downward trend in the past 10 years, despite the fact that the Slovak Republic has the fifth highest energy consumption based on constant prices in the EU 27.

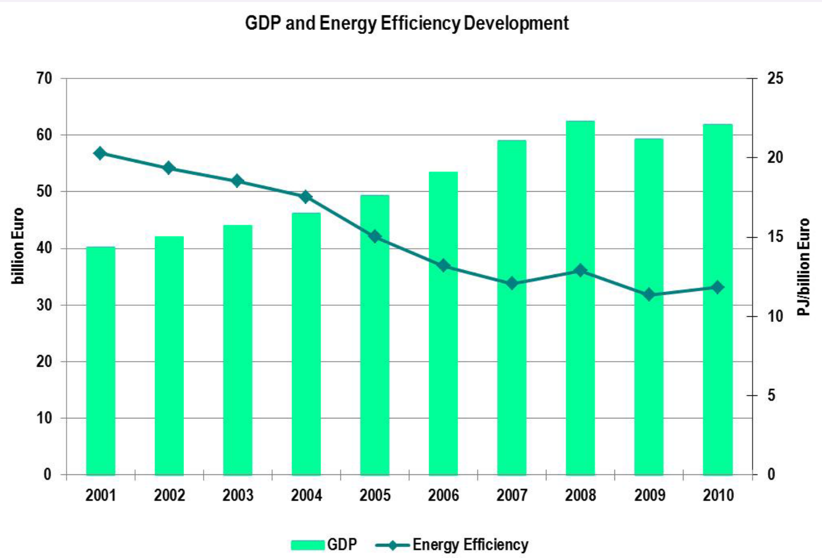
The significant progress in energy intensity reduction was recorded in the years 2002-2009, when the Slovak Republic reduced energy consumption by 38%, which was the highest reduction among all OECD countries and EU Member States. This trend continued also in the period of years 2005-2010, when the reduction by more than 21% was the highest in the EU in that period. The decrease of energy intensity was almost 45% during the period of years 2001-2011.

Table 2.8: Development of energy intensity in the SR

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
GDP in prices 2005 (billion EUR)	40.2	42.0	44.0	46.2	49.3	53.4	59.0	62.4	59.4	61.9	63.9
GIC (PJ/billion EUR)	20.3	19.34	18.54	17.54	15.03	13.19	12.08	12.88	11.35	12.0	11.2

Source: Statistical Office of the SR, Ministry of Economy of the Slovak Republic

Figure 2.10: Development of GDP and GIC



Statistical Office of the Slovak Republic, Ministry of Economy of the Slovak Republic

This positive development is the result of the successful restructuring of industry, the introduction of energy-efficient production processes in industry and effective energy-saving measures in household sector by superseding home appliances with more efficient variants.

Energy intensity expressed in purchasing power parity in 2011 was only by 20% higher than the EU 27 average. From the curve ratio of the energy intensity of the SR and the EU 27 expressed in purchasing power parity it is possible to assume at the present trend that the energy intensity of the Slovak Republic will get closer to the EU 27 average in 2020.

2.6.3 Diversification of Energy Sources and Transport Routes

Interruption of natural gas supply in 2009, with a significant negative impact on the Slovak economy confirmed the need for increased energy security in the country by focusing on diversification of primary energy sources and transport routes, as well as the use of domestic energy sources, especially renewable energy.

Implementation of the measures imposed in the Energy Security Strategy adopted by the Government in October 2008[13] and the measures taken in response to the gas crisis in 2009 occurred during the years 2009/2010 and caused significantly enhanced energy security of the Slovak Republic, especially in the gas supply. The Slovak Republic has a sufficient volume of gas reserves, which allows securing a supply of gas to households eventually to protected customers. These reserves constitute one of the most important tools to ensure a continuous gas supply in case of a crisis.

Since November 2011, the transmission system operator, Eustream, a. s. can run a reverse flow in fully automatic mode in the amount of 25 million m^3/day from the Czech Republic and 18 million m^3/day from Austria to the Slovak Republic. This amount exceeds the total daily consumption of the SR.

2.6.4 Nuclear Energy in the Slovak Republic

Nuclear energy is a major driver of low carbon growth. In terms of efficiency towards meeting the objectives of the EU, diversified supply scenarios and scenario of capture and storage of carbon dioxide with a substantial proportion of nuclear energy belong to the least costly development scenarios.

Besides a safety of the operation, the second most important factor in the use of nuclear energy is how to deal with a final part of nuclear energy.

The Government of the SR in accordance with the Act No. 238/2006 Coll. the “National Nuclear Fund” (Resolution No. 328/2008 of May 21, 2008) approved the “Strategy of final part of nuclear energy”[13] by the Council of Managers of National Nuclear Fund and imposed the Chair of the Nuclear Regulatory Authority of the Slovak Republic and other relevant ministers its implementation by December 31, 2013.

The draft “The Final Part of the Peaceful Usage of Nuclear Energy in the Slovak Republic” was approved under the leadership of the Ministry of Economy of the Slovak Republic in October 2012. It should be submitted to the Government in September 2013 after completing the process of environmental assessment (EIA).

The main objective of the Strategy is to protect the environment from the long-term consequences of nuclear energy used for electricity generation and other consequences of the peaceful uses of nuclear energy. The strategy assesses the financial security of final part of nuclear energy, including impacts on the competitiveness of the electricity producers and reliability of the energy transit system.

The strategy is governed by the principle of “polluter pays” principle. It also reflects recent developments, which are part of the EU Directive on Radioactive Waste Management.

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13 http://www.rokovania.sk/Rokovanie.aspx/BodRokovaniaDetail?idMaterial=14096

2.7 TRANSPORT

The number of cars in Slovakia increases continuously. In 2011, the total number of passenger cars was 1 749 271. In comparison with year 2007 the increase by 315 345 cars was recorded. The same increasing trend has been recorded about CO_2 emissions in the transport, which rose from 6 300.45 Gg CO_2 in 2007 to 6 463.41 Gg CO_2 in 2010. This trend was observed in spite of the measures taken (e.g. new categorization of vehicles, new vehicle technologies, advanced fuels, etc.).

Table 2.9: Number of motor vehicles

Parameter	2007	2008	2009	2010	2011
Personal vehicles	1 433 926	1 544 888	1 589 044	1 669 065	1 749 271
Light Truck	104 439	133 414	145 061	149 877	152 751
Heavy Trucks	130 231	134 923	133 965	135 950	139 118
Special vehicles	18 983	19 675	18 947	21 262	21 953
Buses	10 468	10 537	9 400	9 350	9 074
Motorcycles and mopeds	143 617	148 365	102 570	87 826	98 774
Tractor	44 098	45 387	45 769	46 092	46 846

Source: Ministry of Transport, Construction and Regional Development of the Slovak Republic

2.7.1 Freight Transport

There has been a temporary increase in freight transport between the years 2007-2008, but in overall monitored period between the years 2007-2011, the transport of goods by road dropped significantly, by almost 47 000 tons. The decline in freight transport also occurred in rail and water transport. In the freight segment the road transport is the dominant form according to the amount of transported goods. This is caused mostly by the structure of transported goods, i.e. reduced transport of bulk commodities and increased shipments of lower weight commodities.

Table 2.10: Transport of goods by mode of transport (in tons/year)

Type of transport	2007	2008	2009	2010	2011
Road transport	179 296	199 218	163 148	143 071	132 552
Rail transport	51 813	47 910	37 603	44 327	40 867
Water transport	1 806	1 767	2 192	3 109	1 297
Air transport	0.194	0.12	0.007	0.011	0.011
Transport - total	232 915	248 895	202 943	190 507	174 716

Source: Ministry of Transport, Construction and Regional Development of the Slovak Republic

In terms of the CO_2 emissions the decrease of freight transport by road is positive since it is the least environmentally friendly mode of transport. At the same time there was also a decrease in the intensity of rail transport. This situation has been greatly influenced by low economic growth, slower economic recovery and associated low demand for goods and services.

2.7.2 Passenger Transport

During the period 2007 to 2011, there was generally a decline in passenger transport by 25 782. The sudden drop in nearly all types of transport can be associated with a financial crisis that occurred in 2009. However, even during the time of financial crisis we have seen an interesting development in this type of transport - individual motoring, where the numbers has been growing.

Table 2.11: Transportation of persons by type of transport

Type of transport	2007	2008	2009	2010	2011
Road transport - rural	384 637	365 519	323 142	312 717	291 218
Road transport - private	2 275	1 999	1 779	1 489	1 401
Road transport - individual motoring	1 812 245	1 833 082	1 846 439	1 859 479	1 875 789
Public transport - city	403 466	399 425	389 263	385 594	410 814
Road transport - total	2 602 623	2 600 025	2 560 623	2 559 279	2 579 222
Rail transport	47 070	48 744	46 667	46 583	47 531
Water transport	122	122	110	120	105
Air transport	3 068	4 176	2 288	554	243
Transport - total	2 652 883	2 653 067	2 609 688	2 606 536	2 627 101

Source: Ministry of Transport, Construction and Regional Development of the Slovak Republic

Compared with previous years in 2011 was a slight increase in the volume of traffic in public transport. This year the volume of traffic in public transport stood at 410 814 carried passengers. The overall increase compared to 2010 is 6.5%. A similar situation occurred in passenger transport where, after a slight decline in 2010, was a positive increase in the volume of traffic. In 2011, the number of passengers transported by rail was 47 531 an increase by 2% compared to the previous year. The increase of volume of traffic in the case of public transport and rail transport can be linked to boosting of the mobility of the population. This trend is due to a greater need to commute to work or is related to the economic reasons such as increased expenses on other types of transport. The prices of the fuels have also contributed to the change of the transportation habits (Table 2.11).

2.7.3 Taxes on and Prices of Transport Fuels

The EU has adopted Directive No. 2003/96/EC restructuring the Community framework for the taxation of energy products and electricity which governs a minimum amount of excise duty on mineral oils. Since January 1, 2010 the consumption tax on diesel has been established at the minimum level of EUR 330/1 000 litres. The Slovak Republic has set the rate according to the rates in neighbouring countries and based on the necessity to consolidate public finances.

Table 2.12: Overview rates on selected mineral oils in 2007-2013

		2007	2008	2009	2009*	2010*	2011*	2012*	2013*
Leaded gasoline	Sk/1000l	18 000	18 000	18 000	597.49	597.5	550.5	550.5	550.5
Unleaded petrol	Sk/1000l	15 500	15 500	15 500	514.5	514.5	514.5	514.5	514.5
Gas oil	Sk/1000l	14 500	14 500	14 500	481.31	368.0	368.0	368.0	368.0
Kerosene	Sk/1000l	14 500	14 500	14 500	481.31	481.3	481.3	481.3	481.3
LPG	Sk/t	7 800	3 900	0	0	0.0	182	182	182
CNG	Sk/GJ	0	0	0	0	0.0	2.6	2.6	2.6

Source: Ministry of Finance of the Slovak Republic
** Values in EUR*

Table 2.13: The price of fuels in the SR

year	gasoline 95 EUR/liter	gasoline 98 EUR/liter	LPG EUR/liter	Diesel oil EUR/liter
2007	1.25	1.34	0.68	1.25
2008	1.29	1.42	0.66	1.38
2009	1.11	1.22	0.45	1.10
2010	1.25	1.39	0.50	1.11
2011	1.45	1.60	0.70	1.34
2012	1.54	1.71	0.72	1.44

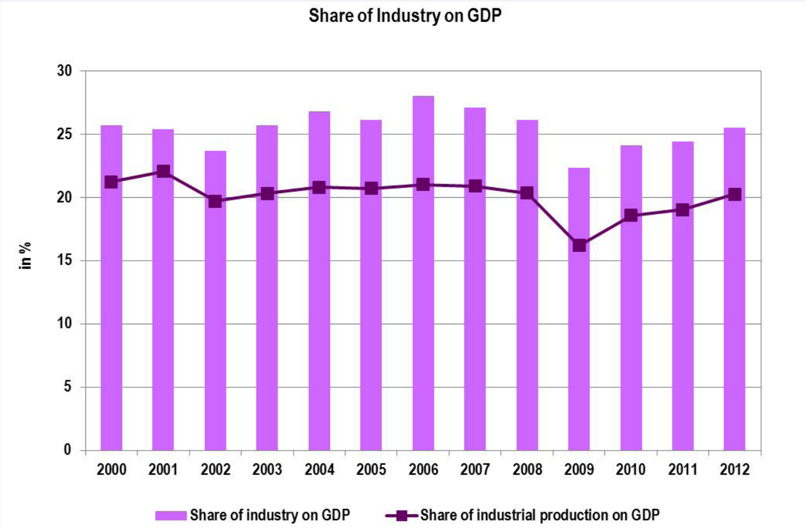
Source: Statistical Office of the Slovak Republic

During the reporting period the lowest level of the price of fuel in the Slovak Republic was in 2009 mainly due to oil price developments on the financial markets.

2.8 INDUSTRY SECTOR

The internal structure of the Slovak industry has been stabilized after significant changes implemented before our accession to the EU. The importance of mining and distribution of electricity, gas and water on production of value added has been significantly reduced and nowadays it is comparable with other developed countries. The share of industry in GDP of the Slovak Republic in 2000 represented 25.7%, in 2012 decreased to 25.5%. Industrial production in 2000 represented 21.3% of GDP, in 2012 its share decreased to 20.3%.[14]

Figure 2.11: Share of industry in GDP (% c. p.)



Source: Statistical Office of the Slovak Republic - Slovstat; Processed by: Slovak Environmental Agency

Production of motor vehicles, trailers and semi-trailers held a dominant position in the revenue generation in the industrial production throughout the assessed period. In 2004, its share in revenues from industrial production was 23.0%, in 2010 increase into 27.5% and in 2011 held in 27.2%. The second place belongs to computer, electronic and optical products. In 2010, its share in revenues from industrial production was 12.5%. Generally, the position of electrotechnical production in revenues from industrial production strengthened during the period of the years 2004-2010 (in 2004 11.0%, in 2010 already 16.8% and in 2011 decreased to 13.9%). The third position in the structure of revenue generation belongs to production and processing of metals. In 2004, the share of this segment in revenues from industrial production was 11.9%, in 2010 15.3% and in 2011 15.0%. Since 2009, the first position in the structure of employment in industrial production in the Slovak Republic belongs to motor vehicles, trailers and semi-trailers production.[15]

Table 2.14: Development of value added according to economic sectors, 2008-2012

	2008	2009	2010	2011	2012
	Interannual changes in % (according to price of 2005)				
Value added (overall)	6.4	-4.7	4.4	2.7	3.2
Agriculture	11.6	-2.0	-13.6	20.5	-5.4
Industry (overall)	4.4	-16.1	15.1	5.2	10.6
Processing industry	7.7	-14.9	20.9	6.1	13.4
Construction	20.3	-7.6	-1.0	4.8	-6.2
Commerce. transport. accommodation	11.5	-7.4	0.2	-2.5	-0.7
Information and communication	-0.9	9.7	-0.2	6.1	9.4
Financial and insurance activities	-4.2	5.1	-2.5	5.3	-2.6
Estate activities	4.5	0.6	7.0	11.3	7.5
Professional Services	10.9	2.4	2.9	0.8	4.5
Public Services	1.6	7.5	4.1	-5.0	0.3
Other services	-21.7	33.1	2.1	7.9	1.3

Source: Statistical Office of the Slovak Republic

Regarding the final energy consumption, industry has the highest share (including construction). The trend in the final consumption of energy in this sector is positive, characterized by a decrease of total energy consumption. The branches of the industry sector, which contribute the most to fuel and energy consumption are as follows: metallurgy 32%, energy industry32%, chemical industry 11%, pharmaceutical industry 11%, wood processing 4%, machinery 3%, textile 2%, electro-production, glass production and leather and shoe-making approximately 1% for each of them.[16]

In 2001, share of industry on the final energy consumption of fuel, electricity and heat in the national economy was 35.8%, in 2011 this share decreased to 34.7%. Iron and steel industry in 2011 represented 30.9% of the final energy consumption of fuel, electricity and heat within this industry and manufacture of pulp, paper and paper products, publishing and printing represented 15.5%. In 2011 compared with 2001, final energy consumption of fuel, electricity and heat in industry decreased by 14.7% (over the entire national economy, final energy consumption of fuel, electricity and heat decreased by 12.1%).[17]

2.9 WASTE SECTOR

The waste sector in the Slovak Republic was affected by the economic crises in the EU during the period of 2009-2012. In particular, in 2009 this effect was evident in terms of decrease in the total quantity of generated waste produced in the Slovak Republic, the disintegration of secondary raw materials market and consequently higher prices for waste treatment processes. On the other hand, positive trend of so called decoupling continues, i.e. waste generation does not follow the growth of GDP per capita per year.

Since January 1, 2010 all municipalities have had an obligation to separately collect four components of municipal waste: waste paper, plastics, glass and metals. Also, a ban on land filling of green waste, which has had a slightly positive effect on the quantity of landfilled biodegradable waste. In 2010 Slovakia has managed to meet the requirements of Directive 1999/31/EC on the landfilling of waste and reduced the amount of landfilled biodegradable municipal waste to 50% of total weight of biodegradable municipal waste in 1995.

During the reporting period, the waste management infrastructure has been completed with a focus on improving the collection of municipal waste, construction of municipal collection sites, improving the system of separate collection of municipal waste components and the construction of sorting lines for the municipal waste and composting plants for organic waste. Some equipment for waste recycling and production of alternative fuels from waste were also put into operation.

Data on the development and management of waste are collected through reporting by waste producers and holders, as well as reporting by operators of waste facilities. These data have been centrally processed in the Regional Waste Information System (RISO) since 1995.[18] Data on the development and management of municipal waste are collected through surveys of the Statistical Office of the Slovak Republic. At the time of writing this report the complete data were available only for the years 2009-2011, data for 2012 have not been processed yet.

2.9.1 Waste Other than Municipal Waste

Data on waste other than municipal waste are listed in the Table 2.15 and Figure 2.12.

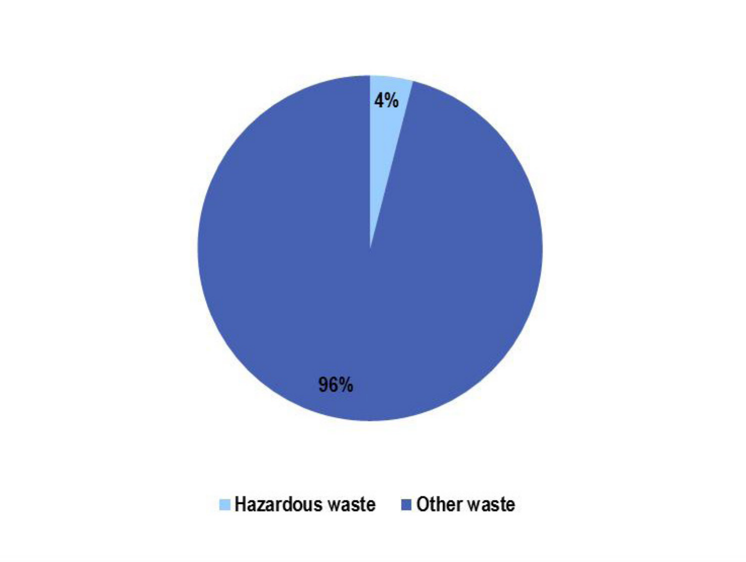
Table 2.15: Establishment of waste other than municipal waste in Slovakia in 2009-2011 (figures in tons per year)

Waste Category	2009	2010	2011
Hazardous waste	468 345	471 850	385 863
Non- hazardous waste	8 032 285	10 283 690	10 449 922
Total	8 500 630	10 755 539	10 835 785

Source: RISO, Slovak Environmental Agency

14 http://www1.enviroportal.sk/indikatory/detail.php?kategoria=120&id_indikator=907
15 http://www.economy.gov.sk/priemyselna-vyroba/127530s
16 http://unfccc.int/files/national_reports/annex_i_ghg_inventories/national_inventories_submissions/application/pdf/svk_nir_2012_august_2012.pdf
17 http://www1.enviroportal.sk/indikatory/detail.php?kategoria=120&id_indikator=910
18 http://riso.sazp.sk/main.php

Figure 2.12: ***Proportion of hazardous and other wastes other than municipal in Slovakia in 2011***



Concerning the waste generation by classification of economic activities (NACE) the industry has been traditionally the largest producer of waste with share of about 59% on the total waste production, followed by construction with 20% share. Other important sectors are agriculture with the 6.4% share and business services with a 5% share. The total amount of waste produced by NACE does not include municipal waste (Table 2.16).

Table 2.16: ***Establishment of waste other than municipal waste in Slovakia in 2009-2011 (figures in tons per year)***

NACE	Activity	2009	2010	2011
A	Agriculture. forestry and fishing	508 198.96	525 604.85	549 251.31
B	Mining and extraction	198 163.04	165 584.61	219 146.15
C	Manufacturing	2 465 267.97	2 711 540.61	3 087 656.04
D	Electricity. gas. steam and cold air	840 968.09	877 644.33	945 336.62
E	Water supply. purification and sewerage. waste management and remediation activities	660 080.10	1 831 010.13	1 193 831.62
F	Construction	1 166 909.10	1 786 429.38	2 140 453.23
G	Wholesale and retail trade. repair of motor vehicles and motorcycles	356 435.88	527 594.31	381 554.22
H	Transport and storage	169 151.20	120 728.63	100 018.59
I	Accommodation and food services	9 816.16	26 259.54	2 719.63
J	Information and communication	5 032.45	3 647.70	3 880.53
K	Financial and insurance activities	410.05	409.53	2 999.87
L	Real estate activities	22 583.88	15 552.23	11 505.20
M	Professional. scientific and technical activities	101 035.58	68 018.71	95 851.77
N	Administrative and support services	17 230.03	15 302.05	24 985.90
O	Public administration and defense. compulsory social security	26 947.79	19 612.53	26 503.80
P	Education	1 173.97	997.97	1 821.10
Q	Health care and social assistance	111 233.79	127 976.60	148 981.36
R	Arts. entertainment and recreation	1 005.44	219.75	249.51
S	Other activities	1 635.89	1 485.40	2 674.74
X	Not specified	91 856.58	121 414.32	129 373.01

Source: RISO, Slovak Environmental Agency

Data on waste treatment are shown in Table 2.17.

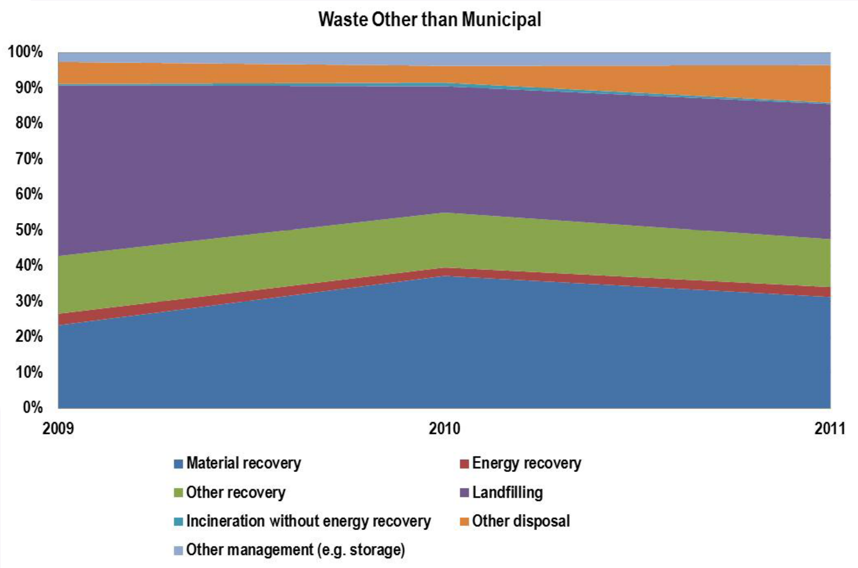
Table 2.17: *Waste other than municipal waste in Slovakia in 2009-2011 (figures in tons per year)*

Processing	2009	2010	2011
Material recovery	1 989 681	4 007 086	3 392 694
Energy recovery	274 091	255 084	303 580
Other recovery	1 378 233	1 658 855	1 457 963
Landfilling	4 079 500	3 818 144	4 114 976
Incineration without energy recovery	31 536	108 795	41 671
Other disposal	525 253	510 177	1 143 431
Other management	222 337	397 398	381 471
Total	8 500 630	10 755 539	10 835 785

Source: RISO, Slovak Environmental Agency

During the period landfilling dominated (35-48%), material recovery of waste had a share of 23-37%, while waste incineration (with or without energy recovery) represented only 3%.

Figure 2.13: *Waste other than municipal waste in Slovakia in 2009-2011*



Source: RISO, Slovak Environmental Agency

2.9.2 Municipal Waste

During the reporting period can be observed a slight decrease in the amount of municipal waste generated in the Slovak Republic in 2009 and the subsequent increase in the value prior to 2009.

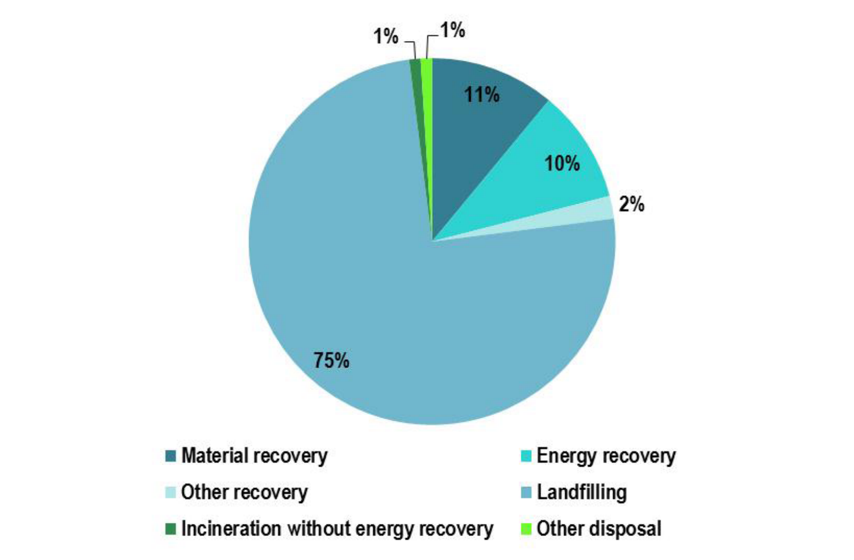
Table 2.18: *Municipal waste in the SR in 2009–2011 (figures in tons per year)*

Waste Category	2009	2010	2011
Hazardous waste	6 244	5 428	6 234
Other waste	1 739 250	1 803 078	1 760 756
Total	1 745 494	1 808 506	1 766 990

Source: Statistical Office of the SR

During the period the share of separately collected fractions of municipal waste increased, especially packaging waste and the share of recycling increased. Despite this, the predominant method of municipal waste disposal is landfilling (75-82%). In the incineration units is incinerated 7-10% of municipal waste.

Figure 2.14: Municipal waste processing in the SR in 2011



Source: Statistical Office of the Slovak Republic

2.9.3 Incineration and Landfilling

During the period 2009-2011 two units of municipal waste incinerators were operating, 6 (in 2010), 8 (in 2009), 7 (in 2011) incinerators of industrial waste, 6 units of hospital waste incinerators and 4 (in 2009) - 5 (in 2010-2011) units for waste co-incineration. 118 municipal landfills were in operation, of which 118 landfills for non-hazardous (municipal) waste, 11 landfills for hazardous waste and 18 for inert waste.

2.10 HOUSING SECTOR, HOUSEHOLDS AND PUBLIC BUILDING

According to the data provided by municipalities (as building authorities supervising housing construction) to the Statistical Office of the Slovak Republic, in 2012 there has begun construction of 13 090 flats[19], were completed 15 255 flats[20] and at the end of the reporting period was 62 783 dwellings under construction. Of the total number of completed dwellings were 9 479 in family homes, which represent a 62.1% share. The existing housing stock in 2012 shrunk in 1 255 dwellings, of which 1 054 due to renovation.

Impact and development of the economic and financial crisis on housing market is an important and is visible when comparing the data of starting and completion of housing construction in 2009 and 2012. Other indicator is the average living area which in 2012 was 71.7 m^2. In an average, living area of the apartment we register a gradual downward trend, e.g. the value of the indicator compared to 2004 value (78.5 m^2) fell by 6.8 m^2, which represents a decrease by 8.66%.

19 issued building permits
20 approval decisions issued

Table 2.19: Indicators of housing in the SR for the period of years 2005–2012

Indicator	2005	2006	2007	2008	2009	2010	2011	2012
Number of dwellings/flats	14 863	14 444	16 473	17 184	18 834	17 076	14 608	15 255
thereof								
Number of houses	8 707	7 657	7 897	8 502	9 022	9 136	8 763	9 479
The average floor area m²	121	116	112	113.1	116.2	113.3	115.8	117.1
The average floor area m²	73	71	70	70.2	70.2	71.5	71.8	71.7

Source: Information on housing development in the Slovak Republic for 2012[21]

The most widespread types of home heating in the Slovak Republic is, according to results of 2011 Census (Census of Population and Housing) is remote central heating (657 307, i.e. 37% of the total number of occupied dwellings in the SR) and local central heating (610 560, i.e. 34.4% of the total number of occupied dwellings in Slovakia).

According to data from the Energy statistics, for the period of 2005-2011 the most used energy for heating was a natural gas, its share was more than 60%. The second most used was coal, whose share in 2011 increased sharply due to increase in gas prices. The adverse effect is an increasing share of emissions from local furnaces. Gradually in homes, especially in family homes as a substitute for coal there has been an increase of share of other supplement like burning wood and biomass.

Table 2.20: The basic source of energy used for heating (%)

	2005	2006	2007	2008	2009	2010	2011
Coal	1 861	1 987	1 885	2 631	1 9 36	2 204	6 300
Gas	59 347	53 727	46 486	49 498	50 570	55 779	49 100
PB	322	690	506	736	736	552	276
Wood	1 418	1 072	1 643	1 486	1 619	1 795	1 861

Balance fuels - in TJ / Balance of Fuels - in TJ
Source: Energy statistics SR

2.11 AGRICULTURE SECTOR

Some sources of emissions in agriculture are difficult to quantify, others remain unidentified. On the rugged territory of the SR, in addition to significant climatic variations there are soils with different properties what influences crop rotations of field crops, the possibility of applying other fertilizers and agricultural management.

In 2011 there was a slight recovery in the economic performance of agriculture, which made a profit of EUR 31.8 million. The profit was influenced by several factors, e.g. increase in commodity prices in the livestock sector, stagnation or decline in production of almost all animal commodities, faster rising of prices of agricultural products, high prices of some inputs, direct payments, further reducing of the workforce, and favourable course of weather during majority of months during the year.

In 2011 direct payments from the EU and national funds were paid to farms in amount of 90%. Gross agricultural production grew according to preliminary data for 2011, due to a significant increase in gross crop production of 44.8% and a slight increase in gross animal production by 0.3%.

Table 2.21: Development of gross agricultural production (GAP) in the SR [22]

Indicator	2001	2002	2003	2004	2005	2006	2007	2008 *	2009 *	2010 *	2011 * a)
GAP (million SKK)	58 030	58 927	57 503	60 722	56 899	57 419	58 183	1820.0	1865.0	1848.5	1781.1
thereof											
Gross crop production	25 596	26 831	24 117	27 767	26 810	27 460	24 268	816.4	925.3	835.4	890.8
Gross animal production	32 434	32 096	33 386	32 955	30 089	29 959	33 915	1003.6	938.8	1013.1	890.3

** in EUR, a) estimation of the Research Institute of Agricultural and Food Economics (year 2011)*

In 2011, the area of utilized agricultural land was 1 929 698 ha. Interannual increase was mainly due to an increase of permanent grassland, pasture and arable land. Decrease of 1 336 ha was observed in the case of permanent crops.

In 2011, the crops area reached 1 329 500 ha. Growing areas of annual forage (10.8%), cereals (3.3%), perennial forage (2.9%) and technical sugar beet (2.2%) interannually increased. As of cereals, the area of maize (8.4%), wheat (4.1%) and other cereals (15.6%) increased.

Production has increased interannually in nearly all crops, most notably in lentils (186.7%), potatoes (72.6%), edible pea (61.4%), corn (56.8%), barley (45.3%), and forage (30.8%). Production of oil crops increased by 14.8%, that is by 33.7% for sunflower and 3.0% for rape. Production of fodder root crops fell by 49.3%, mainly due to the decrease in planted areas.

Beet production increased (18.7%) as a result of higher crop yields per hectare. Lower fruit production was affected by lower acreage of orchards. Wine grape production has increased (231.4%) due to a significant increase in yield per one hectare. The increase in vegetable harvest from one hectare increased production (10.7%) despite the loss of arable land.

There were no major changes in animal husbandry in 2011. Decrease in the total number of cattle has slowed. In 2011, there were 463 400 pieces of cattle in the SR. Cows stocks reached a level of 201 300 pieces, that means about 1.5% less than a year ago. Downward trend of dairy cattle amount continued, on the contrary, the amount of lactating cows increased significantly during the year. Proportion of lactating cows in the total number of cows has increased interannually from 22.0% to 23.5%.

The situation in the pig husbandry again deteriorated significantly. The total number of pigs reached 580 400 pieces, and interannually decreased by 106 900 pieces. Number of poultry also fell, while gaining 11 376 000 pieces. Sheep production in 2011 was slightly stabilized, at the end of 2011, there were 391 600 pieces of sheep in Slovakia.

Table 2.22: Overview of livestock numbers in the SR [23]

Numbers in thousands	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011[a)]
Dairy cattle	271	259	260	246	232	230	219	216	174	163	159	154
Other cattle	375	366	348	347	308	298	289	286	315	310	308	309
Sheep	348	316	316	326	321	320	333	347	362	377	394	394
Goats	51	40	40	39	39	40	38	38	37	36	35	34
Pigs	1 488	1 517	1 554	1 443	1 149	1 108	1 105	952	749	741	687	580
Poultry	12 446	13 612	13 959	14 217	13 713	14 084	13 038	12 880	11 228	13 583	12 992	11 376

a) estimation of the Research Institute of Agricultural and Food Economics (year 2011)

2.12 FORESTRY SECTOR

The current situation in forestry is associated with several problems. One of the most serious one is the deterioration in the health of forests with spruce majority, which is manifested mainly by wasting and mortality in spruce stands. Expansion of bark beetles occurred mainly after the windstorm of November 19, 2004. Implementation of measures against bark beetles brings significant increase in financial performance measured related to the protection of the forest.

Area of forest land in the SR has been increasing in the long term. In 2012 it reached 2 012 414 ha, crop land 1 940 300 ha. Forest coverage reached 41%. According to the results of the National Forest Inventory and Monitoring of the Slovak Republic 2006, which also included the so-called “White areas” (forest on non-forest land), the forest cover in the SR is 44.3 ± 0.4%. In terms of tree species composition of the deciduous tree species predominate (60.7%) in the Slovak forests.

Total wood stock and wood stock per hectare of crop land in the forests of the SR has increasing trend (Table 2.23). In 2012, the average growing stock per hectare of crop land was 244 m^3 of raw wood without bark and total stock reached 472.18 million m^3 of raw wood without bark, which is mainly due to the higher proportion of forests in the 7th, 8th, 9th and 10th age levels.

21 http://www.telecom.gov.sk/index/index.php?ids=81567
22 MARD, Green Report, 2001-2012
23 MARD, Green Report, 2001-2012

Table 2.23: Wood stock in forest[24]

Stock[1)]		2005	2006	2007	2008	2009	2010	2011	2012
		year							
Total (million m³)	total	438.9	443.8	445.9	452.1	456.4	461.95	466.07	472.18
	coniferous	207.4	209.8	209.2	211.2	211.5	212.16	211.93	213.31
	deciduous	231.36	234.0	236.7	240.9	244.9	249.79	254.14	258.87
Per 1 ha (m³)	average	229	231	232	235*	237	239	241	244
	coniferous	264	268	269	272*	274	276	278	281
	deciduous	204	206	207	210*	212	215	217	221

Carbon stock in forest ecosystems has been increasing, which is associated with an increase in timber reserves (Table 2.24). Carbon stock in aboveground living biomass in comparison with 1990 increased by 46.7 million tons.

Table 2.24: Carbon stock in forest[25]

Year	Carbon stock in forests				
	in living biomass		in dead biomass		in soil
	aboveground	ground	dead wood	hummus	
	million ton				
2012	180.6	39.0	16.5	22.4	270.5
2011	178.3	38.5	16.3	22.4	270.5
2010	173.6	37.6	15.3	22.4	270.5
2005	166.3	36.1	15.3	20.4	270.5
2000	156.1	33.7	14.5	19.5	270.5
1990	133.9	28.8	12.5	16.7	270.5

Logging in 2012 slightly decreased compared with the previous year. It reached 8 232 019 m³, which is, compared to 2011, a decrease of 1 235 388 m³, i. e. by 13%. Decrease in the logging volume points to a gradual stabilization and inhibition of calamity processes especially in conifer plantations damaged by harmful agents in the woods. The share of incidental felling reached 3 504 375 m³ (42.57% of the total harvest), which is less by 1 487 285 m³ compared to 2011.

Contribution of forestry to the GDP of the SR in 2012 reached 0.26%. According to the results of integrated environmental and economic accounts for forests the final output of the forestry sector reached EUR 489 million in 2012. Gross value added for industry in that year was about EUR 241 million, net value added was EUR 214 million net income from independent activities reached EUR 60.8 million and a net profit of business reached EUR 40.2 million.

24 NFC-ÚLZI Zvolen, Summary information on the woods conditions in the SR, 2006-2013
25 Moravčík, M. et al. 2010: National Report on Quantitative Indicators for SLOVAKIA. Enquiry on State of Forests and Sustainable Forest Management in Europe 2011; National Data on PAN-EUROPEAN Indicators for Sustainable Forest Management (years 1990-2010), own sources of NFC – LVÚ Zvolen (years 2011 and 2012)

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03

Greenhouse Gas Inventory Information

3.1 INTRODUCTION

Total GHG emissions in the Slovak Republic (without LULUCF) decreased by 36.9% from 1990 to 2011. The biggest relative change has been in the waste sector where the emissions of CH_4 from managed waste disposal on land increased substantially. Major decrease in emissions was in agriculture sector due to the essential changes in management practice.On average, since the year 2000, total GHG emissions (without LULUCF) were more than 30% below the emission level of 1990. The emission situation is similar as was described in the Fifth National Report of the Slovak Republic. Emissions of total greenhouse gases decreased by 1.3% between 2010 and 2011. This was largely due to an emission decrease in energy and industry sectors. Milder winter conditions and the lower demand for heating can partly explain lower emissions in 2011 compared to 2010.

This chapter presents greenhouse gas emission trends of the Slovak Republic for the period 1990-2011. The Slovak Republic submits an inventory under the Kyoto Protocol and under the UNFCCC. The legal basis of the inventory compilation, the inventory methodology and data availability are also described briefly here. The greenhouse gas data presented in this chapter are consistent with the 2013 submission of the Slovak Republic to the UNFCCC Secretariat[1] and its resubmission from August 28, 2013. The resubmission did not affect GHG emissions level in total.

Summary tables of GHG emissions in the common tabular format are presented in CTF Tables 1 (a) and 1 (b) in the CTF Annex. These data and the complete submissions of the Slovak Republic under Decision 280/2004/EC are available on the website.[2]

In the period after the submission of the Fifth National Communication, particularly after the publication of the 2011 Annual Review Report and subsequent decision of the Compliance Committee of the Kyoto Protocol in 2012, the Slovak Republic was rendered as a non-compliance country regarding the functions of the national system. After implementation of plenty of measures to strength and increase robustness of the Slovak National System, the final decision of the Compliance Committee (CC-2012-1-15/Slovakia/EB) was taken during its twenty-third meeting (July 3-4, 2013). The decision changed the temporary status of non-compliance and since that time there has not been any question of implementation with respect to Slovakia.

The current arrangement of the Slovak National System and other descriptions according to the paragraph 5.1 of the Kyoto Protocol is present in the National Inventory Report of the Slovak Republic 2013.

3.2 DESCRIPTIVE SUMMARY OF GHG EMISSIONS TRENDS

3.2.1 Overall Greenhouse Gas Emissions Trends

In 2011, total GHG emissions in the Slovak Republic without LULUCF were 36.9% (26 500 Gg of CO_2 equivalents) below 1990. Between 2010 and 2011 emissions decreased by 1.3% (600 Gg of CO_2 equivalents).

Under the Kyoto Protocol, the Slovak Republic (similarly to majority of European countries) agreed to reduce their GHG emissions individually by 8% over the 2008-2012 period compared to the 'base year' 1990. This commitment was to be achieved by a combination of strong environmental domestic policies and measures implemented in early nineties and with radical change in the structure of industry.

1 Annual Slovak Republic greenhouse gas inventory 1990-2011 submitted on April 15, 2013 and National Inventory Report 2013 resubmitted on August 28, 2013.
2 http://ghg-inventory.shmu.sk/

Latest OECD Environmental Performance Review of the Slovak Republic summaries results in GHG emission reductions since 1990 as follows:

„Significantly reduced CO_2 emissions, combined with strong GDP growth and low population growth rate, resulted in a sharp drop of the economy's carbon intensity as measured by CO_2 emissions per unit of GDP (using purchasing power parities). This was the sharpest decline in any OECD country".[3]

Similarly, ETC/ACM Technical paper states that:

"The fall in emission per GDP observed in Slovakia during 2003-2008 is the highest decline of all EU-27 Member States, as result of a small fall in emissions despite a large increase in GDP. Slovakia project further decoupling of emissions and GDP but at a slower rate than the impressive rate observed during 2003-2008. Based on the trend observed in other Member States, it is fair to assume that Slovakia's emissions per GDP may not continue to fall at the same impressive rate observed in historic years".[4]

Total GHG emissions were 45 296.96 Gg of CO_2 equivalents in 2011 (without LULUCF). It is expected further increase in the transport category and in consumption of F-gases (mainly HFCs and SF_6) emissions. Unexpected increase occurred in agriculture and waste sectors, which can be explained by the latest increase in economic activity after recession year 2009 (Figure 3.1).

Total GHG emissions excluding LULUCF sector have continued to decrease from the base year with the moderate rate in the recent years. Significant changes in methodologies and emission factors were implemented to ensure consistency with the European Emission Trading Scheme (EU ETS), which represent significant progress in quality of estimation through comparison with the verified emissions for all installation included in the EU ETS. Table 3.1 shows the aggregated GHG emissions expressed in CO_2 equivalents and according to gases. In the period 1990-2011, the total greenhouse gas emissions expressed in CO_2 equivalents in the Slovak Republic did not exceed the level of the base year 1990. Figure 3.1 shows trends in the gases without LULUCF comparable to the Kyoto target (92%) in relative expression. Due to their increased usage in industry, F-gases are the only gases which have increasing trend since 1990.

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3 OECD Environmental Performance Reviews, Slovak Republic, 2011
4 Assessment of the member States` projections submitted under the EU Monitoring Mechanism in 2012, ETC/ACM Technical paper 2011/2, February 2012

Table 3.1: Total anthropogenic greenhouse gas emissions by gases in 1990-2011

GREENHOUSE GAS EMISSIONS	Base year 1990	1991	1992	1993	1994	1995	1996	1997
	CO$_2$ equivalent (Gg)							
CO_2 emissions including net CO_2 from LULUCF	50 606.13	42 846.80	36 794.56	34 023.64	32 340.05	34 021.90	34 004.24	34 344.26
CO_2 emissions excluding net CO_2 from LULUCF	60 745.23	54 091.96	49 749.76	46 078.75	43 526.70	44 879.11	44 699.10	44 811.47
CH_4 emissions including CH_4 from LULUCF	4 428.26	4 292.00	4 062.63	3 817.26	3 839.07	4 046.77	4 026.74	4 091.44
CH_4 emissions excluding CH_4 from LULUCF	4 414.17	4 283.03	4 054.61	3 809.15	3 830.55	4 037.22	4 016.51	4 080.17
N_2O emissions including N_2O from LULUCF	6 456.94	5 197.81	4 329.69	3 675.73	4 006.55	4 228.79	4 371.70	4 274.31
N_2O emissions excluding N_2O from LULUCF	6 351.04	5 104.12	4 218.54	3 561.90	3 924.94	4 159.70	4 302.24	4 217.93
HFCs	NA.NO	NA.NO	NA.NO	NA.NO	0.17	11.65	24.06	32.60
PFCs	271.37	266.94	248.42	155.42	132.06	114.32	34.51	34.62
SF_6	0.03	0.03	0.04	0.07	9.27	9.91	10.76	11.34
Total (including LULUCF)	61 762.74	52 603.58	45 435.34	41 672.11	40 327.18	42 433.35	42 472.01	42 788.57
Total (excluding LULUCF)	71 781.85	63 746.08	58 271.38	53 605.29	51 423.69	53 211.91	53 087.19	53 188.12

GREENHOUSE GAS EMISSIONS	Base year 1990	1998	1999	2000	2001	2002	2003	2004
	CO$_2$ equivalent (Gg)							
CO_2 emissions including net CO_2 from LULUCF	50 606.13	33 273.25	32 272.36	30 568.03	33 612.48	31 597.53	32 553.92	33 063.62
CO_2 emissions excluding net CO_2 from LULUCF	60 745.23	44 324.34	43 434.62	41 367.41	44 168.53	42 405.42	42 836.47	42 742.09
CH_4 emissions including CH_4 from LULUCF	4 428.26	4 348.13	4 559.22	4 259.44	4 306.51	4 916.43	4 744.24	4 621.02
CH_4 emissions excluding CH_4 from LULUCF	4 414.17	4 336.85	4 546.42	4 247.68	4 292.24	4 902.38	4 729.13	4 603.82
N_2O emissions including N_2O from LULUCF	6 456.94	3 852.79	3 360.44	3 655.53	3 797.05	3 767.80	3 817.86	3 841.75
N_2O emissions excluding N_2O from LULUCF	6 351.04	3 804.04	3 312.30	3 581.79	3 762.96	3 739.18	3 787.70	3 813.82
HFCs	NA.NO	40.42	58.18	77.01	102.30	130.12	154.22	181.34
PFCs	271.37	25.40	13.60	11.65	15.59	13.75	21.65	19.91
SF_6	0.03	12.24	12.68	13.11	13.48	14.42	15.03	15.53
Total (including LULUCF)	61 762.74	41 552.24	40 276.49	38 584.76	41 847.42	40 440.06	41 306.91	41 743.17
Total (excluding LULUCF)	71 781.85	52 543.30	51 377.81	49 298.65	52 355.10	51 205.27	51 544.20	51 376.51

GREENHOUSE GAS EMISSIONS	Base year 1990	2005	2006	2007	2008	2009	2010	2011
	CO$_2$ equivalent (Gg)							
CO_2 emissions including net CO_2 from LULUCF	50 606.13	36 073.08	33 219.48	31 716.37	33 237.73	28 323.37	30 955.22	30 164.19
CO_2 emissions excluding net CO_2 from LULUCF	60 745.23	42 224.47	41 718.12	39 857.26	40 492.91	35 802.01	37 911.16	37 671.87
CH_4 emissions including CH_4 from LULUCF	4 428.26	4 379.95	4 462.55	4 383.55	4 399.99	4 216.17	4 130.63	4 161.08
CH_4 emissions excluding CH_4 from LULUCF	4 414.17	4 357.51	4 443.65	4 364.81	4 378.94	4 195.41	4 107.72	4 138.49
N_2O emissions including N_2O from LULUCF	6 456.94	3 797.90	4 061.74	3 995.57	3 867.57	3 561.90	3 434.16	3 027.19
N_2O emissions excluding N_2O from LULUCF	6 351.04	3 771.85	4 040.35	3 970.84	3 852.08	3 541.50	3 416.27	3 009.36
HFCs	NA.NO	205.96	248.14	284.44	335.17	380.08	420.16	439.50
PFCs	271.37	20.25	35.82	24.88	36.16	17.76	21.15	17.00
SF_6	0.03	16.27	16.81	17.44	18.51	19.39	19.90	20.74
Total (including LULUCF)	61 762.74	44 493.41	42 044.54	40 422.25	41 895.13	36 518.68	38 981.23	37 829.71
Total (excluding LULUCF)	71 781.85	50 596.32	50 502.89	48 519.67	49 113.78	43 956.15	45 896.36	45 296.96

Table 3.1: *Total anthropogenic greenhouse gas emissions by sectors in 1990-2011*

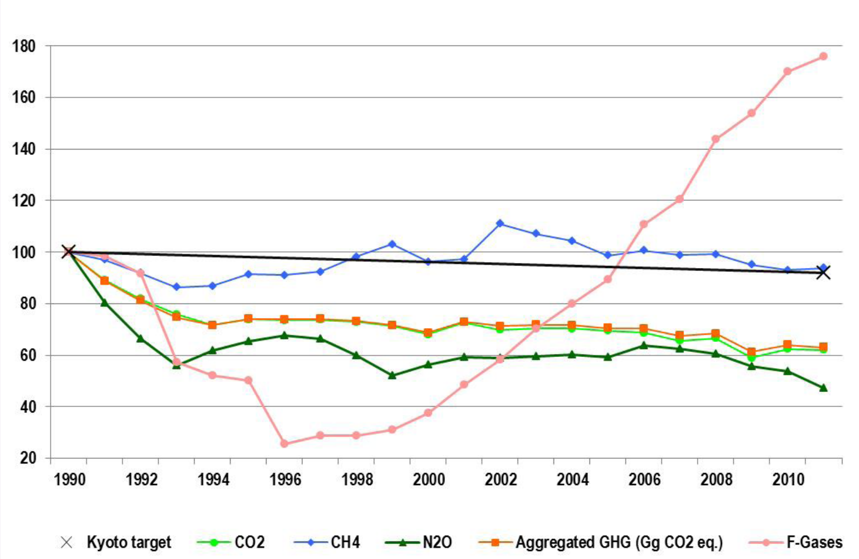
GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Base year 1990	1991	1992	1993	1994	1995	1996	1997
	CO$_2$ equivalent (Gg)							
1. Energy	53 875.84	48 694.21	44 578.88	40 793.10	37 934.98	38 947.71	38 929.38	38 805.77
2. Industrial Processes	9 543.26	7 737.66	7 400.44	7 242.93	8 023.03	8 552.32	8 547.54	8 759.58
3. Solvent and Other Product Use	147.15	126.64	110.00	101.65	102.96	121.53	115.50	97.62
4. Agriculture	7 124.26	6 081.67	5 072.08	4 348.57	4 187.69	4 357.64	4 201.16	4 040.70
5. Land Use, Land-Use Change and Forestry	-10 019.11	-11 142.50	-12 836.04	-11 933.17	-11 096.51	-10 778.56	-10 615.18	-10 399.55
6. Waste	1 091.33	1 105.90	1 109.98	1 119.03	1 175.03	1 232.71	1 293.62	1 484.45
7. Other	NA	NA	NA	NA	NA	NA	NA	NA
Total (including LULUCF)	61 762.74	52 603.58	45 435.34	41 672.11	40 327.18	42 433.35	42 472.01	42 788.57

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Base year 1990	1998	1999	2000	2001	2002	2003	2004
	CO$_2$ equivalent (Gg)							
1. Energy	53 875.84	37 941.63	36 856.98	35 646.59	38 132.84	35 854.22	36 521.34	35 439.92
2. Industrial Processes	9 543.26	8 954.24	8 874.59	8 293.99	8 770.08	9 152.43	9 021.00	10 131.28
3. Solvent and Other Product Use	147.15	94.45	90.52	85.04	99.74	131.92	137.35	163.49
4. Agriculture	7 124.26	3 724.15	3 462.98	3 495.99	3 541.59	3 482.24	3 362.62	3 174.53
5. Land Use, Land-Use Change and Forestry	-10 019.11	-10 991.06	-11 049.45	-10 713.89	-10 507.68	-10 765.22	-10 237.28	-9 633.33
6. Waste	1 091.33	1 828.83	2 092.74	1 777.04	1 810.85	2 584.46	2 501.90	2 467.29
7. Other	NA	NA	NA	NA	NA	NA	NA	NA
Total (including LULUCF)	61 762.74	41 552.24	40 328.36	38 584.76	41 847.42	40 440.06	41 306.91	41 743.17

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Base year 1990	2005	2006	2007	2008	2009	2010	2011
	CO$_2$ equivalent (Gg)							
1. Energy	53 875.84	35 500.64	34 432.40	32 749.51	33 546.07	30 200.64	31 789.70	31 533.37
2. Industrial Processes	9 543.26	9 407.00	10 251.98	10 010.10	9 901.67	8 374.69	8 621.23	8 248.22
3. Solvent and Other Product Use	147.15	171.54	170.59	166.25	166.59	164.38	164.35	170.54
4. Agriculture	7 124.26	3 171.01	3 115.33	3 231.22	3 129.46	3 052.37	3 098.29	3 117.52
5. Land Use, Land-Use Change and Forestry	-10 019.11	-6 102.90	-8 458.35	-8 097.42	-7 218.64	-7 437.46	-6 915.13	-7 467.26
6. Waste	1 091.33	2 346.13	2 532.60	2 362.59	2 369.99	2 164.06	2 222.79	2 227.32
7. Other	NA	NA	NA	NA	NA	NA	NA	NA
Total (including LULUCF)	61 762.74	44 493.41	42 044.54	40 422.25	41 895.13	36 518.68	38 981.23	37 829.71

Total aggregated GHGs emission, emissions are determined as of April 15, 2013

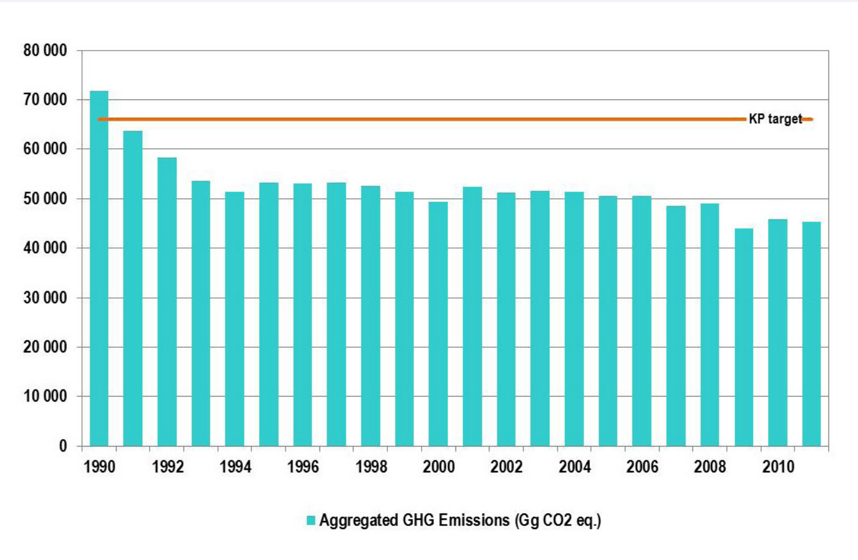
Figure 3.1: The GHG emission trends (1990-2011) compared with the Kyoto target (8%) in the Slovak Republic



GHG emissions without LULUCF; emissions are determined as of April 15, 2013

Total GHG emissions including sinks from sector LULUCF represented 37 829.71 Gg CO_2 equivalents in 2011 and they dropped by more than 38% compared to the reference year 1990 (61 762.74 Gg CO_2 equivalents). The amount of carbon sinks in forest ecosystems in the Slovak Republic shows a high fluctuation due to the sensitivity of sector LULUCF to meteorological conditions and weather extremes.

Figure 3.2: The aggregated GHG emission trends (1990-2011) compared with the Kyoto target (8%) in the Slovak Republic



3.2.2 Emissions Trends by Gas

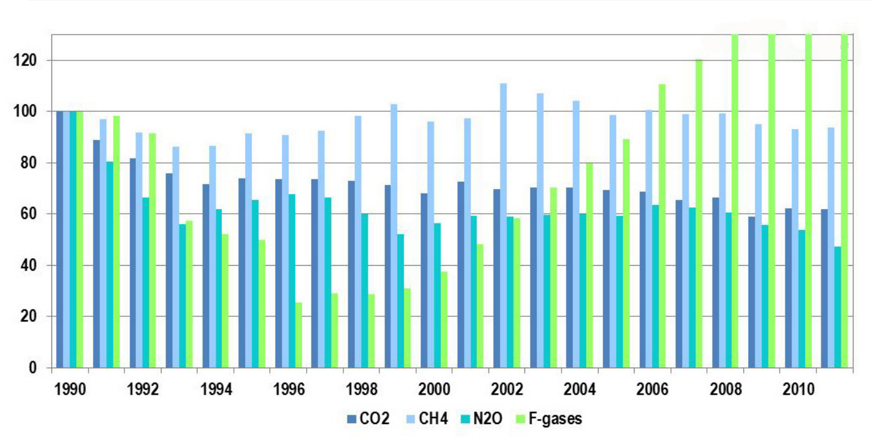
Total anthropogenic emissions of carbon dioxide excluding LULUCF have decreased by 37.98% in 2011 compared to the base year (1990). In 2011, total emissions of CO_2 are 37 671.87 Gg. CO_2 emissions slightly decrease compared to the previous inventory year 2010. The reason for the decrease in CO_2 emissions in 2011 is caused mainly by decreasing CO_2 emissions in energy and industrial processes sectors. In 2011, CO_2 emissions including LULUCF sector decreased by 40.39% compared to the base year, and they decreased by approximately 800 Gg compared to the previous year. In 2011, CO_2 emissions decreased mainly due to the increase of removals in LULUCF.

Total anthropogenic emissions of methane without LULUCF decreased compared to the base year (1990) by 6.25% and currently the emissions are 4 138.49 Gg of CO_2 equivalents. In absolute value, CH_4 emissions were 197.07 Gg without LULUCF. Methane emissions from LULUCF sector are 1.08 Gg of CH_4, caused by forest fires. The trend has been relatively stable during the last years with a slight decrease in the last year due to the emission decrease from category energy and industrial processes sectors. Methane emissions peaked in 2002 due to the implementation of a new waste legislation and increasing emissions from solid waste disposal sites in the Slovak Republic.

Total anthropogenic emissions of N_2O without LULUCF decreased compared to the base year (1990) by 52.62% and currently the emissions are 3 009.36 Gg of CO_2 equivalents. Emissions of N_2O in absolute value were 9.71 Gg without LULUCF. Emissions of N_2O from LULUCF sector are 0.06 Gg, from forest fires and cropland. Emissions decreased compared to the previous year 2010, due to the decrease in energy and industrial processes sectors. The trend depends on the nitric acid production. Overall decreasing trend is mainly driven by the decrease in agriculture due to declining number of animals and usage of fertilizers.

Total anthropogenic emissions of F-gases were 439.50 Gg of HFCs, 17.0 Gg of PFCs and 20.74 Gg of SF_6 in CO_2 equivalents. Emissions of HFCs have increased since 1995 due to the increase in consumption and the replacement of PFCs substances. Emission trend of PFCs is decreasing and emissions of SF_6 are slightly increasing due to the increasing consumption in industry.

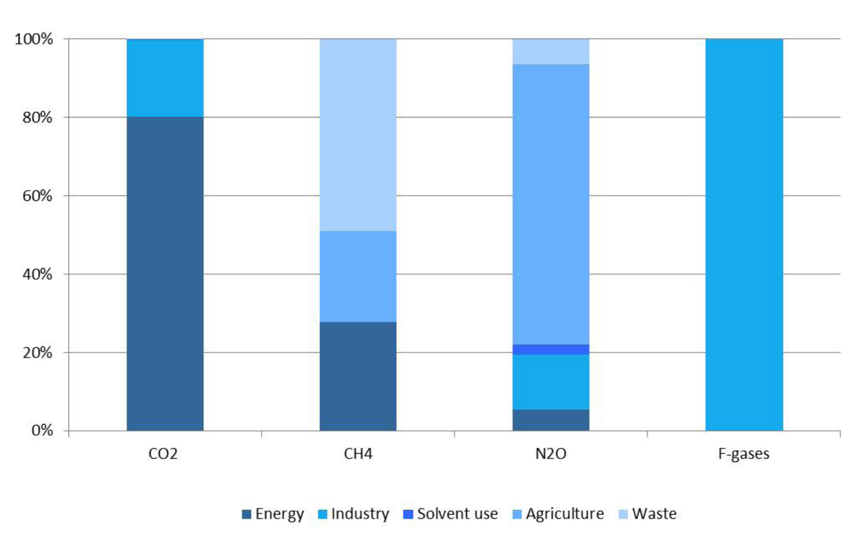
Figure 3.3: Emission trends by gas for the years 2000-2011 relative to the 1990 level (100%)



3.2.3 Emission Trends by Main Source Categories

The major share of CO_2 emissions comes from the energy sector (fuel combustion, transport) with 80.22% share from the total carbon dioxide emissions in 2011 inventory, 19.50% of CO_2 is produced in industrial processes and negligible amount is produced in waste (0.03%) and solvent use sectors (0.25%). The energy related CO_2 emissions from waste incineration are included in energy sector. The 48.92% of CH_4 emissions is produced in waste sector, 27.73% of methane emissions is produced in energy sector and 23.30% in agriculture sector. More than 71.55% of N_2O emissions are produced in agriculture sector (nitrogen from soils), 14.01% in industrial processes sector (nitric acid production), 6.43% in wastewaters and 5.05% in energy sector. F-gases are produced exclusively in sector industrial processes (Figure 3.4).

Figure 3.4: *Emission trends by gas in sectors in 2011*



Aggregated GHG emissions from energy sector based on sectoral approach data in 2011 were estimated to be 31 533.37 Gg of CO_2 equivalents including transport emissions (6 380.02 Gg of CO_2 equivalents), which represent the decrease by 41.47% compared to the base year and 0.8% decrease in comparison with 2010. Transport sub-sector decreased by 4% compared to 2010 and in comparison with the base year it raised by 21.3%.

Total emissions from industrial processes sector were 8 248.22 Gg of CO_2 equivalents in 2011, which was decreased by 13.57% compared to the base year and the increased by 4.3% compared to the previous year. Intensive increase of industrial production has caused the increase in emissions. Total emissions from sector of solvent use were estimated to be 170.54 Gg of CO_2 equivalents, which is the increased by about 15.89% compared to the base year. The time series have been completed, but the period of 1990-1993 (before the Slovak Republic formation) has not been covered sufficiency by statistical data (the lack of the national statistics data). Based on expert judgment, the constant values for this period were reported.

Emissions from agriculture sector were estimated to be 3 117.52 Gg of CO_2 equivalents. It is 56.24% decrease in comparison with the base year and 0.6% increase in comparison to the previous year. The agriculture sector is the sector with the most significant decrease compared to the base year 1990, because of the decreasing trend in cattle numbers.

Emissions from waste sector were estimated to be 2 227.32 Gg of CO_2 equivalents. The increase is 0.2% compared to the previous inventory year and the time series are stable for the last years. Compared to the base year, the increase was more than 104%, because of increased methane emissions from solid waste disposal sites. The emissions from waste incineration with energy use are included into energy sector, category 1.A.1a – energy industries, other fuels. The reallocation of methane emissions from waste incineration was the main driving force for the trend of changes in the last submissions.

Structural changes in sector energy and the implementation of economic instruments have played an important role in achieving the current status, when the trend of GHG emissions does not copy the fast GDP growth. In this context, the most important measure seems to be the adoption of the national legislation on air quality, which was approved in 1991 and it has initiated the positive trend in the reduction of the emissions of basic air pollutants and indirectly also GHG emissions. At the same time the consumption of primary energy resources as well as total energy has decreased.

Total anthropogenic greenhouse gas emissions by sectors in the years 1990-2011 are depicted in the Table 3.1 in this chapter.

Transport is a significant source of emissions in sector energy, with 8% share in total GDP in the Slovak Republic. The proportion of transport is growing each year and the adopted policies and measures have no positive impact on increasing trend of emissions from transport. Emission balances in road transport are modelled according to method COPERT IV version 8.1. GHG emissions from non-road transport are balanced by the use of EMEP/EEA 2010 methodology according to individual transport types (air, water and rail). The share of rail and water transports is decreasing from year to year, while the share of air transport is increasing rapidly, especially due to the increasing activity of low cost airlines.

Fugitive methane emissions from the extraction (only 0.4% share in total GDP) and distribution of fossil fuels are important as the Slovak Republic is an important transit country regarding the transport of oil and natural gas from the former Soviet Union countries to Europe. Raw materials are transported through high pressure pipelines and distribution network and they are pumped in pipeline compressors.

Sector of industrial processes includes all GHG emissions generated from technological processes producing raw materials and products with the 27% share in total GDP in the Slovak Republic. Within the preparation of the GHG emission balance in the Slovak Republic, consistent emphasis is put on the analysis of individual technological processes and distinction between the emissions from fuel combustion in heat and energy production and the emissions from technological processes and production. Most important emission sources are balanced separately, emission and oxidation factors are re-evaluated, as well as other parameters entering the balancing equations and the results are compared with the verified emissions in the Slovak National Registry for CO_2 emissions.

Fundamental emission inventory is based on the balance of non-methane volatile organic compounds (NMVOC) according to EMEP/EEA 2010 methodology. Emissions are recalculated according to the stoichiometry coefficients to CO_2 emissions.

Sector agriculture with 3% share in total GDP in the Slovak Republic is the main source of methane and N_2O emissions in the GHG emissions balance in the Slovak Republic. The emission balance is compiled annually on the basis of sectoral statistics and in recent years on the basis of a new regionalization of agricultural areas of the Slovak Republic. The Ministry of Agriculture and Rural Development of the Slovak Republic issues annual statistics "Green Report", part agriculture and food industry on a yearly basis.

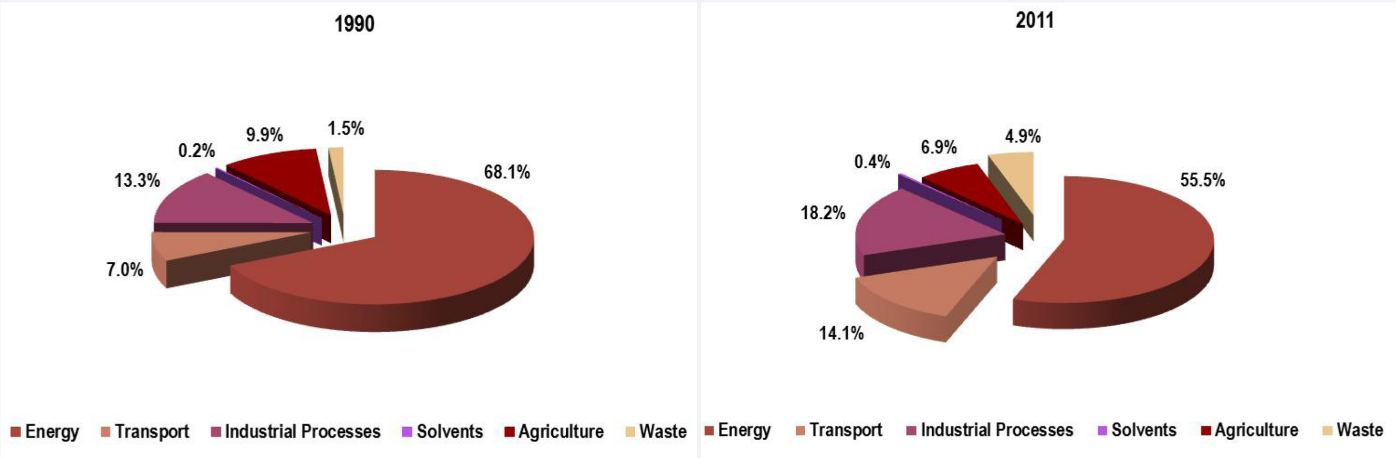
The area of forest land in the Slovak Republic covers 40% of the territory and wood harvesting is historically an important economic activity. Since 1990, sinks from sector LULUCF have remained at the level of 8-10% of total GHG emissions. Historically stable trend was disrupted in 2004 by a wind calamity in the High Tatras, which resulted in increased harvest of wood damaged by the calamity and pests and consequently in the decrease in total sinks to the half of earlier volumes.

Several significant changes and re-evaluations of the applied methods have been carried out in sector waste, followed by recalculations in all categories of waste treatment. Methane emissions from solid waste disposal sites have the largest share in total emissions from the sector. Waste balance methodology has been revised and tier 2 approach- First Order Decay methodology has been used for the recalculations of the time series since 1960. The trend of methane emissions has been increasing depending on the adopted values for parameters of municipal waste landfills. A more detailed description of the methodology as well as with the Monte Carlo uncertainty analyses are described in the references.[5] The disaggregation of emissions from municipal waste incineration into two groups, i.e. waste incineration with and without energy utilisation, was another important change with respect to the quality improvement of the emission inventory. The emissions from waste incineration with energy utilisation were reported under energy sector, sub-category 1.A.1.a (other fuels). The emissions from waste incineration without energy utilisation are reported within sector waste.

CTF Table 1 (b) in the CTF Annex provides an overview of GHG emissions in the main source categories for 1990-2011. The most important sector by far is energy (i.e. combustion and fugitive emissions), accounting for 69.6% of total GHG emissions in 2011. The second largest sector is industrial processes (18.2%), followed by agriculture (6.9%) and waste (4.9%). The comparison of the 2011´s sectors share with the base year is shown on the following Figure 3.5. The significant decrease is visible in energy sector (without transport) and increase in sectors waste and transport. Emissions from international aviation and shipping are excluded from the national totals and therefore not presented in the table.

International bunker emissions of the inventory are the sum of the aviation bunker and maritime bunker emissions. These emissions are reported as memo items but excluded from national totals. Emissions of greenhouse gases from international aviation increased constantly between 1992 and 2008. Between 2009 and 2011 international bunker emissions decreased, partly reflecting the economic recession. Total GHG emissions from international transport reached 139.65 Gg of CO_2 equivalents in 2011. Emissions from international aviation have more than 95% share.

Figure 3.5: The share of individual sectors in total GHG emissions in 1990 and 2011



5 Szemesová J., M. Gera Emission estimation of solid waste disposal sites according to the uncertainty analysis methodology, Bioclimatology and Natural Hazards, ISBN 978-80-228-17-60

Detailed information on GHG emissions, trends and reductions are published in the National Inventory Report of the Slovak Republic 2013, which is available at http://ghg-inventory.shmu.sk.

3.2.4 Change in Emissions from Key Categories

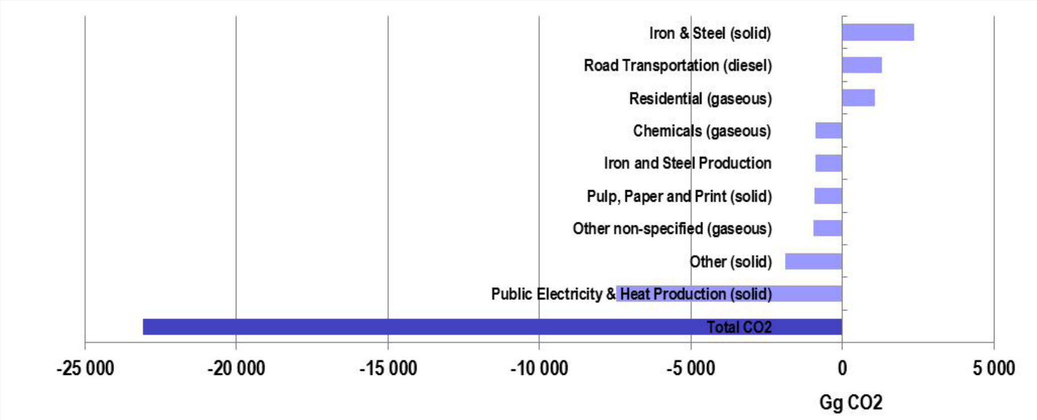
Key categories are defined as the sources or removals of emissions that have a significant influence on the inventory as a whole, in terms of the absolute level of emissions, the trend, or both. The Slovak Republic prepared both Tier 1 and quantitative Tier 2 key categories analysis for 2011 emission sources in line with the IPCC Good Practice Guidelines 2000. The quantitative analyses include combined uncertainty (on emission factors and activity data) and recognized 48 key categories by level assessment with and without LULUCF sector.

CO_2 emissions from solid fuels in the category 1.A.2a "iron and steel" are the largest key category without LULUCF, accounting for 10% of total greenhouse gas emissions in 2011 and for 15% of greenhouse gas emissions of the energy sector. As can be seen in Figure 3.6, below, solid fuels from the category 1.A.1a "public electricity & heat production" shows the largest decrease between 1990 and 2011. The main explanatory factors of emissions decrease is in improvements in energy efficiency and (fossil) fuel switching from coal to gas. A shift from solid and liquid fuels to mainly natural gas took place and an increase of biomass and other fuels has been recorded.

CO_2 emissions from "road transportation – diesel oil" are the second largest key source accounting for 9.8% of total GHG emissions without LULUCF in 2011. Between 1990 and 2011, CO_2 emissions from diesel oil in road transportation increased by 1.3 Mt of CO_2, which is 41% increase due to an increase in fossil fuel consumption in this key category (Figure 3.6). Since 1990, the large increase in 'road transportation' related CO_2 emissions was recognized.

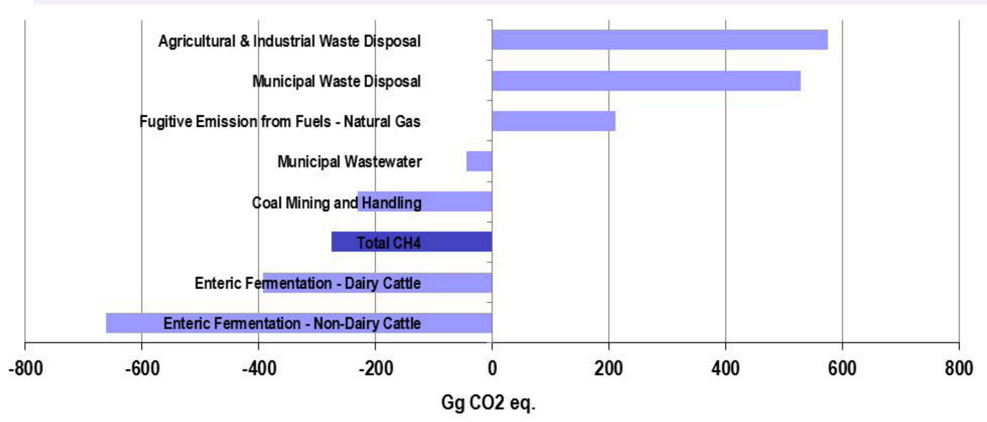
CO_2 emissions from the category "iron and steel production" in industrial processes sector are the fourth largest key source in the Slovak Republic, accounting for 7% of total GHG emissions in 2011. Between 1990 and 2011, emissions from this category showed the decrease, as they declined by 0.9 Mt of CO_2, which is 22%.

Figure 3.6: Absolute change of CO_2 emissions by large key categories 1990 to 2011



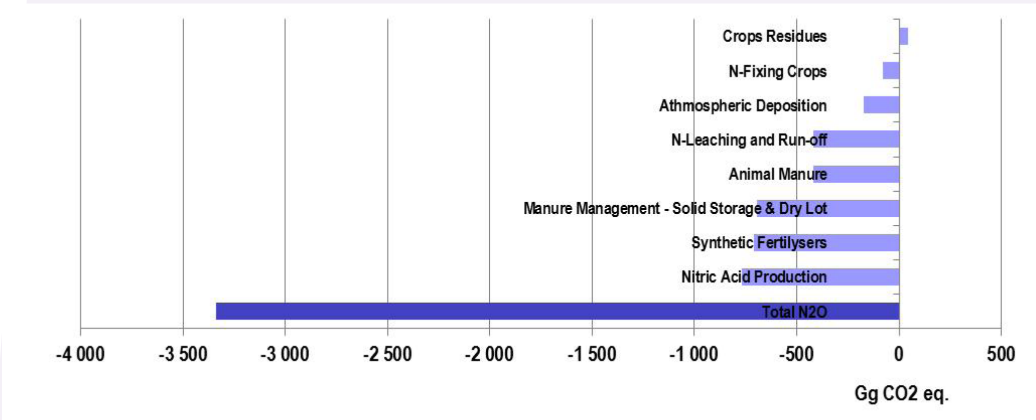
Methane emissions account for 9% of total GHG emissions in 2011 and decreased by 6.25% since 1990 to 197 Gg CH_4 in 2011. The two largest key sources (6.A.1 Managed Waste Disposal on Land at 2.2% and 1.B.2 Fugitive Emission from Fuels - Natural Gas at 1.46% of total greenhouse gas emissions in 2011) account for 40% of CH_4 emissions in 2011. Figure 3.7 shows that the main reasons for declining CH_4 emissions were reductions in "enteric fermentation of dairy and non-dairy cattle" mainly caused by the decreased of animal numbers and use reductions in "coal mining". Figure 3.7 shows significant increase in waste sector and fugitive emissions from natural gas distribution and processing caused by increasing of economic activities and change of IPCC methodology used for solid waste disposal sites which consideres time layer since 1960.

Figure 3.7: *Absolute change of CH_4 emissions by large key categories 1990 to 2011*



N_2O emissions are responsible for 6.6% of total GHG emissions and decreased by 52.6% to 9.71 Gg of N_2O in 2011 (Figure 3.8). The two largest key sources causing this trend (4.D.1.1 Synthetic Fertilysers at 1.1% and 4.D.3 Indirect Emissions at 0.7% of total greenhouse gas emissions in 2011) account for approximately 27% of N_2O emissions in 2011. The main reason for large N_2O emission cuts were reduction measures in the "nitric acid production" and decreasing of agricultural acitivities (Figure 3.8).

Figure 3.8: *Absolute change of N_2O emissions by large key categories 1990 to 2011*



Fluorinated gas emissions account for 1% of total GHG emissions. In 2011, emissions were 477 Gg CO_2 equivalents, which was 57% above 1990 levels. The largest key source "2.F.1 Refridgeration and Air Conditioning" account for 87% of fluorinated gas emissions in 2011. HFC emissions from the "consumption of halocarbons" showed large increases between 1990 and 2011. The main reason for this is the phase-out of ozone-depleting substances such as chlorofluorocarbons under the Montreal Protocol and the replacement of these substances with HFCs (mainly in refrigeration, air conditioning, foam production and as aerosol propellants). On the other hand, PFC emissions decreased substantially. The decrease has started in 1996 and was the strongest in 1999 and 2000.

3.2.5 Key Drivers Affecting Emission Trends

The main reasons for the changes during the period 1990-2011 are described in more detail in section 2 (National Circumstances). Since the last National Communication of the Slovak Republic in 2007, emissions decreased with a sharp drop in 2009 when the economic downturn caused substantial emission reductions. In 2010, emissions increased again, partly driven by the economic recovery from the 2009 recession in many economical and industrial activities. In particular emissions from iron and steel production and other manufacturing industries increased significantly in 2010.

The sections below summarize the main reasons for the changes in emissions in the Slovak Republic during the period 2010-2011.

Main reasons for emission changes in 2010-2011

In comparison with 2010, the emissions decreased by 1.3% without LULUCF. Total GHG emissions in the Slovak Republic slightly decreased in 2011 in comparison with the previous year, which was probably influenced by the international trade (lower export of products), but in generally, the recovery of economy after the economic and financial crises in 2009 and gas and oil crises in delivery from the Ukraine at the beginning of 2009, was completed. Total GHG emissions excluding LULUCF sector have been decreasing continually from the base year with the stable trend in the recent years. Significant changes in methodologies and emission factors are implemented in the frame of trying to keep consistency with the EU ETS. The main reason for emission changes in 2010-2011 were as follows:

- The 2011 winter was warmer than in the previous year, leading to decreased demand for heating and lower emissions from the residential and commercial sectors by 700 Gg of CO_2.
- CO_2 emissions decrease in road transportation (270 Gg of CO_2) caused by lower consumption of gasoline. Slovak Republic is transit country with the strong influence of fuel prices in neighbouring countries.
- CO_2 emissions decrease in metal production (600 Gg of CO_2) caused by decrease in iron and steel production and the production of ferroalloys.
- CO_2 emissions decrease in the industrial waste incineration (28 Gg of CO_2) mainly caused by the lower quantity of industrial waste produced.
- N_2O emissions decrease in nitric acid production (500 Gg of CO_2 eq.) caused by the introducing the technology with secondary YARA catalyst in medium-pressure and high-pressure plant. It resulted in significant decrease of N_2O emissions.

Substantial emission increases between 2010 and 2011 in the Slovak Republic were reported only for:

- CO_2 emissions from manufacturing industries and construction (500 Gg of CO_2) due to the higher industrial production. This increase is connected with the emission increase of mineral production categories (2.A).
- N_2O from industrial waste composting.

3.2.6 Key Drivers Affecting Emission Trends in LULUCF

The increasing trend of forest land-use category is evident in the Slovak Republic since 1970. The opposite, decreasing trend of cropland land-use category was recorded at the same time. Grassland areas decreased from 1980 to beginning of 1990 and since this year increasing trend was recorded up to 2005. Since 2005 moderately downward trend has been taking place. Settlements land-use category has continual increasing trend during the whole period. This situation is mostly caused by development of transport infrastructure, industrial areas, municipal development and raising the standards and infrastructure in country and is very often connected with decreasing of the cropland and other land categories. Wetland represents 1.9% (94 kha) of the Slovak territory and it is considered to be constant, not involving any land use conversions.

The LULUCF sector with net removals -7 467.26 Gg of CO_2 equivalents in 2011 is very important sector and comprises from several key categories. The major share represents CO_2 removals (-7 507.68 Gg) with the contributions of following categories: Forest land with removals of -6 567.96 Gg CO_2, Cropland with removals of -758.15 Gg CO_2, Grassland with removals of -384.27 Gg CO_2, Settlements with the emissions of 81.02 Gg CO_2 and Other land with the emissions of 121.68 Gg CO_2. Total methane emissions were 1.08 Gg and total N_2O emissions were 0.06 Gg from LULUCF sector in 2011. N_2O emissions from the disturbance associated with the land-use conversion to Cropland were reported for the first time in this submission. The emissions of other pollutants originate from forest fires and controlled burning of forest. The estimated amount of NO_x emissions was 0.53 Gg and the estimated amount of CO emissions was 9.41 Gg in 2011.

Table 3.2: Summary of total emissions and removals according to the categories in 2011

CATEGORY	Net CO_2		CH_4	N_2O	NO_x	CO
	Emissions/Removals		Emissions			
	(Gg)					
5. LULUCF	NO	-7 507.68	1.08	0.06	0.53	9.41
A. Forest Land	NO	-6 567.96	1.08	0.01	0.53	9.41
B. Cropland	NO	-758.15	NO		NO	NO
C. Grassland	NO	-384.27	NO	NO	NO	NO
D. Wetlands	NO	NO	NO	NO	NO	NO
E. Settlements	81.02	NO	NO	NO	NO	NO
F. Other Land	121.68	NO	NO	NO	NO	NO

3.2.7 Information on Indirect Greenhouse Gas Emissions

Emissions of CO, NO_x, NMVOC and SO_2 have to be reported to the UNFCCC Secretariat because they influence climate change indirectly: CO, NO_x and NMVOC are precursor substances for ozone which itself is a greenhouse gas. Sulphur emissions produce microscopic particles (aerosols) that can reflect sunlight back out into space and also affect cloud formation. Table 3.2 shows the total indirect GHG and SO_2 emissions in the Slovak Republic between 1990 and 2011. All aforementioned emissions were reduced significantly from 1990 levels: the largest reduction was achieved in SO_2 (-87%), followed by NO_x (-62%), CO (-55%) and NMVOC (-49%).

A major source of SO_2, NOx and CO emissions is power and heat generation. Contribution of transport to NOx and CO emissions is still growing. Metallurgy is an important source of CO emissions. NMVOC emissions occur from the use of solvents, transport, refinery/storage and transport of crude oil and petrol.

Table 3.3: *Anthropogenic emissions of NO_x, CO, NM VOC and SO_2 in 1990-2011*

GHG EMISSIONS	1990	1995	2000	2005	2006	2007	2008	2009	2010	2012
	(Gg)									
NO_x	226.59	179.07	107.75	102.39	96.80	96.05	94.23	83.42	89.14	85.55
CO	521.38	426.85	305.91	281.40	280.42	252.04	253.67	217.90	230.45	236.57
NMVOC	133.60	91.10	67.09	71.46	68.74	67.24	65.60	64.28	62.40	68.29
SO_2	524.13	244.84	126.95	89.01	87.75	70.56	69.41	64.08	69.39	68.48

3.2.8 Accuracy/Uncertainty of the Data

The uncertainty assessment by tier 1 is enclosed in the Annex 5 to this report. Quantification of emissions uncertainty by level and trend assessment was calculated by using tier 1 method published in Good Practice Guidance (IPCC, 2000). The tier 1 estimated 12.9% level uncertainty and 4.4% trend uncertainty in 2011.

The uncertainty assessment by using more sophisticated tier 2 Monte Carlo method was prepared with cooperation with the Faculty of Mathematics, Physics & Informatics. According to the most recent results, the tier 2 uncertainty for methane emissions from solid waste disposal sites in waste sector was estimated in the range of confidence interval (-76%; +72%) in 2011.

The tier 2 uncertainty analyses for fuel combustion in energy sector (including transport) according to the fuels classification was estimated in the range of confidence interval (-2.25%; +2.76%) in 2011.

The tier 2 uncertainty analyses for industrial processes sector including solvent and other product use sector according to the technological emissions was estimated in the range of confidence interval (-4.17%; +4.19%) in 2011.

Results of the Monte Carlo method to estimate uncertainty were published in two papers[6,7] and described in details in the National Inventory Report of the Slovak Republic 2013.

3.2.9 Changes since the 5th National Communication

Since the publication of the 5th National Communication, various updates and revisions to methodologies have been implemented in the GHG inventory and the National Inventory System of the Slovak Republic, which have impacted on the time-series of emissions. Overall, recalculations without LULUCF are insignificant (below 1%) but the recalculations considering LULUCF sector caused changes about 3% of the national total (in absolute numbers). The major changes in the inventory are highlighted in the Table 3.4 below.

6 J. Szemesova, M. Gera: Contributions to Geophysics & Geodesy,37/3, 2007
7 Szemesová J., Gera M. Uncertainty analysis for estimation of landfill emissions and data sensitivity for the input variation, Climatic Change DOI 10.1007/s10584-010-9919-1, 2010

Table 3.4: Major revisions to the GHG inventory since publication of the 5th National Communication

Category (Year of Change)	Change
Road Transportation (1.A.3b) (2011)	• Updating model COPERT version, recalculation back to the base year; • Introducing biomass share in diesel and gasoline; • GHG emissions estimation from CNG consumption.
Energy sector – fuel combustion (2013)	• Change in emission factors for biomass, the IPCC 2006 default EF for biomass (solid, liquid, gaseous) were used instead of one average EF and therefore the timeseries were recalculated back to 2000; • The corrections in biomass consumption mostly caused by the NCVs corrections
Public Electricity and Heat Production/Other Fuels/ISW incineration with energy use (2013)	• The CO_2 emissions were recalculated based on reconstructed time series for the quantity of waste incinerated with energy use.
HFCs emissions from consumption (2012)	• Stock was calculated according to the formula in line with the IPCC GPG 2000. Activity data for stock, new fillings (assembly) and disposal have been disaggregated into sub-subcategories (in refrigeration and air conditioning equipment (2.F.1), foam blowing (2.F.2) and fire extinguishers (2.F.3) subcategories). Disposal emissions for subcategories refrigeration and air conditioning equipment (2.F.1), foam blowing (2.F.2) and fire extinguishers (2.F.3) were included. EFs were revised and weighted average was used for disaggregated data.
LULUCF sector (2012, 2013)	• The main reason was recalculation of land areas due to incorrect determination of the length of the transition period. In previous GHG inventory was used the 21 year transition period instead of 20 year period. It affected the estimation of emissions / removals of GHGs for the categories 5.A.1 Forest Land remaining Forest Land, as well as for 5.A.2 Land converted to Forest Land. The current annual biomass increments were recalculated.

3.3 NATIONAL SYSTEM

3.3.1 Institutional Arrangements

The National Inventory System[8] has been established and officially announced by Decision of the Ministry of the Environment of the Slovak Republic on January 1, 2007 in the official bulletin: Vestnik, Ministry of Environment, XV, 3, 2007.[9] In compliance with paragraph 30(f) of Annex to decision 19/CMP.1, which gives the definitions of all qualitative parameters for the national inventory systems, the description of quality assurance and quality control plan according to Article 5, paragraph 1 is also required.

According to the Governmental Resolution No. 821/2011 Coll. from December 19, 2011, the inter-ministerial High Level Committee on Coordination of Climate Change Policy was established. This Committee was created at the state secretary level and replaced previous coordinating body, i.e. the High Level Committee on Climate-Energy Package established in August 2008. Committee is chaired by the State Secretary of the Ministry of Environment of the Slovak Republic, other members are the state secretaries of the Ministry of Economy of the Slovak Republic, Ministry of Agriculture and Rural Development of the Slovak Republic, the Ministry of Transport, Construction and Regional Development of the Slovak Republic, the Ministry of Education, Science, Research and Sport of the Slovak Republic, the Ministry of Health of the Slovak Republic, the Ministry of Finance of the Slovak Republic, the Ministry of Foreign and European Affairs of the Slovak Republic and the Head of the Regulatory Office for the Network Industries. Main objectives of inter-ministerial body are to develop and implement national strategy on mitigation and adaptation and to ensure cost-effective meeting of reduction commitments both in middle and long-term frame. Committee plays an important role also in the process of evaluation the progress in fulfilment of our climate change objectives and commitments and regularly submits reports about a progress for a consideration to the Slovak Government.

The MoE is responsible for implementation of national environmental policy including climate change and air protection. It serves also as the National Focal Point to the UNFCCC. The Ministry of the Environment of the Slovak Republic is the main body to ensure conditions and to monitor progress of Slovakia in fulfilment of all commitments and obligations in climate change and adaptation policy. It has the responsibility to develop strategies and further instruments of implementation, such as acts, regulatory measures, economic and market based instruments for cost efficient fulfilment of adopted goals. Both, the conceptual documents as well as legislative proposals are always annotated by all ministries and other relevant bodies. Following the commenting process, the proposed acts are negotiated in the Legislative Council of the Government, approved by the Government, and finally by the Slovak Parliament.

The SHMI is authorised by the MoE to provide environmental services in accordance with the current statute[10], which also includes preparation of annual GHG inventories. The range of services, competencies, time schedule and financial budget are updated and agreed annually.

8 http://ghg-inventory.shmu.sk/
9 "Vestnik" (Official Journal of the Ministry of Environment), XV, 3, 2007, page 19: National inventory system of the Slovak Republic for the GHG emissions and sinks under the Article 5, of the Kyoto Protocol
10 http://www.shmu.sk/File/statut.pdf

All details of the SHMI activities are described in the Plan of Main Tasks. The plan, commented by all stakeholders is after approval published at the website of the SHMI.[11] Deadline for the approval of this plan by the ministry is December 31, each year. Organisational changes occurred after the year 2011 at the SHMI (the new structure of SHMI is presented at http://www.shmu.sk/File/organizacna%20struktura(1.1.2012).pdf. They resulted in establishment of the Department of Emissions and Air Quality Monitoring as the Single National Entity with delegated responsibilities. The process of preparing and management of emission inventories is the main workload of the Department of Emissions and Air Quality Monitoring. Permanent staff of emission experts working at the Department is complemented by several external experts from relevant institutions working on annual contracts renewed each year.

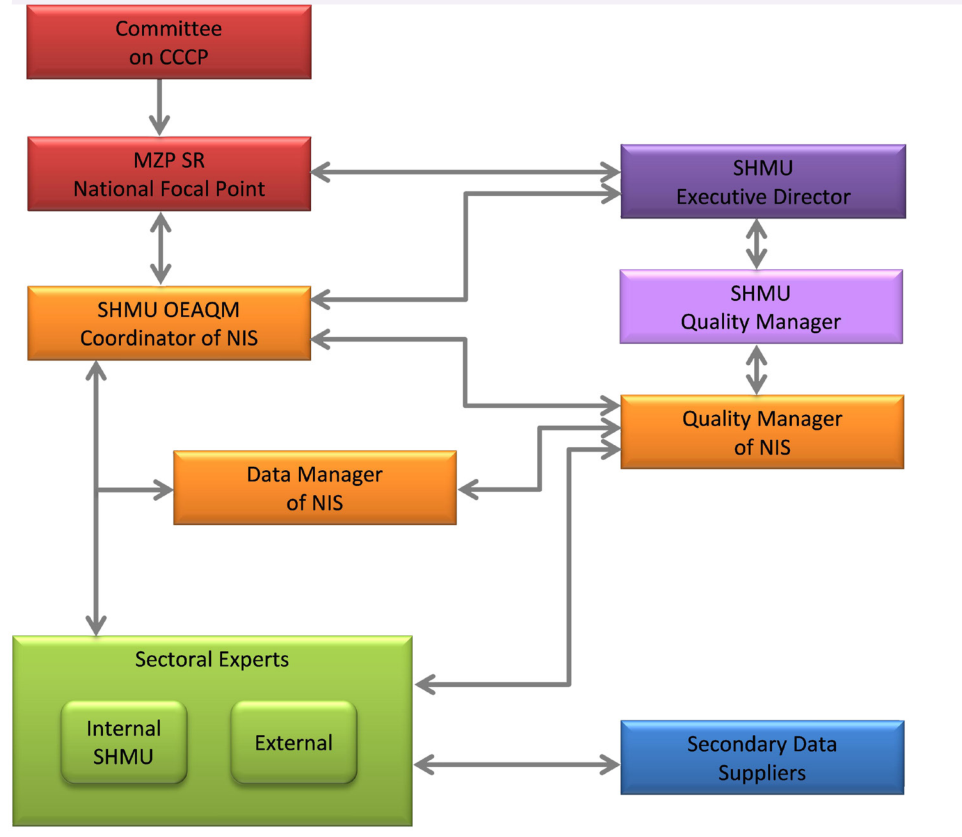
Contracts with external institutions and sectoral experts are fully in competence of the SHMI after previous approval by the MoE. The Department of Emissions and Air Quality Monitoring is fulfilling inventory tasks fully in line with approved Plan of Main Tasks and with financial resources allocated by the MoE. The Department of Emissions and Air Quality Monitoring has usually three main projects per year: Emission Inventory of GHGs, Emission Inventory of Other Pollutants and National Emission Information System. Between January 1 and February 15, at the latest, the external contracts between the SHMI and co-operating institutions or experts are signed.

To specify main objectives for a given year, kick-off workshop with participation of MoE, SHMI and external co-operating bodies and experts is organised regularly, usually at the beginning of February. This workshop is also an official forum for closing and summing up outcomes from the previous year and preparing the activities, including the QA/QC plan and responsibilities for the current year.

The main institutions involved in the compilation of the GHG inventory are:

- Ministry of the Environment of the Slovak Republic
- Slovak Hydrometeorological Institute
- Statistical Office of the Slovak Republic
- National Forest Centre
- Slovak Environmental Agency
- Waste Management Centre Bratislava
- Research Institute on Soil Protection Bratislava
- Slovak Association for Cooling and Air Conditioning Technology

Figure 3.9: *Institutional arrangement of the National Inventory System of the Slovak Republic*



CCCP = Committee on Coordination of Climate Change Policy, DEAQM = Department of Emissions and Air Quality Monitoring, NEIS = National Emission Information System, EI BP = Emission inventory for Basic pollutants EIP OP = Emission inventory and projections for other pollutants, EI GHG = Emission inventory for GHG, SNE = Single National Entity, NIS = National Inventory System under the Article 5.1 KP

3.3.2 Quality Assurance/Quality Control (QA/QC) Procedures

The MoE made a contract with consulting company ISO Management for the project “Implementation Process for QA/QC Model and QMS ISO 9001”. The Project started in March 2009 and was separated into two parts: Part I Implementation Process for QA/QC Model and Part II Implementing QMS according to ISO 9001:2008. The QMS was certified in March 2010. Preparatory phase of Part I of the Project was aimed at the QA/QC plan for internal and external procedurals steps concerning GHG emission inventory. The QA/QC plan for sectors will be updated and evaluated annually by the quality manager of the National Inventory System. The project was finalized at the meeting and workshop for the experts involved in the National Inventory System on January 13, 2010.

Sectoral experts apply the QA/QC methodology according to the Quality Manual, collect data from providers and process emission inventory for a given sector – they provide partial reports with information on quality and reliability of data on activities and emissions. These partial conclusions serve as a basis to estimate total uncertainties in emission inventories by a coordinator for uncertainties for all sectors. In some cases Tier 2 – Monte Carlo methodology (wastes, energy and industry) which requires detailed review of quality of each input parameter, works out uncertainty analysis.

Regarding QA/QC system, the SHMI implement a policy of continuous training process for internal and external experts. Experts are trained during workshops of the National Inventory System which are held two times per year. The minutes of the workshop and all relevant documents are sending to sectoral experts of the National Inventory System. The ways of communication within the National Inventory System are via e-mail, phone call, visits and meetings. Although the efficiency of communication is on a high level in our information system, for further improvement it is planned to create a website forum.

During the first half of 2013, the European Commission of the European Union launched a project to assist its Member States of the EU in the effective implementation of the reporting requirements under the Kyoto Protocol to the UNFCCC. The project aims at providing technical assistance and capacity building support to selected Member States (included Slovakia) that have consistently exhibited difficulties in the preparation of their national inventories. Support is provided via a web-based tool wiki forum. This forum has been designed for an exchange of views and provision of advice and solutions for common GHG estimation and reporting problems under the UNFCCC and Kyoto Protocol. Slovakia has obtained support in energy, F-gases, LULUCF and agriculture sectors including improvement in QA/QC activities. Some experts visit wiki forum to share information between Member States, and between Member States and the project support team experts.

The steps in QA/QC activities are managed and documented in several protocols (verification protocol, recalculation protocol, contracts or sectoral reports) which are in full compliance with internal documentation. All documents are approved and archived. Verification procedures are provided by competent authorities in several steps. The quality manager has the overall responsibility for documentation, formal contact with sectoral experts and approval activities, taking over the sectoral reports and archiving them. The results of the check are recorded in a verification protocol, which are parts of the management system. The sectoral experts shall fill out the first article, sign and shall respond to the comments, specify the actions taken in response to the comments (if necessary, correct the data, calculation methodology or the report accordingly). Quality manager shall fill out the second article, check and sign. National Inventory System coordinator shall fill out the third article, check, sign and return the verification protocol for archiving.

Further improvement of the QA/QC procedures

The sectoral experts must adopt adequate procedures for development and modification of the spread sheets to minimise emission calculation errors. Checks ensure compliance with established procedures as well as allow detecting remaining errors. Parameters, emission units and conversion factors used for the calculations must be clearly singled out and specified. Additional procedures should be also followed to ensure that the parameters and emission factors are correctly written down and that relevant conversion factors are used.

While streamlining reporting requirements will require amending individual legal instruments, the use of consistent data to report greenhouse gas emissions is essential to ensure the quality of emissions reporting. Therefore the online interface between CRF Reporter software and the individual database of the sectoral experts is in development also including QA/QC tools.

Figure 3.10 shows a model proposed by the Certification Company for the timeline of steps provided in the inventory process, QA/QC activities and verification procedures. Experts involved in the National Inventory System are nominated by the National Focal Point. Nomination letters are included in the list of controlled documentation and administrated by the quality manager of National Inventory System. More information on QA/QC activities can be found in the National Inventory Report of the Slovak Republic 2013.

Figure 3.10: *PDCA cycle (Plan, Do, Check, Act)*

3.3.3 The Inventory Methodology and Data

The deadlines and responsibilities are described in the QA/QC external plan. A comprehensive description of the inventory preparation for GHG emissions is described in methodologies for individual sectors. The methodologies are updated annually within the QA/QC plan and they are archived after formal approval at the web page of the National Inventory System.[12]

The methodologies used for the preparation of greenhouse gas inventory in the Slovak Republic are consistent with the Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories (IPCC 1997) and the IPCC Good Practice Guidance (IPCC 2000) and the IPCC Good Practice Guidance for Land Use, Land Use Change and Forestry (IPCC 2003). In line with the recommendations of the expert review teams under the UNFCCC, several methodologies and parameters have been implemented gradually in accordance with the IPCC 2006 Guidelines.

12 http://ghg-inventory.shmu.sk/

Table 3.5: *List of important information sources for inventory preparation*

Sector	Source of input data
Energy	Energy Statistics of the SR, www.statistics.sk, NEIS - www.air.sk, www.spp.sk, www.transpetrol.sk
Industrial Processes	Association of cement and lime producers, Association of refrigeration and air conditioning engineers, Association of paper producers
Solvent Use	Association for coating and adhesives, solvent distributors, Research institute for crude oil, www.vurup.sk
Agriculture	Green Report of the Ministry of Agriculture of the SR - Agriculture, http://www.land.gov.sk/sk/index.php?navID=122&id=1964
LULUCF	Green Report of the Ministry of Agriculture of the SR - Forest, http://www.land.gov.sk/sk/index.php?navID=123&id=2102
Waste	Dbase RISO http://www.sazp.sk/slovak/struktura/COH/oim/data/index.htm

Both, direct GHGs as well as precursor gases are covered by the inventory of the Slovak Republic. The geographic coverage is complete; the whole territory of the Slovak Republic is covered by the inventory. The Slovak Republic reports in the 2013 submission all significant IPCC source and sink categories according to the detailed CRF classification. Estimates are provided for the following gases: CO_2, N_2O CH_4, F-gases (HFC, PFC and SF_6), NMVOC, NO_x, CO and SO_2.

The additional GHG emissions are reported in the CRF Table 9(b). These HFCs gases are not included into national inventory due to the absence of the global warming potential (GWP) in the IPCC Second Assessment Report, the GWP were taken from the IPCC Fourth Assessment Report.

Table 3.6: *List of additional GHG emissions reported in the GHG inventory*

GHG	Source category	Emissions (Gg)	Estimated GWP value (100-year horizon)	Emissions CO_2 equivalent (Gg)	Reference to the source of GWP value
HFC 245fa	Hard Foam	0.52	1 030.00	533.15	4AR IPCC, Chapter 2, WGI
HFC 365mfc	Soft Foam	0.38	794.00	300.95	4AR IPCC, Chapter 2, WGI

In accordance with the IPCC Guidelines, international aviation fuel emissions are not included in national totals. Emissions from water transportation on the Danube River are exclusively included in international bunkers because of international character of the river transportation through the Slovak territory (transit). According to the recommendations of the expert review team during the in-country review for the annual GHG inventory submission of 2011, several categories were completed and which were not reported in the previous submission and which are the following:

- Foam Blowing agents and category 2.F.4 – Aerosols.
- N_2O emissions from disturbance associated with land-use conversion to cropland.
- N_2O from human sewage.

A complete set of CRF tables are provided for all years and the estimates are calculated in a consistent manner. Assessment of completeness is one of the elements of quality control procedure in the inventory preparation on general and sectoral level. The completeness of the emission inventory is improving from year to year and the updates are regularly reported in the national inventory reports. The completeness check for ensuring time series consistency is performed and the estimation is complete in recent inventory submission (2013). The improvements were performed in the previous inventory submissions such as estimation of GHG emissions for the agricultural and industrial waste disposal for the years 1990-1996.

In the GHG national inventory submission 2013 the Slovak Republic reports gases or source/sink categories that are not estimated (NE key) and categories, that are included elsewhere (IE key), as they are explained in Tables 9(a) CRF. The notation keys “NO”, “NA” and “IE” are used to fill in the blanks in all the tables in the CRF. Notation keys used in the National Inventory Report are consistent with those reported in the CRF. Notation keys are used according to the UNFCCC guidelines on reporting and review.[13] Several categories were not estimated due to lack of appropriate methodology or if emissions are below the measurement threshold.

Several categories are reported as not occurring (NO key) due to the not existence of the emission source or the source is out of threshold and measurement range. If the methodology does not exist in the IPCC Guidelines, the notation key not applicable (NA) was used. No “NE” key (not estimated key) categories have been reported in 2013 submission for 1990-2011. “

The Slovak Republic develops Annual Improvement Plan with the identification of further improvements in increasing completeness and accuracy of the individual emission sources and sinks categories. More information can be found in the National Inventory Report of the Slovak Republic 2013.

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13 FCCC/CP/2002/8

3.4 NATIONAL REGISTRY

Slovakia operates its national registry in a consolidated manner with the EU Member States who are also Parties to the Kyoto Protocol (25) plus Iceland, Liechtenstein and Norway. The consolidated platform which implements the national registries in a consolidated manner (including national registry of Slovakia) is called Consolidated System of EU registries (CSEUR). Slovak national registry was successfully connected to Independent Transaction Log (ITL) with other EU countries in October 2008 and it has been fully functional since. Internet address of the registry changed to co2.primabanka.sk in January 2012. Following the change of organization designated as registry system administrator in January 2013 to ICZ Slovakia, a.s. and the email address has further changed to emisie@icz.sk. These changes occurred after the end of the reported period and were reported to the UNFCCC through Slovak National Focal Point. They will be reported in the next submission. More information on changes in the national registry is provided in the Chapters 12 and 14 of this report.

Table 3.7: Organization designated as registry system administrator of the Slovak Republic

Name of the institution:	ICZ Slovakia a.s.
Postal address:	Soblahovská 2050, 911 01 Trencin, Slovakia
Phone & Fax number:	Phone: +421 32 6563 730, Fax: +421 32 6563 754
E-mail:	emisie@icz.sk
Web site address:	www.emisie.icz.sk
Contact person:	Ing. Miroslav Hrobák
Position:	Emission Registry Manager
E-mail address:	miroslav.hrobak@icz.sk

3.4.1 The Changes in the National Registry Software

Directive 2009/29/EC adopted in 2009, provides for the centralization of the EU ETS operations into a single European Union registry operated by the European Commission as well as for the inclusion of the aviation sector. At the same time, and with a view to increasing efficiency in the operations of their respective national registries, the EU Member States who are also Parties to the Kyoto Protocol (25) plus Iceland, Liechtenstein and Norway decided to operate their registries in a consolidated manner in accordance with all relevant decisions applicable to the establishment of Party registries – in particular Decision No. 13/CMP.1 and Decision No. 24/CP.8.

With a view to complying with the new requirements of Commission Regulation 920/2010/EU and Commission Regulation 1193/2011/EU, in addition to implementing the platform shared by the consolidating Parties, EU Member States' registries have undergone a major re-development. The consolidated platform which implements the national registries in a consolidated manner (including the registries of Slovakia and EU) is called Consolidated System of EU registries (CSEUR) and was developed together with the new EU registry on the basis the following modalities:

(1) Each Party retains its organization designated as its registry administrator to maintain the national registry of that Party and remains responsible for all the obligations of Parties that are to be fulfilled through registries;

(2) Each Kyoto unit issued by the Parties in such a consolidated system is issued by one of the constituent Parties and continues to carry the Party of origin identifier in its unique serial number;

(3) Each Party retains its own set of national accounts as required by paragraph 21 of the Annex to Decision 15/CMP.1. Each account within a national registry keeps a unique account number comprising the identifier of the Party and a unique number within the Party where the account is maintained;

(4) Kyoto transactions continue to be forwarded to and checked by the ITL, which remains responsible for verifying the accuracy and validity of those transactions;

(5) The transaction log and registries continue to reconcile their data with each other in order to ensure data consistency and facilitate the automated checks of the ITL;

(6) The requirements of paragraphs 44 to 48 of the Annex to Decision No 13/CMP.1 concerning making non-confidential information accessible to the public would be fulfilled by each Party individually;

(7) All registries reside on a consolidated IT platform sharing the same infrastructure technologies. The chosen architecture implements modalities to ensure that the consolidated national registries are uniquely identifiable, protected and distinguishable from each other, notably:

(a) With regards to the data exchange, each national registry connects to the ITL directly and establishes a distinct and secure communication link through a consolidated communication channel (VPN tunnel);
(b) The ITL remains responsible for authenticating the national registries and takes the full and final record of all transactions involving Kyoto units and other administrative processes such that those actions cannot be disputed or repudiated;
(c) With regards to the data storage, the consolidated platform continues to guarantee that data is kept confidential and protected against unauthorized manipulation;
(d) The data storage architecture also ensures that the data pertaining to a national registry are distinguishable and uniquely identifiable from the data pertaining to other consolidated national registries;
(e) In addition, each consolidated national registry keeps a distinct user access entry point (URL) and a distinct set of authorisation and configuration rules.

Following the successful implementation of the CSEUR platform, the 28 national registries concerned were re-certified in June 2012 and switched over to their new national registry on June 20, 2012. During the go-live process, all relevant transaction and holdings data were migrated to the CSEUR platform and the individual connections to and from the ITL were re-established for each Party.

On October 2, 2012 a new software release (called V4) including functionalities enabling the auctioning of phase 3 and aviation allowances, a new EU ETS account type (trading account) and a trusted account list was deployed. The trusted account list adds to the set of security measures available in the CSEUR. This measure prevents any transfer from a holding account to an account that is not trusted.

P1.3.1 15/CMP.1 annex II.E paragraph 32(a): The change of name or contact:

Changes in the contact information of the national registry administrator occurred during reported period: change of business name (from Dexia banka Slovensko a.s. to Prima banka Slovensko, a.s.) as well as telephone and fax numbers changes. These changes were reported to UNFCCC Secretariat through the Focal Point of the Slovak Republic.

There has been further change in the organization designated as registry system administrator, contact persons and contact information including postal address, web site address, email addresses, phone numbers and fax numbers since the end of the reported period which was reported to UNFCCC through the Focal Point of the Slovak Republic. These changes will be reported in the next submission.

P1.3.2 15/CMP.1 annex II.E paragraph 32.(b): The change of cooperation arrangement:

The EU Member States who are also Parties to the Kyoto Protocol (25, including Slovakia) plus Iceland, Liechtenstein and Norway have decided to operate their registries in a consolidated manner. The Consolidated System of EU registries were certified on June 1, 2012 and went to production on June 20, 2012.

A complete description of the consolidated registry was provided in the common readiness documentation and specific readiness documentation for the national registry of EU and all consolidating national registries. This description includes:

a) Application logging
b) Change management procedure
c) Disaster recovery
d) Manual Intervention
e) Operational Plan
f) Roles and responsibilities
g) Security Plan
h) Time Validation Plan
i) Version change Management

These documents are considered confidential are not to be publicly available. A new central service desk was also set up to support the registry administrators of the consolidated system. The new service desk acts as 2nd level of support to the local support provided by the Parties. It also plays a key communication role with the ITL Service Desk with regards notably to connectivity or reconciliation issues.

P1.3.3 15/CMP.1 annex II.E paragraph 32.(c): The change to the database or the capacity of national Registry:

In 2012, the EU registry has undergone a major redevelopment with a view to comply with the new requirements of Commission Regulation 920/2010/EU and Commission Regulation 1193/2011/EU in addition to implementing the Consolidated System of EU registries (CSEUR).

The complete description of the consolidated registry was provided in the common readiness documentation and specific readiness documentation for the national registry of EU and all consolidating national registries. The documentation is annexed to this submission, but is considered confidential.

P1.3.4 15/CMP.1 annex II.E paragraph 32.(d): The change of conformance to technical standards:

The overall change to a Consolidated System of EU Registries triggered changes in the registry software and required a new conformance testing. The complete description of the consolidated registry was provided in the common readiness documentation and specific readiness documentation for the national registry of the EU and all consolidating national registries.

During certification, the consolidated registry was notably subject to connectivity testing, connectivity reliability testing, distinctness testing and interoperability testing to demonstrate capacity and conformance to the Data Exchange Standard. All tests were executed successfully and lead to successful certification on June 1, 2012.

P1.3.5 15/CMP.1 annex II.E paragraph 32.(e): The change of discrepancy procedures:

The overall change to a Consolidated System of the EU Registries also triggered changes to discrepancies procedures, as reflected in the updated manual intervention document and the operational plan. The complete description of the consolidated registry was provided in the common readiness documentation and specific readiness documentation for the national registry of the EU and all consolidating national registries.

P1.3.6 15/CMP.1 annex II.E paragraph 32.(f): The change of security:

The overall change to a Consolidated System of EU Registries also triggered changes to security, as reflected in the updated security plan. The complete description of the consolidated registry was provided in the common readiness documentation and specific readiness documentation for the national registry of EU and all consolidating national registries.

P1.3.7 15/CMP.1 annex II.E paragraph 32.(g): The change of list of publicly available information:

No change to the list of publicly available information occurred during reported period.

P1.3.8 15/CMP.1 annex II.E paragraph 32.(h): The change of Internet address:

Internet address of the registry changed in January 2012 from co2.dexia.sk to http://co2.primabanka.sk/.

The Internet address has changed further since the end of the reported period and it was reported to UNFCCC through the Focal Point of the Slovak Republic. This change will be reported in the next submission.

P1.3.9 15/CMP.1 annex II.E paragraph 32.(i): The change of data integrity measures:

The overall change to a Consolidated System of EU Registries also triggered changes to data integrity measures, as reflected in the updated disaster recovery plan. The complete description of the consolidated registry was provided in the common readiness documentation and specific readiness documentation for the national registry of EU and all consolidating national registries.

P1.3.10 15/CMP.1 annex II.E paragraph 32.(j): The change of test results:

During certification, the consolidated registry was notably subject to connectivity testing, connectivity reliability testing, distinctness testing and interoperability testing to demonstrate capacity and conformance to the Data Exchange Standard. All tests were executed successfully and lead to successful certification on June 1, 2012.

The previous annual review recommendations:

The recommendations from previous Standard Independent Assessment Report for Slovakia (reference no.: IAR/2011/SVK/2/2) to display complete public information pursuant to part E of the annex to 13/CMP.1, paragraphs 44 to 48 inclusive was not yet fully addressed because of limitations of Union Registry. Partial information is provided on registry administrator's website.[14] The complete information is foreseen to be provided by the end of this year.

Public Information:

Public information is accessible on the national registry administrator's webpage[14] and it includes non-confidential information stated in UN and EU legislation, especially account information, Joint Implementation project information, overall unit holdings and overall transaction information, authorized legal entities information and compliance information.

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14 http://emisie.icz.sk/

Detailed information on holdings of accounts and transactions information is considered confidential according to European law. Currently, there is no officially registered JI project (Joint Implementation Project under Article 6 of the Kyoto Protocol) in Slovakia.

Accounting of Kyoto Protocol Units:

15/CMP.1 annex I.E paragraph 12: No discrepant transactions occurred in 2012.
15/CMP.1 annex I.E paragraph 13 & 14: No CDM notifications occurred in 2012.
15/CMP.1 annex I.E paragraph 15: No non-replacements occurred in 2012.
15/CMP.1 annex I.E paragraph 16: No invalid units exist as at 31st December 2012.

P.1.2.13 15/CMP.1 annex I.E paragraph 17: Actions and changes to address discrepancies:

The overall change to a Consolidated System of EU Registries triggered changes to discrepancies procedures. The complete description of the consolidated registry was provided in the common readiness documentation and specific readiness documentation for the national registry of EU and all consolidating national registries.

REFERENCES

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J. Szemesova, M. Gera: Contributions to Geophysics & Geodesy,37/3, 2007

Szemesová J., Gera M. Uncertainty analysis for estimation of landfill emissions and data sensitivity for the input variation, Climatic Change DOI 10.1007/s10584-010-9919-1, 2010

04
Policies and Measures

Policy Making Process, Additional Information Required under Article 7(2) of the Kyoto Protocol & Cross-Cutting Policies and Measures (PaMs)

4.1 INTRODUCTION

Activities of the Slovak Republic with respect to development of policies and measures to mitigate greenhouse gas emissions have been intensified since the publication of the Fifth National Communication of the Slovak Republic on Climate Change. The MoE and the SHMI have undertaken all the necessary steps to enhance mechanisms to monitor, evaluate and improve tools and measures for fulfilment our reduction commitments under the UNFCCC. All relevant EU-level policies and measures are being strengthened to meet the targets for the year 2020 as agreed in the Climate and Energy Package. This includes legislation put in place by the EU to reduce its greenhouse gas emissions by at least 20% compared to 1990 by 2020, with a conditional offer to move to 30%, provided that other developed countries commit themselves to comparable emission reductions. Furthermore, the EU has committed to achieve 20% of energy from the renewable sources by 2020 (as a share on total EU gross final energy consumption), supplemented by a target to achieve a minimum of 10% renewable energy share on the fuel consumption in the transport sector. Moreover, the EU has committed to 20% reduction of total primary energy consumption by 2020, compared to projections in 2007.[1] Slovakia is on the way to fulfil its commitments as it is seen from recent GHG emission inventories.

The content of the chapter is as follows:

- Description of the policy making process in the Slovak Republic (Section Chyba: Zdroj odkazu nenájdený).
- Monitoring and Evaluation (Section 4.2.1).
- Additional Information Required under the Kyoto Protocol (Section 4.3).
- Descriptions of cross-sectoral PaMs and sectoral PaMs on energy, transport, industry, agriculture, forestry and waste sectors (sections 4.5 to 8).
- Descriptions of the interactions of policies and measures (section 4.10).

4.2 POLICY MAKING PROCESS

The MoE is responsible for the development and implementation of national environmental policy including also the measures to tackle climate change both in mitigation and adaptation part. Preparing and coordination of development for all strategic documents and legal instruments in specific sectoral policies of other ministries is also the competence of the MoE.

The main bodies within the MoE to deal with climate change tasks are the Climate Change Policy Department operating under Division for Environmental Policy and the Emission Trading Department.

According to the resolution of the Slovak Government No. 821/2011 Coll., the High Level Committee on Climate-Energy Package has been replaced by the High Level Committee for Coordination of Climate Change Policy (the Coordination Committee).

The Coordination Committee was established on January 15, 2012 at the state secretary level and is chaired by the State Secretary of the MoE. Other members include the state secretaries of the Ministry of Economy, Ministry of Agriculture and Rural Development, Ministry of Transport, Construction and Regional Development, Ministry of Education, Science, Research and Sport, Ministry of Health, Ministry of Finance, Ministry of Foreign and European Affairs and the Head of the Regulatory Office for the Network Industries.

Coordination Committee fulfils principal role in the inter-ministerial decision making process.

Under the Coordination Committee were created two special working groups: one for preparing the Adaptation Strategy of the Slovak Republic on Adverse Impacts of Climate Change and the other one for all responsibilities within the Low-carbon strategy of the Slovak Republic.

1 The 20% EU energy efficiency target was legally defined in the Energy Efficiency Directive as the 'Union's (at that time: EU-27) 2020 energy consumption of no more than 1 474 Mtoe primary energy or no more than 1 078 Mtoe of final energy.

4.2.1 Monitoring and Evaluation

The Coordination Committee in combination with the above mentioned special working groups represents an institutional framework not only for policy making process but also for the process of monitoring and evaluation of already adopted policies in respect to the fulfilment of our international (not only mitigation) commitments.

The first level of monitoring and evaluation process represent a preliminary review of inventory reports by the aforementioned Working Group for the Low-carbon strategy and an independent review of the Annual Report of the Slovak Republic submitted yearly on January 15 according to the Article 3(1) of Decision 280/2004/EC concerning a mechanism for monitoring Community greenhouse gas emissions and for implementing the Kyoto Protocol. This review is performed on yearly basis by independent experts from the European Commission.

Furthermore, the Coordination Committee as part of an “internal” examination of current climate change policies submits on the regular basis to the Government for its consideration the Report on the Current State of Fulfilment of the International Climate Change Policy Commitments of the Slovak Republic.[2] The Report adopted by the Governmental Resolution No. 261[3] also includes a separate chapter Current State of Fulfilment of Reduction Commitments of the Slovak Republic under the Kyoto Protocol[4], which informs the Government in detail on the state of fulfilment of our reduction commitments based on the information from the most recent available GHG emission inventories. When it is necessary and based on the report, governmental or ministerial resolutions can be adopted to carry out specific tasks to further regulate or enhance fulfilment of our climate change commitments.

4.2.2 Overall Policy Context

Overall policy framework for developing mitigation policies in the Slovak Republic consists of national conceptual and strategic sectoral documents as well as European strategies and climate related policies. Detailed description of the policies and measures on the EU level is presented in the Sixth National Communication of the EU on Climate Change and the EU´ First Biennial Report.

4.2.2.1 Policy Context on the EU level

a) Strategy EUROPA 2020

Europe 2020 is a new ten year growth strategy and builds upon the lessons learnt from the Lisbon Strategy. The main objective of the Europe 2020 is to deliver ‘smart, sustainable, inclusive growth’ as a result of greater coordination of both national and European policy. The three priorities of the Europe 2020 strategy are outlined in Communication Europe 2020.[5] A strategy for smart, sustainable and inclusive growth includes:

- Smart growth- developing an economy based on knowledge and innovation.
- Sustainable growth- promoting a more resource-efficient, greener and more competitive economy.
- Inclusive growth-fostering a high employment economy delivering social and territorial cohesion.

b) Climate and Energy Package

In December 2008, the European Parliament and the European Council agreed on the EU Climate and Energy Package, which for the first time provided an integrated and ambitious package of policies and measures to tackle climate change together with renewable energy sources and energy efficiency elements. The Climate and Energy Package was formally adopted in 2009. It includes aforementioned 20-20-20 targets.

In order to meet the key targets and objectives, the Climate and Energy Package comprises four pieces of complementary legislation:[6]

- Directive revising the EU Emissions Trading Scheme (EU ETS), which covers some 40% of EU greenhouse gas emissions;
- Effort-sharing Decision setting binding national targets for emissions from sectors not covered by the EU ETS;
- Directive setting binding national targets for increasing the share of renewable energy sources in the energy mix;
- Directive creating a legal framework for the safe and environmentally sound use of carbon capture and storage technologies. Carbon Capture and Storage Directive.

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2 Správa o priebežnom stave plnenia prijatých medzinárodných záväzkov SR v oblasti politiky zmeny klímy
3 http://www.rokovanie.sk/File.aspx/ViewDocumentHtml/Uznesenie-12583?prefixFile=u_
4 Aktuálny stav plnenia prijatých redukčných záväzkov SR podľa Kjótskeho protokolu
5 COM (2010) 2020 Final
6 http://europa.eu/rapid/press-release_IP-09-628_en.htm

c) Roadmaps 2050

In 2011, the European Commission launched three roadmaps to promote the discussion on the long-term framework of climate and energy policies in Europe:

- The Roadmap for Moving to a Competitive Low Carbon Economy in 2050;[7]
- The Roadmap to a Single European Transport Area - Towards a Competitive and Resource Efficient Transport System;[8]
- The Energy Roadmap 2050.[9]

The European Council reconfirmed in February 2011 that the objective of the EU is to reduce GHG emissions in the EU by 80 to 95% below 1990 levels by 2050, as part of the effort by developed countries as a group to reduce their emissions by a similar degree. Although the EU is already committed to GHG emission reductions of at least 20% below 1990 levels by 2020 as part of the Climate and Energy Package, longer-term policies are now required to ensure that the ambitious reduction target for 2050 is achieved. The European Commission has therefore published the Communication: Roadmap for moving to a competitive low-carbon economy in 2050, providing guidance on how the EU can decarbonise its economy.

d) 7th Environmental Action Programme

Since the 1970s, the Environment Action Programmes have provided the foundation in the development of EU environmental policy. In July 2012, the 6th Environment Action Programme expired. A political agreement on a new General Union Environment Action Programme to 2020 (titled Living Well, Within the Limits of Our Planet) was reached between the European Commission, the European Parliament and the Council in June 2013. The 7th EAP,[10] as proposed by the European Commission in 2012, provides an overarching framework for environmental policy (without any specific objectives for climate policy embedded as this policy is nowadays a separate policy area) for the next decade, identifying nine priority objectives for the EU and its Member States:

- To protect, conserve and enhance the European Union's natural capital.
- To turn the European Union into a resource-efficient, green and competitive low-carbon economy.
- To safeguard the European Union's citizens from environment-related pressures and risks to health and wellbeing.
- To maximise the benefits of the European Union's environment legislation.
- To improve the evidence base for environment policy.
- To secure investment for environment and climate policy and get the prices right.
- To improve environmental integration and policy coherence.
- To enhance the sustainability of the European Union's cities.
- To increase the European Union's effectiveness in confronting regional and global environmental challenges.

4.2.2.2 Policy Context on National Level

a) The National Reform Programme - it is national and regularly updated programme with the main goal to meet structural policy objectives of the EU 2020 Strategy. It comprises also the Action Plan with targeted policies for particular sectors including dedicated financial allocations.

b) National Sustainable Development Strategy of the Slovak Republic - approved by the Government and the National Council of the Slovak Republic 10 years ago, contains 16 principles, 40 criteria, 10 integrated targets, 28 strategic targets and 236 measures. It consists of the environmental part, which nowadays constitutes the current National Environmental Strategy.

Additional national concepts and strategic documents, programs and action plans, which are new or have been updated and which represent either direct or indirect instruments for implementation of mitigation measures are further presented in specific sectoral sections.

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7 COM (2011) 112 final
8 COM (2011) 144 final
9 COM(2011) 885/2
10 COM (2012) 710 final

4.3 ADDITIONAL INFORMATION REQUIRED UNDER ARTICLE 7(2) OF THE KYOTO PROTOCOL AND CROSS-CUTTING POLICIES AND MEASURES (PAMS)

The following section contains information in accordance with the UNFCCC Decision 15/CMP.1, and contains supplementary information required under Article 7 paragraph 2 of the Kyoto Protocol regarding:

- Use of Kyoto flexible mechanisms (Section 4.3.1).
- Supplementarity relating to the mechanisms pursuant to Articles 6, 12 and 17 (Section 4.3.2).
- Policies and measures in accordance with the Article 2 of the Kyoto Protocol (Section 4.3.3).
- Policies and measures promoting sustainable development in accordance with Art. 2 (1) of the Kyoto Protocol (sub-section 4.3.3.1).
- Minimisation of adverse impacts in accordance with the Article 2(3) of the Kyoto Protocol (sub-section 4.3.3.3).

4.3.1 Use of the Kyoto Flexible mechanisms by the Slovak Republic

According to the current trends of GHG emissions the Slovak Republic does not intend to use units generated with JI and CDM mechanisms for meeting its reduction commitments. Slovakia sold some part of unused AAUs in 2013 according to the Article 17 of the Kyoto Protocol. The revenues from AAUs trade are incomes for the Environmental Fund (Act No. 414/2012 Coll.). In conformity with Act 414/2012 Coll. and taking advantage of existing surplus of AAUs units and current trend in the generation of emissions, the Slovak Republic has made in 2013 the sale of 7 million tons of AAUs. The revenues would be used for industrial energy efficiency projects, renewable energy projects and residential energy efficiency projects under SlovSEFF Greening Programme.

4.3.2 Supplementarity Relating to the Mechanisms Pursuant to Articles 6, 12, 17

This chapter provides information on institutional and financial arrangements and decision making rules to coordinate and support activities related to mechanisms under Articles 6, 12 and 17 of the Kyoto Protocol, including the participation of legal entities.

The Slovak Republic is currently the beneficiary for only one JI project ERUPT no. 2002/CC/01 Disposal of landfill gas in the Slovak Republic. The objective of this project is to catch and dispose of or to recover for energy methane from eight landfills in the country.

Considering the composition of landfills the collected gas is incinerated because its energy recovery is limited by specific composition of landfills. For that reason the expected decrease in emissions determined within the preparatory phase of the project was not reached.

The Slovak Republic has published on the UNFCCC website the National Guidelines and Procedures of the Slovak Republic for Approving Article 6 Projects.[11]

During the first commitment period of the Kyoto Protocol the Slovak Republic as a host country for the Joint Implementation Projects under Article 6 will only apply for Track 2 procedure according to the JI guidelines.

According to the Article 26(2)(b) of the Act No. 414/2012 Coll. on trading with emission allowances all installations in the EU emission trading scheme can also use during the third trading period the CERs and ERUs up to the level set in Commission Regulation 1123/2013/EU of November 8, 2013 on the determining international credit entitlements pursuant to Directive 2003/87/ES of the European Parliament and of the Council.

The using of CERs and ERUs has to be in accordance with Article 11 of the Act No. 414/2012 Coll. on trading with emissions allowances.

The Green Investment Scheme was formally approved in December 2009 as an instrument supporting projects and programs aiming at further reduction of GHG emissions funded through the revenues from the sale of AAUs surplus.

Table 4.1: Quantitative contribution of Kyoto flexible mechanisms for the first commitment period

Kyoto flexible mechanism	Total projected quantities for the first commitment period [Gg CO_2 equivalent]
Total for all Kyoto mechanisms	42 000 Gg CO_2 equivalent
International emissions trading	41 500 Gg CO_2 equivalent
All project based activities	
Joint implementation	500 Gg CO_2 equivalent
Clean development mechanism	

Source: MoE

We expect zero contribution according to the current GHG emission trends. No specification on budget for the Kyoto flexible mechanisms has been approved in Slovakia. The Slovak Republic has signed Memorandum of Understanding on the JI and emission trading mechanisms with The Netherlands, Austria and Denmark.

Description of Planned, On-Going and Completed Clean Development Mechanism and Joint Implementation Projects' Activities

Information about on-going JI project activities: Joint Implementation project Landfill gas recovery in the Slovak Republic:

- Host country is the Slovak Republic.
- Project is developed under the ERUPT scheme: Project developer - BGP Engineers B.V., Loopkantstraat 45, 5400 AB UDEN, The Netherlands, Project implementing organization - Terrasystems, s.r.o., Povstalecká 18, 974 00 Banská Bystrica, Slovak Republic.
- Project type: Waste - landfill gas recovery project (4 landfills).
- Status: terminated.
- Lifetime:
    - Date of official approval: December 2003, the final agreements between the Netherlands Government and the project implementer were finalized.
    - Date of project initiation: the preparatory works have started in January 2004.
    - Expected date of project duration: 2005-2012.
    - Crediting period: 5 years (2008-2012).
    - Date of ERUs issuance: no issuance yet.
- Second track approval procedure (for joint implementation projects only).
- Projected total and annual emissions reductions that accrue until the end of the first commitment period.
- The total acquired amount of ERUs (calculated amount was 617 632 t) will depend on real reduction in the period of 2008-2012 and will be the subject of JISC consideration.

Table 4.2: Planned and realised emission reductions for JI project

Emission Reduction (tonnes CO_2 eq. per year) – as per 30 June 2004		
Year	Envisaged scenario	Realised reductions*
2004	0	0
2005	81.572	0
2006	90.751	0
2007	99.902	0
	272.225	0
2008	108.47	0
2009	116.492	0
2010	124.005	0
2011	131.039	0
2012	137.626	0
Total	*617.632*	0

*Source: MoE; Note: * Calculation of realized reduction was not closed yet.*

So far, the Dutch side has not asked the Slovak Republic for issuance of ERUs within the specified timeframe, so it is not possible to proceed with the issuance of certified units.

4.3.3 Policies and Measures in Accordance with the Article 2 of the Kyoto Protocol

4.3.3.1 Policies and Measures Promoting Sustainable Development in Accordance with Art. 2 (1) of the Kyoto Protocol

Sustainable development is an overarching objective of the European Union and is set out in the founding treaty; therefore it has a reach on all policies and activities of the EU and its member states. Priority actions should be more clearly specified in future. Governance, including implementation, monitoring and follow-up mechanisms should be reinforced, for example through clearer links to the EU 2020 Strategy and other cross-cutting strategies.

4.3.3.2 Policies and Measures Related to Bunker Fuels in Accordance with the Article 2(2) of the Kyoto Protocol

Policies and measures relating to bunker fuels are described in Annex 1 - the EU´ 1st Biennial Report, in section [BR1] 4.4.14 – International maritime transport and for aviation in section [BR1] 4.2.2 – EU Emissions Trading Scheme.

4.3.3.3 Minimisation of Adverse Impacts in Accordance with the Article 2(3) of the Kyoto Protocol

Legislative Background:

- Kyoto Protocol - Article 3.14 requires Annex I countries to implement their GHG emission reduction commitments in a way to minimize the adverse social, environmental and economic impacts on developing country Parties, particularly those listed in Article 4.8 and 4.9 of the Convention.

- Decision 15/CMP.1 – paragraphs 23 – 26 in Article 3.14 and Article 7.1 provide further guidelines and focus the reporting commitments towards the following points:

a) The progressive reduction or phasing out of market imperfections, fiscal incentives, tax and duty exemptions and subsidies in all greenhouse gas emitting sectors, taking into account the need for energy price reforms to reflect market prices and externalities, in pursuit of the objective of the Convention.
b) Removing subsidies associated with the use of environmentally unsound and unsafe technologies.
c) Cooperating in the technological development of non-energy uses of fossil fuels, and supporting developing country Parties to this end.
d) Cooperating in the development, diffusion and transfer of less greenhouse-gas emitting advanced fossil-fuel technologies, and/or technologies relating to fossil fuels that capture and store greenhouse gases, and encouraging their wider use; and facilitating the participation of the least developed countries and other Parties not included in Annex I of the UNFCCC in this effort.
e) Strengthening the capacity of developing country Parties identified in Article 4, paragraphs 8 and 9, of the Convention for improving efficiency in upstream and downstream activities relating to fossil fuels, taking into consideration the need to improve the environmental efficiency of these activities.
f) Assisting developing country Parties which are highly dependent on the export and consumption of fossil fuels in diversifying their economies.

- Decision 22/CMP.1 – paragraphs 121 – 126 provides guidelines for review under Article 8 of the Kyoto Protocol, some of it relevant for Article 3.14.

- Decision 31/CMP.1 – provides a mandate to implement the commitments from the Article 3.14.

Introduction and Methodological Guidelines

Implementation of increasingly stringent environmental regulations and economic policies which penalize further use of environmentally harmful substances, technologies and so on might be associated with a range of side effects. It is not excluded that some of possible adverse economic effects will affect some developing and least developed countries having less means for adequate remedial response measures. The magnitudes of these potential impacts are typically given by the stringency of adopted measures, selection of the particular policy instrument, size and strength of the implementing economy relative to the world markets and also the actual macroeconomic set up of the affected developing countries.

In this chapter are identified potential channels of how domestically implemented environmental policies in the Slovak Republic might have exercised any impact on third countries. Furthermore, any existing evidence about the potential magnitudes of these effects is highlighted. Similarly, the activities in particular those related to the development aid of the Slovak Republic implemented in order to minimize the negative consequences caused by these policies are described in this chapter. The aim is to meet our commitments under the Kyoto Protocol in respect with transparent reporting on potential adverse social, environmental and economic impacts particularly on developing countries.

Adopted Legislative Measures:

a) Fiscal Policy Instruments

Fiscal policy instruments are increasingly being referred to as an efficient instrument to correct existing environmentally related price distortions. The Slovak Republic maintains excise taxes on fossil fuels, electricity and mineral oils. The actual fiscal policy drivers, however, still remain much more linked to the current governmental budgetary situation rather than to provide fiscal incentives for environmentally sound behaviour. Since 2009 only minor changes occurred such as a decrease of the excise tax on diesel, removal of existing exemptions of coal tax payers and increase of excise tax on LPG, CNG and electricity. No impact on any third countries is expected from already implemented fiscal policies and therefore no specific policies to offset any negative effects have been considered.

b) Biofuels Policy

Biofuels policy discussed in more details in chapter 4.4.5 has been in place to meet the targets required by EU legislation. Increased demand and subsequently also the production of biofuels has not only been reflected by rising commodity prices but also induced land use changes resulting from the reduction of the supply of commodities in direct competition with those used for biofuels world-wide. Therefore, international trade represents the key channel through which the potential negative economic, social and environmental impacts[12] might be transmitted towards developing countries. Taking into account the low quantities of biofuels in use in the Slovak Republic, we do not expect any negative effects neither on forests destruction or contribution to the rising world prices of agricultural commodities.[13] Despite its rather low contribution to these developments, the Slovak Republic actively contributes to shaping the international sustainability standards either within its own (and EU internal) legislation process or within the framework of international institutions, such as WTO, FAO, etc. Furthermore, the Slovak Republic has been actively engaged in strengthening the know-how on improving food security and agriculture, land and water management in Kenya. Moreover, scholarships for students from developing countries were offered with preference to those applying to pursue their studies in environmental sciences.

c) GHG Reduction Policies

The key policy option was a development of emerging carbon market with resulting carbon price. Among the complementary policies, targets have been adopted to increase the share of renewable energy resources, increase energy efficiency as well as the new legislation which sets more stringent quality standards for fuels and personal cars.

Adopted policies could have had some implications for third countries either through the underlying carbon market price mechanisms or requirements to comply with new and tighter environmental regulations. CO_2 emission trading (either EU ETS or Kyoto Protocol emission trading) and increasingly stringent fuel quality standards might have some impact. The major example of its direct impact on the third countries is the integration of aviation sector into the trading scheme. Among indirect effects, the major example is the concern about a possible carbon leakage. Most of the impacts of carbon leakage (shifts of industrial activity to the countries without any GHG emission reduction commitments, potential downward pressure on oil prices, etc.) on the third countries would in fact be rather positive for them.[14] Measures in place to minimize a potential carbon leakage include the provision to enlist economic sectors facing immediate threat of carbon leakage, which will under given conditions continue receiving their CO_2 allowances for free.

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12 Implied excessive land use changes, food shortages or compromised food security.

13 Please note that the different conclusion might be drawn when considering the implications of the overall EU biofuel policies. Similarly this would also apply in considering the existing agricultural policies within the EU Common Agricultural policy.

14 In some specific cases, where the polluting entity seeking a location in developing country causing an increase of local pollution, increased environmental damage might outweigh economic benefits.

Furthermore, increasingly stringent fuel quality standards in Europe might in fact turn out to be positive impact because it might trigger increase of investments in the fuel processing industries in third countries. Rising fuel prices in Europe due to the carbon price (or tax) and quality increase might counter play the rising oil prices particularly due to increasing scarcity of this commodity. Such effects might on the one hand negatively affect revenues of the oil exporting countries, which can be on the other hand still balanced by rising demand from the rest of the world. The final net impact will depend on the benefits derived from expansion of industrial production and costs needed to clean up higher levels of pollution including addressing its consequences.

Apart to emission trading, no other Kyoto Protocol flexible instruments have been used to meet the GHG emission reduction targets by the Slovak Republic, therefore no impact on third countries in this respect is reported.

Activities considered within the preparation of the adaptation strategy to climate change have a local character without any implications to third countries.

4.4 CROSS-SECTORAL POLICIES AND MEASURES

Cross-sectoral policies and measures comprise:

- EU Emissions Trading Scheme;
- Effort Sharing Decision;
- Carbon Capture and Storage Directive;
- Taxation of Energy Products and Electricity;
- National Emission Ceilings Directive.

For detailed description of these policies refer to the1st Biennial Report of the Slovak Republic, in section BR1 - 4.2 Cross-cutting Policies and Measures. Quantifications of the PaMs' impacts on GHG emission reduction are given in the CTF Table 3.

4.5 SECTORAL POLICIES AND MEASURES: ENERGY AND TRANSPORT

Majority of policies within this sector presented in the Fifth National Communication of the Slovak Republic on Climate Change (2009) are still relevant and briefly presented with some new measures below.

- Act No. 414/2012 Coll. on emission trading as amended – governs emissions trading, the new allocation rules and principles;
- National Action Plan for Biomass use, Resolution of the Government of the Slovak Republic adopted as Act No. 130/2008 Coll.;
- National Renewable Energy Action Plan, adopted as Resolution of the Government of the Slovak Republic No. 677/2010 Coll.;
- Concept on Energy Efficiency in Buildings by 2010 overlooking to 2020, Resolution of the Government of the Slovak Republic No. 336/2012 Coll.;
- Act No. 258/2011 Coll. on carbon dioxide capture and geological storage in the geological environment;
- Regulation of the Government of Slovak Republic No. 242/2008 Coll. amending the Regulation of the Government No. 583/2006 Coll. on technical requirements for reduction of emissions of pollutants from diesel engines and spark-ignition engines driven by CNG or LPG;
- Act No. 158/2011 Coll. on support of energy-saving and environmental vehicles;
- Current state of transport and transport performance is identical with the transportation forecast until 2030 (in line with the documents from the Ministry of Transport, Construction and Regional Development of the Slovak Republic);
- Technology of road vehicles is in compliance with EURO 5 standards;
- Increasing share of biofuels (biodiesel in diesel and bioethanol in gasoline) up to 8.5% by 2020 to the reference value share on final energy consumption of biofuels in transport according to the Act No 492/2010 Coll. on mineral oil tax;
- Regulation 510/2011/EU on setting emission performance standards for new light commercial vehicles as part of the Union's integrated approach to reduce CO_2 emissions from light-duty vehicles;
- Action Plan for Energy Efficiency 2008-2010, Resolution of the Government of the Slovak Republic No. 922/2007 Coll.;
- Action Plan for Energy Efficiency 2011-2013, Resolution of the Government of the Slovak Republic No. 301/2011 Coll.;
- Energy Security Strategy of the Slovak Republic, Resolution of the Government No. 732/2008 Coll.;
- Act No. 137/2010 Coll. on air protection;
- Decree of Ministry of Environment No. 271/2011 Coll. on sustainability criteria;
- Efficient utilisation of energy regulated by the Act No. 476/2008 Coll.;
- Labelling of energy-related products regulated by the Act No 182/2011 Coll.

4.6 SECTORAL POLICIES AND MEASURES: INDUSTRY

- Act No. 414/2012 Coll. on emission trading in amendments - nitric acid production. The implementation of secondary catalyst at nitric acid production;
- Act No. 414/2012 Coll. on emission trading in amendments - aluminium production;
- Regulation on certain fluorinated greenhouse gases (F-gas Regulation 842/2006/EC);
- Proposed revision of the F-Gas Regulation;
- Emissions from air conditioning systems in motor vehicles (MAC-Directive 2006/40/EC).

Detailed description of these policies and measures is presented in the 1st Biennial Report of the Slovak Republic, in section BR1 - 4.4 Sectoral Policies and Measures: Industrial processes. Quantifications of the PaMs' impacts on GHG emission reduction are given in the CTF Table 3.

4.7 SECTORAL POLICIES AND MEASURES: AGRICULTURE

- Ordinance of the Government of the Slovak Republic No. 488/2010 Coll. on conditions for granting subsidies in agriculture through direct payments;
- Common Agricultural Policy;
- Nitrates Directive;
- Decree of Ministry of Agriculture and Rural Development of the Slovak Republic No. 362/2010 Coll.

All the aforementioned PaMs were included in modelling of emission scenarios and projections in the Slovak Republic. Synergy effects of PaMs have been reflected in modelling.

Detailed description of these policies and measures is presented in the 1st Biennial Report of the Slovak Republic, in section BR1 - 4.5 Sectoral Policies and Measures: Agriculture. Quantifications of the PaMs' impacts on GHG emission reduction are given in the CTF Table 3.

4.8 SECTORAL POLICIES AND MEASURES: WASTE

- Act No. 409/2006 Coll., which consolidates Waste Act No. 223/2001 Coll. and its previous amendments

Detailed description of these policies and measures is presented in the 1st Biennial Report of the Slovak Republic, in section BR1 - 4.6 Sectoral Policies and Measures: Waste. Quantifications of the PaMs' impacts on GHG emission reduction are given in the CTF Table 3.

4.9 POLICIES AND MEASURES NO LONGER IN PLACE

None of PaMs with significant effect on GHG emission reduction have been cancelled without replacement. Act 572/2004 Coll. on emission trading and its previous amendments has been fully replaced by the Act No. 414/2012 Coll. on emission trading in amendments.

4.10 INTERACTIONS OF POLICY AND MEASURES

Table 4.3 shows how can selected policies and measures contribute to non-GHG emission mitigation.

Table 4.3: Summary table of indirect benefits for selected PaMs

No	Name of PAMs	Description of policy interaction	Non-GHG emission mitigation benefits of policies and measures
1	Act No. 414/2012 Coll. on emission trading in amendments - new allocation principles and rules	Increase biomass use in fuel mix	Reduction of CO and SO_2 pollutants
2	National action plan for biomass use, Government Resolution No. 130/2008	Increase biomass use in fuel mix	Reduction of CO and SO_2 pollutants
3	National Renewable Energy Action Plan, Government Resolution No. 677/2010	Increase biomass use in fuel mix	Reduction of CO and SO_2 pollutants in district heat supply sector
4	Concept on Energy Efficiency in Buildings by 2010 overlooking to 2020, Governmental Resolution No. 336/2012 Coll.	Increase biomass use in fuel mix	Reduction of CO and SO_2 pollutants in district heat supply sector
5	Act No. 158/2011 on support for energy-saving and environmental vehicles	Reduction of motor fuels demand	Decrease of NO_x and PM
6	Act. No. 309/2009 Coll. on promotion of renewable energy sources and high efficiency cogeneration	Decrease in fossil fuel consumption, support for biomass use in fuel mix for heat supplying	Reduction of CO and SO_2 pollutants in district heat supply sector
7	Act. No. 656/2004 Coll. on energy industry	Energy savings, decrease in fossil fuel consumption	Positive impact on reduction of basic air pollutants emissions
8	Action Plan For Energy Efficiency 2008-2010, Government Resolution No. 922/2007 Coll.	Energy savings, decrease in fossil fuel consumption	Positive impact on reduction of basic air pollutants emissions
9	Action Plan For Energy Efficiency 2011-2013, Government Resolution No. 301/2011 Coll.	Energy savings, decrease in fossil fuel consumption	Positive impact on reduction of basic air pollutants emissions
10	Act No. 137/2010 Coll. on air quality	Strict emission limits for air pollutants, BATNEEC principles for stationary combustion sources	Positive impacts on CO_2 emission reduction
11	Decree of Ministry of Environment No. 271/2011 Coll. - sustainability criteria	Principles for GHG emission savings during the life cycle for biofuel and bioliquid production, saving of conventional motor fuels	Above reduction of GHG emissions from motor fuel production is also the decrease of NO_x and PM in transport sector.
12	Act No. 476/2008 Coll. on efficient use of energy	Energy savings, decrease in fossil fuel consumption	Positive impact on reduction of basic air pollutants emissions
13	Act No 182/2011 Coll. on labelling of energy-related products	Energy savings, decrease in fossil fuel consumption	Positive impact on reduction of basic air pollutants emissions

Source: MoE, SHMI

To describe interactions of PaMs we can use emission trading as an example, which is a typical cross-cutting measure. Installations included in the EU ETS comprise heat and electricity producers as well as industrial operators. Cap and trade principle, rules for allocations and provisions as given in the Directive 2003/87/EC and on national level in the Act No. 414/2012 Coll. on emission trading as amended have positive impacts on:

- energy savings,
- increase in energy security,
- fuel switching towards less carbon intensive fuel types, including biomass,
- savings of raw material,
- looking for available technological innovations and improvements,
- decrease in air pollution,
- other benefits.

Similarly other policies and measures with wide sectoral applications, for example National action plan for biomass use[15], National Renewable Energy Action Plan[16] or Concept on Energy Efficiency in Buildings by 2010 overlooking to 2020[17], have significant benefits and positive impacts on other environmental and energy goals.

15 Adopted by the Governmental Resolution No. 130/2008
16 Governmental Resolution No. 677/2010 Coll.
17 Governmental Resolution No. 336/2012 Coll.

05

Projections and the Total Effects of Policies and Measures

5.1 OVERALL CONTEXT

Since the publication of the 5th National Communication of the Slovak Republic on Climate Change, some of measurers considered in this communication were implemented in different extent and influenced the GHG emission level of projection base year 2010. Since the end of 2008, the global economic has caused a temporary decrease in economy and production volumes. The level of projected emissions for followed scenarios were determined by assumptions of macro-economic development, main strategies adopted for achievement of specific goals and targets as well as by implemented legal and regulatory framework to mitigate GHG emissions.

Complexity and dynamic changes of economic development in recent years have impacted significantly also the projections of greenhouse gas emissions, particularly with respect to continual changes of forecasts for macro-economic indicators for near future. Impact of changes in economic indicators on emission scenarios has been followed using sensitive analysis. Long-term development of greenhouse gas emissions depends also on other parameters, such as opening of energy market and emission allowance trading. EU ETS represents one of the measures that were implemented before the projection base year and its impact is partly included in scenario without measure. Possibilities and options to achieve the reduction target under the second commitment period of the Kyoto Protocol as well as the potential for further reduction up to the year 2030 were tested in modelled projection scenarios.

5.1.1 Scenarios for Projections

Detailed description of emission scenarios presented in the National Communication is given in the Section BR1 – 5.1.2 of the 1st Biennial Report of the Slovak Republic.

5.1.2 Key Parameters and Assumptions

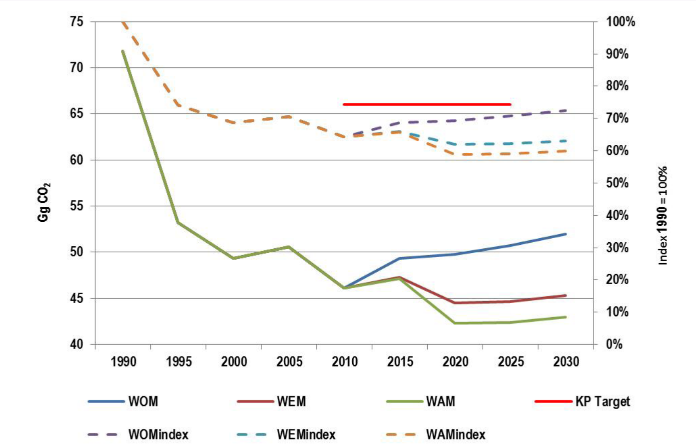
For an introduction of key parameters and assumptions underlying each of the scenarios, please refer to Section BR1 – 5.1.3 of the 1st Biennial Report of the Slovak Republic.

5.2 PROJECTIONS

Figure 5.1 shows historical and projected data for total aggregate GHG emissions according to three scenarios for period 1990-2030. Trends of curves indicate that our reduction target under the Kyoto Protocol for the second commitment period is alredy achievable in the WEM scenario.
The measures used in the WEM and WAM scenarios have influence on GHG reductions only until 2020. We have used linear model and therefore after 2020 GHG emissions are slowly increasing due to expected economic growth which was considered. Projections after the year 2020 neither in WEM nor in WAM still do not reflect any positive impact of reduction measures due to the fact that energy and climate policy framework by 2030 in the Slovak Republic as well as the EU is still only on the preparation. This framework would include mitigation policies and measures and will be reflected in the next Biennial Report of the Slovak Republic.

For the presentation of the greenhouse gas emission projections, please refer to Section BR1 – 5.2 of the 1st Biennial Report of the Slovak Republic.

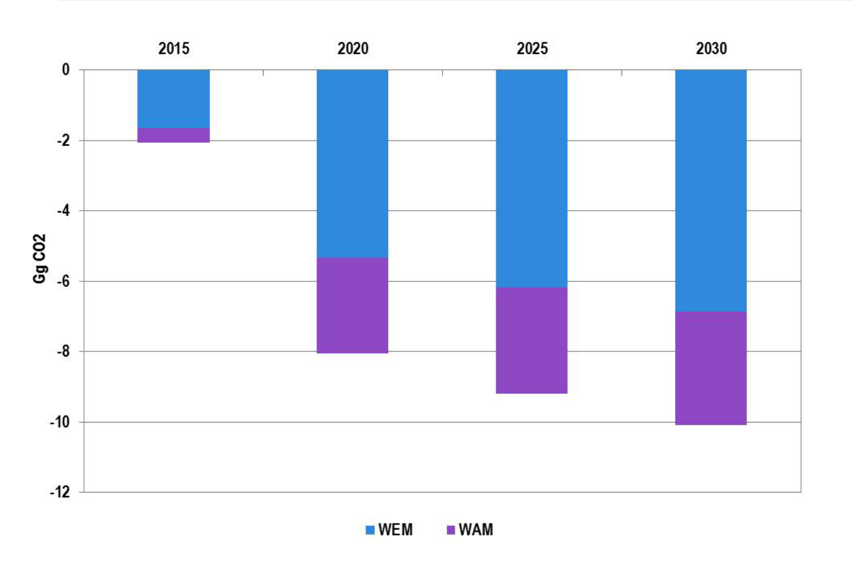
Figure 5.1: Projections of aggregated GHG emissions according to defined scenarios in the followed sectors



5.3 ASSESSMENT OF AGGREGATE EFFECTS OF POLICIES AND MEASURES

Total aggregated effect of policies and measures which are described in the Chapter 4 and Chapter BR1 – 4 can be summarised for the “with existing measures (WEM)” and “with additional measures (WAM)” scenarios and is presented in the Figure 5.2.

Figure 5.2: Total aggregate effect of policies and measures in WEM and WAM scenarios

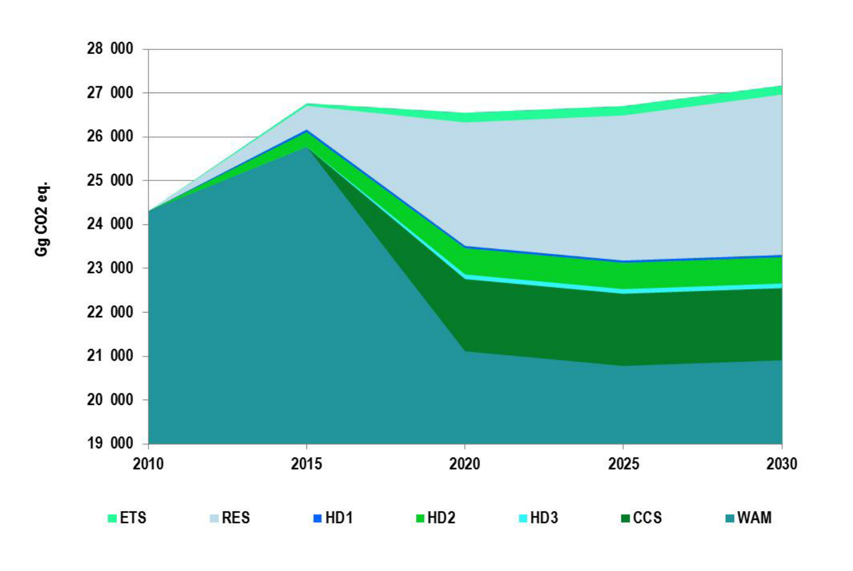


In following tables and figures are presented total effects of sectoral policies and measures as described in the Chapter 4 for WEM and WAM scenarios. Data are given for cross years in absolute terms (Gg CO_2 eq.).

Table 5.1: Impact of measures in energy sector including transport

Measure	Type of measure	Status	Green house gas	Scenario	2015	2020	2025	2030
					Gg CO_2 eq.			
Act No. 414/2012 Coll. on Emission Trading in amendments - Emissions Trading, the new allocation	economic regulative	implemented	CO_2, CH_4, N_2O	WEM	56.42	221.08	213.72	208.15
National action plan for biomass use, Government Resolution of SR No. 130/2008 - NAP Biomass of SR	regulative	implemented	CO_2, CH_4, N_2O	WEM	15.25	1865.37	1860.59	1860
National Renewable Energy Action Plan, Government Resolution of SR No. 677/2010 - Wind, Geothermal and PV	regulative	implemented	CO_2, CH_4, N_2O	WEM	526.01	950.37	1447.13	1794.39
Concept on Energy Efficiency in Buildings by 2010 overlooking to 2020, Governmental Resolution of the SR No. 336/2012	economic regulative	implemented	CO_2, CH_4, N_2O	WEM	389.93	649.87	649.86	649.83
	economic regulative	planned	CO_2, CH_4, N_2O	WEM	5.84	105.28	105.28	105.30
Act No. 258/2011 on carbon capture storage to the geological environment	regulative	planned	CO2	WEM	0.00	1646.49	1646.49	164.49
Regulation of the Government of SR No 242/2008 Coll. amending the Regulation of the Government SR No 583/2006 Coll. on technical requirements for reduction of emissions of pollutants from CI engines and SI engines driven by natural gas or liquefied petroleum gas.	regulative	implemented	CO_2, CH_4, N_2O	WEM	9.25	104.08	190.97	250.21
Act No. 158/2011 on Support for Energy-Saving and Environmental Vehicles	Voluntary agreement	adopted	CO_2, CH_4, N_2O	WEM	253.40	536.69	896.37	1197.40

Figure 5.3: Impact of individual measures in energy sector (without transport) (Gg CO_2 eq.)



Measures presented in the Figure 5.3 comprise:

- EU ETS – impact of emission trading scheme in the period 2013-2020.
- Renewable energy sources – impact of implementation of target for renewable energy sources.
- Heat demand measures (HD1, HD2 and HD3 in Table 5.2) – step by step impacts of demand side measures in heat supply (see Table 5.2). Reduction level HD2 in the table represents the WEM scenario, HD3 represents the WAM scenario reduction.
- Carbon capture and storage – its impact of on thermal power plants accompanied with new modern technology of electricity generation.

Table 5.2: Impact of heat demand decrease measures HD1, HD2 and HD3 (Gg CO_2 eq.)

Year	2015	2020	2025	2030	Scenario
Step	CO_2 (Gg eq.)				
HD1	61	52	52	51	WEM
HD2	330	599	599	599	WEM
HD3	6	105	105	105	WAM

Table 5.3: Impact of measures in industry sector (Gg CO_2 eq.)

Measure	Type of measure	Status	Green house gas	Scenario	2015	2020	2025	2030
					CO_2 (Gg eq.)			
Act No. 414/2012 Coll. on Emission Trading in amendments - nitric acid production	regulative	implemented	N_2O	WEM	270.9	784.3	784.3	784.3
Act No. 414/2012 Coll. on Emission Trading in amendments - aluminium production	regulative	implemented	PFC	WEM	4.46	4.46	4.46	4.46

Table 5.4: Impact of measures in the agriculture sector (Gg CO_2 eq.)

Measure	Type of measure	Status	Green house gas	Scenario	2015	2020	2025	2030
					CO_2 (Gg eq.)			
Ordinance of the Government of the SR No. 488/2010 Coll. on conditions for granting subsidies in agriculture through direct payments - Manure management	economic regulative	implemented	CH_4	WEM	61.55	84.76	99.35	117.11
	economic regulative	adopted	CH_4	WAM	25.46	32.41	33.26	31.75
Ordinance of the Government of the Slovak Republic No. 488/2010 Coll. on conditions for granting subsidies in agriculture through direct payments - Agriculture Soils	economic regulative	implemented	N_2O	WEM	151.28	184.71	211.16	251.18
	economic regulative	adopted	N_2O	WAM	19.36	29.44	26.41	22.46
Ordinance of the Government of the Slovak Republic No. 488/2010 Coll. on conditions for granting subsidies in agriculture through direct payments - Animal production	economic regulative	implemented	CH_4	WEM	5.61	72.18	89.53	114.85
	economic regulative	adopted	CH_4	WAM	92.62	127.84	117.48	101.46

Table 5.5: Impact of measures in the LULUCF sector (Gg CO_2 eq.)

Measure	Type of measure	Status	Green house gas	Scenario	2015	2020	2025	2030
					CO_2 (Gg eq.)			
The Rural Development Programme for the period of 2014 - 2020	economic regulative	adopted	N_2O, CH_4	WAM	15.51	243.27	184.36	122.45

Table 5.6: Impact of measures in the waste management sector (Gg CO_2 eq.)

Measure	Type of measure	Status	Green house gas	Scenario	2015	2020	2025	2030
					CO_2 (Gg eq.)			
Act No. 409/2006 - complete text of the Act. 223/2001 on Waste	economic regulative	implemented	N_2O, CH_4	WEM	169.29	403.89	629.49	828.43

Chapters BR1 - 4.3 – 4.8 contains description of quantitative assumptions applied for above listed measures when using for modelling in the WEM and WAM scenarios.

5.4 SENSITIVITY ANALYSIS

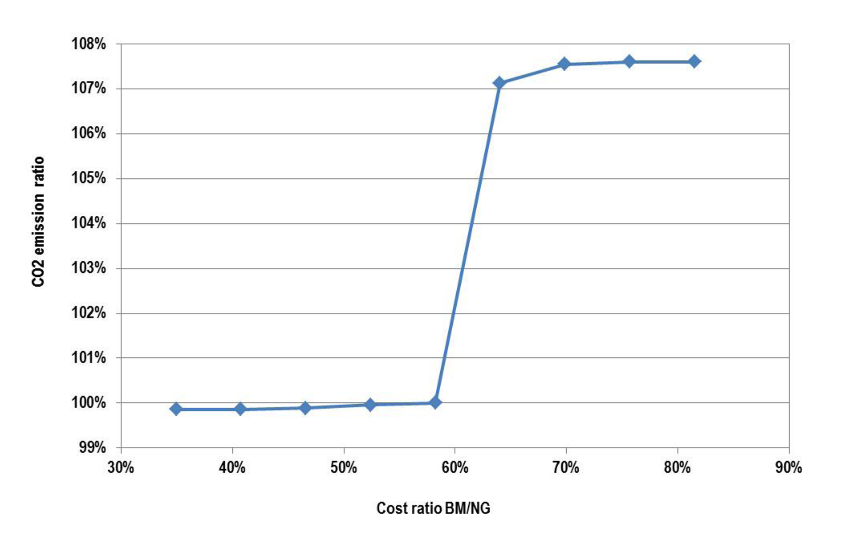
5.4.1 Sensitivity Analysis for Selected Parameters

There are two parameters which can possibly influence biomass penetration into the fuel mix:

- Ratio of biomass /natural gas fuel prices;
- Ratio of investment costs for new boilers with biomass combustion compared to this used for modelling, i.e. 360 EUR/kW.

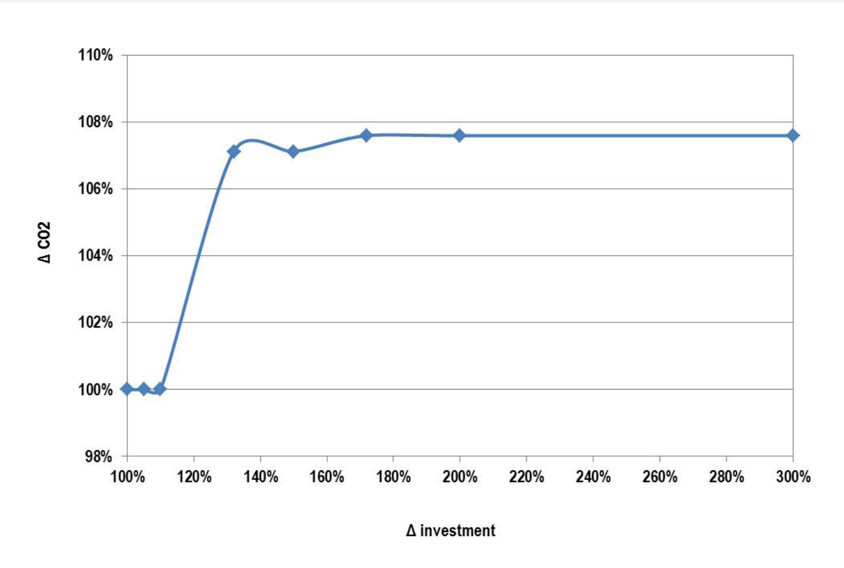
Figure 5.4 illustrates impact of biomass/natural gas fuel cost ratio on the level of CO_2 emissions.

Figure 5.4: Sensitivity analysis showing the impact of biomass/natural gas (BM/NG) fuel costs



The level of 70% for the biomass/natural gas fuel costs ratio limits the space of penetration for new biomass sources. This is also the maximum level for possible decrease of CO_2 emissions. Higher shares are inefficient neither from economic nor from environmental perspective. Similar is the effect of increase of investment costs for new boilers. Results are shown in the Figure 5.5.

Figure 5.5: Sensitivity analysis showing impact of boiler investment costs



Increasing the investment cost to the level of 172%, the biomass source penetration achieved their penetration limit in the energy-heat production mix.

5.5 SUPPLEMENTARITY RELATING TO MECHANISM UNDER ARTICLES 6, 12 AND 17 OF THE KYOTO PROTOCOL

For the information on supplementarity related to the flexible mechanisms of the Kyoto Protocol, please refer to the Section 4.3.2.

5.6 METHODOLOGY

This part shortly describes the methodology used to prepare emission projections for the 6th National Communication and the differences in comparison with the 5th National Communication's projection development.

5.6.1 Methodology for Projections

Modelling emission projections following input data and information were used:

- Updated forecasts of the GDP growth, fuel and energy carriers' prices.
- Population growth forecast from official document titled Predictions of the population development in the Slovak Republic until 2050.
- Document of the Ministry of Transport, Construction and Regional Development of the Slovak Republic titled Scenarios in the energy efficiency sector and the energy efficiency of the building sector – Annex No. 5: Summary measures of energy saving, their benefits and potential.

Outcomes from modelling were determined by the reduction potential of measures, their synergies and also by the costs of implementation. Updated figures from macroeconomic and demographic data forecasts were applied for period of 2010-2030 and increase in GDP growth rate has been reflected in gross value added figures for several industrial sectors.

Specific approaches and software modules for particular sectors were used:

- Energy (except for transport) and industry – model MESSAGE.[1]
- Transport – model TREMOVE, COPERT IV and expert software tool.
- Solvents – expert software tool.
- Agriculture – expert software tool.
- LULUCF – expert software tool.
- Waste – expert software tool.

The energy sector and particularly CO_2 emissions represent the majority of national GHG emission balance. Therefore abatement of CO_2 has the most decisive impact on the national GHG reduction target. Stationary energy sources can be divided into following groups, each of them characterized with the different nature of CO_2 abatement possibilities:

a) Electricity generation:

Large share of electricity is produced by the non-fossil energy sources such as nuclear and hydropower plants. The thermal coal power plants are used for regulation in grid. Due to the social priorities focused on ensuring the employment in coal mining sector Slovakia will still operate power plant to produce electricity by combustion of domestic lignite. The independent power producer (IPP) electricity generation is mainly operated by industrial and local combined heat and power (CHP), where heat demand represents the main driving force for generation level. The other non -fossil fuel generation units (wind, new small hydropower and PV) have only small share on total electricity generation.

Based on this fuel mix balance the apparent CO_2 emission factor in tCO_2/MWh is lower than the recommended value of the EU, as is shown on following figure for WEM scenario.

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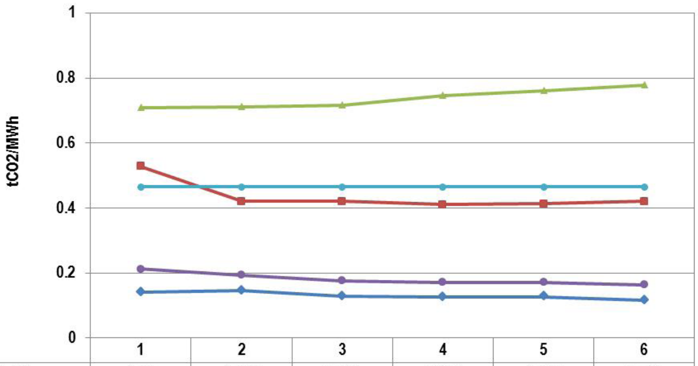
1 Detailed description of model MESSAGE was presented in the Fifth National Communication of the Slovak Republic on Climate Change and the Report on Progress in achieving the Kyoto Protocol, MŽP SR, Bratislava 2005 (www.enviro.gov.sk).

Figure 5.6: *Apparent CO_2 emission factor for electricity generation in Slovakia*



	1	2	3	4	5	6
IEF_PP	0.14	0.145	0.128	0.126	0.127	0.116
IEF_publicCHP	0.528	0.421	0.421	0.41	0.413	0.421
IEF_indCHP	0.708	0.711	0.715	0.745	0.76	0.777
IEF_Total	0.212	0.194	0.176	0.172	0.171	0.164
IEF EU	0.465	0.465	0.465	0.465	0.465	0.465

IEF_PP	*apparent emission factor for public electric utilities*
IEF_publicCHP	*apparent emission factor for public CHP*
IEF_indCHP	*apparent emission factor for industrial CHP*
IEF_Total	*apparent emission factor for electricity generation in SR*
IEF EU	*recommended emission factor by the EU for allocation of emission quotas within the EU ETS (represents the EU fuel mix)*

Future CO_2 abatement could be achieved mainly by efficient co-combustion of biomass with coal as well as by some limited penetration of PV and wind generation into the portfolio. The carbon capture and storage technology is considered for the WAM scenario as one theoretical option which is not yet considered in the electric utility business plan.

b) Oil refinery

There is only one oil refinery that is on-line connected with petrochemicals complex. The implementation of deep processing improvements in previous years resulted in increased production of light products, such as gasoline, gas oil for petrochemical application and in decrease of residual heating oil production. Consumption of residual heating oil significantly declined due the strict environmental legislation targets. The blending of fuels with biomass is applied in this refinery. CO_2 abatement for oil refinery was not considered in applied scenarios.

c) Gas utility

Natural gas demand has increased in previous period and represents the main source for heat production in public and residential sectors. CO_2 emissions and CH_4 fugitive emissions from the gas utilities are connected with the gas transmission from Eastern to Western Europe and also distribution within Slovakia. Emission level will be dependant mostly on the volume of transport and in limited scale also by the implementing of specific measures mostly at the compress stations. The mitigation measures are for example measures to prevent methane leakage from pipelines, substituting electrical ignition to gaseous ignition.

d) Metallurgy

There is one steel mill in Slovakia, US Steel Kosice. It is responsible for the largest share of CO_2 emissions for individual company. Production chain includes the coking battery, blast furnace and primary and secondary making processes of steel. The secondary gases as coking gas, blast furnace gas and converter gas originated from supplied coking coal are used in this company for CHP, technology heating, etc. Small share of coking gas is exported to other company in its neighbourhood. Company is continuously investing in technology improvement. The fuel switching is limited to the large extent by the need of secondary usage of gases. Nevertheless some changes in production activities are considered. One possibility represents the exclusion of pig iron production which should lead to impressive CO_2 emission decrease but with the large negative impact on employment and national economy. Main focus during the modelling was given to following options:

- Fuel switch and co-combustion of coal with biomass.
- Implementation of new renewable energy sources such as biomass, wind, PV and geothermal.
- Demand side measures for the heat supply.
- Carbon capture and storage for electricity production.

Ranking of individual measures and their allocation into the WEM and WAM scenarios were applied according to the installation business plan. Nevertheless, it has nothing to do with the ranking as occurred according to incremental abatement costs designed with the use of MESSAGE model. This approach was based on the following assumptions:

- Fuel price for individual fuels, based on national data.
- Fuel price escalation was based on the assumption of oil, gas and coal price escalation recommended by the European Commission for the Biennial Report 2013.
- CO_2 allowance prices were based on the European Commission's recommendation for the Biennial Report 2013.
- CO_2 abatement was calculated for the whole modelling period of 2010-2030.

The aggregated abatement costs were calculated from MESSAGE model output using the calculation formula:
$AACi = \square OF_i / \square CO_{2i}$

Where:

- AACi means aggregated abatement cost [EUR/tCO_2]
- $\square OF_i$ means difference of MESSAGE objective function between the scenarios with and without followed measures [thousand EUR]
- $\square CO_{2i}$ means difference of CO_2 emission in period 2010-2030 between the scenarios with and without measures [Gg CO_2]
- The highest level of abatement can be achieved by implementing the biomass combustion or carbon capture and storage. The carbon capture and storage technology is considered for the WAM scenario as one theoretical option which is not yet considered in the electric utility business plan.

5.6.2 Models Used for Projections

Model MESSAGE

Model MESSAGE is used for energy and industry projections. Detailed description of model MESSAGE was presented in the Fifth National Communication of the Slovak Republic on Climate Change and the Report on Progress in achieving the Kyoto Protocol.

Model TREMOVE

TREMOVE is a transport and emissions simulation model developed for the European Commission. It is designed to study effects of different transport and environment policies on the emissions of the transport sector. The model estimates the transport demand, the modal split, the vehicle fleets, the vehicle stock renewal, the emissions of air pollutants and the welfare level under different policy scenarios. All relevant transport modes are modelled, including aviation. Maritime transport is treated in a separate model. TREMOVE covers the period of 1995-2030, with yearly intervals.

TREMOVE is a policy assessment model to study effects of different transport and environment policies on the emissions of the transport sector. The model can be applied for environmental and economic analysis of different policies, such as road pricing, public transport pricing, emission standards, subsidies for cleaner cars, etc.

The broad scope of the TREMOVE model makes it possible to assess integrated environmental policy packages covering the whole of Europe and all modes. On the other hand, the level of detail is sufficient to simulate effects of country- or mode-specific measures. Welfare costs of policies are calculated taking into account costs to transport users, transport suppliers, governments as well as the general public.

The strength of TREMOVE is that it is an integrated simulation model. The model simulates, in a coherent way for passenger and freight transport, the changes in volume of transport, modal choice and vehicle choice (size & technology) relative to transport and emissions baseline.

The transport demand module describes transport flows and the users' decision making process when it comes to making their modal choice. Starting from the baseline level of demand for passenger and freight transport per mode, period, region, etc., the module describes how the implementation of a policy measure will affect the users' and company's choice between these 388 different transport types. The key assumption here is that the transport users will select the volume of transport and their preferred mode, period, region, etc. based on the generalized price for each mode, such as cost, tax or subsidy and time cost per kilometres travelled. The output of the demand module consists of passenger kilometres (pkm) and ton kilometres (tkm) that are demanded per transport type for a given policy environment. The pkm and tkm are then converted into vehicle kilometres.

The vehicle stock turnover module describes how changes in demand for transport or changes in vehicle price structure influence the share of age and type of vehicles in the stock. The output of the vehicle stock module is twofold; we split both the total fleet and the number of km for each year according to vehicle type and age.

The fuel consumption and emissions module is used to calculate fuel consumption and emissions based on the structure of the vehicle stock, number of kilometres driven by each vehicle type and driving conditions.

Model COPERT IV

GHG emissions from road transport in annual inventory are calculated by method of EMEP/CORINAIR which is included in the program product for the calculation of emissions from road transport - COPERT IV. Therefore the name of method is the same as the name of model COPERT. Besides GHG emissions, the COPERT IV model calculates emissions of all current pollutants including limited pollutants (CO, NO_2, NO_x, PM, HC), heavy metals and persistent organic pollutants, as well as exhaust and non exhaust emissions. Determination of CO_2 emissions is in principle identical with the method of IPCC tier 2 according to Good Practice Guidelines 2000.

CH_4 and N_2O emissions are calculated for individual categories of vehicles and then they are summarised in order to calculate the total amount. Emission factors for CH_4 and N_2O according to model COPERT IV are different for different fuels, different vehicles and different levels of technology. In the case of CH_4 emissions, they also depend on average speed. In version COPERT 9.0, vehicle fleet is divided into six basic categories and 241 subcategories according to the scale of city/town road and motorway operation. The calculation method makes use of technical data on individual categories and sub-categories of vehicles in combination with several parameters specific for particular country which makes use of this method.

These characteristics are as follows:

- Vehicle park structure
- Age of vehicles
- Prevailing character of the operation
- Fuel parameters
- Climate conditions
- The calculation of emissions is based on five basic parameters:
- Total fuel consumption
- Vehicle park
- Driving conditions
- Emission factors
- Other parameters

Exhaust emissions from road transport are divided in two types, which are hot emissions produced by the engine of vehicles heated on the operational temperature and cold emissions from starting cold engine. These emissions are additional. The calculation of the emissions including CO_2 and partially also N_2O is based on fuel consumption.

Complete set in program format Microsoft Excel is the output of the model according to requirements of the user. The user can process the information in standard formats.

5.6.3 Changes in Projection Methodologies

The projections in transport were prepared by the model TREMOVE and for the first time presented in this National Communication. Except this, no other significant changes in the projection methodology occurred since the 5th National Communication on Climate Change of the Slovak Republic was published.

06

Vulnerability Assessment, Climate Change Impacts and Adaptation Measures

6.1 INTRODUCTION

This chapter deals with a brief evaluation of climate change and variability in Slovakia in the period of 1881-2012 and with new climate change scenarios until 2100 (designed in 2010-2012). Furthermore, the chapter contains a review of expected impacts of climate change and variability on selected natural, social and economic sectors, assessment of vulnerability to climate change in these sectors and proposals for adaptation measures to minimize negative impacts on one hand and on the other hand to utilize positive consequences of climate change in Slovakia. The data presented here link to the Fourth and the Fifth Slovak National Communication on Climate Change (2005, 2009). Details also come from the Slovak National Climate Program, as well as from the results of numerous research projects dealing with this topic in Slovakia, the reports of the IPCC and other relevant sources. Analysis of all documents again confirms that climate change and climate variability might result in a number of negative impacts that presumably will be on increase during next decades. The analysis also shows that there are several effective solutions to mitigate potential damage caused by expected climate change.

6.2 CLIMATE CHANGE AND VARIABILITY IN SLOVAKIA IN 1881-2012

Detail climatic measurements at several meteorological stations and more than 200 precipitation gauges since 1881 has enabled us to prepare the study on climate change and variability for the period of 1881-2012. It is also possible to separate natural causes of climate changes from those induced by enhanced atmospheric greenhouse effect (using global and regional climatic analyses).

Figure 6.1: *Deviations of the mean annual air temperature (dT) in Slovakia (based on 3 stations) from the 1951-1980 normal and annual areal atmospheric precipitation totals (RN) in Slovakia (based on 203 stations) as percentage of normal 1901-1990 in the period 1881-2012, including 11-year moving averages and linear trend (by the SHMI data)*

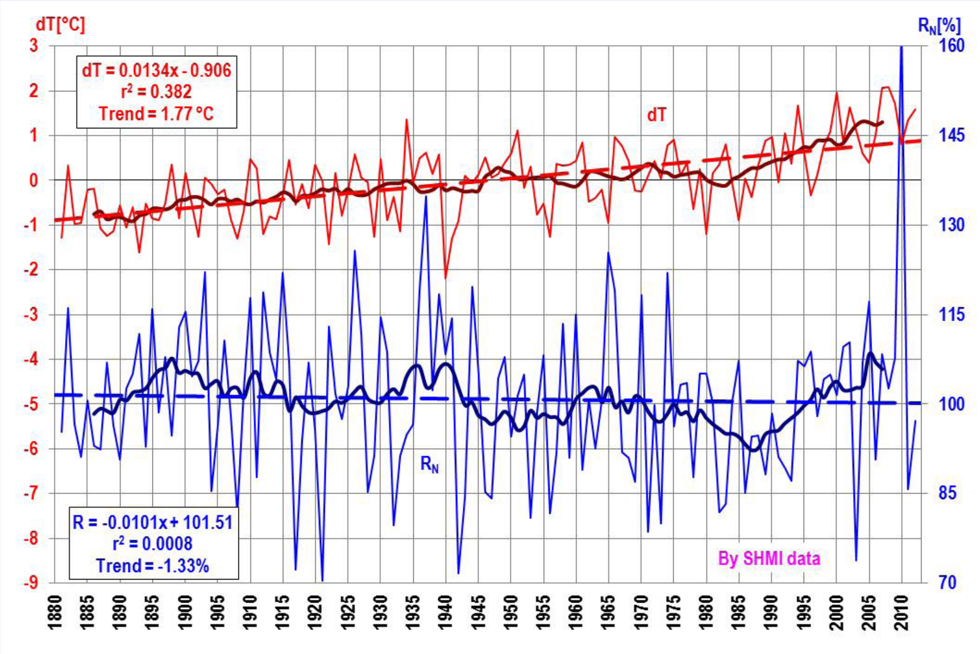


Figure 6.1 demonstrates significant increase of mean annual air temperature (by 1.8 °C in 132 year period) and insignificant decrease of annual areal precipitation totals (by about 1.3% in 132 years). While increase in air temperature is nearly the same in whole territory, significant decrease in annual precipitation totals was observed mainly in the south of Slovakia (up to 10%), small increase in precipitation totals is only at the northern border of Slovakia (about 3%). This development in temperature and precipitation was accompanied by decrease in relative air humidity and increase in potential evapotranspiration by about 5% in the south of Slovakia. The period of 1980-2012 was significant not only by rapid increase in air temperature (by about 2 °C) but also in great variability in precipitation totals (164% of normal in 2010, 74% of normal in 2003), what caused several episodes of serious drought on the one side and local or regional floods on the other. Changes in winter precipitation totals and increase in winter air temperature caused unstable snow conditions in Slovakia; increase of snow cover days and depths was recorded only in higher mountains (altitudes above 1 000 m a. s. l. cover only 5.4% of Slovak territory).

6.3 CLIMATE CHANGE PROJECTIONS FOR SLOVAKIA

Since 1993 climate change scenarios have been prepared for Slovakia as modified outputs from several General Circulation Models (GCMs) by statistical downscaling method. Some scenarios were designed as analogues to past warmer climate. A review of those scenarios was also published in five previous Slovak National Communications on Climate Change (from the years 1995, 1997, 2001, 2005, 2009). Now we are presenting a sample from the last series of climate change scenarios based on GCMs and Regional Circulation Models (RCMs), only for Hurbanovo.[1]

Outputs from four models (GCMs - CGCM3.1 and ECHAM5, RCMs – KNMI and MPI) were used in the daily data downscaling as climate change scenarios for Slovakia. These models belong to the newest category of so called coupled atmosphere-ocean models with more than 10 atmospheric levels and more than 20 oceanic depths of model equations and variables integration in the network of grid points. The model CGCM3.1 has 9 grid points in the Slovak territory and its neighbourhood, the model ECHAM5 has 12 such grid points (about 200x200 km resolution) and with corresponding smoothing of topography. The RCMs, KNMI and MPI represent a more detail integration of the atmospheric and oceanic dynamic equations with grid point's resolution about 25x25 km, while the boundary conditions are taken from the ECHAM5 GCM. The KNMI and MPI RCMs have 19x10 grid points (190) in Slovakia and its neighbourhood with a detailed topography and appropriate expression of all topographic elements larger than 25 km. All the GCMs and RCMs offer outputs of several variables with daily frequency for the period from 1951 to 2100. Based on these outputs and measured meteorological data (1961-1990) the daily scenarios for about 30 climatic and about 50 other precipitation stations in Slovakia have been designed. Scenarios for the following variables have been prepared predominantly: the daily means, maxima and minima of air temperature, daily means of relative air humidity all measured at 2 m elevation above the ground, daily precipitation totals measured at 1 m elevation above the ground, daily means of wind speed measure at 10 m elevation above the ground and daily sums of global radiation. These scenarios and user manuals can be easily used to prepare studies on impacts and vulnerability to climate change.

Besides the new versions of climatic scenarios, also the older ones presented from the 1st to 5th National Communications on Climate Change of the Slovak Republic have been applied in the vulnerability and adaptation studies.

Now we are presenting a sample from the newest climate change scenarios as the table format of changes in several climatic variables for the time frame 2075 (2051-2100 average) compared to 1961-1990 average.

Table 6.1: *Measured monthly and annual air temperature means at Hurbanovo (in °C) in 1961-1990 and scenarios of the mean air temperature change (in °C) in 2051-2100 by 7 different RCMs and GCMs models for Hurbanovo after statistical modification using the nearest 4 grid points (smoothed by formula* $dT = (dT_{i-1} + 2^{*}dT_i + dT_{i+1})/4$*)*

	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Year
Hurbanovo 1961-1990	-1.52	0.95	5.35	10.66	15.65	18.69	20.25	19.48	15.48	10.20	4.69	0.37	10.02
KNMI A1B	3.13	3.07	2.60	2.28	2.58	3.10	3.30	3.08	2.83	2.68	2.52	2.75	2.83
MPI A1B	3.40	3.24	2.60	1.96	1.91	2.33	2.88	3.39	3.47	3.18	2.92	3.07	2.86
CGCM3.1 A2	3.84	4.18	4.34	4.15	3.32	2.75	2.91	3.37	3.54	3.50	3.44	3.44	3.56
CGCM3.1 A1B	3.10	3.41	3.49	3.37	2.97	2.65	2.70	3.00	2.98	2.75	2.62	2.67	2.97
CGCM3.1 B1	2.88	3.08	2.95	2.67	2.15	1.69	1.48	1.66	2.05	2.23	2.22	2.40	2.29
ECHAM5 A2	3.78	3.89	3.56	3.10	2.90	3.43	4.37	4.72	4.42	3.70	3.03	3.22	3.68
ECHAM5 B1	3.12	2.94	2.47	2.09	2.04	2.58	3.22	3.54	3.50	3.01	2.51	2.70	2.81

1 115 m a. s. l., south-western Slovakia, Lapin et al. (2012)

Table 6.2: *Measured monthly and annual mean precipitation totals at Hurbanovo (in mm) in 1961-1990 and scenarios (quotients) of the mean precipitation totals change in 2051-2100 by 7 different RCMs and GCMs models for Hurbanovo after statistical modification using only one representative nearest grid point (1.08 is 8% increase, smoothed by formula $dT = (dT_{i-1} + 2^{*}dT_{i} + dT_{i+1})/4$)*

	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Year
Hurbanovo 1961-1990	34.0	34.1	26.6	38.9	55.7	60.9	50.7	57.7	38.9	32.2	53.8	39.8	523.4
KNMI A1B	1.28	1.23	1.08	1.07	1.09	0.90	0.76	0.93	1.18	1.24	1.22	1.24	1.08
MPI A1B	1.27	1.30	1.23	1.07	0.92	0.86	0.82	0.87	1.12	1.27	1.24	1.23	1.05
CGCM3.1 A2	1.56	1.52	1.57	1.48	1.31	1.19	1.01	0.95	1.12	1.32	1.45	1.56	1.30
CGCM3.1 A1B	1.40	1.36	1.42	1.43	1.31	1.19	1.07	0.94	0.93	1.11	1.35	1.43	1.32
CGCM3.1 B1	1.39	1.35	1.38	1.37	1.29	1.18	1.07	1.13	1.27	1.31	1.31	1.37	1.26
ECHAM5 A2	1.39	1.21	0.92	0.86	0.98	0.81	0.67	0.81	1.03	1.13	1.25	1.42	1.01
ECHAM5 B1	1.36	1.20	0.93	0.85	0.97	0.90	0.76	0.82	0.99	1.06	1.12	1.29	1.00

From Table 6.1 can be seen that models suppose comparable increase of monthly and annual temperatures by 1.5 to 4.7 °C (higher increase is projected by pessimistic Special Report on Emissions Scenarios (SRES) A2 emission scenario, 2.8 to 4.7 °C). Table 6.2 presents scenarios of precipitation totals change, in summer from decrease by 33% to increase by 19%, in winter only increase from 20% to 56%. These scenarios are slightly smoothed by formula $dX = (dX_{i-1} + 2*dX_{i} + dX_{i+1})/4$ to present more characteristic annual course (unsmoothed versions are also acceptable). While temperature scenarios are very close for all Slovak localities, precipitation scenarios exhibit some regional differences. Higher increase of annual precipitation totals was obtained from the north of country; summer decrease of precipitation totals is more significant in the southern lowlands. Comparable increase (decrease) is projected also for daily maximum precipitation totals (Table 6.3 for Hurbanovo, higher increase is in the northern mountains).

Table 6.3: *Scenarios (quotients) of monthly and Apr.-Sept. (WHY) maximum in daily precipitation totals change in 2051-2100 by 7 different RCMs and GCMs models for Hurbanovo after statistical modification using only one representative nearest grid point (0.99 is 1% decrease, unsmoothed)*

	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	WHY
KNMI A1B	1.16	1.28	1.13	1.06	1.65	1.05	0.66	0.95	1.43	1.12	1.25	1.22	1.08
MPI A1B	1.17	1.65	1.22	1.20	0.75	1.17	0.95	0.92	1.04	1.34	1.27	1.34	0.99
CGCM3.1 A2	1.29	1.31	1.68	1.35	1.02	1.19	0.83	0.79	1.48	1.26	1.30	1.34	1.08
CGCM3.1 A1B	1.33	1.30	1.35	1.39	1.10	1.33	1.04	0.92	1.07	1.12	1.40	1.24	1.13
CGCM3.1 B1	1.34	1.04	1.63	1.21	1.36	1.18	0.88	1.09	1.58	1.09	1.39	1.14	1.20
ECHAM5 A2	1.12	1.43	0.89	0.78	1.53	0.86	0.83	1.02	1.07	1.23	1.23	1.63	1.01
ECHAM5 B1	1.24	1.30	0.96	0.71	1.34	0.95	0.85	0.91	1.02	1.03	1.22	1.37	0.96

Table 6.4: *Scenarios (deviations) of monthly and annual saturation deficit means change (in hPa) in 2051-2100 from the 1961-1990 reference by 6 different RCMs and GCMs models for Hurbanovo after statistical modification using the nearest 4 grid points, HURB 1961-1990 – measured values in hPa*

	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Year
HURB 1961-1990	0.95	1.37	2.74	4.76	6.32	7.23	8.48	7.35	4.73	3.05	1.59	1.00	4.13
KNMI A1B	0.29	0.37	0.69	0.94	1.91	2.47	3.48	2.43	1.10	0.54	0.28	0.20	1.23
MPI A1B	0.69	0.69	0.74	0.56	0.49	1.40	1.81	3.31	1.95	0.83	0.53	0.49	1.12
CGCM3.1 A2	0.05	0.20	0.11	2.05	1.46	1.41	1.02	3.24	2.02	1.22	0.39	0.17	1.11
CGCM3.1 B1	0.02	0.22	-0.10	1.32	0.94	1.00	-0.20	1.30	0.70	0.63	0.15	0.14	0.51
ECHAM5 A2	0.62	0.76	1.61	1.98	1.47	2.50	5.78	6.32	4.48	2.04	0.78	0.42	2.40
ECHAM5 B1	0.74	0.49	1.00	1.45	0.97	2.17	3.43	3.98	3.12	1.39	0.67	0.37	1.63

Table 6.5: ***Scenarios of monthly and annual sums of the potential evapotranspiration E_o (in mm) in 2011-2040 (2025 time frame) and in 2071-2100 (2085 time frame) by 4 different RCMs and GCMs models for Hurbanovo, statistical modification of input data using the nearest 4 grid points, HURB 1961-1990 – calculated according to the measured values, all by Zubenok method***

	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Year
HURB 1961-1990	11.7	19.1	47.1	84.3	111.7	130.1	133.7	112.4	77.1	46.8	22.8	12.1	808.9
KNMI A1B 2025	12.5	20.6	52.1	92.2	118.3	135.2	141.0	118.1	82.6	49.6	24.4	12.7	859.4
KNMI A1B 2085	14.7	22.3	54.8	93.7	126.5	148.4	156.6	130.6	86.8	52.7	25.9	13.7	926.7
MPI A1B 2025	14.3	20.7	52.2	91.4	111.2	133.4	136.7	122.4	84.4	52.6	25.9	13.9	859.0
MPI A1B 2085	19.1	25.5	54.6	90.3	116.3	141.7	148.0	135.9	95.3	56.2	29.6	17.0	929.6
CGCM3.1 A2 2025	12.7	21.2	48.2	91.4	116.8	137.7	136.0	120.4	85.1	52.6	23.2	12.2	857.5
CGCM3.1 A2 2085	12.4	21.2	49.3	103.7	123.6	141.5	143.0	135.5	96.7	57.8	27.8	14.1	926.6
CGCM3.1 B1 2025	12.3	22.4	48.0	90.0	117.9	135.3	135.5	116.5	80.2	50.4	24.2	12.7	845.3
CGCM3.1 B1 2085	11.8	20,4	45.8	95.9	117.6	138.7	136.7	122.5	84.3	53.3	24.5	13.6	865.1

Tables 6.4 and 6.5 deal with very important impacts of climate change – saturation deficit (D = e*-e, where e* is saturated and e is actual water vapour pressure) and potential evapotranspiration (E_o) changes. The D increases due to rising air temperature – by 6% at one °C increase of air temperature and no change of relative air humidity, or due to decrease of relative air humidity and no change of air temperature (E_o = k.D, where k is some coefficient depending on geo-botanic conditions and annual course of solar radiation). Climate change scenarios suppose increase of air temperature by about 1.5°C to 4.5°C for growing period (Apr.-Sept.) in Slovak lowlands and no change or small decrease of relative air humidity. This will cause increase of E_o, what can cause decrease of soil moisture because of small changes or decrease of precipitation totals. The increase of E_o by about 50 mm annually in 2025 (2011-2040) time frame and by about 120 mm annually in 2085 (2071-2100) time frame can be considered as a serious for agriculture, water economy, forestry and natural ecosystems. Other methods of E_o calculation show slightly different results, but relative increases of these values up to the time frames of 2025 and 2085 remain nearly the same.

Figure 6.2: ***Scenarios of annual number of warm days (with average temperature ≥ 20°C) at Hurbanovo in 1950-2100, by modified ECHAM5 model outputs, SRES A2 emission scenario and by measured warm days data in 1951-2012 (SHMI data applied)***

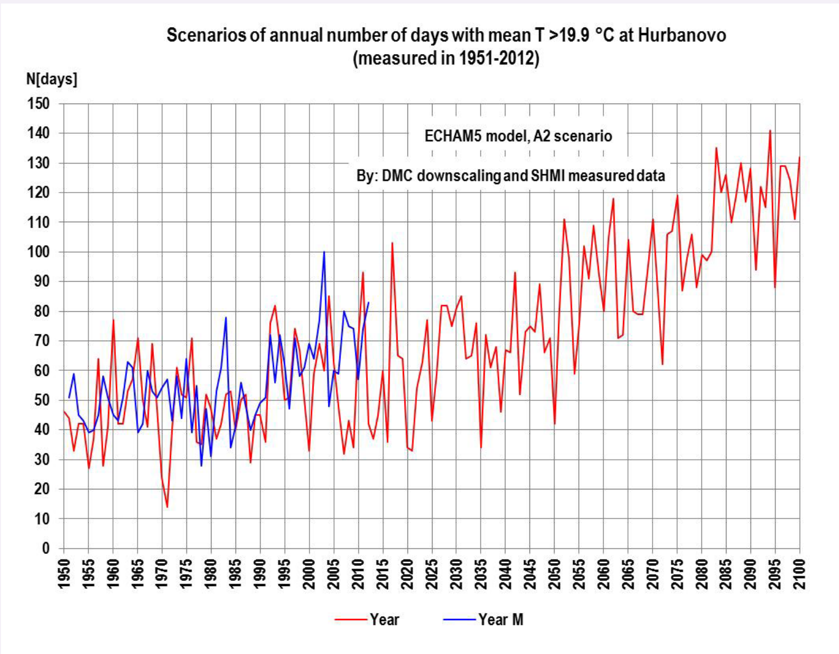


Figure 6.3: *Scenarios of annual number of muggy days (with average water vapour pressure ≥ 18.8 hPa) at Hurbanovo in 1950-2100, by modified ECHAM5 model outputs, SRES A2 emission scenario and by measured muggy days data in 1951-2012 (SHMI data applied)*

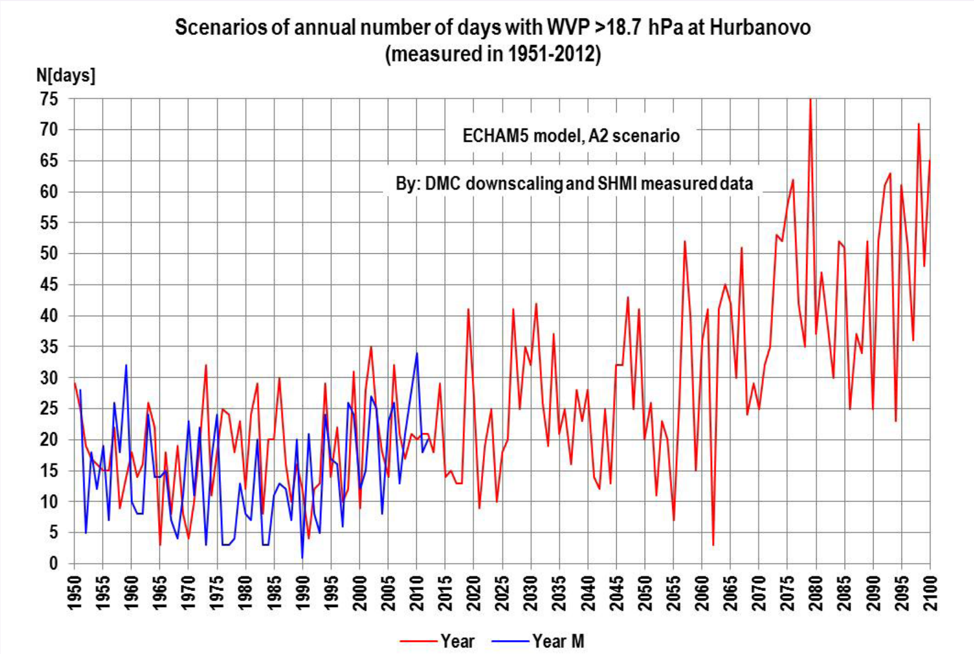
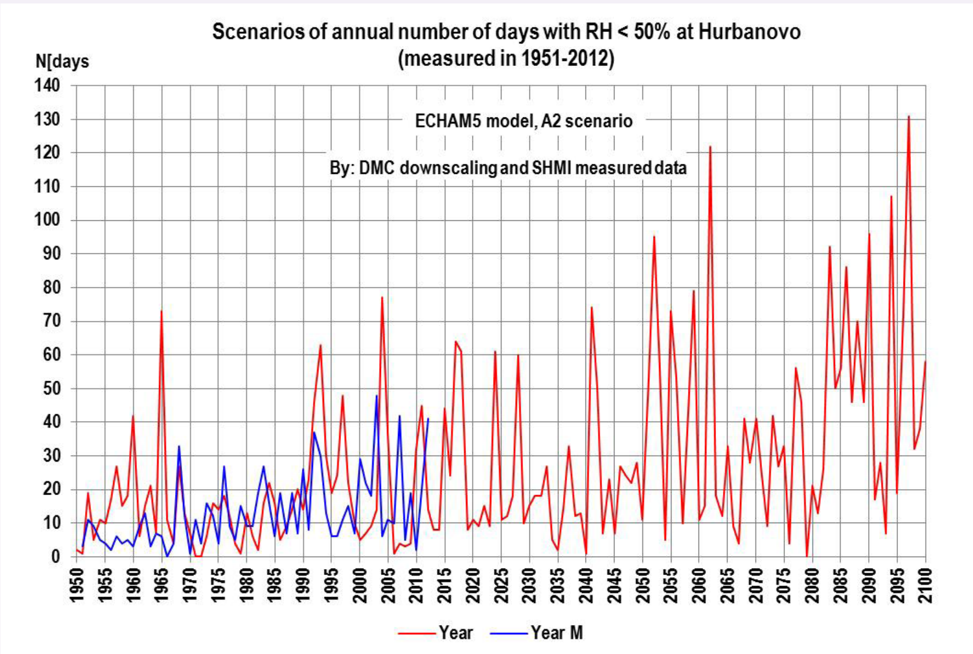


Figure 6.4: *Scenarios of annual number of dry days (with average relative humidity 50%) at Hurbanovo in 1950-2100, by modified ECHAM5 model outputs, SRES A2 emission scenario, and by measured dry days data in 1951-2012 (SHMI data applied)*



New and more detailed climate change scenarios based on global (GCMs) and regional (RCMs) models, including daily data and daily extremes, enabled to calculate a series of statistical characteristics as complex environmental and socio-economic scenarios depending on changing climate: heat waves (series of days with high temperature and humidity, summer days, tropical days), number of frosty days and days with strong frost (below -10 °C), heavy rains (high daily and k-day precipitation totals), days suitable for specific touristic activities (skiing, swimming, summer and winter hiking, etc.), number of days with heavy snowfall (new snow cover depth above 5 cm), number of days with low/high relative air humidity (below 50% and above 80%), etc. In Figures 6.2, 6.3 and 6.4 only examples of such elaboration are presented for Hurbanovo and ECHAM5, SRES A2 scenario (number of warm days, number of muggy days, number of days with low relative humidity (dry days)).

6.4 EXPECTED IMPACTS OF CLIMATE CHANGE, VULNERABILITY ASSESSMENT AND ADAPTATION MEASURES IN SELECTED SECTORS

Adaptation consists of actions altering our behaviour to respond to current and future impacts and vulnerabilities. It means not only protecting against negative impacts, but also taking advantage of any benefits. The earlier we implement adaptation responses, the less it will cost and the better equipped we will be to cope with challenges stemming from climate variability, climate change and unsustainable socio-economic developments, i.e. to (global) environmental change.

The magnitude of climate change impacts on human and natural systems in Europe calls for adaptation responses that both, reduce the vulnerability of these systems through technological solutions and so on, and further strengthen their resilience through ecosystem-based and managerial options and so on. The latter will specifically reinforce the key components of coping and adaptive capacities in terms of socio-economic, institutional and governance structures and natural capital. Two key policy levers for advancing adaptation and alleviating pressures on human and natural systems are the integration and mainstreaming of climate change in the EU policies on the one hand and on the other hand building on the corresponding EU instruments such as river-basin management plans, flood and hazard mapping, structural and cohesion funds, agriculture support, protected natural areas and spatial planning.

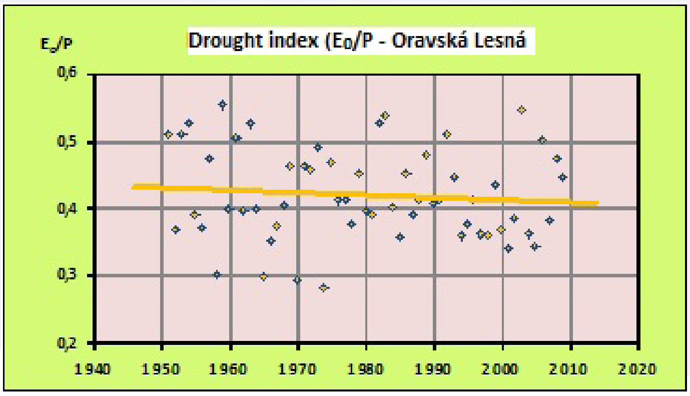
6.4.1 Sector Agriculture

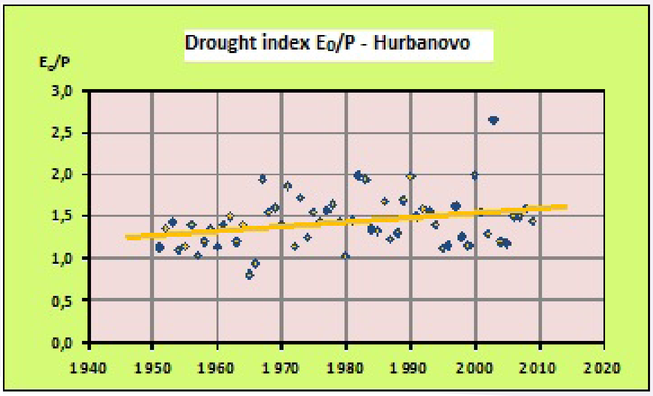
Agriculture in Slovakia went through significant changes in the last 20 years. The structure of vegetable production has been changed by application of some principles of common agriculture policy of the European Union. The quantity of technical crops is rising, mainly oil crops and the area under crops of potatoes, berry plants and vegetables is being reduced. The unbalance of agricultural commodities produces significant inter-annual changes in area under crops.

The area of the agricultural land used for growing crops is reduced. Nowadays it represents approximately 1.9 million hectares. Reducing of the area of the agricultural land is related to the urbanization and the infrastructure development (e.g. highways) but also to changing the agricultural land to forest land, especially in the mountainous areas.

Changing climate is expected to affect the conditions under which is the agricultural production done in many ways. Different indicators show us the possible impacts which are already now occurring and the trend which is continuing. One of the most important indicators through which we can express the possible impacts on agricultural system is drought index. Figure 6.5 illustrates different trends of the drought index expressed by E_o/P (where E_o is potential evapotranspiration and P is precipitation) in Slovak territory. E_o/P represents the relation between energetic supply in the surface layer of the atmosphere and water supply in the respective area. Eo/P >1 represents arid areas while $E_o/P < 0.3$ represents taiga environment.

Figure 6.5: Drought index Eo/P in mountain areas (Oravská Lesná – 780 m a. s. l.) and in lowlands (Hurbanovo – 115 m a. s. l.) for the period 1951-2010

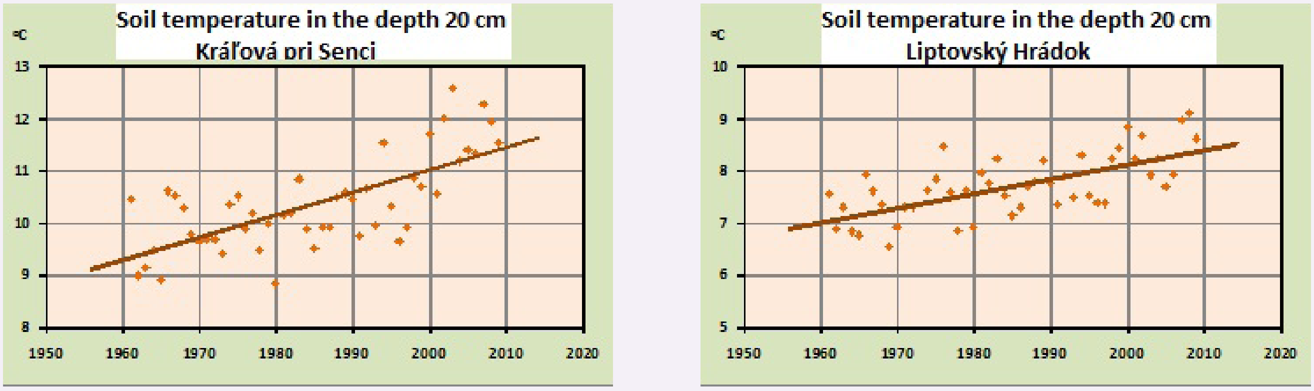




The value of E_o/P in Hurbanovo, representing the most productive part of Slovakia, showed together with other low positioned localities the increasing trend by about 0.3 within 60 years period with very few drops below 1.0. This indicates increasing aridity in low positioned regions. On the other hand, in the highlands and mountain areas the decrease of E_o/P is recognized. This is the result of the fact that the increased precipitations are able to compensate the increase of the energy supply in the highlands and mountain areas while the slight decrease of precipitation and increase of the energy supply in the surface layer of the atmosphere open the gap resulting in increasing aridity of the low positioned regions. The process of increasing humidity of the highlands and mountain areas is expressed less than the process of increasing aridity in the lowlands but it shows the difference in the trends of E_o/P.

Rising temperature is well expressed in air temperature trends. Nevertheless, rising temperature of upper part of the soil shows 1.5-2.0 °C increases in 50 years period (Figure 6.6).

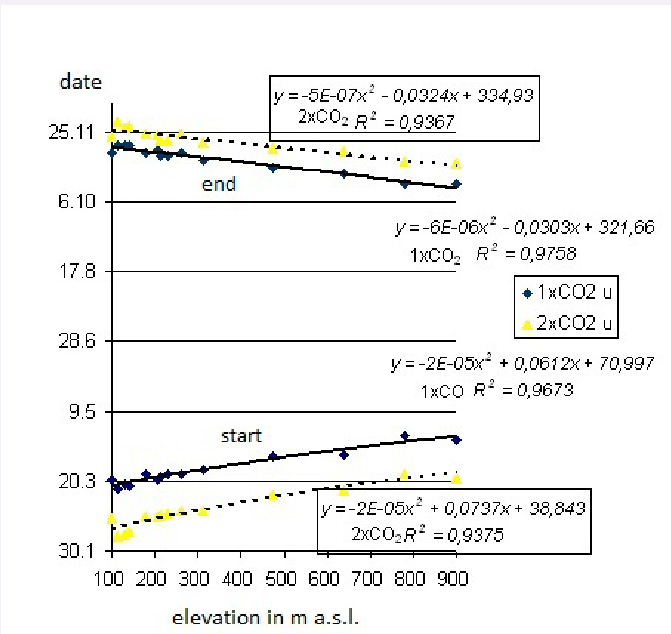
Figure 6.6: *Soil temperature in lowlands (Kráľová pri Senci – 124 m a. s. l.) and in mountain areas (Liptovský Hrádok – 640 m a. s. l.) for the period 1961-2010*



Expected Impacts of Climate Change on Sector Agriculture

Rising global temperature, as well as above documented change of some bioclimatic parameters, brings contradictory impacts. Crop production can benefit from warmer climate and higher content of CO_2 in the atmosphere but rising severity and higher frequency of drought, floods and heat waves would eliminate such benefits. The dependence of the duration of great vegetative period on rising CO_2 concentration is shown on Figure 6.7.

Figure 6.7: *Start and end of great vegetative period under the condition 1xCO_2 and 2xCO_2 in Slovakia*



Furthermore, not all crops are able to benefit from rising temperature and higher level of CO_2 in the atmosphere and global climate change can convert some regions of Slovakia unsuitable for the production of some crops.

Following factors relate the global climate change and agricultural production in Slovakia:

- rising mean air temperature,
- changes in spatial distribution of precipitation as well as in their intensity,
- rising concentration of atmospheric CO_2,
- air pollution (for instance tropospheric ozone, $PM_{2.5}$ and PM_{10}),
- change in climate variability and extreme events.

Next assessment of the impacts was done for the past based on the time series of selected stations while the future projection was based on the assumption of doubling the content of CO_2 in the atmosphere from 330 ppm representing the period 1961-1990 to 660 ppm representing the period 2071-2100. The analyses were done up to 900 m a. s. l. which is approximately the highest elevation with crop production in Slovakia.

One of the most important bioclimatic parameter influencing the crop production, both in agriculture and forestry, is the duration of great vegetation period, i.e. the period with daily mean temperature T≥5.0°C.

The rise of the mean air temperature will generally prolong the vegetation period but in the regions with relatively cold spring it means a sooner start of the vegetation and the threat of cold waves during the generative phases of the vegetation cycle. Sooner start of the start of vegetation also anticipates the move of harvest to less favourable period during the heat waves.

Based on the analysis of the time series it appeared that in extreme years the great vegetation period in southernmost regions of Slovakia can span even over the winter period. This can adversely influence the wintering of some crops, mainly of some fruit trees. The shift in the start of the great vegetative period is more expressed than in the end of this period and under the conditions of double CO_2 the mean shift is 28 days in comparison to $1xCO_2$.

This fact means also strong decrease of snow cover which will have the consequences on all annual and perennial wintering crops. The vegetation period will shift the growth of the crops to the time with lower radiation. This will influence the productive potential of the biomass.

Great vegetative period which takes 235 days under the $1xCO_2$ only in the lowlands will spread practically to the whole territory of Slovakia.

Table 6.6: Projection of some bioclimatic parameters – photosyntheticaly active radiation (PAR), precipitation (R) and temperature sum (TS5) during the great vegetative period for different regions under $1xCO_2$ and $2xCO_2$

Productive region	Elevation in m a.s.l.	*PAR* [kWh.m^{-2}]		*R* [mm]		*TS5* [°C]	
		$1xCO_2$	$2xCO_2$	$1xCO_2$	$2xCO_2$	$1xCO_2$	$2xCO_2$
Corn	<200	460 – 500	510 – 560	400 - 460	500 - 530	3 200 - 3 400	4 000 - 4 400
Beet	200-350	435 – 460	485 – 510	460 - 510	530 - 580	2 900 - 3 200	3 650 - 4 000
Potato	300-650	400 – 435	465 – 485	510 - 560	580 - 650	2 300 - 2 900	3 150 - 3 650
Mountains	>600	<400	<465	>560	>650	<2 300	<3 150

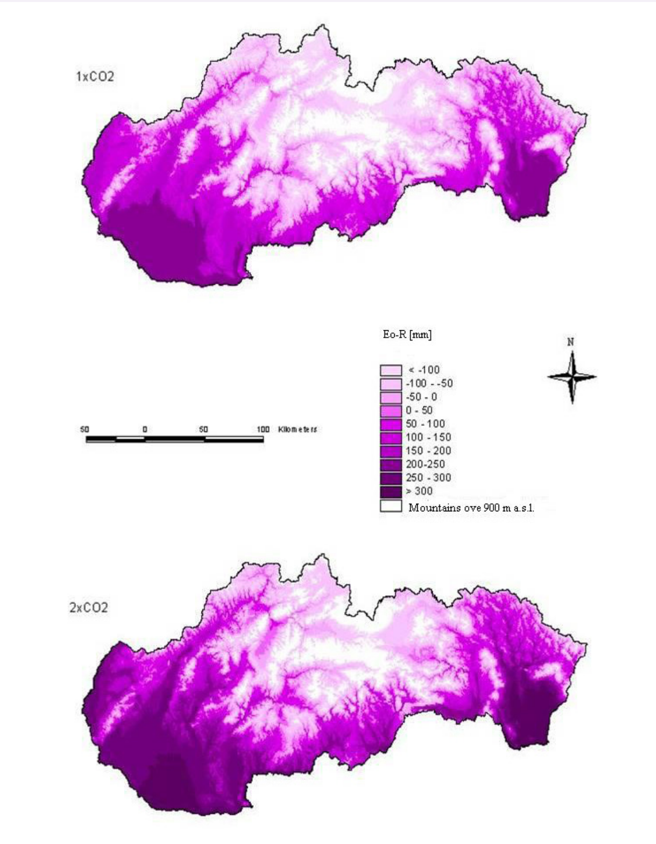
Increased concentration of CO_2 will cause the change of climate condition for all the vegetation areas (Table 6.6). The temperature rise will strongly influence the distribution of productive regions. The temperature sum (in the Table 6.6 as TS5) will rise by 22% in the lowlands but over 40% in the higher elevations. This will increase the area with the temperature sum (in the Table 6.6 as TS5) from 12880 km^2 to over 35 000 km^2. The increase of the precipitation totals should favour the crop production. Generally, precipitation totals will rise under the $2xCO_2$ conditions by 15-20% mm in the lowlands of south and east of Slovakia and by 12-20% in the north. However, the question of the heavy rains and prolonged drought periods will diminish this influence.

Table 6.7: Potential evapotranspiration (E_0) and climatic water balance (E_0-R) during the great vegetative period for different regions under $1xCO_2$ and $2xCO_2$

Productive region	E_0 [mm]		E_0-R [mm]	
	$1xCO_2$	$2xCO_2$	$1xCO_2$	$2xCO_2$
Corn	600 – 660	720 – 810	150 – 220	200 – 300
Beet	550 – 600	650 – 720	50 – 150	110 – 200
Potato	450 – 550	570 – 650	-80 – 50	-50 – 110
Mountains	<450	<570	<-80	<-50

In longer vegetative period the rise of potential evapotranspiration E_0 will also consequently change the water balance E_0-R in all elevations (Table 6.7). The rise of E_0 will not be compensated by the sufficient increase of precipitation. The climatic water balance shows the general increase in the lower regions by 30-50% while in higher regions this parameter does not show any dramatic changes. The important fact is that on the whole territory of Slovakia we can expect E_0 over 500 mm and the in the southern lowlands E_0 over 800 mm. Respecting the fact of uneven distribution of precipitation over the vegetative period we can expect increasing deficit of water. Territorial distribution of climatic water balance respects the distribution of the productive regions. There is an increase in the lowlands and balanced values of E_0-R close to 0 have moved from 500-550 m a. s. l. to 650 m a. s. l. The calculation showed that under $1xCO_2$ the territory of about 21 000 km^2 was influenced by the lack of water supply during the vegetative period. This area will increase under $2xCO_2$ to over 30 000 km^2.This represents the increase by 40%. Under new conditions an important part of the most productive area (about 8 800 km^2) will experience the mean water deficit E_0-R>250 mm. Such deficits were not recognized in the previous period under $1xCO_2$. This difference can be seen in Figure 6.8.

Figure 6.8: Climate water balance (E_0-R) in mm during the great vegetative period for different regions under $1xCO_2$ and $2xCO_2$



Vulnerability Assessment in Sector Agriculture

Expected impacts of the climate change on the agricultural production will differ according to the region. Based on the recent calculations of the past and future agroclimatic conditions, the level of negative impact on agricultural production in nine distinguished regions which involve different geomorphological units was estimated. Following table (Table 6.8.) shows the risk level expressed in four grades.

Table 6.8: The risk of the negative climate change impact on agricultural sector in selected geomorphologic units

Region	Geomorphological units	Risk
1	Malé Karpaty, Biele Karpaty, Považský Inovec, Záhorská nížina, Podunajská nížina, Považské podolie, Podunajská pahorkatina, Pohronský Inovec	***
2	Lučensko-košická zníženina, Krupinská planina, Javorie, Matransko-Slanská oblasť a priľahlé kotliny	**
3	Východoslovenská nížina, Vihorlatské vrchy	*
4	Poloniny, Nízke Beskydy, Východné Beskydy, Spišská Magura	0
5	Stredné Beskydy, Západné Beskydy, Javorníky	0
6	Tatry, Nízke Tatry, Chočské vrchy, Malá Fatra- Krivánska a priľahlé kotliny	0
7	Slovenské rudohorie, Branisko a priľahlé kotliny	0
8	Veľká Fatra, Malá Fatra-Lúčanská, Kremnické vrchy, Štiavnické vrchy, Starohorské vrchy, Poľana a priľahlé kotliny	0
9	Vtáčnik, Tríbeč, Strážovské vrchy, Žiar	0

Risk of negative impact of climate change
*0 – minimal, *moderate **high ***very high*

Adaptation Measures in Sector Agriculture

Following the recent investigation done in Slovakia as well as the general recommendations for agro technical measures, there are some effective means of adaptation to present and future conditions of agricultural production:

1. Change the structure of crops grown in Slovakia.
2. Change the structure of the varieties.
3. Adapt the agro technical terms (mainly sowing) to changed agro climatic conditions.
4. Support the construction of irrigation systems and to ensure sufficient amount of irrigation water in cooperation with water-service sector.

The application of above mentioned measures will have to be selective and will bring different results in different regions.

To change the structure of crops represents a radical step in agricultural production of a region. This will be effective mostly in higher positioned regions because of increasing thermal comfort which were typical only for lowlands in the past. In Slovak conditions this concerns mainly the spread of the production of corn and sugar beet to higher elevations. The use of new varieties of corn is considered by the producers.

The change in varieties is expected also for other cereals, mainly for winter wheat. The present varieties of winter wheat will already ripe 3-4 weeks sooner than they did in the past. Therefore this will result in a lower radiation input and decreasing potential of the yield formation.

The adjustment of the agro technical terms concerns mostly the spring varieties of barley and wheat. The models showed that keeping the sowing days of spring firm can shift the period of ontogenesis to the period of high temperatures. This can diminish number of germinating seeds. Later, high temperatures can negatively influence formation of grain.

Last suggested adaptation measure, irrigation does not depend only on the farmers but also on the water management sector. The effect of the irrigation is known in Slovak conditions and further modelling testified the stabilizing effect of the irrigation. Next two tables (6.9 and 6.10) show the variability of the yields under irrigated and not irrigated conditions and increasing need for irrigation of the main crops in the most productive region of Slovakia.

Table 6.9: Variation coefficients of the yields of spring barley on irrigated and not irrigated soil in 1966-1985 and in the future based on climate scenarios SRES A2 and SRES B2

Region	Option	1966-1985	SRES A2		SRES B2	
			2011-2030	2031-2050	2011-2030	2031-2050
Podunajská lowland	Irrigated	0.090	0.070	0.050	0.063	0.067
	Not irrigated	0.242	0.275	0.323	0.333	0.384
Východoslovenská lowland	Irrigated	0.092	0.136	0.104	0.116	0.092
	Not irrigated	0.184	0.302	0.220	0.218	0.301
Severoslovenské basins	Not irrigated	0.122	0.135	0.176	0.097	0.079

Table 6.10: Number of days with irrigation needs in the Danube lowland in 1966-1990 and in the future based on climate scenarios SRES A2 and SRES B2

Scenario	Period	Spring barley	Winter wheat	Corn	Sugar beet
	1966-1990	24	30	41	64
SRES A2	2011-2040	26	41	46	47
	2041-2070	30	40	60	89
	2071-2100	33	40	67	108
SRES B2	2011-2040	26	41	50	67
	2041-2070	31	41	59	88
	2071-2100	31	44	64	96

Both reached and simulated yields vary according to the regional conditions but the yields under irrigation are visibly more stable and this effect increases with the time scale. The irrigation needs will rise and it looks that the rain fed production of some main crops will become not effective enough. This is well expressed mainly at corn and sugar beet which stresses the possible option of growing these crops in higher elevations with lower water deficit. Further to above mentioned measures, mulching is expected as a general procedure to regulate the soil moisture at reasonable level.

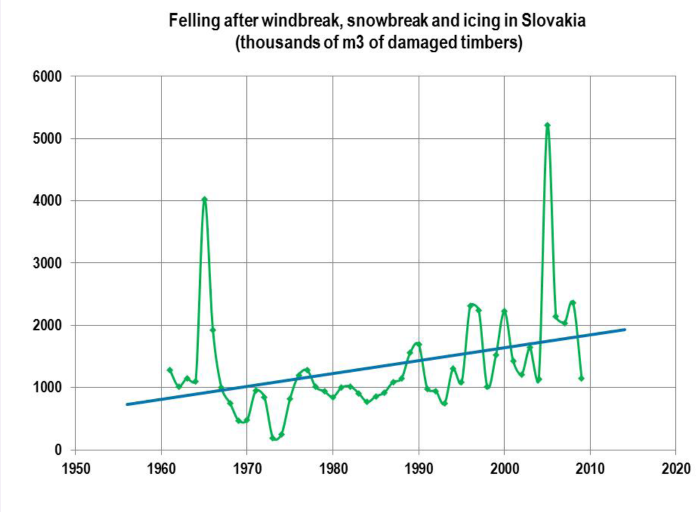
6.4.2 Sector Forestry

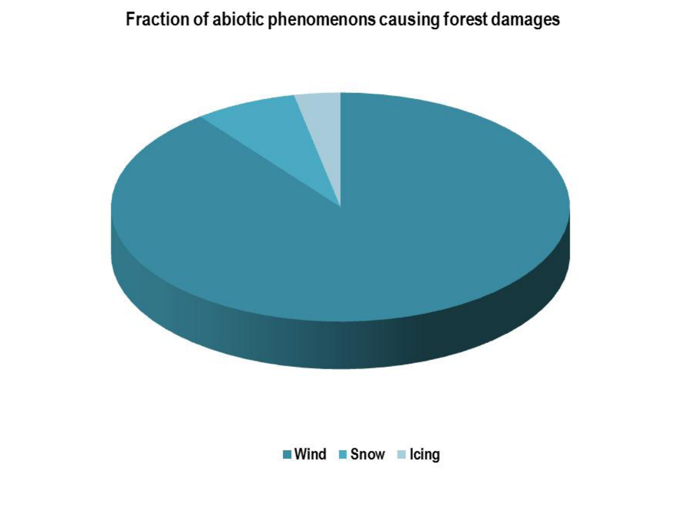
The forest land area in Slovakia increases in the long-term period. It has reached 20 090 km^2 in 2009. Since 1950, the forest cover as a percentage of the total forest land within the area of Slovakia increased by 13.4%. According to the national inventory of forests in Slovakia the forests cover over 44% of land.

Timber reserve within forests of Slovakia also increases in the long-term period. In 2009 it has reached 456.4 million m^3. The rise of wood mass in the forests is expected to continue and culminate between years 2015 and 2020. This trend will change after 2020 because of the change of the composition in forest age. The average store is 237 m^3 per hectare. Increase of timber reserves in the forest cover should continue until the expected culmination between years 2015-2020. Forests in Slovakia have relatively diverse composition of species with the highest representation of beech (31.6%), spruce (25.5%) and oak (13.3%). Slovak classification uses 9 vegetation stages of wood communities: 1. Oak, 2. Beech-oak, 3. Oak-beech, 4. Beech, 5. Fir-beech, 6. Spruce-fir-beech, 7. Spruce, 8. Mountain pine, 9. Alpine vegetation (non-forest high mountain pastures). The vegetation stages of lower elevations, i.e. stage 1, 2 and 3 are rather arid during the vegetation period (from March to September). The beech vegetation (stage 4) is characterized by an equitable climatic water balance. The climate humidity increases in higher vegetation stages and reaches the highest values in the 8th vegetation stage of mountain dwarf pine and the 9th alpine stage, where the amount of precipitation considerably exceeds the evaporation requirements of the atmosphere.

Changing conditions affect the health of the forests. Abiotic phenomenon affects the forest in increasing frequency and severity. In 2009 the abiotic phenomenon caused the calamity of 1.9 million m^3 of wood which is one quarter of the wood mass damaged in Slovak forests. The damages caused by enzymic action reached around 4 million m^3 wood mass. Figure 6.9 shows the rise of felling after calamities caused by abiotic phenomenon and division of abiotic phenomena's origin.

Figure 6.9: Felling after calamities caused by windbreak, snow break and icing and fractions of abiotic phenomena causing forest damages in Slovakia for period 1961-2010





Further to above listed damages we have to consider the damages caused by drought and floods which are not counted separately and often are connected with the biotic/enzymic action. Such changes influence the mechanical stability of the woods as well as physiological processes in woods caused by drought, land waterlogging and by the changes in biological activities of the woods. The analysis of forest economical inventory shows the changes in forest damages caused by abiotic phenomenon in recent 50 years. In previous decades the damages caused by abiotic phenomenon (snow breaks from 500 to 800 m a. s. l. and icing over 900 m a. s. l.) concentrated mostly to pine grove while in the recent decade these damages were recognized rather in beech wood in the middle altitudes up to 500 m a. s. l.

Impacts of Climate Change in Sector Forestry

Climate change will influence mostly the climate water balance. Its impact will be different in different vegetation stages and mostly will impact the lower vegetation stages, what demonstrates data in Table 6.11. Lower vegetation stages 1, 2 and 3 show higher needs for water supply than available precipitation. It means these forest communities have to pump the water from the soil layer. Water deficit will further deepen in these vegetation stages in the future and both 4th and 5th vegetation stages will fall into the negative water balance. It is likely that in vegetation stages 1, 2 and 3 the conditions will deteriorate for the existing woods and we can expect the expansion of xerothermic bush vegetation and creation of steppe and forest steppe vegetation forms involving locust tree, limestone and hornbeam.

Table 6.11: Climate water balance during great vegetative period for vegetation stages in the period of 1951-1980 and time horizon 2075 for various vegetation stages in Slovakia.

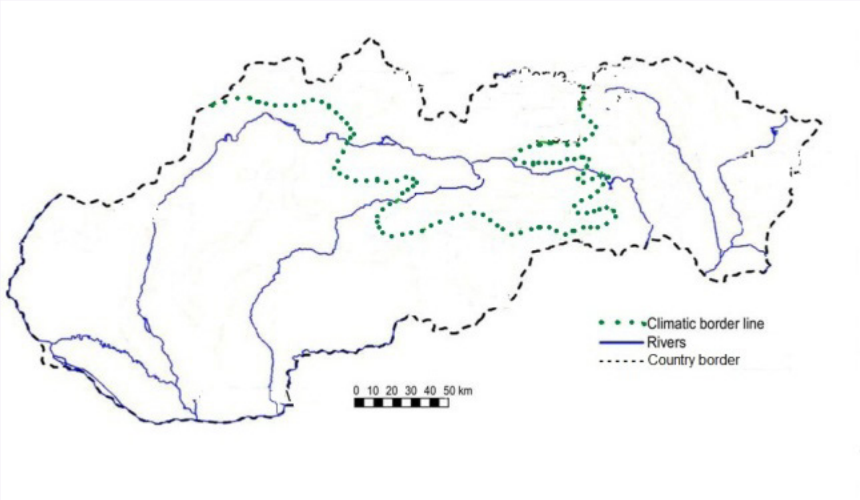
Vegetation stage	Vegetative period (April - September) (Eo -R) (mm)	
	Past climate 1951-1980	Climate scenario CCCM for 2075
1	299	430
2	140	255
3	76	196
4	7	129
5	-65	48
6	-301	-167
7	-498	-342
8	-666	-517

Model calculation and climatic analysis allows making a generalization in relation to the perspective of occurrence and further cultivation of forest plants in the Western Carpathians in terms of projected climate change. The summarized results are presented in the following Table 6.12.

Table 6.12: Summary results of the evaluation of presence and further cultivation of forest plants in the area of the Western Carpathians in terms of projection of climate change.

Forest community	Holdridge model	Forest Gap Model	Analysis of bioclimatic areas	Analysis of climatic water balance
1-3 vegetation stage	▪ absence of good conditions for presence of spruce, fir ▪ good conditions for forest communities of "Balkan type"	▪ extinction of the communities with presence of spruce and fir ▪ succession of oaks xerothermic forests	▪ extinction of good conditions for presence of spruce and fir ▪ deterioration in the condition for beech	▪ limited deficit of precipitation for spruce and the beech
4-6 vegetation stage	▪ conditions for decrease of abundance of spruce, fir ▪ conditions for mixed temperate forests	▪ extinction or marginal presence of spruce, fir ▪ growth of mixed communities of beech with presence of rare deciduous trees	▪ general retreat of conifers (spruce) ▪ positive bioclimatic conditions for beech (vegetation stages 5-6) ▪ creating of conditions for oak communities (mainly vegetation stage4)	▪ precipitation sufficient for spruce, fir only in north of vegetation stage 6 ▪ favourable water balance for the beech
7-8 vegetation stage	▪ conditions for growth of mixed communities of spruce, shift of the upper forest line	▪ growth of mixed communities of spruce - fir -oak, shift of the upper forest line	▪ reduce the representation of the spruce, areal reduction , shift of the upper forest line	▪ precipitation sufficient for spruce existence

Figure 6.10: *Map with the borders of Slovakia (dashed line) representing the West Carpathians. Green dotted line displays the climatic border line. Rivers are shown in blue lines*



The territory of the West Carpathians is divided into the area of Pannonia (Pannonian Lowland) and the foothills to the north, influenced by Mediterranean climate, and the area of the inner Carpathians, influenced by sub-ocean mountainous climate and by the climate of both Northern and Baltic Seas. The line dividing these areas has been determined by *Zlatník* (1959) by the so-called main climatic line, where the Carpathian bow separates two European climatic areas (Figure 6.10). The area to the north of this line is quite wetter and colder than the southern one, which is drier and warmer. The northern part is favourable for the growth of spruce, unlike the southern part, where spruce grows only in the highest vegetation stage.

Consequences of climate change on forest ecosystems and forestry:

- Change of the bioclimatic conditions in forest vegetation stage 1-2, change will be more significant south of climate line set by *Zlatník.*
- Change in growing conditions of forest plants, from 5th forest vegetation stage. Negative influence on the growth activity of timber plants will prevail downwards from 6th vegetation stage, upwards the change will be positive.
- There will be a change in the influence of harmful abiotic factors, snow damage will extend to higher altitudes (6th to 8th vegetation stages).
- The space-time influence of biotic pests will change, gradual invasion of new pests mainly from the Balkan is expected.

Vulnerability Assessment in Sector Forestry

The analysis of the results of current knowledge and understanding of agro-climatic conditions of forest ecosystems in Slovakia enables to estimate the level of risk for negative impact of climate change on the forestry for selected geomorphologic units. Table 6.13 shows the risk level expressed in four grades.

Table 6.13: *Risk of negative impact of climate change on the forestry for selected geomorphologic units in Slovakia*

Region	Geomorphological units	Risk
1	Malé Karpaty, Biele Karpaty, Považský Inovec, Záhorská nížina, Podunajská nížina, Považské podolie, Podunajská pahorkatina, Pohronský Inovec	**
2	Lučensko-košická zníženina, Krupinská planina, Javorie, Matransko-Slanská oblasť a priľahlé kotliny	***
3	Východoslovenská nížina, Vihorlatské vrchy	**
4	Poloniny, Nízke Beskydy, Východné Beskydy, Spišská Magura	*
5	Stredné Beskydy, Západné Beskydy, Javorníky	*
6	Tatry, Nízke Tatry, Chočské vrchy, Malá Fatra- Krivánska a priľahlé kotliny	*
7	Slovenské rudohorie, Branisko a priľahlé kotliny	*
8	Veľká Fatra, Malá Fatra-Lúčanská, Kremnické vrchy, Štiavnické vrchy, Starohorské vrchy, Poľana a priľahlé kotliny	**
9	Vtáčnik, Tríbeč, Strážovské vrchy, Žiar	**

The risk of negative impact of climate change
*0 – minimal risk, *medium risk **high risk ***very high risk*

Adaptation Measures in Sector Forestry

There are two basic groups of suggestions how to proceed with adaptation measures in forest management; a general and a specific one. The first one involves all the activities towards biological and genetic diversity and to natural forest management. The second one involves specific activities which are concentrated on the particular aspects of expected climate change impacts. First category activities represent rather universal measures regardless the uncertainties of climate predictions. Specific set of adaptation measures respects regional environmental conditions and should respect following priorities:

- measures in forest's structure which is not in harmony with current conditions (inappropriate typological wood composition),
- measures in the forests starting general re-creation,
- measures which respect the need of diminishing greenhouse emissions from the forests.

Suggestions for specific adaptation measures are based on following principles:

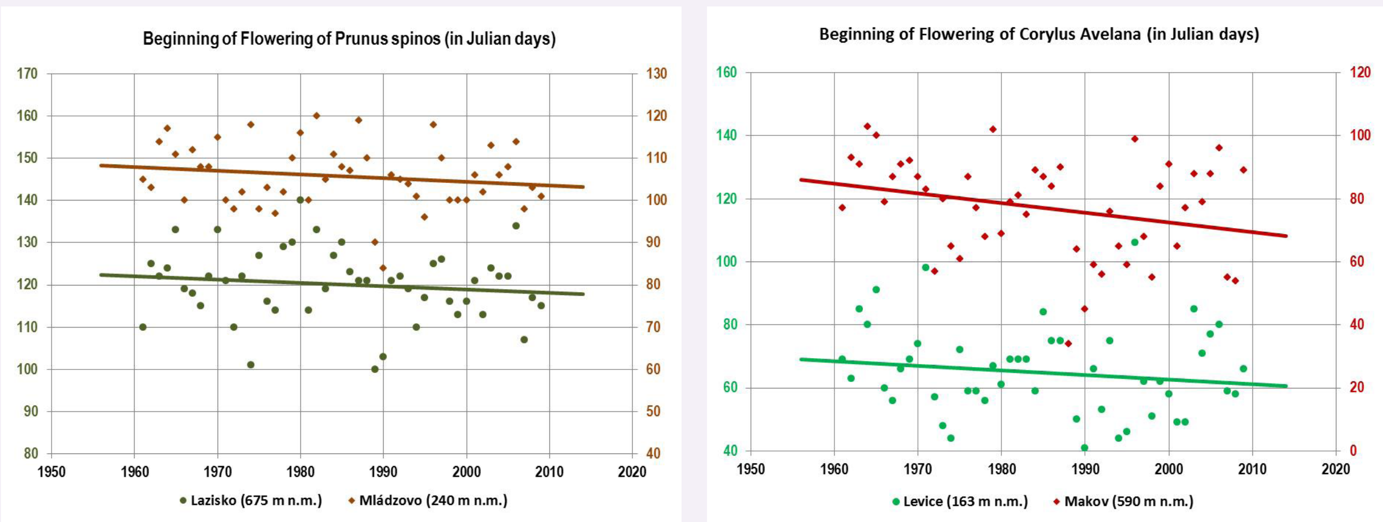
1. Gradual change in composition of tree species in the forests of Slovakia, through regeneration of most vulnerable groups of forest plants with regard to biodiversity measures and adaptability of introduced species to climate change.
2. Conservation and reproduction of the species resistant to the climate change impacts.
3. Forestation of bare areas with regard to the creation of forest communities with suitable structure for biodiversity and carbon seques tration.
4. Applying the principles of integrated forest protection against calamity and invasive species of pests.
5. Securing the implementation of measures to strengthen the hydric functions and biodiversity of forests by applying the principles of close- to- nature forest management and knowledge of forestry hydro melioration.

6.4.3 Sector Biodiversity

Ecosystems run the natural processes which bring the benefits for both natural and artificial human activities. The extent and character of climate change can reach such levels that the natural adaptation of many ecosystems will not be possible. The impact of climate change on natural systems could therefore bring far-reaching consequences, in particular the loss of biodiversity in terms of species and habitats.

There are already recognized the changes in behaviour of some plant communities. One of the visible responses of the nature to the im- pact of climate change is the shift in some phenological phases of many species which are found all over the Central Europe. Following graphs (Figure 6.11) document the changes in the initial generative phonological phases of two common wild species -Prunus spinosa and Corylus avelana in Slovakia living in different altitudes. Fifty year time series show slight trend to earlier start of flowering of Prunus spinosa by 4-6 days. This shift was almost the same in low and middle altitude. Corylus avelana showed much stronger shift towards earlier flowering by 8-14 days and the shift in higher altitude was visibly higher.

Figure 6.11: Beginning of flowering of Prunus spinosa and Corylus avelana for lowland and highland stations in Slovakia in period 1961-2010



Principal document dealing with biodiversity is the National strategy to Protect Biodiversity in Slovakia approved by the Slovak Government in 1996. There are two sources of negative impacts on biodiversity in Slovakia. Natural sources like catastrophes, weather impacts or bad natural development act independently while human activities like air and water pollution, inappropriate land management and unprecedented use of water sources are directly bounded with socio-economic activities of man. One of the technical problems which senselessly invade the biodiversity is a territorial fragmentation bringing inappropriate placement of different constructions which form the barriers in natural migration of animal species and acts as a strange artificial element unacceptable by the environment. This brings degradation of the gene pool of isolated animal communities and raises the vulnerability of the ecosystems.

While the natural biological sources were used beyond the measure in the past by extensive use of arable land, the social changes in the recent decade caused drastic decline of this activities. Some biotopes are threatened because of shrinking of arable land but mainly because of diminished farming activities in pastures as a result of strong decline in beef-raising, sheep-farming as well as in general meat production.

Impacts of Climate Change on Sector Biodiversity

It is generally assumed that biodiversity will be reduced due to influence of several factors, mainly due to increased intensity of land use and associated destruction of natural habitats or sites close to nature. These pressures on biodiversity occur independently from climate change, and therefore it is questionable in how much can climate change improve or worsen the losses of biodiversity.

All recent evidence suggests that in general impact on biodiversity will be negative, due to increasing effect of global climate change on forest, agricultural and aquatic ecosystems. The most endangered are sensitive ecosystems such as pine grove grown in the mountains, swamp ecosystems, agricultural ecosystems developed in foothills and mountains as well as aquasystems. Based on already recognized and anticipated changes in ecosystems following impacts of climate change are expected:

- Increase of endangerment of climatically sensitive species with a narrow ecological niche.
- Change of climatic conditions of particular floral and animal species.
- Potential migration of species.
- Endangerment of autochthonic species of fauna and flora by invasive species.

Databases which document the present status of the ecosystems are already in existence, mostly covering forestry. National inventory and monitoring of the Slovak forests was done in 2005-2006. The second inventory in selected areas is expected in 2015-2016. This enables us to quantify the changes in biodiversity of forest ecosystems in regard to number of species, their occurrence as well as the recognition of invasive species.

Vulnerability Assessment in Sector Biodiversity

Based on the analysis of current knowledge and understanding of existing bioclimatic conditions in agriculture, forestry and land management the level of risk for negative impact of climate change on the biodiversity for selected geomorphologic units was estimated. Table 6.14 shows the risk level expressed in four grades.

Table 6.14: Risk for negative impact of climate change on the biodiversity for selected geomorphologic units

Region	Geomorphological units	Risk
1	Malé Karpaty, Biele Karpaty, Považský Inovec, Záhorská nížina, Podunajská nížina, Považské podolie, Podunajská pahorkatina, Pohronský Inovec	**
2	Lučensko-košická zníženina, Krupinská planina, Javorie, Matransko-Slanská oblasť a priľahlé kotliny	**
3	Východoslovenská nížina, Vihorlatské vrchy	**
4	Poloniny, Nízke Beskydy, Východné Beskydy, Spišská Magura	*
5	Stredné Beskydy, Západné Beskydy, Javorníky	**
6	Tatry, Nízke Tatry, Chočské vrchy, Malá Fatra- Krivánska a priľahlé kotliny	**
7	Slovenské rudohorie, Branisko a priľahlé kotliny	**
8	Veľká Fatra, Malá Fatra-Lúčanská, Kremnické vrchy, Štiavnické vrchy, Starohorské vrchy, Poľana a priľahlé kotliny	**
9	Vtáčnik, Tríbeč, Strážovské vrchy, Žiar	**

The risk of negative impact of climate change
*0 – minimal risk, *medium risk **high risk ***very high risk*

Adaptation Measures in Sector Biodiversity

Adaptation seems to be a decisive instrument for diminishing the climate change impacts on the biodiversity and to conserve existing levels of biodiversity on current levels at least. However, the system can function the opposite way, too. High level of biodiversity brings relatively high level of resiliency of some ecosystems (e.g. forest ecosystems) what finally increases the probability of the adaptability of the particular ecosystem and diminish the impact of climate change on the biodiversity itself. The proposal for the adaptation measures will have to create a wide scheme of defined adaptations, the particular adaptations will have to be concentrated on protected areas and the adaptation plans have to recognize biological feasibility of the adaptations and to bring hierarchical sequence of the adaptation measures respecting their importance and feasibility. General suggestions for the adaptation measures should cover following activities:

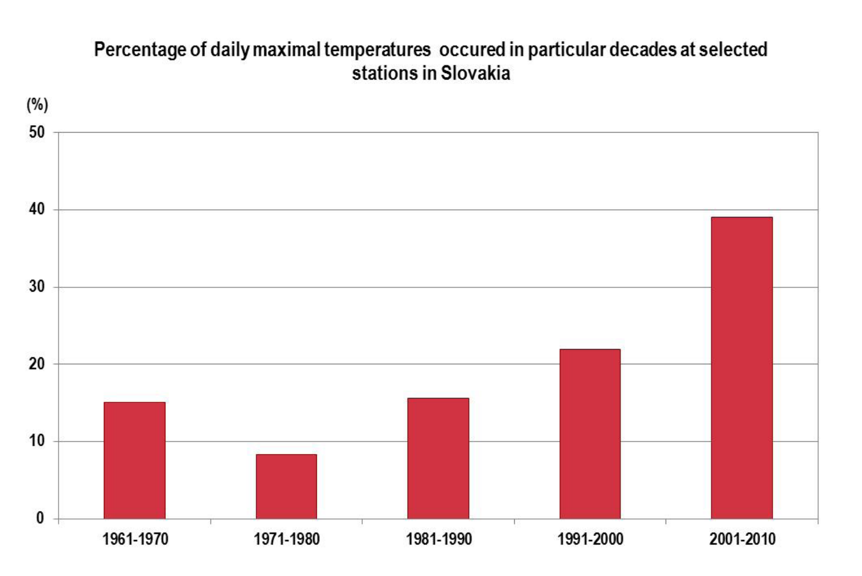
- Completion of infrastructure and capacities in the field of institutional nature protection.
- Minimalize negative impacts on biodiversity in cooperation with other sectors.
- Propose a new strategy of nature protection in Slovakia from the point of view of negative climate change impacts respecting local principles of nature protection.

6.4.4 Sector Public Health

Medical consequences of the climate change will be influenced at first by environmental factors but also by socio-economic development and by introducing the effective adaptation measures.

The basic document in the field of environmental health within the system of public health in Slovakia is the Operational Plan for the Environment and Public Health of the Slovak Republic (NEHAP III /CEHAP). It is a national program approved by the government of the Slovak Republic in Resolution No. 10/2006 Coll. to realize specific activities to achieve primary aims in regional scale based on aforementioned operational plans. The national review about the implementation of the operational plan NEHAP III in the Slovak Republic was prepared in December 2009 and it was accepted by the government in January 2010. Recently, a new operational plan (NEHAP IV), which stresses the problem of climate change in relation to public health in the Slovak Republic, is planned.

Figure 6.12: Percentage of daily maximum temperature occurred in particular decades of the period 1961-2010 in Slovakia



It looks like the weather has become more extreme in recent decades. Results of statistical processing show increasing variability of the occurrence of extreme events. Figure 6.12 shows the percentage of daily maximal temperatures out of the whole number of days in the period of 1961-2010 which occurred in the particular decade. The last decade covers almost 40% of all maximal temperatures. The higher extremity and warming characterized the decade. Next three years since 2010 has continued in this trend.

Bio meteorological conditions can in specific situations strongly influence human health, in particular people suffering with cardiovascular problems. Long periods with high temperatures are the most critical. Days with the maximum temperature reaching over 30°C are called tropical days and have potentially harsh influence on humans. Big cities and city agglomerations in southern Slovakia are in particular threatened by heat waves due to the heat island effect in these urban areas.

Figure 6.13: *Number of tropical days in Bratislava in the period of 1961-2010 and course of maximum daily temperature in Bratislava during extremely hot August 2013*

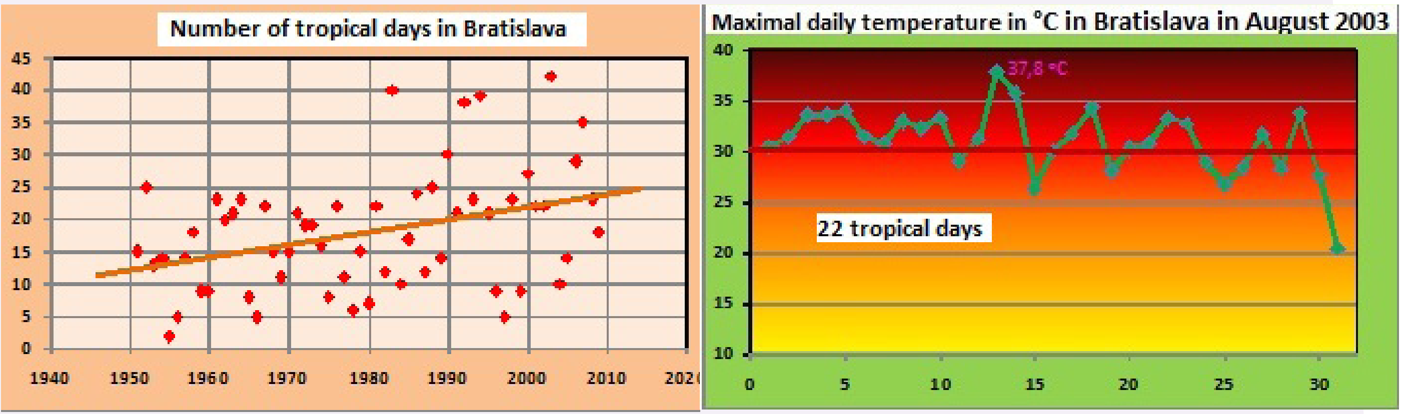


Figure 6.13 shows the characteristics of extremely hot days in Bratislava. It is clear that the number of tropical days is increasing and every year is different from previous one. One of the critical months occurred in Bratislava in August 2003. It had 22 tropical days, which constituted half of the tropical days during that year.

Although, the numbers in the figures are not extreme in comparison with some other regions in Europe it has to be stressed that the infrastructure of southern part of Slovakia is not prepared to eliminate the impact of such heat waves. Air conditioned rooms are still not a common feature of neither private nor public buildings and even the rooms in hospitals are sparsely air-conditioned.

Climate Change Impacts on Sector Public Health

Climate changes undoubtedly multiply the global health problems of people and also multiply premature deaths as a result of natural phenomena. The type and the character of the events depend on conditions in individual parts of the world.

Conclusions of several studies, projects and national reviews of effects of the weather on human health indicate that in next decade health of humans will be exposed to severe climate change impacts in a form of extreme events. Other forms of effects on health can be seen in increased malnutrition in regions, where people depend on crops and animal production. Another forms of such effects represent the change of distribution of infectious diseases, spreading of diseases caused by polluted water (especially in regions where personal hygiene and sanitation is on a very low level), spreading of respiratory diseases as consequence of changes in air and pollen distribution, etc. The most common climate change impacts in Europe and their medical consequences are described in Table 6.15.

Table 6.15: *The most common climate change impacts expected in Europe and their medical consequences*

Phenomenon	Impacts on health
Floods	Deaths, injuries, infectious diseases
Fluctuations of air temperature (extremely high air temperature, very low air temperature) in combination with polluted air and higher occurrence of ground ozone	Deteriorating health conditions of people with cardiovascular and respiratory diseases, asthma, premature deaths, dehydration
Vector of transmission of infectious diseases (mosquitoes, ticks)	Malaria, yellow fever, Lyme Borelli, encephalitis, West Nile fever
Water transmitted diseases	Hepatitis, diarrhoea
UV radiation	Skin diseases
Pollen allergens)	Allergic sensitivity, deterioration of allergic condition, higher number of asthmatic attacks
Groceries	Cases of salmonella

According to the most recent scenario of climate change in the Slovak Republic, we assume that the population will suffer from direct climate change impacts such as higher air temperatures in summer and heat waves by the end of the 21st century. Typical features of a heat wave are extreme air temperatures during the day and relatively high air temperatures at night. The more extremely warm days will happen, the higher as its consequence will occur. The most endangered areas are cities, southern parts of the Slovak Republic and the areas with higher concentration of particles PM_{10} and $PM_{2.5}$. When it is observed both extremely warm day and higher concentration of ground ozone, it can be predicted at least two times higher probability of deaths for people suffering some diseases. According to studies all over the European cities the most endangered group are people at the age from 75 to 84 years. People in this group there are usually lonely and without resources to secure their basic living standards.

Table 6.16: Climate change phenomena and their impacts on public health predicted in the Slovak Republic by the end of 2100

Phenomena	Probability according to the projections	Impact of human health
Extreme air temperature, increased frequency of its occurrence, the length of heat wave	very likely	Higher mortality and morbidity connected to the heat, especially amongst old, chronically ill, very young and isolated people
Increased number of warm days/nights	very likely	Deteriorate general health conditions, the most handicapped ones will be the old and lonely living individuals above the age of 75, children, mentally and physically handicapped
Periods with high precipitation, heavy rains, storms, tornados, flood	very likely	Bigger risk of deaths, injuries caused by floods, respiratory diseases, diseases caused by polluted water (hepatitis) and food (salmonella)
Droughts	likely	Higher risk of infectious diseases caused by water and food
Occurrence of quick changes/fluctuations of weather	likely	Bigger risk of deaths, mental diseases
Prolongation of the pollen season	likely	Asthma, allergies, respiratory diseases
Occurrence of vectors of transmission of infectious diseases	less likely	Malaria, Lyme Borelli, tick-borne encephalitis, West Nile fever
Higher UV radiance, concentrations of ground ozone and PM10	very likely	Bigger risks of cancer, deaths caused by respiratory diseases

Adaptation Measures in Sector Public Health

Reduction of negative climate change impacts including measures taken in non-medical sectors will have positive effect on public health. However, this assumption does not have to be general. Therefore, all the proposals of adaptation strategies and measures should be reviewed by the Office of the Public Health. (There are both positive and negative examples from abroad. For example, a system of micro dams and irrigation pools developed to better handling of starvation in Ethiopia eventually increased mortality caused by malaria by 7.3 times. On the other hand, air condition in both public and private buildings is in the USA are used as a primary measurement to decrease mortality in consequence of heat waves.)

There is no strategy for adaptation measures regarding the public health in Slovakia at the moment. First steps towards the adaptations in this field should comprise:

- Integrated reaction on heat waves such as taking into account climate change scenarios before designing and building new buildings and new blocks of buildings.
- New approaches towards reduction of urban heat islands, emissions of ozone and other air pollutants could be included in programs of effective usage of energy and planning of traffic.
- Creation and sustaining of a public heat wave warning program is a basic requirement of a public health protection against effects of extreme heat waves. The population needs to be repeatedly informed and advised in every possible way about possibilities of an individual protection against the heat.

The system of public health in the Slovak Republic should accept climate change and develop a strategy to react on it properly. The current situation in the public health sector in the Slovak Republic, especially in hospitals, is not favourable, because almost no attention is paid to consequences and prevention of extreme weather events.

Managers of medical institutions in cooperation with its supervisors should design short-term and long-term aims and create conditions for their achievement in such a way, so they are able to react to extreme weather events in local scale and in real time.

It is important to concentrate on education of doctors and medical staff about climate change health impacts in order to recognise early symptoms of diseases connected to heat. The level of knowledge of doctors about the risks of extremely high temperatures, warning, social and rescue systems altogether must guarantee, that patient will have a proper information and instruction, how to behave in case of higher risk.

6.4.5 Sector Hydrology and Water Management

Extreme hydrologic period of 2010-2013 has brought a lot of new knowledge in terms of floods and droughts. Evaluation of the results of monitoring of runoff and groundwater resources have drawn attention to some changes in runoff conditions but did not confirm changes in annual course of runoff. Therefore, the change in hydrological conditions caused by climate change is still one of the main sources of uncertainty in the management of water resources. In particular it concerns the quantification of decline of water resources, the estimation of increased extremity of floods and droughts, determination of the runoff regime changes as well as the quantity and variability of water content in water supplies. Key documents for the inclusion of impact assessments of climate change on runoff are the European Union Framework Directive and the Directive 2007/60/EC on the assessment and management of flood risks, with emphasis to the needs of assessment and prediction of water status, including long-term planning of water resources and ensuring flood safety.

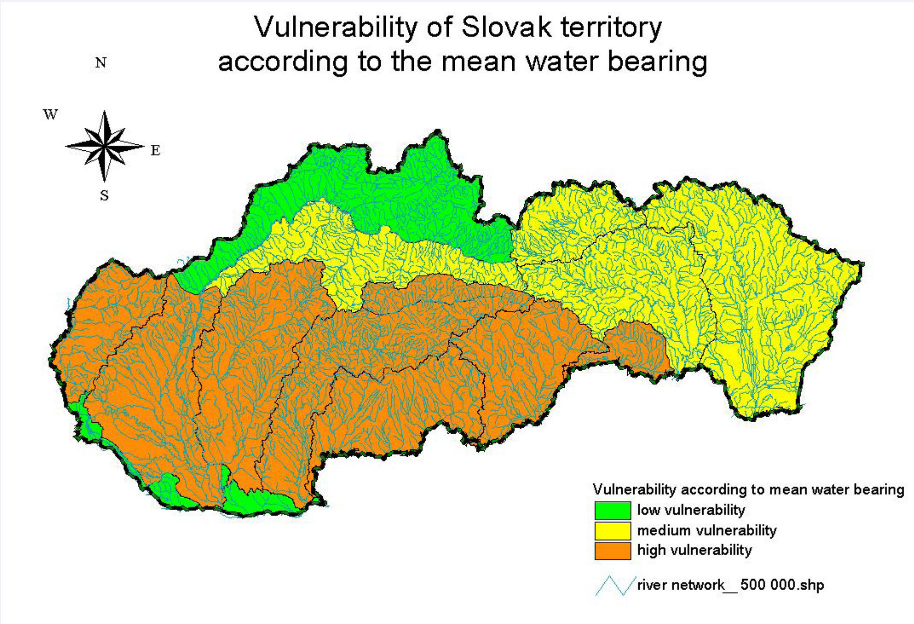
The most important hydrological indicator is the average annual flow which is the main hydrological characteristic of surface flows. The annual flow depends mainly on the amount of precipitation and evaporation but its annual course is modified with several other factors, such as vegetation cover and also part of the water that infiltrates under the earth's surface and replenishes groundwater. At the same time, the presence of water in springs or streams in winter time and runoff regime during winter supplement the retarding effects of the runoff process caused by the behaviour of rock and soil environment in individual river basins.

The course of the trend of the average annual flow in Slovakia for the period of 1931-2010 is generally declining in the most of the catchments of Slovakia. Stagnation or relatively low decline is recorded in the basins of the northwest and northern of Slovakia (eg. the Kysuca, the Orava and the Belá catchments) but also in the Danube, which is fed by precipitation in the Alps. The highest decreasing trend is in the river basins of Ipeľ, Slaná and Bodva rivers in southern Slovakia (Figure 6.13).

The comparison of trends in yield of springs and groundwater resources for the period of 1981-2009 and for the reference period up to 1980 shows that the springs from most of the Slovakia (more than 65% of area) detected the decline of their yield in the range of -5% to -15%, even less (-20%) in some locations. Groundwater in the lowlands and basins of Slovakia in the period of 1981-2009, which were compared to the reference period of 1951 to 1980, show a negative change in water storage, while the values of the decrease of specific groundwater resources vary between 50 000 and -200 000 m^3 per km^2. More significant decline of groundwater resources from -200 000 to -350 000 m^3 per km^2 are in the areas of central Zahorie and lower Považie regions, the entire north-western Slovakia and southern belt of Slovakia close to the state border with Hungary.

Using the maximum specific runoff as the indicator of the risk of floods helped us to locate individual river basins and regions where specific maximum runoffs are the greatest. 10% of the catchments with the highest specific runoff include the upper basins of Topľa, Ondava, Ladomírka, Torysa, Orava, and Laborec and tributaries of the Topľa and the Laborec rivers in their central parts. These catchments are located mostly in north eastern a northern parts of Slovakia. Evaluated trends of maximum specific runoff from at least 30-year time series of maximum annual flows showed that a significantly increased trends are registered only in the rivers where flash floods occurred in the years 2010-2013 as well as tributaries of the Bodrog river from Ukraine. The Danube also experienced an increase of the maximum peak flow rate. On the other rivers prevails decreasing or neutral trends.

Figure 6.14: The vulnerability of Slovakia regarding the mean rate of stream flow



Impact of Climate Change on Sector Hydrology and Water Management

The most important conclusions that arise from the current climate change scenarios and that can subsequently have relatively significant impacts on water management are as follows:

1. Increase of runoff in the cold half year and the loss of winter precipitation naturally accumulated in the snow.
2. Increase of potential evaporation and real evaporation (in case the water supply is available for evaporation) during the warm half year.
3. Decrease of soil moisture and reduction of hypodermic runoff during the warm half year.
4. Increase of surface runoff in the warm half year during episodic precipitation (which can lead to increased soil erosion and faster silting of water reservoirs).
5. Increase in the frequency of flooding (particularly the flash floods) and increase in their size.
6. Increase and extension of drought.
7. Reduction of usable water sources.

Vulnerability Assessment in Sector Hydrology and Water Management

Based on the analysis of current knowledge and understanding of hydrological conditions of water management in Slovakia we estimated the level of risk for negative climate change impact on the water management sector for selected geomorphological units (Table 6.17).

Table 6.17: Risk for negative impact of climate change on the water management sector for selected geomorphological units

Region	Geomorphological units	Risk
1	Malé Karpaty, Biele Karpaty, Považský Inovec, Záhorská nížina, Podunajská nížina, Považské podolie, Podunajská pahorkatina, Pohronský Inovec	*
2	Lučensko-košická zníženina, Krupinská planina, Javorie, Matransko-Slanská oblasť a priľahlé kotliny	***
3	Východoslovenská nížina, Vihorlatské vrchy	**
4	Poloniny, Nízke Beskydy, Východné Beskydy, Spišská Magura	**
5	Stredné Beskydy, Západné Beskydy, Javorníky	**
6	Tatry, Nízke Tatry, Chočské vrchy, Malá Fatra- Krivánska a priľahlé kotliny	*
7	Slovenské rudohorie, Branisko a priľahlé kotliny	***
8	Veľká Fatra, Malá Fatra-Lúčanská, Kremnické vrchy, Štiavnické vrchy, Starohorské vrchy, Poľana a priľahlé kotliny	*
9	Vtáčnik, Tríbeč, Strážovské vrchy, Žiar	*

The risk of negative impact of climate change
*0 – minimal risk, *medium risk **high risk ***very high risk*

Projected climate change will influence the change of water balance in individual basins. Increase in air temperature and the small changes in annual rainfall at the same time will induce redistribution of the flow during the year. It means an increase in winter and a decrease in summer runoff. Particularly in the northern mountainous areas in the winter months we can assume an increase in the flow and opposite tendency of flow in spring. Summer months will be characterised with a slow decrease of runoff.

Autumn seems to be a transient period from summer decrease to winter increase of runoff. Increase in winter flows will have a balancing effect on the fluctuation of runoff within a year. In summer and autumn it will extend the duration of a small rate of stream flow. It has to be taken into consideration that increased runoff will be performed in the form of mixed spring floods and summer droughts and could also be interrupted by extreme events.

Major implications of climate change in Slovakia can be a long-lasting drought in the summer and autumn months associated with a water scarcity. These dry periods may be interrupted by short episodes of extreme torrential rain or severe storm activity with rainfall inducing the formation of floods.

Prolonged drought can cause significant water shortages. According to the current development, it is likely that climate change can have a significant negative impact on the local water resources with low water yields, especially in the southern regions of Slovakia, depending on a wide range of other underlying factors (natural or anthropogenic). Changes in the hydrological regime show increased necessity for redistribution of runoff in the area between north and south of Slovakia (in other words between higher altitudes and lower altitudes), redistribute runoff between years or during the year. It is also important for water supply and hydroelectric power production. It will cover the decrease of yield of water resources, especially in the lowland parts of the central and eastern Slovakia during the summer months.

Changes in precipitation and runoff conditions, an increase of number and intensity of extreme hydro-meteorological and hydrological events due to climate change can have a significant impact on health and lives of residents. In addition to the direct threat to lives and health with the flood wave, risk connected with the deterioration of water resources and epidemiological risk would be also more frequent. Climate change may negatively impact the quality of water resources. Impact of flash floods may cause the chemical contamination of water bodies and groundwater resources used for drinking water supply. During periods of low water levels the risk of increased eutrophication and increased water temperatures, may affect the quality of water.

Adaptation Measures in Sector Hydrology and Water Management

Adaptation in our country could be divided to two parts. One of them is the elimination of drought consequences, e.g. decrease in flow rate and water yield on the one hand and on the other hand, to minimize the impact of floods, especially flash floods in mountainous and foothill areas. It is necessary to prepare and implement proper adaptation measures to eliminate adverse impacts of climate change. The most attention is paid to water resources, their protection and efficient use. Water is becoming a critical strategic resource of our country. This resource has to be protected and managed its effective and efficient use to ensure its sustainable use and the sustainable development in general. Adaptation to climate change in the area of water management should be therefore focused on implementation of measures for better management of runoff in individual catchments:

- Completion of the system of water reservoirs for the purpose of flood protection, public drinking water supply and securing the water for agriculture and industry.
- Completion of the flood protection system of major river basins, such as levees, dry polders and others.
- Revitalization of objects obstructing the streams and gradual implementation of hydro melioration measures in forestry and agriculture to increase flood protection of the area in the most vulnerable “small” river basins.

For adaptation to climate change and the Water Plan of Slovakia (the first river basin management plan) the following additional measures are suggested on the national level:

- Review the system for determining the maximum design flow rates and then assess flood safety of dams.
- Review the prospective water needs.
- Assess assurance abstraction from water works for water supply, electricity generation and augmentation of minimum flows.
- Develop a methodology for drought assessment – use additional indicators in addition to the current practice.
- Examine the drought and its impact on the ecological status of water bodies.
- Increase research on the impacts of climate change.

The Flood Protection System in Bratislava

The Bratislava Flood Protection System, which is supposed to protect citizens of the Slovak capital in a case of a momentous flood, was officially completed in 2010. The 31 million euro project was co-financed from the EU Cohesion Fund (85% from total, 10% share went from the state budget and the rest was paid by the Slovak Water Management Company). The project has been implemented from February 2007 to December 2010. The objectives of the project were as follows:

- construction of new flood protection barrier in urban and suburban areas of Bratislava,
- complete restoration (replacement and increase) of the initial flood protection line in Bratislava Old Town,
- increase of the flood protection barrier in the municipality Petržalka (part of Bratislava),
- increase of the safety of levees on the left side of the flue channel Gabčíkovo municipalities,
- prevention of economic damages in the project area including the capital city Bratislava and its neighbourhood municipalities,
- prevention of environmental damages in the project area including prevention of contamination of drinking water sources.

All objectives of the project were successfully achieved. The Flood Protection System showed its efficiency during the June 2013 Danube flood. That time the damages were by 98% lower than in similar flood from 2002. Further information:
http://www.mowe-it.eu/wordpress/floods-control-barrier-in-bratislava/

6.4.6 Sector Tourism

Tourism is a multidisciplinary sector and many other sectors are cooperating to its realization (e. g. traffic, culture, construction, health, industry, agriculture). It is a sector of services, which in economies of developed countries represent two thirds of value. Even in comparison with dynamical economic systems, tourism belongs to quickly growing ones. Scenarios of World Tourism Organization, World Travel and Tourism Council and other scientific institutions and experts predict its dynamical growth in global scale. The average interannual growth of tourism in global scale is predicted with a ratio of 2.5-2.8%. It is consistent with the growth of free time, pensions, traffic development, growth of educational level and lifestyle changes.

Climate Change Impacts on Sector Tourism

Climate change can significantly affect both natural and socioeconomic conditions for the tourism potential of individual regions, even countries. Prevailing part of tourist's activities is based on a stability of climate conditions and infrastructure, marketing and local socio-economic activities are adjusted to them. We can define 4 main categories of climate change impact on tourism including its competitiveness and sustainable development in the global scale:

- Direct climate change impacts.
- Indirect environmental change impacts.
- Mitigation policy's impact on touristic mobility.
- Indirect social changes' impacts.

Several studies indicate that the transition of attractive climate conditions towards higher latitudes and altitudes is very likely. Also an increase of occurrence of extreme weather events such as heat waves, drought, floods, intense rainfall, hurricanes can influence tourism through the higher risk of infrastructure damage, additional need for safety and higher operating costs (insurance, conditions of evacuation, water and electric supply).

Indirect environmental change impacts as a result of climate change can significantly influence tourism from local to regional scale. Changes, such as water supplies availability, loss of biodiversity, loss of aesthetic value of the country and typical agricultural products (e. g. wine tourism), higher risk of dangerous diseases, can cause distinctive decrease of touristic potential of certain destinations. On the other hand, some other regions can profit from environmental change impacts and their touristic potential can grow.

Climate change impact on tourism in Slovakia:

- Improvement of conditions for summer touristic activities connected to bathing and mountain tourism.
- Improvement of conditions for winter sports related to the occurrence of snow cover – especially in the winter centres under 1 000 m a. s. l.
- Deterioration of conditions for winter touristic activities in mountains (cross-country skiing, alpine skiing, etc.).

Based on the results of analysis of recent knowledge of conditions for realization of touristic activities in Slovakia, we consider the question of realization of winter tourism activities to be the most serious consequence of climate change impact. We estimated the degree of the risk of negative climate change impact on tourism for individual municipal regions by analysing available knowledge (Table 6.18).

Table 6.18: Degree of the risk of negative climate change impact on tourism for individual municipal regions

Tourism	Higher territorial region							
	BA-SK	TT-SK	NR-SK	TN-SK	BB-SK	ZA-SK	PO-SK	KE-SK
Tourism in the city	*	*	*	0	0	0	0	*
Summer tourism - pools	+	+	+	+	+	+	+	+
Summer tourism-mountains	+	+	+	+	+	+	+	+
Winter tourism-mountains	***	***	***	**	**	*	**	**

The risk of a negative impact of climate change on tourism
*+ - positive impact 0 – minimal risk, *medium risk **high risk ***very high risk*

Vulnerability Assessment in Sector Tourism

Tourism has a cross-cutting nature and is present in various areas of economic, social and cultural life. It has an impact on balance of payments, employment development, job creation and positive impact on economic and social development of regions. Consequences of climate change in tourism sector are negative but also positive in different types of tourism.

Previous studies reporting the climate change impact on tourism distinguish winter and summer tourism. Only a marginal attention is paid to urban tourism. As a result of the position of Slovakia, we can expect that the most significant effect of the increase of average air temperature is to be on winter tourism in Slovakia. According to model's results it is not possible to expect extremely positive effect of increasing of average yearly temperature on winter tourism as well as on urban tourism.

Positive consequences of climate change:

- Summer tourism - an increase of air temperature and the number of summer days will help to develop the summer tourism in territories with suitable positions, e.g. lakes and water parks.

Negative consequences of climate change:

- Winter tourism – the reduction of number of days with snow cover will shift the border line of ski resort to higher altitudes and cause the reduction of winter seasons in resorts with lower altitudes.
- Summer tourism in southern parts of Slovakia – decrease of river discharges can affect summer water sports in Slovakia.
- Spa and health tourism – extension of the growing season and consequently of the pollen season will reduce the number of days suitable for this type of recreation. The shift of boundaries (air temperature, vegetation zones) into higher altitudes may cause fewer visitors due to unfavourable conditions.
- Cultural and urban tourism - increasing heat waves and extreme weather events will affect climate comfort of visitors.
- Rural tourism and agro-tourism - effects of climate change on crop and livestock production are indirectly reflected in this type of tourism.

Adaptation Measures in Sector Tourism

- Incorporation of climate change risks in Slovakia into strategic development activities in the field of tourism.
- To design regional studies of climate change impacts for individual touristic regions in Slovakia with reflection of their specifications.
- To complete the infrastructure of winter centres, especially with respect to safety enhancement of artificial snow cover.
- To develop a functioning system of a complex information centres in the main centres of tourism with online information system (meteorological conditions for tourism, dangerous phenomena, services, offers, etc.).
- Completion of safety systems for tourists – reinforcement of technical and capacity centres of mountain rescue service, first aid centres in touristic centres and the centre of avalanche prevention.

6.4.7 Sector Transport

Geographical location in the Central Europe and its location in relation to the most important economic centres and ports of Europe means that Slovakia is in the cross point of important transcontinental traffic directions:

- The north-south direction connecting ports on the northern shore of the Adriatic Sea with St. Petersburg and ports near the Baltic Sea.
- The west-east direction connecting the traditional centres in Western Europe with centres in Russia and Ukraine.
- Connecting north-western Europe with south-eastern part of the continent (the connection between the ports near the Northern Sea and ports on the Balkan Peninsula).

Slovakia is therefore a very important transit territory and its transit role is strengthened by its peripheral locality within the European Union, where it serves as EU's gateway to economically interesting part of the Eastern Europe (Ukraine and other countries of former Soviet Union).

Climate Change Impacts on Sector Transport

Adverse weather phenomena can extent the transport time of goods, passengers and increase likelihood of accidents. In the transport sector are several means of transportation affected directly with weather phenomena. Extreme weather phenomena (high and low temperatures, intense storms, heavy snow) cause serious difficulties in almost all modes of transport. Comprehensive analysis of the potential effects of climate change on various sectors including transport was made by the Ecological & Forest Research Agency and is summarized in the Table 6.19.

Table 6.19: Potential effects of climate change on transportation

Transport	Weather impact	Consequences
Road transport	Extreme weather events (storms, floods)	Shutdown of roads, detours, damage of road infrastructure
	Adverse meteorological conditions (rain, snow, black ice, fog)	Less safe and smooth traffic, traffic jams
	Adverse meteorological conditions (rain, snow, black ice, fog)	Increased request for a winter maintenance, damage of road surface
Air transport	Extreme weather (storms, floods)	Interruption in service of airport, damage of facilities, flight delays
	Adverse meteorological conditions (rain, snow, black ice, fog)	Flight delays
Rail transport	Extreme weather (storms, floods)	Interruption in traffic, damage of infrastructure
	Adverse winter condition (frequent snowing, wind, long winter)	Increased demand for winter maintenance, damage of rails and sidings
Water transport	Extreme weather (storms, floods)	Interruption in traffic, damage of infrastructure
	Frequent snowing, wind, long winter	Frequent snowing, wind, long winter

In terms of conditions in the Slovak Republic following impacts are expected in relation to the climate change impacts in traffic:

- The main road corridors will be negatively affected in the future, especially in winter (e. g. by snow cover, ice coating, wind) and in mountain localities and mountain passes in higher altitudes, predominantly in the central and north parts of the Slovak Republic (e. g. Donovaly, Čertovica, Besník, Šturec, Cesta Slobody (The Freedom Road) in the Hight Tatras – particularly its western part from Smokovec to Podbanské).
- In the highest parts of the road corridors near Štrbské pleso and Čertovica, we can expect higher amount of precipitation in winter.
- Decrease of snowfall in lowlands of the country, number of freezing days and days with a presence of black ice.
- Variability of climate effects on road traffic will increase – from the positive in lowlands to negative in higher altitudes.
- In the rail traffic, positive climate change influences, such as the increase of air temperature, will be in mountains and basins. Negative climate change impacts are represented with heat waves, particularly in lowlands in summer time.
- Considering rail traffic in relation to precipitation, higher amount of precipitation in winter in basins and mountains could have a negative effect.
- Inland waterways on the Danube, the Morava and outfall of the Váh rivers will be influenced in a negative way due to low summer flows.
- Aviation will be more susceptible to extreme weather events, the Bratislava Airport and Košice Airport will be negatively influenced by dangerous climatic phenomena in winter (e.g. black ice, snow cover).
- Projected climate change will probably not affect pipeline transport.
- Most vulnerable mean of transport to climate change impacts seems to be the road traffic (very similarly as nowadays).
- Most vulnerable regions of the Slovak Republic in terms of traffic are basins and higher altitudes in northern, central and eastern part of the country.
- Some shorter road sections above 1 200 m a. s. l. will probably suffer from higher amount of precipitation in winter, therefore road and other means of transport will be more problematic in those particular sections.

Vulnerability Assessment in Sector Transport

Based on the analysis of current knowledge and information about traffic in Slovakia, we estimated the level of risk for all types of transport (road transport is the most affected), including their infrastructure (road and railway transport are the most affected). Table 6.20 shows the risk level expressed in four grades in individual municipal regions.

Table 6.20: Risk of climate change impacts on traffic in individual municipal regions

Type of transport	Higher territorial region							
	BA-SK	TT-SK	NR-SK	TN-SK	BB-SK	ZA-SK	PO-SK	KE-SK
Road transport	**	*	*	*	**	**	**	**
Railway transport	*	*	*	*	*	**	**	**
Air transport	*	0	0	0	*	0	*	*
Water transport	*	*	*	0	0	0	0	0
Pipeline transport	0	0	0	0	0	0	0	0

The risk of a negative impact of climate change on transport
*0 – minimal risk, *medium risk **high risk ***very high risk*

Adaptation Measures in Sector Transport

Adaptation measures in traffic can be divided into two groups of actions. The first one includes the measures focused on reduction of risk and hazard on roads caused by extreme weather events. The second group includes measures improving the traffic infrastructure in what would be the most affected localities.

The issue of traffic safety, in relation to expected impacts of climate change, is closely related to the implementation of the Intelligent Transport Systems. Implementation of the Intelligent Transport Systems can help reducing the impact of extreme weather phenomena on accidents. Another measure in this area could be more pronounced educative activities (media, schools including driving schools) focused on risk awareness of extreme weather conditions in relation to the transport.

The second group of measures is adaptation measures focused on the rebuilding of the transport infrastructure in relation to increase risk of intense thunderstorms and flood situations. This type of adaptation measures is generally recommended throughout the Europe (FIST 2009). These measures can be specified as follows:

- Reconstruction and providing functionality of drainage systems of Classes I, II and III in Žilina, Banská Bystrica, Prešov and Košice Region.
- Reconstruction of bridges and culverts and increase their flow parameters, especially in the Žilina, Banská Bystrica, Prešov and Košice Region.

6.4.8 Sector Energy

Energy system of the Slovak Republic represents the structures of consumption of primary energy sources and their transformation into the final, usable energy carriers for consumption. This system includes all consumption of fossil fuels in stationary and mobile sources. Stationary sources represent heating plants for public and for individual factories, power plants and heating plants as well as fuel consumption for direct heating of technological processes. The part of the system, producing electricity and heat will be affected by climate change mainly through reduced heat consumption in winters, increased consumption of electricity for air conditioning and outages in the power system due to adverse weather events.

Impacts of Climate Change on Sector Energy

The positive impact of the increase of the mean temperature will cause the reduction in annual energy consumption for heating. On the other hand, this increase in temperature does not exclude the occurrence of extremely cold winter days. Coverage of the heat needs in these days requires adequately installed thermal capacity. However, it is still expected that the annual use of installed capacity will be reduced.

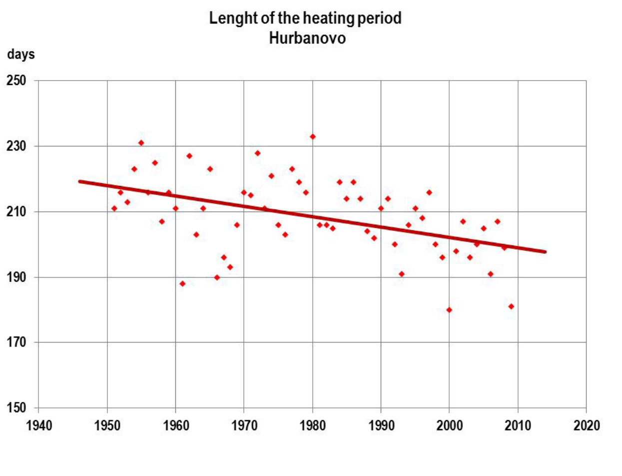
The length of the heating season is determined by the ambient temperature. In the warmest areas of Slovakia, the length of the heating season ranged from 190 to 230 days a year and in Figure 6.14 we can see a clear trend of decline in the length of the heating season, which fell during the period 1951-2010 by 19 days (Hurbanovo). Similarly, in the northern regions of Slovakia (Liptovsky Hrádok) the length of the heating season was reduced by 20 days.

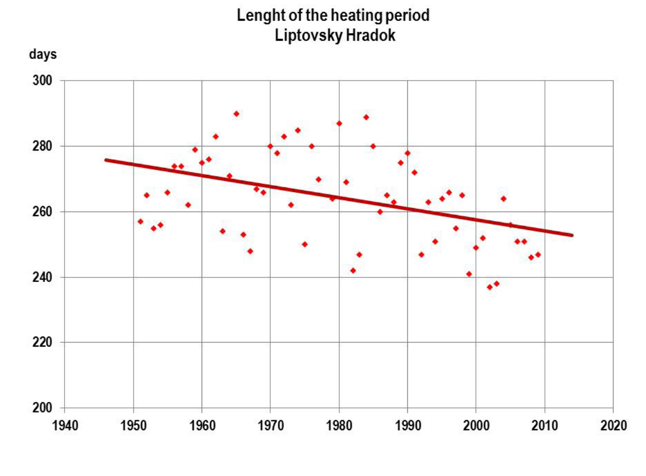
However, increased demand for cooling will be in the warm half year. Number of tropical nights and hot days will increase. It will mean increased demand for air-conditioning units and simultaneously the increase in electricity consumption during hot days.

Extreme weather events such as storms, droughts and a period of high and low surface water level can adversely affect the operation of equipment for energy conversion, transport and supply. More frequent and extreme weather events such as storms or lightning strikes can damage power lines and it means an increased risk for transmission and distribution of electricity. The consequence of this situation could be an interruption of energy or short-term price increase due to lack of energy in real time.

The decisive factor for electricity generation in thermal and nuclear power plants is adequate availability of cooling water. These plants could be affected with water shortages and higher temperature of water in rivers during the summer months. Dry periods will also mean increased water abstraction for irrigation, which without adequate measures increases the likelihood that power plants will lack cooling water.

Figure 6.15: Length of the heating period for lowland (Hurbanovo) and mountainous (Liptovský Hrádok) areas in Slovakia in the period of 1961-2010





There are three basic aspects of the climate change impacts on energetic system of the Slovak Republic:

1. The reduction of energetic demands for heating during winters as a consequence of shortening of heating period.
2. Black-outs connected with an occurrence of meteorological phenomena such as storms, haze, floods. The increase in intensity of extreme weather events could in the year 2050 also increase an occurrence of black – outs by 10% (lower estimation) to 20% (upper estimation), in comparison to the reference period 2000-2010.
3. An increase of energetic demands for needs of air conditioning of buildings, houses, apartments and industrial buildings.

Vulnerability Assessment of Sector Energy

The vulnerability of the energy sector can be divided into several aspects. One of them is increased demand on the safety of energy facilities, especially nuclear power plants to adverse weather phenomena. In particular, phenomena connected with high wind speed, such as tornadoes, strong thunderstorms, and so on but also the accessibility of water for cooling and temperature parameters of this water. Another aspect is the resistance to transmission system failures, namely the strong wind, frost and ice as well as their combinations. In hydropower energetics is increased likelihood of extension of hydrological drought.

Adaptation Measures in Sector Energy

Basic measure for energetic sector can be expressed as follows:

- Creation of precautionary, technical and operational arrangements for an adaptation of transmitting electrified system to increased occurrence of black – outs as a consequence of dangerous meteorological phenomena, such as intense storms, rainfalls and local floods, etc.
- Design a strategy of funding and designing of air conditioning of flats, houses, administrative buildings, hospitals and social services and to propose technical and operational measures which would consider seasonal changes in demand for electricity.
- Reconsidering of heat generation strategies with respect to shortening of heating season.

Table 6.21: Summary of information on vulnerability and adaptation to climate change in the Slovak Republic

Vulnerable field	Examples/Comments/Adaptation measures
Hydrology and water management	Vulnerability: ▪ Threat of water resources for water supply and electric energy production; ▪ Decrease in water resources in the south and east of Slovakia; ▪ Decrease in the electric energy production from big water power stations; ▪ Increase in the occurrence of drought and floods; ▪ Change of hydrologic cycle. Adaptation: ▪ Water resources protection; ▪ Increased need to redistribute runoff between the north and the south; ▪ Identification of prospective and supplementary resources for water supply and their utilization; ▪ Effective water management in the country; ▪ Re-evaluation off big and small flood control reservoirs storage; ▪ Utilization of new energy sources (bio-fuels, wind energy, small hydropower stations).
Agriculture	Vulnerability: ▪ Creeping increase of aridness of maize production area; ▪ Occurrence and spread of pests and diseases of agricultural plants, trees and animals. Adaptation: ▪ Cultivation and introduction of new agricultural and horticultural species; ▪ Development of irrigation systems; ▪ Mulching.
Forest management	Vulnerability: ▪ Adverse influence of drought on forest ecosystems in the south of Slovakia; ▪ Increased risk of forest fires; ▪ Damage to forest ecosystems by new dynamics of pests; ▪ Destruction of spruce forests; ▪ Shift of wet snow zone to higher altitudes resulting in snow break and rooting out trees. Adaptation: ▪ Cultivation of new and more resistant species and the change of tree composition; ▪ Forest protection against biotic pests; ▪ Gradual change in composition of tree species in the forests; ▪ Reduction of permanently deforested areas.
Biodiversity	Vulnerability: ▪ Invasions of some species of insects as agricultural pests; ▪ Invasions of vector diseases threatening human health; ▪ Decrease in biodiversity. Adaptation: ▪ Phytopathological measures in legislation and in practice; ▪ Conservation of original species spectrum of biodiversity in Slovakia; ▪ Protection of extra endangered species and communities; ▪ Prevention of drying of wetlands and water biotopes.
Transport	Vulnerability: ▪ Affecting road transport by higher precipitations and snow in mountains; ▪ Affecting air transport by dangerous meteorological phenomena; ▪ Negative impact of the decrease in precipitation totals on inland water transport. Adaptation: ▪ Support of railway transport; ▪ Improvement of quality of road corridors and their enlargement, construction of motor-ways and tunnels; ▪ Support and development of national air transportation.
Tourism	Vulnerability: ▪ Less snow and irregular occurrence of snow cover in lower localities; ▪ Winter season shortening in lower localities; ▪ Restriction of water tourism in the south of Slovakia. Adaptation: ▪ Transfer of skiing activity to higher centres; ▪ Reorientation of threaten winter centres to other activities; ▪ Supporting development of winter sport centres in higher altitudes.
Energy	Vulnerability: ▪ Affecting power plants by more adverse weather phenomena, tornadoes, strong thunderstorm; ▪ Higher demand to energy in summer season; ▪ Less water in rivers. Adaptation: ▪ Increase of power plants safety;

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07

Provision of Financial, Technological and Capacity Building Support to Developing Countries

7.1 INTRODUCTION

The chapter provides an overview of relevant projects specifically aimed at addressing climate change or related activities that were primarily designed for other purposes, but are also contributing to the area of mitigation or adaptation. Related activities were from projects implemented in the period 2009-2013 under the financial assistance granted by the SR to developing countries. Of the total portfolio, following activities were selected: activities in the field of climate change adaptation, mitigation projects, support and capacity building projects for water, waste management, ecological agriculture, food security, afforestation and renewable energy sources development.

A capacity building project in collaboration with the SHMI was implemented, aimed at professional and practical advice to prepare official reports that developing countries submit to the Secretariat of the UN Framework Convention on Climate Change.

The Slovak Republic has implemented more than 30 capacity building projects, mainly in the form of bilateral cooperation - see Tables 7.6-7.10. Most of them have been realized under the Official Development Assistance (ODA) on the basis of open calls of the Slovak Agency for International Development Cooperation. Another form of support were scholarships that Ministry of Education, science, research and sport of the Slovak Republic provides to students from developing countries, which represent territorial priorities for ODA. Study programs include the topics focused on environmental education. In addition, there were also project implemented through multilateral channels, in particular through the European Bank for Reconstruction and Development (EBRD). Their report is presented in Tables 7.11 to 7.13.

In order to fulfil our fast-start finance mechanism commitment for climate change policy in developing countries in the years 2010-2012, there were projects financed and implemented also beyond the officially approved amount for ODA. Currently in the Slovak Republic is being prepared a comprehensive information system for accounting and reporting of development financial flows of Slovakia, in accordance with the requirements of the OECD Development Assistance Committee which member is Slovakia since September 17, 2013. The aim is to streamline the monitoring, reporting and verification (MRV) of development aid from the Slovak Republic in relation to new programs and areas of possible support.

Table 7.1: Provision of public financial support: Summary information for 2009

Allocation channels	Mitigation (EUR)	Adaptation (EUR)	Mitigation and Adaptation (EUR)	Mitigation (USD)*	Adaptation (USD)*	Mitigation and Adaptation (USD)*	Type of contribution
Total contributions through multilateral channels							
Multilateral financial institutions, including regional development banks							
Total contributions through bilateral, regional and other channels		483 168	770 989		652 277	1 040 835	Core (ODA)
Total		483 168	770 989		652 277	1 040 835	

Table 7.2: Provision of public financial support: Summary information for 2010

Allocation channels	Mitigation (EUR)	Adaptation (EUR)	Mitigation and Adaptation (EUR)	Mitigation (USD)*	Adaptation (USD)*	Mitigation and Adaptation (USD)*	Type of contribution
Total contributions through multilateral channels							
Multilateral financial institutions, including regional development banks	267 000			360 450			Core (EBRD)
Total contributions through bilateral, regional and other channels	370 633	312 759	110 000	500 355	422 225	148 500	Core (ODA)
Total	637 633	312 759	110 000	860 805	422 225	148 500	

Table 7.3: Provision of public financial support: Summary information for 2011

Allocation channels	Mitigation (EUR)	Adaptation (EUR)	Mitigation and Adaptation (EUR)	Mitigation (USD)*	Adaptation (USD)*	Mitigation and Adaptation (USD)*	Type of contribution
Total contributions through multilateral channels							
Multilateral financial institutions, including regional development banks	267 000			360 450			Core (EBRD)
Total contributions through bilateral, regional and other channels	681 583	728 688	160 00	920 137	983 729	216 000	Core (ODA)
Total	948 583	728 688	160 000	1 280 587	983 729	216 000	

Table 7.4: Provision of public financial support: Summary information for 2012

Allocation channels	Mitigation (EUR)	Adaptation (EUR)	Mitigation and Adaptation (EUR)	Mitigation (USD)*	Adaptation (USD)*	Mitigation and Adaptation (USD)*	Type of contribution
Total contributions through multilateral channels							
Multilateral financial institutions, including regional development banks	580 000			783 000			Core (EBRD)
Total contributions through bilateral, regional and other channels		149 393	3 041 034		201 681	4 105 396	Core (ODA)
Total	580 000	149 393	3 041 034	783 000	201 681	4 105 396	

Table 7.5: Provision of public financial support: Summary information for 2013

Allocation channels	Mitigation (EUR)	Adaptation (EUR)	Mitigation and Adaptation (EUR)	Mitigation (USD)*	Adaptation (USD)*	Mitigation and Adaptation (USD)*	Type of contribution
Total contributions through multilateral channels							
Multilateral financial institutions, including regional development banks							
Total contributions through bilateral, regional and other channels		74 952	503 221		101 186	679 349	Core (ODA)
Total		74 952	503 221		101 186	679 349	

Table 7.6: Provision of public financial support: contribution through bilateral, regional and other channels in 2009

Recipient country/region/project/ programme	Total amount (EUR)	Total amount (USD)*	Status	Funding source	Financial instrument	Type of support	Sector
Kenya, Building of a breeding facility for the production of sterile male tsetse flies for the eradication of the affected areas of Kenya	167 508	226 136	Provided	ODA	Grant	Adaptation	Other - Health
Kenya, Enhancing professional capacity in the agricultural sector in Central Kenya	205 912	277 982	Provided	ODA	Grant	Cross-cutting	Agriculture
Afghanistan, Increasing professional capacities in agriculture and combating rural poverty	241 511	326 040	Provided	ODA	Grant	Cross-cutting	Agriculture
Serbia, Construction of sewerage system in Hajdušica	198 916	268 537	Provided	ODA	Grant	Adaptation	Water and sanitation
Montenegro, Macedonia and Bosnia and Herzegovina, Building national capacities for the implementation of quality management systems and environmental management systems management systems and environmental management systems	179 934	242 911	Provided	ODA	Grant	Cross-cutting	Cross-cutting
Georgia, Support of the process of improving quality management and water quality monitoring information system as a tool for decision making in water protection policy	116 744	157 605	Provided	ODA	Grant	Adaptation	Water and sanitation
Ukraine, Building national capacities in the implementation of quality management systems and environmental management systems	143 632	193 904	Provided	ODA	Grant	Cross-cutting	Cross-cutting

Source: http://www.slovakaid.sk/?page_id=3463

Table 7.7: Provision of public financial support: contribution through bilateral, regional and other channels in 2010

Recipient country/region/project/ programme	Total amount (EUR)	Total amount (USD)*	Status	Funding source	Financial instrument	Type of support	Sector
South Sudan, Restarting of Farming with Modern Technology at Maridi	188 103	253 940	Provided	ODA	Grant	Adaptation	Agriculture, Water and sanitation
Kenya, Forest Protection Strategy for Improved Carbon Balance and Preservation of Biodiversity Despite Climate Change	124 656	168 286	Provided	ODA	Grant	Adaptation	Forestry
Kenya, Utilization of Solar Energy	209 970	283 460	Provided	ODA	Grant	Mitigation	Energy
Serbia, Solar Energy for Handicapped Children	160 663	216 896	Provided	ODA	Grant	Mitigation	Energy
Kenya, Capacity Building for Activities Concerning Climate Change MRV System and Adaptation	104 529	141 115	Provided	ODA	Grant	Cross-cutting	Cross-cutting
Various developing countries, Granted Scholarships for students from different developing countries who study in the field of environment and land protection, ecology and environmental sciences.[1]	110 000	148 500	Provided	Ministry of Education, Science, Research and Sport	Grant	Cross-cutting / Other	Cross-cutting / Other

Source: SlovakAid

1 Source: Ministry of Education, Science, Research and Sport of the Slovak Republic (MESRS SR)

Table 7.8: ***Provision of public financial support: contribution through bilateral, regional and other channels in 2011***

Recipient country/region/project/ programme	Total amount (EUR)	Total amount (USD)*	Status	Funding source	Financial instrument	Type of support	Sector
Various developing countries, Granted Scholarships for students in the field of environment and land protection, ecology and environmental sciences[2]	160 000	216 000	Provided	MESRS SR	Grant	Cross-cutting / Other	Cross-cutting / Other
Serbia, Construction of Sewage Treatment Plant and 1st Phase of Canalization Network for town Kovacica	220 000	297 000	Provided	ODA	Grant	Mitigation	Water and sanitation
Serbia, Ecological Agriculture Production System Construction on the EU Level	149 236	201 469	Provided	ODA	Grant	Adaptation	Agriculture
Montenegro, Mobile Flood Protection of Cities and Municipalities - FLOODefence.ME	200 000	270 000	Provided	ODA	Grant	Adaptation	Water and sanitation
Kenya, Mau Forest Ecosystem Degradation Reduction	296 959	400 895	Provided	ODA	Grant	Mitigation / REDD+	Forestry
Montenegro, Flood Protection Aid for Montenegro	199 000	268 650	Provided	ODA	Grant	Adaptation	Water and sanitation
Bosnia and Herzegovina, Solar and Water Energy Sources Mapping	164 624	222 242	Provided	ODA	Grant	Mitigation	Energy
Georgia, EU Directive on Assessment and Management of Flood Risks Implementation Process Support	80 453	108 612	Provided	ODA	Grant	Adaptation	Water and sanitation
Kyrgyzstan, Rice from Uzgen - Poverty Reduction Strategy and Small-Scale Enterprise Development through Traditional Agriculture	100 000	135 000	Provided	ODA	Grant	Adaptation	Agriculture

Source: *http://www.slovakaid.sk/wp-content/uploads/2011/07/Sum%C3%A1r_schv%C3%A1len%C3%A9-projekty_V%C3%BDzvy-2011.pdf*

Table 7.9: ***Provision of public financial support: contribution through bilateral, regional and other channels in 2012***

Recipient country/region/project/ programme	Total amount (EUR)	Total amount (USD)*	Status	Funding source	Financial instrument	Type of support	Sector
Kenya, Drinking Water Source	149 393	201 681	Provided	ODA	Grant	Adaptation	Water and sanitation
Various developing countries, Granted Scholarships for students from countries, which represent territorial priorities of ODA of Slovakia.	1 630 000	2 200 500	Provided	MESRS SR	Grant	Cross-cutting / Other	Cross-cutting / Other
Afghanistan, Higher Expert Education in Parwan Province	266 618	359 935	Provided	ODA	Grant	Cross-cutting	Cross-cutting
Kenya, Agricultural Development and Natural Resources Conservation	268 060	361 881	Provided	ODA	Grant	Cross-cutting	Cross-cutting
South Sudan, Sustainable Agri-Business for Eira	189 836	256 279	Provided	ODA	Grant	Cross-cutting	Agriculture
Kenya, Enhancing professional capacity in the agricultural sector in Central Kenya	205 912	277 982	Provided	ODA	Grant	Cross-cutting	Cross-cutting
Kenya, Improving food security and health status of communities in the district Sigowet in Kericho district	263 232	355 363	Provided	ODA	Grant	Cross-cutting	Cross-cutting
South Sudan, Training Center of St. Peter Claver in Rumbek, phase II.	217 376	293 457	Provided	ODA	Grant	Cross-cutting	Cross-cutting

Source: *http://www.slovakaid.sk/wp-content/uploads/2012/07/Zoznam-ziadosti-2012.xls*

2 Source: Ministry of Education, Science, Research and Sport of the Slovak Republic (MESRS SR)

Table 7.10: Provision of public financial support: contribution through bilateral, regional and other channels in 2013

Recipient country/region/project/programme	Total amount (EUR)	Total amount (USD)*	Status	Funding source	Financial instrument	Type of support	Sector
Kenya, Operation of a health center and agriculture and farming as means to enhance economic and food self-sufficiency	124 900	168 615	Provided	ODA	Grant	Cross-cutting	Agriculture
Kenya, Increasing the food security of small farmers by disseminating practical knowledge vocational schools in Nakuru County	183 970	248 360	Provided	ODA	Grant	Cross-cutting	Agriculture
South Sudan, Strengthening agri-cultural livelihoods of small farmers around Wau	194 351	262 374	Provided	ODA	Grant	Cross-cutting	Agriculture
Montenegro, Support of the implementation process of the EU Directive on the assessment and management of flood risks	74 952	101 186	Provided	ODA	Grant	Adaptation	Water and sanitation

Source: http://www.slovakaid.sk/wp-content/uploads/2013/07/zoznam-schvalenych-ziadosti-s-vyskou-dotacie.xlsx

Table 7.11: Provision of public financial support: contribution through multilateral channels in 2010

Donor funding	Type of contribu-tion	Total amount (EUR)	Total amount (USD)*	Status	Funding source	Financial instrument	Type of support	Sector
Contribution to the Technical Co-operation Fund SR - EBRD	Core	130 000	175 500	Provided	Ministry of Finance	Grant	Mitigation	Energy

Source: Ministry of Finance of the Slovak Republic, Ministry of Foreign and European Affairs of the Slovak Republic

Table 7.12: Provision of public financial support: contribution through multilateral channels in 2011

Donor funding	Type of contribu-tion	Total amount (EUR)	Total amount (USD)*	Status	Funding source	Financial instrument	Type of support	Sector
EBRD Technical Cooperation Fund	Core	267 000	360 450	Provided	EBRD / Slovak consultant	Grant	Mitigation	Energy

Source: Ministry of Finance of the Slovak Republic, Ministry of Foreign and European Affairs of the Slovak Republic

Table 7.13: Provision of public financial support: contribution through multilateral channels in 2012

Donor funding	Type of contribu-tion	Total amount (EUR)	Total amount (USD)*	Status	Funding source	Financial instrument	Type of support	Sector
EBRD Technical Cooperation Fund	Core	267 000	360 450	Provided	EBRD / Slovak consultant	Grant	Adaptation	Water and sanitation
EBRD Technical Cooperation Fund	Core	300 000	405 000	Provided	EBRD / Slovak consultant	Grant	Adaptation	Water and sanitation

Source: Ministry of Finance of the Slovak Republic, Ministry of Foreign and European Affairs of the Slovak Republic

Comment to "*": EURO/USD exchange rate of 1.35, as of September 26, 2013 has been applied for all the tables in the report.

08
Research and Systematic Observation

8.1 DOMESTIC ACTIVITIES IN RESEARCH

The Slovak Republic has developed an Integral Conception of State Scientific and Technical Policy. The Ministry of Education, Science, Research and Sport of the Slovak Republic (MESRS) is the authority with full competences and administration skills to manage research and development in Slovakia according to the Act No. 172/2005 Coll. on the organization of the state support of research and development. In 2007 the Slovak Government approved "Long targets in research, human resources development and international cooperation". It includes also the themes of State programs of research and development. Similarly, ministries, central bodies of state administrations and the Slovak Academy of Sciences have developed their sector conceptions supporting research and development. One of the substantive priorities of research and development is "Environmental protection", which is, among other things, focused on the research and development in the field of measures to mitigate negative impacts connected with climate change.

In 2008, the state support of research and development was adopted. Basic research is supported mainly from the public funds (the state budget and the EU funds) in conformity with the principles applied within the European research area. Research activities are funded from the budget of the MESRS and they are partly realized in common competitive environment through several grant agencies. The Scientific Grant Agency of the MESRS and the Slovak Academy of Sciences supports the basic research carried out mainly at universities and the Institutes of the Slovak Academy of Sciences. The Slovak Research and Development Agency supports research and development infrastructure through the funds of the MESRS. The Grant Agency of the Ministry of Education for Applied Research supports projects in applied research anywhere in Slovakia.

In addition to the budget of the MESRS, research is funded also from the budgets of other ministries, central bodies, Slovak Academy of Sciences and private sector.

8.2 INTERNATIONAL ACTIVITIES IN RESEARCH

In comparison with the previous period some increase in domestic and international activities has been registered. Climate change caused by the human activities, natural climatic changes and variability and their impacts on natural ecosystems and different social and economic sectors have been in the centre of scientific interest of several institutions, domestic and international projects and programs. Particularly within the structures of conjoint European research in the COST projects (Cooperation in Science and Technology) and within the Framework Programs (FP7 – 2007-2013, FP8 – in preparation (2014-2020)) a large number of different activities have been realized. Some projects have been funded partly from the state budget and Structural Funds of the EU. National projects in this field are as important as the international ones, their scope and results are mostly comparable with the European standards. The national projects on climate change, vulnerability and impacts were the most frequent in the process of international projects demands. It needs to be count among them also a large number of projects not dealing directly with climate change issues, but with physical, chemical and biological processes connected with comparable impacts like the climate change is.

List of Institutions involved in climate change oriented research:

- Slovak Hydrometeorological Institute, Bratislava (SHMI);
- Faculty of Mathematics, Physics and Informatics, Comenius University in Bratislava (FMFI UK);
- Faculty of Natural Sciences, Comenius University in Bratislava (PrF UK);
- Faculty of Civil Engineering, Slovak University of Technology in Bratislava (SvF STU);
- Faculty of Forestry, University of Technology in Zvolen (LFTU);
- National Forestry Centre in Zvolen (NLC);
- Slovak University of Agriculture in Nitra (SPU);
- Institute of Geophysics at the Slovak Academy of Sciences (GFU SAV);
- Institute of Parasitology at the Slovak Academy of Sciences (PAU SAV);
- Institute of Landscape Ecology at the Slovak Academy of Sciences (UKE SAV);
- Institute of Botany at the Slovak Academy of Sciences (BOU SAV);
- Institute of Zoology at the Slovak Academy of Sciences (UZ SAV);
- Institute of Hydrology at the Slovak Academy of Sciences (UH SAV);
- Geological Institute at the Slovak Academy of Sciences (GEOU SAV);
- State Geological Institute of Dionyz Stur (SGUDS);
- University of Veterinary Medicine in Košice (UVL);
- Science and Research Institute of Matej Bell University in Banská Bystrica (UMB);
- Soil Science and Conservation Research Institute in Bratislava (VUPOP);
- Water Research Institute in Bratislava (VUVH);
- Institute of Geography at the Slovak Academy of Sciences (GEU SAV).

8.3 SUMMARY INFORMATION ON GLOBAL CLIMATE OBSERVING SYSTEM ACTIVITIES

Decision 11/CP.13 (FCCC/CP/2007/6/Add.2) adopted a separate decision with reporting requirements related to Global Climate Observing System. Detailed technical reports should be provided in conjunction with national communications.

Slovakia has a long tradition in hydrological, meteorological and climatic observation. Some stations have tradition of regular observations longer than 100 years (7 at air temperature, 203 at precipitation totals). Data from 24 synoptic stations are included into the online daily (hourly) international exchange, monthly data from 5 stations (Hurbanovo, Sliač, Poprad, Košice and Piešťany) are included into the CLIMAT Reports.

The hydrological (including springs, ground water and water quality) and meteorological (including climatologic, solar radiation, ozone, air pollution, radar and aerologic) observations and measurements in Slovakia are guaranteed by the Act No. 201/2009 Coll. on the state hydrological service and the state meteorological service. These measurements and observations are carried out by the SHMI in Bratislava (including branch institutes of the SHMI in Banská Bystrica, Žilina and Košice), which is responsible also for gathering, processing and administration of hydrological and meteorological data and information. It covers also the set of basic climatic variables according to the decision FCCC/SBSTA/2007/L.4/Add.1. The SHMI manages the data according to the Quality Management System in compliance with the STN EN ISO 9001:2001. These data are used for the assessment of current state and trends in climatic and hydrologic system in Slovakia. The SHMI is also active in the implementation of internationally approved methods of homogenization of long time series of observed and measured data to improve data reliability. The SHMI also realize modern method of archived old data digitalization (since 1 900) to provide more precise analysis and description of climatic changes and variability in Slovakia during the last 110 years. The SHMI has own research capacities of good quality and it is ready for profound scientific analysis of current state, past and future development of climatic and hydrologic system. The SHMI has also an excellent co-operative potential for research projects solving and for active collaboration with other scientific institutions. Measured and observed data as well as data from outputs of research projects are communicated to the World Data Centers and for internationally solved projects.

8.4 RESEARCH

8.4.1 Climate Process and Climate System Studies, Including Paleoclimate Studies

International activities in the field of the Earth's climate system research are also provided by several Slovak scientific institutions. The World Meteorological Organization and some other UN organizations established the World Climate Program in 1979. The National Climate Program was established in former Czechoslovakia in 1991, since 1993 it continues as the Slovak National Climate Program coordinated by the MoE. As many as 23 institutions and other subjects participated in the Slovak National Climate Program activities (12 monographs, several conferences and seminars, research projects, public informing etc.). The SHMI was mostly the focal point of the Slovak National Climate Program activities, the MoE provided SHMI with financial support to organize climate change monitoring and research on climate changes and variability, vulnerability, impacts and adapting option (the last project on Adaptation to Climate Change was finished in 2011). Climate system studies are realized also in the framework of VEGA projects at the Faculty of Mathematics, Physics and Informatics, Comenius University in Bratislava since 1998 (the last project started in 2011). Limited Paleoclimatic research is focused on collaboration with geologists. The Geological Institute at the Slovak Academy of Sciences and the State Geological Institute of Dionyz Stur are principal institutions in this field of research.

8.4.2 Modelling and Prediction, Including General Circulation Models

There has not yet been established any specific research centre for global climatic modelling in Slovakia. Slovak climatologists applied outputs from several Global General Circulation Models and Regional General Circulation Models for designing local and national climate change scenarios by methods of statistical and dynamic downscaling at the use of measured data at Slovak meteorological stations in 1951-2010 (in 2010-2012 the GCMs CGCM3.1 (Canada) and ECHAM5 (Germany), Regional General Circulation Models KNMI (Netherlands) and MPI (Germany) outputs have been applied). Climate change scenarios have been designed as time series of average daily data (at air temperature also daily maximum and minimum) for meteorological and precipitation stations in Slovakia in the period 1951-2100 (about 40 meteorological and precipitation stations). Air temperature, air humidity, precipitation totals, global radiation and wind speed were the basic climatic variables. Other scenarios have been prepared as analogues, or by use physical equations and data from basic scenarios (snow cover, evapotranspiration, runoff, soil moisture etc.). The Faculty of Mathematics, Physics and Informatics, Comenius University in Bratislava and SHMI were the principal solvers in the field of national climate scenarios design.

8.4.3 Research on the Impacts of Climate Change

Several Slovak institutions, private subjects and individuals participated in assessment of impacts of climatic changes and variability on different socio-economic sectors and ecosystems or in research of vulnerability to climate change. All of them used climatic data series from the SHMI, or some climate change scenarios (prepared by the Faculty of Mathematics, Physics and Informatics, Comenius University in Bratislava or by other subjects from Slovakia and abroad). These issues have been solved mostly as a part of domestic or international projects, predominantly in the sectors of water management, hydrological cycle, forestry and agriculture. The results are published in literature (at the end of this chapter, in part" References", is non-exhaustive list of these papers).

8.5 LIST OF SELECTED PROJECTS AND THEIR OUTPUTS

8.5.1 Climatology

Projects VEGA No. 1/0063/10 (2010-2011) and VEGA No. 1/0992/12 (2012-2014), both solved at the Faculty of Mathematics, Physics and Informatics, Comenius University in Bratislava and focused on the analysis of climate variability in Slovakia and on preparing alternative climate change scenarios for users in Slovakia; Project VEGA No. 2/0079/11 (2011-2013) „Interaction among climatic factors and mountainous environment", solved in GFU SAV; The next listed projects have been solved in the SHMI in cooperation with other institutions in Slovakia and abroad: Project „LOC-CLIM-ACT: Local acting on climate change impacts" No.: HUSKROUA/1001/079), within ENPI: Hungary - Slovakia - Romania - Ukraine collaboration (2007-2013); Project „ClimCross Development - Partnership for climate change impact reduction" Hungary - Slovakia collaboration (2007 – 2013); Project No.: HUSK/1101/1.5.1/0128. „Cities resistant to climate change impacts – Trnava city challenge" (No.: ME-2013-008) within Swiss – Slovak cooperation. "Capacity Building Support for the Activities in Climate Change and Adaptation"; Project number: SAMRS/2010/15 (2010-2011), Partner: Kenya Meteorological Department (KMD); Project PUMAKO – Collaboration among the local management authorities – Regional Development (EFRE) within the Program ETZ-Creating the Future (Slovakia – Austria collaboration, 2007-2013); Project NETCOM (NET working the Covenant of City Mayors); Project No. OPZP-PO3-08-5 ITMS 24130120015 (2009-2011) "Impacts of climate change and adapting options in different sectors in Slovakia" funded partly from EU funds and coordinated by the MoE.

8.5.2 Forestry Sector

Projects solved in the University of Technology, Zvolen: APVV- 0022-07 „Assessment of drought stress in forest stands from the viewpoint of water balance of trees and stands", 09/2008-12/2010. ASFEU, ITMS 26220120006 „Centre of excellence: Adaptive forest ecosystems", 01/2009-10/2011, deputy for activity 2.1 Global and regional changes. ASFEU, ITMS 26220120062 „Centre of excellence for integrated management of catchments under changing environment, 10/2010-03/2013. SRDA-0011-10 „Ecophysiological and spatial aspects of drought impact on forest stands under climate change", 11/2011-10/2014. SRDA-0436-10 Effect of water deficit on physiological and growth processes of selected beech and spruce provenances", 11/2011-10/2014. COST Action FP1206: "European mixed forests. Integrating Scientific Knowledge in Sustainable Forest Management (EuMIXFOR)", 2013-2015. Centre of Excellence for Integrated Research of the Earth's Geosphere (ITMS: 26220120064) 2010-2013. Development of a regional system of climate and rainfall runoff models for the prediction of runoff under changed climate in the mountainous regions of Slovakia (APVV-0303-11) 2012-2015 APVV. Children's Forest University - Tool for Popularization of Forestry Sciences and Research (LPP-0105-09) 2009-2012 APVV. Quantitative assessment and prediction of the effects of forest ecosystems in the accumulation of organic carbon in soils with variable modes use (VEGA 1/1314/12) 2012-2014. The analysis of natural risks concerning the evolution of landscape ecosystems under the conditions of climate change in Slovakia (APVV-0423-10) 2011-2014. The investigation of risk concerning impacts of a climate change on forest ecosystems and the formulation of an adaptation policy under conditions of Slovakia (VEGA 1/0281/11) 2011-2014. The spatial and temporal characteristics of snow conditions in small mountain catchments to the needs of modelling of water supply (VEGA1/1130/12) 2012-2014. Transformation, transport and distribution of matter in surface organic horizon of forest soils (APVV-0580-10) 2011-2014. The impact of climate change on phenological response of ecosystems (VEGA 1/0257/11). Analysis of adaptation of forest habitat conditions for change based on provenance research and genetic markers (APVV-0441-07).
In 2008-2012 COST Action FP 0703 "Expected Climate Change and Options for European Silviculture" - Participation in the Management Committee. Projects of the National Forest Centre, Zvolen: Advanced multifunctional management of European mountain forests (ARANGE, http://www.arange-project.eu). ARANGE is a Collaborative Project within FP7 (Theme KBB.2011.1.2-07) with the aim to provide improved insight in the multifunctional management of European mountain forests under climate change (2012-2015). Ecophysiological and spatial aspects of drought effect on forests in Slovakia under climate change (DRIM). Project supported by Slovak Research and Development Agency (2011-2014). Research about effective use of environmental, economic and social potential of forests in Slovakia (EPOL). WorkPackage 02: Ecology, Structure and Dynamics of Forests under Changing Environment. Project of the Ministry of Agriculture and Rural Development of Slovakia (2000-2012).

8.5.3 Hydrology and Water Management Sector

Project No.: APVV-0015-10 "Identification of changes in the hydrological regime of rivers in the Danube basin" solved in the Institute of Hydrology at the Slovak Academy of Sciences (2011-2014); Project APVV-0089-12 "Prognosis of hydrological drought occurrence in Slovakia" solved in the Faculty of Natural Sciences, Comenius University in Bratislava (2013-2017); Project APVV-0303-11 "Development of a regional system of climate and rainfall-runoff models for the prediction of runoff under changed climate in the mountainous regions of Slovakia" solved in the Faculty of Civil Engineering, Slovak University of Technology in Bratislava (2012-2015); FP6 project, contract No. 036946, "WATCH – WATer and Global Change" solved in the Faculty of Natural Sciences, Comenius University in Bratislava (2007-2011).

8.5.4 Agriculture

Projects solved in the Soil Science and Conservation Research Institute in Bratislava: CC-TAME „Climate Change: Terrestrial Adaptation & Mitigation in Europe" (7th EU RP, in 2008-2011). COST 639: Greenhouse gas budget of soils under changing climate and land use (BurnOut). COST 734: "Impacts of Climate Change and Variability on European Agriculture" (CLIVAGRI, 2008-2011). COST ES1106: "Assessment of European Agriculture Water Use and Trade under Climate Change (EURO-AGRIWAT, 2012-2015)".

8.6 SOCIO-ECONOMIC ANALYSIS, INCLUDING ANALYSIS OF THE IMPACTS OF CLIMATE CHANGE; RESEARCH AND DEVELOPLMENT ON MITIGATION AND ADAPTATION TECHNOLOFIES

In the report titled "Impacts of climate change and possible adapting options in individual sectors in Slovakia" (EFRA Zvolen, 2011, 253 pp., as a result of SHMI's solution of the Project No. OPZP-PO3-08-5 ITMS 24130120015 (2009-2011)) a detail analysis of possible climate change impacts in different socio-economic sectors is included. This report contains also economic (cost/benefit) analysis of recommended adapting and mitigation options in Slovakia. Presented SHMI project was funded partly from EU funds and coordinated by the MoE (http://www.shmu.sk/sk/?page=1817).

8.7 SYSTEMATIC OBSERVATION

8.7.1 Atmospheric Climate Observing Systems, Including those Measuring Atmospheric Constituents

Terrestrial Climate Observing Systems

The framework for complex environmental monitoring in Slovakia has been determined by the resolutions of the Slovak Government No. 623/1990 Coll., No. 449/1992 Coll. and No. 620/1993 Coll. Monitoring subsystems are fundamental units of the National Monitoring System of Slovakia. Some of those subsystems are operated by the SHMI. The Monitoring Subsystem "Meteorology and Climatology" is one of the most important and it includes the observing networks of monitoring stations, distance measurements and observations of some biological subjects (phenology). This subsystem collects data on weather conditions and on the state and development in the regional climate subsystem. The Monitoring Subsystem "Air" ensures monitoring of air quality with continual measurements of gaseous pollutants and atmospheric aerosols. This subsystem monitors also the chemistry of atmospheric precipitation. The Monitoring Subsystem "Water" monitors the quantity and quality of surface and ground water in Slovakia. The SHMI provides data gathered through the monitoring subsystems for decision-making, management, research and development as well as for general public.

Observing networks and objects of the SHMI are owned by the State according to the Act No. 201/2009 Coll. on the State Hydrological Service and State Meteorological Service. The SHMI operates 24 professional stations, about 75 classical climatic stations and about 550 precipitation stations with voluntary observers. All 24 professional stations and about 350 other stations are equipped by the automatic measuring and communication systems. Selected 5 stations (CLIMAT – Hurbanovo, Sliač, Poprad, Košice and Piešťany) are included in the Global Climate Observing System program. Besides these activities, the SHMI operates also the network of about 200 phenologic stations (with biological observations). Remote sensing system includes 2 Doppler radars, 1 upper air (aerologic) station and a lightning detection system. The membership in the European Meteorological Satellite Organization allows Slovakia receiving satellite images in real time. The air quality network consists of 33 automatic stations in the most polluted regions and 4 stations for monitoring of background air pollution. The hydrological network consists of about 400 stations measuring surface water quantity and about 300 stations measuring surface water quality. The quantity and quality of groundwater and springs are monitored in about 1500 SHMI locations. SHMI has introduced the Quality Management System according to the ISO 9001:2001 for monitoring, evaluating and interpreting of data. This System is properly maintained and operated.

Support to Developing Countries to Establish and Maintain Observing Systems.

Project number: SAMRS/2010/15 (2010-2011), Partner: Kenya Meteorological Department. The project can be considered as Slovak support to developing country Kenya to establish and maintain its climate monitoring system and to prepare the National Report on Climate Change. This Project was coordinated by the SlovakAid Agency.

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09
Education, Training and Public Awareness-Raising

9.1 INTRODUCTION

The chapter provides an overview of the activities of the Ministry of Education, Science, Research and Sport of the Slovak Republic (MESRS), MoE as well as other institutions of the Slovak Republic in the field of education, training and public awareness on the subject of climate change and related policies since 2009. Education is generally a responsibility of the MESRS, for this issue, but also in training and in raising public awareness the MoE also contributes significantly directly or through its branches as the Slovak Environmental Agency (SEA) and the Slovak Hydrometeorological Institute (SHMI). Education and information on this subject are also provided by the selected university and scientific institutions, interest groups, as well as professional and non-governmental organizations (NGO).

9.2 EDUCATIONAL ACTIVITIES

Climate change is expertly challenging and cross-cutting theme that goes beyond the content of educational programs for elementary and secondary schools. The issue of climate change and its adverse consequences is a component of a wide spectrum of topics within the environmental education in primary and secondary schools. On the level of colleges and universities, its importance has increased recent years. The topic of climate is possible to study in Comenius University in Bratislava and partially in University of Economics in Bratislava - with regard to its economic and political consequences.

9.2.1 Primary and Secondary Schools

National Institute for Education as a budgetary organization directly managed by MESRS introduced a national training program “Environmental education” for level 1 and 2 of primary schools, secondary schools and grammar schools.

Environmental education covers following climate change areas: renewable sources (RES) and non-renewable natural resources, rational use of natural resources in relation to sustainable development, the use of alternative energy sources, energy transport resources and their impact on the environment, industry and sustainable development of society, recycling, energy consumption, quality of life, diversity of environmental influences on health, ways and means to protect the health or life of the unevenness on the Earth (different environmental conditions and different social development of the Earth, causes and consequences of global environmental problems (and principles of sustainable development).

In secondary schools and high schools, the topic is a part of environmental education in a more comprehensive educational fields such as “Human and society” and “Human and values” that focus on the connection between environmental, technical and economic and social approaches to solving problems and point to further principles of sustainable development related to climate policy (cooperation in diversity, poverty eradication, disease, disparities between people, ensuring a life of dignity for people).

9.2.1.1 Global Education

National Strategy for Global Education for the period 2012-2016 was approved by the Government on January 8, 2012. The strategy defines the main issues of education focusing on global issues, including climate change.

Action Plan for Global Education is submitted annually to the Government in order to fulfil the National Strategy for Global Education and the framework of the National Programme of Official Development Assistance of the Slovak Republic.

9.2.1.2 Training Programs in Schools

Ecological Footprint is an innovative educational program currently conducted via web portal www.ekostopa.sk. Its main objective is for students to correctly identify an impact of our daily activities on the environment.

Enersol is a project was launched in 2000 and is a joint program of six European countries - Germany, the Netherlands, Great Britain, Italy, the Czech Republic and Slovakia. Its importance is mainly in the international exchange of experience of teaching the RES and approximation of technical texts in secondary schools.

To Live Energy in Schools is an educational materials, interactive games and recommendations how to conserve energy at school: www.siea.sk/zit-energiou-kamaratka-energia.

Forest education (National Forest Centre) is an environmental education for learning about nature and life in the woods through games and experiences. Forest education with its activities adds knowledge about the environment, its protection and sustainable development: http://www.lesnapedagogika.sk/. The program is also designed for general lay population.

Slovak specialists’ lectures are series of lectures have been presented on climate change for students and teachers in several Slovak regions each year. This education program was organized partly by the NGO Slovak Catholic Charity and partly also by the MESRS or by other local institutions.

9.2.1.3 National Environmental Competitions

ProEnviro is a competition for the best environmental project implemented by a school, the main objective is to promote projects sustainable development and activities implemented in schools.

EnvirOtázniky is a nationwide knowledge competition for 2nd grade students of primary schools. The aim is to attract interest of primary schools' children to science and environmental issues.

Green World is an international children's art creativity competition.

9.2.1.4 International Activities

Schools are involved in various international, national and regional projects independently or in cooperation with NGOs.

ENVIROPROJECT is a development project funded by MESRS to promote a practical environmental education in primary and secondary schools. In the period of 2004-2012 thanks to ENVIROPROJECT a total of 346 projects were supported and implemented in primary and secondary schools, such as number of seminars, competitions, workshops and methodological materials, workbooks and leaflets. In various regions of Slovakia, pupils build nature trails, cleaned parts of the watercourses, or conducted activities connected with renewable energy and problem of waste.

Green School is an international environmental program the EkoSchools is in Slovakia organized by a network of environmental education organizations- Spiral. In a difficult process of fulfilling the terms of this program, the school implemented the principles of environmental education into the whole educational program and actions of students and teachers.

Conference of environmental education and ethics - MESRS is organised annually in October co-organize a conference as the accompanying program of the International Festival of Sustainable Development EKOTOPFILM. The conference is dedicated for primary and secondary schools, representatives of MESRS and MoE, Methodological Centre, SEA and NGOs working in this field. The goal of the conference is a presentation of realized activities of schools and interested organizations, on-going projects and their results and other information from schools about environmental education.

Challenge Europe Project is realized in Slovakia in 2008-2011 under coordination of the British Council in Bratislava. The project was a three year campaign that aspires to make a definite and lasting impact on the climate change debate, and was ambitious in its aim to accelerate change to a low-carbon future. In Slovakia about 15 young activists, aged 18-35, worked together as 'Climate Advocates' to unearth new ways to reduce carbon use or utilize methods already found but not yet properly exploited. Each group offered a broad representation of skills, attitudes and ideas from all areas of life, working across disciplines to seek, gather, develop and then refine scores of ideas to agree just three concrete concepts. These concepts, they believed, will have real potential to bring about a low-car bon future through changes to law, business practice or human behaviour. The outcome consisted of series of concrete and angible ideas. The project was oriented mainly to primary and secondary schools.

9.2.2 Colleges, Universities

MESRS does not prescribe the content of the courses in universities. Detailed statistics regarding higher education are publicly accessible on http://www.uips.sk/prehlady-skol/statisticka-rocenka—vysoke-skoly. In Slovakia, following faculties are involved in climate change related studies:

Comenius University in Bratislava
Faculty of Natural Sciences - the issue of climate change in the faculty is comprehensively addressed by the Department of Astrono my, Physics of the Earth and Meteorology; Department of Meteorology and Climatology; Department of Environmental Physics.

University of Economics in Bratislava
Faculty of International Relations - the issue of climate change is addressed by the Department of International Economic Relations and Economic Diplomacy.

Faculty of National Economy - the Department of Insurance is marginally dealing with the issue of climate change. On May 31, 2012 an international scientific conference "Trends in insurance in 2012" was held, where there were presentations such as "Insurability of Climate Change" and "Climate change impact on the insurance market in the world".

Slovak University of Technology in Bratislava
Faculty of Chemical and Food Technology - faculty is dealing with the research and development of technologies related to environmental engineering.

9.3 CONFERENCES

9.3.1 Regular Conferences

Enviro-i-forum is a conference on environmental science organized annually by the SEA and the MoE since 2005. Its main objective is creation, sharing and accessing data on the environment.

Technique of Environmental Protection is a conference focused on the development of techniques and technologies in various sectors of the environment.

Air Protection is an international conference organized annually since 1985 devoted to current issues in the air protection techniques, options for reducing emissions to air, problems and experiences with the measurement of emissions trading allowances.

Slovak National Emission Registry is conference organized since 2005 for the stakeholders of trading scheme, operators and verifiers of the CO_2 emission reports, experts and the state administrators.

Conferences for young scientists and experts up to 35 years is organized annually at the SHMI in the field of meteorology, climatology, hydrology and water management from Slovakia and the Czech Republic. The conference is coupled with the contest for the best 3 projects.

Welfare and Health is a scientific and professional conference focused on the relationship of the environment and the health and recovery factors that influence population health.

Environment - problems and possibilities is a conference with the aim brings problems and solutions in the field of environmental and waste management.

Bio-climate is an international conference organized yearly by Slovak and Czech Bio-climatic Society at the Slovak Academy of Sciences and Czech Academy of Sciences since 1960. This conference deals with scientific aspects of climate with relation to the natural environment and socio-economic sectors. Several papers on climate change issues are presented in each Bio-climate conference. Some papers from the last five Bio-climate Conferences were included also in the Web of Science database.

British Council/British Embassy in Bratislava organised seminars and workshops on various climate change related topics.

9.3.2 Other Relevant Conferences and Seminars

Climate change: On the road to Copenhagen – conference was organized in 2009 by several NGOs such as For Mother Earth, Slovak Climate Coalition in partnership with the Heinrich Böll Stiftung Prague Foundation and CA Tatras. It was focused on climate change and its impact on the environment, potential for reducing greenhouse gas emissions, financing of mitigation and adaptation measures, as well as other related topics.

Energy security and climate change – the aim of the workshop held in 2011, as it has defined its organizer - Slovak Foreign Policy Association - was to discuss the energy policy in the context of the development of a common EU energy policy, especially with regard to security of energy supplies, increasing energy efficiency and use of RES.

Options for mitigating the negative impacts of climate change in the city of Špišská Nová Ves and its surroundings – expert seminar held in 2011, organized by the Carpathian Development Institute with cooperation the city Špišská Nová Ves. The seminar was intended for representatives of the municipality, as well as other relevant government entities and the private sector operating in the city. The aim of the seminar was to clarify the context of climate change, to identify and discuss current and future threats to life in the city and its surroundings associated with the impacts of climate change, as well as the possibility of dealing with these threats.

Climate change and local development (challenge for the government) – the Carpathian Development Institute's conference was organized in collaboration with the Union of Towns and Cities of Slovakia and the Regional Centre of the UN Development Programme (UNDP) in 2012. The main objective of the conference, which was addressed to the elected and executive representatives of local governments and organizations that deal with related issues, is to increase motivation and opportunities and to show how local governments respond effectively to the threats and opportunities that climate change brings.

Climate change - the possible impact (not only) on population and development projects – international scientific conference was organized by the Slovak Catholic Charity in 2012 in collaboration with the faculties of Charles University (Faculty of Education, Faculty of Natural Sciences). It focused on the importance of climate change in development assistance and other processes that are under scrutiny specialists and public and media. Its objective was to gather and share experiences on various topics in the field of development cooperation, development education, international relations and development policy of the Slovak Republic and the EU.

Floods 2010: causes, course and experience – the conference organized by the Water Research Institute. Its aim was to analyse the causes of floods in 2010, evaluate progress, implemented flood prevention activities and agree upon effective solutions.

Management of watersheds and flood risks – conference was held in 2011 under the auspices of the MoE. The objective of the scientific conference was to discuss the latest theoretical knowledge and practical experience in river basin management and in particular options to reduce their adverse consequences for human health, the environment, cultural heritage and economic activity.

National water conference on the country revitalisation and integrated basin management – conference was held at the Government Office in connection to Program of revitalization of the countryside and Integrated River Basin Management in 2012. The objective of the national conference was to present the achievements and experiences of mayors, contractors and people who were hired through projects implemented under the Programme and discuss the experience with concrete examples.

Other conferences on various topics organised by various institutions and organisations in various cities.

9.4 OTHER EVENTS

9.4.1 Festivals, Seminars, Fairs, Exhibitions and Other Educational Programs

EKOTOPFILM – International Festival of sustainable development- EKOTOPFILM is the oldest and largest festival of its kind in Slovakia. In 2013 the 40th anniversary took place. The main professional guarantors are the MoE and the Ministry of Economy of the Slovak Republic. The festival is traditionally held under the personal auspices of the President.

Envirofilm – largest educational event of the MoE for a wide professional and lay public. The main objective of the international festival of environmental film, along with cultural and professional events is to raise a public environmental awareness by the implementation of environmental activities, post-festival shows and exhibitions of the works of the Green World. 19th anniversary in 2013 was in the spirit of the European Commission's initiative"A World You Like. With A Climate You Like", which was launched in London by the European Commissioner for Climate Action Connie Hedegaard.

Environmental Fair tutorials ŠIŠKA – designed for people involved in environmental education. Every year 120-140 educators and supporters of environmental education takes part in the trade fair.

Significant environment days (in collaboration with the MoE) – European Mobility Week, World Earth Day, Trees Week and others.

Open Days to the general public on the occasion of the World Meteorological Day, the World Water Day, the World Environment Day (includes seminars and promotional materials related to climate change).

Exhibitions – exhibition on various environmental topics on a weekly basis in the main building of the MoE.

Forestry Day – April, the month of forests.

Olympiad – biological, geographic, chemistry olympiad.

Covenant of Mayors – convention represents a major initiative of several European governments and the European Commission, whose cooperation is aimed at the attainment of the EU Strategy 2020. By signing this Covenant signatories committed on its territory to increase energy efficiency, use of RES and contribute to the objectives of the EU adopted in the Strategy 2020, including a target to reduce CO_2 emissions by 20% by 2020. The main national coordinator of the Convention in Slovakia is the MoE. The MoE cooperates long and intensively with the Ministry of Economy of the Slovak Republic in the fulfilment of the objectives of the Convention.

9.5 TRAINING

9.5.1 Training of Personnel Concerned with the State Administration of Environmental Protection

Education of state administration employees of environmental protection – implemented under the Act No. 525/2003 Coll of. the state administration of environmental protection and on amendments to certain laws, as amended, Decree No. 462/2004 Coll. laying down the details of authority on the performance of certain activities in the field of environmental protection.

Education in green public procurement – is intended for workers of cities, municipalities, central government bodies and their subordinate organizations working in the field of public procurement.

Continuing education for teachers – an accredited educational program called the Ecological Footprint - education for sustainable development for teachers of kindergartens, primary and secondary schools.

9.5.2 Other Relevant Vocational Education

Training of applicants for expert competence to verify the calculations of savings in greenhouse gas emissions over the life cycle of biofuels and bioliquids – the SHMI training was held on January 25, 2012 and organized in collaboration with the MoE pursuant to article 14c, paragraph 6f Act No. 309/2009 Coll. on the promotion of RES and high-efficiency cogeneration and on amendments to certain laws, as amended. The aim of the training was to provide participants with comprehensive information on the issue of proving compliance with the sustainability criteria for biofuels and bioliquids in Slovakia, including legislation that covers this area. During the discussion the participants had the opportunity to get answers to a number of practical issues and problems that are associated with this issue. The trainees had to pass a qualification exam in order to qualify for the authorized person.

The granting of accreditation for verifiers authorized under Act No. 572/2004 Coll. of the emission trading - under article 24 paragraph 1 of the Act No. 414/2012 Coll. on Emissions Trading and on amendments to certain laws, the Slovak National Accreditation Service in charge of the accreditation body for granting accreditation to authorized verifier. On January 1, 2014 is the expiration date of the transitional period, during which eligible verifiers can carry out verification activities under the authority obtained by successful completion of the exam in the MoE and entry in the register of authorized verifiers. More information regarding accreditation is available on the website www.snas.sk.

9.6 SOURCE OR INFORMATION CENTRES

9.6.1 Disclosure of Information by Using Information and Communication Technologies

Official site of the MoE – comprehensive information on climate change published and regularly updated on the official website of the MoE (http://www.minzp.sk/sekcie/temy-oblasti/ovzdusie/politika-zmeny-klimy/medzinarodne-zmluvy-dohovory).

Information system for emissions of greenhouse gases – since 2007 a separate website www.ghg-inventory.shmu.sk is operated by the SHMI, which provides detailed information on the inventory and projections of greenhouse gas emissions.

enviroportal – major resource and information centre for climate change is also www.enviroportal.sk, an information portal focused on making environmental information from one central point, which is operated by the SEA. The target audience is professional but also a general public.

- Furthermore, indicators for environmental assessment are regularly evaluated and made available on the Enviroportal. Some indicators are relevant to climate change. MoE's affiliated organizations make available on the Enviroportal other relevant information concerning, e.g. erosion, landslides, floods, waste management and so on. (www.vuvh.sk, www.sguds.sk, www.shmu.sk, www.sazp.sk, www.svp.sk).

Geoportal NIPI – in the process of building the National Spatial Data Infrastructure in relation to the INSPIRE Directive was created and put into operation the portal accessible under website http://geoportal.sazp.sk. The portal provides access to spatial data and spatial data services through a network service.

enviro.sk – www.enviro.sk is a unique database of professional solutions in the field of waste management and environmental sciences; basis of this database consist of more than 2000 professional contributions.

www.dmc.fmph.uniba.sk – the Department of Astronomy, Physics of the Earth and Meteorology in Comenius University in Bratislava provides scientific information on Climate Change and on the Earth's Climate System Physics within the accredited master and PhD study programs as well as on the web site and is frequently visited also by readers from abroad.

The issue of climate change with its cross-cutting nature extends to the scope of other departments. Ministries mainly through their specialized agencies also make available information, data, studies, reports, relevant to the issue of climate change. This is especially the National Forest Centre - www.nlcsk.org, portal on forests www.forestportal.sk, Research Institute of Soil Science and Conservation - www.vupop.sk, Slovak Innovation and Energy Agency - www.siea.sk. Furthermore, scientific information on climate change and Earth's climate system provides a website of the Faculty of Mathematics, Physics and Informatics - www.fmph.uniba.sk. Dissemination of information to the public is also provided by NGOs, for example Greenpeace (http://www.greenpeace.org/slovakia/sk/kampane/klimaticke-zmeny/) or organization For Mother Earth (http://www.zmz.sk/index.cfm?Module=Static&page=w&s=klima-temy).

9.6.2 Journals

Parlamentný Kuriér – in the journal of the National Council of the Slovak Republic was published an interview in 2013 dealing with climate change policy “New time - new conditions” and an interview on “Maintaining a balance in the environment.”

Enviromagazín – is a magazine which is published by the MoE and the SEA since 1996. In a popular form it meets an information and promotion function. Some of the articles are about the climate change issues some are closely related.

21st century - magazine for industrial ecology is already being issued for 15 years. It remains the only nationwide journals focused on the economic context of the environmental policy with an emphasis on protecting the individual components of the environment in business practice. In addition to the emphasis on the individual components of the environment, the magazine addresses the issues of energy and rational use of energy, particularly in relation to climate and energy measures being taken in Slovakia. The regular topics include promoting the development of RES and trading greenhouse gas emissions.

Slovak Meteorological Journal – is a specialized scientific and expert journal issued by the SHMI in the area of meteorology, climatology, hydrology, air pollution and some other related branches. This journal publishes original scientific papers mostly in English language prepared by Slovak and foreign authors, reviews and short expert papers either in Slovak or Czech language. All papers are reviewed by lectors.

Forest magazine - National Forest Centre - Forest Research Institute Zvolen publishes a scientific journal about forests (publishing house SAP, Bratislava).

Forest & tree rings – is a magazine issued by LESMEDIUM SK, s.r.o. about planting, forest protection and timber.

Waste (minimization, recovery and disposal) – Magazine about creation, minimization, recovery and disposal of waste and associated fields. Published by Miroslav Mračko - EPOS.

Water Management – magazine about current and new knowledge and experience in the field of water policy. Published by the Association of Employers in water management in Slovakia.

EA / Energy Magazine about RES and energy savings – media publisher / ST s.r.o.

9.6.3 Scientific, Professional and Educational Journals Dealing with the Issue of Climate Change

Journal of Hydrology and Hydromechanics – issued by the Institute of Hydrology of Slovak Academy of Sciences and the Institute of Hydrodynamics It is a top scientific journal with sixty year tradition, included in the Web of Science database.

Acta Meteorologica Universitatis Comenianae – issued by the Faculty of Mathematics, Physics and Informatics.

Acta Hydrologica Slovaca – issued by the Institute of Hydrology at the Slovak Academy of Sciences.

Geographic magazine – issued by Institute of Geography at the Slovak Academy of Sciences.

Contributions to Geophysics and Geodesy – issued by the Institute of Geophysics at the Slovak Academy of Sciences is also a top scientific journal included in the Web of Science database (Scopus). It has 42-year tradition and brings original scientific papers and related information on meteorological issues, climatology and hydrologic cycle, including climate change impacts.

Environment – issued by the Institute of Landscape Ecology at the Slovak Academy of Sciences.

Report on the State of the Environment – is published regularly since 1993. The report is in addition to evaluating environmental quality in Slovakia and also points out trends in environmental indicators. The report contains a separate chapter devoted to the issue of climate change.

Air and share their individual sources pollution in the SR – is published annually by SHMI. The report describes the emission and airpollution situation in Slovakia, the most significant stationary sources of air pollution in previous years and the development of creation of emissions of pollutants and greenhouse gases.

mpacts of climate change and possible adapting options in individual sectors in Slovakia – the report issued by Forest Research Institute Zvolen in 2011 is a result of SHMI Project No. OPZP-PO3-08-5 ITMS 24130120015 (2009-2011) (funded partly from EU funds and coordinated by the MoE).

9.6.4 Important Information Centres

Legal framework in Slovakia with respect to collection, assessment and dissemination of environmental information to the public, including the information on climate change, is covered by the Act No. 211/2000 Coll. on the free access to information, Act No. 205/2004 Coll. on collection, storage and dissemination of environmental information, Act No. 478/2002 Coll. on emission, trading with CO_2 allowances. These regulations provide for dissemination of information to the public.

Ministry of Environment (MoE) – process of release of information regarding climate change is under the responsibility of the National Focal Point in the Slovak Ministry of Environment. It provides information about the issue of climate change, international negotiations and the development of specific instruments, including legislative to address it.

Slovak Hydrometeorological Institute (SHMI) – provides information on the causes and consequences of climate change, adaptation and mitigation measures, emissions of pollutants and greenhouse gases.

Slovak Environmental Agency (SEA) – updates and provides information and provides educational programs for professionals but also for general public about the state of the environment, including climate change.

Slovak Innovation and Energy Agency – provides free advice in the field of new energy technologies and energy savings for homes and businesses.

The University environmental education is provided by most of Slovak universities as complete master study programs or only study subjects. Lecturers or scientists from these universities can give also lectures and profound professional information for general public and mass media.

9.6.5 Media

Public informing on climate change, possible impacts and generally on the climate change policy was realized by several means.

Slovak TV prepared 45 minute document on climate change with the title “It will be too hot for us (Bude nám horúco)” in 2010, this document was broadcasted several times on Slovak TV Chanel 2.

The TV station TA3 broadcasted several live discussions lasting from 10 to 90 minutes with Slovak scientists and professionals.

The Slovak Radio 1 broadcasted regularly 15 to 90 minute programs (“K veci”, “Z prvej ruky” and “Nočná pyramída” - live discussion with Slovak experts) on the current topics (climate change was on the program about 5 times a year).

The Slovak Academy of Sciences organizes each month a scientific discussion on current scientific problems (also for general public) by assistance of well-known Slovak and foreign scientists, two discussions were devoted also to climate change problematic in 2011 and 2012.

big fut: big steps for the future – big fut is a series of lively discussions that are looking for answers to urgent questions of today. In addition to technological background it brings in economic, social and moral view. Big fut always takes place in any of the Slovak universities. Discussions include climate-related topics like “If we were all plants?”, “Are we in danger from 2030 global blackout?” (including nuclear vs. alternative energy sources), “If there were only electric cars on roads?”, “When we stop to drive cars?” and festivals on intelligent electricity and electromobility.

The newspapers SME, Pravda, Aktualne.sk and Hospodarske noviny (HN) regularly provide actual information on climate change after consultation with Slovak experts.

9.7 INVOLVEMENT IN INTERNATIONAL ACTIVITIES

Slovak Republic is a member of the European Environment Agency and the European Environment Information and Observation Network since 2001. Coordination on behalf of the Slovak Republic ensures SEA. Within the European Environment Information and Observation Network network the National Reference Centres are created, from which the following activities directly address climate change:

- National Reference Centre: Air pollution reduction and climate change;
- National Reference Centre: Climate change - impacts, vulnerability and adaptation scenarios (includes representatives of SHMI).

The issue of climate change is also related to other activities of the National Reference Centre:

- the National Reference Centre: Agriculture and Forests (includes representatives of Ministry of Agriculture and Rural Development of the Slovak Republic, National forest Centre and SEA),
- the National Reference Centre: Energy (includes representatives of the Ministry of Economy, SEA),
- the National Reference Centre: Land (includes representatives of Matej Bel University, SEA),
- the National Reference Centre RC: Waste (includes representatives of SEA, Statistical Office of the Slovak Republic).

Outcomes of the European Environment Agency in the field of climate change are the following reports:

- Climate change, impacts and vulnerability in Europe 2012;
  http://www.eea.europa.eu/publications/climate-impacts-and-vulnerability-2012
- Greenhouse gas emission trends and projections in Europe 2012 - Tracking progress towards Kyoto and 2020 targets;
  http://www.eea.europa.eu/publications/ghg-trends-and-projections-2012
- Approximated EU GHG inventory: early estimates for 2011.
  http://www.eea.europa.eu/publications/approximated-eu-ghg-inventory-2011

In 2003, a network of “European Network of the Heads of Environment Protection Agencies”, whose members on behalf of the Slovak republic are SEA and SHMI. Network is an independent platform for exchange of views on various thematic issues of environment protection, as well as the formation of common positions in their further development.

In the OECD Climate Change Expert Group, in the Working Party on Environmental Information and the Joint Working Party on Agriculture and Environment activities related to the development of methodologies and evaluation indicators are implemented, which have a relevance to the issue of climate change.