THE SEVENTH NATIONAL COMMUNICATION OF THE SLOVAK REPUBLIC ON CLIMATE CHANGE

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

Bratislava 2017

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LIST OF ABBREVIATIONS

Abbreviation	English
7NC SR	The Seventh 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	Koninklijk Nederlands Meteorologisch Instituut – author of the Regional Circulation model RACMO
LPG	Liquid petroleum gas
LULUCF	Land use, land-use change and forestry
MŠVVaŠ SR	Ministry of Education, Science, Research and Sport of the Slovak Republic
MŽP SR	Ministry of Environment of the Slovak Republic
MPI	Max Planck Institute – author of the Regional Circulation model REMO
MS	Member state
NA	Not applicable
NACE	The waste generation by classification of economic activities
NGO	Nongovernmental non-profit organization
ODA	Official Development Assistance
OMK FMFI UK	Division of Meteorology and Climatology, Faculty of Mathematics, Physics and Informatics, Comenius University
PaMs	Policies and measures
PV	Photovoltaic
QA	Quality Assurance
QC	Quality Control
RCM	Regional Circulation Models
RISO	Regional Waste Information System
SAŽP	Slovak Environmental Agency
SHMÚ	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
WOM	Without measures

EXECUTIVE SUMMARY

Chapter 2: National Circumstances

The population of the Slovak Republic as at 31 December 2016 was 5,435,343. The average residential density is 110.8 inhabitants per km². In the context of demographic development, a very positive trend is the decrease in emissions per capita – in 2015 there were 7.64 tons of CO_2 eq. compared to the 1990 value of 14.09.

According to global climatologic classifications, the Slovak Republic is located in a mild climate zone with mean monthly precipitation totals equally distributed over the whole year. During the period 1881 - 2017, the significant increase of annual air temperature by 2.0°C and insignificant trend of annual precipitation totals by about 1% on average were recorded in the Slovak Republic.

In 2007, the Slovak economy reached its historically 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, real GDP decreased by 4.9%. Thus the Slovak Republic was ranked as the country with the largest GDP slump. The year 2010 marked a turnaround for the Slovak economy in the form of a relatively strong recovery in economic growth – with 4.4% resulting in the SR being second in the EU after Sweden. In 2011, the situation on the labour market improved as a result of renewed growth, although unemployment lagged far behind the pre-crisis level. After this period, full recovery began. In 2016, the Slovak economy grew by 3.3%. This growth was mainly driven by household consumption and, after a two-year period, also by net exports.

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 2015 were as follows: natural gas 23.8%, coal 20%, nuclear fuel 23.7%, oil 20.4%, renewable sources, including hydropower 10.9%.

Gross inland energy consumption (GIC) has a long-term downward trend in the Slovak Republic along with the growth of GDP. The GIC decline occurred mainly as a result of industrial restructuring with higher added value and wider application of the principles of energy efficiency. The overall decrease in the GIC of the Slovak Republic in the period from 1995 to 2015 is 7.3%.

Energy intensity in the Slovak Republic has had a declining trend in the past 20 years as significant progress in the reduction of energy intensity has been achieved. In the period 1995-2015, the Slovak Republic reduced its energy intensity by 57%. This is the second biggest reduction in terms of percentage among all EU Member States. Additionally, according to the Joint Research Centre of the European Commission, the highest reduction in energy intensity values during the 15-year period from 2000 to 2014 was found in the Slovak Republic, which underwent a growth rate of 82.5%.

An important role in the policy and decision making process with respect to climate change is played by 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, the Ministry of Agriculture and Rural Development, the Ministry of Transport and Construction, the Ministry of Education, Science, Research and Sport, the Ministry of Health, the Ministry of Interior, the Ministry of Finance, the 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 44.6% from 1990 to 2015. The biggest relative change was in the agricultural and energy sectors, where GHG emissions decreased substantially by 54% and 52% respectively in comparison with the base year 1990. These reductions were caused by essential changes in the management practice of agriculture and increasing energy efficiency and fuel consumption.

On average, since the year 2010, total GHG emissions (without LULUCF) were more than 40% below the emission level of 1990. This effect was caused by additional implementation of strict policies and measures and their impacts.

Emissions of total greenhouse gases increased by 1.45% between 2014 and 2015; this was largely due to the increase in energy, industrial processes and the waste sector in reaction to increasing economic growth in the Slovak Republic.

While the indicator of carbon intensity can be changed much more rapidly in a situation of high economic growth, GHG per capita is an indicator with a significant decreasing trend between 1990 and 2015 and reducing on a half value.

Since the sixth National Communication of the Slovak Republic in 2013, emissions have decreased by 9.2% with the lowest level in 2014 when the economic downturn caused substantial emission reductions. In 2015, emissions increased again slightly, partly driven by the economic recovery in many economic and industrial activities.

Since the last National Communication of the Slovak Republic in 2013, many updates and revisions to methodologies, emission factors, covering of sources and gases and structure of the submission have been implemented in the GHG inventory and the National Inventory System of the Slovak Republic which have impacted the time-series of emissions. These changes are connected with the full implementation of the 2006 IPCC Guidelines for National GHG Inventories.[1]

Chapter 4: Policies and Measures

The 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 Climate and Energy Package - to reduce greenhouse gas emissions by at least 20% compared to 1990 by 2020. Furthermore, the EU has committed itself to achieving a goal of 20% of energy from renewable sources by 2020 (as a share of total EU gross final energy consumption), supplemented by a target to achieve a minimum of 10%

[1] http://www.ipcc-nggip.iges.or.jp/public/2006gl/

renewable energy share of the fuel consumption in the transport sector. Moreover, the EU has committed itself to a 20% reduction of total primary energy consumption by 2020, compared to projections in 2007. The Slovak Republic is on the way to fulfilling its commitments as seen from recent GHG emission.

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).

Policies and measures with wide sectoral applications, for example the National action plan for biomass use[2], the National Renewable Energy Action Plan[3] or the Energy Efficiency Action Plan for the period 2014 - 2016 with the outlook for 2020[4], have significant benefits and positive impacts on other environmental and energy goals.

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

7NC SR presents results of GHG emission projections up to 2040 for three scenarios: "with existing measures (WEM)", "with additional measures (WAM)" and "without measures (WOM)" reference scenarios structured by sectors, by gases and as total aggregated form.

The year 2014 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 2015 up to 2040.

In spite of existing restrictions resulting from the dynamic changes of governing parameters, the reality of achieving the reduction targets, as well as the potential for further reduction of emissions after 2020, can be done through the results of modelling. The trends according to three modelled scenarios show that the reduction target under the Kyoto Protocol can also be achieved by the scenario without measures during the first binding period with the prospective until 2030.

The projected decrease in total aggregate GHG emissions (without LULUCF) in 2020 compared to 1990 for the WEM scenario is around 34,124 Gg of CO_2 eq., for the WAM scenario more than 35,580 Gg of CO_2 eq.

Projections of aggregated GHG emissions according to the WEM scenario gradually decrease till 2025, when the emissions start to rise slightly. A similar trend is observable in the WAM scenario, but the emissions start to grow later, in 2030.

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

The Fifth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC) confirms that global warming is running faster than predicted by some scenarios in the past, and by 2100 the global temperature can grow on average by 1.5 to 4.5 degrees Celsius

[2] Adopted by Governmental Resolution No. 130/2008
[3] Governmental Resolution No. 677/2010 Coll.
[4] Governmental Resolution No. 350/2014 Coll.

compared to pre-industrial level. Concentrations of atmospheric carbon dioxide, methane and nitrous oxide have risen to levels exceeding the 800,000-year levels, mainly due to human activities (fossil fuel emissions, land use change and deforestation). Climate change scenarios, described in this communication, assume a comparable increase of monthly and annual temperatures by 1.5 to 4.7°C in the Slovak Republic. While temperature scenarios are very close for all Slovak localities, precipitation scenarios exhibit some regional differences. A higher increase of annual precipitation totals was obtained from the north of country; the decrease of summer precipitation totals is more significant in the southern lowlands. A comparable increase (decrease) is also projected for daily maximum precipitation totals.

The solution, that should ultimately prevent or at least minimize the risks and negative impacts of climate change, is to combine measures aimed at reducing greenhouse gas (mitigation) with measures that reduce vulnerability and allow people and ecosystems to adapt with lower economic, environmental and social costs. The aim of the adaptation is to mitigate the negative effects of climate change, reduce vulnerability and increase the adaptive capacity of natural and man-made systems against the actual or expected negative impacts of climate change, and to strengthen the resilience of the whole society by raising public awareness and building a knowledge base for more effective adaptation.

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 further strengthen their resilience through ecosystem-based and managerial options, etc. This Chapter focuses on the expected impacts of climate change, vulnerability and adaptation measures in several important sectors of the Slovak economy such as Agriculture, Forestry, Biodiversity, Public Health, Hydrology and 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 2014 - 2016 under the financial assistance granted by the SR to developing countries. Of the total portfolio, the following activities were selected: activities in the field of climate change adaptation, mitigation projects, support and capacity building projects for water management, ecological agriculture, food security and the development of renewable energy sources.

The Slovak Republic has implemented more than 135 projects, mainly in the form of bilateral cooperation, by providing a total sum nearing EUR 8 million. All Slovak bilateral and multilateral climate financial support provided to developing country Parties in 2014 - 2016 was channelled through the Official Development Assistance (ODA) in accordance with OECD DAC methodology.

Chapter 8: Research and Systematic Observation

The Slovak Republic has developed an Integral Conception for state scientific and technical policy. The Ministry of Education, Science, Research and Sport of the Slovak Republic (MŠVVaŠ SR) is the authority with full competences and administration skills to manage research and development in the Slovak Republic according to Act No. 172/2005 Coll. on the organization of state support for 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 the SHMÚ, universities and other institutions dealing with research.

National projects in this field are as important as the international ones, their scope and results are mostly comparable with European standards. Also of note are a large number of projects not dealing directly with climate change issues, but with physical, chemical and biological processes connected with impacts comparable to climate change. The list of projects includes a number of projects in the field of climatology, the forestry sector, the hydrology and water management sector and agriculture.

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

Chapter 9: Education, Training and the Raising of Public Awareness

Education is generally the responsibility of the Ministry of Education, Science, Research and Sport of the Slovak Republic (MŠVVaŠ SR) for this issue, but the Ministry of Environment of the Slovak Republic (MŽP SR) also contributes significantly directly or through its branches such as the Slovak Environmental Agency (SAŽP) and the Slovak Hydrometeorological Institute (SHMÚ) in training and raising public awareness. Education and information on this subject are also provided by select university and scientific institutions, interest groups, as well as professional and non-governmental organizations (NGOs).

Climate change is an extremely challenging and cross-cutting theme that goes beyond the context of educational programs for elementary and secondary schools. The issue of climate change and its adverse consequences are a component of a wide spectrum of topics within environmental education in primary and secondary schools. The activities include global

education, training programs, national competitions as well as international activities. At the level of colleges and universities, its importance has increased in recent years.
Other climate-related activities include conferences, seminars, festivals, exhibitions, trainings, resource or information centres and involvement in international activities.

1. INTRODUCTION

Climate change has become one of the biggest, if not the biggest challenge for environmental policy in the 21st century. The World Economic Forum Global Risks 2017 Report[5], which regularly assesses the 50 biggest global risks according to their impacts, possibility and inter-connectedness with other issues, sets extreme weather events, failure of climate change mitigation and adaptation as well as the water crisis among the top 5 risks that the world faces in 2017. The report appeals to us to deepen our efforts to protect the environment and requires new approaches that take a wider "systems view" of the interconnected challenges, and that involve a larger and more diverse set of actors.

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

To fulfil this obligation, the Slovak Republic is submitting its 7th National Communication on Climate Change, which contains the 3rd 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 7th National Communication on Climate Change, the 3rd 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 analysis of how our commitments are being fulfilled and provides information about important changes in the area of climate change policy since the submission of our last National Communication in 2013.

Since 2013, the most important achievements in the context of the fulfilment of the 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 being maintained and carbon intensity is being decreased;
- There is enhancement of cooperation between ministries and other state agencies in order to implement more effectively our climate change commitment;
- Research programmes and projects related to climate change in various areas, such as forestry, hydrology, water management, agriculture sector and renewable energy sources is continuing;
- Improvements have been made in educational programmes and the climate-change awareness of the general public, which also includes the organisation of several international environmental events.

[5] http://www3.weforum.org/docs/GRR17_Report_web.pdf

To sum up our mitigation commitments, under the second commitment period of the Kyoto Protocol, the Slovak Republic agreed to reduce aggregated GHG emissions by 20% compared to the base year 1990.

In 2015, total GHG emissions in the Slovak Republic without Land use, land-use change and forestry (LULUCF) were 44.6% below 1990.

In compliance with Decision 2/CP.17 the Slovak Republic also submits in the Annex 1 to this National Communication the 3rd Biennial Report of the Slovak Republic, which contains:

- Information on GHG emissions and trends and the GHG inventory including information on the national inventory system;
- Quantified economy-wide emission reduction targets;
- Policies and measures;
- Projections of GHG emissions up to 2040 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[6] are enclosed as Annex 2 to this National Communication.

[6] Decision 19/CP.18

2 NATIONAL CIRCUMSTANCES RELEVANT TO GREENHOUSE GAS EMISSIONS AND REMOVAL

This chapter brings a brief overview of natural conditions relevant for the policy of climate change, including the legal and institutional frame for its practical implementation. The 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 2013, when the Sixth 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 emission production.

2.1 INSTITUTION AND LEGISLATIVE ARRANGEMENT

Since the establishment of the Slovak Republic in 1993, the arrangement of state authority has not changed. The President, the 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 a 4-year period and the Government of the Slovak Republic is led by the Prime Minister. The Government of the SR consists of 3 Deputy Prime Ministers and 13 ministers. The arrangement and responsibilities of central state administration bodies are governed by Act No. 575/2001 Coll. on the organization of Government activities and central state administration bodies.

The Ministry of Environment of the Slovak Republic (MŽP SR) 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.The UNFCCC was signed on behalf of the Slovak Republic on 19 May 1993.[7] The Slovak Republic expressed its approval with the UNFCCC by Resolution of the National Council of the SR No. 555 of 18 August 1994.[8] The Kyoto Protocol was signed on behalf of the SR on 26 February 1999 in New York. The National Council expressed its approval with the Kyoto Protocol by Resolution No. 1966 of 20 March 2002.[9] In Doha, Qatar, on 8 December 2012, the Doha Amendment to the Kyoto Protocol[10] was adopted, establishing the second commitment period of the Kyoto Protocol (2013 - 2020) with legally binding emission-reduction targets. The National Council of the Slovak Republic expressed its approval with the Doha Amendment by Resolution No. 1571 of February 2015. The process of national ratification is finished. The European Union and its Member States intend to deposit their ratification instruments for the Doha Amendment of the Kyoto Protocol by the end of the year 2017 at the latest.

[7] Notice of the Ministry of Foreign Affairs of the Slovak Republic No. 548/2006 Coll.
[8] The Act on Ratification was deposited at UN Depositary on August 25, 1994
[9] The Act on Ratification was deposited at UN Depositary on May 30, 2002
[10] http://unfccc.int/kyoto_protocol/doha_amendment/items/7362.php

At the Paris Climate Conference (COP21) in December 2015, the first-ever universal, legally binding global climate agreement was adopted - the Paris Agreement. On 5 October 2016, the threshold for entry into force of the Paris Agreement was achieved. The Paris Agreement entered into force on 4 November 2016.

The National Council of the Slovak Republic approved the Paris Agreement by Resolution No. 215 of September 2016. The process of ratification was finished by the signature of President of the Slovak Republic Andrej Kiska on 28 September 2016 in New York. The Slovak Republic deposited its instrument of ratification jointly with the EU on 5 October 2016. The Climate Change Policy Department of the MŽP SR 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, a joint Committee on Climate-Energy Package at the level of State Secretaries, consisting of State Secretaries of selected ministries was created by Resolution of the Government No. 416/2008 of 18 June 2008.

Based on the resolution of the Slovak Government No. 821/2011, from 2011 Committee on Climate-Energy Package was replaced by the Committee for Coordination of Climate Change Policy at the level of State Secretaries (Committee).

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

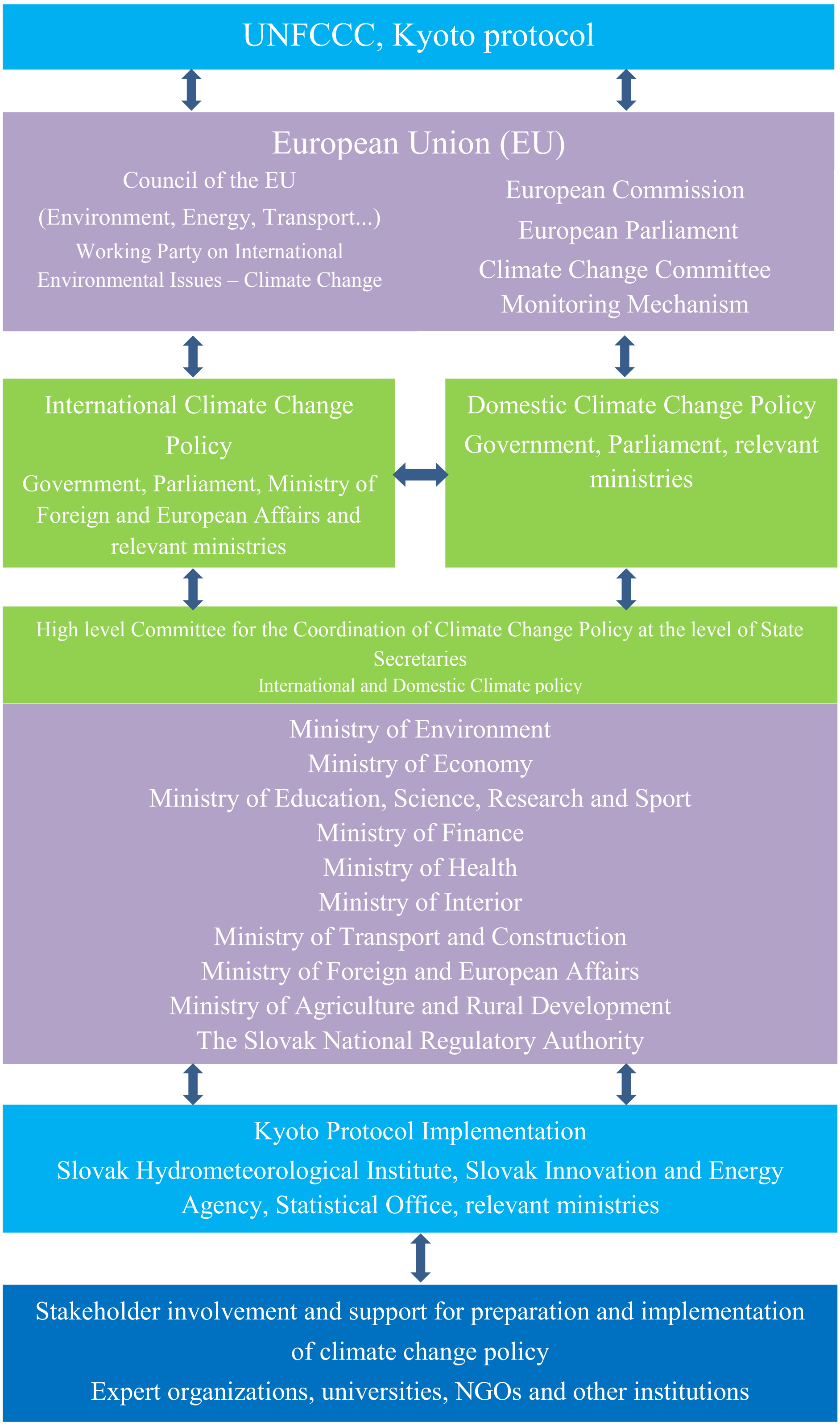
The main objective of the Coordination Committee is the effective coordination of the development and implementation of mitigation and adaptation policies and selection of appropriate measures to fulfil international obligations.

An important output of the Coordination Committee's activities is also the 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 the aim to inform it on the basis of a detailed analysis of current progress on this issue. So far, 5 reports have been submitted – the latest one in April 2017.[11]

The Working group on Ad-hoc Working Group for preparing the Low-Carbon Strategy of the SR were created under the Committee in 2012. These working groups include experts from other relevant ministries, academic and university positions and other expert institutions. The Working Group on Adaptation is currently working on the updated version of the Adaptation Strategy of the Slovak Republic, which is expected to be finished by 2018.

[11] http://www.rokovania.sk/Rokovanie.aspx/BodRokovaniaDetail?idMaterial=26360

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



2.2 DEMOGRAPHIC PROFILE

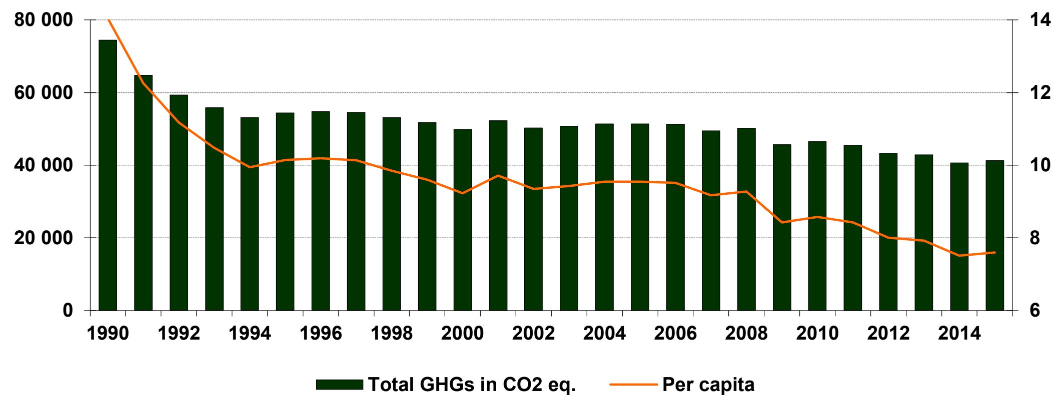
The population of the Slovak Republic as at 31 December 2016 was 5,435,343. The average residential density is 110.8 inhabitants per km². Besides towns, the population is concentrated in lowlands and basins, highlands and mountains are populated very sparsely. Extensive settlement and landscape exploitation have greatly influenced the original landscape structure and ecosystems. Bratislava, the capital, is also the biggest city in the Slovak Republic, with a population of 425,932.

In 2016, 57,557 living children were born, i.e. 1,955 more than in 2015. Furthermore, in 2016 52,351 people died, which is about 1,475 less than in 2015. These numbers therefore indicate a slight trend of population increase, in spite of the recent years where such a trend was halted.

Half of the Slovak Republic's population is over 39.8 years old. However, the major demographic trend is the increase in the share of the group over 65 years of age. The main reason is the change in reproductive behaviour, which has caused the Slovak Republic to drop under the replacement level fertility rate.

In the context of demographic development, a very positive trend is the decrease in emissions per capita – in 2015 there were 7.64 tons of CO_2 eq. compared to the 1990 value of 14.09 tons of CO_2 eq. This level of emissions per capita in the Slovak Republic is below the EU-27 average level, which was 8.75 tons of CO_2 eq. per capita[12] at that time.

Figure 2.1: *History of aggregated GHG emissions per capita in the Slovak Republic from 1990 to 2015* [13]



2.3 GEOGRAPHIC PROFILE

The information on the 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 a mild climate zone with mean monthly precipitation totals equally distributed over the whole year.

[12] http://www.eea.europa.eu/data-and-maps/data/data-viewers/greenhouse-gases-viewer
[13] National Inventory Report of the Slovak Republic 2013

The Atlantic Ocean impacts the western part of the country more and continental influence is more typical for the eastern part. The Mediterranean climate mainly influences the south of the central part of the Slovak Republic, in particular through higher precipitation totals in autumn. A regular rotation of spring, summer, autumn and winter seasons is typical for the country.

During the period 1881 - 2017, a significant increase of annual air temperature by 2.0°C and insignificant trend of annual precipitation totals by about 1% on average were recorded in the Slovak Republic. Annual precipitation totals increased up to 3% in the north and also decreased more than 10% in the south of the country. Relative air humidity decreased up to 5% in the south-west of the Slovak Republic. A snow cover decrease up to the altitude of 800 m was recorded (moderate snow cover increase occurred only in the highlands, above 1,000 m a.s.l.). There is evidence of gradual desertification, particularly in the south of the country (increase of potential evapotranspiration and decrease of soil moisture), nevertheless, the year 2010 and the cold half-year 2012/2013 were the wettest since 1881. Significant increases in regional floods and flash floods were recorded after 1993. Sun radiation characteristics changed insignificantly, except for the temporal decrease in 1965 - 1985. Figures 2.2 and 2.3 show deviations of seasonal mean temperatures from the norm in the Slovak Republic for the 1980 - 2017 period and areal mean precipitation totals in the Slovak Republic in the 1881 - 2017 period. The temperature increase in the last 38 years is even more significantly than in the whole 1881 - 2017 period and the precipitation totals have started to increase slightly since 1994 (the extreme year of 2010 was exceptional).

Figure 2.2: *Deviations of warm and cold half-year mean temperatures from 1961 - 1990 norms in the Slovak Republic in 1980 - 2017 (according to SHMÚ data)*

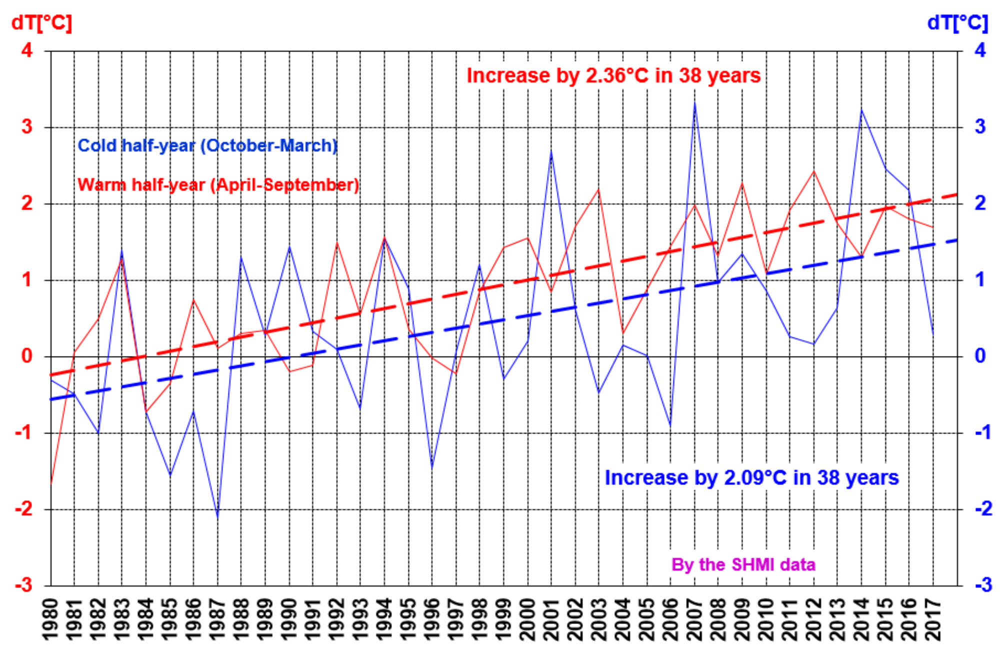
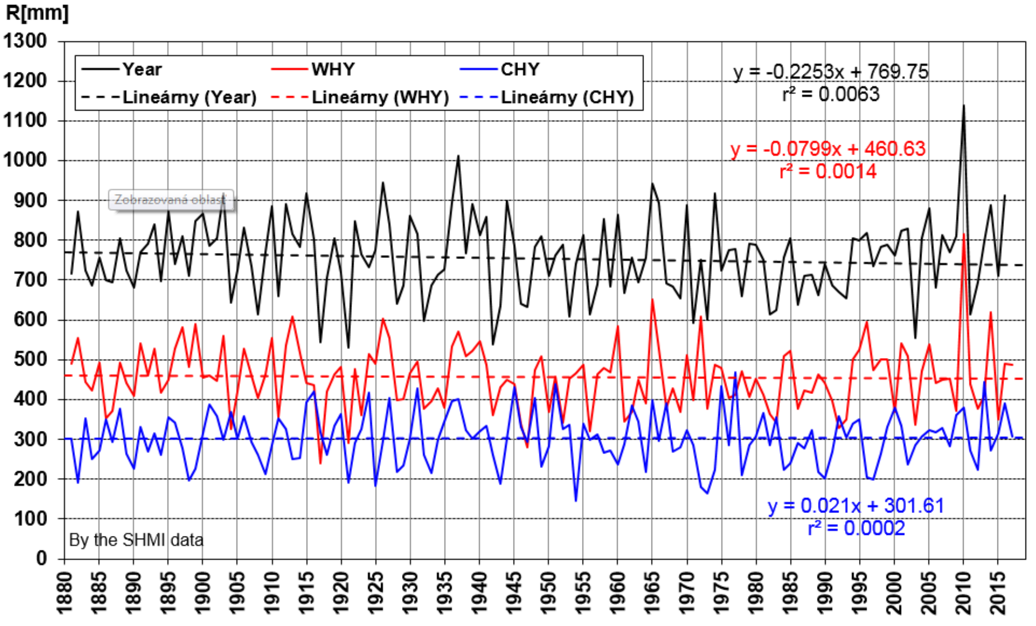


Figure 2.3: *Annual (Year), warm half-year (WHY, Apr.-Sept.) and cold half-year (CHY, Oct.-March) areal mean precipitation totals in the Slovak Republic in 1881 - 2017 (according to SHMÚ data)*



Particular attention needs to be paid to climate change and variability, in particular to precipitation totals and the hydrologic cycle. Over the last 24 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 the period of 1975 - 1993. This trend has resulted in higher risk of local floods in several localities of the Slovak Republic. On the other hand, local and regional droughts caused by long periods of relatively warm weather and low precipitation totals in some parts of the growing seasons have been recorded in the period of 1989 - 2017. Particularly strong droughts were in 1990 - 1994, 2000, 2002, 2003, 2007, 2009, 2011, 2012, 2015 and 2017. Based upon the indicators of air temperature, precipitation totals, evapotranspiration, snow cover and some other elements, the decades 1991 - 2000 and mainly 2001 - 2010 and 2011 - 2017, have approached the conditions expected in about 2030/2040 with respect to climate change scenarios designed for the Slovak Republic.

Evaluation of extreme weather events till 2016

Extreme weather events in relation to temperature, precipitation, air humidity, sunshine duration, evaporation and snow cover have been evaluated. In terms 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. Daily precipitation totals above 100 mm usually cause at least a local flash flood, the change in the number of such events in the Slovak Republic is a good indicator. The number of days with muggy weather (water vapour pressure above 18.7 hPa), and number of days with 1 cm, 10 cm, 50 cm or 100 cm of snow cover have been evaluated similarly. These results show a different climate change evolution in lowlands and mountainous regions. More details in the decades from 1951 - 1960 to the period 2011 - 2016 can be seen in Tables 2.1, and 2.2 and in Figure 2.4.

Tables 2.1 and 2.2 show that significant changes occurred at some climatic characteristics and extreme values, mainly in the 2001 - 2010 and 2011 - 2016 periods, compared to the 1901 - 1990 or 1951 - 1990 periods: the number of days with an average temperature of 27°C and more and tropical nights with a minimum temperature of 20°C and more increased more than 5-times, the number of tropical days with a maximum temperature of 30°C and more increased by about 2-times, the number of days with average relative humidity below 50% by about 3-times, the number of muggy days (average water vapour pressure above 18.7 hPa) increased by about 2-times, the summer average saturation deficit increased by 30%, the number of days with a harmful saturation deficit of 10 hPa and more increased by 80%, the number of daily precipitation totals above 10 mm increased in the whole Slovak Republic by about 15%, but the number of all days with precipitation slightly decreased, precipitation totals decreased in the south, but increased in the north of the Slovak Republic (at Oravská Lesná by about 10% compared to the 1951 - 1990 period).

Table 2.1: *Some climatic characteristics of mean and extreme weather elements for Hurbanovo (SW of the Slovak Republic, 115 m a.s.l. in the decades from 1951 - 1960 to the period of 2011 - 2016)*

	1901-1950	1951-1960	1961-1970	1971-1980	1981-1990	1991-2000	2001-2010	2011-2016
Annual average temperature (T), °C	9.7	9.9	9.9	10.0	10.1	10.7	11.1	11.6
Mean maximum aver. daily T in Summer, °C	N	26.9	27.0	26.3	27.3	27.8	28.9	29.6
Number of daily aver. T 24°C and more, Days	N	9.2	12.2	8.4	11.4	17.6	23.0	24.8
Number of daily aver. T 27°C and more, Days	N	1.2	1.0	0.2	1.0	3.6	4.5	11.2
Number of daily aver. T below 0°C, Days	N	46.3	56.6	40.0	48.0	44.3	45.7	35.7
Number of daily aver. T below -5°C, Days	N	12.2	17.0	7.8	13.5	9.6	9.5	5.3
Mean daily max. temperature in Summer, °C	25.4	N	26.1	25.6	26.0	27.2	27.5	28.1
Number of daily max. T 25°C and more, Days	67.8	N	76.5	71.6	75.7	86.0	89.9	96.3
Number of daily max. T 30°C and more, Days	14.8	N	22.9	14.5	21.2	27.8	33.9	37.0
Mean daily minimum temperature in Winter, °C	-3.7	N	-4.7	-2.1	-3.1	-2.6	-2.7	-1.6
Number of daily min. T below 0°C, Days	96.7	N	103.5	88.5	90.5	90.0	85.6	77.7
Number of daily min. T below -10°C, Days	14.2	N	15.1	6.4	10.4	7.5	8.0	4.5
Number of daily min. T 20°C and more, Days	1.0	N	0.6	1.2	1.9	3.2	3.9	7.5
Annual mean relative humidity (RH), %	75.6	76.1	74.4	74.2	72.4	73.1	72.7	72.5
Number of days with aver. RH below 50%	N	5.2	8.8	11.2	15.5	16.2	18.3	18.4
Summer mean water vapour pressure (WVP), hPa	15.4	16.2	15.4	15.1	14.8	15.8	16.3	16.5
Number of days with aver. WVP above 18.7 hPa	N	17.5	14.1	11.9	9.7	16.8	22.0	24.2
Summer mean saturation deficit (SD), hPa	6.6	6.9	7.6	7.4	8.1	8.8	9.1	9.6
Number of days with aver. SD 10 hPa and more	N	20.8	30.5	24.6	34.4	42.8	46.0	47.3
Annual mean sum of sunshine duration (SSD), hours	1,987	1,850	1,774	1,831	1,951	1,979	2,082	2,111
Number of days with 10 hr SSD and more	N	N	55.5	62.8	66.2	71.4	86.0	87.5
Annual mean precipitation totals (PPT), mm	581	567	556	518	497	555	589.0	574.0
Number of days with 10 mm PPT and more	16.3	15.7	15.8	15.1	12.8	15.0	17.8	16.8
Number of days with snow cover 1 cm and more	37.7	34.1	50.4	27.2	32.9	34.0	34.8	19.0
Number of days with snow cover 10 cm and more	13.5	12.4	22.2	6.1	12.8	14.3	5.5	2.0

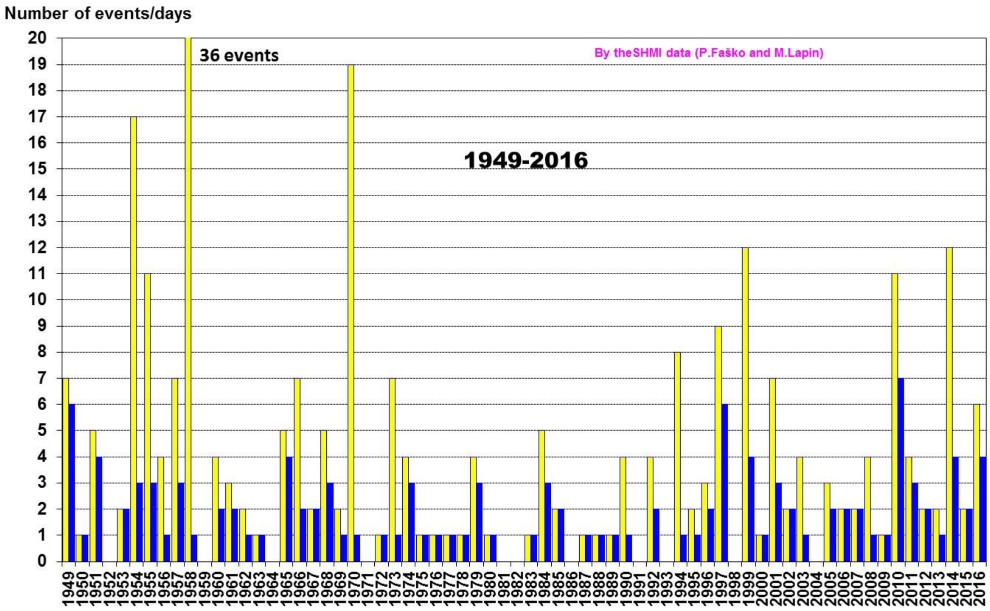
	1901-1950	1951-1960	1961-1970	1971-1980	1981-1990	1991-2000	2001-2010	2011-2016
Average annual potential evapotranspiration sum, mm	N	692	730	742	773	782	792	809
Average annual actual evapotranspiration sum, mm	N	445	432	417	417	442	464	430

Potential evapotranspiration increased in the whole Slovak Republic, 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). Number of snow cover days decreased slightly in the whole Slovak Republic, in the lowland the number of days with a snow cover depth of 10 cm and more decreased significantly, but in the mountains the number of days with a snow cover depth of 100 cm and more increased by about 3-times in the period of 2001 - 2010 (at Oravská Lesná, Table 2.2).

Table 2.2: *Some climatic characteristics of mean and extreme weather elements for Oravská Lesná (NW of the Slovak Republic, 780 m a.s.l. in the decades from 1951 - 1960 to the period of 2011 - 2016)*

	1901-1950	1951-1960	1961-1970	1971-1980	1981-1990	1991-2000	2001-2010	2011-2016
Annual mean precipitation totals (PPT), mm	1,109	1,045	1,155	1,059	1,071	1,170	1,241	1,085
Average annual potential evapotranspiration sum, mm	N	448	452	437	461	467	492	527
Average annual actual evapotranspiration sum, mm	N	421	434	416	440	434	459	465
Number of days with snow cover 1 cm and more	N	126.9	139.3	126.5	120.6	132.6	124.6	101.7
Number of days with snow cover 10 cm and more	N	107.7	114.5	104.1	95.6	106.7	113.6	79.8
Number of days with snow cover 50 cm and more	N	30.4	51.7	30.6	42.5	29.1	40.3	26.7
Number of days with snow cover 100 cm and more	N	4.2	3.1	4.1	6.0	3.4	10.1	4.8

Figure 2.4: *Number of events (yellow) and days (blue) with measured daily precipitation totals 100 mm and more at about 700 stations in the Slovak Republic from 1949 - 2016*



Heavy and intense precipitation events play a very important role in flash flood events, evidence of such cases is based on measurements at about 700 station since 1949 and a smaller number of stations before 1949 (about 100 stations in 1881 - 1900, more than 200 stations in the Slovak Republic since 1901). From Figure 2.4 the 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 extreme events/stations on 29 June 1958).

2.5 ECONOMIC PROFILE

This chapter brings a short analysis of the economic development of the Slovak Republic in the past decade. Besides the basic macroeconomic indicators such as GDP, GDP per capita and foreign trade development, data on the amount of investment in environmental protection and activities in the area of science and research are also mentioned without specifying their orientation. The economic crisis that began in 2008 brought a significant weakening of external demand, causing decreasing dynamics for Slovak export, manufacturing, the 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	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
GDP at curr.pr. (Bill. EUR)	63.05	68.49	64.02	67.58	70.63	72.7	74.17	75.95	78.69	80.96
GDP at const. PPY (Bill. EUR)	62.35	66.6	64.78	67.25	69.48	71.8	73.79	76.08	78.86	81.27
GDP at const.pr.10 (Bill. EUR)	64.4	68.02	64.33	67.58	69.48	70.63	71.69	73.53	76.35	78.85
GDP per capita at curr.pr. (thous. EUR)	11.68	12.67	11.82	12.45	13.8	13.45	13.7	14.1	14.51	14.91
GDP per capita at const.PPY (thous. EUR)	11.55	12.32	11.96	12.39	12.87	13.28	13.63	14.4	14.54	14.96
GDP per capita at const.pr.10 (thous. EUR)	11.93	12.58	11.87	12.45	12.87	13.7	13.24	13.57	14.8	14.52

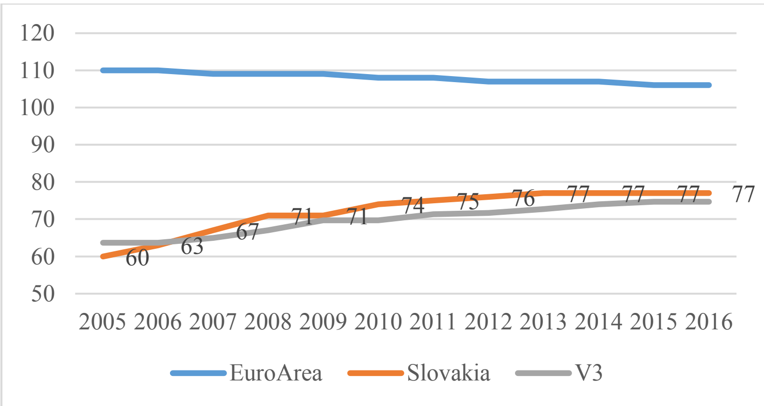
Source: SLOVSTAT, Note: ESNÚ 95 methodology, according to quarterly national accounts

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

Indicator	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Export of goods and services	52.5	54.8	43.3	51.6	60.1	66.5	69.3	69.7	73.6	76.0
Import of goods and services	53.2	56.8	44.2	52.6	60.7	63.8	66.1	67.0	71.7	72.9
Balance	-0.7	-1.9	-0.9	-1.0	-0.6	2.7	3.1	2.7	1.9	3.0

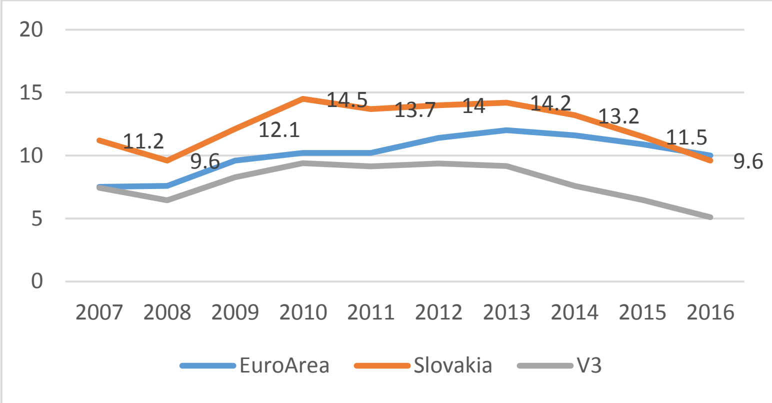
Source: Statistical Office of the Slovak Republic; Methodology ESA2010 by quarterly NA

Figure 2.5: *GDP per capita in purchasing power standard (PPS) (indices; EU28=100)*



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

Figure 2.6: *Rate of unemployment (%)*



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

In 2007, the Slovak economy reached its highest growth historically at 10.5%. The growth was the result of the co-operation of foreign direct investment, positive developments in the external environment, structural reforms and 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 the Slovak Republic 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[14], unemployment in 2004 - 2007 showed a positive downward trend and in 2008 for the first time during the existence of the independent Slovak Republic 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 grew. Labour productivity growth in this period, however, outpaced wage growth, therefore these developments have not threatened the competitiveness of Slovak industry.

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

The year 2010 marked a turnaround for the Slovak economy in the form of a relatively strong recovery in economic growth (which lasts until today) - which at 4.4% resulted in the SR being in second place in the EU after Sweden. Boosting growth in years 2010 - 2012 has not been translated into the labour market - still falling employment and a decline in household gross disposable income contributed to a decline in household consumption. The labour market reacted to the production side of the economy with a delay. Thus, in 2010 the decline in employment continued, declining by 2.0%, and the unemployment rate fluctuated 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 ended at 13.9% in 2012. The

[14] http://portal.statistics.sk/showdoc.do?docid=1801

debt crisis in the Eurozone that broke out in 2012 again caused a decline in external demand. The Slovak Republic managed to avoid recession due to new investments in the automobile industry, which supported exports and due to which the Slovak Republic finished with a historical trade balance surplus.

After this period, full recovery began. In 2016, the Slovak economy grew by 3.3%. This growth was mainly driven by household consumption and, after a two-year period, also by net exports. The slackening of growth compared to the last year is particularly owing to lower EU funding drawdown in the new programming period, resulting in a 9% decrease in investments in the whole economy. A positive sign was the growth of household consumption, which hit its highest figures since 2008 owing to excellent labour market conditions and falling prices. Exports did not manage to hit the strong growth figures of 2015 again in spite of record-breaking production in the automotive industry, which could not have compensated for the slowdown in the V3 countries.

The year 2016 was one of the best years for the labour market. The increase in the number of people employed by 54 thousand reduced the unemployment rate (according to the LFS methodology) to the level of 9.6%. It reached the level of the record-breaking year of 2008. Job creation occurred evenly across all sectors of the domestic economy. The growth of the number of foreigners working in the Slovak Republic was record-breaking (an increase of 8 thousand); foreigners occupied 15% of all new job positions. Nominal wages grew by 3.3%. Real wages saw even more growth at a rate of 3.8% thanks to the deflationary trend. It was the third year in a row that they surpassed the growth in labour productivity.

As described in 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 in the GDP development structure (SK NACE Rev. 2) (in %)*

Indicator	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Economy in total	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
A Agriculture. forestry and fishing	4%	4%	3%	3%	3%	3%	4%	4%	3%	3%
B.C.D.E Industry total	27%	26%	22%	24%	24%	24%	23%	24%	24%	25%
C Manufacturing	21%	20%	16%	19%	19%	19%	18%	20%	20%	21%
F Construction	7%	9%	9%	8%	8%	8%	7%	7%	7%	7%
G-U Services	52%	53%	57%	56%	55%	56%	57%	55%	56%	55%
Net taxes on products	10%	9%	9%	9%	9%	9%	9%	9%	10%	10%

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

Table 2.6: *Environmental expenditures (million EUR)*

Indicator	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Environmental investments	332.43	292.15	321.26	279.60	260.01	269.47	252.11	201.79	246.67	581.74
Investments covered by the state budget	37.93	28.49	33.80	23.50	23.32	37.62	46.36	27.01	37.11	73.90
Investments covered by foreign investors					56.24	73.73	63.84	46.75	39.22	155.88
Current expenditures total	772.67	579.29	479.12	448.59	474.01	515.83	550.65	554.10	547.54	599.44
Income from the protection of environment combined	265.71	268.83	396.29	355.31	449.02	528.17	596.99	579.54	644.69	716.19
Income from sales of products, instruments and environmental components	2.16	2.81	1.54	6.02	5.78	16.04	17.43	10.70	13.02	21.11
Income from sales of environment. technologies				2.92	1.63					
Income from services provided for protection	149.59	191.15	264.65	275.49	326.39	329.37	381.59	407.06	465.10	525.39

Source: SLOVSTAT

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

Indicator	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Gross domestic expenditure on R&D	267.65	282.63	316.46	302.99	416.37	468.44	585.23	610.88	669.63	927.27

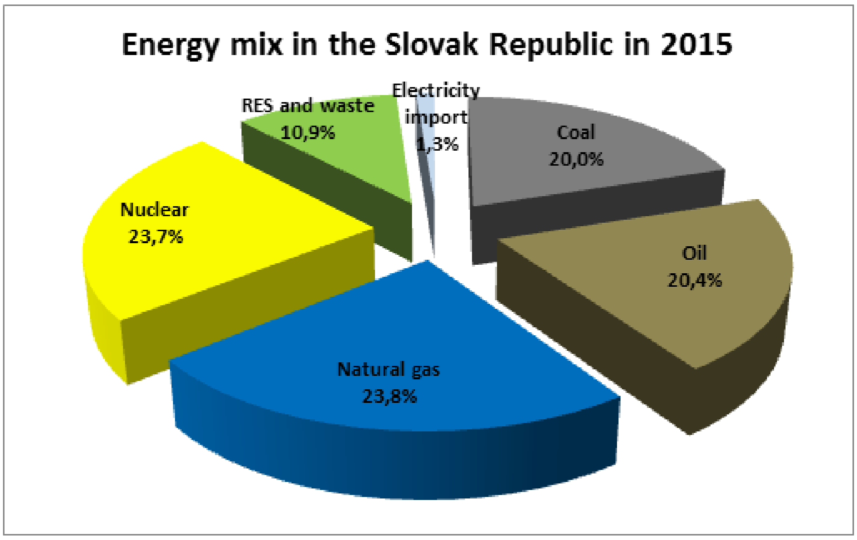
Source: SLOVSTAT

As results from the figures in Table 2.7, 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 energy mix with gross inland energy consumption composed of nuclear fuel, fossil fuels and renewable energy sources. Shares of energy sources in gross inland consumption in 2015 were as follows: natural gas 23.8%, nuclear fuel 23.7%, oil 20.4%, coal 20% and renewable sources, including hydropower 10.9%. The Energy Policy of the Slovak Republic, approved by the Government of the Slovak Republic in 2014, is focused on optimizing the energy mix in terms of energy security.

Figure 2.7: *Energy mix in the Slovak Republic in 2015*



Source: Statistical Office of the Slovak Republic

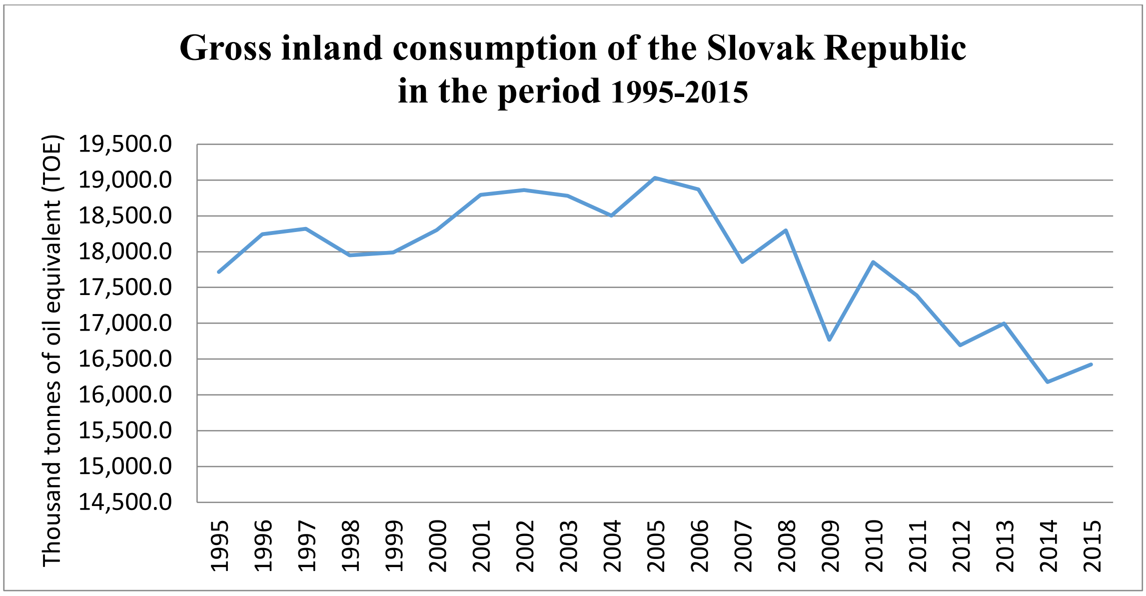
2.6.1 Development of Energy Consumption

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

The overall decrease in GIC in the Slovak Republic in the period from 1995 to 2015 is 7.3%. GIC peaked in 2005 with more than 19,000 thousand tonnes of oil eq. consumed.

However, GIC exhibited a decreasing trend from 2005 till 2015, with an overall decrease of 13.7% over the decade (Figure 2.8).

Figure 2.8: *Gross inland consumption of the Slovak Republic in the period 1995-2015 (GIC)*



Source: Eurostat

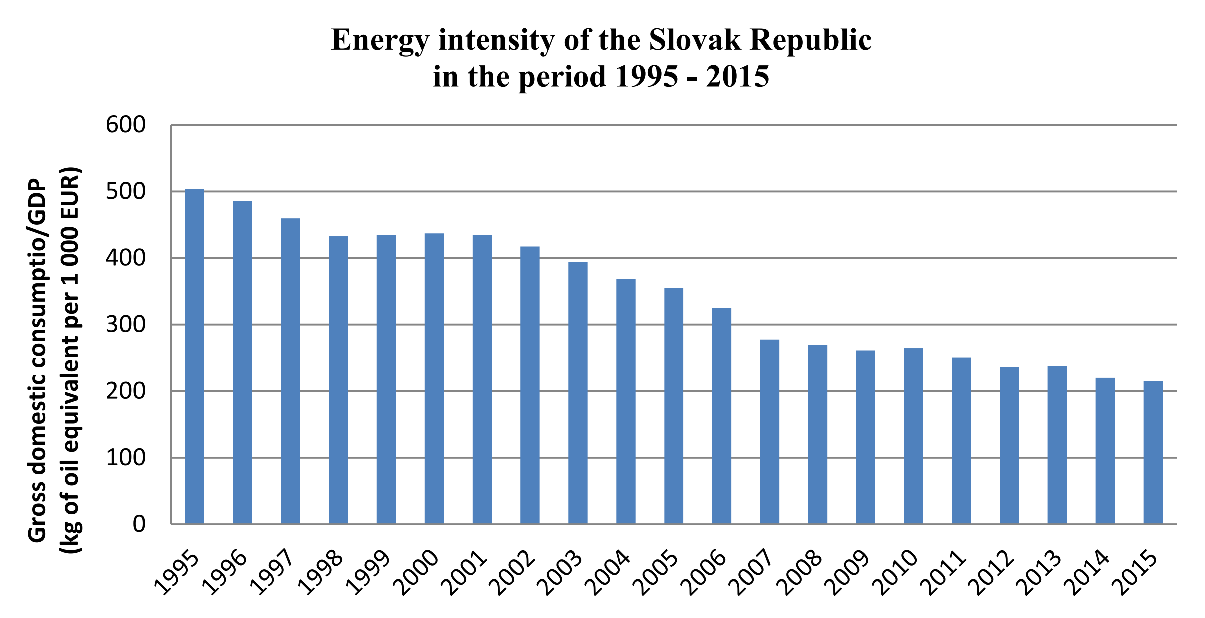
2.6.2 Development of Energy Intensity of the Slovak Republic

Energy intensity as the ratio of the gross inland consumption and the gross domestic product (GDP) for a given calendar year is an important economic indicator of the national economy. It measures the energy consumption of an economy and its overall energy efficiency. Energy intensity in the Slovak Republic has had a declining trend in the past 20 years as significant progress in the reduction of energy intensity has been achieved. In the period 1995 - 2015, the Slovak Republic reduced its energy intensity by 57% (Figure 2.9). This is the second biggest reduction in terms of percentage among all EU Member States. Additionally, according to the Joint Research Centre of the European Commission, the highest reduction in energy intensity values during the 15-year period from 2000 to 2014 was found in the Slovak Republic, which underwent a growth rate of 82.5%.[15]

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 the household sector such as superseding home appliances with more efficient variants.

[15] Joint Research Centre: Energy Consumption and Energy Efficiency Trends in the EU-28 2000-2014 2016). p. 19. URL: http://iet.jrc.ec.europa.eu/energyefficiency/node/9145

Figure 2.9: *Energy intensity of the Slovak Republic in the period 1995 - 2015*



Source: Eurostat

The Slovak Republic also improved its relative energy intensity vis-à-vis other EU Member States; in 2000 it was the third most energy-intensive economy among the current 28 EU Member States, while in 2015 cumulative improvements in energy intensity in the Slovak Republic caused its ranking to improve to the seventh most energy-intensive economy in the EU. Despite the achieved progress, the Slovak Republic remains an energy-intensive economy with energy intensity approximately 1.8 times higher than the average of the 28 EU Member States.

2.6.3 Nuclear Energy in the Slovak Republic

Nuclear energy is a major driver of low carbon growth. In terms of efficiency, diversified supply scenarios and scenarios of capturing and storing carbon dioxide including a substantial proportion of nuclear energy are among the least costly development scenarios in moving towards meeting the objectives of the EU.

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

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

The draft of "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 was to 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 the final part of nuclear energy, including impacts on the competitiveness of electricity producers and the reliability of the energy transit system.

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

In the year 2015, the Government of the Slovak Republic approved the National Policy and National Program for the Handling of Spent Nuclear Fuel and Radioactive Wastes in the Slovak Republic. This document substituted the previous Strategy and was prepared according to the obligation of Council Directive 2011/70/EURATOM on establishing a Community framework for the responsible and safe management of spent fuel and radioactive waste.

2.7 TRANSPORT

The number of cars in the Slovak Republic is continuously increasing. In 2015, the total number of passenger cars was 2,034,574. In comparison with the year 2011, an increase of 16% was recorded. The same increasing trend has been recorded for CO_2 emissions in road transport, which rose from 5,923.5 Gg CO_2 in 2001 to 6,343.0 Gg CO_2 in 2015. This trend was observed in spite of the measures taken (e.g. new categorizations of vehicles, new vehicle technologies, advanced fuels, biofuels, etc.).

Table 2.8: *Number of motor vehicles*

Parameter	2011	2012	2013	2014	2015
Passenger cars	1,749,271	1,824,190	1,879,759	1,949,055	2,034,574
Light duty vehicles	152,751	-	-	-	185,781
Heavy duty vehicles	139,118	-	-	-	150,313
Buses	9,074	8,957	8,821	8,876	8,939
Motorcycles and mopeds	98,774	105,213	112,455	120,154	129,104

Source: Presidium of the Police Force of the Slovak Republic

2.7.1 Freight Transport

There was a temporary increase in freight transport between the years 2011 - 2015, but overall during the monitored period between the years 2011 - 2015, the transport of goods by road dropped by almost 15,000 tons. An increase in rail transport occurred in the period between the years 2011 - 2014, but slightly decreased in 2015. The decline in freight transport occurred in water transport between the years 2012 - 2015. The transport of goods by air transport increased significantly, by about 24,100 tons in the period between 2011 - 2015. In the freight segment, road transport is the dominant form taking into account 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 2.9: *Transport of goods by mode of transport*

Type of transport	2011	2012	2013	2014	2015
Road transport	132,552	132,074	128,855	142,622	147,275
Rail transport	40,867	42,599	48,401	50,997	47,358
Water transport	1,297	2,472	1,920	1,838	1,683
Air transport	0.011	4	7	9,116	24,106
Transport - total	**174,716**	**177,145**	**179,176**	**195,466**	**196,340**

Source: Statistical Office of the Slovak Republic

2.7.2 Passenger Transport

During the period from 2011 to 2015, there was a general decline in passenger transport by 18,941. However, in nearly all types of road transport, where a decline is observable, we can see an interesting development in this type of transport - individual motoring, where the numbers are growing.

Table 2.10: *Transportation of persons by type of transport*

Type of transport	2011	2012	2013	2014	2015
Road transport - rural	291,218	289,228	270,123	262,262	252,175
Road transport - private	1,401	873	1,742	1,863	1,718
Road transport - individual motoring	1,875,789	1,894,197	1,900,418	1,903,761	1,913,518
Public transport - city	410,814	388,239	369,323	380,576	379,468
Road transport - total	**2,579,222**	**2,572,507**	**2,541,606**	**2,548,462**	**2,546,879**
Rail transport	47,531	44,698	46,064	49,272	60,566
Water transport	105	120	109	154	132
Air transport	243	669	610	576	583
Transport - total	**2,627,101**	**2,617,994**	**2,588,389**	**2,598,464**	**2,608,160**

Source: Statistical Office of the Slovak Republic

Compared with previous years, there was a slight decrease in 2015 in the volume of traffic in public transport. This year the volume of traffic in public transport stood at 379,468 carried passengers. The overall decrease compared to 2011 is 7.6%. In 2015, the number of passengers transported by rail was 60,566, an increase by 22.9% compared to the previous year. The increase in the volume of traffic in the case of individual motoring and rail transport can be linked to the boosting of the mobility of the population. This trend is due to a greater need to commute to work and supporting of rail transport use by passengers (free tickets for students and seniors and other discounts). The prices of fuel have also contributed to the change in transportation habits (Table 2.12).

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 1 January 2010, the consumption tax on diesel has been established at the minimum level of EUR 481.31/1,000 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 2.11: *Overview rates on selected mineral oils in 2009-2016*

		2009	2010	2011	2012	2013	2014	2015	2016
Leaded gasoline	EUR/1,000 l	597.49	597.5	550.5	550.5	550.5	550.5	550.5	550.5
Unleaded petrol	EUR/1,000 l	514.5	514.5	514.5	514.5	514.5	514.5	514.5	514.5
Gas oil	EUR/1,000 l	481.31	368.0	368.0	368.0	368.0	368.0	368.0	368.0
Kerosene	EUR/1,000 l	481.31	481.3	481.3	481.3	481.3	481.3	481.3	481.3
LPG	EUR/t	258.91	258.91	182	182	182	182	182	182
CNG	EUR/GJ	0	0	2.6	2.6	2.6	2.6	2.6	2.6

Source: Ministry of Finance of the Slovak Republic

Table 2.12: *The price of fuels in the Slovak Republic*

year	gasoline 95	gasoline 98	LPG	Diesel oil	CNG
			EUR/litre		
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	-
2013	1.49	1.64	0.72	1.39	1.21
2014	1.45	1.61	0.71	1.33	1.16
2015	1.29	1.47	0.62	1.14	1.05
2016	1.21	1.41	0.56	1.04	0.99

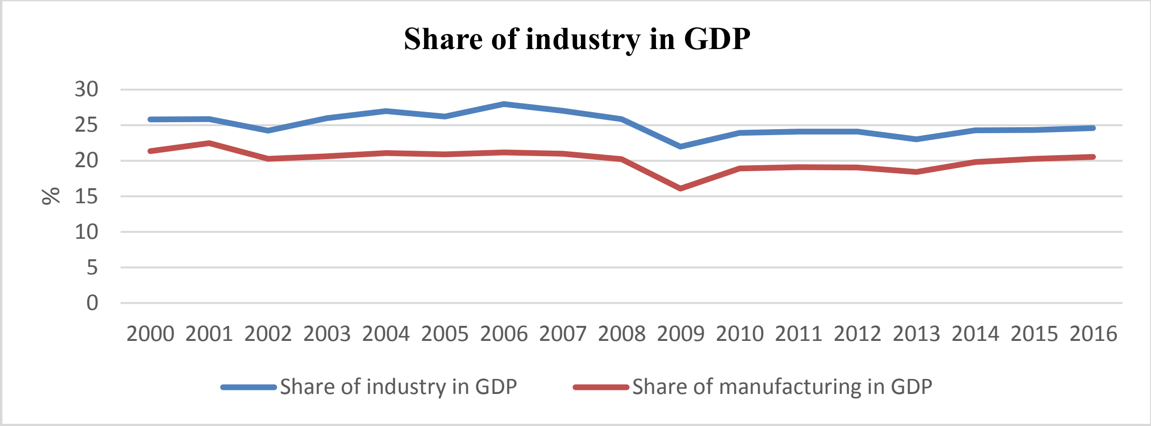
Source: Statistical Office of the Slovak Republic

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. The only exception is diesel oil, whose price dropped in 2016 due to developments on the oil market.

2.8 INDUSTRY SECTOR

The internal structure of Slovak industry has stabilized after significant changes implemented before our accession to the EU. The importance of mining and the distribution of electricity, gas and water on the production of value added has been significantly reduced and nowadays is comparable with other developed countries. The share of industry in the GDP of the Slovak Republic represented 25.8% in 2000 and decreased to 24.6% in 2016. Manufacturing represented 21.4% of GDP in 2000 and its share decreased to 20.6% in 2016.

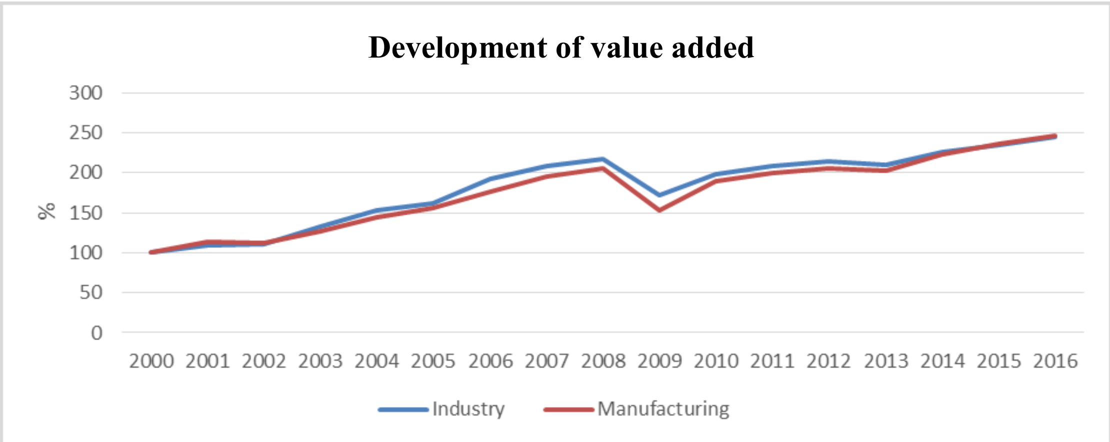
Figure 2.10: *Share of industry in GDP (% c. p.)*



Source: Statistical Office of the Slovak Republic - Slovstat;

The production of motor vehicles, trailers and semi-trailers held a dominant position in revenue generation in industrial production throughout the assessed period. In 2008, its share in revenues from industrial production was 23.3%, in 2016 this increase to 35.1%. Revenue generation in 2016 compared to 2008 increased by 89.6%. Second place belongs to the manufacture of metals and metal structures, except machinery and equipment. In 2008, its share in revenues from industrial production was 16.9%, but in 2016 this decreased to 14.7%. Revenue generation increased by 8.9% in 2016 compared to 2008. The third position in the structure of revenue generation belongs to the manufacture of rubber and plastic products and other non-metallic mineral products. In 2008, its share in revenues from industrial production was 8.4%, but increased to 8.6% in 2016. Revenue generation increased by 27.5% in 2016 compared to 2008. In 2000, the share of employment in industry was 27.9% (manufacturing 24.3%) and in 2016 this decreased to 22.9% (manufacturing 20.9%).

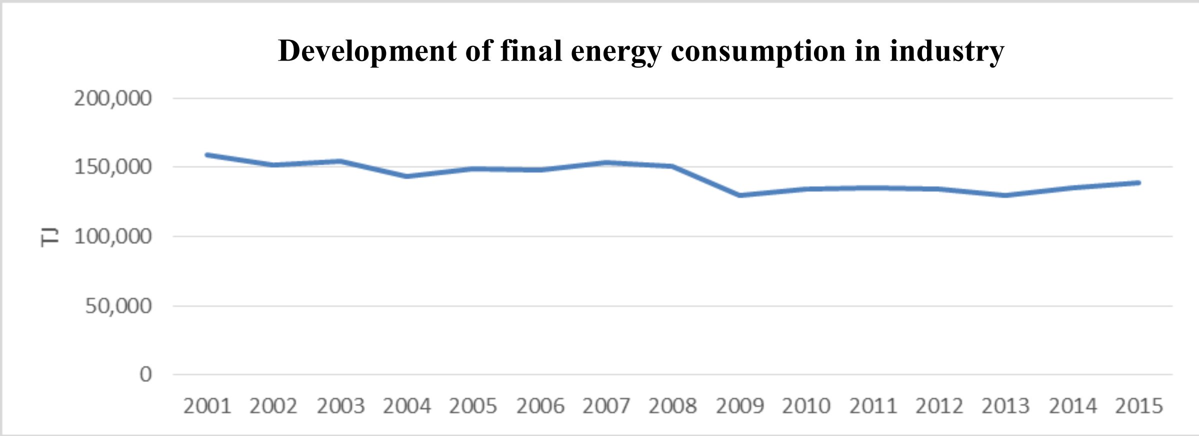
Figure 11: *Development of value added in relative % share to the year 2000*



Source: Statistical Office of the Slovak Republic - Slovstat

Value added in industry at current prices increased by 144.3% in 2016 compared with 2000, in industrial production this was 146.2%.

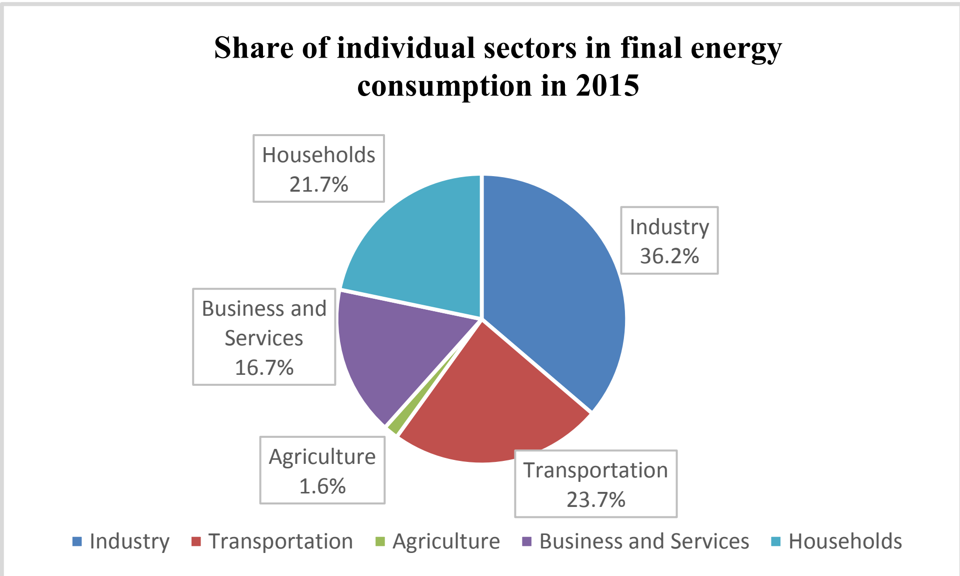
Figure 12: *Development of final energy consumption in industry (TJ)*



Source: Statistical Office of the Slovak Republic - Slovstat

Regarding 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 industry which contributed the most to fuel and energy consumption in 2015 are as follows: metallurgy 29.6%, production of cellulose, paper and polygraph 15.9%, production of non-metal mineral products 13.2%, machinery 11.2% and chemical industry 10.6%.

Figure 13: *Share of individual sectors on final energy consumption in 2015 (%)*



Source: Statistical Office of the Slovak Republic – Slovstat

In 2001, the share of industry in the final energy consumption of fuel, electricity and heat in the national economy was 35.8%, in 2015 this share increased to 36.2%. In 2015, final energy consumption in industry decreased by 12.6% compared with 2001 (over the entire national economy, final energy consumption decreased by 13.8%).

2.9 WASTE SECTOR

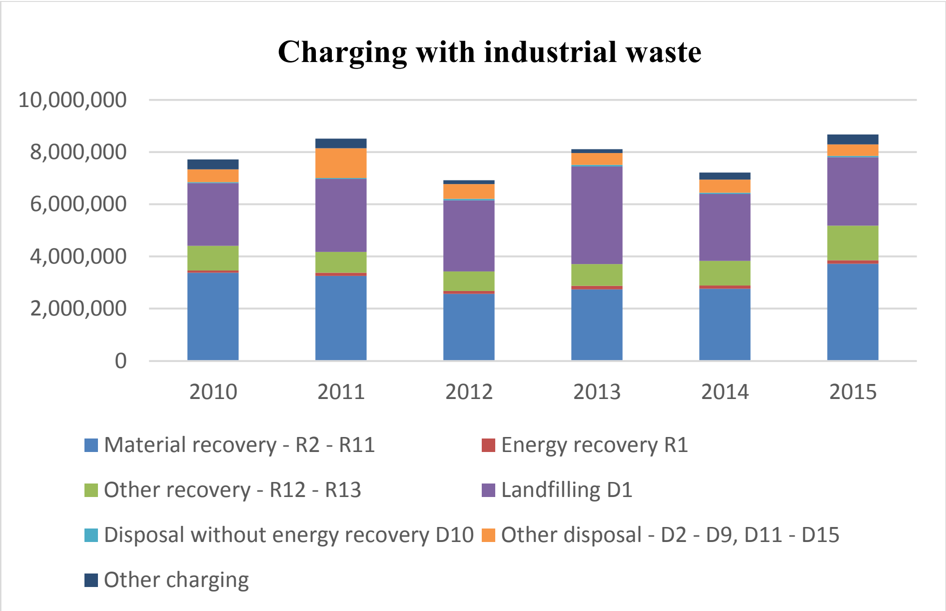
From 2012 to 2015 the Waste Management Department was affected in particular by discussion about the new Act on Waste. However, the production of waste remained at the same level with the same fluctuations as in previous years. Despite the fact that since 2010 municipalities have been obliged to implement waste sorting of the four main parts of municipal waste – paper, glass, plastic and metal, there was no report of any significant improvement in the sorting of these materials. Similarly, there has been no significant improvement in the sorting of biologically degradable municipal waste.

In the area of waste management infrastructure, the focus remained on building the infrastructure for waste sorting in municipalities, for facilities to improve the recycling rate of electrowaste, old vehicles and sorted materials of municipal waste. All these activities focused on technologies for material waste recovery.

2.9.1 Industrial waste

There were no reports of any significant changes in the production of industrial waste when compared to previous years. Some deviations in industrial waste production in some years were mostly caused by development or the reduction of construction or reconstruction of highways and railways, where large waste amounts are created in particular through excavation works – codes 17 05 04 and 17 05 06. Industrial waste management is showing a positive tendency towards material recovery, landfilling of industrial waste remains at the same level.

Figure 2.14: *Charging with industrial waste.*



Waste produced by industry classified according to economic activities (NACE) is listed in Table 2.13. Based on the data, the biggest producers of industrial waste are industrial operating facilities, and the construction, water management and agriculture sectors.

Table 2.13: *Establishment of waste other than municipal waste in the Slovak Republic in 2009 - 2011 (figures in tons per year)*

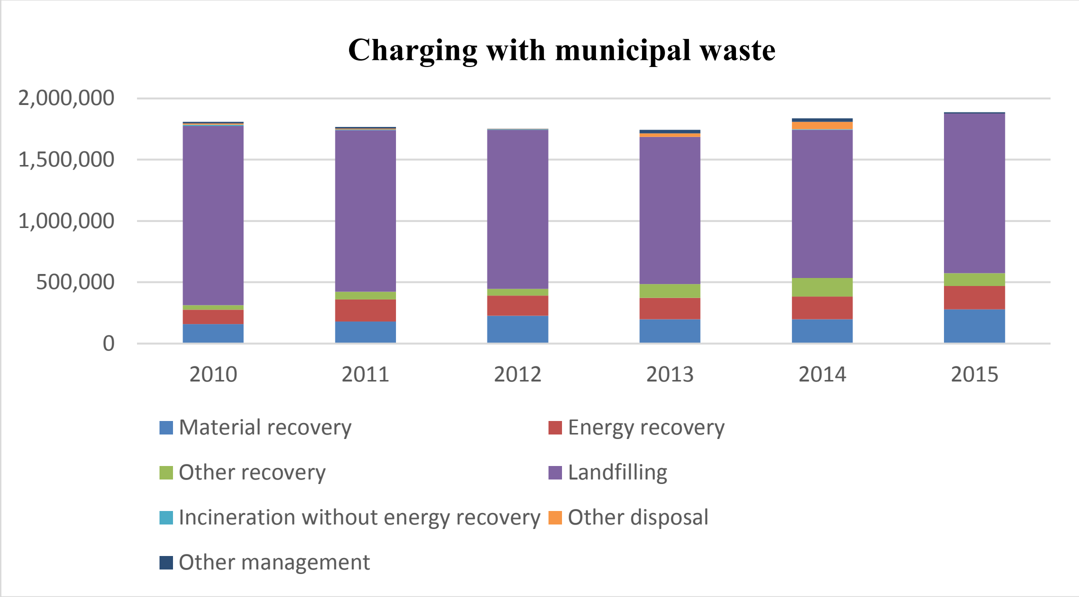
SKNACE1	Activity	2010	2011	2012	2013	2014	2015
A	Agriculture, forestry and fishing	530,635	535,947	549,391	265,605	577,480	607,022
B	Mining and extraction	165, 585	219,146	310,579	383,825	289,111	317,108
C	Manufacturing	2,723,812	3,155.988	2,644,942	2,428,589	2,641,546	3,298,830
D	Electricity, gas, steam and cold air	913,783	963,099	1,045,757	898,004	537,055	605,606
E	Water supply, purification and sewerage, waste management and remediation activities	783,818	715,747	670,565	829,662	1,023,231	652,405
F	Construction	1,835,696	2,169,257	806,187	1,995,352	1,391,107	2,086,242
G	Wholesale and retail trade, repair of motor vehicles and motorcycles	436,788	351,601	337,445	425,977	357,614	661,564
H	Transport and storage	123,220	100,125	112,606	147,737	101,636	130,144
I	Accommodation and food services	4,635	2,001	3,234	10,398	3,577	3,820
J	Information and communication	3,469	4,033	4,600	3,361	2,839	3,669
K	Financial and insurance activities	411	425	532	367	518	661
L	Real estate activities	17,260	13,513	121,662	156,781	31,440	41,205
M	Professional, scientific and technical activities	17,760	73,997	98,092	177,166	80,840	86,132
N	Administrative and support services	10,415	16,054	12,094	24,452	11,146	18,346
O	Public administration and defence, compulsory social security	19,634	26,518	21,497	25,312	5,216	65,421
P	Education	999	1,820	811	875	1,042	2,882
Q	Health care and social assistance	114,088	149,084	154,566	264,793	139,441	81,911
R	Arts, entertainment and recreation	228	274	1,205	9,352	637	594
S	Other activities	1,010	1,934	1,513	1,481	1,333	11,378
X	Not specified	22,148	16,863	23,257	65,503	26,684	0

2.9.2 Municipal Waste

The production of municipal waste is stable in the long-term and the amount of municipal waste produced per citizen is approximately 320-330 kg/cap., which is significantly below the EU average – 470 kg/cap. This is also caused by the method of collecting statistics in the SR based on which municipal waste includes only the waste from group 20 01 of the waste catalogue. Most member states also include waste from group 15 01 into the amount of municipal waste. The SR is currently in discussion with the European Commission concerning its methodology and we are also following developments in the discussion about the drafting of new waste directives which will make the reporting of statistics consistent and make the data comparable among all MS of the EU.

A positive aspect of the development of handling municipal waste is the continual improvement of material recovery and mild reduction in landfilling. Incineration of municipal waste without energy recovery has been limited to zero, as well as other disposal – other than landfilling.

Figure 2.15: *Charging with municipal waste*



2.9.3 Incineration and Landfilling

In the area of the two least popular ways to handle waste based on the hierarchy of waste management – energy recovery and landfilling – the Slovak Republic does not support the development of these technologies, in particular when defining the criteria and conditions for assigning financial funds from Euro funds or support from the Environmental Fund. In terms of switching to a circular economy, the priority is material recovery and their re-introduction into the production cycle in the form of raw materials produced from waste.

2.10 HOUSING SECTOR, HOUSEHOLDS AND PUBLIC BUILDING

According to the data provided by municipalities (such as building authorities supervising housing construction) to the Statistical Office of the Slovak Republic, the construction of 21,441 flats[16] has begun in 2016, 15,672 flats[17] were completed and at the end of the reporting period 71,581 dwellings were under construction. Of the total number of completed dwellings 11,195 were family homes, which represents a 71.43% share. The existing housing stock in 2016 shrunk by 1,292 dwellings, of which 1,158 due to renovation.

Another indicator is the average living area, which in 2016 was 73.83 m^2. On average, we registered a gradual upward trend in the living area of a flat, e.g. the value of the indicator compared to the 2015 value (71.4 m^2) increased by 2.43 m^2.

[16] issued building permits
[17] approval decisions issued

Table 2.14: *Indicators of housing in the SR for the period of 2008-2016*

Indicator	2008	2009	2010	2011	2012	2013	2014	2015	2016
Number of dwellings/flats	17,184	18,834	17,076	14,608	15,255	15,100	14,985	15,471	15,672
thereof									
Number of houses	8,502	9,022	9,136	8,763	9,479	10,208	10,041	9,860	11,195
The average house's floor area m^2	113.1	116.2	113.3	115.8	117.1	119.5	118.8	113.7	116.81
The average flat's floor area m^2	70.2	70.2	71.5	71.8	71.7	73.7	72.6	71.4	73.83

Source: Information on housing development in the Slovak Republic for 2015[18]

The most widespread type of home heating in the Slovak Republic is, according to the results of the 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 the Slovak Republic).
In 2015, most of the final energy consumption in the residential sector was covered by natural gas (52.8%), derived heat (22.8%) and electricity (21.8%). Renewables accounted for 1.5%, followed by solid fuels (0.9%). A small proportion was covered by petroleum products (0.2%).

Table 2.15: *Share of fuels in the final energy consumption in the residential sector (%), 2015*

	Solid Fuels	Petroleum products	Gas	Derived heat	Renewable enegry	Electrical energy
Slovak Republic	0.9	0.2	52.8	22.8	1.5	21.8
EU-28	3.3	12.7	35.6	7.8	15.7	25.0

Source: Eurostat

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, which influence the crop rotations of field crops, the possibility of applying other fertilizers and agricultural management.
In 2016, there was a slight recovery in the economic performance of agriculture, which made a profit of EUR 50.4 million. The economy of agricultural enterprises was influenced by several factors, namely:

- stagnation of revenues and a decrease in costs,
- stagnation of the production performance of agriculture i.e. stagnation of gross agricultural production at current prices, with an increase in crop production (4.5%) and considerable decrease in animal production (6.7%),
- a drop in the price development of agricultural products (5.3%), with a decrease in both crop production (7.0%) and animal production (4.5%) prices,
- an increase in the yields per hectare of most plant production thereby creating higher production in terms of the volume of crop output,
- higher production in terms of the volume of all decisive groups of slaughter animals,
- a drop in total expenditure on agriculture.

[18] http://www.telecom.gov.sk/index/index.php?ids=81567

In 2016, total expenditure on agriculture production amounted to €694.7 m and it decreased on year-n-year basis by 20.2%. The highest share in total expenditure consisted of expenditure related to direct payments (58.7%) and expenditure related to rural development programmes (23.4%).

Table 2.16: *Development of gross agricultural production (GAP) in the SR*[19]

Indicator	2011	2012	2013	2014	2015	2016
GAP (in current prices)	1,815.0	2,213.2	2,223.4	2,202.6	1,944.5	1,945.0
thereof						
Gross crop production	862.3	1,230.6	1,244.2	1,309.5	1,160.8	1,213.6
Gross animal production	952.7	982.6	979.3	893.1	783.7	731.4

** in EUR, a) estimation of the Research Institute of Agricultural and Food Economics (year 2016)*

In 2016, the area of utilized agricultural land was 1,918,878 ha. The interannual decrease was mainly due to the decrease in permanent grassland and arable land. An increase was observed in the case of permanent meadows and pasture and domestic gardens.

In 2016, the area sown with agricultural crops reached 1,347.3 thousand ha and on a year-on-year basis decreased by 0.2%. Growing areas of cereals decreased by 0.3% due mainly to the decrease in the area of barley by 18.0% and grain maize by 6.5%. As for oilseeds, the area increased by 2.7%.

Crop production in terms of the value of output has increased interannually by 4.5% due mainly to the increase in terms of the volume of all decisive crops, most notably in cereals (27.4%), sugar beet (25.0%) and oilseeds (38.2%).

Animal production in terms of the value of output has decreased interannually by 6.7% due mainly to the decrease in prices of all decisive animal commodities contrary to the increase in animal production in terms of the volume of output (bovine animals by 16.7 %, pigs by 12.5% and poultry by 10%).

Year-on-year, the number of cattle was reduced to 446.1 thousand (2.3%), of which the number of cows fell to 194.2 thousand heads (2.5%). Production of cow's milk fell by 2.5% to 933.3 thousand t. The number of pigs reached 585.8 thousand heads, which was less by 5.7% compared to 2015.The number of sheep fell by 1.0 % to 368.9 thousand heads. The number of goats grew by 0.1% to 36.4 thousand. The number of poultry together reached 12,130.5 thousand heads, which was 5.5% less compared to 2015. The number of horses fell by 6.7% to 6.4 thousand heads.

Table 2.17: *Overview of livestock numbers in the SR*[20]

Numbers in thousands	2011	2012	2013	2014	2015	2016
Cattle	463.4	471.1	467.8	465.5	457.6	446.1
of that dairy cows	154.1	150.3	144.9	143.1	139.2	132.6
Sheep	393.9	409.6	399.9	391.2	381.7	368.9
Goats	34.1	34.8	35.5	35.2	36.3	36.4
Pigs	580.4	631.5	637.2	641.8	633.1	585.8
Poultry	11,375.6	11,849.8	10,968.9	12,494.1	12,836.2	12,130.5

estimation of the Research Institute of Agricultural and Food Economics (year 2016)

[19] MARD, Green Report, 2001 - 2012
[20] MARD SR, Report on Agriculture and Food Sector in the SR (Green Report), 2011 - 2016

2.12 FORESTRY SECTOR

The current situation in forestry is associated with several problems. One of the most serious is the deterioration in the health of forests with a spruce majority, which is manifested mainly by wasting and mortality in spruce stands. The expansion of bark beetles occurred mainly after the windstorms in November 2004 and May 2014. Implementation of measures against bark beetles has brought a significant increase in financial performance measured related to the protection of the forest.

The area of forest land in the SR has been increasing in the long term. In 2015, it reached 2,014,731 ha, with crop land at 1,942,567 ha. Forest coverage reached 41.1%. According to the results of the National Forest Inventory and Monitoring of the Slovak Republic 2015-2016, which also included the so-called "White areas" (forest on non-forest land), the forest coverage in the SR is 45.1 ± 1%. In terms of tree species composition, deciduous tree species predominate (62.5%) in the Slovak forests.

Total wood stock and wood stock per hectare of crop land in the forests of the SR has an increasing trend (Table 2.18). In 2015, the average growing stock per hectare of crop land was 247 m^3 of raw wood without bark and total stock reached 478.12 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.

Table 2.18: *Wood stock in forests*[21]

Stock[1)]		year										
		2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Total (million m^3)	total	438.9	443.8	445.9	452.1	456.4	461.95	466.07	472.18	475.5	476.6	478.1
	coniferous	207.4	209.8	209.2	211.2	211.5	212.16	211.93	213.31	204.2	203.06	202.2
	deciduous	231.6	234.0	236.7	240.9	244.9	249.79	254.14	258.87	271.3	273.56	275.9
Per 1 ha (m^3)	average	229	231	232	235*	237	239	241	244	246	246	247
	coniferous	264	268	269	272*	274	276	278	281	274	275	276
	deciduous	204	206	207	210*	212	215	217	221	229	229	229

Carbon stock in forest ecosystems has been increasing, which is associated with an increase in timber reserves (Table 2.19). Carbon stock in aboveground living biomass in comparison with 1990 increased by 52.7 million tons.

Table 2.19: *Carbon stock in forests*[22]

Year	Carbon stock in forests				
	in living biomass		in dead biomass		in soil
	aboveground	ground	dead wood	hummus	
	million ton				
2015	186.6	40.3	16.9	22.4	270.5
2014	185.8	40.2	16.9	23.5	270.5
2013	185.4	40.1	16.9	23.5	270.5

[21] NFC-ÚLZI Zvolen, Summary information on wood conditions in the SR, 2006 - 2015

[22] Moravčík, M. et al. 2010: National Report on Quantitative Indicators for the Slovak Republic. Enquiry on the 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 - 2015), Green Report (Report on Forestry in the Slovak Republic per year 2015)

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 2015 decreased slightly compared with the previous year. It reached 9,142,619 m^3, which is, compared to 2014, a decrease of 68,003 m^3, i. e. by 1.8%, but it is higher compared to 2013 by 18%. The main reason behind the increased volume of timber felled in 2015, especially when compared to 2012 and 2013, was the high volume of incidental (calamitous) felling. The share of incidental felling reached 5,213,405 m^3 (57% of the total harvest), which is more by 2,126,368 m^3 compared to 2013.

The contribution of forestry to the GDP of the SR reached 0.28% in 2015. According to the results of the integrated environmental and economic accounts for forests, the final output of the forestry sector reached EUR 491.41 million in 2015. Gross value added for industry in that year was about EUR 239.7 million, net value added was EUR 216 million, net income from independent activities reached EUR 61.0 million and net profit for business reached EUR 44.7 million.

3 GREENHOUSE GAS INVENTORY INFORMATION

Total GHG emissions in the Slovak Republic (without LULUCF) decreased by 44.6% from 1990 to 2015. The biggest relative change was recorded in the agricultural and energy sectors, where GHG emissions decreased substantially by 54% and 52% respectively in comparison with the base year 1990. These reductions were caused by essential changes in the management practice of agriculture and increasing energy efficiency and fuel consumption.

On average, since the year 2010, total GHG emissions (without LULUCF) started an additional decreasing trend and were more than 40% below the emission levels of 1990. This effect was caused by additional implementation of strict policies and measures and their impacts. More information can be found in Chapter 4 and Chapter 5 of this communication.

While the indicator of carbon intensity can be changed much more rapidly when there is high economic growth, the GHG per capita indicator shows a significant decreasing trend between 1990 and 2015, reducing by a half value.

3.1 INTRODUCTION

This chapter presents the greenhouse gas emission trends of the Slovak Republic for the period of 1990-2015. The Slovak Republic submits an inventory under the Kyoto Protocol and under the UNFCCC. The legal basis of inventory compilation, inventory methodology and data availability are also briefly described here. The greenhouse gas data presented in this chapter are consistent with the 2017 submission of the Slovak Republic to the UNFCCC.[23]

Summary tables of GHG emissions in 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 the UNFCCC and the Kyoto Protocol are available on the website.[24]

The current arrangement of the Slovak National System and other descriptions according to paragraph 5.1 of the Kyoto Protocol are present in the National Inventory Report of the Slovak Republic 2017 (SVK NIR 2017, Chapter 1).

3.2 DESCRIPTIVE SUMMARY OF GHG EMISSIONS TRENDS

3.2.1 Overall GHG emission trends

In 2015, total GHG emissions in the Slovak Republic without LULUCF were 44.6% (33,190 Gg of CO_2 eq.) below 1990. However, between 2014 and 2015, emissions increased by 1.4% (590 Gg of CO_2 eq.), between 2010 and 2015 emissions decreased by 5,290 Gg of CO_2 eq., which is almost 13%.

Under the Kyoto Protocol, the Slovak Republic (similarly to the majority of European Member States) agreed to reduce their GHG emissions individually by 8% over the 2008-2012 period compared to the 'base year' of 1990. This commitment was to be achieved by a

[23] Annual Slovak Republic greenhouse gas inventory 1990-2015 submitted on April 12, 2017 and National Inventory Report of the Slovak Republic 2017.

[24] http://ghg-inventory.shmu.sk/documents.php

combination of strong environmental domestic policies and measures implemented in the early nineties and with the radical change in the structure of industry. The Kyoto Protocol, under Article 4, provides the option for Parties to fulfil their commitments jointly under Article 3. The European Union, its Member States and Iceland have agreed to fulfil their quantified emission limitation and reduction commitments for the second commitment period to the Kyoto Protocol, reflected in the Doha Amendment, jointly. The Union, its Member States and Iceland agreed to a quantified emission reduction commitment that limits their average annual emissions of greenhouse gases during the second commitment period to 80% of the sum of their base year emissions, which is reflected in the Doha Amendment.

In 2010, the EU submitted a pledge to reduce its GHG emissions by 2020 by 20% compared to 1990 levels (UNFCCC, 2014a). As this target under the convention has only been submitted by the EU-28 and not by each of its Member States (MS), there are no specified convention targets for single MS. Due to this, the Slovak Republic as part of the EU-28, takes on a quantified economy-wide emission reduction target jointly with all Member States.

Total GHG emissions were 41,269.49 Gg of CO_2 eq. in 2015 (without LULUCF). This represents a reduction by 44.6% against the base year of 1990. In comparison with 2014, the emissions increased by 1.45%. The increase in total emissions of 2015 compared to 2014 was due to an increase in energy, industrial processes and waste sectors in the reaction to increasing economic growth in the Slovak Republic. This trend was slightly corrected with the interannual increase of removals in the LULUCF sector (Figure 3.1).

However, these negligible fluctuations in the trend have no influence on the overall decrease in GHG emissions in the Slovak Republic. Between 2011 and 2015, since the publication of the Sixth National Communication, almost 10% was recorded, which is clear evidence that actual policies and measures are effective and useful.

Total GHG emissions excluding the LULUCF sector have continued to decrease from the base year with a moderate rate in recent years. Significant changes in methodologies and emission factors were implemented to ensure consistency with the 2006 IPCC Guidelines for National Greenhouse Gas Inventories, which represents significant progress in quality of estimation through refined methodologies, completeness and accuracy. In addition, comparison with the verified emissions for all installation included in the EU ETS improved energy and industry inventory.

Tables 3.1 and 3.2 show aggregated GHG emissions expressed in CO_2 eq. and according to gases and sector. In the period 1990-2015, the total greenhouse gas emissions expressed in CO_2 eq. 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 and "Doha" targets in relative expression. Due to their increased usage in industry, F-gases are the only gases which have an increasing trend since 1990.

Table 3.1: *Total anthropogenic greenhouse gas emissions by gases in 1990 - 2015*

GREENHOUSE GAS EMISSIONS	Base year 1990	1991	1992	1993	1994	1995	1996	1997	1998
	CO_2 eq. (Gg)								
CO_2 emissions including net CO_2 from LULUCF	61,935.05	53,549.31	49,082.55	46,569.29	43,740.36	44,779.18	45,081.93	45,136.91	44,115.61
CO_2 emissions excluding net CO_2 from LULUCF	52,856.70	43,743.15	38,572.93	36,045.91	33,911.17	35,430.48	35,776.40	35,951.53	33,884.00
CH_4 emissions including CH_4 from LULUCF	7,198.63	6,914.50	6,567.88	6,151.45	5,957.92	6,010.81	5,984.05	5,722.56	5,621.28
CH_4 emissions excluding CH_4 from LULUCF	7,206.07	6,920.43	6,573.89	6,159.18	5,963.30	6,016.92	5,990.99	5,729.68	5,628.29
N_2O emissions including N_2O from LULUCF	5,011.74	4,009.18	3,400.35	2,922.63	3,312.83	3,465.49	3,647.49	3,621.51	3,267.95
N_2O emissions excluding N_2O from LULUCF	5,091.40	4,083.12	3,472.63	2,994.22	3,379.80	3,523.95	3,702.67	3,671.94	3,314.50
HFCs	NO	NO	NO	NO	0.20	13.32	28.39	41.21	54.61
PFCs	314.86	309.73	288.24	180.32	153.23	132.65	40.72	40.16	29.10
SF_6	0.06	0.04	0.04	0.09	17.62	10.15	11.16	11.47	12.65
Total (including LULUCF)	**74,460.34**	**64,782.75**	**59,339.06**	**55,823.78**	**53,182.16**	**54,411.60**	**54,793.75**	**54,573.82**	**53,101.20**
Total (excluding LULUCF)	**65,469.09**	**55,056.46**	**48,907.73**	**45,379.72**	**43,425.32**	**45,127.47**	**45,550.33**	**45,445.99**	**42,923.14**

GREENHOUSE GAS EMISSIONS	1999	2000	2001	2002	2003	2004	2005	2006	2007
	CO_2 eq. (Gg)								
CO_2 emissions including net CO_2 from LULUCF	43,283.29	41,265.80	43,573.57	41,736.23	42,200.62	42,733.00	42,747.51	42,486.48	40,879.31
CO_2 emissions excluding net CO_2 from LULUCF	33,218.71	31,495.57	34,661.89	32,233.33	32,941.00	33,775.27	37,097.84	34,111.80	32,776.01
CH_4 emissions including CH_4 from LULUCF	5,577.13	5,355.32	5,262.45	5,144.28	5,040.82	5,024.42	5,024.37	4,836.77	4,708.28
CH_4 emissions excluding CH_4 from LULUCF	5,590.82	5,366.21	5,271.47	5,154.26	5,053.80	5,035.14	5,039.83	4,848.96	4,721.98
N_2O emissions including N_2O from LULUCF	2,844.95	3,108.95	3,273.85	3,203.92	3,234.95	3,341.54	3,290.21	3,547.42	3,450.42
N_2O emissions excluding N_2O from LULUCF	2,893.70	3,149.39	3,309.31	3,232.68	3,264.47	3,369.62	3,319.47	3,573.32	3,476.40
HFCs	77.29	105.04	138.78	178.46	213.52	254.39	292.99	341.49	388.26
PFCs	16.27	14.91	16.2	17.18	26.45	23.63	24.16	42.47	29.42
SF_6	12.64	13.4	13.33	14.78	15.6	15.43	16.38	16.71	17.39
Total (excluding LULUCF)	**51,811.57**	**49,863.07**	**52,278.00**	**50,294.85**	**50,731.42**	**51,392.40**	**51,395.62**	**51,271.33**	**49,473.09**
Total (including LULUCF)	**41,809.43**	**40,144.17**	**43,410.81**	**40,830.68**	**41,514.29**	**42,473.47**	**45,790.67**	**42,934.74**	**41,409.46**

GREENHOUSE GAS EMISSIONS	2008	2009	2010	2011	2012	2013	2014	2015	% relative to 1990
	CO_2 eq. (Gg)								
CO_2 emissions including net CO_2 from LULUCF	41,384.89	37,590.29	38,536.13	37,811.21	36,001.10	35,543.38	33,442.47	33,816.79	-45.40
CO_2 emissions excluding net CO_2 from LULUCF	34,399.93	30,724.01	32,483.97	31,362.70	28,343.95	27,441.49	27,276.06	27,342.58	-48.27
CH_4 emissions including CH_4 from LULUCF	4,962.84	4,491.87	4,531.00	4,603.57	4,224.88	4,367.75	4,215.96	4,352.44	-39.54
CH_4 emissions excluding CH_4 from LULUCF	4,976.48	4,506.26	4,545.93	4,618.46	4,237.12	4,376.77	4,233.11	4,369.24	-39.37
N_2O emissions including N_2O from LULUCF	3,315.85	3,012.08	2,850.69	2,394.87	2,350.33	2,295.53	2,340.21	2,342.56	-53.26
N_2O emissions excluding N_2O from LULUCF	3,341.06	3,037.22	2,875.30	2,419.41	2,373.56	2,317.11	2,367.71	2,371.18	-53.43
HFCs	454.47	516.93	597.24	605.03	628.20	646.88	653.84	734.88	100.00
PFCs	42.76	21.00	25.1	20.11	25.66	9.81	11.15	8.50	-97.30
SF_6	18.85	19.51	19.62	20.80	21.24	22.30	14.17	14.31	24,423.49
Total (excluding LULUCF)	**50,179.67**	**45,651.68**	**46,559.69**	**45,455.58**	**43,251.41**	**42,885.65**	**40,677.79**	**41,269.49**	**-44.58**
Total (including LULUCF)	**43,233.55**	**38,824.93**	**40,547.07**	**39,046.50**	**35,629.74**	**34,814.36**	**34,556.04**	**34,840.70**	**-46.78**

Table 3.2: *Total anthropogenic greenhouse gas emissions by sector in 1990 - 2015*

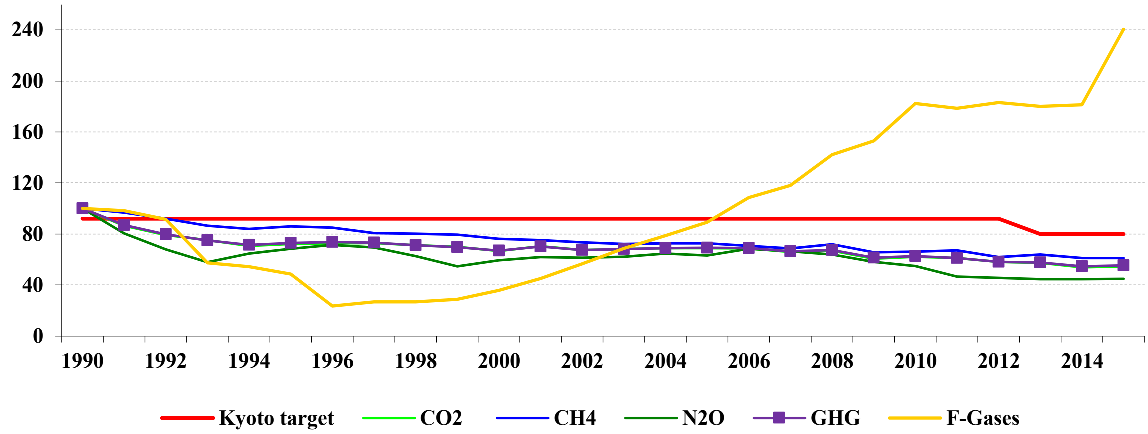
GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Base year (1990)	1991	1992	1993	1994	1995	1996	1997	1998
	CO_2 eq. (Gg)								
1. Energy	56,667.66	50,115.38	45,887.39	41,993.22	39,345.17	39,567.82	39,729.95	39,523.12	38,210.90
2. Industrial Processes	9,813.05	7,604.19	7,226.74	8,243.04	8,457.31	9,383.33	9,695.95	9,733.40	9,875.36
4. Agriculture	6,587.01	5,673.13	4,846.84	4,215.04	4,034.36	4,121.87	4,032.85	3,976.12	3,665.83
5. Land Use, Land-Use Change and Forestry	-8,991.25	-9,726.29	-10,431.33	-10,444.06	-9,756.84	-9,284.13	-9,243.42	-9,127.82	-10,178.05
6. Waste	1,392.62	1,390.06	1,378.10	1,372.49	1,345.32	1,338.58	1,335.00	1,341.17	1,349.10

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	1999	2000	2001	2002	2003	2004	2005	2006	2007
	CO_2 eq. (Gg)								
1. Energy	37,585.12	36,539.52	38,759.52	35,710.47	36,691.32	36,296.84	36,759.25	35,785.45	34,122.64
2. Industrial Processes	9,490.25	8,594.17	8,765.51	9,810.85	9,411.98	10,701.28	10,257.56	11,136.95	10,978.20
4. Agriculture	3,388.21	3,378.74	3,398.24	3,417.03	3,273.44	3,036.22	3,021.66	2,951.14	3,014.18
5. Land Use, Land-Use Change and Forestry	-10,002.14	-9,718.90	-8,867.19	-9,464.16	-9,217.13	-8,918.93	-5,604.95	-8,336.59	-8,063.63
6. Waste	1,347.99	1,350.64	1,354.73	1,356.49	1,354.69	1,358.06	1,357.15	1,397.78	1,358.07

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	2008	2009	2010	2011	2012	2013	2014	2015	% relative to 1990
	CO_2 eq. (Gg)								
1. Energy	35,040.80	32,173.39	32,741.10	32,022.32	29,779.31	29,621.67	27,089.27	27,445.21	-51.57
2. Industrial Processes	10,850.00	9,292.97	9,609.94	9,200.01	9,123.09	8,846.91	9,064.43	9,285.16	-5.38
4. Agriculture	2,904.63	2,798.28	2,813.38	2,806.24	2,890.52	2,970.82	3,047.13	3,014.46	-54.24
5. Land Use, Land-Use Change and Forestry	-6,946.12	-6,826.76	-6,012.61	-6,409.08	-7,621.67	-8,071.29	-6,121.76	-6,428.80	-28.50
6. Waste	1,384.23	1,387.05	1,395.27	1,427.02	1,458.49	1,446.26	1,476.96	1,524.67	9.48

Total aggregated GHG emissions, emissions are determined as of April 12, 2017

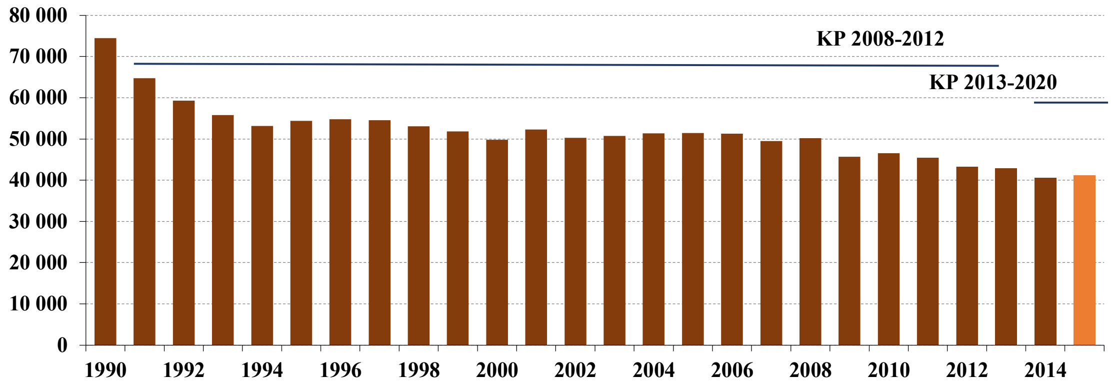
Figure 3.1: *GHG emission trends (1990 - 2015) compared with the Kyoto target (8% and 20%) in the Slovak Republic*



GHG emissions without LULUCF; emissions are determined as of April 12, 2017

Total GHG emissions including sinks from the LULUCF sector represented 34,840.70 Gg CO_2 eq. in 2015 and they dropped by more than 46% compared to the reference year 1990 (65,469.09 Gg CO_2 eq.). The amount of carbon sinks in forest ecosystems in the Slovak Republic shows a high fluctuation due to the sensitivity of the LULUCF sector to meteorological conditions and weather extremes.

Figure 3.2: *Aggregated GHG emission trends (1990 - 2015) compared with the Kyoto target (8% and 20%) in the Slovak Republic*



3.2.2 Emission trends by gas

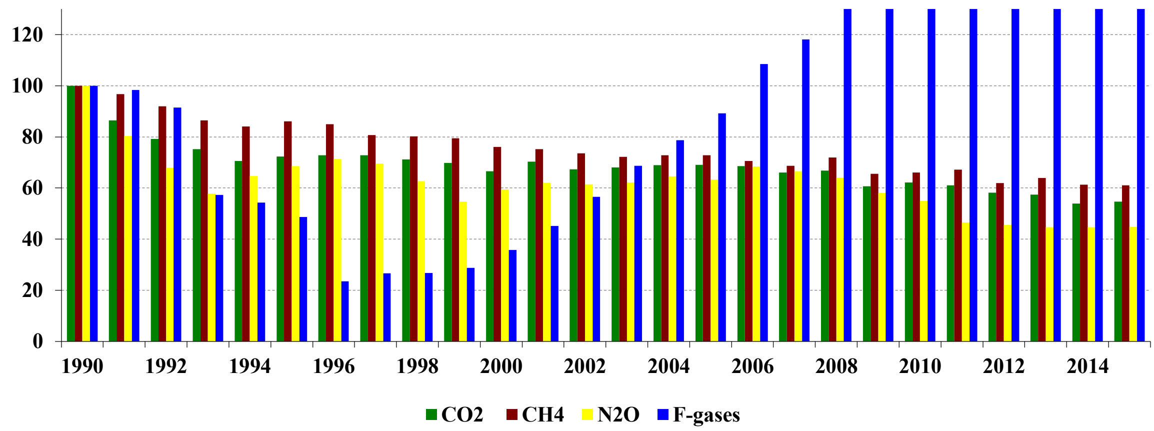
Total anthropogenic emissions of carbon dioxide excluding LULUCF have decreased by 45.4% in 2015 compared to the base year (1990). In 2015, total emissions of CO_2 are 33,816.79 Gg. CO_2 emissions decreased compared to the year 2011 presented in the previous communication by 10.5%. The reason for the decrease in CO_2 emissions in 2015 was mainly the decrease of CO_2 emissions in the energy and industrial processes sectors. In 2015, CO_2 emissions including the LULUCF sector decreased by 48.3% compared to the base year, and they decreased by 13% compared to the year 2011. In 2015, CO_2 removals in the LULUCF sector are approximately on the same level as the year 2011, but in comparison with the base year, removals decreased by 28.5%.

Total anthropogenic emissions of methane without LULUCF decreased compared to the base year (1990) by 39.6% and currently the emissions are 4,352.44 Gg of CO_2 eq. In absolute value, CH_4 emissions were 174.1 Gg without LULUCF. Methane emissions from LULUCF sector were 0.67 Gg of CH_4, caused mainly by forest fires. The trend has been relatively stable during the most recent five years with a slight increase in the last year due to the emissions increase from the energy and waste sectors. Methane emissions in the waste sector are continually increasing due to the low level of the implementation of new waste legislation in the Slovak Republic.

Total anthropogenic emissions of N_2O without LULUCF decreased compared to the base year (1990) by 53.3% and currently the emissions are 2,342.56 Gg of CO_2 eq. Emissions of N_2O in absolute values were 7.86 Gg without LULUCF. Emissions of N_2O from the LULUCF sector are 0.46 Gg, from forest fires and cropland. N_2O emissions decreased compared to other gases in all sectors driven mostly by nitric acid production and by agricultural production due to the declining number of animals and the usage of fertilizers.

Total anthropogenic emissions of F-gases were 734.88 Gg of HFCs, 8.50 Gg of PFCs and 14.31 Gg of SF_6 in CO_2 eq. Emissions of HFCs have increased since 1995 due to the increase in consumption and the replacement of PFCs in substances. The emission trend of PFCs is decreasing and emissions of SF_6 are slightly increasing due to increasing consumption in industry (Figure 3.3).

Figure 3.3: *Emission trends by gas for the years 1990 - 2015 relative to the 1990 level (100%)*

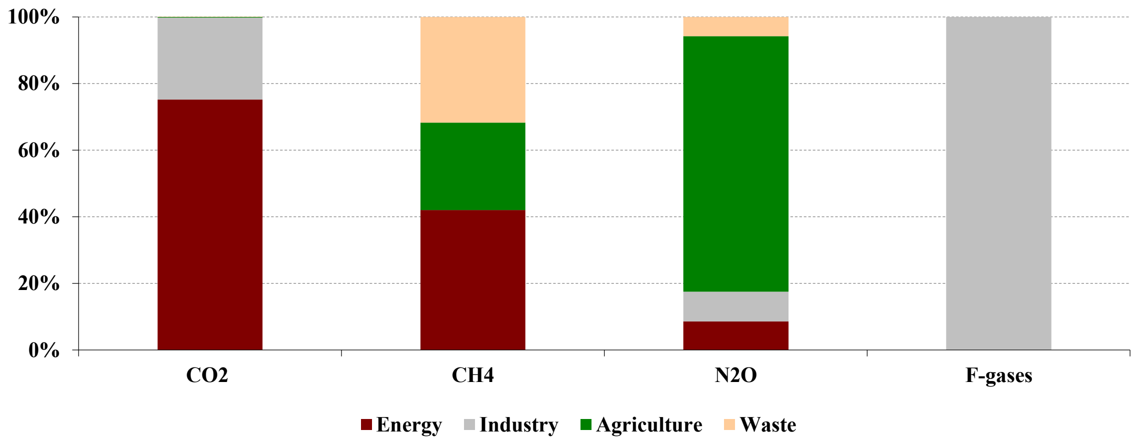


3.2.3 Emission trends by main source categories

The major share of CO_2 emissions comes from the energy sector (fuel combustion, transport) with a 75% share of total carbon dioxide emissions in 2015's inventory, 25% of CO_2 is produced in industrial processes and product use and a negligible amount is produced in waste (0.02%) and in agriculture (0.22%). The energy related to CO_2 emissions from waste incineration are included in the energy sector. The waste sector produces 32% of CH_4

emissions, 42% of methane emissions are produced in the energy sector and 26% in the agriculture sector. More than 75% of N_2O emissions are produced in the agriculture sector (nitrogen from soils), 9% in the industrial processes sector (nitric acid production), 6% in wastewaters and 9% in the energy sector. F-gases are produced exclusively in the industrial processes sector (Figure 3.4).

Figure 3.4: *Emission trends by gas in sectors in 2015*



Aggregated GHG emissions from the energy sector based on sectoral approach data in 2015 were estimated to be 24,445.21 Gg of CO_2 eq. including transport emissions (6,704.75 Gg of CO_2 eq.), which represent a decrease by 52% compared to the base year and a 19% decrease in comparison with 2011. The transport sector decreased by 4% compared to 2011 and in comparison with the base year it declined by 2%.

Total emissions from the industrial processes sector were 9,285.16 Gg of CO_2 eq. in 2015, which decreased by 5% compared to the base year and increased by 1% compared to the year 2011. The intensive increase of select industrial production caused the increase in emissions. This sector also covers emissions from solvents and other product use.

Emissions from the agriculture sector were estimated to be 3,014.46 Gg of CO_2 eq. This is a 56% decrease in comparison with the base year and a 7% increase in comparison to the year 2011. The agriculture sector is the sector with the most significant decrease compared to the base year of 1990 because of the decreasing trend in cattle numbers and synthetic fertiliser use.

Emissions from the waste sector were estimated to be 1,524.67 Gg of CO_2 eq. The increase is 7% compared to the year 2011 and the time series have been increasing slightly over the last few years. Compared to the base year, the increase was more than 9% because of increased methane emissions from solid waste disposal sites. The emissions from waste incineration with energy use are included into the energy sector, category 1.A.1.a – 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 submission.

Structural changes in the energy sector and the implementation of economic instruments have played an important role in achieving the current status, where 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 national legislation on air quality, which was approved in 1991 and initiated the positive trend in the reduction of 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 sector in the years 1990-2015 are depicted in Tables 3.1 and 3.2 in this chapter.

Transport is a significant source of emissions in the energy sector, with a 16% share in total GHG emissions of the Slovak Republic. The proportion of transport is growing each year and the adopted policies and measures have not had a visible positive impact on the trend of emissions from transport in recent years. Emission balances in road transport are modelled according to the method COPERT V version 1.0. GHG emissions from non-road transport are balanced by the use of the 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, especially due to the increasing activity of Bratislava airport.

Fugitive methane emissions from 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 former Soviet Union countries to Europe. Raw materials are transported through high pressure pipelines and a distribution network and they are pumped in pipeline compressors.

The industrial processes sector includes all GHG emissions generated from technological processes producing raw materials and products with a 23% share in total GDP of 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 a distinction is made 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 EU Emission Trading System.

The fundamental emissions inventory is based on the balance of non-methane volatile organic compounds (NMVOC) according to the revised EMEP/EEA Guidebook 2016 methodology. Emissions are recalculated according to the stoichiometry coefficients to CO_2 emissions.

The share of agriculture and food industry in the macro-economic indicators of the national economy has increased in most indicators in 2015 (income, cost, sales from own products). A result of this development was the consequence of the stagnation of the agriculture and food sector in the Slovak economy and a continuing dampening of agriculture and food industry production with a negative impact on the total economic income and social benefits generated by these sectors. There are subsidies from EU funds to improve these economic results without which most businesses would have losses. Gross value added in agriculture upsurges a result of the increase in gross agricultural output, more so in crops than in animals, with a concurrent in intermediate consumption and a significant upsurge in product subsidies.

The agriculture sector, with 4% share in the total GDP of 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 the new regionalization of agricultural areas of the Slovak Republic. The Ministry of Agriculture and Rural Development of the Slovak Republic issues annual statistics in its “Green Report” regarding the 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 the LULUCF sector have remained at the level of 8 - 10% of total GHG emissions. This 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 half of the earlier volumes.

The Forestry and Land Use sector covers the wide range of biological and technical processes within the landscape, which are reflected in the GHG inventory. This sector includes all GHGs (CO_2, CH_4 and N_2O) and basic pollutants from forest fires (NOx and CO). Individual inventory categories are linked with all relevant processes related to all five carbon pools (living biomass – above and below ground, dead organic matter – dead wood and litter, soil carbon), as have been defined in the Marrakech Accords. In addition, wood products referred to as harvested wood products (HWP) are reported as an additional pool under LULUCF (CRF sector 4.G).

The inventory in the LULUCF sector is based on the definition of representative types of land use – forest land, cropland, grassland, wetlands, settlements and other land and their temporal changes. The first three types of land use have the highest importance due to their relative coverage of the Slovak Republic, representing more than 90% of the whole territory. The processes linked to land use and land use change are mostly related to CO_2 balance.

Several significant changes to applied methods and recalculations have been carried out in the waste sector, 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. This required development of a country-specific model which generates inputs for the IPPC Waste model. This model is based on the selection of waste groups from the European Waste Classification (EWC) which are rich on biodegradable waste.

This approach excludes from emission estimations the majority of non-biodegradable waste (e.g. soils, rocks, ashes, chemicals), thus emissions are estimated only from waste which has the potential to generate them and use default parameters from the IPPC waste model.

For development of activity data back to 1950, two types of surrogates for each waste group were tested to identify the correlation with generated and disposed waste: the index of production and final energy consumption. The CORREL function in Excel was used for assessing correlation. The surrogate with the higher correlation coefficient was used for the extrapolation of the data.

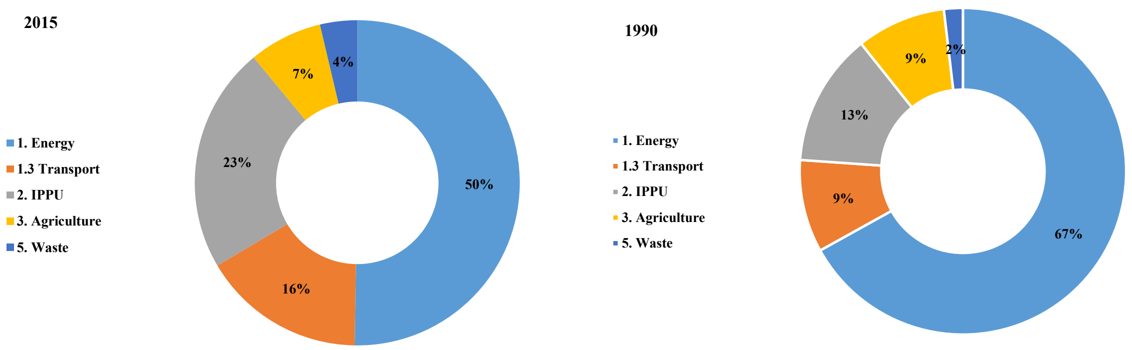
A more detailed description of the methodology of the Monte Carlo uncertainty analyses is described in the references.[25]

The emissions from waste incineration with energy utilisation were reported under the energy sector, sub-category 1.A.1.a (other fuels). The emissions from waste incineration without energy utilisation are reported within the waste sector.

CTF Table 1(b) in the CTF Annex provides an overview of GHG emissions in the main source categories for 1990-2015. The most important sector by far is energy (i.e. combustion and fugitive emissions), accounting for 66% of total GHG emissions in 2015. The second largest sector is industrial processes (23%), followed by agriculture (7%) and waste (4%). The comparison between the share of the sectors 2015 with the base year is shown in Figure 3.5. A significant decrease is visible in the energy sector (without transport) and an increase in the waste and transport sectors. 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 2015 international bunker emissions decreased, partly reflecting the economic recession. Total GHG emissions from international transport reached 167.72 Gg of CO_2 eq. in 2015, of which emissions from international aviation make up more than 95%.

Figure 3.5: *The share of individual sectors in total GHG emissions in 1990 and 2015*



Detailed information on GHG emissions, trends and reductions are published in the National Inventory Report of the Slovak Republic 2017, 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 a key categories analysis for 2015 and 1990 emission

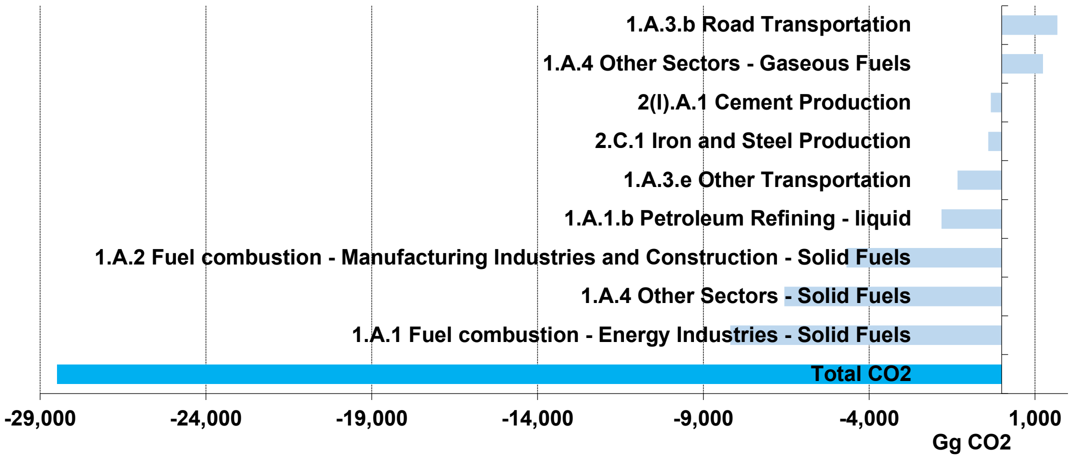
[25] Szemesová J., M. Gera Emission estimation of solid waste disposal sites according to the uncertainty analysis methodology, Bioclimatology and Natural Hazards, ISBN 978-80-228-17-60

sources in line with the IPCC 2006 Guidelines by using Approach 1. The quantitative analyses include combined uncertainty (on emission factors and activity data) and recognized key categories by level assessment with and without the LULUCF sector (more information can be found in the SVK NIR 2017 Chapter 1.2.12 and in Annex 1).

CO_2 emissions from the category 1.A.3.b - Road Transportation – diesel fuel are the largest key category, accounting for 19% of total CO_2 emissions without LULUCF in 2015. Between 1990 and 2015, CO_2 emissions in road transportation increased by 1.8 Mt of CO_2, which is a 19% increase due to an increase in fossil fuel consumption in this key category (Figure 3.6). Since 1990, a large increase in 'road transportation' related CO_2 emissions was recognized. Figure 3.6 below shows that solid fuels from the category 1.A.1 Fuel Combustion - Energy Industries is the second largest key category without LULUCF (14%) and the decrease (64%) is between 1990 and 2015. The main explanatory factors for the emission 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 in biomass and other fuels has been recorded.

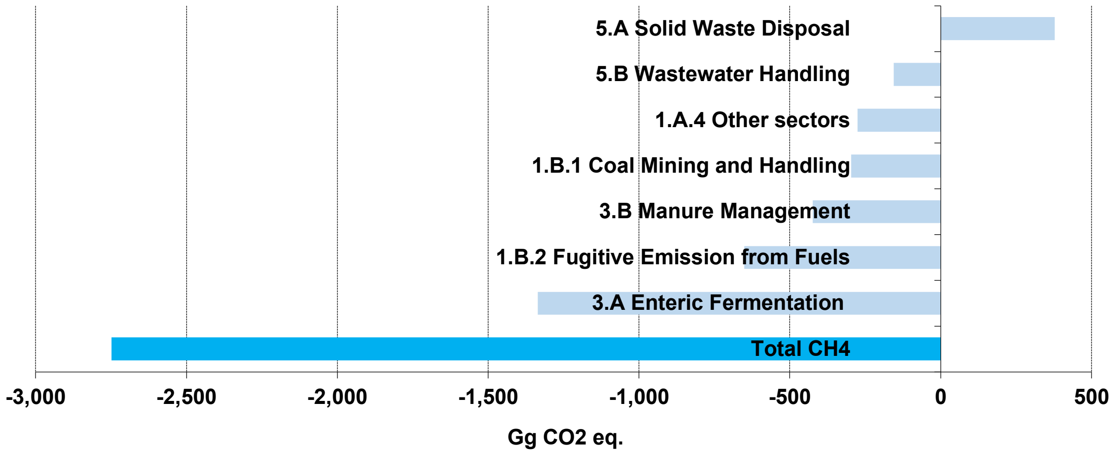
CO_2 emissions from fuels in the category 2.C.1 - Iron and Steel Production are the largest key source without LULUCF in the IPPU sector, accounting for 12% of total CO_2 emissions in 2015. CO_2 emissions from the category 1.A.2 in the energy sector are the third largest key source in the Slovak Republic, accounting for 12.3% of total GHG emissions in 2015. Between 1990 and 2015, emissions from this category showed a decrease of 54%.

Figure 3.6: *Absolute change of CO_2 emissions by large key categories 1990 - 2015*



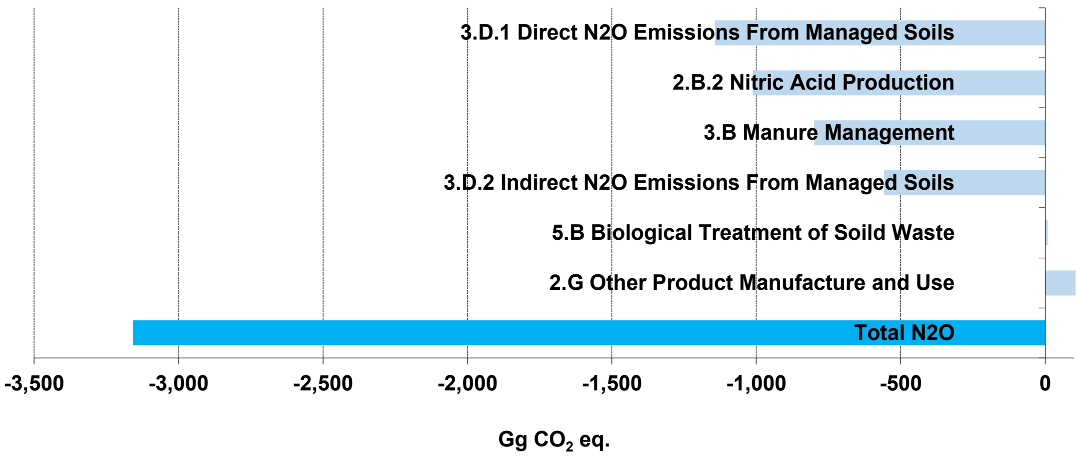
Methane emissions accounted for 11% of total GHG emissions in 2015 and decreased by 40% from 1990 to 174.10 Gg CH_4 in 2015. The two largest key sources (5.A Solid Waste Disposal at 23% and 3.A Enteric Fermentation at 22% of total CH_4 emissions in 2015) accounted for 50% of CH_4 emissions in 2015. Figure 3.7 shows that the main reasons for declining CH_4 emissions were reductions in Enteric Fermentation caused mainly by the decrease in animal numbers and use reductions in fugitive emissions and coal mining. Figure 3.7 shows a significant decrease in categories 3.A and 3.B and an increase in 5.A waste sector caused by the change of IPCC methodology used for solid waste disposal sites, which considers time layer since 1960.

Figure 3.7: *Absolute change of CH_4 emissions by large key categories 1990 - 2015*



N_2O emissions are responsible for 5.7% of total GHG emissions and decreased by 53% to 7.86 Gg of N_2O in 2015 (Figure 3.8). The two largest key sources causing this trend were 3.D.1 Direct N_2O Emissions from Managed Soils 53% and 3.D.2 Indirect N_2O Emissions from Managed Soils at 16% of total N_2O emissions in 2015. The main reason for the large N_2O emission cuts were reduction measures in "nitric acid production" and decreasing agricultural activities *(*Figure 3.8). N_2O emissions increased in the Biological Treatment of Waste and Other Products Manufactured categories. This increase was caused by an increase in operations and production.

Figure 3.8: *Absolute change of N_2O emissions by large key categories 1990 - 2015*



Fluorinated gas emissions account for 1.84% of total GHG emissions. In 2015, emissions were 757.69 Gg CO_2 eq., which was 141% above 1990 levels. The largest key source is 2.F.1 Refrigeration and Air Conditioning and accounts for 93% of fluorinated gas emissions in

2015. HFC emissions from the consumption of halocarbons showed large increases between 1990 and 2015. 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 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 of 1990 - 2015 are described in more detail in Chapter 2 (National Circumstances) of this Communication.

Since the last National Communication of the Slovak Republic in 2013, emissions have decreased by 9.2% with the lowest level in 2014, when the economic downturn caused substantial emission reductions. In 2015, emissions increased slightly again, partly driven by the economic recovery in many economic and industrial activities. In particular emissions from the energy industries, transport, the chemical industry, F-gases utilisation and waste increased in 2015. On the other hand, removal in LULUCF also increased in 2015.

The sections below summarize the main reasons for the changes in emissions in the Slovak Republic during the period of 2010 - 2015.

3.2.6 Main reasons for emission changes in 2014 - 2015

Total GHG emissions in 2015 in the Slovak Republic increased significantly, by 1.45%, in comparison with the previous year, which was influenced by an increase in the energy, industrial processes and waste sectors in reaction to increasing economic growth in Slovakia. Total GHG emissions excluding the LULUCF sector have been decreasing continually from the base year with an almost stable trend in the recent years. Significant changes in methodologies and emission factors have been implemented in order to keep consistency with the EU ETS and new IPCC 2006 Guidelines. The main reason for emission changes in 2014 - 2015 were as follows:

- CO_2 emission increase in the energy industry (500 Gg of CO_2) caused by an increase in liquid, solid and also gaseous fuels.
- CO_2 emission increase in the transport category (200 Gg of CO_2) caused mainly by the increase of driven operations in passenger, light and heavy duty vehicles.
- CH_4 increase (200 Gg of CO_2 eq.) in fugitive emissions from oil and natural gas caused mainly by international trade.
- CO_2 increase (200 Gg of CO_2 eq.) in the chemical industry caused by higher productivity in this industry.
- F-gases increase (100 Gg of CO_2 eq.) due to increasing industrial productivity.
- Increase in biological treatment of solid waste by 50 Gg of CO_2 eq.
- The relatively cold winter of 2014 - 2015.

3.2.7 Key drivers affecting emission trends in LULUCF

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

The LULUCF sector, with net removals of -6,428.79 Gg of CO_2 eq. in 2015, is a very important sector and comprises several key categories. The major share represents CO_2 removals with the contributions of the following categories: Forest Land with net removals of -4,998.12 Gg CO_2, Cropland with net removals of -830.21 Gg CO_2, Grassland with net removals of -191.10 Gg CO_2, Settlements with emissions of 84.15 Gg CO_2 and Other Land with the emissions of 182.51 Gg CO_2. Total methane emissions were 0.67 Gg and total N_2O emissions were 0.096 Gg from the LULUCF sector in 2015. N_2O emissions from the disturbances associated with land-use conversion to Cropland, Grassland, Settlements and Other Land were reported in this submission. Removals from harvested wood products were also estimated in this submission. The emissions of other pollutants originate from forest fires and the controlled burning of forest. The estimated amount of NOx emissions was 0.43 Gg and the estimated amount of CO emissions was 15.30 Gg in 2015 (Table 3.3).

Table 3.3: *Summary of total emissions and removals according to category in 2015*

CATEGORY		Net CO_2	CH_4	N_2O	NO_x	CO
	EMISSIONS/REMOVALS (Gg)			EMISSIONS (Gg)		
4. LULUCF	**NO**	**-6,474.21**	**0.67**	**0.096**	**0.43**	**15.30**
A. Forest Land	NO	-4,998.12	0.67	0.04	0.43	15.30
B. Cropland	NO	-830.21	NO	0.03	NO	NO
C. Grassland	NO	-191.10	NO	0.002	NO	NO
D. Wetlands	NO	NO	NO	NO	NO	NO
E. Settlements	84.15	NO	NO	0.01	NO	NO
F. Other Land	182.51	NO	NO	0.02	NO	NO

3.2.8 Information on indirect greenhouse gas emissions

In general, the national totals of CO, NO_x, SO_x and NMVOC emissions are below the national emission ceilings from 2010 that were determined in Directive 2001/81/EC. The new Directive 2284/2016/EU repeals and replaces Directive 2001/81/EC, the National Emission Ceilings Directive (NEC Directive) and ensures that the emission ceilings set for 2010 in that Directive shall apply until 2020. Directive 2016/2284 also transposes the reduction commitments for 2020 taken by the EU and its Member States under the revised Gothenburg

Protocol and sets more ambitious reduction commitments for 2030 so as to cut the health impacts of air pollution by half compared with 2005.[26]

CO, NO_x, SO_x and NMVOC emissions have a decreasing trend as a result of the intensive air protection policy in the Slovak Republic. Although the decline of CO and SO_X emissions is more dramatic throughout the entire time series compared to NO_x and NMVOC, SO_x emissions have greatly increased inter-annually (2014/2015) due to the reconstruction of a particular heating plant which used unabated granulated coal boilers. An overview of NO_x, CO, NMVOC and SO_2 emissions for the year 2015 is shown in the Table in Annex II (Article 7) of the Commission Implementing Regulation (EU) No. 749/2014 provided in this submission.

Several recalculations were done in reporting under NECD. The general revision of methodology used in the Slovak emission inventory is still ongoing and the first results were applied in the NECD 2016 submission and continued in the 2017 submission. The major changes are visible in NMVOC emissions. These recalculations were performed as the result of the QA/QC activity in improving the process of transparency, accuracy and consistency of the emission inventory.

- The revision of methodology in solvents, energy, transport and industry was performed. The final values are slightly different compared to the previous reports due to modelling of activity data and emissions. Modelling of emissions was performed back to 1990. The revision of the EMEP/EEA 2016 Guidebook also had an influence on the recalculation of emissions.
- Emissions from Agriculture for category 3.B were recalculated due to a change in activity data. The Statistical Office of the Slovak Republic provided very detailed data about the number of livestock up to the year 1990. According to this improvement, more accurate estimates of all emissions from all animal species were prepared. The new NEX, which was calculated in the GHG inventory, was implemented. The discrepancy in the NH_3 emissions in 3.B Manure management found during the last year caused the overestimation of emissions in the 2016 submission. In the 2017 submission, we prepared a revision of the NH_3 estimate. The revision of the EMEP/EEA Guidebook also had an influence on the recalculation of emissions. We prepared a new estimate of NMVOC emissions for the cattle category. New detailed information about the number of livestock, ratio data and a new estimate of NH_3 emissions was available and these implementations had an influence on the total amount of NMVOC emissions.

Emissions of basic pollutants are available in a public database: DATAcube: http://datacube.statistics.sk/TM1Web/TM1WebLogin.aspx. Air Emissions Accounts are also publicly available:

- SOSR website – Air Emission Accounts data are available in the STATdat database. Data are updated annually.

[26] http://ec.europa.eu/environment/air/pollutants/ceilings.htm

SHMU website – Air Emission Accounts – preliminary 2016 data are available as aggregates in the format of separate PDF files for particular years – 2008, 2009, 2010, 2011, 2012, 2013, 2014.

Table 3.4: *Anthropogenic emissions of NO_x, CO, NMVOC and SO_2 according to gases and sectors in 2015*

EMISSIONS	TOTAL	ENERGY	INDUSTRY	AGRICULTURE	LULUCF	WASTE
	Gg					
NOx	**63.79**	56.11	0.85	6.38	0.43	0.02
CO	**231.06**	214.67	1.09	NE,NA,NO	15.30	0.00
NMVOC	**93.82**	27.83	50.17	9.15	NE,NA,NO	6.67
SO_2	**71.21**	70.76	0.44	NA,NO	NE	0.00

3.2.9 Accuracy/Uncertainty of the data

The uncertainty assessment by Approach 1 is enclosed in Annex 3 of the SVK NIR 2017. Quantification of emissions uncertainty by level and trend assessment was calculated using the Approach 1 method published in the IPCC 2006 Guidelines. Approach 1 estimated a 10.67% level uncertainty and a 3.46% trend of uncertainty in 2015.

The uncertainty assessment using the more sophisticated tier 2 Monte Carlo method was prepared in cooperation with the Faculty of Mathematics, Physics & Informatics.

The tier 2 uncertainty analyses for fuel combustion in the energy sector (including transport) according to the fuels classification was estimated in the range of confidence interval (-2.38%; +3.12%) in 2015.

The tier 2 uncertainty analyses for industrial processes and the product use sector, including the solvent and other product use sector according to technological emissions, was estimated in the range of confidence interval (-3.66%; +3.63%) in 2015.

Results of the Monte Carlo method to estimate uncertainty were published in the following papers[27,28] and a detailed description is in Chapters 3 and 4 of the SVK NIR 2017.

3.2.10 Changes since the 6th National Communication

Since the publication of the 6th National Communication, many updates and revisions to methodologies, emission factors, the covering of sources and gases and the structure of the submission have been implemented in the GHG inventory and the National Inventory System of the Slovak Republic, which have impacted the time-series of emissions. The most significant change is connected with the implementation of the IPCC 2006 Guidelines on GHG emissions inventories. The process of implementation was finished in the 2015 submission and the time series were recalculated back to base years. These changes were fully in line with the international requirements and were reviewed and accepted. Therefore it is not possible to compare the results of the emissions trend published in the 6th National Communication with the present emissions trend published here.

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

[28] 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

The major changes and recalculations connected with the implementation of the IPCC 2006 Guidelines and the recalculations based on the recommendations of the previous expert reviews are highlighted in Table 3.5.

Table 3.5: *Major revisions to the GHG inventory since publication of the 6th National Communication*

SECTOR	CHANGE
Energy sector	▪ The most important change in methodological description is the national inventory report related to the change of the source of activity data. In previous submissions the source of activity data was the NEIS database. In the current submission, the activity dates are obtained from desegregated datasets, provided by Statistical Office of the Slovak Republic and from ETS reports; ▪ Modification of refinery model (1.A.1.b) and biomass recalculation in 1.A.1c; ▪ Emissions from ethylene production were shifted to 2.B.8b and emissions from hydrogen production were shifted to 2.B.10; ▪ Most of the emission factor for CH_4 and N_2O were modified according to guidelines. Significant improvements were made in the estimation of emissions from the combustion of waste and biomass; ▪ Update of the biomass share in fuels; ▪ Due to changing methodology and the introduction of new sub categories, emissions from 1.A.2 and 1.A.5 where shifted to 1.A.4; ▪ The main change is the reclassification of natural gas used for pipeline transport, which was previously reported under 1.A.5. In accordance with guidelines, all natural gas from pipeline transport is now reported under transport (1.A.3e); ▪ The new share between domestic and international fuel consumption based on EUROCONTROL data.
IPPU sector	▪ Use of calcium carbide was evaluated. A part of the acetylene produced from calcium carbide is consumed for vinyl chloride monomer that is reported in 2B8 sub-category. Thus, this part of acetylene was subtracted from 2.B.4; ▪ Use of calcium carbide was evaluated. A part of acetylene produced from calcium carbide is used for vinyl chloride monomer production and it is reported in 2.B.8. Thus, this part of acetyl was subtracted from 2.B.4. New sub-categories in 2.B.8 and 2.B.10 are reported as well. The new categories represent the major difference; ▪ HFCs. Calculation formulas for stocks were unified across the whole time series in all sub-categories; ▪ Methodological change. Revision of F-gases emissions in 2.F.1 – from decommissioned equipment; ▪ Calculation formulas for stock were unified across the whole time series in 2.G.1.
Agriculture sector	▪ Methodological change. Revision of Ym parameter, and change AD, change of dividing: dairy cattle are taken to be only milk cows. Suckling cows were allocated to non-dairy cattle. Revision of Ym parameter; ▪ New category was added: 3.A.2 growing lambs and other mature sheep; ▪ AD change. Extrapolating data were changed for available statistical data on animal numbers; ▪ Revision of AWMS allocation of animal categories based on national data. Revision of emission factors and Nex for AWMS based on national data; ▪ Revision of emission factors for manure applied to soil based on the IPCC 2006 GL; ▪ Revision of EFs for grazing based on the IPCC 2006 GL; ▪ Revision of EFs for atmospheric deposition and N-leaching and run-off based on the IPCC 2006 GL.
LULUCF sector	▪ Changes in EF for biomass burning – controlled biomass (CH_4, N_2O) and changes in land-use matrix (minor); ▪ Change of methodology IPCC 2006 and EFs.
Waste sector	▪ Emissions from municipal waste disposed to SWDSs were fully recalculated. The use of the IPCC waste model was accompanied by review of all parameters and new time series were defined. Results from IPPC 2006 model (31 Gg) are lower than results from previous FOD model (48 Gg). New extrapolation of activity data for the period 1990 – 2001 was prepared. Estimation of CH_4 was included into existing spreadsheet model; ▪ Emissions from wastewater (5.D) were fully recalculated because of introducing the time variable share of industrial waste water in public sewers. Also, previous year estimates of BOD and protein

SECTOR	CHANGE
	consumption were replaced by reported figures. Emissions from wastewater treatment (5.D) were recalculated due to new information on the share of modern waste water treatment plants in the Slovak Republic. ▪ Emissions from biological treatment (5.B) were recalculated due to the requirement to apply new emission factors for N_2O according to the corrigendum of IPCC guidelines from July 2015; ▪ Emissions from the incineration of waste without energy recovery (5.C) were recalculated due to the requirement to apply oxidation factor 1. The previously used OF based on 0.9 was not accepted by the ERT because we could not provide documentation for this change of the default value 1.

3.3 NATIONAL INVENTORY SYSTEM

3.3.1 Institutional arrangements

The Ministry of Environment of the Slovak Republic is responsible for the development and implementation of the national environmental policy including climate change and air protection objectives. It has the responsibility to develop strategies and further instruments of implementation, such as acts, regulatory measures, and economic- and market-based instruments for the 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 Ministry of Environment of the Slovak Republic is the main body to ensure conditions and to monitor the progress of the Slovak Republic on meeting all commitments and obligations of climate change and adaptation policy.

According to Governmental Resolution No. 821/2011 Coll. from 19 December 2011, the inter-ministerial High Level Committee on the Coordination of Climate Change Policy was established. This Committee is created at the state secretary level and replaces the previous coordinating body, i.e. the High Level Committee on Climate-Energy Package established in August 2008. The Committee is chaired by the State Secretary of the Ministry of Environment, other members are the state secretaries of the Ministry of Economy, the Ministry of Agriculture and Rural Development, the Ministry of Transport and Construction, the Ministry of Education, Science, Research and Sport, the Ministry of Health, the Ministry of Finance, the Ministry of Foreign Affairs and European Affairs and the Head of the Regulatory Office for the Network Industries.

The main objective of the Coordination Committee is effective coordination of the development and implementation of mitigation and adaptation policies and selection of appropriate measures to fulfil international obligations. An important output of its activities is also the "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 the aim to inform it on the basis of a detailed analysis of current progress on this issue. The first was in June 2012[29], another in April 2013,[30] in April 2014,[31] in April 2015[32] , in April 2016 [33] and in April 2017.[34]

The establishment of the National Inventory System (NIS) of emissions in compliance with the Kyoto Protocol requirements was framed with functions which it should fulfil according to decision 19/CMP.1 The basic characteristics of the NIS are as follows:

- To ensure linkages and co-operation among involved institutions, bodies and individuals to perform all activities for the monitoring and estimation of GHG emissions from all sectors/categories according to UNFCCC guidelines and relevant decisions and according to the approved IPCC methodologies. To enable use of all relevant data from national and international databases for preparing and improving the GHG emission inventory.
- To define the role and competencies of all involved stakeholders including the role of the National Focal Point to the UNFCCC.
- To define and regularly implement quality assurance and quality control (QA/QC) processes in two forms; both internally and also externally by appropriate body.
- To ensure an ongoing process of development capacities; financial, technical and expert sources in relation to QA/QC but also in relation to new tasks rising from the international process.

The National Inventory System of the Slovak Republic (http://ghg-inventory.shmu.sk/) was established and officially announced by the Decision of the Ministry of Environment of the Slovak Republic on 1 January 2007 in the official bulletin: Vestnik, Ministry of Environment, XV, 3, 2007.[35] In agreement with paragraph 30(f) of the 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. The revised report of the National Inventory System, dated on November 2008, was focused on the changes in the institutional arrangement, quality assurance/quality control plan and planned improvements. A regular update of the National Inventory System with all qualitative and quantitative indicators is provided in the National Inventory Reports and was also provided in the Sixth National Communication of the SR on Climate Change, published in December 2013.

The Slovak Hydrometeorological Institute (SHMÚ) www.shmu.sk is authorised by the Ministry of Environment of the Slovak Republic to provide environmental services, including annual GHG inventories according to the approved statutes (http://www.shmu.sk/File/statut.pdf). The range of services, competencies, time schedule and financial budget are updated and agreed annually. All details of the SHMÚ activities are described in the Plan of Main Tasks. The

[29] http://www.rokovania.sk/Rokovanie.aspx/BodRokovaniaDetail?idMaterial=21144
[30] http://www.rokovania.sk/Rokovanie.aspx/BodRokovaniaDetail?idMaterial=22264
[31] http://www.rokovanie.sk/Rokovanie.aspx/BodRokovaniaDetail?idMaterial=23392
[32] http://www.rokovanie.sk/Rokovanie.aspx/BodRokovaniaDetail?idMaterial=24429
[33] http://www.rokovanie.sk/Rokovanie.aspx/BodRokovaniaDetail?idMaterial=25426
[34] http://www.rokovania.sk/Rokovanie.aspx/BodRokovaniaDetail?idMaterial=26360 (No.151/2017)
[35] "Vestnik" (Official Journal of the Ministry of Environment), XV, 3, 2007, page 19: National inventory system of the Slovak Republic
for GHG emissions and sinks under Article 5 of the Kyoto Protocol

plan, commented by all stakeholders, is published after approval at the website of the SHMÚ http://www.shmu.sk/File/Kontrakt_SHMU/Kontrakt_SHMU_2016.pdf. The deadline for the approval of this plan by the ministry is 31 December each year.

Organisational changes occurred on 1.1.2017 at the SHMÚ (the new structure of SHMÚ was presented).[36] They resulted in the establishment of the Department of Emissions and Biofuels (OEaB). The OEaB has two main tasks: emission inventories (GHG, NECD, and CRLTAP) and the National System of Biofuels. The OEaB is also responsible for developing and maintaining the National Emission Information System (the NEIS) – the database of stationary sources to monitor the development of SO_2, NO_x and CO emissions at the regional level and to fulfil reporting commitments under national regulations and EU Directives (https://www.air.sk). The NEIS software product is constructed as a multi-module system corresponding fully to the requirements of current legislation. The NEIS database also contains some technical information about sources like fuel consumption and use for the estimation of sectoral approach.

The Single National Entity is a part of the OEaB with a defined structure and overall responsibility for the compilation and finalization of inventory reports and their submission to the UNFCCC Secretariat and the European Commission according to the announcement in the official document.[18] The SNE was officially appointed by Decision of the Director General of the SHMÚ No. 16/2011 in August 2011 and amended by Decision of the Director General of the SHMÚ No. 8/2012 in September 2012. The SNE coordinates the National Inventory System of the SR (the NIS SR). It currently comprises 8 experts working on inventory tasks as a full time job. Composition of the SNE is: NIS coordinator, deputy NIS coordinator and data manager, energy expert and agricultural expert. Permanent staff of the SNE is complemented to the NIS SR by several institutions and external experts from relevant sectors working on contracts updated as necessary and also partly other experts of the OEaB (Figure 3.9). This figure shows the new structure of the NIS, where the Committee on CCP is the intergovernmental body responsible for climate change policy implementation on a cross-ministerial level. On Table 1.2 presented in the SVK NIR 2017 is an updated list of internal experts within SHMU and a list of external experts and institutions within the NIS SR.

3.3.2 Quality assurance/Quality control (QA/QC) procedures

This section presents the quality management and inventory process. The category – specific QA/QC details with improvements and recommendations are discussed in the relevant section of the SVK NIR 2017.

3.3.2.1 Quality management

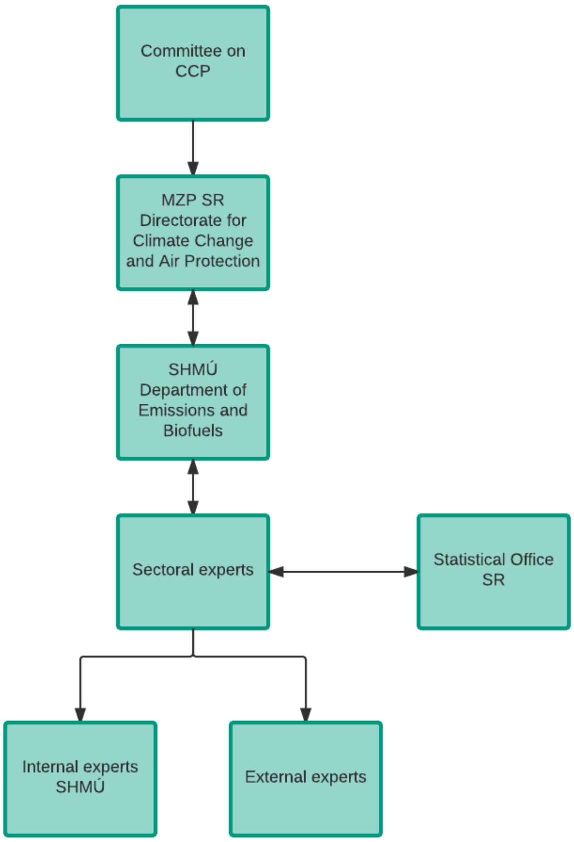
The Slovak Hydrometeorological Institute has built and introduced the quality management system (QMS) according to the requirements of EN ISO 9001:2008 standard of conformity. In the frame of introduction of the QMS for the SHMÚ as a global standard, the certification itself proceeds according to the partial processes inside of the SHMÚ structure. The process of Emission Inventories was the subject of internal and external audits during March 2010 by

[36] http://www.shmu.sk//File/Org_Struktura_SHMU/Struktura_bezVO_1_1_2017.pdf

the certification body ACERT, accredited by the Slovak National Accreditation Service. The quality manager completed several trainings regarding QMS. A recertification process takes place every two years.

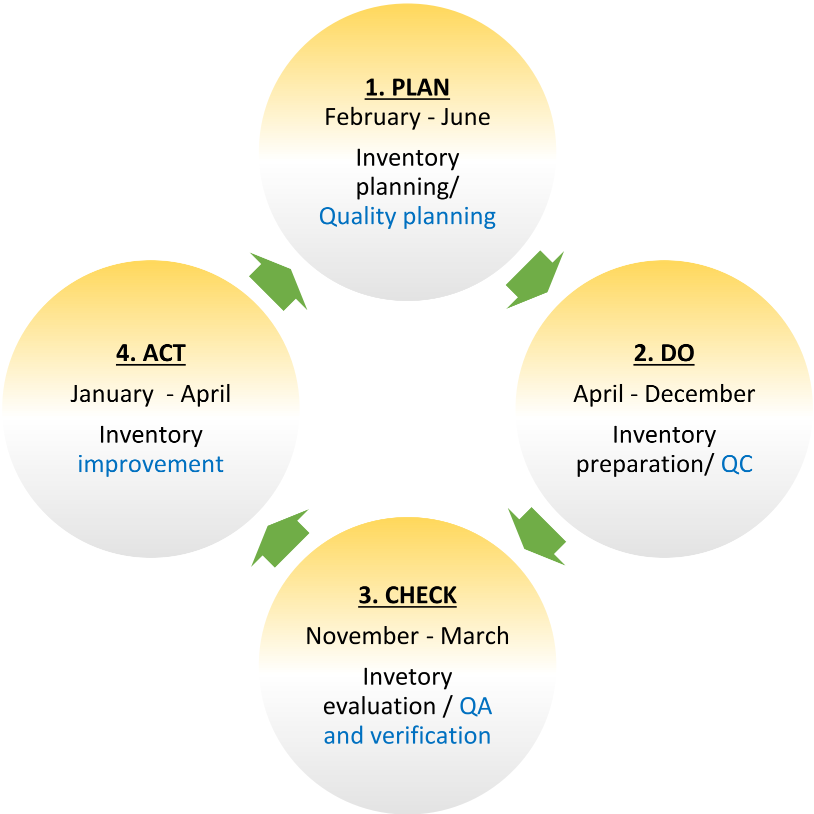
The objective of the National Inventory System (NIS) is to produce high-quality GHG inventories. In the context of GHG inventories, high quality provides that both the structures of the national system (i.e. all institutional, legal and procedural arrangements) for estimating GHG emissions and removals and the inventory submissions (i.e. outputs, products) comply with the requirements, principles and elements arising from UNFCCC, the *Kyoto Protocol*, the IPCC guidelines and the EU GHG monitoring mechanism (Regulation No. 525/2013 of the European Parliament and of the Council).

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



The starting point for accomplishing a high-quality GHG inventory is consideration of the expectations and requirements directed at the inventory. The quality requirements set for the annual inventories - transparency, consistency, comparability, completeness, accuracy, timeliness and continuous improvement - are fulfilled by implementing the QA/QC process consistently. Figure 3.10 shows a model for the timeline steps provided in the inventory process, QA/QC activities and verification procedures.

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



1. Inventory planning/Quality planning

- Setting roles and responsibilities
- Elaboration of QA/QC and verification plan
- Specifying necessary processes and resources
- Selecting methods and emission factors

2. Inventory preparation/Quality control

- Collecting activity data
- Estimating GHG emissions and removals
- Implementing QC checks
- Uncertainty estimation, calculations, compile CRF tables

3. Inventory evaluation/QA and verification

- Implementing QA
- Verification
- Final QC
- NIR preparation
- Documenting and archiving inventory material

4. Inventory improvement

- reviews
- addressing comments and errors
- assessing the effectiveness
- conclusions for future action

The SHMÚ implemented a continuous training process policy for internal and external experts. Experts are trained during workshops of the SVK NIS, which are held two times per year. The minutes of the workshop and all relevant documents are sent to sectoral experts of the SVK NIS. The ways of communication within the SVK NIS are via e-mail, phone call, visits and meetings. Although the efficiency of communication is of a high level in our information system, for further improvement a website forum was created.

Sectoral experts apply the QA/QC methodology according to the Quality Manual, collect data from providers and process the emission inventory for a given sector – they provide partial reports with information on the quality and reliability of data on activities and emissions. The quality manual including e.g. guidelines, QA/QC plans, templates and checklists is available to all experts of the national inventory system via the Internet. The set of templates and checklists consists of these documents:

- ✓ QA/QC Plan (external, internal)
- ✓ Matrix of Responsibility
- ✓ General QC
- ✓ Source Category-specific QC
- ✓ Quality Assurance
- ✓ Archive Document
- ✓ Improvement plan
- ✓ Recommendation list

All documents are approved after being filled out by experts by a responsible inventory system person and then are archived. The data manager has the overall responsibility for documentation, formal contact with sector experts and approval activities, taking over the sectoral reports and archiving them.

3.3.2.2 Inventory planning (PLAN)

The inventory planning stage includes the setting of quality objectives and elaboration of the QA/QC plans for the coming inventory preparation, compilation and reporting work. The setting of quality objectives is based on the inventory principles.

The quality objectives regarding all calculation sectors for inventory submissions are the following:

1. <u>Continuous improvement</u>
   - ✓ Treatment of review feedback is systematic
   - ✓ Improvements promised in the NIR are introduced
   - ✓ Improvement of the inventory is systematic
   - ✓ QC procedures meet the requirements and QA is appropriate
2. <u>Transparency</u>
   - ✓ Archiving of the inventory is systematic and complete
   - ✓ Internal documentation of calculations supports emission and removal estimates
   - ✓ CRF Tables and the NIR include transparent and appropriate descriptions of emission and removal estimates and of their preparation.
3. <u>Consistency</u>
   - ✓ The time series are consistent
   - ✓ Data have been used in a consistent manner in the inventory.
4. <u>Comparability</u>
   - ✓ The methodologies and formats used in the inventory meet comparability requirements.
5. <u>Completeness</u>
   - ✓ The inventory covers all emission sources, sinks and gases
6. <u>Accuracy</u>
   - ✓ The estimates are systematically neither greater nor less than the actual emissions or removals
   - ✓ The calculation is correct
   - ✓ Inventory uncertainties are estimated
7. <u>Timeliness</u>

✓High-quality inventory reports reach their recipient (EU/UNFCCC) within the set time.

The quality objectives and the planned QC and QA activities regarding all sectors are set in QA/QC plans (internal and external). In these documents deadlines and responsibilities are descripted. These plans are updated and evaluated annually by the quality manager of the NIS and approved by the MZP SR.

3.3.2.3 Quality control procedures (DO)

General and category-specific QC procedures are performed by experts during inventory calculation and compilation.

General quality control includes routine checks, correctness, completeness of data, identification of errors, deficiencies and documentation and archiving of the inventory material. The sectoral experts must adopt adequate procedures for development and modification of the spreadsheets to minimise emission calculation errors. Checks ensure compliance with the established procedures as well as allow detecting the remaining errors. Parameters, emission units and conversion factors used for the calculations must be clearly singled out and specified.

Category-specific QC includes reviews of the source categories, activity data and emission factors focusing on key categories and on categories where significant methodological changes or data revision have taken place.

Experts fill QC forms during the compilation of inventory, results from QC activities are documented and archived.

3.3.2.4 Quality assurance (CHECK)

Quality assurance is performed after the application of QC checks concerning the finalised inventory. QA procedures include reviews and audits to assess the quality of inventory and the inventory preparation and reporting process, determine the conformity of the procedures taken and to identify areas where improvements could be made. These procedures are in different levels, including basic reviews of the draft report, general public review, external peer review, internal audit, EU and UNFCCC reviews.

Thanks to the uploading to the website of SHMÚ, printing and distribution of the final inventory document, we can have feedback from the general public. Sectoral experts and members of the inventory team during the year participate in various seminars, meetings, conferences and sector-specific workshops, where the activities of inventory members and the results of the national inventory emission are reported. A broader range of researchers and practitioners in non-government organizations, industry and academia, trade associations as well as the general public have the opportunity to contribute to the final document. The comments received during these processes are reviewed and, as appropriate, incorporated into the Inventory Report or reflected in the inventory estimates.

When checking the quality of data of each sector, the NIS coordinator, quality manager of NIS, data manager of the NIS and other stakeholders must conduct the following general activities:

Checking: Check whether the data in the sectoral reports (calculations and documents) for each sector conform both to the general and specific procedures.

Documentation: Write down all verification results, filling out a checklist, including conclusions and irregularities that have to be corrected. Such documentation helps to identify potential ways to improve the inventory as well as store evidence of the material that was checked and of the time when the check was performed.

Follow-up of corrective actions: All corrective actions necessary for documenting the activities carried out and the results achieved must be taken. If such a check does not provide a clear clue concerning the steps to be taken, the quality control, a bilateral discussion between the expert and NIS coordinator will take place.

Data transference: All checked documents (including the final questionnaire and all annexes) shall be put into the project file and copies shall be forwarded to all NIS experts. Since the data quality supervision procedures must be observed all the time, it is not mandatory to conduct all checks annually during the inventory preparation. Certain activities, such as verification of the electronic data quality or project documentation for checking whether all documents have been provided, must be carried out every year or at least at set intervals. Some checks may be conducted only once (however, comprehensively) and then only from time to time.

Part of the QA procedures is bilateral cooperation with the Czech Republic. The first meeting took place in July 2013 and since then has been repeated every year.

3.3.2.5 Verification activities

An independent verification procedure was introduced after the inter-ministerial High Level Committee on Coordination of Climate Change Policy was established. The members of the Committee nominated experts involved in the verification and approval process for the selected parts of the emission inventory. The stakeholders (experts) are responsible for the official and legislative agreement of the presented results and ensure harmonisation among the international reporting.

Verification refers to the collection of activities and procedures that can be followed during the planning and development, or after the completion of an inventory, that can help to establish its reliability for the intended applications of that inventory. The used parameters and factors, and the consistency of data are checked regularly. Completeness checks are undertaken, new and previous estimates are compared every time. Data entry into the database is checked many times by the sector expert for uncertainty. If possible, activity data from different data sources are compared and thus verified. Comprehensive consistency checks between national energy statistics and IEA time series, checking the results of the EU's internal review for the EU28, and analyses its relevance for the Slovak Republic.

Confidential information is provided to the SVK NIS experts based on bilateral agreements but cannot be reported separately (only as a national total).

3.3.2.6 Inventory improvement (ACT)

The main aim of the QA/QC process is the continuous improvement of the quality of inventory. In the reflection of ERT request No G.3 of the SVK 2016 ARR, the outcomes and experiences from the annual reviews are the main sources for the preparation of recommendation lists and improvement plans based on these recommendation lists.

The recommendation and improvement plans are updated annually after the regular UNFCCC and EU compliance reviews take place. As the Slovak Republic is one of the Member States of the European Union, a separate review regime is undertaken under EU Monitoring Mechanism Regulation EU No 525/2013 and the Effort Sharing Decision (ESD) in spring every year. These outcomes and recommendations are included in the improvement plan as well. The prioritisation process is based on problems and recommendations raised during reviews and also based on experts' consultations. Results of prioritisation are included in the improvement plans. A detailed recommendation list and improvement plan are prepared by sectors and delivered to the sectoral experts for consideration and prioritisation of planned activities for the next inventory cycle.

Recently the prioritisation of the improvement plan was focused on the energy sector and the harmonisation of different data sources for energy balance and implementation of the IPCC 2006 Guidelines. Last year the priority was the revision and implementation of methodological changes and national parameters in the emissions inventory of the agricultural sector. This process was not completely implemented in the 2016 submission and will also continue this year. For the SVK NIR 2017, problems and recommendation which were identified in the 3 previous reviews have top priority - chapters LULUCF, Transport and Energy. Items identified in the previous review chapters have high priority– General and Agriculture and newly identified recommendations in chapters IPPU, Waste and KP LULUCF.

3.3.2.7 Inventory methodology and data used

The compilation of the emission inventory starts with the collection of activity data. A comprehensive description of the inventory preparation for GHG emissions is described in methodologies for individual sectors. The methodologies are updated annually within the improvement plan and recommendation list and they are archived after formal approval at the web page of the National Inventory System http://ghg-inventory.shmu.sk/ and by the sectoral experts and NIS coordinator. The most important source of activity data is the Statistical Office of the Slovak Republic and the sectoral statistics of the ministries. The National Emissions Information System (the NEIS database) is also an important reference source of emission data on fuels and other characteristics of stationary air pollution sources. The NEIS is operated by the OEaB of the SHMU. Other important sources are listed in Table 3.6.

Table 3.6: *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, EU ETS Reports, Reports of verifiers
Industrial Processes and Product Use	Association of cement and lime producers, Association of refrigeration and air conditioning engineers, Association of paper producers; 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, Institute for Fertilisers Research, http://www.mpsr.sk/sk/index.php?navID=122
LULUCF	Green Report of the Ministry of Agriculture of the SR - Forest, Cadastral Office, http://www.mpsr.sk/sk/index.php?navID=123
Waste	Dbase RISO http://www.sazp.sk/slovak/struktura/COH/oim/data/index.htm, dbase of industrial wastewater of the SHMU, Waste Statistics of the SU SR

Collected input data are compared and checked with international statistics (Eurostat, IAE, FAO and others). In some cases, the collected input data are compared with the results from models (e.g. in road transport it is the COPERT model, the model for the waste sector, etc.).

Archiving of inventory documents and the database is in the competence of the quality and data managers of the NIS SR. Archiving of the database is in the competence of the NIS coordinator. Documents and emission inventories are archived at three levels. Official documents, methodologies and reports are archived and stored at the web page of the National Inventory System. Access to sensitive documents is through user name and password. Statistics and calculations are archived at the level of external institutions and managed by sectoral experts. All other relevant documents, papers and reports are stored in electronic and printed forms at the OEaB.

Archiving is controlled by rules for archival systems in organizations at the SHMU level. The documents are archived in electronic and printed form. Electronic archiving of sectoral reports, inventory submissions and other specific documents (ERT reports, ARR, National Reports etc.) is at the webpage http://ghg-inventory.shmu.sk/, with a password (all details for experts) and without a password (less detailed information for the public). The documents needed for quality management systems are archived in electronic form at the webpage of the SHMÚ (intranet). Printed documents are archived in the central archive of the SHMU and at the OEaB.

An archival system allows information to be easily reproduced, allows safeguards against data and information loss, and allows reproducibility of the estimates. The archival system includes relevant data sources and spreadsheets, reproduces the inventory and reviews all decisions about assumptions and methodologies. The archival system checklist contains these archiving activities: documenting methods used, including those used to estimate uncertainty and data sources for each category; expert comments; revisions, changes in data inputs or methods and recalculation, also the reason and source of changes; documenting the used software for the calculation of emission. Each new inventory cycle benefits from effective data and document management during the development of the previous inventory.

All information used to create the inventory is archived at a single location in both electronic and/or hard copy (paper) storage so that future inventory managers can reference all relevant files to respond to reviewer feedback including questions about methodologies. Archived information includes all emission factors and activity data at the most detailed level, and documentation of how these factors and data have been generated and aggregated for the preparation of the inventory. This information also includes internal documentation on QA/QC procedures, external and internal reviews, documentation of annual key categories and key category identification, and planned inventory improvements and recommendations. All the information about archiving is recorded in the Archival System form.

3.4 NATIONAL REGISTRY

The Slovak Republic operates its national registry in a consolidated manner with the EU Member States who are also Parties to the Kyoto Protocol plus Iceland, Liechtenstein and Norway. The consolidated platform, which implements the national registries in a consolidated manner (including the national registry of the Slovak Republic), is called the Consolidated System of EU registries (CSEUR). The Slovak national registry was successfully connected to the ITL with other EU countries in October 2008 and it has been fully functional since.

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

NAME OF THE INSTITUTION:	ICZ SLOVAK REPUBLIC A.S.
Postal address:	Soblahovská 2050, 911 01 Trenčín, Slovak Republic
Phone & Fax number:	Phone: +421 32 6563 730, Fax: +421 32 6563 754
E-mail:	emisie@icz.sk
Web site address:	emisie.icz.sk
Contact person:	Ing. Miroslav Hrobák
Position:	Unit Manager (Emission Registry)
E-mail address:	miroslav.hrobak@icz.sk

3.4.1 Changes in the National Registry software

The EU Member States who are also Parties to the Kyoto Protocol 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 13/CMP.1 and Decision 24/CP.8. The consolidated platform, which implements the national registries in a consolidated manner (including the registries of the Slovak Republic and EU), is called the Consolidated System of EU registries (CSEUR).

The following changes to the national registry of the Slovak Republic have occurred in the reported period:

REPORTING ITEM	DESCRIPTION
15/CMP.1 annex II.E paragraph 32.(a) Change of name or contact	No change of name or contact occurred during the reported period.
15/CMP.1 annex II.E paragraph 32.(b) Change regarding cooperation arrangement	No change of cooperation arrangement occurred during the reported period.

REPORTING ITEM	DESCRIPTION
15/CMP.1 annex II.E paragraph 32.(c) Change to database structure or the capacity of national registry	New tables were added to the CSEUR database for the implementation of the CP2 SEF functionality. Versions of the CSEUR released after 6.7.3 (the production version at the time of the last submission) introduced other minor changes in the structure of the database. The database model, including the new tables, is provided in Annex A. No change to the capacity of the national registry occurred during the reported period.
15/CMP.1 annex II.E paragraph 32.(d) Change regarding conformance to technical standards	Changes introduced since version 6.7.3 of the national registry are listed in Annex B. Each release of the registry is subject to both regression testing and tests related to new functionality. These tests also include thorough testing against the DES and were successfully carried out prior to the relevant major release of the version to Production (see Annex B). Annex H testing was completed in January 2017 and the test report is provided. No other change in the registry's conformance to the technical standards occurred for the reported period.
15/CMP.1 annex II.E paragraph 32.(e) Change to discrepancies procedures	No change of discrepancies procedures occurred during the reported period.
15/CMP.1 annex II.E paragraph 32.(f) Change regarding security	The mandatory use of hard tokens for the authentication and signature of processes was introduced for privileged users such as registry administrators and the service desk.
15/CMP.1 annex II.E paragraph 32.(g) Change to list of publicly available information	No change to the list of publicly available information occurred during the reported period.
15/CMP.1 annex II.E paragraph 32.(h) Change of Internet address	No change of the registry internet address occurred during the reported period.
15/CMP.1 annex II.E paragraph 32.(i) Change regarding data integrity measures	No change of data integrity measures occurred during the reported period.
15/CMP.1 annex II.E paragraph 32.(j) Change regarding test results	Both regression testing and tests on the new functionality were successfully carried out prior to the release of each version to Production. The site acceptance test was carried out by quality assurance consultants on behalf of and assisted by the European Commission, the report is attached as Annex B. Annex H testing was carried out in January 2017 and the test report is provided.

4. 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 the 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 MŽP SR and the SHMÚ have undertaken all the necessary steps to enhance mechanisms to monitor, evaluate and improve tools and measures for the 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% by 2020compared to 1990, 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 achieving 20% of energy from 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 fuel consumption in the transport sector. Moreover, the EU has committed to a 20% reduction of total primary energy consumption by 2020, compared to projections in 2007.[37] The Slovak Republic is on the way to fulfilling its commitments as 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 4.2).
- 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 4.4 to 4.9).
- Descriptions of the interactions of policies and measures (section 4.11).

4.2 POLICY MAKING PROCESS

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

The main bodies within the MŽP SR to deal with climate change tasks are the Climate Change Policy Department and the Emission Trading Department operating under the Directorate for Climate Change and Air Protection.

[37] 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.

According to 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 15 January 2012 at the state secretary level and is chaired by the State Secretary of the MŽP SR. Other members include the state secretaries of the Ministry of Economy, the Ministry of Agriculture and Rural Development, the Ministry of Transport and Construction, the Ministry of Education, Science, Research and Sport, the Ministry of Health, the Ministry of Finance, the Ministry of Foreign and European Affairs and the Head of the Regulatory Office for the Network Industries.

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

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

A Low-Carbon Development Strategy is under preparation under contract between the World Bank and the Ministry of Environment (expected finalisation spring 2018).

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 the 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 the monitoring and evaluation process represents 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 15 January, Article 7 of the Regulation (EU) No. 525/2013 (MMR), Article 7 of the Decision 529/2013/EU and relevant Articles of the Regulation (EU) No. 749/2014[38,39,40]. This review is performed on a 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 a 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.[41] The Report, adopted by the Governmental Resolution No. 151[42], also includes a separate chapter, the Current State of Fulfilment of Reduction

[38] Regulation (EU) No 525/2013 of the European Parliament and of the Council of 21 May 2013 on a mechanism for monitoring and reporting Greenhouse gas emissions and for reporting other information at national and Union level relevant to climate change and repealing Decision No 280/2004/EC, OJ,18.6.2013, p. 13;

[39] Decision No 529/2013/EU of the European Parliament and of the Council of 21 May 2013 on accounting rules on greenhouse gas emissions and removals resulting from activities relating to land use, land-use change and forestry and on information concerning actions relating to those activities;

[40] Commission Implementing Regulation (EU) No 749/2014 of 30 June 2014 on structure, format, submission processes and review of information reported by Member States pursuant to Regulation (EU) No 525/2013 of the European Parliament and of the Council, OJ L.203,11:7:2014, p. 23.

[41] Správa o priebežnom stave plnenia prijatých medzinárodných záväzkov SR v oblasti politiky zmeny klímy

[42] http://www.rokovania.sk/File.aspx/ViewDocumentHtml/Uznesenie-16113?prefixFile=u_

Commitments of the Slovak Republic under the UNFCCC and Kyoto Protocol[43], which informs the Government in detail on the state of fulfilment of our reduction commitments based on the information from the most recently 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

The 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. A detailed description of the policies and measures on the EU level is presented in the Seventh National Communication of the EU on Climate Change and the EU Third Biennial Report.

4.2.2.1 Policy Context on the EU level

a) Strategy EUROPA 2020

Europe 2020 is a ten-year growth strategy and builds upon the lessons learnt from the Lisbon Strategy. The main objective of 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.[44] 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 the aforementioned 20-20-20 targets:

- To reduce greenhouse gas emissions by at least 20% by 2020 compared to 1990, with a firm commitment to increase this target to 30% in the event of a satisfactory international agreement being reached;
- To achieve 20% of energy from renewable sources by 2020 (as a share of total EU gross final energy consumption), supplemented by a target to achieve a minimum of 10% renewable transport fuel;

[43] Plnenie medzinárodných záväzkov SR podľa Rámcového dohovoru OSN o zmene klímy a Kjótskeho protokolu
[44] COM (2010) 2020 Final

- To save 20% of total primary energy consumption by 2020 compared to a business as usual baseline.

In order to meet the key targets and objectives, the Climate and Energy Package comprises four pieces of complementary legislation[45]:

- 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, the Carbon Capture and Storage Directive.

c) 2030 Climate and Energy Framework

This framework was agreed by EU leaders in October 2014 and builds on the 2020 climate and energy package mentioned above. It sets three key targets for the year 2030:

- At least 40% cuts in greenhouse gas emissions (from 1990 levels). To achieve this, EU ETS sectors would have to cut emissions by 43% (compared to 2005), and the ETS will be reformed and strengthened to achieve this. Non-ETS sectors would need to cut emissions by 30% (compared to 2005), and this will need to be translated into individual binding targets for Member States
- At least 27% share of EU energy consumption for renewable energy
- At least 27% improvement in energy efficiency.

The legislative proposals are being discussed in the European Council and European Parliament, with an 18 months implementation period into national legislation.

d) Roadmaps 2050

In 2011, the European Commission launched three roadmaps to promote 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[46];
- The Roadmap to a Single European Transport Area - Towards a Competitive and Resource-Efficient Transport System[47];
- The Energy Roadmap 2050[48].

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

[45] http://europa.eu/rapid/press-release_IP-09-628_en.htm
[46] COM (2011) 112 final.
[47] COM (2011) 144 final.
[48] COM(2011) 885/2.

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.

e) 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,[49] 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 the National Level

a) **The National Reform Programme** - it is a national and regularly updated programme with the main goal of meeting structural policy objectives of the EU 2020 Strategy. It also comprises 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 an environmental part, which nowadays constitutes the current National Environmental Strategy.

[49] Decision No 1386/2013/EU OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL on a General Union Environment Action Programme to 2020 ‘Living well, within the limits of our planet’

c) **National Environmental Strategy** – the Slovak Republic has an environmental strategy which is over 20 years old. Over time policies and environmental objectives have developed and the Slovak Republic is therefore preparing a new environmental strategy that will contain new principles, targets and measures supplemented by indicators.
d) **Low-carbon Strategy** – considering the need to develop long term low emission strategies under the Paris Agreement, the Slovak Republic is currently preparing in cooperation with the World Bank its Low-carbon development strategy with development paths up to 2050.

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.

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 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 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 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. The Slovak Republic sold some part of unused AAUs in 2013 according to Article 17 of the Kyoto Protocol. The revenues from AAU trade are incomes for the Environmental Fund (according to Act No. 414/2012 Coll. on Emission Trading). In conformity with Act No. 414/2012 Coll. and taking the advantage of existing surplus of AAUs units and current trend in the generation of emissions, the Slovak Republic has made sales of 7 million tons of AAUs in 2013. The revenues would be used for industrial energy efficiency projects, renewable energy projects and residential energy efficiency projects under the 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 was 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 was 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 the specific composition of the 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 the National Guidelines and Procedures of the Slovak Republic for Approving Article 6 Projects on the UNFCCC website.[50]

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

According to Article 11 of Act No. 414/2012 Coll. on Emission Trading, all installations in the EU emission trading scheme can also use the CERs and ERUs during the third trading period up to the level set in Commission Regulation 1123/2013/EU of 8 November 2013 on determining international credit entitlements pursuant to Directive 2003/87/ES of the European Parliament and of the Council.

The use of CERs and ERUs has to be in accordance with Article 11 of the Act No. 414/2012 Coll. on Emission Trading.

The Green Investment Scheme was formally approved in December 2009 as an instrument supporting projects and programs aiming at the further reduction of GHG emissions funded through 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 eq.]
Total for all Kyoto mechanisms	42,000 Gg CO_2 eq.
International emissions trading	41,500 Gg CO_2 eq.
All project based activities	
Joint implementation	500 Gg CO_2 eq.
Clean development mechanism	

Source: MŽP SR

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

50 http://ji.unfccc.int/UserManagement/FileStorage/6IWYQACEFTXPLGBKU0SZHN849DJVM7

Table 4.2: *Planned and realised emission reductions for JI project*

Emission Reduction (tonnes CO_2 eq. per year)		
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: MŽP SR; Note: * Calculation of realized reduction was not closed yet.*

So far, the Dutch side has not asked the Slovak Republic for the 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 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 the 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 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 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 the possible adverse economic effects will affect some developing and less developed countries having fewer means for adequate remedial response measures. The magnitudes of these potential impacts are typically given by the stringency of the 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 potential channels of how domestically implemented environmental policies in the Slovak Republic might have exercised any impact on third countries are identified. 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 on coal tax payers and an 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

The biofuels policy has been put in place to meet the targets required by EU legislation. Increased demand and subsequently also production of biofuels might be reflected by rising commodity prices, respectively might cause 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 might be transmitted towards developing countries. Taking into account the relatively low quantities of biofuels in use in the Slovak Republic and domestic production of raw materials for their production, we do not expect any negative effects either on forests destruction or contribution to rising world prices of agricultural commodities. Despite its rather low contribution to these developments, the Slovak Republic actively contributes to shaping the international sustainability standards either within its own (and internal EU) legislation process or within the framework of international institutions, such as the 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 development of the emerging carbon market with the 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 third countries is the integration of the aviation sector into the trading scheme. Among indirect effects, the major example is the concern about possible carbon leakage. Most of the impacts of carbon leakage (shifts of industrial activity to countries without any GHG emission reduction commitments, potential downward pressure on oil prices, etc.) on third countries would in fact be rather positive for them.[51] Measures in place to minimize a potential carbon leakage include the provision to enlist economic sectors facing the immediate threat of carbon leakage, which will under the given conditions continue receiving their CO_2 allowances for free.

Furthermore, increasingly stringent fuel quality standards in Europe might in fact turn out to be a positive impact because it might trigger an 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 the scarcity of this commodity. Such effects might on the one hand negatively affect revenues of oil-exporting countries, which could on the other hand still be 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 from 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

4.4.1 EU Emission Trading System (EU ETS)

The EU ETS was established by Directive 2003/87/ES and has undergone several revisions to strengthen its implementation in the course of its three trading periods (2005 - 2007, 2008 - 2012, and the current one, 2013 - 2020).

Phase one (2005 - 2007) was a three-year pilot period of learning-by-doing to prepare for phase two, when the EU ETS would need to function effectively to help ensure that the EU and Member States meet their Kyoto Protocol emission targets.

Before the start of the first phase, the Slovak Republic had to decide how many allowances to allocate to each EU ETS installation on its territory. This was done through the first National Allocation Plan. The Slovak Republic prepared and published the National Allocation Plan on 1 May 2004. The European Commission’s Decision on the Phase I National Allocation Plan of the Slovak Republic was adopted on 20 October 2004. Statistics from phase one:

- 175 installations;
- 38 installations closed their accounts;
- 1 installation’s permit revoked.

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

***Table 4.3:** Statistics from Phase I of the National Allocation Plan*

Year	2005	2006	2007
Allocation	30,299,021	30,357,450	30,357,404
Verified emissions	24,892,813	25,200,029	24,153,151

Source: Ministry of Environment

The second phase of the EU ETS was the five year period from 2008 - 2012 and it corresponded with the first commitment period of the Kyoto Protocol. The EC Decision on the Phase II National Allocation Plan of the Slovak Republic was adopted on 29 November 2006 and amended with a decision from 7 December 2007.

Statistics from phase two:

- 193 installations;
- 30 installations closed their accounts;
- 1 installation's permit revoked.

***Table 4.4:** Statistics from Phase II of the National Allocation Plan*

Year	2008	2009	2010	2011	2012
Allocation	32,166,094	32,140,581	32,356,123	32,617,164	33,432,258
Verified emissions	25,336,706	21,595,209	21,698,625	22,222,534	20,932,903

Source: Ministry of Environment

The third phase of the EU ETS began 1 January 2013 and introduced several changes to the EU ETS. It brought harmonized rules for free allocation, introduced auctioning as the main instrument to comply with the reduction target, added additional sectors under its scope (i.e. civil aviation, aluminium) and set an annual reduction target of 1.74%. The Slovak Republic notified the Commission with a list of installations covered by the Directive in its territory on 17 August 2012.

***Table 4.5:** Statistics from Phase III of the National Allocation Plan*

Year	2013	2014	2015	2016
Allocation	16,466,336	15,821,315	15,029,434	14,522,533
Verified emissions	21,829,374	20,918,069	21,181,280	21,264,045

Source: Ministry of Environment

In July 2015, the Commission presented a legislative proposal to reform the EU ETS for the period after 2020 (i.e. Phase IV). This was followed by a series of consultations on the proposal, including an expert meeting to discuss technical aspects of the proposed free allocation and carbon leakage rules, and separate consultations with stakeholders around the proposed Innovation Fund. The Council of EU Environment Ministers agreed its negotiating position (general approach) for the review of the EU ETS for Phase 4 on 28 February 2017. The European Parliament had adopted its position in support of the revision of the EU ETS half a month earlier (on 15 February). The proposal is currently being discussed in the so called "trilogues process" with the goal of reaching a common position between the European Parliament and the Council before it can be adopted.

- New Entrants Reserve

A maximum of 5% of the EU-wide quantity of allowances over the period of 2013 to 2020 will be reserved for new entrants. To this day, the Slovak Republic registers three official requests.

- New Entrants Reserve 300

None of the carbon dioxide capture and geological storage or innovative renewable projects from the Slovak Republic have participated in the first or second 300 New Entrants Reserve announcements.

- Auctioning

Auctioning is a new way of distributing allowances in phase three. Preliminary auctioning started in 2012 with the auctioning of 120 million EUAs, from which the Slovak Republic's share was 1.8 million EUAs. The auctions are held at the European Energy Exchange every Monday, Tuesday and Thursday. The whole auction revenue has been income of the Environmental Fund of the Slovak Republic since 2015.

Table 4.6: *The Slovak Republic's revenue from auctions during the period 2012 – 2016*

Period	2016	2015	2014	2013	2012
			EUR		
Slovak Republic Revenue (EUAs)	64,991,430	84,312,060	57,590,625	61,702,620	12,193,290
Slovak Republic Revenue (EUAAs)	55,815	197,300	44,590	-	-
Total SVK Revenue	65,047,245	84,509,360	57,635,215	61,702,620	12,193,290

Source: Ministry of Environment

- Backloading

Backloading is a term used for describing the process to temporarily withhold a larger amount of allowances from the auctions in the years 2014-2016 and loading them back to the auctions in the years 2019-2020. The main objective is to eliminate the current surplus of allowances in the EU ETS and to ensure the rise in the price of carbon on the market.

- Connecting the EU ETS with other GHG trading schemes, i.e. linking

Directive 2009/29/EC contains provisions which enable the linking of the EU ETS with other similar schemes created at regional or national levels outside the EU. Currently negotiations related to linking are on-going between the EU and Switzerland.

- MSR

Market stability reserve (MSR) was introduced as a long term solution to fight the existing surplus of allowances within the EU ETS. It is an automated mechanism that will automatically decrease the auctioning volume of the allowances if there is a significant surplus on the market. If there is need for additional allowances, the MSR will be used to increase the auctioning volume. The MSR will be operational from 2019 and all backloaded allowances will become part of this reverse. This will cause a continuous increase of carbon price in the EU ETS and a stable environment for investors for the next decade.

GHG affected: CO_2, CH_4, N_2O, HFC, PFCs and SF_6
Type of measure: regulatory

4.4.2 Effort Sharing Decision

The Effort Sharing Decision[52] establishes annual targets for GHG emissions of Member States between 2013 and 2020 which are legally binding and only refer to GHG emissions that are not included within the scope of the EU ETS, i.e. transport (except aviation), buildings, agriculture (excluding LULUCF) and waste. Each Member State must define and implement national policies and measures, such as the promotion of public transport, energy performance standards for buildings, more efficient farming practices and conversion of animal waste to biogas, in order to limit the GHG emissions covered by the Effort Sharing Decision. The emission limit for the Slovak Republic is +13% by 2020 compared to 2005 levels.

According to Slovak GHG emission trends and projections, the Slovak Republic could achieve its individual 2020 targets in the sectors not covered by the EU ETS with the current set of domestic policies and measures.

Table 4.7: *Progress towards GHG target Decision (ESD emissions) based on projections*

2020 ESD target (% vs 2005)	+13.0%
2015 ESD emissions (% vs 2005)	-23.2%
2020 ESD projections WEM (% vs 2005)	-23.0%
2020 ESD projections WAM (% vs 2005)	-26.0%

Source: MŽP SR

Transport and residential heating are the most treated sectors covered and regulated under the ESD. Total aggregated GHG emissions in transport are at the same level as in the base year even though the intensity of transport has increased. Transport currently contributes 16.3% to total GHG emissions (in CO_2 eq.) and its share of total emissions increased from 1990. Therefore, it is necessary to pay continuous attention and implement effective policies and measures to control and reduce road transport emissions in the Slovak Republic.

The Effort Sharing Decision has been effective in helping stimulate new national policies and measures, which has resulted in Member States becoming more active in considering new measures, as well as improved coordination between national, regional and local governments. This positive progress informed a new legislative proposal "Effort Sharing Regulation", which was presented by the Commission in July 2016. The regulation sets out binding annual greenhouse gas emission targets for Member States for the period 2021 - 2030, which maintains binding annual greenhouse gas emission limits for each Member State. Emission limits will be set for each year in a 10 year period up to 2030 according to a

[52] Decision 406/2009/EC

decreasing linear trajectory. The main changes proposed from the current decision are as follows:

- Existing flexibilities under the Effort Sharing Decision are retained, and two new flexibilities are added. These are:
  - A one-off flexibility to transfer a limited amount of allowances from the EU ETS: covering some emissions in non-ETS sectors with EU ETS allowances which would normally have been auctioned.
  - A new flexibility to transfer a limited amount of credits from the land use, land use change and forestry (LULUCF) sectors: to stimulate additional action in the land use sector.

The European Parliament adopted its position with respect to the proposed regulation on 14 June 2017, and the Council (Environment) reached a general approach on the above-mentioned proposal at its meeting on 13 October 2017, enabling the start of trilogue negotiations.

Table 4.8: *Evaluation of ETS and ESD GHG emissions in 2015*

Reported year 2015					
Category	**Unit**	**Total GHG Emissions**	**ETS emissions**	**ESD emissions**	**Ratio ETS/ESD in %**
GHG emissions	Gg of CO_2 eq.	41,269.49	21,181.22	20,084.62	51.32/48.68
Emissions of CO_2	Gg	33,816.79	21,032.71	12,784.08	62.20/37.80
Emissions of N_2O	Gg	2,342.56	139.78	2,202.78	5.97/94.03
Emissions of PFCs	Gg of CO_2	8.50	8.50	0.00	100%

Source: SHMÚ, based on GHG emissions inventory submitted on 12 April 2017

GHG affected: CO_2, CH_4, N_2O and PFCs
Type of measure: regulatory

4.4.3 Energy policy of the Slovak Republic adopted by the Government Resolution of the Slovak Republic No. 548/2014

The Energy Policy of the Slovak Republic (Energy Policy) is the strategic document defining the energy sector's primary objectives and priorities to 2035 with a view to 2050. The Energy Policy is a component of the Slovak Republic's national economic strategy, given that ensuring sustainable economic growth is conditioned by the reliable supply of affordable energy. The Ministry of Economy of the Slovak Republic is responsible for completing the Energy Policy. The Energy Policy is intended to ensure the sustainability of the Slovak energy sector to contribute to the sustainable growth of the national economy and its competitiveness. The priority from this perspective is ensuring the reliability and stability of the energy supply, efficient energy utilization at optimum costs and ensuring environmental protection. A well-functioning energy market with a competitive environment will be strengthened by Energy Policy implementation. As a result, the Energy Policy signals certain measures aimed at decreasing final electricity prices, including the phase-out by 2020 of feed-in tariffs for electricity from renewable energy sources, focus on the use of renewable energy

sources in the production of heat, and certain efficiency-enhancing changes to feed-in tariffs applicable to the co-generation of electricity and heat.
GHG affected: CO_2, CH_4 and N_2O
Type of measure: regulatory

4.4.4 Biofuels policy

Directive of the European Parliament and of the Council 2009/28/EC on the promotion of energy from renewable sources, amending and subsequently repealing Directives 2001/77/EC and 2003/30/EC, was adopted on 23 April 2009. Directive (EU) 2015/1513 of the European Parliament and of the Council amending Directive 98/70/EC relating to the quality of petrol and diesel fuels and amending Directive 2009/28/EC on the promotion of the use of energy from renewable sources was adopted on 9 September 2015. The body responsible for the implementation of both directives is the Ministry of Economy of the Slovak Republic. The Ministry of Environment is responsible for the area of compliance with the sustainability criteria for biofuels and bioliquids, calculations to determine the impact of biofuels and bioliquids on quantities of greenhouse gas emissions and calculation of greenhouse gas emissions released during the life cycle of fossil fuels.
Concerning the sustainability criteria, the Slovak Republic implemented articles 17, 18 and 19 of Directive 2009/28/EC and substantively identical articles 7b, 7c and 7d of Directive 2009/30/EC and the relevant articles of Directive 2015/1513 via Act No. 309/2009 Coll. as amended and Ordinance of the Ministry of Environment of the Slovak Republic No. 271/2011 Coll. as amended. The Act No. 181/2017 Coll. and the Ordinance of the Ministry of Environment of the Slovak Republic No. 191/2017 Coll. (the amendment to the Act No. 309/2009 Coll. and to the Ordinance No. 271/2011 Coll.) came into force in 2017. These implemented the provisions of the Directive 2015/1513 and the Directive 2015/652.
The Act No. 309/2009 Coll. as amended addresses the basic roles and responsibilities of the competent authorities and economic operators in the context of demonstrating compliance with the sustainability criteria for biofuels and bioliquids, which are the conditions for their accounting towards the national target for renewable energy sources.
Ordinance of the Ministry of Environment of the Slovak Republic No. 271/2011 Coll. as amended establishing sustainability criteria and targets to reduce greenhouse gas emissions from fuels has been in force since September 2011. The ordinance deals with the details of proving compliance with the sustainability criteria for biofuels and bioliquids.
For assessing compliance with the sustainability criteria throughout the production chain of biofuels and bioliquids, voluntary schemes were established. The schemes are subject to European Commission approval and therefore not subject to national approval and national control, while each Member state has to accept the results of these schemes unreservedly.
Ordinance of the Ministry of Agriculture and Rural Development No. 295 Coll. of 6 September 2011 laying down a detailed declaration of producer and supplier of biomass for producing biofuels or bioliquids has been in force since October 2011. The Slovak Republic has been running a national system of demonstrating compliance with the sustainability criteria for biofuels and bioliquids since 2011. The system is based on independent verifiers

whose training is organized and who are subject to mandatory examination and registration by the Ministry of Environment of the Slovak Republic.

GHG affected: CO_2, CH_4 and N_2O

Type of measure: regulatory

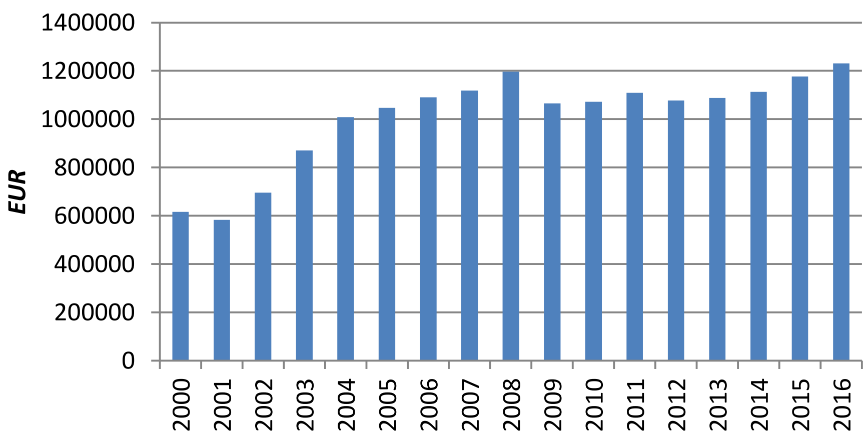
4.4.5 Taxation of energy products and electricity

The most significant in terms of generating tax revenue is the tax on mineral oils. Income from electricity, coal and natural gas is relatively low. The Slovak Republic raises relatively little revenue from environmentally related taxes (Figure 4.1) and the implicit tax rate (Figure 4.2) on energy is low. There is substantial scope for environmentally related tax reforms. Heating and process energy use accounts for the largest share in total energy use and CO_2 emissions in the Slovak Republic. As a result, a more harmonized tax treatment of heating and process energy use would raise substantial tax revenues and provide incentives to mitigate CO_2 emissions. This could be achieved by increasing taxes on all fuels used for heating and processing up to the standard rate per unit of energy for natural gas. Ad quantum excise duties could also be indexed for inflation to help prevent the decline in environmentally related tax revenues in real terms over time. Moreover, the Slovak Republic should consider eliminating the gasoline-diesel taxation differential. A gradual increase in the taxation of diesel could also be used to lower the burden from direct taxes, although there might be limited scope for such an increase in the short run without similar rate increases in neighbouring countries to prevent fuel tourism. Company cars should also be taxed more effectively within the personal income tax (PIT). Lastly, the support for electricity production with lignite should be eliminated. Instead, the tax on electricity consumption could be increased and the exemption of the electricity tax for households could be abolished to increase incentives for a more efficient use of electricity. The government could compensate lower income households through targeted tax or benefit measures.

GHG affected: CO_2, CH_4 and N_2O

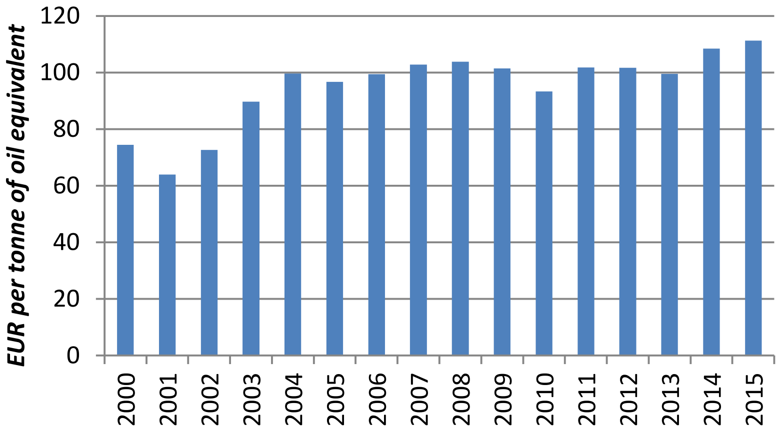
Type of measure: regulatory

Figure 4.1: *Tax revenues from energy product taxation*[53]



[53] http://ec.europa.eu/taxation_customs/tedb/taxDetails.html?id=4148/1496928576#tax_revenueTitle1

Figure 4.2: *Development in implicit tax rate on energy products in the Slovak Republic in 2000 - 2015*



Source: Eurostat

4.4.6 Carbon Capture and Storage

Directive 2009/31/EC on the geological storage of carbon dioxide was transposed into national legislation through Act No. 258/2011 Coll. on the permanent storage of carbon dioxide in the geological reservoirs on the amendment and supplementation of some articles. Suitable geological locations were identified in Slovak Republic.

GHG affected: CO_2

Type of measure: regulatory

4.4.7 National Emission Ceilings

Existing NEC Directive 2001/81/EC will be replaced from 1 July 2018 by revised NEC Directive 2016/2284. Its overarching aim is to reduce adverse health impacts of air pollution, including reducing cases of premature deaths per year due to air pollution by more than half. This revised directive includes national emission reduction commitments for each Member State for 2030 (with interim targets also set for 2025) for six specific pollutants: NO_x, SO_2, NMVOC, NH_3, $PM_{2.5}$ and CH_4. The NEC Directive is transposed into national legislation through Act No. 137/2010 Coll on air protection and complemented with Act No. 401/1998 Coll. on charges for air pollution.

GHG affected: Atmospheric pollutants: NO_x, SO_2, NMVOC, NH_3, $PM_{2.5}$ and CH_4

Type of measure: regulatory

4.5 SECTORAL POLICIES AND MEASURES: ENERGY AND TRANSPORT

The majority of policies within this sector presented in the Sixth National Communication of the Slovak Republic on Climate Change (2013) are still relevant. In addition to legislative instruments on emission trading, Act No. 137/2010 Coll. on air protection as amended plays an important role. This act is complemented with Act No. 401/1998 Coll. on charges for air pollution as amended, which serves for the control and regulation of emission limits for basic air pollutants. Monitoring and keeping records on emissions from stationary air polluting sources, as well as the system of fees and charges that is mandatory for the operators of medium and large scale sources of air pollution, have positively affected greenhouse gas emissions reduction and contributed to the decoupling (greenhouse gas emissions do not follow the growth of GDP) of the emission trajectory in the Slovak Republic since 1997.

All the aforementioned PaMs were considered in scenarios for modelling of emission projections in the Slovak Republic up to 2040. Synergy effects of PaMs have been reflected in the modelling. Quantifications of the PaMs' impacts on GHG emission reduction are given in the CTF Table 3.

- The Energy Policy of the Slovak Republic (adopted in November 2014) as referred to in section 4.4.3.

4.5.1 National Renewable Energy Action Plan, Government Resolution of the Slovak Republic No. 677/2010

Impact renewable energy sources in heat and electricity generation. Increase the share of electricity production from RES in the power system. Increase consumption of biomass for the production of electricity and heat.

GHG affected: N_2O

Type of measure: regulatory and economic

Status: in force since 2013

Implemented in scenario: WEM

4.5.2 Improving the thermal performance of family house buildings - Energy Efficiency Action Plan for the period 2014 - 2016 with the outlook for 2020 (adopted in July 2014)

Improving the thermal performance of buildings - family houses. Renovation of family houses with energy savings of at least 20%. Measures financed from owners' resources and through the banking sector.

GHG affected: CO_2, N_2O, CH_4

Type of measure: regulatory and economic

Status: in force since 2014

Implemented in scenario: WEM

4.5.3 Improving the thermal performance of public sector buildings - Energy Efficiency Action Plan for the period 2014 - 2016 with the outlook for 2020 (adopted in July 2014)

Improving the thermal performance of buildings - office buildings, hotels and restaurants, wholesale and retail trade, schools, school facilities, hospitals. Renewal of the selected type of buildings saving energy by at least 20%. Measures financed from own resources.

GHG affected: CO_2, N_2O, CH_4

Type of measure: regulatory and economic

Status: in force since 2014

Implemented in scenario: WEM

4.5.4 Improving the thermal performance of residential buildings - Energy Efficiency Action Plan for the period 2014 - 2016 with the outlook for 2020 (adopted in July 2014)

Improving the thermal performance of buildings - residential buildings and renovation of residential buildings. The State Housing Development Fund was established in 1997 under the Act No. 124/1996 Coll. the State Housing Development Fund, providing support for the expansion and modernization of the housing stock, particularly in the form of favorable long-term loans.

GHG affected: CO_2, N_2O, CH_4

Type of measure: regulatory and economic

Status: in force since 2014

Implemented in scenario: WEM

4.5.5 Energy efficiency improvement in industry - Energy Efficiency Action Plan for the period 2017 - 2019 with the outlook for 2020

Energy efficiency improvement and reducing the energy consumption of the industrial sector.

GHG affected: CO_2, N_2O, CH_4

Type of measure: regulatory and economic

Status: in force since 2017

Implemented in scenario: WAM

4.5.6 Improving the thermal performance of family house buildings – 4th Energy Efficiency Action Plan for the period 2017 - 2019 with the outlook for 2020 (adopted in April 2017)

Improving the thermal performance of buildings - family houses. Renovation of family houses with energy savings of at least 20%. Measures financed from owners' resources and through the banking sector.

GHG affected: CO_2, N_2O, CH_4

Type of measure: regulatory and economic

Status: in force since 2017

Implemented in scenario: WAM

4.5.7 Improving the thermal performance of public sector buildings - 4th Energy Efficiency Action Plan for the period 2017 - 2019 with the outlook for 2020 (adopted in April 2017)

Improving the thermal performance of buildings - office buildings, hotels and restaurants, wholesale and retail trade, schools, school facilities, hospitals. Renewal of the selected type of buildings saving energy by at least 20%. Measures financed from own resources.

GHG affected: CO_2, N_2O, CH_4

Type of measure: regulatory and economic

Status: in force since 2017

Implemented in scenario: WAM

4.5.8 Improving the thermal performance of residential buildings - 4th Energy Efficiency Action Plan for the period 2017 - 2019 with the outlook for 2020 (adopted in April 2017)

Improving the thermal performance of buildings - residential buildings and renovation of residential buildings. The State Housing Development Fund was established in 1997 under the Act No. 124/1996 Coll. the State Housing Development Fund, providing support for the expansion and modernization of the housing stock, particularly in the form of favorable long-term loans.

GHG affected: CO_2, N_2O, CH_4

Type of measure: regulatory and economic

Status: in force since 2017

Implemented in scenario: WAM

4.5.9 Emission trading, the new allocation - Act No. 414/2012 Coll. on Emission Trading in amendments

The ETS stimulates the use of biomass in the fuel mix of energy units. Economic and regulatory measure primarily focused on air protection with high positive impact on the reduction of GHG emissions.

GHG affected: CO_2, CH_4

Type of measure: regulatory and economic

Status: in force since 2012

Implemented in scenario: WEM

4.5.10 Hybrid transport in cities - Action Plan for Energy Efficiency 2011 - 2013, Government Resolution of the Slovak Republic No. 301/2011 Coll.

Buying low floor hybrid buses in selected cities (Žilina, Bratislava, Košice).

GHG affected: CO_2

Type of measure: regulatory and economic

Status: in force since 2011

Implemented in scenario: WEM

4.5.11 Modal shift to public transport - Action Plan for Energy Efficiency 2011 - 2013, Government Resolution of the Slovak Republic No. 301/2011 Coll.

The measure consists of the implementation of these specific projects: "The support system of urban public transport operating segment Janíkov Dvor - Šafárikovo sq., Part 1 Šafárikovo sq. - Bosákova street", "Tramway Dúbravka in section Hanulova - At the Cross" "NS MHD Phase 1 Central Station - Janíkov Dvor operating segment Bosákova street - Janíkov Dvor, Part 2 Bosákova - Janíkov Dvor",„The modernization of tram tracks - Karloveská, Vajnorská and Račianska Radial", "railway station, integrated passenger transport terminals (TIOP) in Bratislava, Bratislava section of the main station - Podunajské Biskupice (implementation)" ZSR integrated passenger transport terminals (TIOP) in Bratislava, Bratislava section of the main station - Devínska Nová Ves (implementation)", "NS MHD Phase 1 Central Station - Janíkov Dvor,Operations Department Central Station - Šafárikovo sq.", "ZSR integrated

passenger transport terminals (TIOP) in Košice Region Phase I (PD implementation)", "Modernisation of tram tracks in Košice - second stage".
GHG affected: CO_2, N_2O
Type of measure: regulatory and economic
Status: in force since 2011
Implemented in scenario: WEM

4.5.12 Modal shift to public transport - Transport Policy of the Slovak Republic into 2015

Free travel for students and citizens of retirement age. Discount fares for rail for working people. The modernization of the railway corridor Žilina - Košice - Čierna nad Tisou.
GHG affected: CO_2, N_2O
Type of measure: regulatory and economic
Status: in force since 2005
Implemented in scenario: WEM

4.5.13 Improved transport behaviour and road infrastructure - Transport Policy of the Slovak Republic into 2015

Energy savings are achieved by reducing fuel consumption by users of the road infrastructure in the new technically superior infrastructure in comparison with the original technically outdated road infrastructure. Ensure speedy completion of the motorway network included in the TEN-T routes Bratislava - Žilina - Košice - Vyšné Nemecke - state border SR / Ukraine (Va corridor; D1 motorway section) Priority of Bratislava - Košice as the main transport and urban connection for the SR, Construction of new high-capacity road infrastructure segments, troubleshooting first-class roads and modernizing rail infrastructure.
GHG affected: CO_2, N_2O
Type of measure: regulatory and economic
Status: in force since 2005
Implemented in scenario: WEM

4.5.14 Introduction of Euro 6 emission standards - Transport Policy of the Slovak Republic into 2015

The introduction of more stringent Euro 6 emission standards for new vehicles set significantly stricter emission limits for basic pollutants and particulates from traffic. There are anticipated reductions in fuel consumption due to the improved efficiency of engines and reductions in greenhouse gas emissions are anticipated.
GHG affected: CO_2
Type of measure: regulatory and economic
Status: in force since 2005
Implemented in scenario: WEM

4.5.15 Government Regulation of the Slovak Republic No. 246/2006 Coll. on the minimum quantity of fuels produced from renewable sources in the petrol and diesel fuels placed on the market in the Slovak Republic

Continuously increasing the share of bioethanol and biodiesel blended with gasoline and diesel. It is planned to increase the use of CNG - filling station infrastructure support.

GHG affected: CO_2

Type of measure: regulatory and economic

Status: in force since 2010

Implemented in scenario: WEM

4.5.16 Decree No. 362/2010 Coll. determining the requirements for quality of fuels and maintaining the operational evidence on fuels

Defines rules for fuel suppliers, i.e. requirements for higher share of biofuel in gasoline and mineral oil, and the duty of providing information of the share of biofuels in transport petrol and diesel consumption.

GHG affected: CO_2

Type of measure: regulatory and economic

Status: in force since 2010

Implemented in scenario: WEM

4.5.17 Regulation No. 655/2007 Coll. on technical conditions to reduce emissions from air conditioning systems in motor vehicles

Reduction of emissions from air conditioners.

GHG affected: CO_2, HFC, PFC, SF_6

Type of measure: regulatory and economic

Status: in force since 2007

Implemented in scenario: WEM

4.5.18 Effect of European legislative – Regulation No. 2009/443/EC and Regulation No. 2011/510/EC which sets limits for CO_2 emissions from car and vans

Increase car efficiency and decrease GHG emission production from cars and vans. Effect of European legislative - Regulation No. 2009/443/EC and Regulation No. 2011/510/EC which set limits for CO_2 emissions from cars and vans.

GHG affected: CO_2

Type of measure: regulatory and economic

Status: in force since 2010

Implemented in scenario: WEM

4.5.19 Emissions trading, allocation for civil aviation - Act No. 414/2012 Coll. on Emission Trading in amendments

The measure sets the decrease of GHG emissions from civil aviation through the EU ETS cap-and-trade system.

GHG affected: CO_2

Type of measure: regulatory and economic

Status: in force since 2012

Implemented in scenario: WEM

4.5.20 Strategy of Development of Electromobility

Electromobility brings a significant improvement of driving parameters from the point of view of its impact on the environment. The Strategy of Development of Electromobility in Slovakia deals with its support for electric vehicles.

GHG affected: CO_2

Type of measure: regulatory and economic

Status: in force since 2015

Implemented in scenario: WEM

4.5.21 Effect of European legislative - EU White Paper on Transport

Commitment from EU White Paper on the long-distance transportation of goods by trucks to rail: in total it should be 30% of goods currently transported by road over a distance longer than 300 km. According to this measure, goods should be transported by rail transport.

GHG affected: CO_2

Type of measure: regulatory and economic

Status: in force since 2011

Implemented in scenario: WEM

4.6 SECTORAL POLICIES AND MEASURES: INDUSTRY

4.6.1 Nitric acid production - Act No. 414/2012 Coll. on Emission Trading in amendments

The act gives provisions for the implementation of a secondary catalyst at nitric acid production. Nitric acid production is the major source of N_2O emissions. Nitric acid is produced in two plants. In 2014, improved technology with a secondary catalyst was used in both plants. This led to a reduction of N_2O emissions.

GHG affected: N_2O

Type of measure: regulatory and economic

Status: in force since 2013

Implemented in scenario: WEM, WAM

4.6.2 Aluminium production - Act No. 414/2012 Coll. on Emission Trading in amendments

Its implementation enables the control of efficiency on aluminium production. The technology was changed from Söderberg to prebaked technology in 1996. It resulted in a significant decrease of CO_2 and PFC emissions. The improvements in production also resulted in a decrease of PFC emissions after 2009. Further improvement in a better performance controlling process of electrolysis cells was achieved in 2013. The CO_2 emissions from pitch volatiles combustion and from bake furnace packing material were

calculated in 2013 for the first time (according to the IPCC 2006 GL) and the resulting implied emission factor per aluminium produced was estimated.
GHG affected: PFCs
Type of measure: regulatory and economic
Status: in force since 2013
Implemented in scenario: WEM, WAM

4.6.3 Cement production - Act No. 414/2012 Coll. on Emission Trading in amendments

Its implementation may cause a partial change in raw materials used. The utilisation of non-carbon raw materials for cement production will start after 2020 (such as ground granulated blast-furnace slag). It is assumed 5% input into kiln load.
GHG affected: CO_2
Type of measure: regulatory and economic
Status: estimated after 2020
Implemented in scenario: WAM

4.6.4 Lime production - Act No. 414/2012 Coll. on Emission Trading in amendments

Its implementation may cause the reduction of dolomite lime production and its replacing with quicklime production. The reduction or closure of dolomite lime mines after 2020 can occur.
GHG affected: CO_2
Type of measure: regulatory and economic
Status: estimated after 2020
Implemented in scenario: WAM

4.6.5 HFC gases with lower GWP

The HFC emission increase will be less dynamic due to the significant increase of coolants with new HFC gases (with lower GWP) after 2020 and continual replacement of recycling HCFC coolants with “natural coolants”.
GHG affected: HFC
Type of measure: regulatory and economic
Status: in force since 2015
Implemented in scenario: WEM

4.6.6 New mandatory parameters of F-Gases

In addition to the parameters described in the WEM scenario for F-gases, foams containing HFCs will be forbidden; coolants with high GWP will also be restricted. Increased use of F-gases that are not covered by IPCC (such as hydrofluoroolefins) will start in a significant manner after 2025. The utilisation of F-gases with lower GWP in aerosols and fire extinguishers will be mandatory.
GHG affected: HFC

Type of measure: regulatory and economic
Status: in force since 2017
Implemented in scenario: WAM

4.6.7 Lower content of N_2O in aerosol cans

Decrease the content of N_2O in aerosol cans after 2020.
GHG affected: N_2O
Type of measure: regulatory and economic
Status: in force since 2010
Implemented in scenario: WEM

4.6.8 Additional decrease in the content of N_2O in aerosol cans

Additional decrease in the content of N_2O in aerosol cans after 2025.
GHG affected: N_2O
Type of measure: regulatory and economic
Status: in force since 2017
Implemented in scenario: WAM

4.6.9 BAT at servicing of electrical equipment

Stable SF_6 emission factors from electrical equipment due the use of "best available technology" BAT for the servicing of units.
GHG affected: SF_6
Type of measure: regulatory and economic
Status: in force since 2015
Implemented in scenario: WEM

4.6.10 Service of electric equipment only on BAT level technology

Service of electric equipment will be possible only on BAT level technology and only in "sealed for life" systems.
GHG affected: SF_6
Type of measure: regulatory and economic
Status: in force since 2017
Implemented in scenario: WAM

4.7 SECTORAL POLICIES AND MEASURES: AGRICULTURE

- Decree of the Ministry of Agriculture and Rural Development of the Slovak Republic No. 362/2010 Coll.

4.7.1 Common Agricultural Policy

The Common Agricultural Policy (CAP) is the agricultural policy of the European Union. It implements a system of agricultural subsidies and other programmes. It was introduced in 1962 and has undergone several changes since then to reduce the cost (from 71% of the EU budget in 1984 to 39% in 2013) and also to consider rural development in its aims.

GHG affected: CO_2, N_2O, CH_4
Type of measure: regulatory and economic
Status: in force since 2010
Implemented in scenario: WEM

4.7.2 Nitrates Directive

The Nitrates Directive (1991) aims to protect water quality across Europe by preventing nitrates from agricultural sources polluting ground and surface waters and by promoting the use of good farming practices. The Nitrates Directive forms an integral part of the Water Framework Directive and is one of the key instruments in the protection of waters against agricultural pressures.
GHG affected: CO_2, N_2O, CH_4
Type of measure: regulatory and economic
Status: in force since 2010
Implemented in scenario: WEM

4.7.3 The Rural Development Programme for the period of 2014 - 2020

The programme will increase the competitiveness of agriculture and forestry (by supporting investments on 1,250 farms and 400 food enterprises). It will ensure appropriate management of natural resources and encourage farming practices which are climate-friendly. Around 20% of farmland will be farmed in a manner that protects biodiversity, soil and/or water resources. The program of financial support scheme for select thematic priorities in rural development comprises 56 frame targets for specific policies and measures in this sector with positive environmental impacts. Contribution of supported PaMs to the sustainable development will serve as horizontal criteria for support.
GHG affected: CH_4, N_2O, CO_2
Type of measure: regulatory and economic
Status: in force since 2015
Implemented in scenario: WEM

4.7.4 Conception of the Agricultural Development of the Slovak Republic for the years 2013 - 2020

The concept of agricultural development plans an increase in animal numbers for the years 2013-2020. Pursuant to the Conception, the endeavour of the Slovak Republic is to ensure self-sufficiency for important agricultural commodities with the aim to achieve the level of 80% up to 2020. That leads to the support of livestock primary production in the Slovak Republic, which is also closely linked to the employment policy in the agricultural sector.
GHG affected: CH_4, N_2O
Type of measure: regulatory and economic
Status: in force since 2013
Implemented in scenario: WEM

4.7.5 Manure management - Ordinance of the Government of the Slovak Republic No. 342/2014 Coll. laying down the rules for the granting of agricultural aid in respect to the direct payments schemes

Measures in manure manipulation and processing in enteric fermentation. Measures to implement better technologies of manure manipulation and processing in enteric fermentation.

GHG affected: CH_4, N_2O

Type of measure: regulatory and economic

Status: in force since 2014

Implemented in scenario: WEM

4.7.6 New manure management - Ordinance of the Government of the Slovak Republic No. 342/2014 Coll. laying down the rules for the granting of agricultural aid in respect to the direct payments schemes

New measures in manure manipulation and processing and in addition new animal feeding policy implementation.

GHG affected: CH_4, N_2O

Type of measure: regulatory and economic

Status: in force since 2015

Implemented in scenario: WAM

4.7.7 Agricultural soils - Ordinance of the Government of the Slovak Republic No. 342/2014 Coll. laying down the rules for the granting of agricultural aid in respect to the direct payments schemes

Efficient use and appropriate timing of nitrogen inputs from mineral fertilizers.

GHG affected: N_2O

Type of measure: regulatory and economic

Status: in force since 2014

Implemented in scenario: WEM

4.7.8 Agricultural soils after the year 2015 - Ordinance of the Government of the Slovak Republic No. 342/2014 Coll. laying down the rules for the granting of agricultural aid in respect to the direct payments schemes

Efficient use and appropriate timing of nitrogen inputs from mineral fertilizers after the year 2015.

GHG affected: N_2O

Type of measure: regulatory and economic

Status: in force since 2016

Implemented in scenario: WAM

4.7.9 Reduced number of dairy cattle - Ordinance of the Government of the Slovak Republic No. 342/2014 Coll. laying down the rules for the granting of agricultural aid in respect to the direct payments schemes

Decreasing the number of dairy cattle.

GHG affected: CH_4

Type of measure: regulatory and economic
Status: in force since 2014
Implemented in scenario: WEM

4.7.10 New animal feeding policy implementation - Ordinance of the Government of the Slovak Republic No. 342/2014 Coll. laying down the rules for the granting of agricultural aid in respect to the direct payments schemes

Decreasing the number of dairy cattle, intensive feeding with active substances.
GHG affected: CH_4
Type of measure: regulatory and economic
Status: in force since 2016
Implemented in scenario: WAM

4.8 SECTORAL POLICIES AND MEASURES: WASTE

4.8.1 Act No. 79/2015 Coll. on Waste and amendments to certain acts as amended

This act introduces emphasis on the separation of packagings and recyclables. It also changes the financing scheme for separate collection from the State Recycling Fund to Organisation of Waste Producers. The impact of this change is not known. Disposal of waste is allowed only in permitted managed sites (Art. 13). This Act bans the disposal of garden waste and requires separate collection of kitchen waste but these regulations are not yet fully implemented (Art. 80).
GHG affected: CO_2, CH_4, and N_2O
Type of measure: regulatory and economic
Status: in force since 2015
Implemented in scenario: WEM

4.8.2 Waste Management Program of the Slovak Republic for 2011 - 2015

The Waste Management Plan for 2011 - 2015 includes several key targets referring to climate change mitigation: increase of waste recycling to 35% by 2015, reduction of biodegradable waste disposal in line with the Landfilling Directive (reduction to 50% by 2013, reduction to 45% by 2015 and reduction to 35% by 2020, compared with the 1995 level) requirement to introduce the separate collection of biodegradable waste and increase of land application of stabilized waste water sludge.
GHG affected: CO_2, CH_4, and N_2O
Type of measure: regulatory and economic
Status: in force since 2015
Implemented in scenario: WEM, WAM

4.8.3 Strategy on the Reduction of the Biodegradable Waste Deposition to Landfills 2010

The Strategy was prepared to enable implementation of the Landfilling Directive. Measures are aimed on increasing separation of recyclables, composting and preparation of RDF.

GHG affected: CH_4 and N_2O
Type of measure: regulatory
Status: in force since 2015
Implemented in scenario: WEM, WAM

4.8.4 Water Plan 2009 - 2015

The Water Plan for 2009 - 2015 identified the need for the reduction of organic pollution of surface water and calls for the reconstruction of 157 WWT plants, the development of 54 new WWT plants and the development of sewer systems in 277 municipalities.
GHG affected: CH_4 and N_2O
Type of measure: regulatory
Status: in force since 2009
Implemented in scenario: WEM, WAM

4.8.5 Regulation No. 372/2015 on dumping waste and temporary dumping of iron mercury

Energy efficiency improvement and reducing the energy consumption of the Industry sector.
GHG affected: N_2O, CH_4
Type of measure: regulatory and economic
Status: in force since 2015
Implemented in scenario: WEM, WAM

4.8.6 Act. No. 309/2009 Coll. On on support of renewable sources of energy and highly effective co-generation in amendments

The Regulatory Office for Network Industries defined the price for energy generated from landfill gas as €70/MWh and for energy generated from WWT biogas from €100 to €120/MWh (depending on capacity).
GHG affected: N_2O, CH_4
Type of measure: regulatory and economic
Status: in force since 2009
Implemented in scenario: WEM, WAM

4.8.7 Act No. 364/2004 on water management last amended by Act No. 303/2016

The measure regulating waste water management through the Maximum concentrations of waste water parameters allowed for discharge are defined in Governmental Regulation No. 269/2010.
GHG affected: N_2O, CH_4
Type of measure: regulatory and economic
Status: in force since 2004
Implemented in scenario: WEM, WAM

4.8.8 Plan for Development of Public Sewers for the period 2010 - 2015

The measure implements legislation on waste management. This plan was updated to cover the period up to 2021, but lacks information which would allow quantification of waste water sector development on emissions.
GHG affected: N_2O, CH_4
Type of measure: regulatory and economic
Status: in force since 2010
Implemented in scenario: WEM, WAM

4.9 SECTORAL POLICIES AND MEASURES: LAND USE, LAND USE AND CHANGE AND FORESTRY (LULUCF)

- The Rural Development Programme for the period of 2014 - 2020 (as referred to in section 4.7.4)
- Conception of the Agricultural Development of the Slovak Republic for the years 2013 -2020 (as referred to in section 4.7.5)

4.9.1 Forest Strategy/Forest Action Plan

The Forest Action Plan includes several key actions referring to climate change mitigation: the promotion of forest biomass for energy generation, EU compliance with UNFCCC and Kyoto obligations, and protection of EU forests.
GHG affected: CO_2
Type of measure: regulatory with direct impact on emissions
Status: in force from 2006
Implemented in scenario: WEM

4.9.2 Forest measures within the Rural Development Policy

Forestry is an integral part of rural development, support for sustainable and climate-friendly land use should encompass forest area development and the sustainable management of forests.
GHG affected: CO_2
Type of measure: regulatory, economic
Status: in force from 2015
Implemented in scenario: WEM

4.9.3 LULUCF accounting

Provides the basis for the formal inclusion of the LULUCF sector and ensures a harmonized legal framework allowing the collection of reliable data by robust accounting and reporting in a standardized way.
GHG affected: CO_2
Type of measure: economic

Status: in force from 2002
Implemented in scenario: WAM

4.10 POLICIES AND MEASURES NO LONGER IN PLACE

None of the PaMs with a significant effect on GHG emission reduction have been cancelled without replacement. Act No. 572/2004 Coll. on Emission Trading and its previous amendments has been fully replaced by Act No. 414/2012 Coll. on Emission Trading in amendments.
Ordinance of the Government of the Slovak Republic No. 488/2010 Coll. has been fully replaced by Ordinance of the Government of the Slovak Republic No. 342/2014 Coll. laying down the rules for the granting of agricultural aid in respect to the direct payments schemes.

4.11 INTERACTIONS OF POLICY AND MEASURES

Table 4.9 shows how select policies and measures can contribute to non-GHG emission mitigation.

Table 4.9: *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	Energy Efficiency Action Plan for the period 2014 - 2016 with the outlook for 2020	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 fuel demand	Decrease of NOx and PM
6	Act. No. 309/2009 Coll. on the promotion of renewable energy sources and high efficiency cogeneration	Decrease in fossil fuel consumption, support for biomass use in the fuel mix for heat supplies	Reduction of CO and SO_2 pollutants in the 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 pollutant 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 the reduction of basic air pollutant 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 the reduction of basic air pollutant 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 the Ministry of Environment No. 271/2011 Coll. - sustainability criteria	Principles for GHG emission savings during the life cycle for biofuel and bioliquid	Reduction of GHG emissions from motor fuel production as well as the decrease of NOx and PM in transport

No	Name of PAMs	Description of policy interaction	Non-GHG emission mitigation benefits of policies and measures
		production, saving of conventional motor fuels	sector.
12	Act No. 476/2008 Coll. on the efficient use of energy	Energy savings, decrease in fossil fuel consumption	Positive impact on the reduction of basic air pollutant emissions
13	Act No 182/2011 Coll. on labelling of energy-related products	Energy savings, decrease in fossil fuel consumption	Positive impact on the reduction of basic air pollutant emissions

Source: MŽP SR, SHMÚ

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. The cap and trade principle, rules for allocations and provisions as given in Directive 2003/87/EC and on the national level in Act No. 414/2012 Coll. on emission trading as amended have positive impacts on:

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

Similarly, other policies and measures with wide sectoral applications, for example, the National action plan for biomass use[54], National Renewable Energy Action Plan[55] or Energy Efficiency Action Plan for the period 2014 - 2016 with the outlook for 2020[56], have significant benefits and positive impacts on other environmental and energy goals.

[54] Adopted by Governmental Resolution No. 130/2008
[55] Governmental Resolution No. 677/2010 Coll.
[56] Governmental Resolution No. 350/2014 Coll.

5 PROJECTIONS AND TOTAL EFFECTS OF POLICIES AND MEASURES

Since the publication of the 6th National Communication of the Slovak Republic on Climate Change, some of the measures considered in this communication were implemented to a different extent and influenced the GHG emission level of the projection base year 2014. The basic development of the activities determining the level of projected emissions has resulted from the assumptions of macro-economic development and conceptions of relevant sectors of the national economy.

The complexity and dynamic changes of the economic development in recent years have also significantly complicated the preparation of projections of greenhouse gas emissions, particularly with respect to continual changes of estimated development of macro-economic indicators for the near future. The long-term development of greenhouse gas emissions also depends on other parameters, such as the opening of the energy market and CO_2 emission allowance trading. ETS represents one of the measures that were implemented before the projection base year and its impact is partly included in the scenario without measure. Nevertheless the additional impact of this measure is limited due to the technical and economic potential. In spite of existing restrictions resulting from the dynamic changes of governing parameters, the reality of achieving the reduction targets, as well as the potential for the further reduction of emissions after 2020, can be done through the results of modelling.

5.1 PROJECTIONS OF EMISSIONS

The year 2014 was determined as the reference year for modelling of greenhouse gas emissions for all the scenarios for which verified data sets were available from the national inventory of greenhouse gas emissions. Projections of GHG emissions were prepared for the years 2015 - 2040 within the following scenarios:

Without measures scenario (WOM) – projections exclude reductions achieved or expected from all measures adopted after 1 January 2015 and exclude all planned measures. The without measures scenario represents the reference scenario to define emission levels and represents a business as usual scenario type - BAU.

With measures scenario (WEM) – projections reflect all measures implemented or adopted before the date of preparation of the projections (31 December 2016).

With additional measures scenario (WAM) – projections include WEM policies and measures and all other measures still planned (not yet adopted by the date of preparation of the projections).

Table 5.1 represents main projection parameters for the projection in the base year 2014 and additional cross years.

***Table 5.1:** Main parameters applied in emission projections*

Item	Units	2014	2015	2020	2025	2030	2035	2040
Gross domestic product: Constant prices	EUR million	73,530	76,347	88,878	101,774	116,443	127,210	127,210
Population	1,000 People	5,419	5,424	5,503	5,543	5,558	5,550	5,550
EU ETS carbon price	EUR/EUA	4.5	4.5	15	22.5	33.5	42	42
International coal import prices	EUR/GJ	1.8	1.9	2.2	2.6	3.2	3.4	3.4
International oil import prices	EUR/GJ	9.5	9.8	11.6	13.2	14.5	15.1	15.1
International gas import prices	EUR/GJ	6.1	6.3	7.5	8.1	8.8	9.4	9.4

5.2 ASSESSMENT OF AGGREGATE EFFECTS OF POLICY AND MEASURES

This chapter presents the results of GHG emission modelling by individual sectors and gases together with the assessment of the impact of policies and measures for all scenarios. The total impact of policies and measures has been determined as the distinctions between scenarios after the definition of the impact of a particular measure.

5.2.1 Energy sector including transport

The energy sector produces GHG emissions from the combustion and transformation of fossil fuels. Fugitive methane emissions are generated from fuel extraction, transport and processing.

The modelling of emission projections was based on updated predictions of the sectoral value added (VA) growth, fuel prices and energy carriers' prices, sectoral energy demand as well as the predictions of population development in the Slovak Republic from the Slovak Demographic Research Centre and the Energy Efficiency Action Plan for the period 2014 - 2016 with the outlook for 2020.

The outputs from modelling were determined by reduction potential of measures to reduce greenhouse gas emissions. Updated figures from macroeconomic and demographic data forecasts were applied for the period of 2015 - 2040 and an increase in the VA growth rate and sectoral energy demand has been reflected in final energy demand for several industrial sectors (Table 5.2) according to the EU Reference Scenario 2016.

The MESSAGE model was used for stationary sources i.e. CRF categories 1.A.1, 1.A.2, 1.A.4 and 1.A.5 while the TREMOVE model was used for transportation category 1.A.3.

***Table 5.2:** Parameters applied for energy consumption projection in relevant economical branches*

Item	Units	2014	2015	2020	2025	2030	2035	2040
Final energy demand:-Total	TJ	364,705	382,904	397,295	389,636	384,929	378,169	368,164
Final energy demand:-Industry	TJ	134,830	138,781	142,804	139,060	134,950	127,889	118,995
Final energy demand:-Transport	TJ	90,765	90,828	96,788	99,370	104,337	108,324	109,846
Final energy demand:-Residential	TJ	81,723	83,219	84,436	85,050	85,278	85,161	85,045
Final energy demand:-Agriculture/Forestry	TJ	5,754	6,297	6,670	6,483	6,357	6,158	5,872
Final energy demand:-Services	TJ	51,633	63,779	66,598	59,671	54,008	50,637	48,406
Transport parameters								

Item	Units	2014	2015	2020	2025	2030	2035	2040
Number of passenger-kilometres	million pkm	37,631	37,979	45,075	51,338	57,597	62,133	62,133
Freight transport tonnes-kilometres	million tkm	22,713	22,938	26,055	28,985	32,067	34,289	34,289
Final energy demand for road transport	TJ	86,851	86,911	92,184	94,099	98,391	101,904	101,904

In the *WOM* scenario all implemented measures are included in the emission level for the scenario base year 2014. Emission levels in the following years are determined by the final energy growth rate only.

Parameters and PAMs used in the energy sector:
Modelling emission projections in the energy sector are based on the following input data and information:

- Updated forecasts of the VA growth, based on the annual growth rate used in Reference Scenario 2016 (PRIMES Model).
- Updated forecasts of final energy consumption of industrial branches, residential heat generation and other energy consumption in residential, and other non/industrial sectors from Reference Scenario 2016 (PRIMES Model).
- The impact of energy savings in family house buildings has been modelled by implementing the Energy Efficiency Action Plan for the period of 2014 - 2016 with the outlook for 2020 adopted in July 2014 (as referred to in section 4.5.2).
- The impact of energy savings in the public sector has been modelled by implementing the Energy Efficiency Action Plan for the period of 2014 - 2016 with the outlook for 2020 adopted in July 2014 (as referred to in section 4.5.3).
- The impact of energy savings in the residential sector, e.g. individual and apartment houses, has been modelled by implementing the Energy Efficiency Action Plan for the period of 2014 - 2016 with the outlook for 2020 adopted in July 2014 (as referred to in section 4.5.4).
- The impact of RES in heat and electricity generation has also been implemented in the WEM scenario, considering the National Renewable Energy Action Plan (Government Resolution of the SR No. 677/2010) (as referred to in section 4.5.1).
- The input data from this plan in the period of 2014 - 2020 has been implemented in the WEM scenario.
- The 4th Energy Efficiency Action Plan for the period of 2017 - 2019 with the outlook for 2020 has been used for the WAM scenario; (as referred to in section 4.5.6; 4.5.7; 4.5.8).
- The population growth forecast from the Demographic Research Center;
- The fuel mix and emission data from individual ETS sources as well as data from energy statistics were used as input data in the MESSAGE model.
- Fuel prices from the Regulatory Office have been used for the base year 2014 and the year 2015. The trend was modelled using EU recommended data. The CO_2 marker prices for ETS have been used from this source as well.

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 the period of 2010 - 2040 and the trend of gross value added, or final energy demand has been reflected in figures for several industrial sectors.

Parameters and PAMs used in the energy sector – Transport:

The existing measures in transport and the other sectoral information from the Ministry of Transport, Construction and Regional Development of the Slovak Republic were taken into consideration for WOM, WEM and WAM scenarios. Projections in transport were prepared by the TREMOVE model, which is based on data from the COPERT model, used for emission inventory in road transport. Data for transport projected parameters have been obtained from the Reference Scenario 2016.

Emission projections from transport were prepared with the following assumptions:

- Biofuels support: additional increase of biofuel share in fuel. The biofuel share in fuels should be in accordance with Act No. 309/2009 Coll. on the promotion of renewable energy sources and highly efficient cogeneration.

Table 5.3: *Expected biofuels share in fuels*

Item	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
BIODIESEL	5.2%	5.3%	5.4%	6.8%	6.8%	6.9%	6.9%	6.9%	6.9%	6.9%
BIOETANOL	3.1%	3.2%	3.3%	4.1%	4.5%	4.6%	4.7%	5.9%	6.2%	7.4%
Item	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**
BIODIESEL	6.9%	6.9%	6.9%	6.9%	6.9%	6.9%	6.9%	6.9%	6.9%	6.9%
BIOETANOL	7.4%	7.4%	7.4%	7.4%	7.4%	7.4%	7.4%	7.4%	7.4%	7.4%

- Effect of European legislative – Regulation No. 2009/443/EC and Regulation No. 2011/510/EC which set limits for CO_2 emissions from cars and vans (as referred to in section 4.5.18).
- Effect of EU White Paper on the transportation of goods over long distances from trucks to rail (as referred to in section 4.5.21).
- Support of rail transport use by passengers: free tickets for students and seniors and other discounts (as referred to in section 4.5.12).
- Civil aviation under the ETS scheme (as referred to in section 4.5.19).
- Hybrid transport in cities - Action Plan for Energy Efficiency 2011 - 2013, Government Resolution of the SR No. 301/2011 Coll. (as referred to in section 4.5.10).
- Modal shift to public transport - Action Plan For Energy Efficiency 2011 - 2013, Government Resolution of the SR No. 301/2011 Coll. (as referred to in section 4.5.11).
- Modal shift to public transport - Transport Policy of the Slovak Republic into 2015 (as referred to in section 4.5.12).

- Improved transport behaviour and road infrastructure - Transport Ppolicy of the Slovak Republic into 2015 (as referred to in section 4.5.13).
- Introduction of Euro 6 emission standards - Transport Policy of the Slovak Republic into 2015 (as referred to in section 4.5.14).
- Government Regulation No. 246/2006 Coll on the minimum quantity of fuels produced from renewable sources in the petrol and diesel fuels placed on the market in the Slovak Republic (as referred to in section 4.5.15).
- Decree N. 362/2010 Coll. determining the requirements for the quality of fuels and maintaining operational evidence on fuels (as referred to in section 4.5.16).
- Regulation N. 655/2007 Coll. on technical conditions to reduce emissions from air conditioning systems in motor vehicles (as referred to in section 4.5.17).
- Electromobility Development Strategy – sales support for electric vehicles (as referred to in section 4.5.20).

Parameters and PAMs used in the energy sector – fugitive emissions:
The fugitive emissions of CH_4 from transport and the distribution of natural gas and oil in the SR have been calculated from the following data:

A. Data of NG and oil have been obtained from the sources:
   - the Statistical Office of the SR (for the years 2014 and 2015);
   - the "Reference Scenario 2016" (for the years 2015 - 2035).

B. For the calculation of fugitive methane emissions, emission factors from the following sources were used:
   1. 2006 IPCC Guidelines for National GHG Inventories - Chapter 4: Fugitive Emissions.

Table 5.4: *Expected production, transmission and distribution of oil and NG in the SR in the years 2015 - 2035*

Activity	Units	2014	2015	2020	2025	2030	2035
Oil production	t	12,000	12,000	0	0	0	0
Oil processing	t	5,220,000	5,954,527	5,272,940	5,123,536	5,018,020	5,011,865
NG production	mil. m^3	100	93	93.078	92.754	91.735	87.372
Long-distance NG transmission	mil. m^3	46,500	55,800	68,454.601	67,601.291	66,659.537	69,201.164
NG distribution	mil. m^3	4,014	4,639	5,601.683	5,579.961	5,523.536	5,287.752

The fugitive methane emissions from underground coal mining and post-mining activities in the Slovak Republic have been calculated from the following data:

A. Data of coal production in the years 2014 and 2015 from single underground mines, have been obtained from official sources – the companies: HBP, a.s., Baňa Dolina, a.s. and Baňa Čáry, a.s.

B. Data of expected coal production for the years 2015 - 2035, have been obtained from sources of the Ministry of Economy of the SR – "The Energy Policy of the Slovak Republic 2014". Table 1 provides expected values of coal production in the years 2015 – 2035.

C. For the calculation of fugitive methane and CO_2 emissions, emission factors from "IEA – CIAB Global Methane and the Coal Industry" and specifications of mine operator HBP, a.s. were used.

Table 5.5: *Production of coal and expected mining activities up to 2035*

Mine	Unit	2014	2015	2020	2025	2030	2035
Cigeľ	kt	606	401	0	0	0	0
Handlová	kt	253	233	0	0	0	0
Nováky	kt	1,093	1,187	1,350	1,300	1,300	1,300
HBP, a. s. total	kt	1,952	1,820	1,350	1,300	1,300	1,300
BD, a. s.	kt	70	22	0	0	0	0
BČ, a. s.	kt	166	97	450	500	500	500
Slovak Republic total	kt	2,188	1,939	1,800	1,800	1,800	1,800

5.2.1.1 Projections of CO_2 emissions

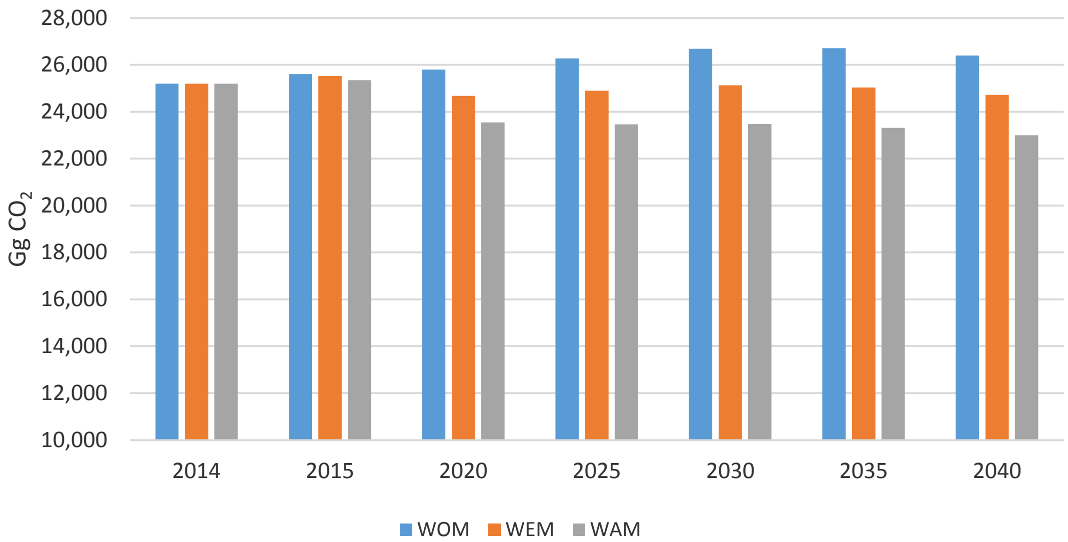
Table 5.6 shows the results of modelling projections of CO_2 emissions according to the particular scenarios. Anticipated dynamics of economic growth will lead to an increase in CO_2 emissions. The effect of the included measures caused a decrease of emissions in the WEM and WAM scenarios.

Table 5.6: *Projections of CO_2 emissions in sector energy (Gg)*

WOM	**2014**	**2015**	**2020**	**2025**	**2030**	**2035**	**2040**
1. Energy	**25,202.3**	**25,609.4**	**25,792.2**	**26,279.5**	**26,684.7**	**26,717.1**	**26,401.5**
1.A Fuel Combustion Activities	25,174.6	25,588.6	25,773.8	26,261.5	26,666.7	26,699.2	26,383.5
1.A.1 Energy Industries	7,072.7	7,272.6	6,627.6	6,615.1	6,501.2	6,341.9	6,125.8
1.A.2 Manufacturing Industries and Construction	7,235.4	7,196.9	7,362.7	7,352.7	7,381.9	7,363.7	7,342.7
1.A.3 Transport	6,415.7	6,665.3	7,205.6	7,863.1	8,479.3	8,780.2	8,772.0
1.A.4 Other Sectors	4,398.8	4,402.7	4,523.1	4,375.1	4,246.6	4,156.5	4,088.6
1.A.5 Other	52.0	51.1	54.7	55.4	57.8	56.9	54.5
1.B Fugitive Emissions from Fuels	27.7	20.8	18.4	18.0	18.0	17.9	17.9
WEM	**2014**	**2015**	**2020**	**2025**	**2030**	**2035**	**2040**
1. Energy	**25,202.3**	**25,529.9**	**24,674.0**	**24,903.2**	**25,126.3**	**25,031.6**	**24,720.3**
1.A Fuel Combustion Activities	25,174.6	25,509.1	24,655.7	24,885.2	25,108.3	25,013.7	24,702.4
1.A.1 Energy Industries	7,072.7	7,218.0	6,128.1	6,040.3	5,864.5	5,638.4	5,414.6
1.A.2 Manufacturing Industries and Construction	7,235.4	7,196.9	7,183.7	7,173.6	7,202.6	7,184.2	7,175.1
1.A.3 Transport	6,415.7	6,665.3	6,917.5	7,392.2	7,888.3	8,129.2	8,120.9
1.A.4 Other Sectors	4,398.8	4,377.8	4,371.7	4,223.7	4,095.2	4,005.1	3,937.2
1.A.5 Other	52.0	51.1	54.7	55.4	57.8	56.9	54.5
1.B Fugitive Emissions from Fuels	27.7	20.8	18.4	18.0	18.0	17.9	17.9
WAM	**2014**	**2015**	**2020**	**2025**	**2030**	**2035**	**2040**
1. Energy	**25,202.3**	**25,352.7**	**23,542.1**	**23,461.1**	**23,473.6**	**23,308.2**	**23,006.2**
1.A Fuel Combustion Activities	25,174.6	25,331.9	23,523.8	23,443.1	23,455.6	23,290.2	22,988.2
1.A.1 Energy Industries	7,072.7	7,137.8	5,568.5	5,489.9	5,371.3	5,208.3	4,993.8
1.A.2 Manufacturing Industries and Construction	7,235.4	7,169.4	7,097.9	7,087.8	7,116.8	7,098.4	7,089.3
1.A.3 Transport	6,415.7	6,665.3	6,754.0	6,909.3	7,137.6	7,244.6	7,236.4
1.A.4 Other Sectors	4,398.8	4,308.4	4,048.7	3,900.7	3,772.2	3,682.1	3,614.2

1.A.5 Other	52.0	51.1	54.7	55.4	57.8	56.9	54.5
1.B Fugitive Emissions from Fuels	27.7	20.8	18.4	18.0	18.0	17.9	17.9

Figure 5.1: *Projections of CO_2 emissions according to defined scenarios in the energy sector*



5.2.1.2 Projections of CH_4 emissions

The energy-related CH_4 emissions arise from the combustion and transformation of fossil fuel. Fugitive methane emissions arise from the extraction, transport and processing of fuels. The projections of CH_4 emissions from the combustion and transformation of fossil fuels have been modelled by means of the fuel consumption in individual scenarios according to the IPCC method and recommended IPCC aggregated emission factors. In the case of CH_4 emissions in transport, emission factors from the COPERT IV model were applied for individual types of vehicles. Modelling made use of the same scenarios as in the case of CO_2 emissions from the combustion and transformation of fuels (chapter 5.2.1.1). This approach allows for finding out the effect of measures aimed at the reduction of CO_2 emissions to the level of CH_4 emissions. Annual fugitive emissions of CH_4 have been calculated for the following activities (Table 5.7):

- underground mining and post-mining activities;
- transport and processing of oil and oil products.
- extraction and transport of natural gas;
- venting and flaring.

Table 5.7: *Projections of CH_4 emissions in the energy sector (Gg)*

WOM	2014	2015	2020	2025	2030	2035	2040
1. Energy	**67.8**	**72.8**	**83.7**	**82.7**	**81.7**	**80.6**	**80.5**
1.A Fuel Combustion Activities	**9.6**	**9.6**	**9.7**	**9.6**	**9.6**	**9.5**	**9.5**
1.B Fugitive Emissions from Fuels	**58.2**	**63.2**	**74.0**	**73.0**	**72.2**	**71.1**	**71.1**
1.B.1 Solid fuels	15.3	12.8	11.5	11.6	11.5	11.4	11.4
1.B.2 Oil and natural gas	42.8	50.4	62.5	61.5	60.7	59.7	59.7

WEM	2014	2015	2020	2025	2030	2035	2040
1. Energy	**67.8**	**72.7**	**83.4**	**82.3**	**81.3**	**80.1**	**80.0**
1.A Fuel Combustion Activities	**9.6**	**9.6**	**9.4**	**9.2**	**9.1**	**9.0**	**9.0**
1.B Fugitive Emissions from Fuels	**58.2**	**63.2**	**74.0**	**73.0**	**72.2**	**71.1**	**71.1**
1.B.1 Solid fuels	15.3	12.8	11.5	11.6	11.5	11.4	11.4
1.B.2 Oil and natural gas	42.8	50.4	62.5	61.5	60.7	59.7	59.7
WAM	**2014**	**2015**	**2020**	**2025**	**2030**	**2035**	**2040**
1. Energy	**67.8**	**72.6**	**82.8**	**81.7**	**80.7**	**79.5**	**79.5**
1.A Fuel Combustion Activities	**9.6**	**9.5**	**8.8**	**8.7**	**8.5**	**8.4**	**8.4**
1.B Fugitive Emissions from Fuels	**58.2**	**63.2**	**74.0**	**73.0**	**72.2**	**71.1**	**71.1**
1.B.1 Solid fuels	15.3	12.8	11.5	11.6	11.5	11.4	11.4
1.B.2 Oil and natural gas	42.8	50.4	62.5	61.5	60.7	59.7	59.7

5.2.1.3 Projections of N_2O emissions

The energy-related N_2O emissions arise from the combustion and transformation of fossil fuel. The production of N_2O emissions from transport has also been calculated within this sector. Similarly to methane, the projections of N_2O emissions are calculated by means of the IPCC method, which makes use of recommended emission factors. In transport the emission factors for individual types of vehicles from the COPERT IV model are used. Scenarios for the calculation of emissions from the combustion and transformation of fuels are the same as the scenarios for CO_2 and CH_4 emissions and it allows for analysing the effect of measures focused on the reduction of CO_2 emissions and the production of N_2O.

Table 5.8: *Projections of N_2O emissions in the energy sector (Gg)*

WOM	2014	2015	2020	2025	2030	2035	2040
1. Energy	**0.641**	**0.666**	**0.701**	**0.727**	**0.751**	**0.757**	**0.754**
1.A Fuel Combustion Activities	0.641	0.666	0.701	0.727	0.751	0.757	0.754
1.A.1 Energy Industries	0.148	0.156	0.142	0.144	0.141	0.139	0.137
1.A.2 Manufacturing Industries and Construction	0.124	0.124	0.126	0.124	0.123	0.119	0.122
1.A.3 Transport	0.207	0.223	0.264	0.292	0.322	0.336	0.336
1.A.4 Other Sectors	0.162	0.163	0.169	0.166	0.164	0.162	0.158
1.A.5 Other	0.001	0.001	0.001	0.001	0.001	0.001	0.001
WEM	**2014**	**2015**	**2020**	**2025**	**2030**	**2035**	**2040**
1. Energy	**0.641**	**0.662**	**0.673**	**0.696**	**0.718**	**0.722**	**0.720**
1.A Fuel Combustion Activities	0.641	0.662	0.673	0.696	0.718	0.722	0.720
1.A.1 Energy Industries	0.148	0.152	0.118	0.119	0.117	0.113	0.111
1.A.2 Manufacturing Industries and Construction	0.124	0.124	0.125	0.124	0.123	0.119	0.122
1.A.3 Transport	0.207	0.223	0.261	0.287	0.315	0.329	0.329
1.A.4 Other Sectors	0.162	0.163	0.167	0.165	0.163	0.160	0.157
1.A.5 Other	0.001	0.001	0.001	0.001	0.001	0.001	0.001
WAM	**2014**	**2015**	**2020**	**2025**	**2030**	**2035**	**2040**
1. Energy	**0.641**	**0.656**	**0.633**	**0.655**	**0.675**	**0.668**	**0.666**
1.A Fuel Combustion Activities	0.641	0.656	0.633	0.655	0.675	0.668	0.666
1.A.1 Energy Industries	0.148	0.147	0.085	0.085	0.082	0.080	0.078
1.A.2 Manufacturing Industries and Construction	0.124	0.124	0.125	0.123	0.122	0.118	0.121
1.A.3 Transport	0.207	0.223	0.261	0.286	0.313	0.314	0.314
1.A.4 Other Sectors	0.162	0.162	0.162	0.160	0.158	0.155	0.152
1.A.5 Other	0.001	0.001	0.001	0.001	0.001	0.001	0.001

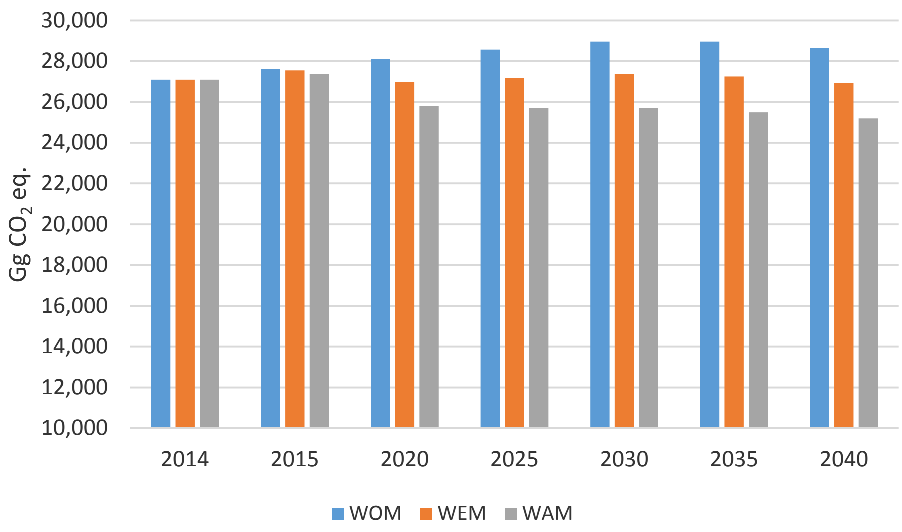
5.2.1.4 Projections of aggregated GHG emissions

Table 5.9 shows aggregate projections of GHG emissions in the energy sector. Figure 5.2 shows the comparison of projected emissions in the energy sector in CO_2 eq. by 2020 for all scenarios as well as their index of emission level toward the UNFCCC base year (1990).

Table 5.9: *Aggregated projections of GHG emissions in the energy sector (Gg CO_2 eq.)*

WOM	**2014**	**2015**	**2020**	**2025**	**2030**	**2035**	**2040**
1. Energy	27,088	27,627	28,093	28,563	28,952	28,957	28,640
1.AFuel Combustion Activities	**25,605**	**26,027**	**26,225**	**26,719**	**27,129**	**27,162**	**26,845**
1.A.1 Energy Industries	7,135	7,338	6,689	6,677	6,562	6,402	6,185
1.A.2 Manufacturing Industries and Construction	7,290	7,251	7,418	7,407	7,436	7,417	7,397
1.A.3 Transport	6,493	6,748	7,299	7,963	8,587	8,892	8,883
1.A.4 Other Sectors	4,634	4,639	4,764	4,615	4,486	4,394	4,324
1.A.5 Other	53	52	55	56	59	58	55
1.B Fugitive Emissions from Fuels	**1,482**	**1,600**	**1,868**	**1,844**	**1,822**	**1,795**	**1,795**
WEM	**2014**	**2015**	**2020**	**2025**	**2030**	**2035**	**2040**
1. Energy	27,088	27,546	26,959	27,168	27,372	27,248	26,936
1.A Fuel Combustion Activities	**25,605**	**25,946**	**25,092**	**25,324**	**25,550**	**25,454**	**25,141**
1.A.1 Energy Industries	7,135	7,281	6,178	6,091	5,914	5,687	5,462
1.A.2 Manufacturing Industries and Construction	7,290	7,251	7,238	7,228	7,257	7,237	7,229
1.A.3 Transport	6,493	6,748	7,009	7,487	7,988	8,232	8,223
1.A.4 Other Sectors	4,634	4,613	4,611	4,462	4,332	4,241	4,171
1.A.5 Other	53	52	55	56	59	58	55
1.B Fugitive Emissions from Fuels	**1,482**	**1,600**	**1,868**	**1,844**	**1,822**	**1,795**	**1,795**
WAM	**2014**	**2015**	**2020**	**2025**	**2030**	**2035**	**2040**
1. Energy	27,088	27,364	25,801	25,699	25,693	25,494	25,191
1.A Fuel Combustion Activities	**25,605**	**25,764**	**23,934**	**23,855**	**23,870**	**23,700**	**23,396**
1.A.1 Energy Industries	7,135	7,199	5,603	5,525	5,405	5,241	5,026
1.A.2 Manufacturing Industries and Construction	7,290	7,224	7,152	7,142	7,170	7,151	7,143
1.A.3 Transport	6,493	6,748	6,845	7,003	7,237	7,343	7,334
1.A.4 Other Sectors	4,634	4,542	4,277	4,129	3,999	3,907	3,838
1.A.5 Other	53	52	55	56	59	58	55
1.B Fugitive Emissions from Fuels	**1,482**	**1,600**	**1,868**	**1,844**	**1,822**	**1,795**	**1,795**

Figure 5.2: *Projections of aggregated GHG emissions*



5.2.2 Sector industrial processes and product use

The industrial processes and products use sector is not in general as sensitive to different PaMs implementation as the energy sector due to the principle of emission production following stoichiometry. One of the most important measures in this sector is using BAT technologies. Therefore the basis for both scenarios is the value added growth following the reference scenario with only limitation being maximal technological capacity of production. The following measures were included in all scenarios.

- In the ***WOM*** scenario all implemented measures are included in emission levels in the scenario base year 2014. Emission levels in the following years are determined by the value added growth rate only.

*Parameters and other key information for trend development in industry for the **WEM** scenario:*

- Improved technology was installed in 2 ammonia plants in 2014 and outcomes were used in the scenario.
- Modernization of the production unit of ethylene with lower emissions by -16% will be put in operation in 2016.
- Stable N_2O emission factors from nitric acid production due to the precise control of the technological process (as referred to in section 4.6.1).
- Stable PFCs emissions from aluminium production due to the precise control of the technological process (as referred to in section 4.6.2).
- The increase of HFC emissions will be less dynamic due to the significant increase of coolants with new HFC gases (with lower GWP) after 2020 and continual replacement of recycling HCFC coolants with “natural coolants” (as referred to in section 4.6.5).
- Stable SF_6 emission factors from electrical equipment due to the use of BAT when servicing units (as referred to in section 4.6.9).

- Lower content of N_2O in aerosol cans after 2020 (as referred to in section 4.6.7).

*Parameters and other key information for trend development in industry for the **WAM** scenario:*

- Improved technology was installed in 2 ammonia plants in 2014 and outcomes were used in the scenario.
- The utilisation of non-carbonates raw materials for cement production will start after 2020 (such as ground granulated blast-furnace slag) with an assumed 5% input into kiln load (as referred to in section 4.6.3).
- The reduction or closure of dolomite lime mining operations after 2020 can occur (as referred to in section 4.6.4).
- In addition to the parameters described in the WEM scenario for F-gases, foams containing HFCs will be forbidden; coolants with high GWP will also be restricted. Increased use of F-gases that are not covered by IPCC (such as HFO) will start in a significant manner after 2025. The utilisation of F-gases with lower GWP in aerosols and fire extinguishers will be mandatory (as referred to in section 4.6.6).
- Service of electric equipment will be possible only on BAT level technology and only in "sealed for life" systems (as referred to in section 4.6.10).

5.2.2.1 Projections of CO_2 emissions

The drivers in the mineral, chemical, metallurgy and other industries were value added growth. This driver estimates non-energy CO_2 projections. Emission generation is influenced only by stoichiometry. Production of CO_2 emissions in scenarios depends directly on the production of construction materials and the use of mineral raw materials. Projections of emissions reflect the influence of applied measures with a gradual increase in production by 2040. Measures connected with fuel consumption and the increasing share of renewable energy sources were already included in projections of the energy sector (category 1.A.2). Table 5.10 shows CO_2 emission projections of the industrial processes and product use sector.

Table 5.10: *Projections of CO_2 emissions in the industrial processes and product use sector (Gg)*

WOM	2014	2015	2020	2025	2030	2035	2040
2. Industrial Processes	**8,134.3**	**8,119.8**	**8,344.5**	**8,550.8**	**8,911.3**	**9,355.7**	**9,738.0**
2.A Mineral Products	2,277.1	2,268.8	2,199.6	2,329.5	2,701.5	3,305.2	4,056.3
2.B Chemical Industry	1,219.1	1,232.1	1,299.2	1,401.4	1,517.8	1,588.7	1,662.8
2.C Metal Production	4,540.4	4,523.2	4,754.9	4,721.0	4,583.6	4,347.7	3,904.8
2.D Non-energy products	97.8	95.8	90.9	98.8	108.4	114.1	114.1
WEM	**2014**	**2015**	**2020**	**2025**	**2030**	**2035**	**2040**
2. Industrial Processes	**8,134.3**	**8,112.9**	**8,054.4**	**8,285.8**	**8,673.2**	**9,117.3**	**9,499.2**
2.A Mineral Products	2,277.1	2,268.8	2,199.6	2,329.5	2,701.5	3,305.2	4,056.3
2.B Chemical Industry	1,219.1	1,232.1	1,230.2	1,367.6	1,511.1	1,581.8	1,655.6
2.C Metal Production	4,540.4	4,516.3	4,533.8	4,489.8	4,352.2	4,116.2	3,673.2
2.D Non-energy products	97.8	95.8	90.9	98.8	108.4	114.1	114.1

WAM	2014	2015	2020	2025	2030	2035	2040
2. Industrial Processes	**8,134.3**	**8,112.9**	**7,965.4**	**8,117.4**	**8,495.8**	**8,936.2**	**9,317.5**
2.A Mineral Products	2,277.1	2,268.8	2,158.9	2,213.5	2,578.4	3,179.8	3,930.9
2.B Chemical Industry	1,219.1	1,232.1	1,219.6	1,355.9	1,498.2	1,568.4	1,641.6
2.C Metal Production	4,540.4	4,516.3	4,496.0	4,449.1	4,310.8	4,073.9	3,630.9
2.D Non-energy products	97.8	95.8	90.9	98.8	108.4	114.1	114.1

5.2.2.2 Projections of CH_4 emissions

The production of ammonia and ferroalloys is the main sources of methane emissions in the industrial processes sector in the Slovak Republic. The projections are shown in Table 5.11. Methane emissions are directly connected with the consumption of natural gas (and thus with the production of ammonia) and with the production of ferrosilicium alloys. Thus only one scenario was assumed, based on value added growth.

Table 5.11: *Projections of CH_4 emissions from ammonia and ferroalloys production (Gg)*

WEM	2014	2015	2020	2025	2030	2035	2040
2. Industrial Processes	**0.0622**	**0.0706**	**0.0673**	**0.0723**	**0.0770**	**0.0805**	**0.0805**
2.B Chemical Industry	0.0119	0.0222	0.0209	0.0226	0.0245	0.0256	0.0256
2.C Metal Production	0.0504	0.0484	0.0463	0.0497	0.0526	0.0549	0.0549

5.2.2.3 Projections of N_2O emissions

Nitric acid production is the major source of N_2O emissions. Nitric acid is produced in two plants. In 2014, improved technology with a secondary catalyst was used in both plants. This led to a reduction of N_2O emissions. The inclusion of this activity into the EU ETS was an impulse to further steps leading to a reduction of emissions. The other source of N_2O emissions (use of natural gas for the production of ammonia) is negligible. Modelling results are presented in Table 5.12.

Table 5.12: *Projections of N_2O emissions from ammonia and nitric acid production (Gg)*

WEM	2014	2015	2020	2025	2030	2035	2040
2. Industrial Processes	**0.756**	**0.672**	**0.649**	**0.674**	**0.703**	**0.718**	**0.709**
2.B Chemical Industry	0.487	0.471	0.426	0.460	0.498	0.521	0.521
2.G Other product manufacture and use	0.269	0.201	0.223	0.214	0.205	0.196	0.187

5.2.2.4 Projections of PFCs, HFCs and SF_6 emissions

PFC emissions

During aluminium production, the perfluorocarbons CF_4 a C_2F_6 emissions are produced. These emissions are produced by the technological perturbation of the so called “anode effect”. This effect is connected with the quality of technological process. This quality is very high in the Slovak Republic, therefore these emissions are on a low level. The inclusion of this activity into the EU ETS was an impulse to further steps leading to reducing emissions. The projected emissions of PFC from aluminium production are presented in Table 5.13.

Table 5.13: *Projections of PFCs emissions in the industrial processes and product use sector (Gg CO_2 eq.)*

WOM	2014	2015	2020	2025	2030	2035	2040
2.C.3 Aluminium Production	11.1	8.5	10.7	11.4	12.1	12.6	12.6
WEM	**2014**	**2015**	**2020**	**2025**	**2030**	**2035**	**2040**
2.C.3 Aluminium Production	11.1	8.5	8.1	8.7	9.2	9.6	9.6

HFC and SF_6 emissions

Fluorinated gases (F-gases) are among three basic groups of greenhouse gases defined in Annex A to the Kyoto Protocol (HFCs PFCs and SF_6). These substances have replaced the ozone depleting Freon and are monitored under the Montreal Protocol. Projections of F-gas emissions are complicated due to the relatively high number of various mixtures of gases. Some mixtures can contain 12 different gases in different proportions. The last implementation policies and measures in the F-gas agenda were taken into consideration in the WEM scenario for the sector of industrial processes. The application of new natural cooling agents (such as ammonia or CO_2) influenced emission projection trends. No trend can be predicted in fire extinguisher emissions. The F gas emissions with high GWP have a significant impact on emission level. The measures for reduction in this sector are based on the selection of appropriate equipment, filling media and services. This also allows for a supply of several gases or excluding it from use. Projected emissions of HFCs and SF_6 are summarized in Tables 5.14 and 5.15, respectively.

Table 5.14: *Projections of HFCs emissions in the industrial processes and product use sector (Gg CO_2 eq.)*

WOM	2014	2015	2020	2025	2030	2035	2040
2.F Product use as a substitutes for ODS	653.8	734.9	662.5	533.6	500.4	500.4	500.4
WEM	**2014**	**2015**	**2020**	**2025**	**2030**	**2035**	**2040**
2.F Product use as a substitutes for ODS	653.8	734.9	637.7	430.9	322.5	250.2	250.2
WAM	**2014**	**2015**	**2020**	**2025**	**2030**	**2035**	**2040**
2.F Product use as a substitutes for ODS	653.8	734.9	637.7	406.1	264.4	153.5	58.7

Table 5.15: *Projections of SF_6 emissions in the industrial processes and product use sector (Gg CO_2 eq.)*

WOM	2014	2015	2020	2025	2030	2035	2040
2.G Other product manufacture and use	14.2	14.3	25.6	26.4	27.1	27.8	28.6
WEM	**2014**	**2015**	**2020**	**2025**	**2030**	**2035**	**2040**
2.G Other product manufacture and use	14.2	14.3	16.8	17.2	17.6	18.1	18.5
WAM	**2014**	**2015**	**2020**	**2025**	**2030**	**2035**	**2040**
2.G Other product manufacture and use	14.2	14.3	16.8	16.3	12.3	8.3	4.3

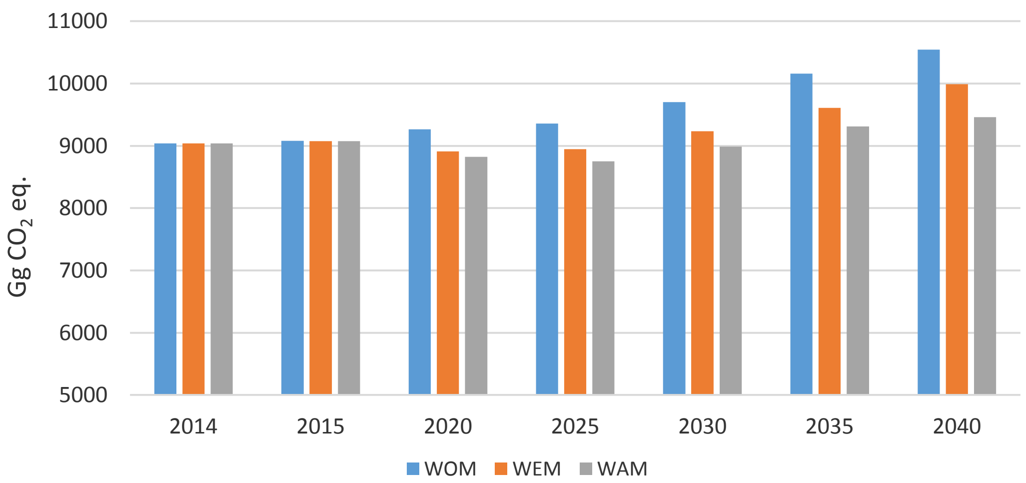
5.2.2.5 Projections of aggregated GHG emissions

Table 5.16 and Figure 5.3 show aggregated data on the projections of technological GHG emissions in the industrial processes sector including F-gasses.

Table 5.16: *Projections of aggregated GHG emissions in industrial processes and product use including F-gasses (Gg CO_2 eq.)*

WOM	**2014**	**2015**	**2020**	**2025**	**2030**	**2035**	**2040**
2. Industrial Processes and Product Use	**9,040**	**9,080**	**9,262**	**9,355**	**9,700**	**10,157**	**10,542**
2.A Mineral Products	2,277	2,269	2,200	2,330	2,702	3,305	4,056
2.B Chemical Industry	1,365	1,373	1,449	1,563	1,693	1,772	1,846
2.C Metal Production	4,553	4,533	4,767	4,734	4,597	4,362	3,919
2.D Non-energy products	98	96	91	99	108	114	114
2.F Product uses as substitutes for ODS	654	735	663	534	500	500	500
2.G Other product manufacture and use	94	74	93	96	100	103	106
WEM	**2014**	**2015**	**2020**	**2025**	**2030**	**2035**	**2040**
2. Industrial Processes and Product Use	**9,040**	**9,073**	**8,912**	**8,945**	**9,234**	**9,611**	**9,991**
2.A Mineral Products	2,277	2,269	2,200	2,330	2,702	3,305	4,056
2.B Chemical Industry	1,365	1,373	1,358	1,505	1,660	1,738	1,812
2.C Metal Production	4,553	4,526	4,543	4,500	4,363	4,127	3,684
2.D Non-energy products	98	96	91	99	108	114	114
2.F Product uses as substitutes for ODS	654	735	638	431	322	250	250
2.G Other product manufacture and use	94	74	83	81	79	77	74
WAM	**2014**	**2015**	**2020**	**2025**	**2030**	**2035**	**2040**
2. Industrial Processes and Product Use	**9,040**	**9,073**	**8,823**	**8,751**	**8,988**	**9,313**	**9,460**
2.A Mineral Products	2,277	2,269	2,159	2,213	2,578	3,180	3,931
2.B Chemical Industry	1,365	1,373	1,347	1,493	1,647	1,724	1,669
2.C Metal Production	4,553	4,526	4,505	4,459	4,321	4,085	3,642
2.D Non-energy products	98	96	91	99	108	114	114
2.F Product uses as substitutes for ODS	654	735	638	406	264	154	59
2.G Other product manufacture and use	94	74	83	80	68	57	45

Figure 5.3: *Projections of aggregated GHG emissions according to defined scenarios in industrial processes and product use including F-gasses (Gg CO_2 eq.)*



5.2.3 Agriculture sector

The mitigation potential in agriculture is mostly connected with manure management (storage, application on soil) and animal feeding policy. Since 2011, there have been no policy papers approved on climate change in the field of plant production or animal management. The Rural Development Programme for 2014 - 2020 was prepared where these issues were incorporated into the measures (for example, organic farming). The older policy, Act No. 220/2004 Coll. on the Protection and Use of Agricultural Land as amended, partly address the issue of poorer quality land use for the establishment of plantations of fast growing trees. It is land of a lower quality and the biomass production from it will increase renewable energy use, thereby reducing the need for fossil fuels. Current legislation and recommended good agricultural practice with measures taken are mainly manifested in the storage of waste from animal production and the integration of waste into agricultural land. Although detailed mapping of storage space is lacking, it can be assumed that in 2015in the Slovak Republic, all liquid waste was stored in a covered area for more than 120 days. This also allows the use of effective measures in the field of the incorporation of waste into agricultural land. This assumption will be fulfilled for the new construction of storage space. This measure has the greatest impact on pig breeding. Part of the liquid waste is then absorbed by straw and is stored in solid form. After 2015, therefore, a further scope for the reduction of emissions from manure storage is not expected. Effective control of nitrogen paths in the cycle of agricultural production changes the loss of nitrogen emissions into valuable fertilizer. The storage of waste is possible only in intensive farms for grazing animals (sheep, goats, horses, some categories of cattle) and has only limited application for housing. The most relevant climate change mitigation activities in the agriculture sector are part of the EU Common Agricultural Policy, Agricultural Market and Income Support (1st pillar of the EU Common Agricultural Policy) and in the Rural Development Policy (2nd pillar of the EU Common Agricultural Policy).

Previous emission projections up to the year 2030 assumed additional significant decreases in the number of animals, which is not in compliance with the Conception of Agricultural Development of the Slovak Republic.

An increase in animal numbers was planned in the recent internal document Conception of Agricultural Development of the Slovak Republic for the years 2013 - 2020 prepared by the Ministry of Agriculture and Rural Development of the Slovak Republic (Table 5.17). Pursuant to the Conception, the endeavour of the Slovak Republic is to ensure self-sufficiency for important agricultural commodities with the aim to achieve the level of 80% up to 2020. That leads to the support of primary livestock production in the Slovak Republic, which is also closely linked to the employment policy in the agricultural sector.

Input data on the number of livestock used for the projections of GHG emissions in the agriculture sector are shown in Table 5.17.

Table 5.17: *Projections of livestock numbers in the Slovak Republic by 2020 (thousands of animals)*

Animal	2014*	2015*	2016	2017	2018	2019	2020	2025	2030
	Animal numbers (in thousands)								
	Conception of Agricultural Development of the Slovak Republic for the years 2013-2020								
cattle	465.5	457.6	470.3	471.9	473.0	473.8	474.4	437.6	427.2
pigs	641.8	633.1	677.4	724.9	775.6	829.9	888.0	963.3	949.5
poultry	12,494.1	12,836.2	13,415.2	13,817.6	14,093.9	14,729.5	14,994.5	13,235.1	13,235.1

* Real data

Parameters and other key information for trend development in the agriculture sector:
The ***WOM*** (BAU) scenario is identical with the scenario with measures. The scenario with additional measures includes the strict implementation of CAP recommendations, mostly in manure management and agricultural soils as was implemented in Ordinance of the Government of the Slovak Republic No. 342/2014 Coll. laying down the rules for the granting of agricultural aid in respect to the direct payments schemes.

- Scenario with existing measures (***WEM***):
  - The scenario includes new measures in manure manipulation and processing in the enteric fermentation and manure management categories (as referred to in section 4.7.3).
  - Efficient use and appropriate timing of nitrogen input from mineral fertilizers (as referred to in section 4.7.5).
  - Decreasing the number of dairy cattle (as referred to in section 4.7.7).
  - Increasing self-sufficiency of important agricultural commodities with the aim to achieve a level of 80% up to 2020 (as referred to in section 4.7.2).
- Scenario with additional measures (***WAM***):
  - The scenario includes new measures in manure manipulation and processing and in addition new implementation of the animal feeding policy in the enteric fermentation and manure management categories (as referred to in section 4.7.4).
  - More efficient use and appropriate timing of nitrogen inputs from mineral fertilizers (as referred to in section 4.7.6).
  - Decreasing the number of dairy cattle, intensive feeding with active substances (as referred to in section 4.7.8).

5.2.3.1 Projections of CH_4 emissions

Table 5.18 shows projections of methane emissions from enteric fermentation and manure management.

Table 5.18: *Projections of CH_4 emissions in sector agriculture (Gg)*

WEM	2014	2015	2020	2025	2030	2035	2040
3. Agriculture	**46.93**	**45.98**	**41.30**	**39.06**	**34.80**	**34.80**	**34.80**
3.A Enteric fermentation	40.40	39.56	35.41	33.63	30.01	30.01	30.01
3.B Manure management	6.53	6.42	5.89	5.44	4.79	4.79	4.79

WAM	2014	2015	2020	2025	2030	2035	2040
3. Agriculture	**46.93**	**45.98**	**35.55**	**33.37**	**29.82**	**29.97**	**29.97**
3.A Enteric fermentation	40.40	39.56	29.66	27.93	25.03	25.18	25.18
3.B Manure management	6.53	6.42	5.89	5.44	4.79	4.79	4.79

5.2.3.2 Projections of N_2O emissions

Scenarios for modelling projections of N_2O emissions are defined in the same way as the projections for methane emissions and according to the description of measures above (in chapter 5.2.3).

Table 5.19 shows all three scenarios prepared for the projections of N_2O emissions in the agriculture sector.

Table 5.19: *Projections of N_2O emissions in agriculture (Gg)*

WEM	2014	2015	2020	2025	2030	2035	2040
3. Agriculture	**6.06**	**6.03**	**6.28**	**5.73**	**5.80**	**5.79**	**5.81**
3.B Manure management	0.58	0.57	0.64	0.62	0.61	0.61	0.62
3.D Agricultural soils	5.47	5.46	5.64	5.11	5.20	5.19	5.20
WAM	**2014**	**2015**	**2020**	**2025**	**2030**	**2035**	**2040**
3. Agriculture	**6.06**	**5.89**	**6.06**	**5.55**	**5.65**	**5.64**	**5.66**
3.B Manure management	0.58	0.53	0.57	0.56	0.56	0.55	0.56
3.D Agricultural soils	5.47	5.36	5.49	4.99	5.09	5.08	5.09

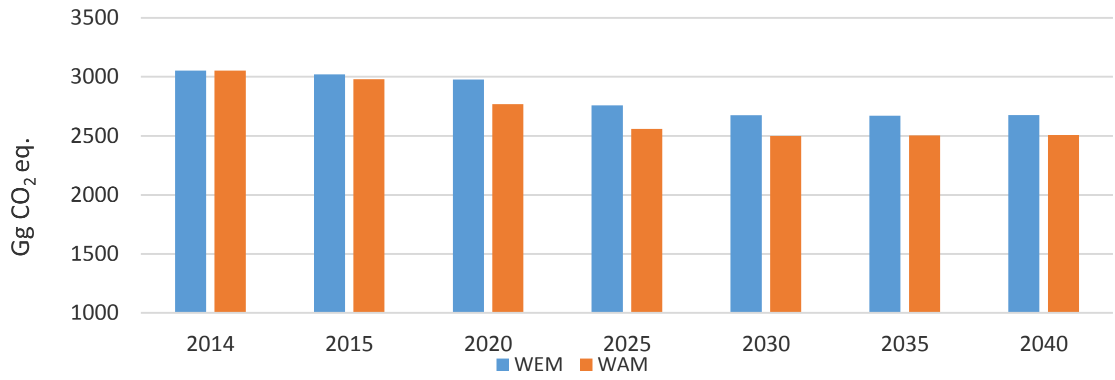
5.2.3.3 Projections of aggregated emissions

Table 5.20 and Figure 5.4 show aggregated data on the projections of GHG emissions in the agriculture sector.

Table 5.20: *Projections of aggregated emissions in agriculture (Gg CO_2 eq.)*

WEM	2014	2015	2020	2025	2030	2035	2040
3. Agriculture	**3,051**	**3,020**	**2,977**	**2,758**	**2,673**	**2,670**	**2,676**
3.A Enteric fermentation	1,010	989	885	841	750	750	750
3.B Manure management	336	331	338	320	301	300	303
3.D Agricultural soils	1,632	1,626	1,680	1,524	1,548	1,546	1,549
3.G Liming	16	16	16	16	16	16	16
3.H Urea application	58	58	58	58	58	58	58
WAM	**2014**	**2015**	**2020**	**2025**	**2030**	**2035**	**2040**
3. Agriculture	**3,051**	**2,979**	**2,768**	**2,561**	**2,502**	**2,502**	**2,509**
3.A Enteric fermentation	1,010	989	741	698	626	629	629
3.B Manure management	336	318	318	302	285	285	288
3.D Agricultural soils	1,632	1,598	1,635	1,487	1,517	1,514	1,518
3.G Liming	16	16	16	16	16	16	16
3.H Urea application	58	58	58	58	58	58	58

Figure 5.4: *Projections of aggregated GHG emissions according to defined scenarios in the agriculture sector (Gg CO_2 eq.)*



5.2.4 Sector land use, land use change and forestry (LULUCF)

The emission and removal projections in the LULUCF sector were based on the sectoral strategy included in the Rural Development Programmes of the Slovak Republic for 2007 - 2013 and 2014 - 2020, taking into account the adopted National Forest Program (NFP) of the SR as well as the Action Plans of the NFP for 2009 - 2013 and 2015 - 2020. Emission and sink projections consider all scenarios (without measures, with existing measures and with additional measures) and projection parameters (area of managed forest). The base year for the projection was the year 2015.

Parameters and other key information for trend development in the Land Use, Land Use Change and Forestry (LULUCF) sector:

Projections of GHG emissions/removals in sector LULUCF were prepared based upon the following measures:

- afforestation of non-forested areas;
- grassing of arable soil;
- increasing protection against forest fires.

Scenario without measures (*WOM*) – corresponds to the status of forest management and land use without the measures realised till 2015 as well as measures planned for the following decades. The development of forests is estimated according to effective forest management plans without an introduction of any specific measure.

Scenario with existing measures (*WEM*) – represents the effect of considered measures realized by the year 2015. In 2004 - 2006, only minimal specific mitigating measures were implemented in forest management and land use. In this period the afforestation of agricultural land was supported by the Rural Development Programme (RDP) and the Sector Operational Programme Agriculture and Rural Development (as referred to in section 4.7.1). The conversion of agricultural land to forest land (afforestation) was approved within these programmes for 15 projects covering 100 ha in total. In the period 2007 - 2015, afforestation of non-forested areas and grassing of arable soil continued according to the RDPs for 2007 - 2013 and 2014 - 2020. The following mitigation measures were considered in the scenario:

- Afforestation of 800 ha of low productive soil by fast growing tree species and the first afforestation of 600 ha of agricultural land by 2015.
- Grassing of 50,000 ha of arable land by 2015.
- The effect of Regulation No. 2152/2003/EC Forest Focus in relation to forest fires estimates the reduction of risk of forest fires to 90% compared to the period of 2000-2003.

Scenario with additional measures (*WAM*) – corresponds to the measures foreseen after the year 2015. The RDP (2014 - 2020) was adopted as a continuation of the previous document, with no newly introduced specific measures. Afforestation of 23,000 ha of agricultural land by 2020 - 2030 was taken into account in the WAM scenario (as referred to in section 4.6.3). The methodical procedure used for calculations was based on mathematical relations as defined in the the IPCC 2006 GL, the basic instrument for the balance of greenhouse gas emissions and sinks. The values of the emission factors and conversion/expansion factors used for the projections are identical to the values applied in the emission inventories for the LULUCF sector in 2017.

5.2.4.1 Projections of CO_2 sinks

Table 5.21 shows the results of modelling CO_2 sinks in the land use land use change and forestry sector. The scenarios without measures and with existing measures mostly do not differ as no significant measures applied so far are being considered and the evolution of emissions and removals by sinks of CO_2 has almost the same course as the LULUCF sector reports in the period 1990 - 2014, when the whole period shows a sink of CO_2 in the range of 4,600 - 9,000 Gg of CO_2. The increase of CO_2 removal in 2020 compared to 2015 is due to the decrease in the harvest volume. Projections of CO_2 removals in the period 2020 - 2035 show a decreasing trend. The main driver is the decrease of biomass increments in managed forest due to the lower relative share of forest age classes with the highest increments of wood biomass. The scenario with additional measures reflects the development of emissions with the afforestation of 23,000 ha of grassland by 2030 and grassing of 50,000 ha of cropland by 2015. Based on such an assumption, the scenario shows a rise of CO_2 removals in forests and in cropland and a slight decrease in meadows and pastures and likewise an increase in emissions from settlements and other land categories.

Table 5.21: *Projections of CO_2 sinks in LULUCF (Gg)*

WOM	2014	2015	2020	2025	2030	2035	2040
4. Land Use, Land-Use Change and Forestry	**-6,166**	-5,248	-5,297	-4,825	-4,563	-4,714	-4,714
4.A Forest land	-4,633	-3,876	-3,881	-3,443	-3,173	-3,327	-3,327
4.B Cropland	-803	-736	-768	-722	-722	-722	-722
4.C Grassland	-185	-192	-215	-215	-215	-215	-215
4.E Settlements	81	88	110	110	110	110	110
4.F Other Land	104	188	132	132	132	132	132
4.G Harvested wood products	-731	**-721**	**-675**	**-687**	**-695**	**-693**	**-693**

WEM	2014	2015	2020	2025	2030	2035	2040
4. Land Use, Land-Use Change and Forestry	**-6,166**	**-5,274**	**-5,310**	**-4,837**	**-4,575**	**-4,727**	**-4,727**
4.A Forest land	-4,633	-3,902	-3,894	-3,456	-3,185	-3,339	-3,339
4.B Cropland	-803	-736	-768	-722	-722	-722	-722
4.C Grassland	-185	-192	-215	-215	-215	-215	-215
4.E Settlements	81	88	110	110	110	110	110
4.F Other Land	104	188	132	132	132	132	132
4.G Harvested wood products	-731	-721	-675	-687	-695	-693	-693
WAM	**2014**	**2015**	**2020**	**2025**	**2030**	**2035**	**2040**
4. Land Use, Land-Use Change and Forestry	**-6,166**	**-5,274**	**-5,321**	**-4,848**	**-4,586**	**-4,738**	**-4,738**
4.A Forest land	-4,633	-3,902	-3,905	-3,467	-3,196	-3,350	-3,350
4.B Cropland	-803	-736	-768	-722	-722	-722	-722
4.C Grassland	-185	-192	-215	-215	-215	-215	-215
4.E Settlements	81	88	110	110	110	110	110
4.F Other Land	104	188	132	132	132	132	132
4.G Harvested wood products	-731	-721	-675	-687	-695	-693	-693

5.2.4.2 Projections of CH_4 emissions from forest fires

The projections of CH_4 emissions from forest fires are shown in Table 5.22.

Table 5.22: *Projections of CH_4 emissions in LULUCF from forest fires (Gg)*

WEM	2014	2015	2020	2025	2030	2035	2040
4. Land Use, Land-Use Change and Forestry	**0.69**	**0.69**	**0.69**	**0.69**	**0.69**	**0.69**	**0.69**
4.A Forest land	0.69	0.69	0.69	0.69	0.69	0.69	0.69

5.2.4.3 Projections of N_2O emissions from forest fires

The projections of N_2O emissions from forest fires are shown in Table 5.23.

Table 5.23: *Projections of N_2O emissions in LULUCF from forest fires (Gg)*

WEM	2014	2015	2020	2025	2030	2035	2040
4. Land Use, Land-Use Change and Forestry	**0.092**	**0.092**	**0.092**	**0.092**	**0.092**	**0.092**	**0.092**
4.A Forest land	0.038	0.038	0.038	0.038	0.038	0.038	0.038
4.B Cropland	0.028	0.028	0.028	0.028	0.028	0.028	0.028
4.C Grassland	0.002	0.002	0.002	0.002	0.002	0.002	0.002
4.E Settlements	0.013	0.013	0.013	0.013	0.013	0.013	0.013
4.F Other Land	0.012	0.012	0.012	0.012	0.012	0.012	0.012

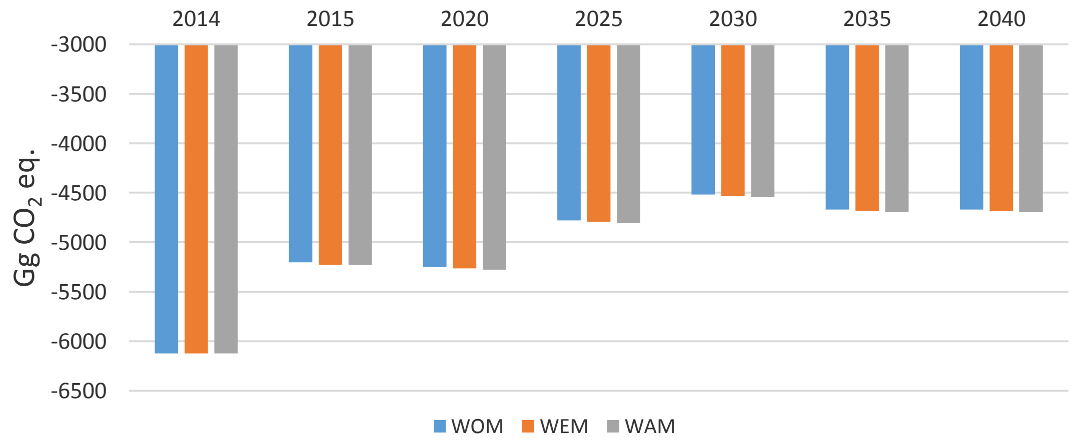
5.2.4.4 Projections of aggregated emissions and sinks

Table 5.24 and Figure 5.5 show aggregated projections of GHG emissions and sinks in the LULUCF sector.

Table 5.24: *Projection of aggregated emissions and sinks in LULUCF (Gg CO_2 eq.)*

WOM	2014	2015	2020	2025	2030	2035	2040
4. Land Use, Land-Use Change and Forestry	**-6,122**	**-5,204**	**-5,253**	**-4,780**	**-4,518**	**-4,670**	**-4,670**
4.A Forest land	-4,605	-3,848	-3,853	-3,415	-3,144	-3,298	-3,298
4.B Cropland	-795	-728	-760	-713	-713	-713	-713
4.C Grassland	-184	-191	-215	-215	-215	-215	-215
4.E Settlements	84	92	114	114	114	114	114
4.F Other Land	108	192	136	136	136	136	136
4.G Harvested wood products	-731	-721	-675	-687	-695	-693	-693
WEM	**2014**	**2015**	**2020**	**2025**	**2030**	**2035**	**2040**
4. Land Use, Land-Use Change and Forestry	**-6,122**	**-5,230**	**-5,265**	**-4,793**	**-4,530**	**-4,682**	**-4,682**
4.A Forest land	-4,605	-3,873	-3,865	-3,428	-3,157	-3,311	-3,311
4.B Cropland	-795	-728	-760	-713	-713	-713	-713
4.C Grassland	-184	-191	-215	-215	-215	-215	-215
4.E Settlements	84	92	114	114	114	114	114
4.F.Other Land	108	192	136	136	136	136	136
4.G Harvested wood products	-731	-721	-675	-687	-695	-693	-693
WAM	**2014**	**2015**	**2020**	**2025**	**2030**	**2035**	**2040**
4. Land Use, Land-Use Change and Forestry	**-6,122**	**-5,230**	**-5,276**	**-4,804**	**-4,542**	**-4,693**	**-4,693**
4.A Forest land	-4,605	-3,873	-3,876	-3,439	-3,168	-3,322	-3,322
4.B Cropland	-795	-728	-760	-713	-713	-713	-713
4.C Grassland	-184	-191	-215	-215	-215	-215	-215
4.E Settlements	84	92	114	114	114	114	114
4.F Other Land	108	192	136	136	136	136	136
4.G Harvested wood products	-731	-721	-675	-687	-695	-693	-693

Figure 5.5: *Projections of aggregated GHG emissions and sinks according to defined scenarios in LULUCF (Gg CO_2 eq.)*



5.2.5 Waste management sector

Policies and strategies in the waste sector influencing the prediction of emissions in the Slovak Republic are prepared and implemented by the Ministry of Environment, the Ministry of Economy and the Regulatory Office for Network Industries.

Solid waste

The Ministry of Environment is regulating waste management through the Act on Waste Management in the latest wording in No. 79/2015 as amended, which is introducing emphasis on the separation of packagings and recyclables. It is also changing the financing scheme for separate collection from the State Recycling Fund to the Organisation of Waste Producers. The impact of this change is not known. Disposal of waste is only possible on authorized landfill sites (§ 97). The Act on waste management prohibits not only the disposal of biodegradable garden waste, but also the disposal of sorted biodegradable kitchen and restaurant waste (§ 13), and the Act establishes the obligation for municipalities to ensure the implementation of sorted collection for biodegradable kitchen waste from households, foot oils and fats and so-called biodegradable green waste (§ 81). The Act on Waste, as well as Decree of the Ministry of Environment of the Slovak Republic no. 371/2015 Coll., which implements certain provisions of the Act on Waste, come into force from 1 January 2016, the collection standards for biodegradable municipal waste set out in this Decree, whose efficiency was shifted to 1 January 2017, is currently in force.

The Waste Management Plan of the Slovak Republic defines the approach to waste management in the period of 2016 - 2020. It sets the following targets for separate collection (or diversion from disposal):

Fraction (tons)	Target 2020	Real 2015	Base 2013
Glass	90,000	53,518	48,890
Plastics	110,000	34,658	29,010
Paper	120,000	65,158	64,022
Kitchen waste		4,755	2,838
Garden waste		133,582	98,168
Biodegradable waste (see Note)	717,185	212,263	169,523

Note: The target for biodegradable waste (paper + kitchen + garden + other biodegradable fractions) was estimated as the difference between the modelled amount of generated biodegradable waste (1,047,585 t) and the amount which can be disposed in accordance with the targets of the Landfilling Directive (35%, which equals 330,400 t).

Landfill gas must be collected and burned if a landfill generates it in amounts sufficient for burning and the site operator is required to monitor its occurrence, amounts and composition. (Regulation of the Ministry of Environment No. 372/2015, Art. 5).

There is no specific strategy supporting the utilization of landfill gas by the Ministry of Environment in the Slovak Republic.

The Ministry of Economy regulates the use of landfill gas and biogas from waste water treatment through the Act on the Support of Renewable Sources of Energy and Highly Effective Co-generation No. 309/2009 last amended by Act No. 173/2015 and by the Act on Energy No. 656/2004 Coll. last amended by Act No. 251/2012.

The Regulatory Office for Network Industries defined the price for energy generated from landfill gas as €70/MWh and for energy generated from WWT biogas from €100 to €120/MWh (depending on capacity).

All these efforts to increase the share of renewable sources of energy were halted by energy distributing companies, which do not accept the connection of new renewable sources of energy bigger than 10 kW from December 2013, arguing that these sources endanger the safety and reliability of the distribution network. The Regulatory Office for Network Industries published information stating that the share of energy produced by renewable sources dropped in 2015 to 17%, compared to 21% in 2014. It is not clear how the situation will develop in the future.

The Ministry of Environment started supporting the clean-up of illegal dump sites in 2015. For the first round, 10 million Euros was provided by the Environmental Fund in 2015 and 9 million Euros was allocated to 211 municipalities. The Ministry of Environment continued this activity in 2016, providing 7 million Euros to 165 municipalities.

Waste water treatment

The Ministry of Environment regulates waste water management through the Act on Water Management No. 364/2004 last amended by Act No. 303/2016. The maximum concentrations of waste water parameters allowed for discharge are defined in Governmental Regulation No. 269/2010.

The strategy which implements this legislation is formulated in the Plan for the Development of Public Sewers for the period of 2010 - 2015. This plan was updated to cover the period up to 2021, but lacks information which would allow the quantification of waste water sector developments on emissions.

Approach to projections

The waste sector is represented by a scenario with existing measures only. The input data for the scenario with existing measures are only partially available, measures supporting renewable sources are in contradiction with steps taken by distribution companies and targets defined in the Waste Management Plan do not seem to be achievable. There are no additional measures in the waste sector used in the Slovak Republic.

WEM scenario

The projections of waste sector emissions are based on the emissions from municipal solid waste and from municipal waste water. These emissions represent 65% of total emissions of the waste sector expressed in CO_2 eq. The remaining 35% of emissions are considered to remain constant over the projecting period.

MSW disposal projections

Emissions from disposal of MSW depend on population, waste generation per capita and share of landfilled waste. Information on the future development of the population of the Slovak Republic was obtained from the Ageing Report 2015 (AR2015) and from the INFOSTAT Demographic Research Centre (DRC). AR2015 expects a decrease of population of the Slovak Republic by 4% in 2035 and the DRC expects an increase by 2%.

Because waste generation per capita shows strong correlation with the index of real wage, the prediction of the Institute of Financial Policy on the development of real wage until 2020 was used. The IFP expects that in the long term (2020), the real wage index will grow 2.9% annually. The share of MSW disposal in the Slovak Republic in high, reaching 65% - 70%.

The observed long-term trend in the share of MSW disposal shows a decrease by 10% in a decade. It is assumed that this trend will also continue in the future and the share of disposal will decrease to 50% in 2035.

Waste water projections

Emissions from municipal waste water depend on population, protein consumption and distribution of waste water according to the type of treatment. Projections of waste water emissions are based on the same demographic projections as for MSW disposal.

Although the data indicate a downward trend of protein consumption, the FAO expects that it will increase by 20% by 2035. This expectation was included as a target value for 2035 for the nitrogen balance.

The key question in the distribution of waste water according to the type of treatment is the share of septic tanks, as they are the main source of waste water emissions. First, the share of population using centralised WWT plants and household WWT plants was estimated and the remaining population is expected to use septic tanks. Due to the mountainous character of the Slovak Republic, it is expected that the share of the population connected to centralised WWT plants will increase from 65% to 70% and for household WWT plants from 2% to 5%. This development will result in a decrease of the share of septic tanks from 30% to 22%. It is also assumed that the share of waste water treated in advanced WWT plants will increase from 60% to 70%. This will lead to an increase of direct emissions from waste water treatment.

Sources with constant emissions

Waste sector sources for which it is assumed that their emissions will remain constant include industrial waste disposal, biological treatment, incineration and industrial waste water. There is a lack of information on their development in the next 20 years. The probability of increase or decrease of these emissions cannot be quantified.

There are no plans for the development of new waste incineration plants, it is therefore expected that the existing ones will continue operation without change. Generation of industrial waste may increase if industrial production goes up, but it may decrease if modern low-waste technologies are introduced.

Results

The WEM scenario indicates that total emissions from the waste sector will decrease by 4.4% if demography develops according to the AR2015, or decrease 1.5% if demography follows the DRC predictions. The main driver for this decrease would be the reduction of septic tank use.

MSW disposal, as the main source of emissions in the waste sector, will remain without change. The increase in MSW generation will be compensated by the increase of MSW separation. Also, the utilization of landfill gas has an important effect on emissions from MSW disposal.

5.2.5.1 Projections of CO_2 emissions

CO_2 emissions are only generated from the waste incineration category. Results of modelling are shown in Table 5.25. The scenario with measures is identical with the WAM scenario.

Table 5.25: *Projections of CO_2 emissions from waste incinerations (Gg)*

WEM	2014	2015	2020	2025	2030	2035	2040
5. Waste	**6.85**	**6.41**	**6.41**	**6.41**	**6.41**	**6.41**	**6.41**
5.C Incineration and open burning of waste	6.85	6.41	6.41	6.41	6.41	6.41	6.41

5.2.5.2 Projections of CH_4 emissions

CH_4 emissions are generated from the landfilling of solid waste and waste water treatment. The scenario with measures is identical with the scenario with additional measures.

Table 5.26: *Projections of CH_4 emissions in waste (Gg)*

WEM	2014	2015	2020	2025	2030	2035	2040
5. Waste	**54.4**	**53.4**	**54.3**	**54.8**	**53.1**	**50.9**	**50.9**
5.A Solid Waste Disposal	38.5	38.3	39.7	40.9	40.0	38.6	38.6
5.B Biological treatment of solid waste	3.5	2.8	2.8	2.8	2.8	2.8	2.8
5.C Incineration and open burning of waste	0.03	0.03	0.03	0.03	0.03	0.03	0.03
5.D Wastewater treatment and discharge	12.4	12.2	11.7	11.0	10.3	9.5	9.5

5.2.5.3 Projections of N_2O emissions

N_2O emissions are generated from waste water treatment, waste incineration and other waste and waste composting. The scenario with measures is identical with the scenario with additional measures.

Table 5.27: *Projections of N_2O emissions in waste (Gg)*

WEM	2014	2015	2020	2025	2030	2035	2040
5. Waste	**0.42**	**0.40**	**0.42**	**0.43**	**0.44**	**0.45**	**0.45**
5.B Biological treatment of solid waste	0.21	0.21	0.21	0.21	0.21	0.21	0.21
5.C Incineration and open burning of waste	0.02	0.02	0.02	0.02	0.02	0.02	0.02
5.D Wastewater treatment and discharge	0.19	0.17	0.19	0.20	0.21	0.22	0.22

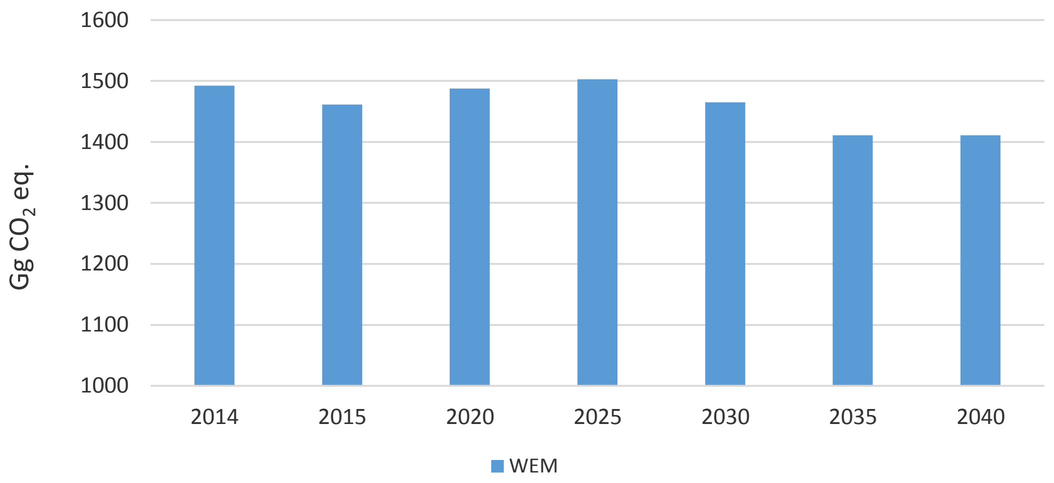
5.2.5.4 Projections of aggregated GHG emissions

Table 5.28 and Figure 5.6 show aggregated data on projections of GHG emissions in the waste management sector.

Table 5.28: *Projection of aggregated GHG emissions in waste management (Gg CO_2 eq.)*

WEM	2014	2015	2020	2025	2030	2035	2040
5. Waste	**1,492.58**	**1,461.26**	**1,487.72**	**1,502.98**	**1,465.09**	**1,411.17**	**1,411.17**
5.A. Solid Waste Disposal	962.20	958.32	992.42	1,021.80	1,000.01	963.81	963.81
5.B. Biological treatment of solid waste	149.73	132.80	132.80	132.80	132.80	132.80	132.80
5.C. Incineration and open burning of waste	13.20	12.86	12.86	12.86	12.86	12.86	12.86
5.D. Wastewater treatment and discharge	367.45	357.29	349.64	335.52	319.42	301.70	301.70

Figure 5.6: *Projections of aggregated GHG emissions according to defined scenarios in waste management (Gg CO_2 eq.)*



5.2.6 Projections of aggregated GHG emissions in monitored sectors

GHG emissions from international transport are not included in the national balance. GHG emission projections from international aviation and international navigation have been developed for the scenario with measures. From the data in Table 5.29, it is obvious that projected GHG emissions from these categories are negligible in comparison with other sources.

Table 5.29: *Aggregated data on the projections of GHG emissions from international transport for scenario with existing measures (Gg CO_2 eq.)*

WEM	2014	2015	2020	2025	2030	2035	2040
M.International bunkers	**133.84**	**134.38**	**137.11**	**138.15**	**139.66**	**139.66**	**139.66**
M.IB.Aviation	119.43	119.97	122.71	123.74	125.26	125.26	125.26
M.IB.Navigation	14.40	14.40	14.40	14.40	14.40	14.40	14.40

The projections of GHG emissions recalculated to equivalents of CO_2 according to valid values of GWP have been developed for all IPCC sectors, defined years and relevant scenarios. Table 5.30 shows the results of modelling data in summary.

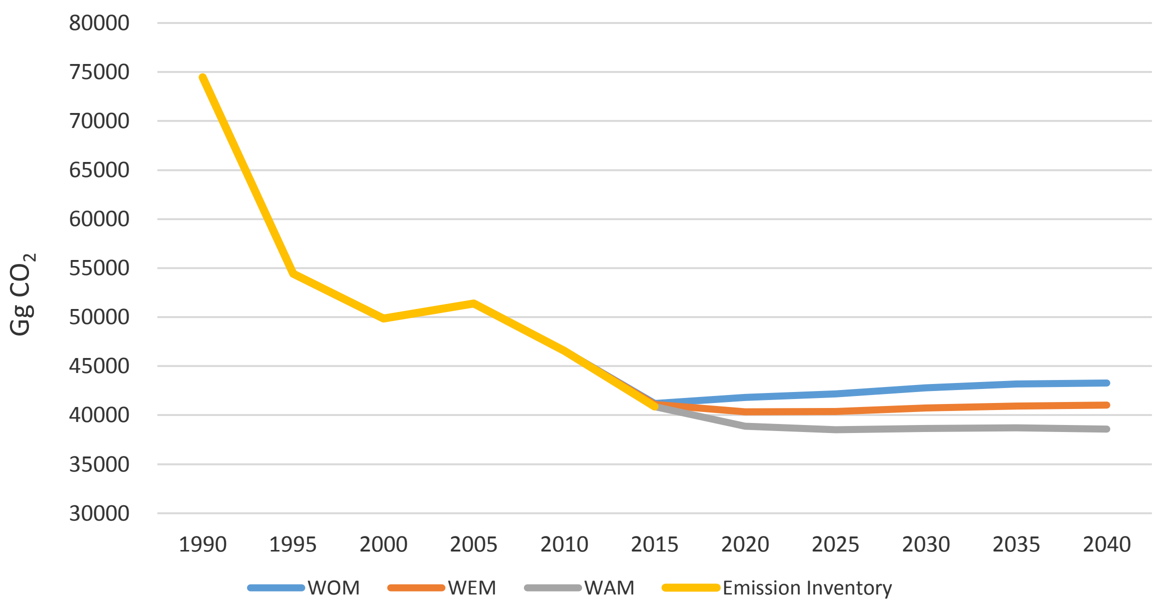
Table 5.30: *Projection of aggregated GHG emissions in monitored sectors (Gg CO_2 eq.)*

WOM	1990	1995	2000	2005	2010	2015	2020	2025	2030	2035	2040
Total excluding LULUCF	**74,460**	**54,412**	**49,863**	**51,396**	**46,560**	**41,188**	**41,819**	**42,179**	**42,790**	**43,194**	**43,269**
Total including LULUCF	**65,469**	**45,127**	**40,144**	**45,791**	**40,547**	**35,984**	**36,567**	**37,399**	**38,272**	**38,524**	**38,600**
1. Energy	56,668	39,568	36,540	36,759	32,741	27,627	28,093	28,563	28,952	28,957	28,640
2. Industrial processes	9,813	9,383	8,594	10,258	9,610	9,080	9,262	9,355	9,700	10,157	10,542
3. Agriculture	6,587	4,122	3,379	3,022	2,813	3,020	2,977	2,758	2,673	2,670	2,676
4. LULUCF	-8,991	-9,284	-9,719	-5,605	-6,013	-5,204	-5,253	-4,780	-4,518	-4,670	-4,670
5. Waste	1,393	1,339	1,351	1,357	1,395	1,461	1,488	1,503	1,465	1,411	1,411

WEM	1990	1995	2000	2005	2010	2015	2020	2025	2030	2035	2040
Total excluding LULUCF	**74,460**	**54,412**	**49,863**	**51,396**	**46,560**	**41,099**	**40,336**	**40,374**	**40,744**	**40,940**	**41,014**
Total including LULUCF	**65,469**	**45,127**	**40,144**	**45,791**	**40,547**	**35,870**	**35,070**	**35,582**	**36,214**	**36,258**	**36,332**
1. Energy	56,668	39,568	36,540	36,759	32,741	27,546	26,959	27,168	27,372	27,248	26,936
2. Industrial processes	9,813	9,383	8,594	10,258	9,610	9,073	8,912	8,945	9,234	9,611	9,991
3. Agriculture	6,587	4,122	3,379	3,022	2,813	3,020	2,977	2,758	2,673	2,670	2,676
4. LULUCF	-8,991	-9,284	-9,719	-5,605	-6,013	-5,230	-5,265	-4,793	-4,530	-4,682	-4,682
5. Waste	1,393	1,339	1,351	1,357	1,395	1,461	1,488	1,503	1,465	1,411	1,411
WAM	**1990**	**1995**	**2000**	**2005**	**2010**	**2015**	**2020**	**2025**	**2030**	**2035**	**2040**
Total excluding LULUCF	**74,460**	**54,412**	**49,863**	**51,396**	**46,560**	**40,877**	**38,880**	**38,514**	**38,647**	**38,721**	**38,570**
Total including LULUCF	**65,469**	**45,127**	**40,144**	**45,791**	**40,547**	**35,647**	**33,603**	**33,710**	**34,106**	**34,028**	**33,877**
1. Energy	56,668	39,568	36,540	36,759	32,741	27,364	25,801	25,699	25,693	25,494	25,191
2. Industrial processes	9,813	9,383	8,594	10,258	9,610	9,073	8,823	8,751	8,988	9,313	9,460
3. Agriculture	6,587	4,122	3,379	3,022	2,813	2,979	2,768	2,561	2,502	2,502	2,509
4. LULUCF	-8,991	-9,284	-9,719	-5,605	-6,013	-5,230	-5,276	-4,804	-4,542	-4,693	-4,693
5. Waste	1,393	1,339	1,351	1,357	1,395	1,461	1,488	1,503	1,465	1,411	1,411

Aggregated data on projections of GHG emissions according to the three modelled scenarios in the period of 1990 - 2040 are summarised in Figure 5.7. Their trends show that the reduction target under the Kyoto Protocol can also be achieved by the scenario without measures during the first binding period with the prospective until 2030.

Figure 5.7: *Projections of aggregated GHG emissions according to defined scenarios in the monitored sectors*



5.3 SUPPLEMENTARY RELATING TO MECHANISMS UNDER ARTICLES 6, 12 AND 17 OF THE KYOTO PROTOCOL

This part is included and processed in chapter 4.

5.4 METHODOLOGY USED FOR THE PRESENTED GHG EMISSION PROJECTIONS

Various procedures and software modules for particular sectors were used in the projections of GHG emissions:

- Energy (except of transport) and industry –MESSAGE model [57]
- Transport –TREMOVE and COPERT IV models and expert estimation
- Solvents – expert approach
- Agriculture – expert approach
- LULUCF – expert approach
- Waste – expert approach

5.3.1 Energy (except transport) and industry – model MESSAGE

Message is an optimization model with linear programming. The program seeks an optimal solution for a selected period. The model is flexible and allows seeking a minimum optimal function for whatever parameters (not only energy systems). The mathematical description is complex. The optimization function seeks minimum costs to meet demands for the final consumption supply from primary and imported energy sources. The model also allows inserting certain constraints that simulate regulation of the system based upon the source limits, price regulation, and emission impact. The electricity network creates an integrated part and curves of load could be adjusted for individual periods. It also supports modelling of combined electricity and heat production

5.3.2 Transport –TREMOVE and COPERT IV models and expert judgment

TREMOVE is a transport and emission simulation model developed for the European Commission. It is designed to study the effects of different transport and environment policies on the emissions of the transport sector. The model estimates transport demand, the modal split, vehicle fleets, vehicle stock renewal, the emission 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 - 2035, with yearly intervals.

TREMOVE is a policy assessment model to study the 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.

[57] Detailed description of the MESSAGE model was presented in the Fourth National Communication of the Slovak Republic on Climate Change and the Report on Progress in achieving the Kyoto Protocol, MŽP SR, Bratislava 2005 (http://www.minzp.sk/sekcie/temy-oblasti/ovzdusie/politika-zmeny-klimy/dokumenty/).

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.

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 the method is the same as the name of the COPERT model. Besides GHG emissions, the COPERT IV model calculates emissions of all current pollutants including limited pollutants (CO, NO_2, NOx, PM, HFCs), 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 applied in the emission inventories.

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 the COPERT IV model 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 COPERT version 9.0, the vehicle fleet is divided into six basic categories and 241 sub-categories 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 the 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 and climate conditions. The calculation of emissions is based on five basic parameters: total fuel consumption, vehicle park, driving conditions, emission factors and other parameters. Exhaust emissions from road transport are divided in two types, which are hot emissions produced by the engine of vehicles heated to operational temperature and cold emissions from starting a cold engine. These emissions are additional. The calculation of the emissions including CO_2 and also partially N_2O is based on fuel consumption.

5.3.3 Industry products and other product use – expert software tool

The basic approach for both scenarios is following the value added growth in industrial categories. The maximal production capacity and stoichiometry is the limitation of emission projections and in general follows the reference scenario.
Software is based on the MS Excel platform and was developed for automatic emission projection generation. The basic input data of value added growth and maximal production capacity were included in the WOM scenario. In the following steps, additional specific parameters were included step by step into the model and emission projections were calculated for WEM and WAM scenarios.

5.3.4 Agriculture – expert software tool

Calculation of emission projections were based on the mathematical formulas and definitions described in the IPCC Guidelines for the agriculture categories. Emission factors and conversion factors are consistent with the factors used in the emission inventory. The calculation tool is based on the MS Excel platform and the calculation includes different PAMs (in numerical formulation) according to the WEM and WAM scenarios.

5.3.5 LULUCF – expert software tool

Calculation of emission projections were based on the mathematical formulas and definitions described in the IPCC Guidelines for the land use and land use change categories. Emission factors and conversion factors are consistent with the factors used in the emission inventory. The calculation tool is based on the MS Excel platform and the calculation includes different PAMs (in numerical formulation) according to the WEM and WAM scenarios.

5.3.6 Waste – expert software tool

Calculation of emission projections were based on the mathematical formulas and definitions described in the IPCC Guidelines for waste categories. Emission factors and conversion factors are consistent with the factors used in the emission inventory. The calculation tool is based on the MS Excel platform and the calculation includes different PAMs (in numerical formulation) according to the WEM and WAM scenarios.

5.3.7 Sensitivity analysis (SA)

A decomposition analysis tool has been used for the sensitivity analysis. Change of the GDP parameter has been used. The following Table 5.31 shows the value of GDP for WEM scenario, low and high GDP value.

Table 5.31: *Overview of GDP values used in SA*

Mio Euro (2010)	2014	2015	2020	2025	2030	2035
WEM GDP	73,530	76,347	88,878	101,774	116,443	127,210
High GDP	73,530	76,347	93,322	106,863	122,265	133,570
Low GDP	73,530	76,347	84,434	96,685	110,621	120,849

The level of GHG emissions under the different GDP assumptions are comprised in Table 5.32.

Table 5.32: *Total GHG emissions excluding LULUCF using different GDP assumptions*

Scenario GHG emissions (Mt CO_2 eq.)	2014	2015	2020	2025	2030	2035
Reference	40.40	40.78	40.02	40.07	40.46	40.67
Higher GDP	40.40	40.78	42.02	42.07	42.49	42.71
Lower GDP	40.40	40.78	38.02	38.06	38.44	38.64

6 VULNERABILITY ASSESSMENT, CLIMATE CHANGE IMPACTS AND ADAPTATION MEASURES

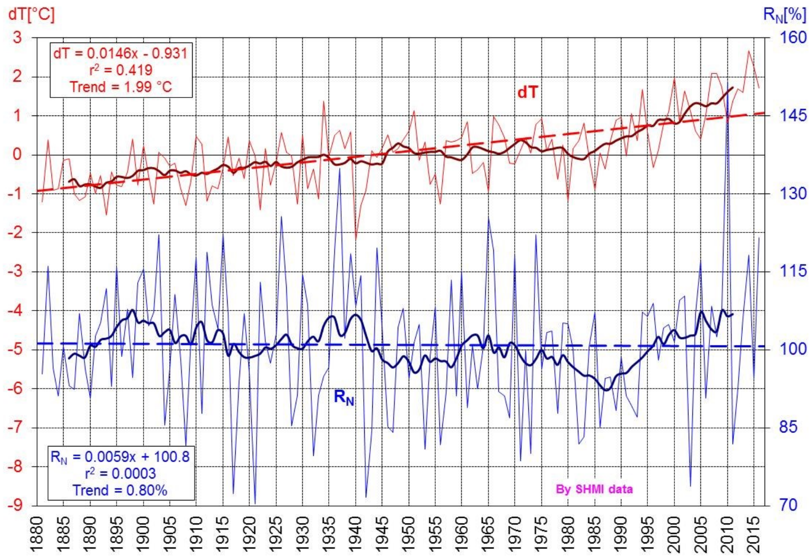
This chapter deals with a brief evaluation of climate change and variability in the Slovak Republic in the period of 1881 - 2016 and with new climate change scenarios until 2100 (designed in 2010 - 2012). Furthermore, the chapter contains a review of expected impacts of climate change and variability on select natural, social and economic sectors, an 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 the Slovak Republic. The data presented here links to the Fourth, Fifth and the Sixth Slovak National Communication on Climate Change (2005, 2009, 2013). Details also come from the Slovak National Climate Program, as well as from the results of numerous research projects dealing with this topic in the Slovak Republic, 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 prevent potential damage caused by expected climate change.

6.1 CLIMATE CHANGE AND VARIABILITY IN THE SLOVAK REPUBLIC IN 1881 - 2016

Detailed climatic measurements at several meteorological stations and more than 200 precipitation gauges since 1881 have enabled us to prepare the study on climate change and variability for the period of 1881 - 2016. 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 demonstrates the significant increase of mean annual air temperature (by 2.0°C in the 136-year period) and insignificant increase of annual areal precipitation totals (by about 0.8% in 136 years). While the increase in air temperature is nearly the same in the whole territory, a significant decrease in annual precipitation totals was observed mainly in the south of the Slovak Republic (up to 10%), a small increase in precipitation totals is only at the northern border of the Slovak Republic (about 5%). This development in temperature and precipitation was accompanied by a decrease in relative air humidity and an increase in potential evapotranspiration by about 5% in the south of the Slovak Republic. The period of 1980 - 2016 was significant not only for the rapid increase in air temperature (by about 2°C) but also for its great variability in precipitation totals (152% of normal in 2010, 74% of normal in 2003), which caused several episodes of serious drought on the one hand and local or regional floods on the other. Changes in winter precipitation totals and an increase in winter air temperature means the existence of unstable snow conditions in the Slovak Republic; increase of snow cover days and depths was recorded only in the higher mountains (altitudes above 1,000 m a. s. l. cover only 5.4% of the Slovak territory).

Figure 6.1: *Deviations of the mean annual air temperature (dT) in the Slovak Republic (based on 3 stations) from the 1901 - 2000 normal and annual areal atmospheric precipitation totals (RN) in the Slovak Republic (based on 203 stations) as percentage of normal 1901 - 2000 in the period 1881 - 2016, including 11-year moving averages and linear trend (from the SHMÚ data)*



6.2 CLIMATE CHANGE PROJECTIONS FOR THE SLOVAK REPUBLIC

Since 1993 climate change scenarios have been prepared for the Slovak Republic as modified outputs from several General Circulation Models (GCMs) by the statistical downscaling method. Some scenarios were designed as analogues to a past warmer climate. A review of those scenarios was also published in the six previous Slovak National Communications on Climate Change (from the years 1995, 1997, 2001, 2005, 2009, 2013). 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.

Outputs from four models (GCMs - CGCM3.1 (Canada) and ECHAM5 (Germany), RCMs – RACMO (Netherland – KNMI) and REMO (Germany – MPI) were used in the daily data downscaling as climate change scenarios for the Slovak Republic. These models belong to the new category of so called coupled atmosphere-ocean models with more than 10 atmospheric levels and more than 20 oceanic depths of model equations and variable integration in the network of grid points. The CGCM3.1 model has 9 grid points in the Slovak territory and its neighbourhood, the ECHAM5 model has 12 such grid points (about 200x200 km resolution) and with corresponding smoothing of topography. The RCMs KNMI and MPI represent a more detailed integration of the atmospheric and oceanic dynamic equations with grid point 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 the Slovak Republic 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, 1981 - 2010), the daily scenarios for about 60 climatic and about 150 other precipitation stations in the Slovak Republic have been designed. Scenarios for the following variables have predominantly been prepared: 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 measured at 10 m elevation above the ground and daily sums of global radiation. Based on these elementary scenarios, several other scenarios for such climatic elements as snow cover, evapotranspiration, heat waves, soil moisture, runoff, etc., were designed by analogues, regression or simple models tested by measured data in 1951 - 2016. These scenarios and user manuals can easily be used to prepare studies on impacts and vulnerability to climate change.

Besides the new versions of climatic scenarios, the older ones presented from the 1st to 6th National Communications on Climate Change of the Slovak Republic have also been applied in the vulnerability and adaptation studies. Now we are presenting a sample from the mentioned 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 RCM and GCM 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

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 RCM and GCM 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	1.23

	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Year
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 it can be seen that the models suppose a comparable increase of monthly and annual temperatures by 1.5 to 4.7°C (a higher increase is projected by the pessimistic Special Report on Emissions Scenarios (SRES) A2 emission scenario, 2.8 to 4.7°C). Table 6.2 presents scenarios of precipitation total changes, in summer from a decrease by 33% to an increase by 19 %, in winter only an 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 a 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. A higher increase of annual precipitation totals was obtained from the north of country; the summer decrease of precipitation totals is more significant in the southern lowlands. A comparable increase (decrease) is also projected for the daily maximum precipitation totals (Table 6.3 for Hurbanovo, the higher increase is in the northern mountains).

Table 6.3: *Scenarios (quotients) of monthly and Apr.-Sept. (WHY) maximum in daily precipitation total changes in 2051 - 2100 by 7 different RCM and GCM 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 mean changes (in hPa) in 2051 - 2100 from the 1961 - 1990 reference by 6 different RCM and GCM 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	0.47	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 potential evapotranspiration E_o (in mm) in 2011 - 2040 (2025 time frame) and in 2071 - 2100 (2085 time frame) by 4 different RCM and GCM 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 a 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 an increase of air temperature by about 1.5°C to 4.5°C for the growing period (Apr.-Sept.) in the Slovak lowlands and no change or a small decrease of relative air humidity. This will cause an increase of E_o, which can cause a decrease of soil moisture because of small changes or a decrease of precipitation totals. The increase of E_o by about 50 mm annually in the 2025 time frame (2011 - 2040) and by about 120 mm annually in the 2085 time frame (2071 - 2100) can be considered serious for agriculture, water economy, forestry and natural ecosystems. Other methods of E_o calculation show slightly different results, but the relative increases of these values up to the time frames of 2025 and 2085 remain nearly the same.

Figure 6.2: *Scenarios of number of summer days with precipitation totals 0.1 - 4.9 mm and ≥ 10 mm at Hurbanovo in 1951 - 2100 by modified CGCM3.1 model outputs, SRES A2 emission scenario and by measured precipitation data in 1951 - 2016 (dashed line) (OMK FMFI UK scenarios and SHMÚ data applied)*

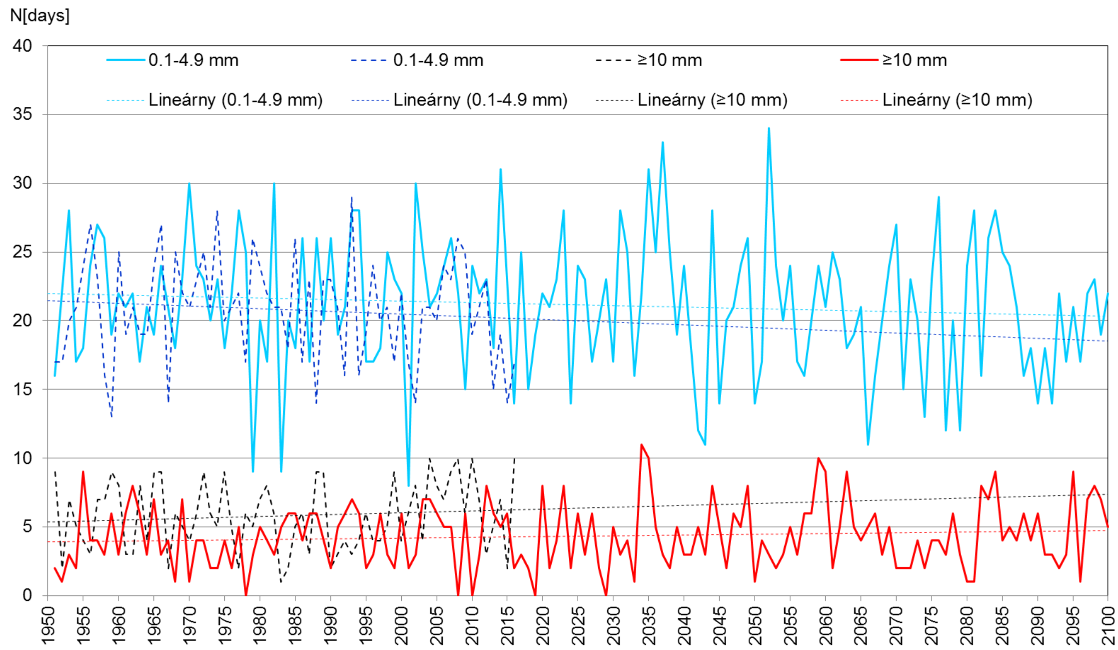


Figure 6.3: *Scenarios of annual number of days with maximum temperature ≥ 30°C (Tropical) and ≥ 35°C (Super-Tropical) at Hurbanovo in 1951 - 2100 by modified CGCM3.1 model outputs, SRES A2 emission scenario and by measured temperature data in 1951 - 2016 (dashed line) (OMK FMFI UK scenarios and SHMÚ data applied)*

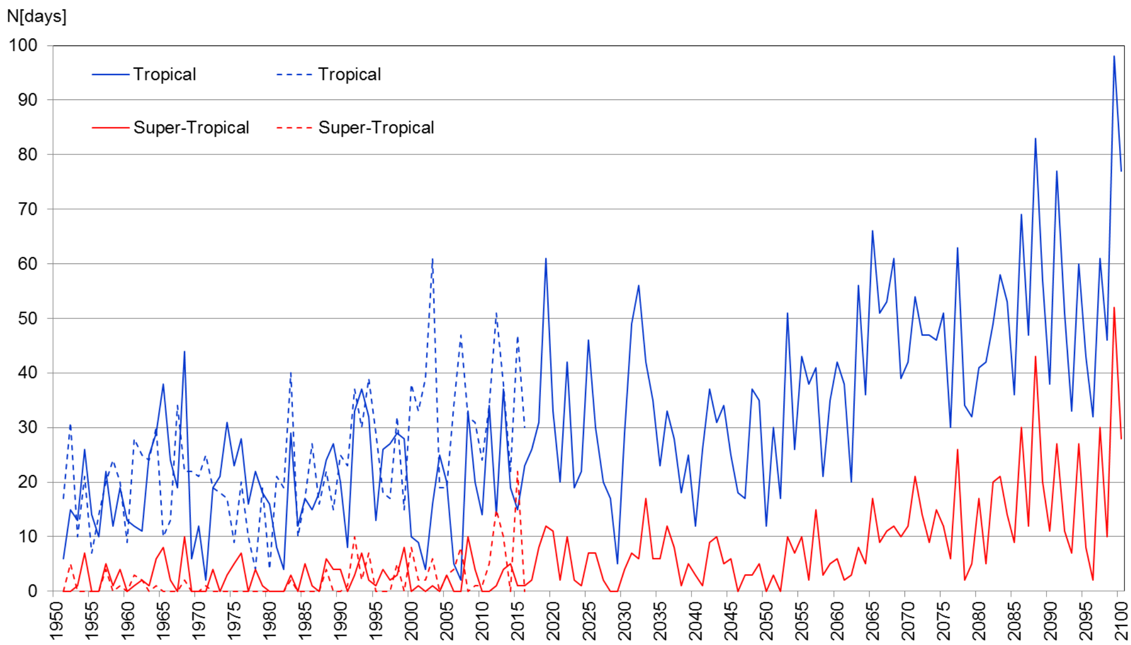


Figure 6.4: *Scenarios of annual number of days with maximum temperature ≤ 0°C (Icy) and ≤ -5°C (Cold) at Hurbanovo in 1951 - 2100 by modified CGCM3.1 model outputs, SRES A2 emission scenario and by measured temperature data in 1951 - 2016 (dashed line) (OMK FMFI UK scenarios and SHMÚ data applied)*

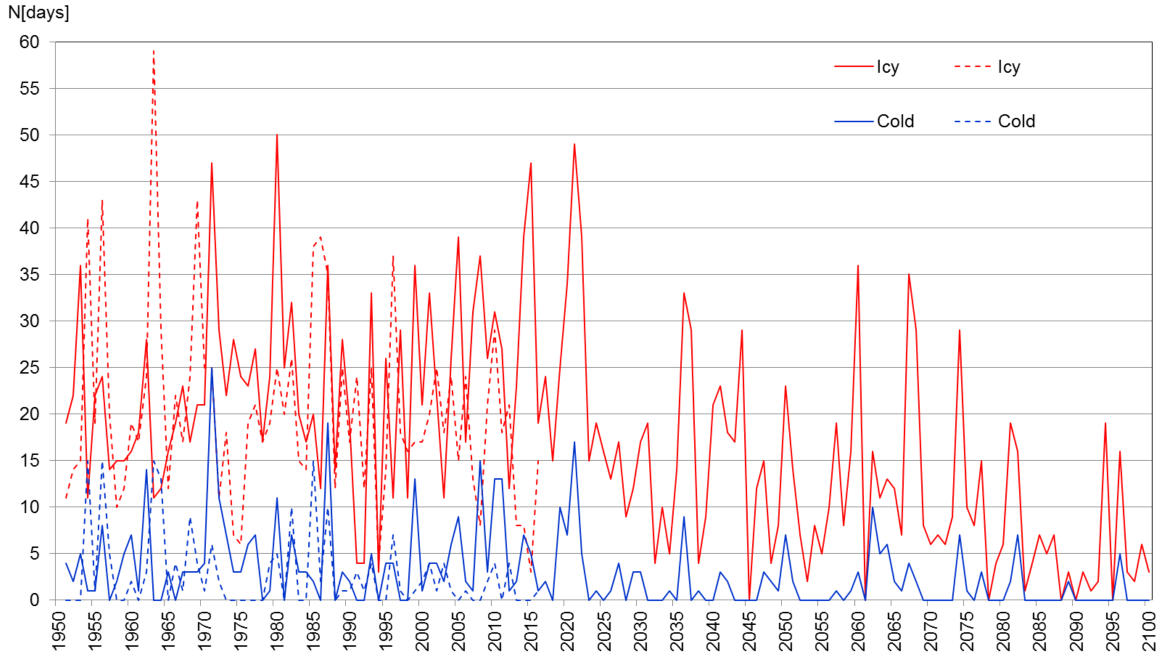
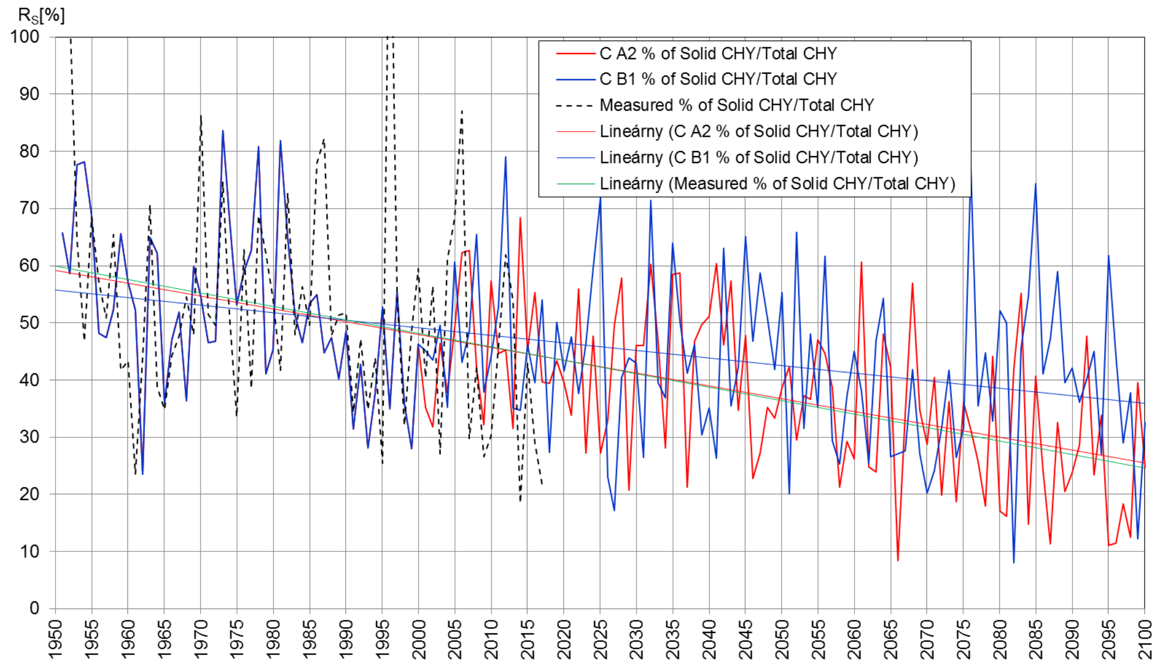
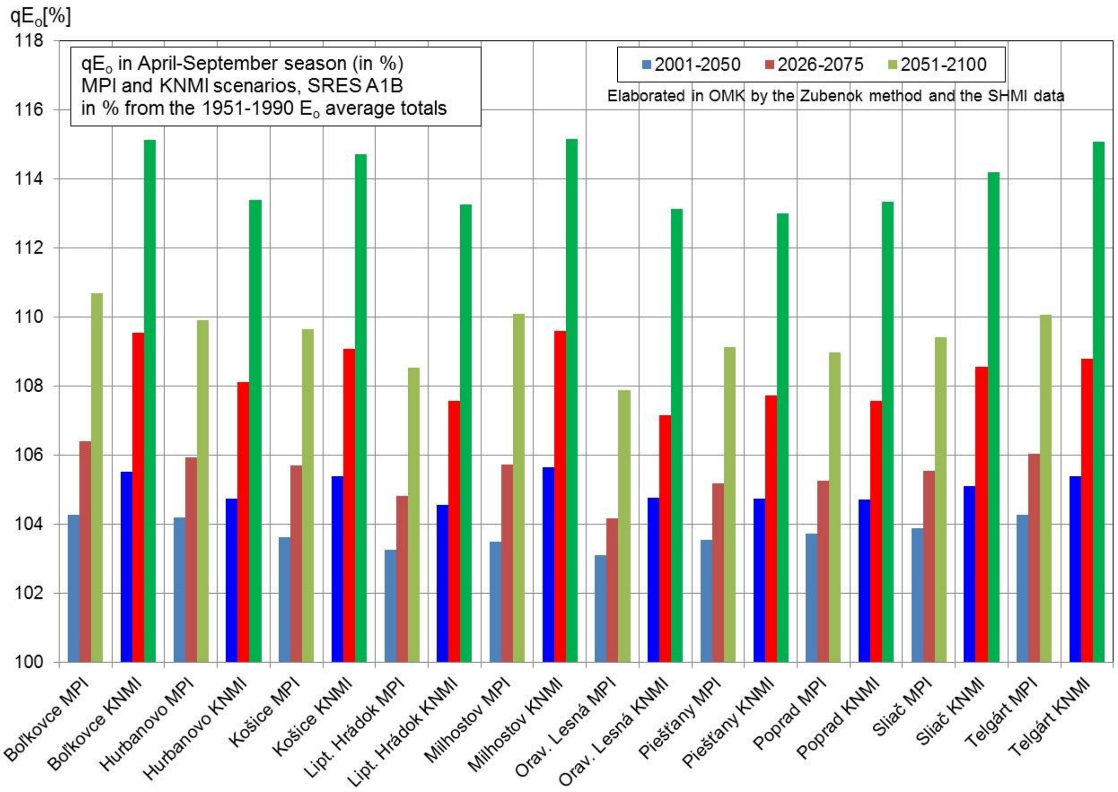


Figure 6.5: *Scenarios of* the *Oct-March share of solid precipitation from all precipitation totals at Poprad (695 m a.s.l.) in 1951 - 2100 by modified CGCM3.1 model outputs, SRES A2 and B1 emission scenario and by measured new snow data in 1951 - 2016 (dashed line) (OMK FMFI UK scenarios and SHMÚ data applied)*



New and more detailed climate change scenarios based on global (GCMs) and regional (RCMs) models, including daily data and daily extremes, enabled the calculation of a series of statistical characteristics such as complex environmental and socio-economic scenarios depending on the changing climate: heat waves (a series of days with high temperature and humidity, summer days, tropical days, super-tropical days, icy days, cold days, etc.), the number of frosty days and days with strong frost (below -10°C), heavy rains (high daily and k-day precipitation totals), days with low or no precipitation, days suitable for specific tourist activities (skiing, swimming, summer and winter hiking, etc.), the number of days with snowfall and heavy snowfall (new snow cover depth above 1 and 5 cm), the number of days with low/high relative air humidity (below 50% and above 80%), etc. In Figures 6.2, 6.3, 6.4 and 6.5 only some examples of such elaborations are presented for Hurbanovo and Poprad and a CGCM3.1, SRES A2 (B1) scenario (the number of days with low and high precipitation totals, the number of tropical, super-tropical, icy and cold days, the share of solid precipitation totals (snow) from all precipitation totals in cold half-years). Figure 6.6 shows possible changes in potential evapotranspiration (E_o), annual totals based on KNMI and MPI saturation deficit (D) model outputs and the Zubenok method of calculation. It can be seen there that an increase of E_o by 13 - 15% will very probably be generally throughout Slovakia in the 2075 time horizon on average compared to the 1951 - 1990 average.

Figure 6.6: *Scenarios of potential evapotranspiration totals (E_o) at 10 stations in Slovakia by the KNMI and MPI RCM models based on saturation deficit (D)scenarios and the Zubenok method for periods in 2001 - 2100 (the lowest Milhostov, 105 m amsl, the highest Telgárt, 901 m amsl, OMK FMFI UK scenarios and SHMÚ data applied)*



6.3 EXPECTED IMPACTS OF CLIMATE CHANGE, VULNERABILITY ASSESSMENT AND ADAPTATION MEASURES IN SELECT SECTORS

An analysis of current and future climate change scenarios confirms the existence of extremes and risks, their interdependence and possible consequences in the whole range from ecosystems, natural resources to the economy and the social sphere. Bonds and interactions between the effects of climate change and its possible consequences are very complex and dynamic system, whose management requires a large amount of information and is largely limited by the uncertainties of the future development of the scenarios. Climate change projections and modeling results confirm that past human activities will cause global warming and rising of the sea levels over the next decades.

The magnitude of climate change impacts on human and natural systems in Europe calls for adaptation measures that both reduce the vulnerability of these systems and further strengthen their resilience through technological and ecosystem-based solutions and managerial options. 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 on the one hand and structural and cohesion funds, agriculture support, protected natural areas and spatial planning on the other.

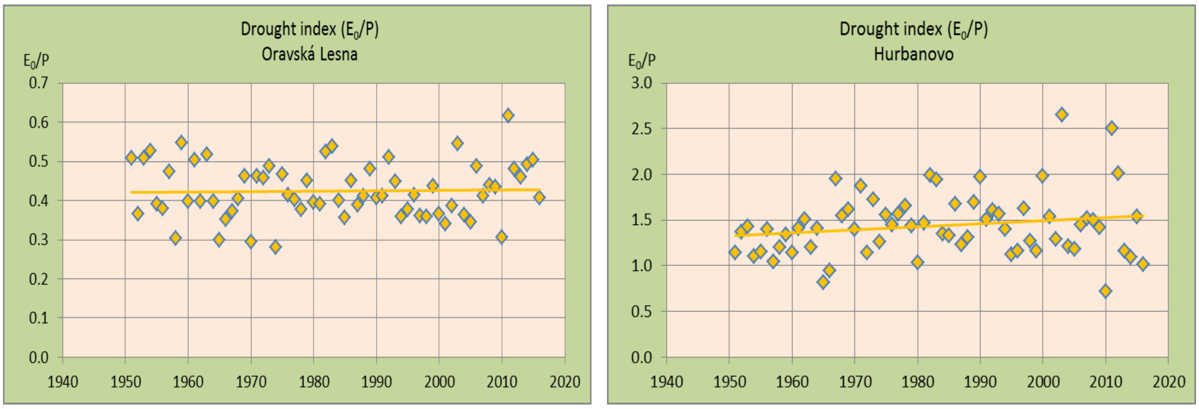
6.3.1 Sector Agriculture

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

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

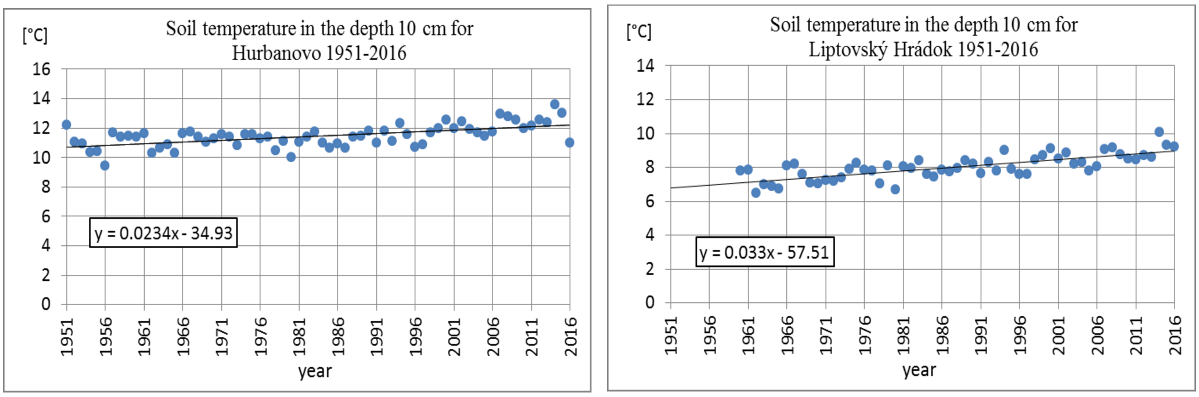
Climate change is expected to affect the conditions under which agricultural production is done in many ways. Different indicators show us possible impacts which are already occurring now and the trend which is continuing. One of the most important indicators through which we can express the possible impacts on the agricultural system is the drought index. Figure 6.6 illustrates different trends of the drought index expressed by E_o/P (where E_o is potential evapotranspiration and P is precipitation) in the Slovak territory. E_o/P represents the relationship between energy supply in the surface layer of the atmosphere and water supply in the respective area. E_o/P >1 represents arid areas while Eo/P < 0.3 represents a taiga environment.

Figure 6.7: *Drought index E_o/P in mountain areas (Oravská Lesná – 780 m a. s. l.) and in lowlands (Hurbanovo – 115 m a. s. l.) for the period 1951 - 2016*



The value of E_o/P in Hurbanovo, representing the most productive part of the Slovak Republic, showed, together with other low positioned localities, an increasing trend by about 0.3 within a 60-year 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, a decrease of E_o/P is recognized. This is the result of the fact that increased precipitation is 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 in 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, the rising temperature of the upper part of the soil shows a 1.5 - 2.0°C increase over a50-year period (Figure 6.8).

Figure 6.8: *Soil temperature in lowlands (Hurbanovo - 115 m a. s. l.) and in mountain areas (Liptovský Hrádok - 640 m a. s. l.) for the period 1961 - 2016*



Expected Impacts of Climate Change on the Agriculture Sector

The following climate factors influence agricultural production: an increase of average air temperature, a change in precipitation and its distribution, increased CO_2 concentration and occurrence of weather extremes. Agriculture reacts very sensitively to climate variability and weather extremes like droughts, storms, torrential rainfall and floods. Crop production may benefit from a warmer climate but the occurrence of weather extremes and the increase in their intensity will cause other problems.

Climate change impacts, mainly the occurrence of drought periods and more frequent floods, are causing changes in agricultural production in the Slovak Republic. The summer period is getting longer due to the warming trends, not only in the south but also in the other regions of the Slovak Republic. Increased air temperatures accelerate the intensity of physiological processes. The phenological phases change and the crops ripen faster. Climate change influences not only the regionalization of crops grown (the spreading of thermophilic crops to the northern parts of the Slovak Republic) but also quality characteristics of the soil.

Long term values of the Aridity index AI_{UNEP} (defined as the ratio between annual precipitation and potential evaporation) place the southern parts of the Slovak Republic in the sub-humid area. The rest of the country belongs to the humid area. The AI_{UNEP} values imply the trend of drying of the land. According to the AI_{UNEP} values, the year 2003 was the driest year in the Slovak Republic in the period of 1961 - 2016. The AI_{UNEP} values fell to values belonging to the semiarid area in the southern Slovak Republic. In the south of central and eastern Slovakia, the AI_{UNEP} values were on a level typical for a dry sub-humid area. The indicator of average annual reserve of available water (% VVK) in ground horizon 0 - 100 cm was chosen for selected localities for the years 1961 - 2016.

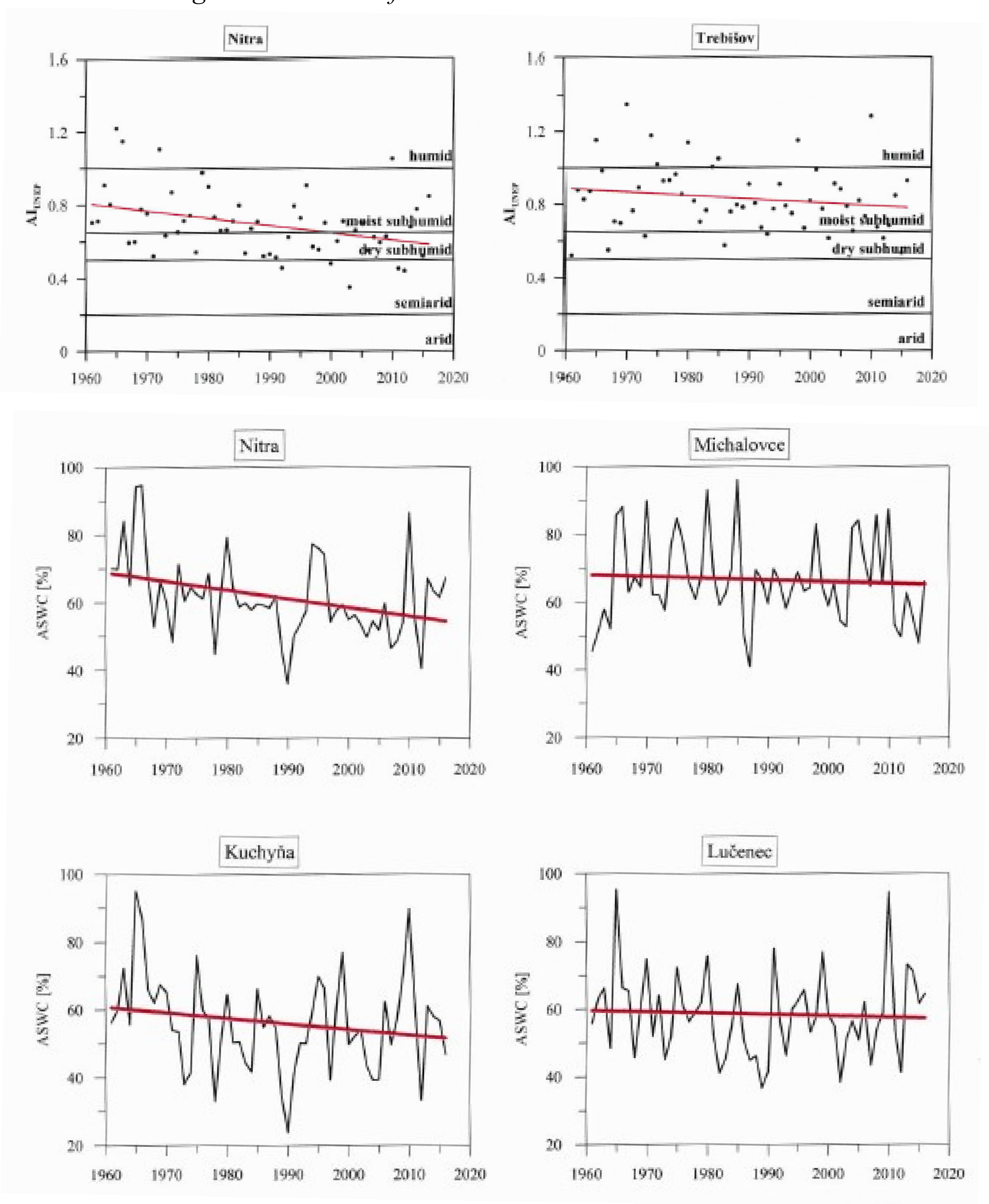
The negative change to the water balance of the land is shown in the reserve of water reachable by crops. Due to the increase of the land aridity, the tendency of the decrease of ground water reserve reachable by crops is notable and we can see it most significantly in light soils (Figure 6.8). The decrease of soil water is caused by growing evapotranspiration due to increasing temperatures.

Climate change and the global increase in average annual temperatures will affect the well-being of livestock. Increasing temperatures in stable houses will increase also CO_2 and NH_3 levels. Similarly, we can expect the occurrence of parasites and illnesses of livestock that require higher temperatures for their existence. We also expect new pests on crops, leading to the increased use of pesticides and possible impacts on bees. Due to the impacts of climate change on crop production, the nutrition for animal production will also be affected. Higher temperatures, drought periods and changes in precipitation might influence feed crops and the production of natural pastures. Feed crops ripen faster and that causes a decrease of nitrogen substances by 0.7%, an increase of fibre by 0.5 - 0.7% and a decrease of energy by 0.6% in them.

Climate change may cause loss of natural sources of water for livestock. The increase of average annual temperatures causes the number of summer days to increase and the period with permanent high temperature to extend. It is expected that animals will face temperature stress. Due to droughts we can notice a decrease of feed production by about 40% on average.

We expect also positive impacts of climate change in the northern parts of the Slovak Republic. Warm weather conditions will cause more favourable conditions for thermophilic feed crop production. This could positively affect the economy of cattle breeding, when the farmers in northern localities will not have to buy expensive feed and will be able to plant it themselves. The increased concentration of CO_2 could have an effect on phytomass production, where the so-called CO_2 fertilizing effect would cause more intensive photosynthesis and then also plant water usage. The increased speed of photosynthesis then results in an increase of phytomass.

Figure 6.9: *Aridity index AI_{UNEP} and average annual reserve of available water (% VVK) in the ground horizon of 0 - 100 cm in chosen localities in 1961 - 2016*



Vulnerability Assessment in the Agriculture Sector

Climate change influences the soil cover in the Slovak Republic. There will be regional differences but generally we can say that there will be mild and more humid winters, hotter and drier summers and more frequent intensive weather extremes. The climate change impacts on agriculture are related to water. Increased soil erosion is expected as well as aggravation of the soil structure, worse water reachability in the soil profile and a more intensive salinization and sodification process.

In dry and windy periods in open landscape there will be wind erosion. During torrential rainstorms water erosion is expected to increase. As a result of more torrential rains and the lower antierosion effectiveness of crop coppice, the occurrence of groove erosion is expected as well. In this regard the shallow soils especially in mountain areas belong to threatened soils.

Climate change will also significantly influence the direction and speed of the accumulation and transformation of organic compounds in the soil. Higher temperatures can influence the decomposition of soil organic matter and the processes of mineralization will outweigh humidification processes. It could cause acidification of soils. It will also influence the worsening of soil physical characteristic such as soil structure and might also increase soil compaction.

We can also expect a significant effect of climate on the change in water regime. Higher temperatures and evaporation as well as gradually increased mineralization of the ground water will affect the increased accumulation of salts in middle and surface soil horizons. The area of salted soils is expected to increase.

We can expect a significant effect on intensive livestock production, where the animals are more sensitive to the changes of external factors and are less resilient against parasites and illnesses. It will cause losses in production and the state of health of the animals as well. Such production is highly dependent on the production of high quality feed. That can be a problem in areas with more frequent occurrence of drought periods. The changes in precipitation will also affect the extensive animal production dependent on natural pastures. In the future, the demands on cooling systems in animal production will increase and is linked with the higher costs that can cause high economic loss to these farms.

Adaptation Measures in the Agriculture Sector

Following the recent investigation done in the Slovak Republic 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 and varieties of cultivated crops and the species grown in the Slovak Republic.
   - Launch breeding programs to support the development of new breeds and/or alternative options, further breeding of Slovak species and varieties to ensure their resiliency.
   - Application of integrated crop protection.
   - Diversification of crop production and gradual inclusion of drought-resistant crops.

Changing the structure of crops represents a radical step in the agricultural production of a region. This will be most effective in higher positioned regions because of increasing thermal comfort which were typical only for lowlands in the past. In the 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 being considered by producers. A change in varieties is also expected for other cereals, mainly for winter wheat. The present varieties of winter wheat will already ripen 3 - 4 weeks sooner than they did in the past. Therefore, this will result in lower radiation input and decreasing potential of the yield formation.

2. Adapt the agro technical measures (mainly sowing) to changed agro climatic conditions.

The adjustment of 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 the number of germinating seeds. Later, high temperatures can negatively influence the formation of grain.

3. Support the revitalization of old and the construction of new irrigation systems, ensure sufficient amount of irrigation water in cooperation with the water-service sector, and support the effective use of irrigation systems (micro irrigation systems).

Irrigation does not depend only on the farmers but also on the water management sector. The effect of irrigation is known in the Slovak conditions and further modelling testified to the stabilizing effect of irrigation.

4. Prefer and apply agro technical measures supporting soil protection, cultivation technologies for soils endangered by erosion, use of more organic matter in soil, improve the retention capacity of soil

5. Ensure good practices in land use, preserve the mosaic landscape and segmentation of land, support the maintenance of windbreaks, grass strips, terraces and permanent grasslands.

6. Support ecological agriculture.

7. In animal farms it is recommended to use well ventilated stables with temperature regulation. To avoid temperature stress on animals, it is important to cool them in the critical period. It will require the installation of cooling systems in every highly effective animal farm. The balance of feeding doses with regard to the decrease of metabolic heat will be important. In the sphere of breading it will be necessary to focus on adaptability and resilience. Here the domestic local breeds can be of a big advantage, because they retain a sufficient level of adaptability.

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

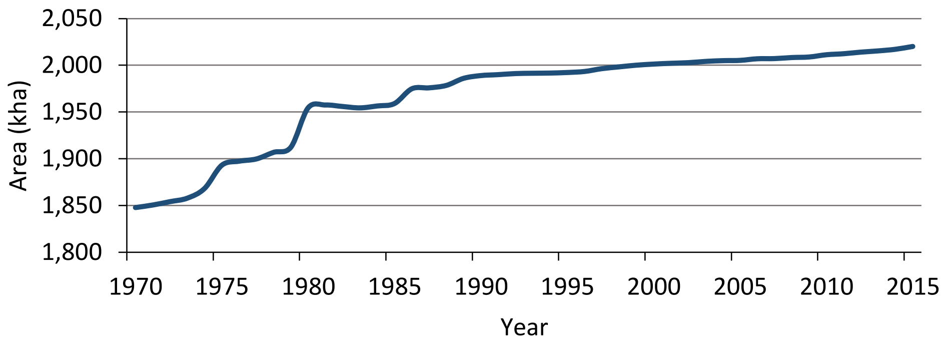
6.3.2 Forestry sector

The forest area of the Slovak Republic reached 2,014,731 ha in the year 2015, which accounts for 41.1% of the total area of the country; the National Forest Inventory 2005 - 2006 (National Forest Centre, Zvolen) has indicated that the total forest area, including forest at non-forest land, even reached 44.3 ± 0.4% of the area of the country. Broadleaved tree species dominate (62.2%), while coniferous occupy 37.8% of the forest area. The dominant species are European beech (*Fagus sylvatica* L) (33.2%), Norway spruce (*Picea abies* L Karst), several oak species (*Quercus* sp.) (10.6%) and Scots pine (*Pinus sylvestris* L). The average stocking volume in 2015 reached 247 $m^3.ha^{-1}$ of forest land.

The forest cover of the Slovak Republic has been steadily increasing in recent decades, and the increase reached almost 10% during the most recent 45 years (Figure 6.10). The tree species composition has also recently been subject to changes, which can be mostly thought of as supportive to the inherent adaptive mechanisms of forests. The share of highly vulnerable Norway spruce has decreased by 2.9% (from 26.3% to 23.4%) during the recent decade; such a decrease was mainly driven by increasing damage caused by an array of biotic and abiotic agents. At the same time, the share of less vulnerable broadleaved species has increased; for example, the recent increase in the proportion of beech was as much as 2.2%.

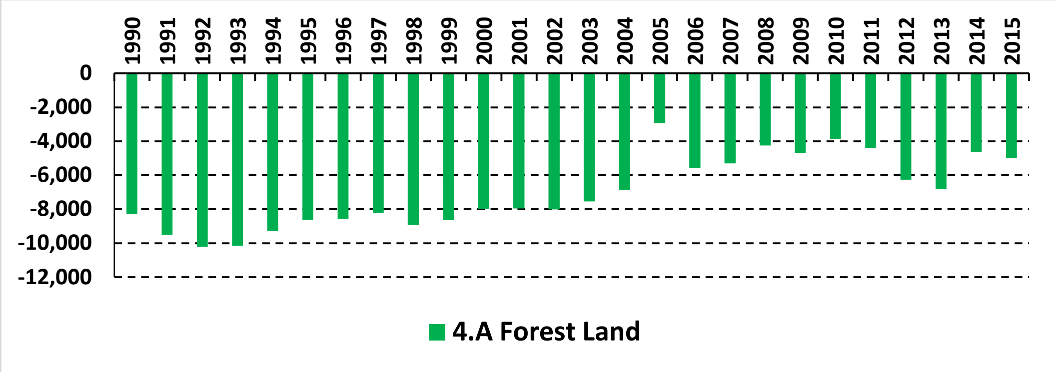
Forest stands with higher diversity and better horizontal and vertical structure can be considered to be naturally better adaptable to climate change. The share of monospecific coniferous forest stands in the Slovak Republic is considerably lower than in other Central European countries and tree species composition is closer-to-nature. However, existing forest stands with inadequate structures are susceptible to the spread of pests and to mechanical damage, mainly by wind. The share of overmatured forest stands is rather high as well, and the susceptibility of such stands to damage is higher.

Figure 6.10: *Development of the forest area in the Slovak Republic (kha, ha^3) during the period of 1970 - 2015 (based on data from the Geodesy, Cartography and Cadastre Authority of the Slovak Republic)*



Forests represent an important carbon sink, which globally accumulates as much as 30% of the total emissions of carbon dioxide (CO_2), and thus significantly contributes to the moderation of climate change. In 2015, the total amount of CO_2 removed by the forests in the Slovak Republic from the atmosphere was 4,998 Gg (Figure 6.11). The decreasing trend in the period of 1993 - 2004 is mainly related to the natural changes in forest structure, related changes in harvest intensity and disturbances. The decreasing removal rate is expected to also persist in the future, but the forests are still expected to act as a net carbon sink.

***Figure 6.11:** CO_2 removals (in Gg, g[9]) in the category of Forest Land (definition according to IPCC) in the period 1990 - 2015 in the Slovak Republic*

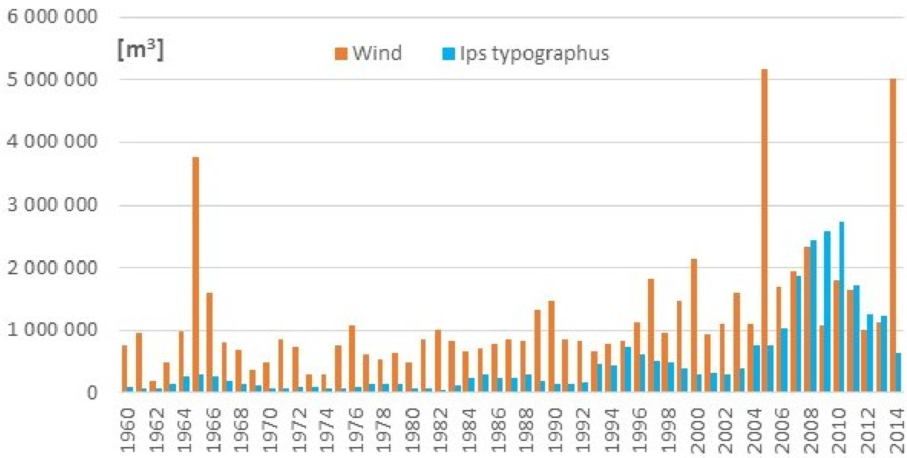


Source: National Inventory Report 2017

Recent damage to forests

Damage to forest has been steadily increasing in the Slovak Republic in the recent decades, and such an increase corresponds with amplifying disturbance regimes across Europe. In the Slovak Republic, most of the damage was caused by wind and bark beetles; the increase in the forest area affected by these two agents has been remarkable mainly in the recent decade (Figure 6.12). While the average annual salvage felling (i.e. the removal of trees damaged by disturbances) was 2.3 mil. m^3 of wood during the last 55 years, the average salvaged volume during the most recent 10 years reached as much as 4 mil. m^3 of wood. The forests have been heavily affected mainly by two windstorm events in 2004 and 2014 as well as by the subsequent secondary damage by biotic agents. The notoriously high damage occurs in regions affected by the persisting decline of spruce forests, particularly in the regions of Kysuce and Orava (north-western Slovak Republic), Spiš, the Low Tatras and the High Tatras (central to eastern Slovak Republic).

***Figure 6.12:** Development of the volume of wood removed from forests as a consequence of damage by wind and spruce bark beetle (i.e. salvage and sanitary felling) during the period 1960 - 2015*



Source: Kunca et al. 2015

Recent warm and dry periods are thought to greatly amplify the above-reported damage by both compromising tree defence systems and fuelling the growth of bark beetle populations. Legislative regulations directing the proper application of sanitary and salvage operations accelerated secondary damage as well, particularly in the period of 2008 - 2014 (Figure 6.12). Such damage is likely to further increase due to the aggravating climate conditions as well as by the climate change-mediated appearance of new insect pests and diseases. The Forest Protection Service (National Forest Centre, Slovak Republic) has recently recorded in some regions an increased density of northern bark beetle (*Ips duplicatus* Sahlberg, 1836) or ambrosia bark beetle (*Xylosandrus germanus,* Blandford 1894), which might further increase the damage to forests. Although those pests' appearance cannot be directly related to climate change, intensive pest monitoring, and improved preparedness to face the climate change mediated alterations of the long-term disturbance regimes is needed and at the same time the proper application of salvage and sanitary operations is highly desired.

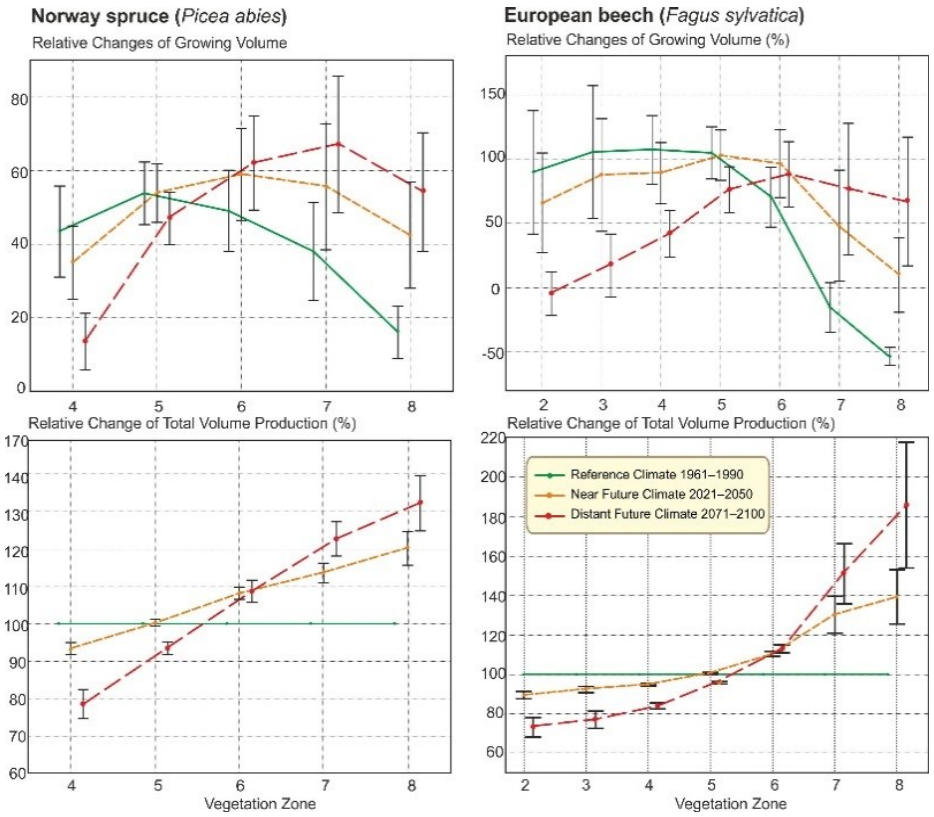
Damage to forests by drought and excessive air temperatures has not been severe in the recent decades, though the drought and heat stress represented the second most important abiotic harmful agent in the Slovak Republic. The damage during the recent decades amounted for 70 – 100,000 m^3 annually. Although such damage is only a fraction of the total damage, the observations from drier environments in Europe as well as future climate projections indicate that drought monitoring and adaptation should be considered in the Slovak Republic.

Impacts of Climate Change in the Forestry Sector

The impact of climate on forest contain *direct impacts*, which are directly related to the changes in air temperature, precipitation pattern, increased CO_2 concentration or prolonged vegetation season, and *indirect impacts*, which are mostly manifested through the change in forest disturbance regimes. Here we present the impacts on forest productivity and impacts on the development of the spruce bark beetle, which have profound importance in the Forestry Sector.

Forest productivity is expected to be largely affected by climate change, and such changes might have serious implications for the quality of ecosystem services, including timber production, as well as for the forestry economy. The changes in productivity are expected to follow a specific pattern along the gradient of zonal forest communities which occur in the Slovak Republic (Figure 6.13). While the productivity of most species is expected to decline in low elevations in response to increasing water scarcity, the prolonged vegetation season and other beneficial processes are likely to increase productivity in high elevations. While most oaks were found to also maintain their current productivity in the future, the impact on two commercially and ecologically important species – European beech and Norway spruce – can be severe. The production optimum of spruce is expected to shift from the 5th vegetation zone (VZ) to the 5th - 7th VZ. At the same time, the productivity is expected to decrease by up to 20% in the 4th - 5th VZ, and increase by up to 30% in the 7th VZ. In beech, the productivity dramatically decreases in the 2nd – 5th VZ, and an increase is expected in the 6th – 7th VZ.

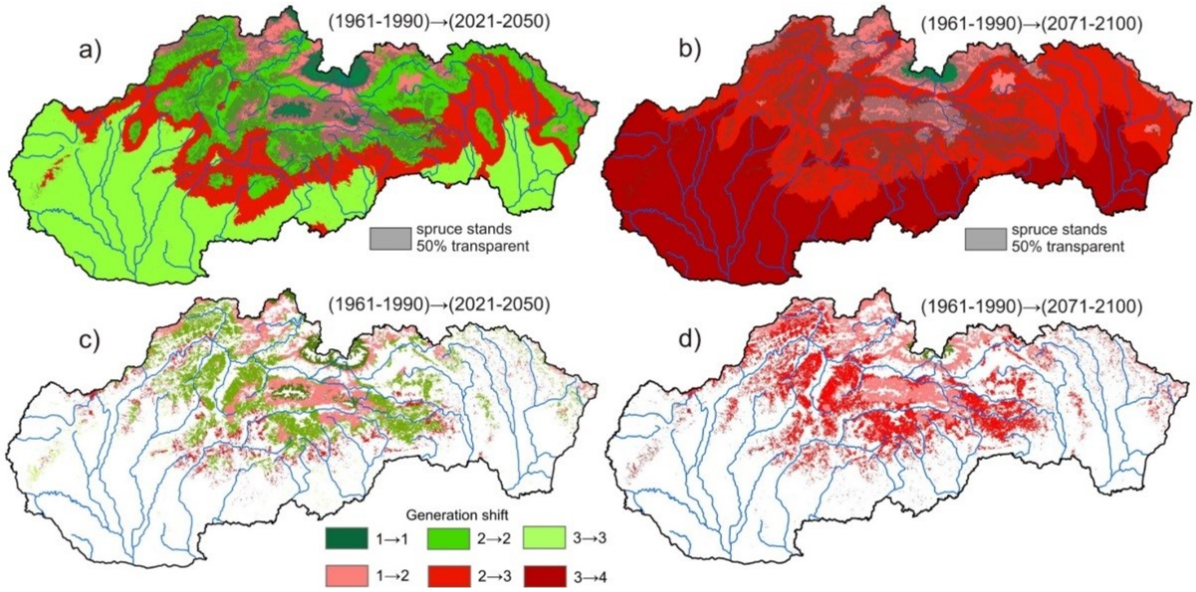
Figure 6.13: *Change in productivity of two commercially and ecologically important tree species – Norway spruce and European beech. The upper row shows the shift of species production optima as indicated by the relative change in growing volume. The lower row shows relative change in the total volume production*



Spruce bark beetle (*Ips typographus*) is a climate-sensitive agent, and increased air temperature is expected to increase the number of generations the beetle can generate per year. Higher densities of the beetle indicate a serious threat to the forests.

In the reference period of 1961 – 1990, spruce stands were equally distributed within regions allowing for the development of one and two generations. Only the marginally distributed spruce stands in low elevations faced the pressure of three generations. A one-generation regime was observed mainly in mountain areas. In the period of 2021 - 2050, a two-generation regime was projected to dominate over 80% of all (current) spruce stands in the country. A three-generation regime is projected to occur at almost 7% of spruce stands (assuming actual spruce distribution). The one generation regime will recede to elevations above 1,100 m a.s.l., where 13% of spruce stands of the country are distributed. Interpretations of projections for the period of 2071 - 2100 are rather uncertain because of expected changes in spruce distribution related to both disturbances and adaptive forest management. Still, a three-generation regime is projected to dominate over a large part of the current distribution of spruce (52%), while the one-generation regime almost disappears. A two-generation regime is likely to occur in 44% of areas currently occupied by spruce (Figure 6.14).

Figure 6.14: *Differences in number of generations projected to develop in the 2021 - 2050 and 2071 - 2100 periods as compared with the period 1961 - 1990. The upper row describes the differences in the number of developed generation (Example: 1→2 – number of developed generations increased from 1 to 2) in the whole of the country, the bottom row describes the increase in bark beetle generations within the current distribution of spruce*



Vulnerability Assessment in the Forestry Sector

We present here a simplified vulnerability assessment which uses the natural zonal arrangement of forest communities in the Slovak Republic. The addressed zones are:

- low to medium elevations, dominated mostly by broadleaved species, where drought effects are expected to be the most pronounced;
- medium to high elevations, which contain a large share of vulnerable secondary spruce forests, and where accelerated forest dynamics can be expected;
- mountain areas naturally dominated by conifers with protective and other regulatory functions, where climate change can be beneficial to forest vegetation.

The presented assessment considers all three elements of vulnerability – climatic exposure, sensitivity of ecosystems and adaptive capacity. The latter component mainly considers the adaptive capacity related to forest management, though the inherent adaptive mechanism of species and communities are also considered.

That the low elevation forest communities of the Slovak Republic are expected to face the highest climatic exposure in terms of increasing water scarcity and increasing frequency and severity of hot spells elevates the overall vulnerability of the forests. On the other hand, tree species and communities here show a high degree of heat and drought tolerance; however, the projected climate change is very likely to exceed these limits. Biotic vulnerability of the forests can be thought of as low, provided no new pest species occur. Adaptation by management should mainly include support to drought tolerant species and management interventions, which maintain water and nutrient regimes. An introduction of drought tolerant tree species and provenances, which show higher tolerance to drought than the native species, could also be considered; the current legislation, however, prevents such actions. Hence the vulnerability of these ecosystems is mainly determined by high climatic exposure and limited options to support these ecosystems' drought tolerance by using new species and provenances. The relative vulnerability in the scale of the Slovak Republic can be thought of as *moderate*.

Vulnerability of forests in medium to high elevations is mainly determined by the composition of altered species and a high share of secondary Norway spruce stands, which show high biotic and mechanical vulnerability. The forests are likely to be increasingly damaged in the future in response to the physiological weakening of tree defence systems by an unfavourable climate and by the potential influx of new pests. The adaptive capacity of forest management is likely to be insufficient to face the increasing damage adequately. The adaptive capacity can also be eroded by the lacking awareness of climate change related risks and options for adaptation, and the persisting orientation on spruce oriented management; such facts may prevent taking timely, anticipatory and effective actions. The relative vulnerability of these forests in the scale of the Slovak Republic can be thought of as *high*.

Mountain forests can be expected to benefit from the prolonged vegetation season, shortened period with frozen soil and increased nutrient input related to accelerated decomposition. Such processes along with sufficient precipitation are likely to maintain the vitality of these forests. On the other hand, an increased frequency of windstorms and an expansion of pests from lower elevations might compromise those ecosystems' vitality. Expansion of tree species from lower elevations can represent a risk to biodiversity. Because large parts of these forests are unmanaged and provide protective and other regulatory functions, capacity of forest management to adapt these forests is uncertain. The relative vulnerability of these forests can be thought of as *moderate*.

Adaptation Measures in the Forestry Sector

Change of tree species composition

Changing the prevailing tree species' composition in response to increasing drought and pest outbreaks is a paramount measure in adapting the forest in a number of regions in the Slovak Republic. The measure is primarily aimed at increasing the share of drought tolerant species, reduction of water demanding and drought vulnerable species, increasing stand diversity (which supports the inherent adaptive capacity of forests), and reducing the share of host trees within the outbreak range of climate sensitive insect pests. The importance of such measures increases towards the lower range (xeric) limits of tree species, where the adverse effects of drought might be more pronounced. However, such measures are associated with considerable lead times and will only gradually become effective, which underlines the importance for timely and anticipatory adaptation actions.

The introduction of species which currently do not occur in Central Europe could be thought of as a questionable approach, mainly because of the potential risks to biodiversity and unclear prospects of their long-term vitality. Substantial changes in climate may, however, favour southern species and provenances and they eventually may become alternatives to the current species, which may not be able to persist under a drier and warmer climate; hence adaptive actions such as assisted migration may warrant consideration.

Assisted transfer of reproductive material

Concerning the source of reproductive material, the rule “local is always best” is still the consent of both foresters and environmentalists. However, the current legislation specifies the rules for the transfer of reproductive material, and thus also provides a good basis for the adaptive changes in forest composition. If the projected climatic changes are within the range of the expected stability potential of the provenance, adaptation may be achieved through exploiting phenotypic stability. In the case of beech, for instance, field tests indicate that the increase of water deficit expressed in terms of an increased Ellenberg climatic quotient of up to 5 units can be buffered through phenotypic stability (plasticity) of the local population.

Regeneration, tending and thinning

Adaptive silvicultural interventions should minimise the biotic risk after an intervention is performed, support species and structural diversity of stands, support natural regeneration and facilitate water, carbon and nutrient cycling. In natural regenerations, long regeneration phases in small patches should be favoured. In the case of aggravating site conditions, enrichment planting, i.e. the combination of natural and artificial regeneration, can be applied. The approach was found to positively influence genetic diversity and thus increase the inherent adaptive capacity of forests.

Harvesting

Shortening the rotation period can be used to reduce the share of overmature stands with high susceptibility to insects and diseases. Such a measure also has the potential to accelerate the transition to a more suitable species composition. For example, a reduction by 10 to 30 years was suggested for most of the commercial tree species in the Czech Republic (except oaks); such a reduction was found beneficial from the view of forest production, safety and economy. Given the similar ecological and management environments, such a practice could also be well applicable in the Slovak Republic.

However, a shortening of the rotation period should be considered in combination with all relevant site- and species-specific factors, and needs to balance the positive effects of climate risk with the effects on wood production, carbon storage, or biodiversity. Negative effects of reduced rotation length should also be considered, such as undesired temporary overharvesting and a market surplus of timber supplies, which could potentially have a negative effect on the timber economy.

Other actions

The importance of continuous and long-term forest monitoring increases under climate change because early identification of development trends in the forest and environment is a prerequisite of adaptive management under changing environmental conditions.

Adaptation of forest infrastructure also includes the optimisation of forest road networks. Increasing the density and improving the quality of forest roads provides accessibility to areas that require sanitation operations, stimulates small-scale management and reduces overharvesting in accessible locations. However, this measure has to be applied with caution as there is strong evidence that improperly built road networks can negatively affect the water regime, and thus amplify the adverse effects of drought.

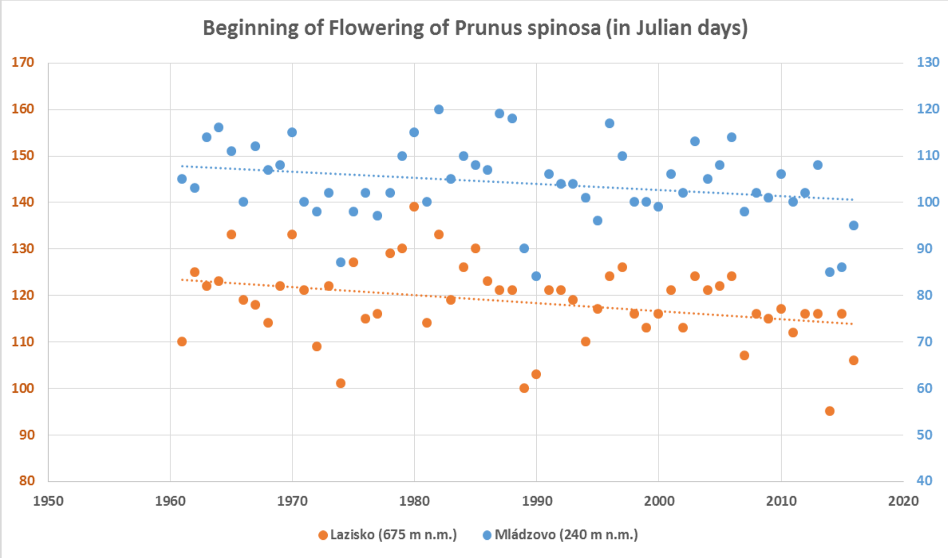
The forest planning infrastructure should also be improved, as many current planning tools such as yield tables and empirical models are not able to address the effects of a changing environment. In this regard it is important to consider climate sensitive processes explicitly in alternative models used for planning. For example, financial support to management practices which address climate change adaptation can be considered.

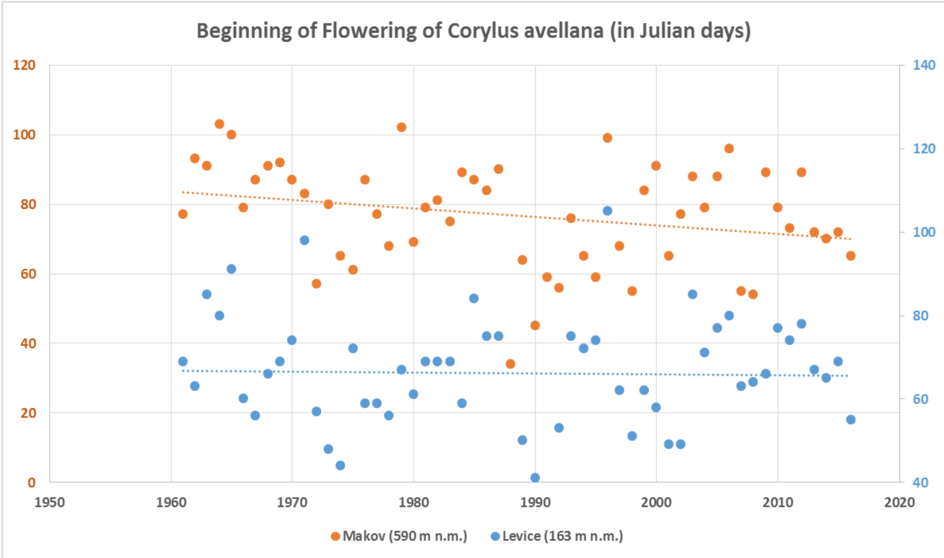
6.3.3 Biodiversity Sector

It is now widely recognized that climate change and biodiversity are interconnected. Biodiversity is affected by climate change, with negative consequences for human well-being, but biodiversity, through the provision of specific ecosystem ecosystem services, also makes an important contribution to both climate-change mitigation and adaptation. Consequently, conserving and sustainably managing biodiversity is critical to address climate change. Ecosystems run natural processes which bring the benefits for both natural and human activities. The extent and character of climate change can reach such levels that the natural adaptation of many ecosystems will not be possible anymore. 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 changes in behaviour of some plant communities. One of the visible responses of nature to the impact of climate change is the shift in some phenological phases of many species which are found all over Central Europe. The following graphs (Figure 6.15) document the changes in the initial generative phenological phases of two common wild species - Prunus spinosa and Corylus avelana in the Slovak Republic living at different altitudes. The fifty-year time series shows a slight trend to the earlier start of flowering of Prunus spinosa by 4 - 6 days. This shift was almost the same at low and middle altitudes. Corylus avelana showed a much stronger shift towards earlier flowering by 8 - 14 days and the shift at higher altitudes was visibly higher.

Figure 6.15: *Beginning of flowering of Prunus spinosa and Corylus avelana for lowland and highland stations in the Slovak Republic in the period 1961 - 2016*





The principal document dealing with biodiversity is the National Strategy to Protect Biodiversity in the Slovak Republic, approved by the Slovak Government in 1996; the new revised version of the national strategy was approved in 2014.

Impacts of Climate Change on the Biodiversity Sector

It is generally assumed that biodiversity will be reduced due to the 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 how much climate change can improve or worsen the losses of biodiversity.

All recent evidence suggests that in general the impact on biodiversity will be negative due to the increasing effect of global climate change on forest, agricultural and aquatic ecosystems. The most endangered are the sensitive ecosystems such as pine groves 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, the 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 round of inventory and monitoring was done in 2015 - 2016. The results are currently being analysed and should be made public at the end of 2017. This enables us to quantify the changes in biodiversity of forest ecosystems in regard to the number of species, their occurrence as well as the recognition of invasive species.

Vulnerability Assessment in the Biodiversity Sector

The present global biota has been affected by fluctuating Pleistocene (last 1.8 million years) concentrations of atmospheric carbon dioxide, temperature, precipitation, and has coped through evolutionary changes, and the adoption of natural adaptive strategies. Such climate changes, however, occurred over an extended period of time in a landscape that was not as fragmented as it is today and with little or no additional pressure from human activities. Habitat fragmentation has confined many species to relatively small areas within their previous ranges, resulting in reduced genetic variability. Current rates and magnitude of species extinction far exceed normal background rates. Human activities have already resulted in the loss of biodiversity and thus may have affected goods and services crucial for human well-being. The rate and magnitude of climate change induced by increased greenhouse gas emissions has and will continue to affect biodiversity either directly or in combination with other drivers of change.

Links between biodiversity and climate change

There is ample evidence that climate change affects biodiversity. According to the Millennium Ecosystem Assessment, climate change is likely to become one of the most significant drivers of biodiversity loss by the end of the century. Climate change is already forcing biodiversity to adapt either through shifting habitat, changing life cycles, or the development of new physical traits. Conserving natural terrestrial, freshwater and marine ecosystems and restoring degraded ecosystems (including their genetic and species diversity) is essential for the overall goals of both the Convention on Biological Diversity and the United Nations Framework Convention on Climate Change because ecosystems play a key role in the global carbon cycle and in adapting to climate change, while also providing a wide range of ecosystem services essential for human well-being and the achievement of the Millennium Development Goals. The Slovak Republic has been a party to the Convention on

Biological Diversity and also a party to the United Nations Framework Convention on Climate Change since 1994.

Adaptation Measures in the Biodiversity Sector

Adaptation seems to be a decisive instrument for diminishing climate change impacts on biodiversity and conserving existing levels of biodiversity at least at current levels. However, the system can function the opposite way, too. A high level of biodiversity brings a relatively high level of resiliency to some ecosystems (e.g. forest ecosystems), which finally increases the probability of the adaptability of the particular ecosystem and diminishes the impact of climate change on the biodiversity itself. Adaptation measures in the biodiversity sector concentrate on protected areas. General suggestions for adaptation measures should cover the following activities:

- Completion of infrastructure and capacities in the field of institutional nature protection.
- Minimalize negative impacts on biodiversity in cooperation with other sectors.

Ecosystem-based Adaptation

Ecosystem-based adaptation, which integrates the use of biodiversity and ecosystem services into the overall adaptation strategy, can be cost-effective and generate social, economic and cultural co-benefits and contribute to the conservation of biodiversity.

Conservation and management strategies that maintain and restore biodiversity can be expected to reduce some of the negative impacts of climate change; however, there are rates and magnitudes of climate change for which natural adaptation will become difficult. Options to increase the adaptive capacity of species and ecosystems in the face of accelerating climate change include:

- Reducing non-climatic stresses, such as pollution, over-exploitation, habitat loss and fragmentation and invasive alien species.
- Wider adoption of conservation and sustainable use practices including through the strengthening of protected area networks.
- Facilitating adaptive management through strengthening monitoring and evaluation systems.

Ecosystem-based adaptation uses biodiversity and ecosystem services in an overall adaptation strategy. It includes the sustainable management, conservation and restoration of ecosystems to provide services that help people adapt to the adverse effects of climate change. Examples of ecosystem-based adaptation activities include:

- Sustainable management of upland wetlands and floodplains for maintenance of water flow and quality.
- Conservation and restoration of forests to stabilize land slopes and regulate water flows.
- Establishment of diverse agroforestry systems to cope with increased risk from changed climatic conditions.

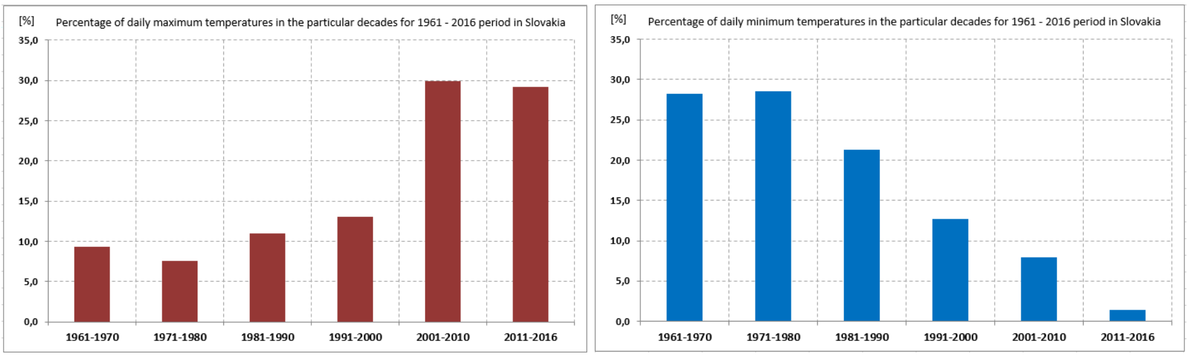
- Conservation of agrobiodiversity to provide specific gene pools for crop and livestock adaptation to climate change.

6.3.4 Public Health Sector

Public health consequences of climate change are influenced firstly by environmental factors but also by socio-economic development and by the introduction of effective adaptation measures.

The basic document in the field of environmental health within the system of public health in the Slovak Republic is the National Environmental Health Action Plan of the Slovak Republic (I.NEHAP IV.). It is a national plan adopted by the government of the Slovak Republic in Resolution No. 1012012. The main aim is to realize specific activities to protect environmental health. Climate change and its impact in relation to public health is one of the areas which is stressed. Every two years the national review about the implementation of the realized activities of this action plan is prepared.

Figure 6.16: *Percentage of daily maximum (left) and minimum (right) temperatures occurring in particular decades for the period 1961 - 2016 in Slovakia (SHMÚ data applied)*



Results of statistical processing show increasing variability of the occurrence of extreme events. Figure 6.16 shows the percentage of daily maximum and minimum temperatures of the entire number of days in the period of 1961 - 2016 which occurred in the particular decade. The 2001 - 2010 decade covers almost 30% of all maximal temperatures and the 2011 - 2016 period continues this trend. Regarding the minimum temperatures, the significant decrease of the occurrence of daily minimum records is typical for the last two decades.

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 a maximum temperature reaching over 30°C are called tropical days and have a potentially harsh influence on humans. Big cities and city agglomerations in the southern Slovak Republic are in particular threatened by heat waves due to the heat island effect in these urban areas.

Figure 6.17: *Number of tropical days in Bratislava in the period of 1961 - 2016 and course of maximum daily temperature in the extremely hot August of 2015 (SHMÚ data applied)*

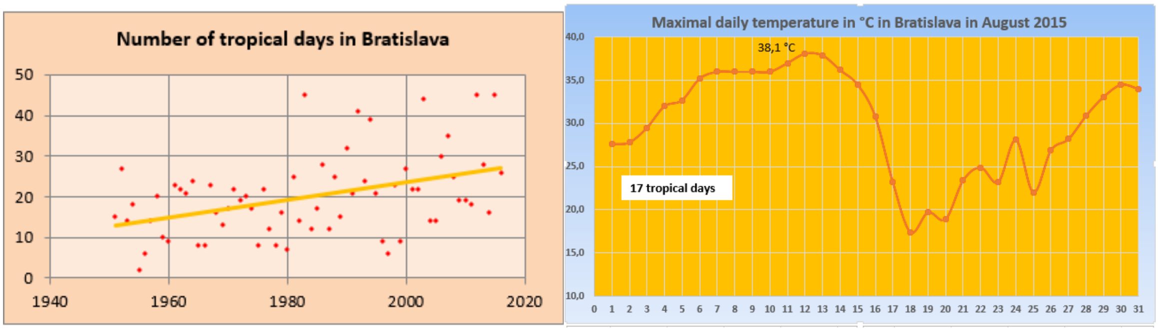


Figure 6.17 shows the characteristics of extremely hot days in Bratislava. It is clear that the number of tropical days is increasing and every year is different from the previous one. One of the critical months occurring in Bratislava in the last decade was August of 2015, with 17 tropical days.

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 the southern part of the Slovak Republic is not prepared to eliminate the impact of such heat waves. Air conditioned rooms are still not a common feature of either private or public buildings and even the rooms in hospitals are sparsely air-conditioned.

Climate Change Impacts on the Public Health Sector

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

Conclusions of several studies, projects and national reviews of the effects of the weather on human health indicate that in next decade the health of humans will be exposed to severe climate change impacts in the 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 form of such effects is represented by the change in distribution of infectious diseases, spreading of diseases caused by polluted water (especially in regions where personal hygiene and sanitation is of a very low level), spreading of respiratory diseases as a 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 6.6.

Table 6.6: *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

Phenomenon	*Impacts on health*
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 happen, the higher its consequence will occur. The most endangered areas are cities, southern parts of the Slovak Republic and the areas with a higher concentration of the particles PM_{10} and $PM_{2.5}$. When both extremely warm day and a higher concentration of ground ozone occur, it can be predicted that the probability of deaths for people suffering some diseases will be at least two times higher. According to studies all over European cities, the most endangered group are people in the age range from 75 to 84 years. People in this group are usually lonely and without resources to secure their basic living standards.

Table 6.7: *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 on human health
Extreme air temperatures, increased frequency of occurrences, 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	Deterioration of general health conditions, the most handicapped will be the old and lonely above the age of 75, children, the mentally and physically handicapped
Periods with high precipitation, heavy rains, storms, tornados, flood	very likely	Greater 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	Greater risk of deaths, mental diseases
Prolongation of the pollen season	likely	Asthma, allergies, respiratory diseases
Occurrence of vectors of transmission of infectious diseases	likely	Malaria, Lyme Borelli, tick-borne encephalitis, West Nile fever
Higher UV radiance, concentrations of ground ozone and PM_{10}	very likely	Greater risks of cancer, deaths caused by respiratory diseases

Adaptation Measures in the Public Health Sector

Reduction of negative climate change impacts including measures taken in non-medical sectors will have a positive effect on public health. Therefore, the Public Health Department at the Ministry of Health of the Slovak Republic is invited to consult all the proposals of adaptation strategies and measures in cooperation with the Public Health Authority of the Slovak Republic according Act 355/2007.

There is no single strategy for adaptation measures regarding public health in the Slovak Republic at the moment. The first steps towards 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 the reduction of urban heat islands, emissions of ozone and other air pollutants could be included in programs of effective usage of energy and traffic planning.
- Creation and sustaining of a public heat wave warning program is a basic requirement of a public health protection effort against the effects of extreme heat waves. The population needs to be repeatedly informed and advised in every possible way about the possibilities of individual protection against the heat.

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

Managers of medical institutions in cooperation with supervisors should design short-term and long-term goals and create conditions for their achievement in such a way as to be able to react to extreme weather events on a local scale and in real time.

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

6.3.5 Sector Water Management

Climate models indicate a change in the distribution of atmospheric precipitation on Earth and a change in the frequency and intensity of extreme weather events. According to the climate change models, described in the Seventh National Report on Climate Change, the total rainfall in Slovakia will be about 10% lower up to now, the utilizable water resources will fall by 30 - 50% over the horizon of 2075 - 2100 in Slovakia. It is assumed that there will be a much more uneven distribution of precipitation sums over the year and in the individual regions of Slovakia. This will also be in line with the evolution of the runoff regime in Slovakia. According to different climatic scenarios, the long-term average annual runoff can be changed in most of the area, with a more pronounced decline expected especially in the lowlands. In particular, changes in long-term monthly flows are expected, an increase in winter and spring outflows and a decrease in summer and autumn outflows are expected, especially during the vegetation period.

The long-term drought periods in the summer and autumn months can be associated with a lack of water as a significant manifestation of climate change in our territory. This phenomenon can be caused as a result of a significant decrease of snow in the winter and early spring, the early start of the growing season, and hence considerable evaporation in the spring months, but also due to lower precipitation and higher temperatures during the summer. The result is a significant lack of soil moisture in the second half of the summer and early autumn.

Dry periods can be interrupted by heavily rainfall or strong storms with intense precipitation, while the number of days with storm compared to the current (15 to 30 in the summer) should not change, but very strong storms are likely to be up to 50% more. It is also assumed that tornadoes will arise during extreme storms in the Slovak republic. It is possible to expect a more frequent occurrence of flash local floods in various parts of the Slovak Republic.

The extreme hydrologic period of 2010 - 2016 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 the 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 the decline of water resources, the estimation of increased extremity of floods and droughts, determination of 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 Directive 2000/60/EC of the European Parliament and of the Council on establishing a framework for Community action in the field of water policy and Directive 2007/60/EC on the assessment and management of flood risks, with emphasis on 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. Annual flow depends mainly on the amount of precipitation and evaporation but its annual course is affected by several other factors, such as vegetation cover and also the amount of 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 charakteristics of rock and soil environment in individual river basins.

In the assessment of the hydrological characteristics of the Slovak Republic for the reference period of 1961 - 2000, the basins of the rivers Ipeľ, Slaná and Bodva were classified as the most vulnerable. Basins of the eastern Slovak Republic, the upper part of the river Váh and its left-hand tributaries, the rivers Poprad, Nitra and Hron as well were classified as having medium vulnerability. The right-hand tributaries of the Váh and the Danube itself were classified as the least vulnerable rivers. The next period of 2001 - 2016 changed this distribution because this period was very extreme.

The less vulnerable areas, where the average annual discharge is rising, include the Poprad and Danube basins as well as the rivers White Váh, Ľubochnianka, White Orava, Hornád, Torysa and Latorica. Basins without trends are the Danube, Upper Váh, Polhoranka, Bytča, Vlára, and upper Hron, the upper part of the Slana, Ondava and Bodrog. Moderate decreasing trends of average annual flows are in the basins of the left-hand tributaries of the Váh, Veselianka, Oravica, Kysuca and Hnilca, the upper part of the river Labor and Uh. The largest decrease of water discharge is recorded in the basins of the rivers Varínka, Rajčianka, Pružinka, the entire Danube River Basin and the Nitra, the central and lower Hron, the rivers Ipeľ, Štítnik, Rimava, Blh, Bodva and Topľa.

Possible impacts of climate change on groundwater sources (processed on the basis of measurements of 98 anthropogenically unaffected spring discharge located in 35 geomorphological units) during the period of 1981 - 2016, as compared to the reference period up to 1980 are as follows:

- in the period of 2010 - 2016, in spite of the dry and, from a groundwater point of view, below average year 2012, there was a very slight mitigation of the negative impacts of climate change on groundwater sources in the Slovak Republic, which were indicated and published in groundwater assessments till the year 2009;
- the negative impacts of climate change on groundwater sources continue to prevail in over more than 60% of the Slovak Republic's territory after 1980;
- documented average decline in the yield of springs (groundwater sources) were in the range of about -6% to 8% over the period of 1981 - 2016;
- the largest declines were documented in the Kysucká vrchovina, Vtáčnik Mts., Podtatranska kotlina, Muránska planina, Slovak raj and Vihorlat Mts., where the decline in the yield of springs during period of 1981 - 2016 reached values of -15 to -20% (compared to the reference period up to 1980).

Possible impacts of climate change on the groundwater reserves in the lowlands and basins of the SR (probes, groundwater level) during the period of 1981 - 2016, as compared to the reference period up to 1980:

- similarly to groundwater sources (springs), the probability of mitigating the negative effects of climate change on groundwater level in monitoring wells for the period 2010 - 2016 was also documented;
- nearly 80% of the lowlands and the basin of the Slovak Republic still have estimated negative changes in groundwater reserves between 1981 - 2016 compared to the reference period up to 1980;
- the average value of documented declines in specific groundwater reserves for all 10 sub-basins is around -20,000 to -40,000 $m^3.km^{-2}$ during the period 1981 - 2016;
- significant decreases in groundwater reserves (in average) of about -80,000 $m^3.km^{-2}$ were documented mainly in the Hron and Slana basins in 1981 - 2016.

Using maximum specific runoff as an 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 the 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 and northern parts of the Slovak Republic. Evaluated trends of maximum specific runoff from at least a 30-year time series of maximum annual flows showed that significantly increased trends are registered only in the rivers where flash floods occurred in the years 2010 - 2016 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 decreasing or neutral trends prevail.

Impact of Climate Change on the Water Management Sector

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. Decrease of soil moisture and reduction of hypodermic runoff during the warm half year.
3. 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).
4. Increase and extension of drought.
5. Reduction of usable water sources.

Vulnerability Assessment in the Water Management Sector

Based on the analysis of current knowledge and understanding of hydrological conditions of water management in the Slovak Republic, we estimated the level of risk of negative climate change impact on the water management sector for select geomorphological units (Table 6.8).

Table 6.8: *Risk of negative impact of climate change on the water management sector for select 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

Major implications of climate change in the Slovak Republic can be a long-lasting drought in the summer and autumn months associated with 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 the Slovak Republic, 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 the north and south of the Slovak Republic (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 in the yield of water resources, especially in the lowland parts of the central and eastern Slovak Republic during the summer months.

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

Adaptation in our country could be divided to two parts. One of them is the elimination of drought consequences, e.g., a decrease in the 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 the adverse impacts of climate change. Most attention is paid to water resources, their protection and efficient use. Water is becoming a critical strategic resource in our country. This resource has to be protected and its effective and efficient use managed to ensure its sustainable use and sustainable development in general. Adaptation to climate change in the area of water management should therefore be focused on the 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 water for agriculture and industry.
- Completion of the flood protection system of major river basins, such as levees, dry detention basins and others.
- Revitalization of objects obstructing streams and a gradual implementation of hydro melioration measures in forestry and agriculture to increase the flood protection of the area in the most vulnerable "small" river basins.

For adaptation to climate change and the Water Plan of the Slovak Republic, the following additional measures are suggested on the national level:

- Review the system for determining the maximum design flow rates and then assess the flood safety of dams.
- Review 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 droughts and their impact on the ecological status of water bodies.
- Increase research on the impacts of climate change.

6.3.6 Tourism Sector

In the Slovak Republic, the sector of tourism is determined by the varied topography and temperate climate conditions of the country. In Slovakia several types of tourism can be identified: summer tourism, winter tourism, spa and health tourism, cultural and urban tourism, conference tourism, rural tourism, agrotourism, ecotourism and geotourism.

In the near future, according to experts, a shift of vegetation zones towards the poles is to be expected. In winter the average temperature is expected to increase. The diminution of days with continuous snow cover will be felt by operators of ski resorts through lower revenues and higher costs for artificial snow. Although less energy will be consumed for heating, on the other hand, during summer months there will be higher costs for air conditioning. Tropical summers will occur more often. The years 2011 - 2016 were characterized by heat waves, with the exception of 2014. Lower rainfall in the summer months is expected, which will be reflected in a lack of water, which is the most intensively used raw material in the tourism sector.

Climate Change Impacts on the Tourism Sector

Regional manifestations of climate change will affect both tourist destinations and tourists, because weather conditions are a significant factor in the decision-making of tourists when choosing a destination. Climate primarily defines the length and quality of the tourist season. The tourism sector is heavily dependent on seasonality and climate change alters the environmental surroundings of tourist destinations. Tourists opt for a climate which corresponds to their holiday plans. Climate change is causing them to seek for other destinations and travel in different seasons.

While tourists can relatively easily change their behaviour, service providers in the tourism sector are less flexible and climate change will have a negative impact on their business. The very high competitive environment within the tourism sector and small margin should also be taken into consideration. The effects of climate change require more spending on artificial snow, irrigation and air conditioning. Tourists and tour operators have a greater capacity for adjustment to climate change than local providers of tourism services and local economies dependent on revenues from tourism.

The loss of snow cover - *Territorial study of climate change in the Slovak Republic* suggests that global warming in our area may be manifested by an average air temperature increase in 2075 of 2 - 4°C. There will most likely not be continuous snow cover below 1,100 meters above sea level. 76% of the Slovak Republic's ski resorts are located below 1,100 meters above sea level, 16% around that elevation and 6% above that elevation. The construction and operation of ski areas in most mountain ranges, due to the need for artificial snow, are costly and energy-intensive. Experts argue that an increase in temperature of 1.8°C would mean that at 1,500 meters above sea level, there will be about 40 days of snowless. There is a threat of an up to 60-percent reduction in the area of natural snow by the warming of 1°C. The period of continuous snow cover will start later; the snow cover will be significantly lower in ridges, which moreover will have an impact on the increasing amount of avalanches. Mountain resorts claims they will have to shorten the winter season by up to three weeks. Lift operation costs are rising; in particular for small businesses investing in new technologies could have a detrimental impact, especially in uncertain forecasts. The price of snow cannons range in the hundreds of thousands of euros and consume huge amounts of energy and water. Artificial snow melts slowly and changes the conditions for growthof local flora. Itsunnatural composition enriches the soil with substances affecting the specie composition. Season attractions are of increasing importance for mountain areas.

Increased number of tropical days - 2015 was the first time that the highest level of heat alertfor several consecutive days was issued by the Slovak Hydrometeorological Institute for the whole area of the Slovak Republic. By 2050 it is likely to quadruple, while the incidence and duration of heat waves will be extended by three days. It is predicted that the number of days with temperatures higher than 35 - 40°C will increase in areas with dryer conditions and lower cooling effects of vapour. Temperatures above 40°C are not only inconvenient but they can lead to heart attacks from heat. A decrease in rainfall in the summer months is expected, which will be reflected in water scarcity.

Holidaymakers therefore will postpone their vacation to periods when heat is not so intense. This is reflected particularly in the domestic summer tourismOverheated buildings require increased sourcesof electricity and water. Forest fires caused by heatwaves may result in the destruction of natural attractions and tourism infrastructure.

Increased activity and intensity of rainfall - Towns are threatened with flooding during heavy rains, or torrential rain. Old sewage systems have difficulty with diverting more water, causing damage to transport infrastructure, worsening traffic flow and closures on the railways, as well as delays in services. Tourists react sensitively to information on floods. In the last 10-12 years, extreme daily precipitation has had an increasing tendency, resulting in local flooding in various parts of the country, which represents a risk for tourist facilities and increases in insurance costs.

Storms - It can be assumed that severe weather events will be repeated, and this will have a negative impact on the safety of tourists.

Change in soil - Erosion, changes in acidity and soil moisture in extreme cases can mean the destruction of archaeological sites and natural resources.

New diseases - Warming causes the migration of animals that are not typical for our climate zone and will possibly spread diseases (e.g. malaria). It is also necessary to count on an increased incidence of infectious diseases, tick-borne diseases and extension of the pollen season. The increased number of pests that survive the milder winter may result in a price increase of agricultural production and thus reduction of household disposable income.

Threats to biodiversity - Reduction of environmental and aesthetial values automatically means a decrease in interest for tourist destinations.

Impact of tourism on climate change

The sector of tourism has a considerable impact on climate change. The biggest emitters releasing GHG emissions into the atmosphere are: air transportation and accommodation facilities using heating and air conditioning. Tourists are simultaneously becoming agents and victims of climate change. They contribute to climate change while transporting themselves to their destinations, accommodation, catering, activities, tours and shopping.

In the Slovak Republic, tourists use cars for travelling to holiday destinations; the intensity of motor transport for other purposes (commuting, business travel, shopping, etc.) is much higher. The number of visitors to the Slovak Republic who are transported by air is not significant compared to the total volume of air traffic. Rising living standards and purchasing power of the population of the Slovak Republic, however, predicts a rise in the use of car and air transport for tourist purposes. The transport of raw materials (eg. food preparation) is particularly intense in areas with limited local resources.

Tourism in general overuses water resources for the operation of hotels, aqua parks, swimming pools, golf courses, ski slopes with artificial snow and tourist consumption. With incorrect destination management, which leads to improper localization of facilities, the effects of climate change are even more intense. Soil erosion occurs, which significantly reduces the vitality of the plants and changes the composition of the flora in the area.

Vulnerability Assessment in the Tourism Sector

Consequences of climate change in the tourism sector could be either negative or positive, depending on the type of tourism.

Positive impacts of climate change:

- Summer tourism – the increased number of summer days will help to develop summer tourism in territories with suitable positions.

Negative impacts of climate change:

- Winter tourism – the reduction in the number of days with snow cover will shift the border line of ski resorts to higher altitudes and cause a reduction to the winter season in resorts with lower altitudes.
- Summer tourism in southern parts of the Slovak Republic – drought could affect summer water sports.
- Spa and health tourism – extension of the growing season and the pollen season will reduce the number of days suitable for this type of recreation, which may cause fewer visitors due to unfavourable conditions.
- Cultural and urban tourism – heat waves and extreme weather events will affect the 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 the Tourism Sector

Sustainable tourism and development practices could contribute to adaptation of the tourism sector to the impacts of climate change with:

- Responsible destination management based on the principles of sustainable tourism.
- Shift the focus of tourism activities to environmentally innovative forms that represent the perfect balance between conservation and development of tourism.
- Development of ecotourism – including activities with a relatively small impact on ecosystems.
- Development of geoturism, which not only preserves, but also develops natural, cultural and historical values of the area for future generations and allows visitors to actively live the atmosphere of a specific area.
- Due to the negative impacts of climate change, tourism functionaries will be forced to pay more attention to those tourism product groups that are not influenced by season (eg. spa tourism, which has the highest occupancy rate in summer, but allows year-round operation as well).

6.3.7 Transport Sector

With its geographical location in Central Europe and its location in relation to the most important economic centres and ports of Europe, the Slovak Republic is in the crossroads of important transcontinental traffic routes:

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

The Slovak Republic 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 the EU's gateway to the economically interesting part of Eastern Europe (Ukraine and other countries of the former Soviet Union).

Climate Change Impacts on Sector Transport

Adverse weather phenomena can extent the transport time of goods and passengers and increase the likelihood of accidents. In the transport sector, there are several means of transportation affected directly by weather phenomena. Extreme weather phenomena (high and low temperatures, intense storms, heavy snowfall) cause serious difficulties in almost all modes of transport. A 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 Table 6.9.

Table 6.9: *Potential effects of climate change on transportation*

Transport	Weather impact	Consequences
Road transport	Extreme weather events (storms, floods)	Shutdown of roads, detours, damage to 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 requests for winter maintenance, damage to road surface
Air transport	Extreme weather (storms, floods)	Interruption in the service of airports, damage to facilities, flight delays
	Adverse meteorological conditions (rain, snow, black ice, fog)	Flight delays
Rail transport	Extreme weather (storms, floods)	Interruption in traffic, damage to infrastructure
	Adverse winter condition (frequent snowing, wind, long winter)	Increased demand for winter maintenance, damage to rails and sidings
Water transport	Extreme weather (storms, floods)	Interruptions in traffic, damage to infrastructure
	Frequent snowing, wind, long winter	Freezing of rivers – interruption of water ways

In terms of conditions in the Slovak Republic, the following impacts are expected in relation to the climate change impacts on 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 northern 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 amounts of precipitation in winter.
- Decrease of snowfall in the lowlands of the country, the number of freezing days and days with the presence of black ice.
- Variability of climate effects on road traffic will increase – from positive in the lowlands to negative in higher altitudes.
- In rail traffic, positive climate change influences, such as the increase in air temperature, will be in mountains and basins. Negative climate change impacts are represented by heat waves, particularly in the lowlands in summer time.
- Considering rail traffic in relation to precipitation, a 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 and during the winter due to the freezing of water levels.
- 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.
- The most vulnerable means of transport to climate change impacts seems to be road traffic (very similarly to nowadays).

- The most vulnerable regions of the Slovak Republic in terms of traffic are basins and higher altitudes in the northern, central and eastern part of the country.
- Some shorter road sections above 1,200 m a. s. l. will probably suffer from higher amounts of precipitation in winter, therefore road and other means of transport will be more problematic in those particular sections.

Vulnerability Assessment in the Transport Sector

Based on the analysis of current knowledge and information about traffic in the Slovak Republic, we have 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 6.10 shows the risk level expressed in four grades in individual municipal regions.

Table 6.10: *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 the Transport Sector

Adaptation measures in traffic can be divided into two groups of actions. The first includes measures focused on the 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 reduce 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 transport.

Measures in water transport:

- reconstruction and completion of water transport infrastructure;
- improvements to the regular maintenance of the Danube waterway;
- transfer of bulk goods transport from railways to waterways;
- achievement of targets for the introduction of alternative fuels in water transport;
- support of the remotorisation of vessels in accordance with Regulation (EU) 2016/1628 of the European Parliament and of the Council.

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

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

6.3.8 Energy Sector

The energy system of the Slovak Republic represents the structures of consumption of primary energy sources and their transformation into 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 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 in summers and outages in the power system due to adverse weather events.

Impacts of Climate Change on the Energy Sector

The positive impact of the increase of the mean temperature will cause a 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 heating needs in these days requires adequate installed thermal capacity. However, it is still expected that the annual use of installed capacity will be reduced.

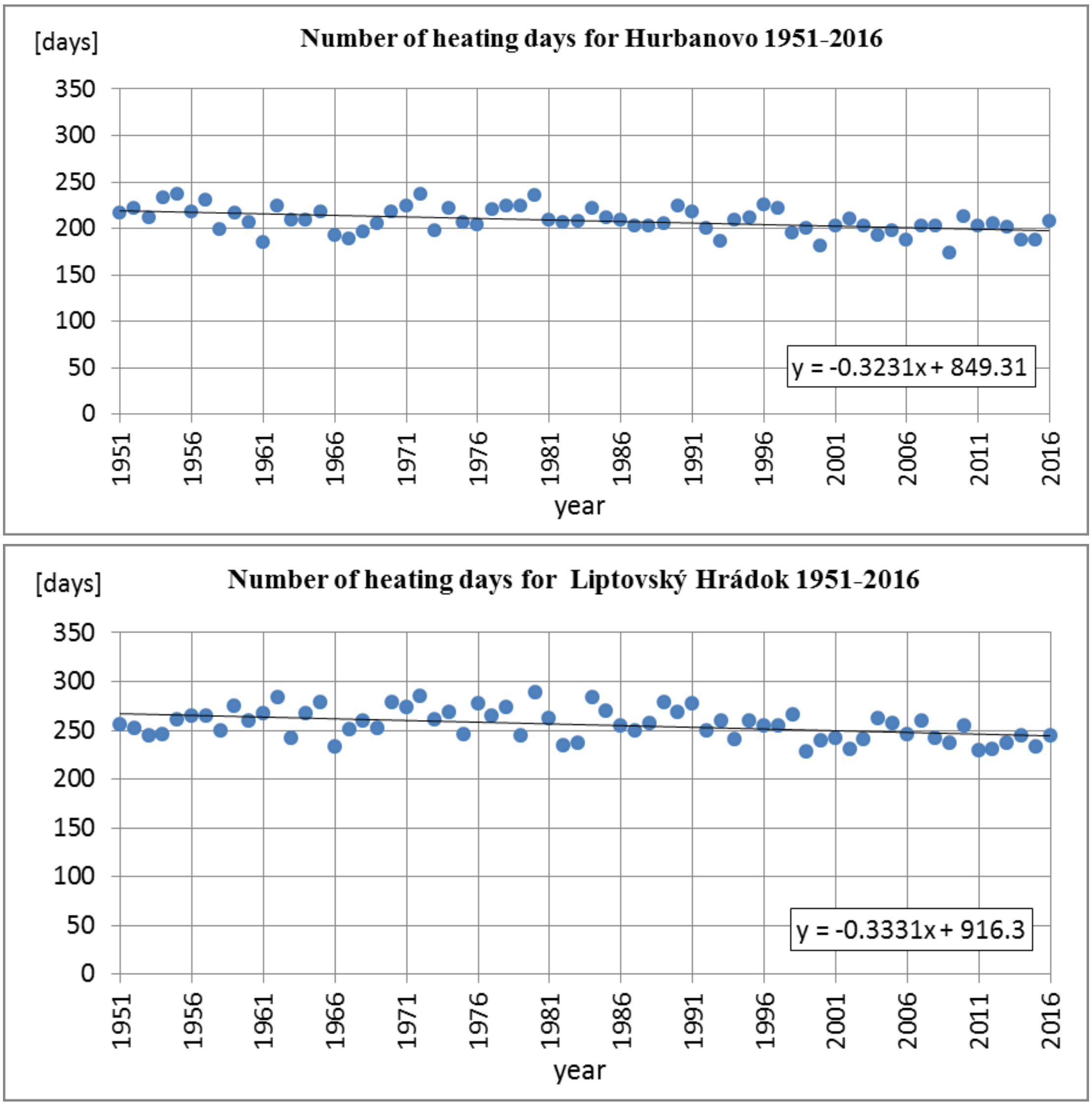
The length of the heating season is determined by the ambient temperature. In the warmest areas of the Slovak Republic, the length of the heating season ranged from 190 to 230 days a year and in Figure 6.18 we can see a clear trend of decline in the length of the heating season, which fell during the period of 1951 - 2010 by 19 days (Hurbanovo). Similarly, in the northern regions of the Slovak Republic (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. The number of tropical nights and hot days will increase. This will mean increased demand for air-conditioning units and simultaneously an increase in electricity consumption during hot days.

Extreme weather events such as storms, droughts and periods of high and low surface water levels 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 mean an increased risk for the transmission and distribution of electricity. The consequence of this situation could be an interruption of energy or a 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 the adequate availability of cooling water. These plants could be affected by 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 6.18: *Length of the heating period for lowland (Hurbanovo) and mountainous (Liptovský Hrádok) areas in the Slovak Republic in the period of 1961 – 2010*



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

1. The reduction of energy demands for heating during winters as a consequence of the shortening of the heating period.
2. Black-outs connected with the occurrence of meteorological phenomena such as storms, haze and floods. The increase in intensity of extreme weather events could

also increase the occurrence of black-outs by 10% (lower estimation) to 20% (upper estimation) in the year 2050, in comparison to the reference period 2000 - 2010.

3. An increase of energy demands for the needs of air conditioning for buildings, houses, apartments and industrial buildings.

Vulnerability Assessment of the Energy Sector

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. This includes, in particular, phenomena connected with high wind speed, such as tornadoes, strong thunderstorms, and so on but also the accessibility to water for cooling and the temperature parameters of this water. Another aspect is the resistance to transmission system failures, namely strong wind, frost and ice as well as their combinations. In hydropower energetics there is the increased likelihood of the extension of hydrological drought.

Adaptation Measures in the Energy Sector

Basic measure for the energy 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 air conditioning for 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 heat generation strategies with respect to the shortening of the heating season.

Table 6.11: *Summary of information on vulnerability and adaptation to climate change in the Slovak Republic*

Vulnerable field	Examples/Comments/Adaptation measures
Agriculture	Vulnerability: • Creeping increase of aridness of maize production area. • Increased water, wind and soil erosion, aggravation of the soil structure, worse water reachability in the soil profile and more intensive salinization and sodification process. • Occurrence and spread of pests and diseases of agricultural plants, trees and animals. Adaptation: • Change the structure of species and varieties of crops grown in the Slovak Republic. • Adapt the agro technical measures to changed agro climatic conditions. • Support the revitalization of old and construction of new irrigation systems. • Apply agro technical measures supporting soil protection, cultivation technologies for soils endangered by erosion, use of more organic matter in soil, improve the retention capacity of soil. • Ensure good practices in land use, preserve mosaic landscape and segmentation of land, support the maintenance of windbreaks, grass strips, terraces and permanent grasslands. • Support ecological agriculture. • Introduce adaptation measures in farming to minimise the temperature stress on animals.
Forest management	Vulnerability: • Increasing frequency and severity of drought and hot spells with an impact on forest health,

Vulnerable field	Examples/Comments/Adaptation measures
	productivity and susceptibility to secondary biotic damage. High mainly in low to medium elevations. • Appearance of new pests and diseases, and development of more generations of spruce bark beetle. High throughout the forest area. • Persisting decline of secondary Norway spruce forests, potentially amplified by climate change. Moderate mainly in medium elevations. • Increased severity of windstorms with impacts mainly on mountain forests. Moderate with impact mainly on high elevation forests. • Increased risk of forest fires. Moderate mainly in low to medium elevations. Adaptation: • Change of tree species composition, increasing the share of drought tolerant species, reduction of water demand, increasing stand diversity, reducing the share of host trees within the outbreak range of climate sensitive pests, consideration of assisted migration in favour of southern species and provenances with phenotypic stability. • Adaptive silvicultural interventions to support species and structural diversity of stands, natural regeneration and combination with artificial regeneration, long regeneration phases in small patches. • Shortening the rotation period of tree species with high susceptibility to insects and diseases, to accelerate the transition to a more suitable species composition. • Supporting forest monitoring activities to early identify adverse trends in forest development. • Optimalization of forest road networks. • Improvement of the accessibility of areas that require sanitation operations and stimulation of small-scale management. • Financial support to management practices which address climate change adaptation.
Biodiversity	Vulnerability: • Invasions of some species of insects as agricultural pests. • Invasions of vector diseases threatening human health. • Decrease in biodiversity. • The most vulnerable are sensitive ecosystems such as pine groves grown in the mountains, swamp ecosystems, agricultural ecosystems developed in foothills and mountains as well as aquasystems. Adaptation: • Phytopathological measures in legislation and in practice. • Conservation of the original species spectrum of biodiversity in the Slovak Republic. • Protection of extra endangered species and communities; Prevention of drying of wetlands and water biotopes. • Completion of infrastructure and capacities in the field of institutional nature protection. • Minimalization of negative impacts on biodiversity in cooperation with other sectors. • Application of ecosystem-based adaptation measures.
Public Health	Vulnerability: • Extending the pollen period and its dissemination to new geomorphologic areas. Adaptation: Monitoring of the pollen season and dissemination of information to the public. • The impact of extreme air temperatures on cyanobacteria in bathing waters. Adaptation: Monitoring of the bathing waters to assess their quality, dissemination of information to the public. • Deteriorating health conditions of people with cardiovascular and respiratory diseases, asthma, premature deaths, dehydration due to extreme weather (increasing heat-waves and cold-waves, floods). Adaptation: Awareness and information dissemination related to prevention. • Exposure to increasing UV radiation and its negative skin effects. Adaptation: Indirectly through the state health supervision within solaria. • Extending the vector of transmission of infectious diseases (mosquitoes, ticks) to new geographic areas. Adaptation: Collection of incidence data, awareness and information dissemination related to prevention. • The effects of heat on mortality and morbidity in the population. • Mortality and morbidity associated with flooding. • Potential future distribution of important disease vector species. • Food safety at all stages from production to consumption. Adaptation: • Monitoring of the pollen season and dissemination of information to the public. • Monitoring of the bathing waters to assess their quality, dissemination of information to the public. • Awareness and information dissemination related to prevention. • Collection of incidence data on transmission of infectious diseases, awareness and information dissemination related to prevention • Reduce heat-related health effects through health protection and health promotion measures - changes in housing and infrastructure in the future, improvement of heat-related health warning systems. • Disease surveillance programs and vaccination.

Vulnerable field	Examples/Comments/Adaptation measures
	• National monitoring and control in food safety.
Hydrology and water management	Vulnerability: • Threat to water resources for water supply and electric energy production. • Decrease in water resources in the south and east of the Slovak Republic. • 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 of big and small flood control reservoirs storage. • Utilization of new energy sources (bio-fuels, wind energy, small hydropower stations).
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 the Slovak Republic. Adaptation: • Reorientation of threatened winter centres to other activities. • Development of sustainable tourism (ecotourism, geotourism). • Diversifying tourism options for different seasons.
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.
Energy	Vulnerability: • Affecting power plants by more adverse weather phenomena, tornadoes and strong thunderstorms. • Higher demand for energy in summer season. • Less water in rivers. Adaptation: • Increase of power plant safety.

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7 PROVISION OF FINANCIAL, TECHNOLOGICAL AND CAPACITY BUILDING SUPPORT TO DEVELOPING COUNTRIES

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 of 2014 - 2016 under the financial assistance granted by the SR to developing countries. Of the total portfolio, the 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.

All the Slovak bilateral (Tables 7.4 - 7.6) and multilateral climate financial support (Tables 7.7- 7.9) provided to developing country Parties in 2014 - 2016 was channelled through the Official Development Assistance (ODA) in accordance with OECD DAC methodology. The Slovak Republic uses Rio markers developed for the OECD Development Assistance Committee's Creditor Reporting System (OECD DAC CRS) to track adaptation- and mitigation-related (and also biodiversity and desertification) finance based on the data provided in the CRS.

In 2014 - 2016 the Slovak Republic supported 52 capacity building projects among developing countries in which a capacity building was the principal objective (Tables 7.10 - 7.12). The following projects and programmes illustrate the efforts of the Slovak Republic Development Cooperation as regards capacity building.

In 2014, the Slovak Republic financially supported one technology transfer project, in 2015 and 2016 it did not support any technology transfer (Table 7.13).

As of 2013, the Slovak Republic is the 27th member of the OECD Development Assistance Committee (DAC), the leading international forum for bilateral providers of development co-operation. The Slovak Republic's accession to the DAC comes after a period of rapid expansion in its development activities, notably growth of official development assistance (ODA). The Slovak Republic has also developed legislative and strategic frameworks as well as monitoring and evaluation systems for providing effective development co-operation.

Table 8.1: *Provision of public financial support: summary information in 2014*

Allocation channels	*Year*									
	European euro - EUR					*USD**				
	Core/ general	*Climate-specific*				*Core/ general*	*Climate-specific*			
		Mitigation	*Adaptation*	*Cross-cutting*	*Other*		*Mitigation*	*Adaptation*	*Cross-cutting*	*Other*
Total contributions through multilateral channels:										
Multilateral climate change funds		198,996.50	3,676.36	25,493.73			234,935.27	4,340.31	30,097.90	
Multilateral financial institutions, including regional development banks				124,975.00					147,545.49	
Specialized United Nations bodies	305,224.72					360,348.3				
Total contributions through bilateral, regional and other channels			760,370.96					897,693.96		
Total climate specific by funding type (total for mitigation, adaptation, crosscutting, other)		198,996.50	764,047.32	150,468.73			234,935.27	902,034.27	177,643.38	
Total climate specific finance		1,113,512.55					1,314,612.917			

Values calculated by Euro Foreign Exchange Reference Rates (European Central Bank) on 29.09.2017; EUR 1 = USD 1.1806; Source: http://www.ecb.int/stats/eurofxref/

Table 8.2: *Provision of public financial support: summary information in 2015*

Allocation channels	*Year*									
	European euro - EUR					*USD**				
	Core/ general	*Climate-specific*				*Core/ general*	*Climate-specific*			
		Mitigation	*Adaptation*	*Cross-cutting*	*Other*		*Mitigation*	*Adaptation*	*Cross-cutting*	*Other*
Total contributions through multilateral channels:										
Multilateral climate change funds		244,705.99	109,225.36				288,899.89	128,951.46		
Multilateral financial institutions, including regional development banks		74,705.00					88,196.72			
Specialized United Nations bodies	255,846.07		200,000.00			302,051.87		236,120.00		
Total contributions through bilateral, regional and other channels			1,468,634.78	98,736.00				1,733,870.19	116,567.72	

Total climate specific by funding type (total for mitigation, adaptation, crosscutting, other)		319,410.99	1,777,860.14	98,736.00			377,096.61	2,098,941.65	116,567.72	
Total climate specific finance		2,196,007.13					2,592,606.018			

Values calculated by Euro Foreign Exchange Reference Rates (European Central Bank) on 29.09.2017; EUR 1 = USD 1.1806; Source: http://www.ecb.int/stats/eurofxref/

Table 8.3: *Provision of public financial support: summary information in 2016*

Allocation channels	*Year*									
	European euro - EUR					*USD* *				
	Core/ general	*Climate-specific*				*Core/ general*	*Climate-specific*			
		Mitigation	*Adaptation*	*Cross-cutting*	*Other*		*Mitigation*	*Adaptation*	*Cross-cutting*	*Other*
Total contributions through multilateral channels:										
Multilateral climate change funds		191,254.51	99,650.00				225,795.07	117,646.79		
Multilateral financial institutions, including regional development banks		1,440,327.00					1,700,450.10			
Specialized United Nations bodies	897,019.58					1,059,021.30				
Total contributions through bilateral, regional and other channels		188,532.50	733,225.45	333,654.72			222,581.47	865,645.97	393,912.76	
Total climate specific by funding type (total for mitigation, adaptation, crosscutting, other)		1,820,114.01	832,875.45	333,654.72			2,148,826.60	983,292.76	393,912.76	
Total climate specific finance		2,986,644.18					3,526,032.119			

Values calculated by Euro Foreign Exchange Reference Rates (European Central Bank) on 29.09.2017; EUR 1 = USD 1.1806; Source: http://www.ecb.int/stats/eurofxref/

Table 8.4: *Provision of public financial support: contributions through bilateral, regional and other channels in 2014*

Recipient country/ region/project/programme	*Total amount*		*Status:*	*Funding source:*	*Financial instrument:*	*Type of support:*	*Sector*	*Additional information*
	Climate-specific							
	European euro - EUR	*USD**						
Afghanistan	1,475.00	1,741.39	*provided*	*ODA*	*other (scholarship)*	*adaptation*	*Post-secondary education*	Study programme aimed at horticulture
Albania	4,320.00	5,100.19	*provided*	*ODA*	*other (scholarship)*	*adaptation*	*Post-secondary education*	Study programme aimed at architecture and urban planning
	3,586.96	4,234.76	*provided*	*ODA*	*Grant*	*adaptation*	*Waste management / disposal*	Project: Green Tirana. Implemented by donor country NGO
Armenia	5,160.00	6,091.90	*provided*	*ODA*	*other (scholarship)*	*adaptation*	*Post-secondary education*	Study programme aimed at environmental management
Benin	4,320.00	5,100.19	*provided*	*ODA*	*other (scholarship)*	*adaptation*	*Post-secondary education*	Study programme aimed at agricultural machinery
Belarus	4,320.00	5,100.19	*provided*	*ODA*	*other (scholarship)*	*adaptation*	*Post-secondary education*	Study programme aimed at environmental science
Burkina Faso	2,880.00	3,400.13	*provided*	*ODA*	*other (donor country personnel)*	*adaptation*	*Agricultural development*	Evaluation of the activities of an association of vegetable growers. Slovak ODA Volunteer programme
Ecuador	4,320.00	5,100.19	*provided*	*ODA*	*other (scholarship)*	*adaptation*	*Post-secondary education*	Study programme aimed at environmental engineering
Ethiopia	4,320.00	5,100.19	*provided*	*ODA*	*other (scholarship)*	*adaptation*	*Post-secondary education*	Study programme aimed at hydraulic engineering and water management
Georgia	5,892.60	6,956.80	*provided*	*ODA*	*other (donor country personnel)*	*adaptation*	*Agricultural development*	Identifying needs and preparation of project objectives in the field of agricultural development
	67,808.40	80,054.60	*provided*	*ODA*	*Grant*	*adaptation*	*Water resources conservation - including data collection*	Strengthening of water protection through a controlling system of effluent quality and monitoring of the water bodies at risk in Georgia. Implemented by Slovak agency for international development cooperation
Kenya	3,500.00	4,132.10	*provided*	*ODA*	*Grant*	*adaptation*	*Basic drinking water supply*	Onyalo Biro Agriculture and Water Project. Implemented by donor country NGO
	5,520.00	6,516.91	*provided*	*ODA*	*other (donor country personnel)*	*adaptation*	*Agricultural development*	Skilled volunteers for Kenya. Slovak ODA Volunteer programme
	5,600.00	6.611.36	*provided*	*ODA*	*other (donor country personnel)*	*adaptation*	*Health education*	Skilled volunteers for Kenya, Nairobi. Slovak ODA Volunteer programme
	178.185.00	210.365.21	*provided*	*ODA*	*Grant*	*adaptation*	*Agricultural development*	Implemented by Slovak agency for international development cooperation

	3.500.00	4.132.10	*provided*	*ODA*	*Grant*	*adaptation*	*Primary education*	Nileroad ablution block. Increasing food security through economic empowerment, agricultural development and sustainable natural resources utilisation at the coast of Kenya. Implemented by donor country NGO
Kazakhstan	2.880.00	3.400.13	*provided*	*ODA*	*other (scholarship)*	*adaptation*	*Post-secondary education*	Study programme aimed at geodesy and cartography
Moldova	70.646.00	83.404.67	*provided*	*ODA*	*Grant*	*adaptation*	*Waste management / disposal*	Support to development of the programme of measures focusing on water and sanitation issues in river basin management planning in Moldova. Implemented by Slovak agency for international development cooperation
	78.729.00	92.947.46	*provided*	*ODA*	*Grant*	*adaptation*	*Water supply and sanitation - large systems*	Access to qualitative water in Hincesti district. Implemented by Slovak agency for international development cooperation
Mongolia	4.620.00	5.454.37	*provided*	*ODA*	*other (scholarship)*	*adaptation*	*Post-secondary education*	Study programme aimed at landscaping and general agriculture
	5.600.00	6.611.36	*provided*	*ODA*	*other (donor country personnel)*	*adaptation*	*Agricultural development*	Skilled volunteers for Mongolia. Slovak ODA Volunteer programme
Peru	8.645.00	10.206.29	*provided*	*ODA*	*other (scholarship)*	*adaptation*	*Post-secondary education*	Study programme aimed at general agriculture, environmental science, architecture and urban planning
South Sudan	143.700.00	169.652.22	*provided*	*ODA*	*Grant*	*adaptation*	*Agricultural education/training*	Improving the food security in Deim Zubeir through increased crop production, food processing and food storage in community groups. Implemented by Slovak agency for international development cooperation
Seychelles	2,880.00	3,400.13	*provided*	*ODA*	*other (scholarship)*	*adaptation*	*Post-secondary education*	Study programme aimed at environmental management
Serbia	71,680.00	84,625.41	*provided*	*ODA*	*other (scholarship)*	*adaptation*	*Post-secondary education*	Study programme aimed at environmental science, environmental biochemistry, environmental management, lanscaping, land protection and land use, crop protection, processing of agricultural products, synecology, hydraulic engineering and water management, general/system ecology, general agriculture and horticulture
Sudan	13,850.00	16,351.31	*provided*	*ODA*	*other (scholarship)*	*adaptation*	*Post-secondary education*	Study programme aimed at hydrotechnical melioration, environmental planning and management
Tajikistan	2,880.00	3,400.13	*provided*	*ODA*	*other (scholarship)*	*adaptation*	*Post-secondary education*	Study programme aimed at environmental engineering
Ukraine	2,950.00	3,482.77	*provided*	*ODA*	*other (scholarship)*	*adaptation*	*Post-secondary education*	Study programme aimed at environmental management
Uzbekistan	16,320.00	19,267.39	*provided*	*ODA*	*other (scholarship)*	*adaptation*	*Post-secondary education*	Study programme aimed at agricultural products processing, general ecology and environmental management
The former	1,475.00	1,741.39	*provided*	*ODA*	*other (scholarship)*	*adaptation*	*Post-secondary*	Study programme aimed at architecture and urban

Yugoslav Republic of Macedonia							*education*	planning
The former Yugoslav Republic of Macedonia and Moldova	28,808.00	34,010.72	*provided*	*ODA*	*Grant*	*adaptation*	*Agriculture*	Project: Developement of food database program for developing countries. Macedonia: training in building food database or alike. Moldova: training in utilization of food database.
Total contributions through bilateral, regional and other channels	**760,371.00**	**897,694.00**						

Values calculated by Euro Foreign Exchange Reference Rates (European Central Bank) on 29.09.2017; EUR 1 = USD 1.1806; Source: http://www.ecb.int/stats/eurofxref/

Table 8.5: *Provision of public financial support: contributions through bilateral, regional and other channels in 2015*

Recipient country/ region/project/programme	*Total amount*		*Status*	*Funding source*	*Financial instrument*	*Type of support*	*Sector*	*Additional information*
	Climate-specific							
	European euro - EUR	*USD**						
Afghanistan	11,160.00	13,175.50	*provided*	*ODA*	*other (scholarship)*	*adaptation*	post-secondary education	Study programme aimed at gardening, architecture, urbanism
Albania	4,320.00	5,100.19	*provided*	*ODA*	*other (scholarship)*	*adaptation*	post-secondary education	Study programme aimed at architecture and urban planning
Armenia	5,700.00	6,729.42	*provided*	*ODA*	*other (scholarship)*	*adaptation*	post-secondary education	Study programme aimed at environmental management
Belarus	4,320.00	5,100.19	*provided*	*ODA*	*other (scholarship)*	*adaptation*	post-secondary education	Study programme aimed at environmental science
Bosnia and Herzegovina	4,320.00	5,100.19	*provided*	*ODA*	*other (scholarship)*	*adaptation*	post-secondary education	Study programme aimed at processing agricultural products

Ecuador	7,200.00	8,500.32	*committed*	*ODA*	*grant*	*adaptation*	rural development	Volunteer sending programme
	4,320.00	5,100.19	*provided*	*ODA*	*other (scholarship)*	*adaptation*	post-secondary education	Study programme aimed at environmental science
Ethiopia	2,260.00	2,668.16	*provided*	*ODA*	*other (scholarship)*	*adaptation*	post-secondary education	Study programme aimed at water construction and water economy
Georgia	6,140.00	7,248.88	*committed*	*ODA*	*grant*	*adaptation*	basic drinking water supply and basic sanitation	Volunteer sending programme
	99,265.50	117,192.85	*committed*	*ODA*	*grant*	*adaptation*	water sector policy and administrative management	The project is aimed at support of effective management of water management projects. The project is realised by NISPAcee.
Kenya	247,500.00	292,198.50	*committed*	*ODA*	*grant*	*adaptation*	agricultural development	The project is aimed at strengthening the socio-economical conditions of 500 farmers in the Busier region through enhanced production of sesame seeds, access to local markets and generation of profit. The project is realised by a Slovak NGO, ADRA.
	249,961.50	295,104.55	*committed*	*ODA*	*grant*	*adaptation*	industrial crops/export	The project is aimed at the support of production and marketing of Fair-trade oil and developing economic independence of small farmers. The project is realised by a Slovak NGO, Integra.
	35,000.00	41,321.00	*committed*	*ODA*	*grant*	*adaptation*	basic drinking water supply and basic sanitation	The project is aimed at support of Kenyan entrepreneurs in the area of water management and access for local communities to drinking water. The project is realised by a private company, AQUA SOLUTIONS, s.r.o.
	21,490.00	25,371.09	*committed*	*ODA*	*grant*	*adaptation*	basic drinking water supply and basic sanitation	Volunteer sending programme

	19,209.48	22,678.71	*committed*	*ODA*	*grant*	*adaptation*	agriculture	Agriculture - food production/food security, financial contributions to local organizations
	8,640.00	10,200.38	*provided*	*ODA*	*other (scholarship)*	*adaptation*	post-secondary education	Study programme aimed at transport construction and environmental engineering
Kosovo	4,320.00	5,100.19	*provided*	*ODA*	*other (scholarship)*	*adaptation*	post-secondary education	Study programme aimed at environmental architecture and urbanism
Macedonia	4,320.00	5,100.19	*provided*	*ODA*	*other (scholarship)*	*adaptation*	post-secondary education	Study programme aimed at environmental architecture and urbanism
Moldova	78,285.00	92,423.27	*committed*	*ODA*	*grant*	*adaptation*	water supply and sanitation - large systems	The project is aimed at methodological and technical support of a drinking water safety system as well as related institutional support. The project is realised by the Slovak Water Management Research Institute.
	93,905.00	110,864.24	*committed*	*ODA*	*grant*	*adaptation*	basic sanitation	The project is aimed at building a sustainable system of waste water cleaning in the small country side village of Bucovat. The project is realised by a private Slovak company, DEKONTA Slovensko, s.r.o.
	96,882.30	114,379.24	*committed*	*ODA*	*grant*	*adaptation*	Sanitation - large systems	Installation of three sewage treatment plants for houses in the Hincesti region
	34,800.00	41,084.88	*committed*	*ODA*	*grant*	*adaptation*	agriculture	Beekeeping
	5,960.00	7,036.38	*committed*	*ODA*	*grant*	*adaptation*	basic drinking water supply and basic sanitation	Volunteer sending programme
	200,000.00	236,120.00	*committed*	*ODA*	*grant*	*adaptation*	water supply and sanitation - large systems	Multilateral cooperation with the Czech Republic in Moldova
	54,966.00	64,892.86	*committed*	*ODA*	*grant*	*adaptation*	water and sanitation	Water and sanitation, financial contributions to local organizations
	8,640.00	10,200.38	*provided*	*ODA*	*other (scholarship)*	*adaptation*	post-secondary education	Study programme aimed at architecture and urbanism, environmental management

Mongolia	5,000.00	5,903.00	*committed*	*ODA*	*grant*	*adaptation*	agriculture	Agriculture - cheese production, financial contributions to local organizations
Peru	8,640.00	10,200.38	*provided*	*ODA*	*other (scholarship)*	*adaptation*	post-secondary education	Study programme aimed at architecture and urbanism, production of plants
Serbia	81,485.00	96,201.19	*provided*	*ODA*	*other (scholarship)*	*adaptation*	post-secondary education	Study programme aimed at architecture and urbanism, environmentalist, biochemistry, landscape protection, production of plants, processing of agricultural products, synecology, water constructions, general and system ecology and gardening
Tajikistan	5,130.00	6,056.48	*provided*	*ODA*	*other (scholarship)*	*adaptation*	post-secondary education	Study programme aimed at environmental engineering
Ukraine	98,736.00	116,567.72	*committed*	*ODA*	*grant*	*crosscutting*	energy policy and administrative management	The aim of the project is the transition of Slovak knowledge in the area of energy efficiency including EU legislation implementation. The project is realised by the Research Institute of the Slovak Foreign Policy Society.
	10,890.00	12,856.73	*committed*	*ODA*	*grant*	*adaptation*	basic drinking water supply and basic sanitation	Volunteer sending programme
	10,115.00	11,941.77	*provided*	*ODA*	*other (scholarship)*	*adaptation*	post-secondary education	Study programme aimed at architecture, urbanism and environmental management
Uzbekistan	7,200.00	8,500.32	*provided*	*ODA*	*other (scholarship)*	*adaptation*	post-secondary education	Study programme aimed at environmental management, general ecology and ecology of population
Ukraine and Moldova	27,290.00	32,218.57	*provided*	*ODA*	*grant*	*adaptation*	agriculture	Project: Development of food database program for developing countries. Uzhgorod: training in building and use of food database for one expert from Uzhgorod National University. Moldova: providing a revised version of the Daris program comprising the data gathered by the Technical University in Moldova during cooperation in the year 2015.
Total contributions through bilateral, regional and other channels	**1,567,370.78**	**1,850,437.94**						

Values calculated by Euro Foreign Exchange Reference Rates (European Central Bank) on 29.09.2017; EUR 1 = USD 1.1806; Source: http://www.ecb.int/stats/eurofxref/

Table 8.6: *Provision of public financial support: contributions through bilateral, regional and other channels in 2016*

Recipient country/ region/project/programme	*Total amount*		*Status*	*Funding source*	*Financial instrumen*	*Type of support*	*Sector*	*Additional information*
	Climate-specific²							
	European euro - EUR	*USD**						
Afghanistan	110,000.00	11,475.43	*disbursed*	*ODA*	*grant*	*crosscutting*	Post-secondary education	
Afghanistan	9,720.00	6,044.67	*provided*	*ODA*	*other (scholarship)*	*adaptation*	post-secondary education	Study programme aimed at gardening, architecture and urbanism
Albania	5,120.00	8,075.30	*provided*	*ODA*	*other (scholarship)*	*adaptation*	post-secondary education	Study programme aimed at architecture and urbanism, environmental management
Armenia	6,840.00	4,132.10	*provided*	*ODA*	*other (scholarship)*	*adaptation*	post-secondary education	Study programme aimed at environmental management
Albania	3,500.00	3,400.13	*disbursed*	*ODA*	*grant*	*crosscutting*	General environmental protection	
Belarus	2,880.00	6,800.26	*provided*	*ODA*	*other (scholarship)*	*adaptation*	post-secondary education	Study programme aimed at environmental science
Bosnia and Herzegovina	5,760.00	4,131.60	*provided*	*ODA*	*other (scholarship)*	*adaptation*	post-secondary education	Study programme aimed at processing agricultural products, environmental management
Bosnia and Herzegovina	3,499.58	4,132.10	*disbursed*	*ODA*	*grant*	*crosscutting*	Water and sanitation	
Bosnia and Herzegovina	3,500.00	3,858.28	*disbursed*	*ODA*	*grant*	*crosscutting*	Energy generation and supply	
Bosnia and Herzegovina	3,268.07	11,475.43	*disbursed*	*ODA*	*grant*	*crosscutting*	Water and sanitation	
Bosnia and Herzegovina	90,000.00	106,254.00	*disbursed*	*ODA*	*grant*	*adaptation*	Water and sanitation	
Ecuador	4,320.00	5,100.19	*provided*	*ODA*	*other (scholarship)*	*adaptation*	post-secondary education	Study programme aimed at environmental science
Ethiopia	2,260.00	2,668.16	*provided*	*ODA*	*other (scholarship)*	*adaptation*	post-secondary education	Study programme aimed at water constructions and water economy
Georgia	2,185.48	2,580.18	*disbursed*	*ODA*	*grant*	*adaptation*	Water and sanitation	
Georgia	902.94	1,066.01	*disbursed*	*ODA*	*grant*	*crosscutting*	Water and sanitation	

Georgia	5,9017.50	69,676.06	*disbursed*	*ODA*	*grant*	*mitigation*	Water and sanitation	
Georgia	3,500.00	4,132.10	*disbursed*	*ODA*	*grant*	*crosscutting*	Water and sanitation	
Georgia	1,440.00	1,700.06	*provided*	*ODA*	*other (scholarship)*	*adaptation*	post-secondary education	Study programme aimed at architecture and urbanism
Kenya	4,320.00	5,100.19	*provided*	*ODA*	*other (scholarship)*	*adaptation*	post-secondary education	Study programme aimed at transport constructions and environmental engineering
Kenya	214,892.00	253,701.50	*disbursed*	*ODA*	*grant*	*adaptation*	Agriculture	
Kenya	7,000.00	8,264.20	*disbursed*	*ODA*	*grant*	*crosscutting*	Agriculture	
Kenya	7,000.00	8,264.20	*disbursed*	*ODA*	*grant*	*crosscutting*	Agriculture	
Kenya	7,000.00	8,264.20	*disbursed*	*ODA*	*grant*	*crosscutting*	Agriculture	
Kenya	853.79	1,007.98	*disbursed*	*ODA*	*grant*	*crosscutting*	Agriculture	
Kenya	129,515.00	152,905.41	*disbursed*	*ODA*	*grant*	*mitigation*	Agriculture	
Kenya	1,500.00	1,770.90	*disbursed*	*ODA*	*grant*	*crosscutting*	Agriculture	
Kenya	1,077.56	1,272.17	*disbursed*	*ODA*	*grant*	*crosscutting*	Agriculture	
Kenya	1,410.00	1,664.65	*disbursed*	*ODA*	*grant*	*crosscutting*	Agriculture	
Kenya	1,352.84	1,597.16	*disbursed*	*ODA*	*grant*	*crosscutting*	Water and sanitation	
Kenya	1,440.00	1,700.06	*disbursed*	*ODA*	*grant*	*crosscutting*	Water and sanitation	
Kosovo	1,440.00	1,700.06	*provided*	*ODA*	*other (scholarship)*	*adaptation*	post-secondary education	Study programme aimed at architecture and urbanism
Kosovo	4,181.00	4,936.09	*disbursed*	*ODA*	*grant*	*crosscutting*	Education	
Kosovo	4,019.00	4,744.83	*disbursed*	*ODA*	*grant*	*crosscutting*	General environmental protection	
Kosovo	4,350.00	5,135.61	*disbursed*	*ODA*	*grant*	*crosscutting*	Forestry	
Lebanon	7,000.00	8,264.20	*disbursed*	*ODA*	*grant*	*adaptation*	Water and sanitation	
Macedonia, Ukraine, Moldova	27,290.00	32,218.57	*disbursed*	*ODA*	*grant*	*adaptation*	Agriculture	
Macedonia	1,440.00	1,700.06	*provided*	*ODA*	*other (scholarship)*	*adaptation*	post-secondary education	Study programme aimed at architecture and urbanism
Moldova	5,760.00	6,800.26	*provided*	*ODA*	*other (scholarship)*	*adaptation*	post-secondary education	Study programme aimed at architecture and urbanism, environmental science
Moldova	1,130.29	1,334.42	*disbursed*	*ODA*	*grant*	*crosscutting*	Water and sanitation	
Moldova	14,136.31	16,689.33	*disbursed*	*ODA*	*grant*	*crosscutting*	Water and sanitation	

Moldova	1,500.00	1,770.90	*disbursed*	*ODA*	*grant*	*adaptation*	Water and sanitation	
Moldova	1,500.00	1,770.90	*disbursed*	*ODA*	*grant*	*adaptation*	Water and sanitation	
Moldova	1,271.84	1,501.53	*disbursed*	*ODA*	*grant*	*adaptation*	Water and sanitation	
Moldova	437.68	516.73	*disbursed*	*ODA*	*grant*	*adaptation*	Water and sanitation	
Moldova	5,000.00	5,903.00	*disbursed*	*ODA*	*grant*	*adaptation*	Water and sanitation	
Moldova	1,287.75	1,520.32	*disbursed*	*ODA*	*grant*	*adaptation*	Water and sanitation	
Moldova	1,500.00	1,770.90	*disbursed*	*ODA*	*grant*	*adaptation*	Water and sanitation	
Moldova	1,498.79	1,769.47	*disbursed*	*ODA*	*grant*	*adaptation*	Water and sanitation	
Moldova	636.95	751.98	*disbursed*	*ODA*	*grant*	*crosscutting*	Water and sanitation	
Moldova	3,500.00	4,132.10	*disbursed*	*ODA*	*grant*	*adaptation*	Water and sanitation	
Moldova	60,955.00	71,963.47	*disbursed*	*ODA*	*grant*	*adaptation*	Water and sanitation	
Moldova	3,496.50	4,127.97	*disbursed*	*ODA*	*grant*	*adaptation*	Water and sanitation	
Moldova	69,923.00	82,551.09	*disbursed*	*ODA*	*grant*	*adaptation*	Water and sanitation	
Moldova	7,000.00	8,264.20	*disbursed*	*ODA*	*grant*	*adaptation*	Water and sanitation	
Moldova	7,000.00	8,264.20	*disbursed*	*ODA*	*grant*	*adaptation*	Water and sanitation	
Moldova	7,000.00	8,264.20	*disbursed*	*ODA*	*grant*	*adaptation*	Water and sanitation	
Moldova	4,529.00	5,346.94	*disbursed*	*ODA*	*grant*	*adaptation*	Water and sanitation	
Moldova	6,267.28	7,399.15	*disbursed*	*ODA*	*grant*	*adaptation*	Water and sanitation	
Moldova	6,999.75	8,263.90	*disbursed*	*ODA*	*grant*	*adaptation*	Water and sanitation	
Moldova	3,276.00	3,867.65	*disbursed*	*ODA*	*grant*	*adaptation*	Water and sanitation	
Mongolia	1,500.00	1,770.90	*disbursed*	*ODA*	*grant*	*crosscutting*	Agriculture	
Peru	4,320.00	5,100.19	*provided*	*ODA*	*other (scholarship)*	*adaptation*	post-secondary education	Study programme aimed at architecture and urbanism
Serbia	94,850.00	111,979.91	*provided*	*ODA*	*other (scholarship)*	*adaptation*	post-secondary education	Study programme aimed at architecture and urbanism, environmentalist, biochemistry, landscape protection, production of plants, processing of agricultural products, synecology, water constructions, general and system ecology and gardening
South Sudan	9,045.38	10,678.98	*disbursed*	*ODA*	*grant*	*adaptation*	Agriculture	

Syria	1,440.00	1,700.06	*provided*	*ODA*	*other (scholarship)*	*adaptation*	post-secondary education	Study programme aimed at architecture and urbanism
Tadjikistan	6,840.00	8,075.30	*provided*	*ODA*	*other (scholarship)*	*adaptation*	post-secondary education	Study programme aimed at environmental engineering
Ukraine	12,960.00	15,300.58	*provided*	*ODA*	*other (scholarship)*	*adaptation*	post-secondary education	Study programme aimed at architecture and urbanism, environmental management
Ukraine	143,397.00	169,294.50	*disbursed*	*ODA*	*grant*	*crosscutting*	Water and sanitation	
Ukraine	3,499.39	4,131.38	*disbursed*	*ODA*	*grant*	*crosscutting*	Water and sanitation	
Uzbekistan	14,280.00	16,858.97	*provided*	*ODA*	*other (scholarship)*	*adaptation*	post-secondary education	Study programme aimed at environmental management, general ecology and ecology of the population
Vietnam	2,880.00	3,400.13	*provided*	*ODA*	*other (scholarship)*	*adaptation*	post-secondary education	Study programme aimed at environmental management
Total contributions through bilateral, regional and other channels	**1,255,412.67**	**1,482,140.20**						

*****Values calculated by Euro Foreign Exchange Reference Rates (European Central Bank) on 29.09.2017; EUR 1 = USD 1.1806; Source: http://www.ecb.int/stats/eurofxref/*

***Table 8.7:** Provision of public financial support: contributions through multilateral channels in 2014*

Donor funding	*Total amount*				*Status*	*Funding source*	*Financial instrument*	*Type of support:*	*Sector*
	Core/general		*Climate-specific*						
	European euro - EUR	*USD**	*European euro - EUR*	*USD**					
Multilateral climate change funds									
Montreal Protocol Multilateral Fund			173,975.00	205,394.89	provided	ODA	other (membership fee)	mitigation	Not applicable
Montreal Protocol Trust Fund			5,370.96	6,340.96	provided	ODA	other (membership fee)	mitigation	Not applicable
UNFCCC			25,493.73	30,097.90	provided	ODA	other (membership fee)	cross-cutting	Not applicable
Kyoto Protocol under UNFCCC			19,650.54	23,199.43	provided	ODA	other (membership fee)	mitigation	Not applicable
World Meteorological Organisation (WMO)			3,676.36	4,340.31	provided	ODA	other (membership fee)	adaptation	Not applicable

Multilateral financial institutions, including regional development banks									
European Bank for Reconstruction and Development SK-EBRD Technical Co-operation Fund *Projects: Kyrgyz Republic, Capacity enhancement of the Kyrgyz Civil Society Organisation Camp Alatoo regarding residential energy efficiency (II)*			74,975.00	88,515.49	provided	ODA	grant	cross-cutting	Energy efficiency, community/social services
European Bank for Reconstruction and Development as a manager *Contribution to the Eastern Europe Energy Efficiency and Environment Partnership Regional Fund - Moldova window*			50,000.00	59,030.00	provided	ODA	grant	cross-cutting	Energy efficiency, climate change and environment
Specialized United Nations bodies									
United Nations Environment Programme	40,644.40	47,984.78			provided	ODA	other (membership fee)		Not applicable
Other: CITES Multilateral Treaty	8,969.61	10,589.52			provided	ODA	other (membership fee)		Not applicable
Other : The United Nations Convention to Combat Desertification in Those Countries Experiencing Serious Drought and/or Desertification, Particularly in Africa	12,833.00	15,150.64			provided	ODA	other (capital subscription)		Agriculture
Other: The Food and Agriculture Organization of the United Nations	217,287.71	256,529.87			provided	ODA	other (capital subscription)		Agriculture
Other: European and Mediterranean Plant Protection Organization (EPPO)	25,490.00	30,093.49			provided	ODA	other (capital subscription)		Agriculture
Total contributions through multilateral channels	**305,224.72**	**360,348.30**	**353,141.59**	**416,918.96**					

*Values calculated by Euro Foreign Exchange Reference Rates (European Central Bank) on 29.09.2017; EUR 1 = USD 1.1806; Source: http://www.ecb.int/stats/eurofxref/

Table 8.8: *Provision of public financial support: contributions through multilateral channels in 2015*

Donor funding	*Total amount*				*Status*	*Funding source*	*Financial instrument*	*Type of support*	*Sector*
	Core/general		*Climate-specific*						
	European euro - EUR	*USD**	*European euro - EUR*	*USD**					
Multilateral climate change funds									
World Meteorological Organisation (WMO)			109,225.36	128,951.46	provided	ODA	other (membership fee)	adaptation	Not applicable
Montreal Protocol Multilateral Fund			237,984.00	280,963.91	provided	ODA	other (membership fee)	mitigation	Not applicable
Montreal Protocol Trust Fund			6,721.99	7,935.98	provided	ODA	other (membership fee)	mitigation	Not applicable
Multilateral financial institutions, including regional development banks									
European Bank for Reconstruction and Development *Turkey: Assessment of sustainable energy investment potential in the municipal infrastructure sector. Slovak - EBRD TC Fund.*			74,705.00	88,196.72	provided	ODA	grant	mitigation	231: Energy generation, distribution and efficiency – general
Specialized United Nations bodies									
United Nations Development Programme			200,000.00	236,120.00	committed	ODA	grant	adaptation	Energy policy and administrative management
Other: The United Nations Convention to Combat Desertification in Those Countries Experiencing Serious Drought and/or Desertification, Particularly in Africa	12,820.00	15,135.29			provided	ODA	other: capital subscription		Agriculture
Other: The Food and Agriculture Organization of the United Nations (FAO)	215,806.07	254,780.65			provided	ODA	other: capital subscription		Agriculture
Other: European and Mediterranean Plant Protection Organization (EPPO)	27,220.00	32,135.93			provided	ODA	other: capital subscription		Agriculture
Total contributions through multilateral channels	**255,846.07**	**302,051.87**	**628,636.35**	**742,168.07**					

*Values calculated by Euro Foreign Exchange Reference Rates (European Central Bank) on 29.09.2017; EUR 1 = USD 1.1806; Source: http://www.ecb.int/stats/eurofxref/

***Table 8.9:** Provision of public financial support: contributions through multilateral channels in 2016*

Donor funding	*Total amount*				*Status*	*Funding source*	*Financial instrument*	*Type of support*	*Sector*
	Core/general		*Climate-specific*						
	European euro - EUR	*USD**	*European euro - EUR*	*USD**					
Multilateral climate change funds									
World Meteorological Organisation (WMO)			99,650.00	117,646.79	provided	ODA	other (membership fee)	adaptation	Not applicable
Montreal Protocol Multilateral Fund			177,560.00	209,627.34	provided	ODA	other (membership fee)	mitigation	Not applicable
Montreal Protocol Trust Fund			13,694.51	16,167.74	provided	ODA	other (membership fee)	mitigation	Not applicable
Multilateral financial institutions, including regional development banks									
International Finance Corporation: The Sustainable EnergyFinance (SEF) programme in Western Balkans, Belarus and Kyrgyzstan			440,327.00	519,850.06	committed	ODA	grant	mitigation	Energy generation, distribution and efficiency – general; Energy generation, renewable sources
European Bank for Reconstruction and Development: Green Economic Transition Policy Dialogue Framework for ODA countries of operation			1,000,000.00	1,180,600.00	committed	ODA	grant	mitigation	Energy generation, distribution and efficiency – general; Energy generation, renewable sources
Specialized United Nations bodies									
United Nations Development Programme	150,000.00	177,090.00			disbursed	ODA	grant	crosscutting	Energy generation and supply
Other :The United Nations Convention to Combat Desertification in Those Countries Experiencing Serious Drought and/or Desertification, Particularly in Africa	12,986.00	15,331.27			provided	ODA	other: capital subscription	crosscutting	Agriculture
Other: The Food and Agriculture Organization of the United Nations (FAO)	707,583.58	835,373.17			provided	ODA	other: capital subscription	crosscutting	Agriculture
Other: European and Mediterranean Plant Protection Organization (EPPO)	26,450.00	31,226.87			provided	ODA	other: capital subscription	crosscutting	Agriculture
Total contributions through multilateral channels	897,019.58	1,059,021.32	1,731,231.51	2,043,891.90					

*Values calculated by Euro Foreign Exchange Reference Rates (European Central Bank) on 29.09.2017; EUR 1 = USD 1.1806; Source: http://www.ecb.int/stats/eurofxref/

Table 8.10: *17 capacity building projects (2014) which were realised in developing countries, amount of received financial contributions and specializations of the study programmes.*

Recipient country and/or region	*Targeted area*	*Programme or project title*	*Description of programme or project*
Afghanistan	*adaptation*	*Inter-ministerial programme SR 05T 08* ***2014***	The programme is aimed at providing governmental scholarships to students from developing countries. The study programmes were aimed at protection of the environment, ecology and environmental sciences - **Horticulture.**
Albania	*adaptation*	*Inter-ministerial programme SR 05T 08* ***2014***	The programme is aimed at providing governmental scholarships to students from developing countries. The study programmes were aimed at protection of the environment, ecology and environmental sciences -**Urban planning and protection**
Armenia	*adaptation*	*Inter-ministerial programme SR 05T 08* ***2014***	The programme is aimed at providing governmental scholarships to students from developing countries. The study programmes were aimed at protection of the environment, ecology and environmental sciences - **Environmental management.**
Belarus	*adaptation*	*Inter-ministerial programme SR 05T 08* ***2014***	The programme is aimed at providing governmental scholarships to students from developing countries. The study programmes were aimed at protection of the environment, ecology and environmental sciences - **Environmental science.**
Benin	*adaptation*	*Inter-ministerial programme SR 05T 08* ***2014***	The programme is aimed at providing governmental scholarships to students from developing countries. The study programmes were aimed at protection of the environment, ecology and environmental sciences - **Agricultural machinery.**
Ecuador	*adaptation*	*Inter-ministerial programme SR 05T 08* ***2014***	The programme is aimed at providing governmental scholarships to students from developing countries. The study programmes were aimed at protection of the environment, ecology and environmental sciences - **Environmental engineering.**
Ethiopia	*adaptation*	*Inter-ministerial programme SR 05T 08* ***2014***	The programme is aimed at providing governmental scholarships to students from developing countries. The study programmes were aimed at protection of the environment, ecology and environmental sciences - **Hydraulic engineering and water management.**
Kazakhstan	*adaptation*	*Inter-ministerial programme SR 05T 08* ***2014***	The programme is aimed at providing governmental scholarships to students from developing countries. The study programmes were aimed at protection of the environment, ecology and environmental sciences - **Geodesy and cartography.**

Mongolia	*adaptation*	*Inter-ministerial programme SR 05T 08* ***2014***	The programme is aimed at providing governmental scholarships to students from developing countries. The study programmes were aimed at protection of the environment, ecology and environmental sciences - **Landscaping and general agriculture.**
Peru	*adaptation*	*Inter-ministerial programme SR 05T 08* ***2014***	The programme is aimed at providing governmental scholarships to students from developing countries. The study programmes were aimed at protection of the environment, ecology and environmental sciences - **General agriculture, environmental science, architecture and urban planning.**
Serbia	*adaptation*	*Inter-ministerial programme SR 05T 08* ***2014***	The programme is aimed at providing governmental scholarships to students from developing countries. The study programmes were aimed at protection of the environment, ecology and environmental sciences - **Environmental science, biochemistry, land protection and land use, hydraulic engineering, general/system ecology, general agriculture.**
Seychelles	*adaptation*	*Inter-ministerial programme SR 05T 08* ***2014***	The programme is aimed at providing governmental scholarships to students from developing countries. The study programmes were aimed at protection of the environment, ecology and environmental sciences - **Environmental management.**
Sudan	*adaptation*	*Inter-ministerial programme SR 05T 08* ***2014***	The programme is aimed at providing governmental scholarships to students from developing countries. The study programmes were aimed at protection of the environment, ecology and environmental sciences - **Hydrotechnical melioration, environmental planning and management.**
Tajikistan	*adaptation*	*Inter-ministerial programme SR 05T 08* ***2014***	The programme is aimed at providing governmental scholarships to students from developing countries. The study programmes were aimed at protection of the environment, ecology and environmental sciences - **Environmental engineering.**
The former Yugoslav Republic of Macedonia	*adaptation*	*Inter-ministerial programme SR 05T 08* ***2014***	The programme is aimed at providing governmental scholarships to students from developing countries. The study programmes were aimed at protection of the environment, ecology and environmental sciences - **Architecture and urban planning.**
Ukraine	*adaptation*	*Inter-ministerial programme SR 05T 08* ***2014***	The programme is aimed at providing governmental scholarships to students from developing countries. The study programmes were aimed at protection of the environment, ecology and environmental sciences - **Environmental management**.
Uzbekistan	*adaptation*	*Inter-ministerial programme SR 05T 08* ***2014***	The programme is aimed at providing governmental scholarships to students from developing countries. The study programmes were aimed at protection of the environment, ecology and environmental sciences - **Agricultural products processing, general ecology and environmental management.**

Table 8.11: *16 capacity building projects (2015) which were realised in developing countries, amount of received financial contributions and specializations of the study programmes.*

Recipient country and/or region	*Targeted area*	*Programme or project title*	*Description of programme or project*
Afghanistan	*adaptation*	*Inter-ministerial programme SR 05T 08* ***2015***	The programme is aimed at providing governmental scholarships to students from developing countries. The study programme aimed at **gardening, architecture and urbanism.**
Albania	*adaptation*	*Inter-ministerial programme SR 05T 08* ***2015***	The programme is aimed at providing governmental scholarships to students from developing countries. The Study programme aimed at **architecture and urban planning**.
Armenia	*adaptation*	*Inter-ministerial programme SR 05T 08* ***2015***	The programme is aimed at providing governmental scholarships to students from developing countries. The study programme aimed at **environmental management**.
Belarus	*adaptation*	*Inter-ministerial programme SR 05T 08* ***2015***	The programme is aimed at providing governmental scholarships to students from developing countries. The study programme aimed at **environmental science**.
Bosnia and Herzegovina	*adaptation*	*Inter-ministerial programme SR 05T 08* ***2015***	The programme is aimed at providing governmental scholarships to students from developing countries. The study programme aimed at **processing agricultural products**.
Ecuador	*adaptation*	*Inter-ministerial programme SR 05T 08* ***2015***	The programme is aimed at providing governmental scholarships to students from developing countries. The study programme aimed at **environmental science**.
Ethiopia	*adaptation*	*Inter-ministerial programme SR 05T 08* ***2015***	The programme is aimed at providing governmental scholarships to students from developing countries. The study programme aimed at water **constructions and water economy**.
Kenya	*adaptation*	*Inter-ministerial programme SR 05T 08* ***2015***	The programme is aimed at providing governmental scholarships to students from developing countries. The study programme aimed **at transport constructions and environmental engineering**.
Kosovo	*adaptation*	*Inter-ministerial programme SR 05T 08* ***2015***	The programme is aimed at providing governmental scholarships to students from developing countries. The study programme aimed at **environmental architecture and urbanism**.
Macedonia	*adaptation*	*Inter-ministerial programme SR 05T 08* ***2015***	The programme is aimed at providing governmental scholarships to students from developing countries. The study programme aimed at **environmental architecture and urbanism**.

Moldova	*adaptation*	*Inter-ministerial programme SR 05T 08* ***2015***	The programme is aimed at providing governmental scholarships to students from developing countries. The study programme aimed at **architecture and urbanism, environmental management**.
Peru	*adaptation*	*Inter-ministerial programme SR 05T 08* ***2015***	The programme is aimed at providing governmental scholarships to students from developing countries. The study programme aimed at **architecture and urbanism, production of plants**.
Serbia	*adaptation*	*Inter-ministerial programme SR 05T 08* ***2015***	The programme is aimed at providing governmental scholarships to students from developing countries. The study programme aimed at **architecture and urbanism, environmentalist, biochemistry, landscape protection, production of plants, processing of agricultural products, synecology, water constructions, general and system ecology and gardening**
Tajikistan	*adaptation*	*Inter-ministerial programme SR 05T 08* ***2015***	The programme is aimed at providing governmental scholarships to students from developing countries. The study programme aimed at **environmental engineering**.
Ukraine	*adaptation*	*Inter-ministerial programme SR 05T 08* ***2015***	The programme is aimed at providing governmental scholarships to students from developing countries. The study programme aimed at **architecture, urbanism and environmental management**.
Uzbekistan	*adaptation*	*Inter-ministerial programme SR 05T 08* ***2015***	The programme is aimed at providing governmental scholarships to students from developing countries. The study programme aimed at **environmental management, general ecology and ecology of population**.

Table 8.12: *19 capacity building projects (2016) which were realised in developing countries, amount of received financial contributions and specializations of the study programmes.*

Recipient country and/or region	*Targeted area*	*Programme or project title*	*Description of rograme or project*
Afghanistan	*adaptation*	*Inter-ministerial programme SR 05T 08* ***2016***	The programme is aimed at providing governmental scholarships to students from developing countries. The study programme aimed at **gardening, architecture and urbanism**.
Albania	*adaptation*	*Inter-ministerial programme SR 05T 08* ***2016***	The programme is aimed at providing governmental scholarships to students from developing countries. The study programme aimed at **architecture and urbanism, environmental management**.
Armenia	*adaptation*	*Inter-ministerial programme SR 05T 08* ***2016***	The programme is aimed at providing governmental scholarships to students from developing countries. The study programme aimed at **environmental management**.

Belarus	*adaptation*	*Inter-ministerial programme SR 05T 08* ***2016***	The programme is aimed at providing governmental scholarships to students from developing countries. The study programme aimed at **environmental science**.
Bosnia and Herzegovina	*adaptation*	*Inter-ministerial programme SR 05T 08* ***2016***	The programme is aimed at providing governmental scholarships to students from developing countries. The study programme aimed at **processing agricultural products, environmental management**.
Ecuador	*adaptation*	*Inter-ministerial programme SR 05T 08* ***2016***	The programme is aimed at providing governmental scholarships to students from developing countries. The study programme aimed at **environmental science**.
Ethiopia	*adaptation*	*Inter-ministerial programme SR 05T 08* ***2016***	The programme is aimed at providing governmental scholarships to students from developing countries. The study programme aimed at **water constructions and water economy**.
Georgia	*adaptation*	*Inter-ministerial programme SR 05T 08* ***2016***	The programme is aimed at providing governmental scholarships to students from developing countries. The study programme aimed at **architecture and urbanism**.
Kenya	*adaptation*	*Inter-ministerial programme SR 05T 08* ***2016***	The programme is aimed at providing governmental scholarships to students from developing countries. The study programme aimed at **transport constructions and environmental engineering**.
Kosovo	*adaptation*	*Inter-ministerial programme SR 05T 08* ***2016***	The programme is aimed at providing governmental scholarships to students from developing countries. The study programme aimed at **architecture and urbanism**.
Macedonia	*adaptation*	*Inter-ministerial programme SR 05T 08* ***2016***	The programme is aimed at providing governmental scholarships to students from developing countries. The study programme aimed at **architecture and urbanism**.
Macedonia, Ukraine, Moldova	*adaptation*	*Inter-ministerial programme SR 05T 04* ***2016***	The programme is aimed at development of a food database program. The project aimed at **capacity building and technical support** of selected developing countries in the field of **food databases**.
Moldova	*adaptation*	*Inter-ministerial programme SR 05T 08* ***2016***	The programme is aimed at providing governmental scholarships to students from developing countries. The study programme aimed at **architecture and urbanism, environmental science**.
Peru	*adaptation*	*Inter-ministerial programme SR 05T 08* ***2016***	The programme is aimed at providing governmental scholarships to students from developing countries. The study programme aimed at **architecture and urbanism**.
Serbia	*adaptation*	*Inter-ministerial programme SR 05T 08* ***2016***	The programme is aimed at providing governmental scholarships to students from developing countries. The study programme aimed at **architecture and urbanism, environmentalist, biochemistry, landscape protection, production of plants, processing of agricultural products, synecology, water constructions, general and system ecology and gardening**.

Syria	*adaptation*	*Inter-ministerial programme SR 05T 08* ***2016***	The programme is aimed at providing governmental scholarships to students from developing countries. The study programme aimed at **architecture and urbanism**.
Tajikistan	*adaptation*	*Inter-ministerial programme SR 05T 08* ***2016***	The programme is aimed at providing governmental scholarships to students from developing countries. The study programme aimed at **environmental engineering**.
Ukraine	*adaptation*	*Inter-ministerial programme SR 05T 08* ***2016***	The programme is aimed at providing governmental scholarships to students from developing countries. The study programme aimed at **architecture and urbanism, environmental management**.
Uzbekistan	*adaptation*	*Inter-ministerial programme SR 05T 08* ***2016***	The programme is aimed at providing governmental scholarships to students from developing countries. The study programme aimed at **environmental management, general ecology and ecology of population**.

Table 8.12: *Provision of support for technology development and transfer (2014 – 2016)*

Recipient country and/or region	*Targeted area*	*Measures and activities related to technology transfer*	*Sector*	*Source of the funding for technology transfer*	*Activities undertaken by*	*Status*	*Additional information*
Macedonia and Moldova (2014)	Databases on nutritional composition of food	SK provided the database programme Daris and supported the development and utilization of the food database	Training support and software development	Slovak programme 05T04	University of St.Cyril and Methodius and Technical University of Moldova	provided	The method of implementation focuses on three main areas - capacity building, training support and software development.

8 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 (MŠVVaŠ SR) is the authority with full competences and administration skills to manage research and development in the Slovak Republic according to 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 also includes 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 research and development in the field of measures to mitigate the negative impacts connected with climate change.

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

In addition to the budget of the MŠVVaŠ SR, research is also funded 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 human activities, natural climatic changes and variability and their impacts on natural ecosystems and different social and economic sectors have been at the centre of scientific interests 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: 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 international ones, their scope and results are mostly comparable with European standards. The national projects on climate change, vulnerability and impacts were the most frequent in the process of

international project demands. A large number of projects not dealing directly with climate change issues, but with physical, chemical and biological processes connected with comparable impacts like climate change also need to be counted among them.
List of Institutions involved in climate change oriented research:

- Slovak Hydrometeorological Institute, Bratislava (SHMÚ);
- Faculty of Mathematics, Physics and Informatics, Comenius University in Bratislava (FMFI UK);
- Faculty of Natural Sciences, Comenius University in Bratislava (PriF UK);
- Faculty of Civil Engineering, Slovak University of Technology in Bratislava (SvF STU);
- University of Technology in Zvolen (LFTU);
- National Forestry Centre in Zvolen (NLC);
- Slovak University of Agriculture in Nitra (SPU);
- Earth Science Institute of the Slovak Academy of Sciences (ÚVZ SAV);
- Institute of Parasitology at the Slovak Academy of Sciences (PAÚ SAV);
- Institute of Landscape Ecology at the Slovak Academy of Sciences (ÚKE SAV);
- Institute of Forest Ecology at the Slovak Academy of Sciences (ÚEK SAV)
- Institute of Zoology at the Slovak Academy of Sciences (ÚZ SAV);
- Institute of Hydrology at the Slovak Academy of Sciences (ÚH SAV);
- State Geological Institute of Dionýz Štúr (ŠGÚDŠ);
- University of Veterinary Medicine and Pharmacy in Košice (UVLF);
- Science and Research Institute of Matej Bell University in Banská Bystrica (UMB);
- Soil Science and Conservation Research Institute in Bratislava (VÚPOP);
- Water Research Institute in Bratislava (VÚVH);
- 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 the Global Climate Observing System. Detailed technical reports should be provided in conjunction with national communications.

The Slovak Republic has a long tradition of hydrological, meteorological and climatological observation. Some stations have a tradition of regular observations longer than 100 years (7 for air temperature, 203 for precipitation totals). Hourly data from 20 synoptic stations are incorporated into the online international exchange, monthly data from 5 stations (Hurbanovo, Sliač, Poprad, Košice and Piešťany) are included into the CLIMAT Reports.

The hydrological network's (including flows, springs, ground water and water quality) and the meteorological network's (including climatological, solar radiation, ozone, radar and upper air) observations and measurements as well as air quality measurements in the Slovak Republic are guaranteed by Act No. 201/2009 Coll. on the State Hydrological Service and the State Meteorological Service. These measurements and observations are carried out by the

Slovak Hydrometeorological Institute (SHMÚ) in Bratislava (including branches of the SHMÚ in Banská Bystrica, Žilina and Košice), which is also responsible for gathering, processing and administration of hydrological and meteorological data and information. It also covers the set of essential climate variables according to decision FCCC/SBSTA/2007/L.4/Add.1. The SHMÚ manages the data according to the Quality Management System in compliance with the STN EN ISO 9001:2001 Standard. These data are used for the assessment of the current state and trends in climatic and hydrologic systems in the Slovak Republic. The SHMÚ 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 SHMÚ also utilises a modern method for the digital archival of old data (from 1872) to provide a more precise analysis and description of climate changes and variability in the Slovak Republic during the last 140 years. The SHMÚ has its own research capacities of good quality and is ready for profound scientific analysis of the current state, past and future development of the climatic and hydrologic system. The SHMÚ also has excellent co-operative potential for research project handling and for active collaboration with other scientific institutions. Measured and observed data as well as data from outputs of research projects are also communicated to the World Data Centres for internationally handled projects.

8.4 RESEARCH

8.4.1 Climate Process and Climate System Studies, Including Paleoclimate Studies

International activities in the field of research on the Earth's climate system 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 the former CzechoSlovak Republic in 1991, since 1993 it continues as the Slovak National Climate Program coordinated by the MŽP SR. As many as 23 institutions and other subjects participated in activities of the Slovak National Climate Program. The SHMÚ was mostly the focal point of the Slovak National Climate Program activities, the MŽP SR provided the SHMÚ with financial support to organize climate change monitoring and research on climate change and variability, vulnerability, impacts and adaptation options. Climate system studies have also been realized 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 the Slovak Republic. Slovak climatologists applied outputs from several Global General Circulation Models and Regional General Circulation Models to design local and national climate change scenarios by methods of statistical and dynamic downscaling with 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 were applied). Climate change scenarios have been designed as time series of average daily data (for air temperature also daily maximum and minimum) for meteorological and precipitation stations in the Slovak Republic 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 the use of 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 SHMÚ were the principal solvers in the field of national climate scenario design.

8.4.3 Research on the Impacts of Climate Change

Several Slovak institutions, private subjects and individuals participated in the assessment of the impacts of climatic change 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 SHMÚ, or some climate change scenarios (prepared by the Faculty of Mathematics, Physics and Informatics, Comenius University in Bratislava or by other subjects from the Slovak Republic and abroad). These issues have mostly been solved as a part of domestic or international projects, predominantly in the sectors of water management, the hydrological cycle, forestry and agriculture.

8.5 LIST OF SELECT PROJECTS

8.5.1 Climatology

Project VEGA No. 1/0992/12 (2012 - 2014), was managed at the Faculty of Mathematics, Physics and Informatics, Comenius University in Bratislava and focused on the analysis of climate variability in the Slovak Republic and on preparing alternative climate change scenarios for users in the Slovak Republic. Project VEGA No. 2/0079/11 (2011 - 2013) “Interaction between climatic factors and a mountainous environment”, was managed in GFU SAV. The next listed projects have been managed at the SHMÚ in cooperation with other institutions in the Slovak Republic and abroad: The project “LOC-CLIM-ACT: Local acting on climate change impacts” (No.: HUSKROUA/1001/079), within ENPI: Hungary - Slovak Republic - Romania - Ukraine collaboration (2007-2013). Project “ClimCross Development - Partnership for climate change impact reduction” Hungary - Slovak Republic collaboration (2007 - 2013). Project PUMAKO – Collaboration among the local management authorities – Regional Development (EFRE) within the Program ETZ-Creating the Future (Slovak Republic – Austria collaboration, 2007 - 2013). Projects APVV-15-0292 “Deglaciation and postglacial climatic evolution recorded in the lake deposits of the High Tatra Mountains” (2016 - 2020); Deterioration of climate during Greenhouse phases: Causes and consequences of short-term sea-level changes (2013 - 2017); Continental crises of the Jurassic: Major extinction events and environmental changes within lacustrine ecosystems (2014 - 2018) and Climate-environmental deterioration during Greenhouse phases: Causes and consequences of short-term Cretaceous sea-level changes (2014 - 2019) managed at the Earth Science Institute, Slovak Academy of Sciences. The project of the Faculty of Natural Sciences, Comenius University in Bratislava: APVV-15-0575 "Palaeoclimate record and Miocene climate variability in Central and Eastern Paratethys" (2016 - 2020).

8.5.2 Forestry Sector

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 select 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 the Slovak Republic (APVV-0303-11) 2012 - 2015 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 the Slovak Republic (APVV-0423-10) 2011 - 2014. The investigation of risk concerning impacts of climate change on forest ecosystems and the formulation of an adaptation policy under conditions of the Slovak Republic (VEGA 1/0281/11) 2011 - 2014. The spatial and temporal characteristics of snow conditions in small mountain catchments to the needs of modelling of the water supply (VEGA1/1130/12) 2012 - 2014. Transformation, transport and distribution of matter in the surface organic horizon of forest soils (APVV-0580-10) 2011 - 2014. The impact of climate change on the phenological response of ecosystems (VEGA 1/0257/11 (2011 - 2013)). ARANGE is a Collaborative Project within the FP7 (Theme KBB.2011.1.2-07) with the aim to provide improved insight into the multifunctional management of European mountain forests under climate change (2012 - 2015). Ecophysiological and spatial aspects of the effect of drought on forests in the Slovak Republic under climate change (DRIM). Project supported by Slovak Research and Development Agency (2011 - 2014). Projects managed at the Faculty of Forestry, Technical University in Zvolen: APVV 0303-10 "Development of a regional system of climate and rainfall runoff models for the prediction of runoff under changed climate in the mountainous regions of the Slovak Republic" (collaboration with the Slovak University of Technology in Bratislava) (2012 - 2014); APVV-0135-12 Adaptive genetic potential of forest tree populations in the context of climate change (2013 - 2017); VEGA 2/0038/14 Adaptation strategies to natural and social disturbances in the forest landscape (2014 - 2017); COST Action FP11202 "Strengthening conservation: a key issue for adaptation of marginal/peripheral populations of forest tree to climate change in Europe" (2013 - 2015); "COST Action FP1304 Towards robust Projections of European Forests under

Climate Change" (2014 - 2018); COST Action ES1308 "Climate Change Manipulation Experiments in Terrestrial Ecosystems: Networking and Outreach" (2014 - 2018); APVV-15-0265 "Modelling tree species growth in the Carpathian forest ecosystems under different climate change scenarios" (2016 - 2020) and APVV-15-0425 "The impact of natural hazards on forest ecosystems in the Slovak Republic under future climate conditions" (2016 – 2019). Projects of the National Forest Centre, Zvolen: APVV-15-0413 "Computer aided forest management optimization under climate change" (2016 - 2020) and APVV-15-0032 "Assessment of the growth, structure and production value of beech stands under the long-term influence of different management measures" (2016 - 2020). Project VEGA 2/0053/14 "Atmospheric processes and tropospheric ozone in the mountain environment" (2014 - 2017) managed at the Earth Science Institute, Slovak Academy of Sciences.

8.5.3 Hydrology and Water

Project No.: APVV-0015-10 "Identification of changes in the hydrological regime of rivers in the Danube basin" (2011 - 2014) and project COST Action ES1404 "A European network for the harmonized monitoring of snow for the benefit of climate change scenarios, hydrology and numerical weather prediction" (2014 - 2018) managed at the Institute of Hydrology at the Slovak Academy of Sciences. Project APVV-0089-12 "Prognosis of hydrological drought occurrence in the Slovak Republic" managed at 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 the Slovak Republic" managed at the Faculty of Civil Engineering, Slovak University of Technology in Bratislava (2012 - 2015). Project APVV-14-0735 "New possibilities for the use of drainage canal systems taking into account the protection and use of landscape" (2015 - 2019) managed at the Water Research Institute.

8.5.4 Agriculture

COST ES1106: "Assessment of European Agriculture Water Use and Trade under Climate Change (EURO-AGRIWAT, 2012 - 2015)". Project VEGA 1/0513/12 "Research on agroecosystems to mitigate climate change, produce bioproducts and improve nutritional and health parameters of people" (2012 - 2015) was managed at the Faculty of Agrobiology and Food resources, Slovak University of Agriculture in Nitra. Projects managed at the National Agricultural and Food Centre, Soil Science and Conservation Research Institute: APVV-15-0136 "The effect of impermeable soil cover on urban climate in the context of climate change" (2016 - 2020); APVV-15-0406 "Upgrading the soil units system in the agricultural land of the Slovak Republic - mapping, digitizing and vectorization" (2016 - 2020). Projects APVV-15-0562 "Effective irrigation management as a device of changing climate adaptation" (2016 - 2020) and APVV-15-0721 "Innovative phenomic tools in the assessment of wheat genetic resources towards improved performance and adaptability to climate extremes" (2016 - 2019) are managed at the Horticulture and Landscape Engineering Faculty, Slovak University of Agriculture in Nitra.

8.5.5 Biodiversity

Project APVV-15-0210 "Distribution potential of different fungal trophic groups in Europe" is managed at the Institute of Botany, Plant Science and Biodiversity Centre, Slovak Academy of Sciences (2016 - 2020). The aim of the project is to identify geographical elements within each trophic group and to assign bioclimatic and geographical factors influencing their area of distribution. Moreover, it is investigated whether defined environmental factors are related to select morphological traits.

8.5.6 Monitoring of climate extremes and weather

Project of the Earth Science Institute, Slovak Academy of Sciences: "Drought monitoring in the Slovak Republic" (2015). This activity was funded by the participating institutes. Project of the MicroStep-MIS, spol. s.r.o.: APVV-15-0663 "A Novel Method for Low-level Windshear Alert Calculation from Data Measured by LIDAR" (2016 - 2020).

8.6 SYSTEMATIC OBSERVATION

8.6.1 Meteorological Observing Systems (Including those Measuring Atmospheric Constituents) and Hydrological Observing Systems

The framework for complex environmental monitoring in the Slovak Republic has been determined by 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 the Slovak Republic. Some of those subsystems are operated by the SHMÚ. The Monitoring Subsystem "Meteorology and Climatology" is one of the most important and includes the observing networks of monitoring stations, remote sensing systems and phenological observations. 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 also monitors the chemistry of atmospheric precipitation. The Monitoring Subsystem "Water" monitors the quantity and quality of surface and ground water in the Slovak Republic. The SHMÚ provides data gathered through the monitoring subsystems for decision-making, management, research and development as well as for the general public.

The observation networks and objects of the SHMÚ are owned by the State according to Act No. 201/2009 Coll. on the State Hydrological Service and State Meteorological Service. During the last 3 years, the automatization of monitoring systems, mainly in meteorology, continued. The SHMÚ operates 93 automatic weather stations, 20 of them are professional and about 60 have voluntary observers. Of the network of 540 precipitation stations about 200 are automated. Five select stations (CLIMAT – Hurbanovo, Sliač, Poprad, Košice and Piešťany) are included in the Global Climate Observation System program. Besides these activities, the SHMÚ also operates a network of about 200 phenological stations (with biological observations). The remote sensing system includes 4 Doppler radars, 1 upper air (aerologic) station and a lightning detection system. Membership in the EUMETSAT allows the Slovak Republic to receive satellite images in real time. The air quality network consists of 34 automatic stations in the most polluted regions and 4 stations for the monitoring of background air pollution. The hydrological network consists of about 400 stations measuring surface water quantity and quality. The quantity and quality of groundwater and springs are monitored in about 1,500 SHMÚ locations. The SHMÚ has introduced its Quality Management System according to the ISO 9001:2001 for monitoring, evaluating and interpreting data. This system is properly maintained and operated.

9 EDUCATION, TRAINING AND RAISING OF PUBLIC AWARENESS

The chapter provides an overview of the activities of the Ministry of Education, Science, Research and Sport of the Slovak Republic (MŠVVaŠ SR), MŽP SR 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 MŠVVaŠ SR. For this issue, however, including training and raising public awareness, the MŽP SR also contributes significantly either directly or through its branches, such as the Slovak Environmental Agency (SAŽP) and the Slovak Hydrometeorological Institute (SHMÚ). Education and information on this subject is also provided by select universities and scientific institutions, interest groups, as well as professional and non-governmental organizations (NGOs).

9.1 EDUCATIONAL ACTIVITIES

Climate change is a cross-cutting theme that challenges experts and goes beyond the context of educational programs for elementary and secondary schools. The issue of climate change and its adverse consequences are a component of a wide spectrum of topics within environmental education in primary and secondary schools. At the level of colleges and universities, its importance has increased in recent years. The topic of climate is available to study at Comenius University in Bratislava and partially at the University of Economics in Bratislava - with regard to its economic and political consequences.

The Ministry of Environment of the Slovak Republic launched the Green Education Fund, which supports environmental education, training and the raising of public awareness. The main role of the Green Education Fund is to support the implementation of projects by non-governmental organizations focused on environmental education, training and awareness for children, youth and the general public in the Slovak Republic.

Supported Activities:

- environmental education (educational programs, practical environmental education in the field, games, competitions, interactive activities);
- environmental training (educational programs, practical environmental training in the field, lectures, conferences, seminars, presentations, workshops, interactive activities, discussions, festivals, publishing activities, teaching aids for environmental education activities);
- environmental awareness (lectures, conferences, seminars, presentations, workshops, interactive activities, discussions, festivals, exhibitions).

Financial means are provided to non-governmental organizations:

- civic associations;
- interest associations of legal entities;
- foundations;
- non-profit organizations providing environmentally oriented public services.

9.1.1 Primary and Secondary Schools

The National Institute for Education, as a budgetary organization directly managed by MŠVVaŠ SR, introduced a national training program called "Environmental education" for level 1 and 2 of primary schools, secondary schools and grammar schools.

Environmental education covers the following climate change areas: renewable sources (RES) and non-renewable natural resources, the 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 the sustainable development of society, recycling, energy consumption, quality of life, diversity of environmental influences on health, ways and means to protect the health of diversity in Earth (different environmental conditions and different social development regions 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 more comprehensive educational fields such as "People and society" and "People and values", which 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, the eradication of poverty, disease, disparities between people, ensuring a life of dignity for people).

9.1.1.1 Global Education

The National Strategy for Global Education for the period of 2012-2016 was approved by the Government on 8 January 2012. The strategy defines the main issues of education focusing on global issues, including climate change.

The 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.

9.1.1.2 Training Programs in Schools

The Ministry of Education, Science, Research and Sport of the Slovak Republic annually allocates funds for schools in its budget for the implementation of successfully expanded development projects aimed at supporting and developing environmental education and education in primary and secondary schools under the title "Enviroprojekt", in the field of leading a healthy lifestyle, health and safety in schools "Health and Safety in Schools", "Health on Dans", and others. The practical output of the projects include a number of seminars, competitions, workshops or methodical materials, workbooks and sheets. In various regions of the Slovak Republic, pupils build educational paths, clean part of protected areas, watercourses and cultural heritage, implement social welfare programs or healthy nutrition programs or solve problems about energy use, renewable resources or dealing with waste.

Ecological Footprint is an innovative educational program currently conducted via the web portal www.ekostopa.sk. Its main objective for students is to correctly identify the impacts of our daily activities on the environment. "Ekomerač" is an interactive model of the Earth with an average width of 3.5 m that help us calculate our ecological footprint.

Learning by playing is a pilot environmental program for the public and students of primary and high schools.

Enersol as a project that was launched in 2000 and is a joint program of six European countries – the Czech Republic, the Slovak Republic, Germany, Slovenia, Poland and Austria. Its importance is mainly in the international exchange of experience of teaching and approximation of technical, ecology and environmental ideas and texts in secondary schools.

To Live Energy in Schools includes educational materials, interactive games and recommendations on how to conserve energy at school: www.siea.sk/zit-energiou-kamaratka-energia.

Forest education (National Forest Centre) is an environmental education program for learning about nature and life in the woods through games and experiences. With its activities Forest education gives knowledge about the environment, its protection and sustainable development: http://www.lesnapedagogika.sk/. The program is also designed for the general lay population.

The Learning by playing program offers inspiration for activities and has an informative and educational character. The aim is to increase environmental awareness in the field of environmental protection through interactive game activities. The target groups are kindergarten, primary and secondary schools. Emphasis is put on the interactive and experiential forms of education.

I separate, you separate, we separate is program which motivates and engages students in waste sorting through practical environmental education and promotes the minimization of waste. The target group is students of primary schools.

9.1.1.3 National Environmental Competitions

Clever Nature is a literary competition with three categories: poetry, descriptions and narrative. The target group is students of primary schools.

EnvirOtázniky is a nationwide knowledge competition for students of the 2nd level of primary schools. The aim is to attract the interest of primary school children to science and environmental issues.

Green World is an international children's art creativity competition.

An Hour with an Ecological Footprint is a national competition for teachers of nursery schools, primary and high schools with an ecological and environmental theme.

Hypericum is an active-scientific competition for 2 nd grade students of primary schools.

ProEnviro is a competition for the best environmental project implemented by a school, the main objective is to promote projects of sustainable development and activities implemented in school.

Smile for a Tree is a national competition with three categories: Pickup and recycle, Plant a tree and Create your own eco-project. The target groups are students of primary and high schools.

The European mobility week national competition (EMW) is presented to the local authority that is judged to have done the most to raise awareness of sustainable mobility during the European Mobility Week.

Enviróza is a school competition for 2nd grade students of primary schools and secondary schools. It is designed as an outdoor game and the aim is to obtain and disseminate information on environmental burdens in the Slovak Republic. Players search for and determine environmental burdens and publish their data online.

Invasive plant species is a school competition organized by the school program "On tour with NATURA". The main goal is to set up observation and research groups focused on mapping the occurrence of invasive plants and animals in the environment.

9.1.1.4 International Activities

Schools are involved in various international, national and regional projects independently or in cooperation with NGOs.

Roots & Shoots is a youth service program for young people of all ages, founded in 1991 by Dr. Jane Goodall. The aim is to foster respect and compassion for all living things, to promote understanding of all cultures and beliefs, and to inspire each individual to take action to make the world a better place for people, other animals, and the environment. Since 2016 the pilot education project has been based on an adaptation of the global action program – Jane Goodall's Roots & Shoots. Participation of SAŽP in this project starts in 2016.

Junior festival is a unique part of the EKOTOPFILM (International festival of sustainable development films) with a specialized program for elementary, secondary and high school students. It brings real environmental education to select cities and towns around the Slovak Republic. Kids learn how to sort waste, protect forests, save energy and conserve the environment.

ENVIROPROJECT is a development project funded by MŠVVaŠ SR to promote practical environmental education in primary and secondary schools. Thanks to ENVIROPROJECT a total of 121 projects in the period of 2013-2016 were supported and implemented in primary and secondary schools, such as a number of seminars, competitions, workshops and methodological materials, workbooks and leaflets. In various regions of the Slovak Republic, pupils built nature trails, cleaned parts of the watercourses, or conducted activities connected with renewable energy and the problem of waste.

Eco Schools is an international environmental program 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 the actions of students and teachers.

9.1.1.5 Colleges, Universities

The MŠVVaŠ SR does not prescribe the content of the courses offered by higher education institutions. Detailed statistics regarding higher education are publicly available at http://www.cvtisr.sk/cvti-sr-vedecka-kniznica/informacie-o-skolstve/statistiky/statisticka-rocenka-publikacia/statisticka-rocenka-vysoke-skoly.html?page_id=9596. In the Slovak Republic, the following faculties are involved in climate change related studies:

Comenius University in Bratislava

Faculty of Mathematics, Physics and Informatics – comprehensive research and education on climate change at the faculty is conducted by the Department of Astronomy and Astrophysics; the Department of Physics of the Earth; the Department of Environmental Physics; and the Department of Meteorology and Climatology.

Slovak University of Agriculture in Nitra

Faculty of Horticulture and Landscape Engineering – the issue of climate change is addressed by the Department of Biometeorology and Hydrology.

Faculty of Agrobiology and Food Resources – the impact of climate change on agriculture is studied by the Department of Plant Protection and the Department of Sustainable Agriculture and Herbology.

Technical University in Zvolen

Faculty of Forestry – research by the Department of Natural Environment includes climate change.

Faculty of Ecology and Environmental Sciences – research activities of the Department of Applied Ecology and the Department of Biology and General Ecology include a focus on the impact of climate change.

Technical University of Košice

Faculty of Civil Engineering –research conducted by the faculty includes the issue of the impact of the changing climate on infrastructure design.

Slovak Technical University in Bratislava

Faculty of Civil Engineering – the activities of the Department of Land and Water Resources Management and the Department of Sanitary and Environmental Engineering address climate change adaptation.

Faculty of Chemical and Food Technology - the faculty deals with the research and development of technologies related to environmental engineering.

9.2 CONFERENCES

9.2.1 Regular Conferences

Enviro-i-forum is a conference on environmental science which has been organized annually by the SAŽP and the MŽP SR since 2005. Its main objective is the creation, sharing and accessing of data on the environment.

Green Infrastructure conference – this scientific symposium about a network of healthy ecosystems provides cost-effective alternatives to traditional 'grey' infrastructure and offers many other benefits for both citizens and biodiversity.

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 which has been organized annually since 1985 devoted to current issues in air protection techniques, options for reducing emissions into the air, problems and experiences with the measurement of emissions trading allowances.

Slovak National Emission Registry is conference organized since 2005 for stakeholders of the trading scheme, operators and verifiers of CO_2 emission reports, experts and state administrators.

Conferences for young scientists and experts up to 35 years from the Slovak Republic and the Czech Republic is organized annually at the SHMÚ in the field of meteorology, climatology, hydrology and water management. The conference is coupled with a contest for the best 3 projects.

Environment - problems and possibilities is a conference regarding problems and solutions in the field of environmental and waste management.

Bio-climate is an international conference organized yearly by the 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 at each Bio-climate conference. Some papers from the last five Bio-climate Conferences were also included in the Web of Science database.

9.2.2 Other Relevant Conferences and Seminars

Transition to a green economy - *T2gE* aimed to attract the attention of all relevant stakeholders and create a space for informed discussion on key questions regarding the transition to a green economy. The focus of the discussion was on the actions of key stakeholders, including financial and investment stakeholders.

Ecoinovation Slovak Republic 2016 is an international forum for the presentation and introduction of ecoinnovation and practice good examples.

City environment conference about environmental problems in cities finds ways to make our *cities* more "green" and sustainable.

Other conferences on various topics organised by various institutions and organisations in various cities.

9.3 OTHER EVENTS

9.3.1 Festivals, Seminars, Fairs, Exhibitions and Other Educational Programs

Ekotopfilm-Envirofilm – the largest educational event of the MŽP SR for a wide range of professionals and the general public. The main objective of the international festival of environmental film, along with cultural and professional events, is to raise public environmental awareness by the implementation of environmental activities, post-festival shows and exhibitions of the works of the Green world. The junior festival is an accompanying programme and integral part of the Envirofilm festival.

Environmental Fair tutorials ŠIŠKA – designed for people involved in environmental education. Every year hundreds of educators and supporters of environmental education take part in the trade fair. The theme for the 19th volume of Environmental Fair tutorials ŠIŠKA 2016 was: (In)formally about informal environmental education.

Significant environment days (in collaboration with the MŽP SR) – World Wetlands Day, International Day of Forests, World Water Day, World Earth Day, International Day for Biological Diversity, World Environment Day, International Tree Day, European Mobility Week, Buy Nothing Day.
Exhibitions – exhibitions of various environmental topics on a weekly basis in the main building of the MŽP SR (the winners of the Green World competition).
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 commit to, on their territory, increasing energy efficiency, using RES and contributing to the objectives of the EU adopted in the Strategy 2020, including the target to reduce CO_2 emissions by 20% by 2020. The main national coordinator of the Convention in the Slovak Republic is the MŽP SR. The MŽP SR cooperates long and intensively with the Ministry of Economy of the Slovak Republic in the fulfilment of the objectives of the Convention.
Open Days to the general public on the occasion of World Meteorological Day, World Water Day and World Environment Day (including seminars and promotional materials related to climate change).
Forestry Day – April, the month of forests.
Olympiad – biological, geographic, chemistry olympiad.

9.4 TRAINING

9.4.1 Training of Personnel Concerned with the State Administration of Environmental Protection

Education of state administration employees of environmental protection – implemented under 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, 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 nursery schools, primary and high schools.

9.4.2 Other Relevant Vocational Education

The granting of accreditation for verifiers authorized under Act No. 572/2004 Coll. on emission trading, under article 24 paragraph 1 of Act No. 414/2012 Coll. on Emissions Trading and on amendments to certain laws, to the Slovak National Accreditation Service, in charge of the accreditation body for granting accreditation to authorized verifiers. The expiration date of the transitional period was 1 January 2014, after which eligible verifiers could carry out verification activities under the authority obtained by successful completion of the exam in the MŽP SR and entry in the register of authorized verifiers. More information regarding accreditation is available on the website www.snas.sk.

The SHMÚ organized training on amendments to certain law and on practical issues raised during the practise. Training was held on 30 October 2017 with the aim to provide participants with comprehensive information on the amendment to the law on the issue of proving compliance with the sustainability criteria for biofuels and bioliquids in the Slovak Republic. During discussion participants had the opportunity to get answers to a number of practical issues and problems that are associated with this issue.

9.5 RESOURCE OR INFORMATION CENTRES

9.5.1 Disclosure of Information by Using Information and Communication Technologies

Enviroportal – a major resource and information centre for climate change, www.enviroportal.sk is an information portal focused on making environmental information available from one central point, operated by the SAŽP. The target audience is professionals but also the general public.

Furthermore, indicators for environmental assessment are regularly evaluated and made available on the Enviroportal, other relevant information concerning, e.g., erosion, landslides, floods, waste management, etc. (www.vuvh.sk, www.sguds.sk, www.shmu.sk, www.sazp.sk, www.svp.sk)

Facebook –includes information, news, inspiration, activities and SAŽP events. (www.facebook.com/Slovenský-hydrometeorologický-ústav, www.facebook.com/vuvh.sk, www.facebook.com/svp.sk, www.facebook.com/SAZPBB)

Official site of the MŽP SR – comprehensive information on climate change published and regularly updated on the official website of the MŽP SR (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 has been operated by the SHMÚ, providing detailed information on the inventory and projections of greenhouse gas emissions.

Geoportal NIPI – during the process of building the National Spatial Data Infrastructure in relation to the INSPIRE Directive, the portal was created and put into operation accessible under the 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; the basis of this database consists of more than 2,000 professional contributions.

www.dmc.fmph.uniba.sk – the Department of Astronomy, Physics of the Earth and Meteorology of Comenius University in Bratislava provides scientific information on Climate Change and on the Physics of the Earth's Climate System within accredited master and PhD study programs as well as on their website and is also frequently visited by readers from abroad.

The issue of climate change, with its cross-cutting nature, extends to the scope of other departments. Ministries also make information, data, studies and reports relevant to the issue of climate change available, mainly through their specialized agencies. This is especially the National Forest Centre - www.nlcsk.org, the portal on forests www.forestportal.sk, the Research Institute of Soil Science and Conservation - www.vupop.sk, the Slovak Innovation and Energy Agency - www.siea.sk. Furthermore, scientific information on climate change and the Earth's climate system is provided by the website of the Faculty of Mathematics, Physics and Informatics - www.fmph.uniba.sk. The dissemination of information to the public is also provided by NGOs, for example, Greenpeace (http://www.greenpeace.org/Slovak Republic/sk/kampane/klimaticke-zmeny).

9.5.2 Journals

Enviromagazín – is a magazine which has been published by the MŽP SR and the SAŽP since 1996. Of a popular form, it fulfils an informational and promotional function. Some of the articles are about climate change issues, some are closely related.

Parlamentný Kuriér – in the journal of the National Council of the Slovak Republic an interview was published in 2016 dealing with climate change policy "The Slovak Republic spent almost 2 million euros on climate change last year". In 2014, it was "The consequences of and solutions for climate change".

21st century – the magazine for industrial ecology is already in its 15th year. It remains the only nationwide journal focused on the economic context of environmental policy with an emphasis on protecting the individual components of the environment in business practice. In addition to emphasis on the individual components of the environment, the magazine addresses the issues of energy and the rational use of energy, particularly in relation to climate and energy measures being taken in the Slovak Republic. 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 SHMÚ in the area of meteorology, climatology, hydrology, air pollution and other related branches. This journal publishes original scientific papers mostly in the English language prepared by Slovak and foreign authors, reviews and short expert papers either in the Slovak or Czech language. All papers are reviewed by lectors.

Central European Forestry Journal - the National Forest Centre - Forest Research Institute Zvolen publishes a scientific journal about forests (SAP publishing house, Bratislava).

Forest & tree rings – is a magazine issued by LESMEDIUM SK, s.r.o. about planting, forest protection and timber.

Quark - Magazine publishing the most current information on science, research, discoveries and new technologies in the Slovak Republic and the world on a monthly basis.

Waste (minimization, recovery and disposal) – Magazine about the 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 the Slovak Republic.

EA / Energy Magazine about RES and energy savings – media publisher / ST s.r.o.

9.5.3 Scientific, Professional and Educational Journals Dealing with the Issue of Climate Change

Journal of Hydrology and Hydromechanics – issued by the Institute of Hydrology of the Slovak Academy of Sciences and the Institute of Hydrodynamics. It is a top scientific journal with a 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 the Institute of Geography at the Slovak Academy of Sciences.

Contributions to Geophysics and Geodesy – issued by the Earth Science Institute at the Slovak Academy of Sciences, also a top scientific journal included in the Web of Science database (Scopus). It has a 42-year tradition and publishes original scientific papers and related information on meteorological issues, climatology and the hydrologic cycle, including climate change impacts.

The Environment – issued by the Institute of Landscape Ecology at the Slovak Academy of Sciences.

Ecological Studies - is a domestic peer-reviewed scientific journal published by the Institute of Landscape Ecology at the Slovak Academy of Sciences in collaboration with the Slovak Ecological Society (SEKOS) and the Department of Ecology and Environmental Sciences, Faculty of Natural Sciences of the Constantine the Philosopher University in Nitra. The journal presents original scientific studies in the field of ecology, landscape ecology, environmental sciences, ecological and environmental education, as well as other related disciplines.

Report on the State of the Environment – has been published regularly since 1993. The report evaluates environmental quality in the Slovak Republic 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 the SHMÚ. The report describes the situation of emissions and air pollution in the Slovak Republic, the most significant stationary sources of air pollution in previous years and the development of pollutant and greenhouse gas emission creation.

9.5.4 Important Information centres

The legal framework in the Slovak Republic with respect to the collection, assessment and dissemination of environmental information to the public, including information on climate change, is covered by Act No. 211/2000 Coll. on the free access to information, Act No. 205/2004 Coll. on the collection, storage and dissemination of environmental information, and Act No. 478/2002 Coll. on emissions, trading with CO_2 allowances. These regulations provide for the dissemination of information to the public.

Ministry of Environment (MŽP SR) – the process of the 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 legislation to address it.

Slovak Hydrometeorological Institute (SHMÚ) – provides information on the causes and consequences of climate change, adaptation and mitigation measures, emissions of pollutants and greenhouse gases.

Slovak Environmental Agency (SAŽP) – updates and provides information and educational programs for professionals but also for the 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 Slovak universities as complete master study programs or only study subjects. Lecturers or scientists from these universities can also give lectures and profound professional information to the general public and mass media.

9.5.5 Media

Informing the public on climate change, its possible impacts and climate change policy in general was realized by several means.

RTVS (Slovak TV) - RTVS runs a program called Meteoklub where meteorologists discuss, for instance, the topic of climate change. Reports, discussions or documentaries such as "Slovak forests – climate change" or the six part documentary "Climate change and animals" are common.

The TV station TA3 broadcasted several live discussions lasting from 10 to 90 minutes with Slovak scientists and professionals. For instance, "Climate change: What's ahead for us?" was broadcasted in the program Rozhovory cez polnoc; "Climate summit and the Slovak Republic" resonated in the show Téma dňa. Similar themes were discussed in the programs Tak takto? and Spektrum and the station has already aired the document "Climate error".

The Slovak Radio 1 regularly broadcasted 15- to 90-minute programs ("K veci", "Z prvej ruky" and "Nočná pyramída" - live discussions with Slovak experts) on current topics (climate change is on the program about 5 times a year). Climate related topics have been the theme of the programs Spektrum and Magnes, which bring recent news from science and technology.

The Slovak Academy of Sciences organizes a scientific discussion each month on current scientific problems (also for the general public) with the assistance of well-known Slovak and foreign scientists. Climate change was addressed in the discussions "Will nature heat up or will we be able to use science effectively to bring the heat down? How does space weather affect climate change?" or "Global changes – navigation and adaptation". In 2015, SAV coproduced “The climate atlas of the Slovak Republic”, which depicts the climate development in the Slovak Republic over the last 50 years.

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 an economic, social and moral view. Big fut always takes place in one of the Slovak universities. Discussions include climate-related topics like “What if we were all plants?”, “Are we in danger of a global blackout in 2030?” (including nuclear vs. alternative energy sources), “What if there were only electric cars on the roads?”, “When will we stop driving cars?” and festivals on intelligent electricity and electromobility.

The newspapers SME, Denník N, Pravda, Hospodárske noviny, Nový Čas Plus Jeden Deň and the news websites Aktuálne.sk, Aktuality.sk, Euractiv.sk regularly provide current information on climate change after consultation with Slovak experts.

Ekotopfilm – with its 44-year tradition, this movie festival is the oldest event of its kind in the world. The festival is an extraordinary platform that connects public, private and the third sector through sustainable development themes.

9.6 INVOLVEMENT IN INTERNATIONAL ACTIVITIES

The Slovak Republic has been a member of the European Environment Agency and the European Environment Information and Observation Network since 2001. Coordination on behalf of the Slovak Republic is ensured by SAŽP. The National Reference Centres were created within the European Environment Information and Observation Network, from which the following activities directly address climate change:

- National Reference Centre: Mitigation of Air Pollution and Climate Change,
- National Reference Centre: Climate change - impacts, vulnerability and adaptation scenarios (includes representatives of the SHMÚ).

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 the Ministry of Agriculture and Rural Development of the Slovak Republic, the National forest Centre and SAŽP),
- the National Reference Centre: Energy (includes representatives of the Ministry of Economy, SAŽP),
- the National Reference Centre: Land (includes representatives of Matej Bel University, SAŽP),
- the National Reference Centre RC: Waste (includes representatives of SAŽP, the Statistical Office of the Slovak Republic).

The following reports are outcomes of the European Environment Agency in the field of climate change:

- Climate change, impacts and vulnerability in Europe 2016; https://www.eea.europa.eu//publications/climate-change-impacts-and-vulnerability-2016

- Trends and projections in Europe 2016 - Tracking progress towards Europe's climate and energy targets;
  https://www.eea.europa.eu//publications/trends-and-projections-in-europe
- Approximated EU GHG inventory: early estimates for 2015.
  https://www.eea.europa.eu//publications/approximated-eu-ghg-inventory-2015

In 2003, a network of "European Network of the Heads of Environment Protection Agencies" was established, whose members on behalf of the Slovak Republic are SAŽP and SHMÚ. The network is an independent platform for the 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 relevance to the issue of climate change.