COMPONENTS OF THE ENVIRONMENT AND THEIR PROTECTION

• AIR

Key questions and key findings

What is the recent trend in the area of production of polluting substances in the Slovak Republic?

- **Basic pollutant emissions (PM, SO_2, NO_X, CO) over a long-term horizon (1993 - 2011) have been consistently declining; however, the speed of decline after 2000 has been significantly slower. There was a temporary increase in emissions detected in 2003 - 2005; however, after 2005 the trend was falling again until 2009. Positive year-to-year change was recorded in SO_2 and NO_X, on the contrary, PM and CO emissions showed a rising trend over the last year.**
- **Ammonia emissions have been persistently decreasing over a long time period.**
- **Non-metal volatile organic compounds (NMVOC) emissions over a longer time horizon (1993 - 2000) have been decreasing persistently. In the period of 2000 to 2010 the values were maintained more-less at the same level, with slight fluctuations in specific years. Growth in NMVOC emissions in 2011 (compared to 2010) was mostly influenced by increased volumes of solvents production and purchase.**
- **Persistent organic pollutants (POPs) emissions declined significantly over the period of 1993 - 2000. When the years 2000 and 2011 were compared, there was seen a decline in PCDD/PCDF emissions by 52.8%; however, PCB emissions increased by 1.9%, and the sum of PAH emissions increased by 42.6%. From year to year, PCDD/PCDF emissions show declining values. The same trend is seen in PCB. On the contrary, other PAH emissions show a slight increase.**

Is Slovakia fulfilling its obligations given by international conventions in the area of air protection?

- **Slovakia is fulfilling its obligations given by international legislation in the area of air protection.**

Are the air pollutants limit values for human health protection complied with?

- **Notwithstanding the persistent decrease in the pollutants emission, in 2012 a number of monitoring stations again detected exceeded limit values for selected air-borne pollutants (NO_X, PM_{10}, $PM_{2.5}$) designated to ensure human health protection.**

Are the air pollutants limit values for vegetation protection complied with?

- **Limit values of air-born pollutants (SO_2, NO_X) designated for the protection of vegetation have not been exceeded. Exceeded values were detected for ground ozone.**
- **The massive reduction in national emissions of ozone precursors over the last years has not resulted in reduced ground ozone concentrations in Slovakia. Some ground ozone characteristics in 2012 remained at a relatively high level achieved in the previous years.**

What has been the trend in the condition of the ozone layer and intensity of solar radiation over the SR territory?

- **Total atmospheric ozone was above the long-term average values, within a 5.4% deviation above the mean value; total sum of daily doses of the ultraviolet erythema radiation decreased.**

Is the SR fulfilling its international obligations in the area of the Earth's ozone layer protection?

- **Slovakia is fulfilling its obligations given by international legislation in the area of ozone layer protection.**

Emission situation

♦ Balance of basic pollutants emissions

Trend in emissions of particulate matter

Emissions of particulate matter have shown a steady reduction since 1990, which, apart from reduction in production and energy consumption, has been caused by a change within the fuel group toward more purified fuels, as well as by using fuels with higher quality labels.

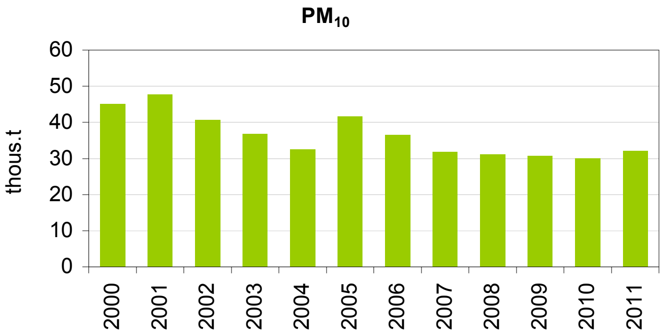
Increase in the PM emissions over 2004-2005 was caused by an increased consumption of wood within the sector of small-size sources (heating up of houses) due to increased natural gas and coal prices for small consumers. Reduction in the PM emissions in 2006 was caused mainly by reconstructions of the separation equipment in several power management and industrial installations. Further decrease in the PM emissions by large stationary sources in 2007 was caused by the fact that some incineration units installed at significant sources were out of operation. Since 2008, the PM emissions trend has continued to decrease slightly.

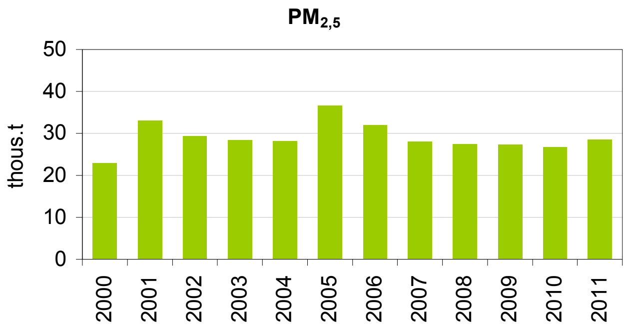
Slight increase in PM emissions in 2011 was recorded in the sector of small-sized sources - households with increased consumption of firewood at the expense of natural gas.

Balance of PM_{10}, $PM_{2.5}$ emissions

In the sector of road transport, diesel engines are among the major contributors to the PM_{10} and $PM_{2.5}$ emissions. The share of abrasion is less significant than in the case of the PM emissions. In total, the most significant contributors to the PM_{10} and $PM_{2.5}$ emissions include small sources (heating of houses). Increased emissions in this sector reflect the increased consumption of wood caused by growing prices of natural gas and coal.

Development trends in PM_{10} a $PM_{2.5}$ emissions





Source: SHMI

Trend in emissions of nitrogen oxides

Emission of nitrogen oxides since 1990 dropped slightly despite the fact that they grew slightly in 1994-1995 due to an increased natural gas consumption.

Decrease in nitrogen oxides in 1996 was caused by a change to the emission factor that took into consideration the level of equipment and technology of incineration processes. Reduction in solid fuel consumption since 1997 has led to a further decrease in NO_X emissions. In the years 2002 and 2003, de-nitrification played a significant role in emission reduction (electric power plant Vojany). In 2006, there was a significant reduction in the NO_X emissions, especially in case of large and medium stationary sources. This reduction relates to reduced production (Zemianske Kostoľany and Vojany electrical power plants) and consumption of solid fuels and natural gas (Zemianske Kostoľany and Vojany electrical power plants and the Slovak gas industry company – transit, Inc. Nitra - /SPP/). Mobile sources also, mainly road transportation, have shown significant NO_X emissions.

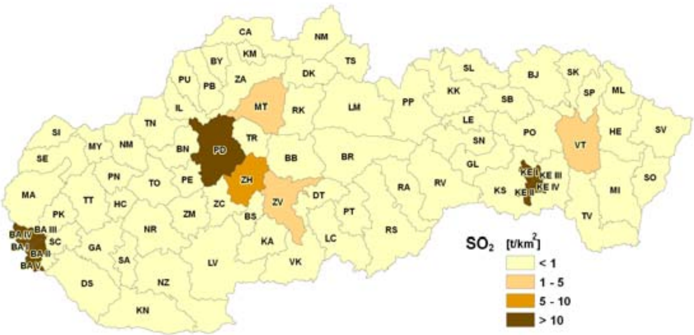
This reduction also relates to the modernisation of personal and freight vehicles, as well as the use of a more exact emission factor and it was the most important factor influencing emissions drop in 2011.

Trend in carbon monoxide emissions

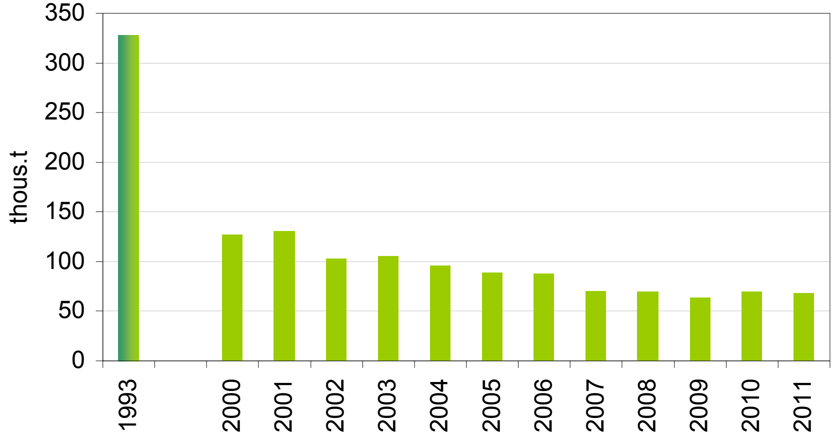
Carbon monoxide emissions (CO) since 1990 have shown a falling tendency, which was caused mainly by reduced consumption and change in fuel composition in the sphere of retail consumers. CO emissions from large sources were decreasing only slightly. The most significant share on CO emissions from large sources comes from iron and steel industries.

The decrease in CO emissions since 1996 was due to the effects of policy and measures (determined on the results of measurements) to reduce CO emissions from the most significantly sources. The emission trend changes of CO within 1997 and 2003 is also affected by the quantity of pig iron production as well as the fuel consumption. In 2004 the CO emissions slightly increased mainly at large sources (the CO emissions specified by continuous measurement in U.S. Steel Ltd., Košice), since then the emissions have had only moderately decreasing trend. In 2005 the decrease of CO emissions was announced atlarge sources too, mainly as a consequence of agglomerate production cutting down in U.S. Steel Ltd., Košice and by the implementation of a new technology with effective combustion at lime production (Dolvap Ltd., Varín). Significant decrease (22%) in CO emissions of major sources in 2009 was mainly due to decrease in iron and steel production as a result of economic recession. Increase of CO emissions was achieved only in the sector of small sources (residential heating) and it is related to the increase of wood consumption caused by the increasing price of natural gas and coal. The emission decrease in the sector road transport is associated with onward renovation of rolling stock by the generationally new vehicles equipped by the three-way catalysts. Emissions in year 2010 increased (about to the level of year 2002) due to increased production of iron and steel in facility U.S. Steel s.r.o., Košice. increase in CO emissions continued in 2011 but still below the level in the years 2004 to 2006, when emissions were the highest during the decades.

Element regional emission of SO_2 in 2011 ($t.km^{-2}$)

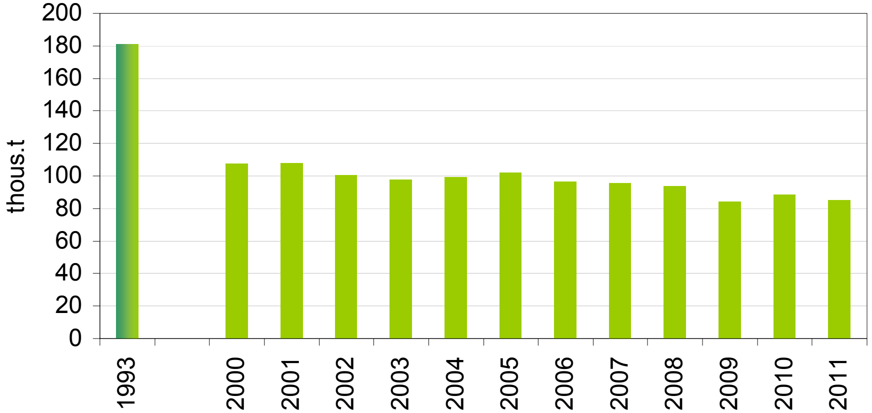


Trend in emission of SO_2

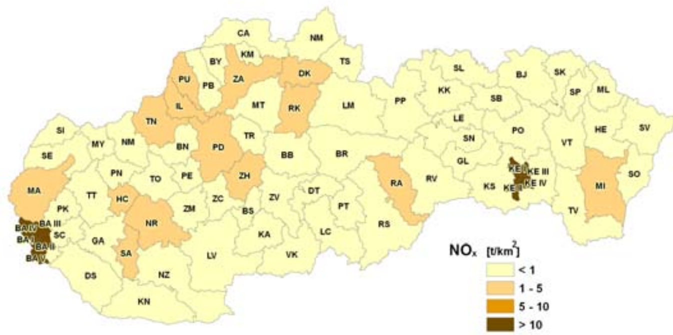


Source: SHMI

Trend in emission of NO_X

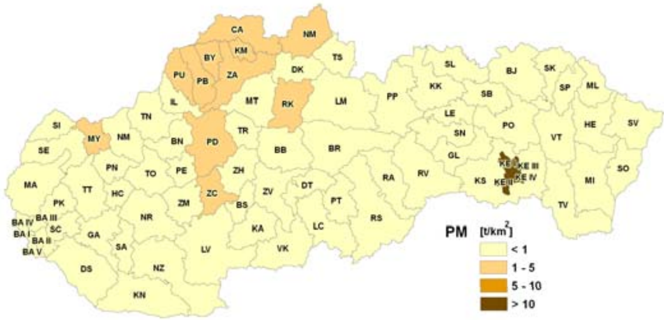


Element regional emission of NO_X in 2011 ($t.km^{-2}$)

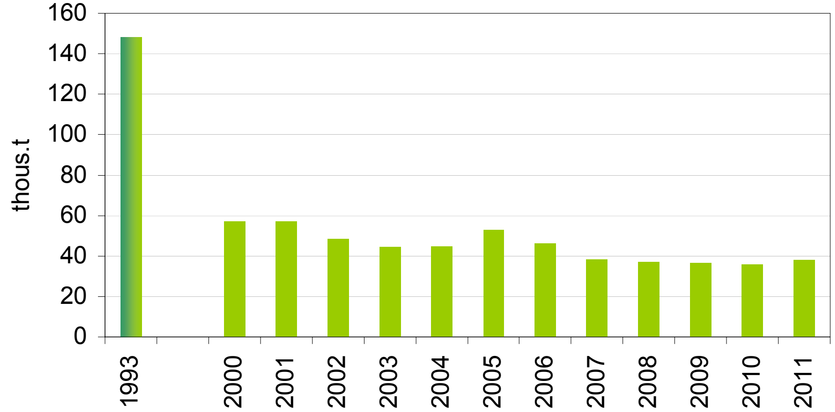


Source: SHMI

Element regional emission of PM in 2011 ($t.km^{-2}$)

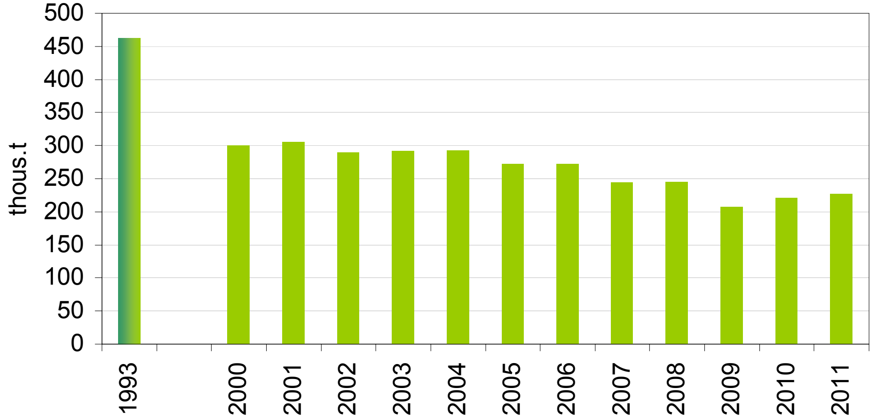


Trend in emission of PM

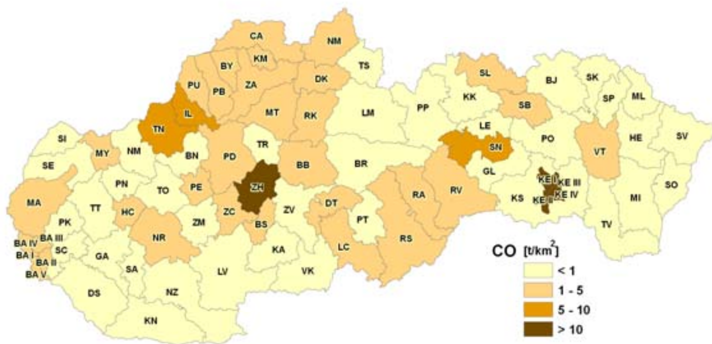


Source: SHMI

Trend in emission of CO



Element regional emission of CO in 2011 ($t.km^{-2}$)



Source: SHMI

Meeting international obligations for the basic pollutants emissions

Slovakia is a signatory to the UN Economic Commission Convention on Long-Range Trans-boundary Air Pollution (which became effective for ČSFR in March, 1984, and Slovakia being its successor since May, 1993). This Convention became the basis for protocols, which also spelled out obligations for the signatories to reduce individual anthropogenic emissions of pollutants contributing to global environmental problems. The following text shows how individual protocols' obligations in the area of acidification are met:

- ***Protocol on further reduction of sulphur emissions***

This protocol was signed in Oslo in 1994. Ratified by the Slovak Republic in January 1998 the protocol became effective in August 1998. Obligations of the Slovak Republic to reduce the SO_2 emissions as set forth in the Protocol (compared to the reference year of 1980) include:

Obligation to reduce SO_2 emission pursuant to Protocol on further reduction of sulphur emissions

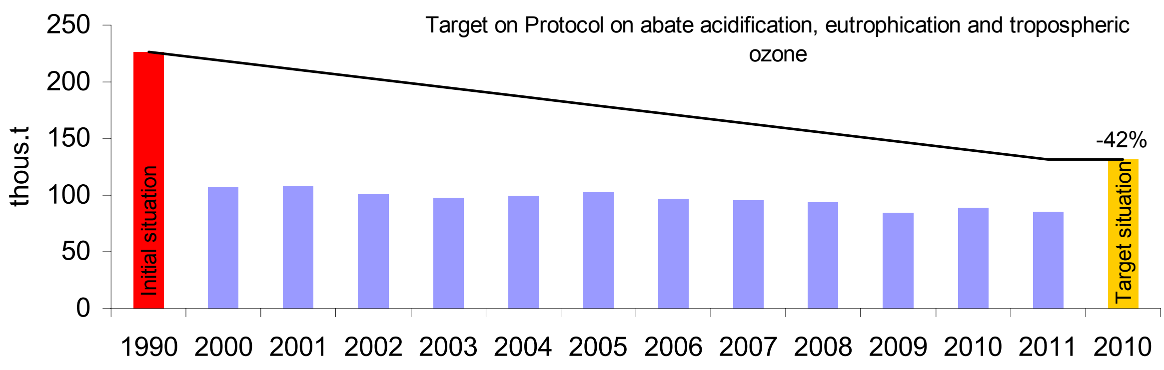
Year	1980 (initial year)	2000	2005	2010
SO_2 emission (thous. t)	843	337	295	236
SO_2 emission reduction (%)	100	60	65	72

Slovakia met one of its Protocol objectives to reduce the SO_2 emissions in 2000 by 60%, in 2005 by 65% and in 2010 by 72%, compared to the reference year of 1980. In 2000, sulphur dioxide emissions reached the level of 126.953 thousand tons, which is 85% less than in the years 1980. In 2005 it was 89 thousand t, which is 89% less than in 1980. In 2010, sulphur dioxide emissions reached the level of 63.393 thousand tons, which is 92% less than in 1980. The year 2011 shows a positive trend.

- ***Protocol on the Reduction of Acidification, Eutrophication and Ground Ozone***

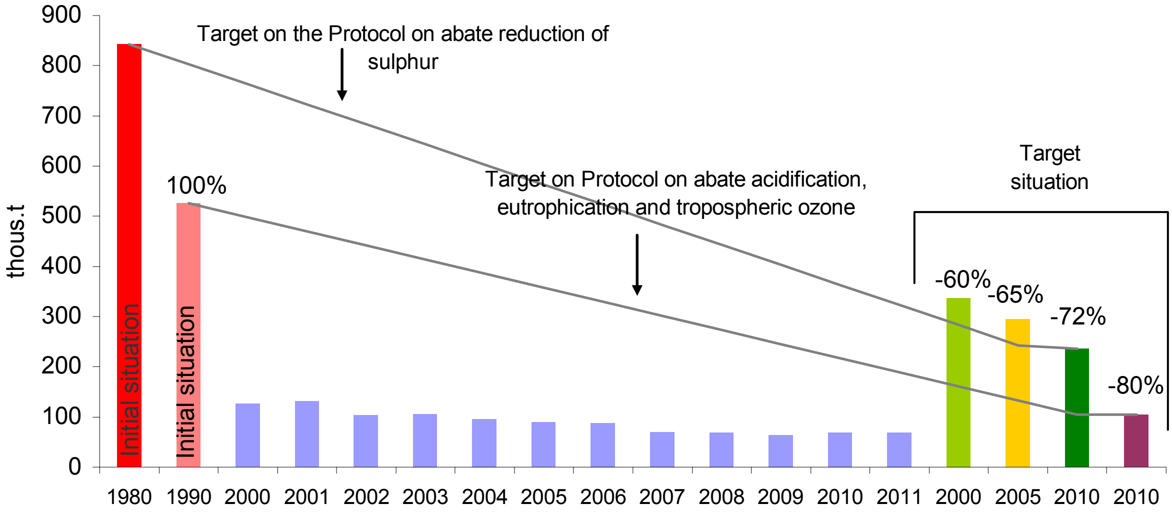
The protocol was signed in Göteborg in 1999. Slovakia signed the protocol in 1999 and ratified in 2005. Slovakia obliged itself to reduce the SO_2 emissions by 2010 by 80%, the NO_2 emissions by 2010 by 42%, the NH_3 emissions by 2010 by 37% and the VOC emissions by 2010 by 6% in comparison to the year 1990. As to date, the Slovak Republic achieved the set objective and continues in the same trend.

Trend in NO_X emission with regard to following the outcomes of international agreements



Source: SHMI

Trend in SO_2 emission with regard to following the outcomes of international agreements



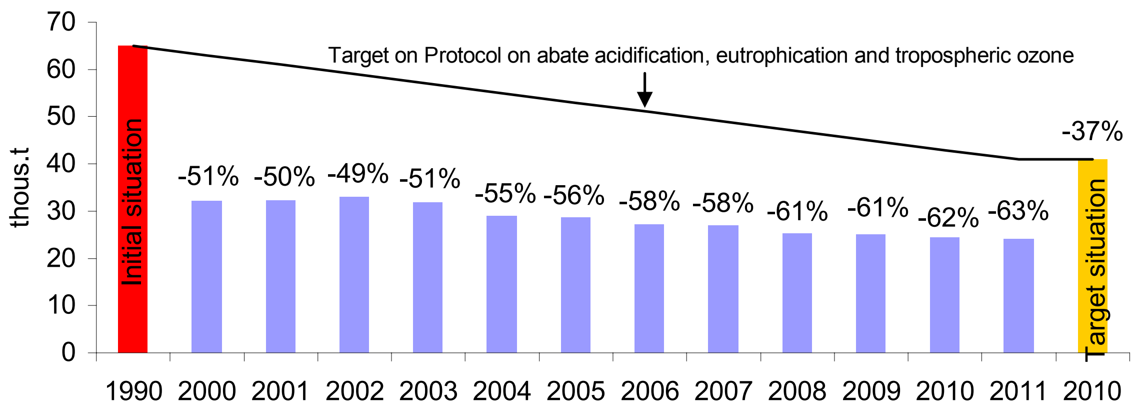
Source: SHMI

- **Balance of ammonia emissions (NH_3)**

Production of the NH_3 emissions$_3$ in 2011 was 24 184 tonnes. More than 95% of all NH_3 emissions originate in the sector of agriculture - livestock production and animal waste management. NH_3 emissions from the use of artificial nitrogen fertilisers also represent a significant category in the sector of agriculture. NH_3 emissions from the energy sector/industrial production and transport are less significant. NH_3 emissions from industrial production originate mainly from nitric acid production. NH_3 emissions from transport originate mainly from road transport.

Over a long-term period, there is a persistent decrease in total volumes of NH_3 emissions.

Trend in NH_3 emission with regard to following the outcomes of international agreements



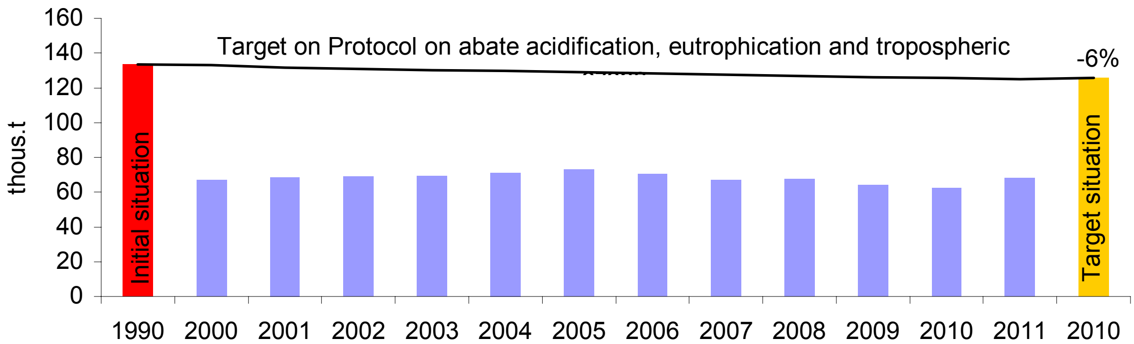
Source: SHMI

- **Emissions of non-methane volatile organic compounds**

Non-methane volatile organic compounds (NMVOC) are set in compliance with the requirements of the international methodology of EMEP/EEA. (Air Pollutant Emission Inventory Guidebook) Since 2001, inventories of NMVOC emissions have been included also emissions balance from asphalting roads which resulted in adequate increase in total emissions in individual years. Emission factor used for the calculation of emissions from given sector was revised and changed in 2004. As for the sector of burning by households, emissions have increased slightly due to burning wood. In the sector of fuel distribution, emissions from LPG distribution was introduced since 2001.

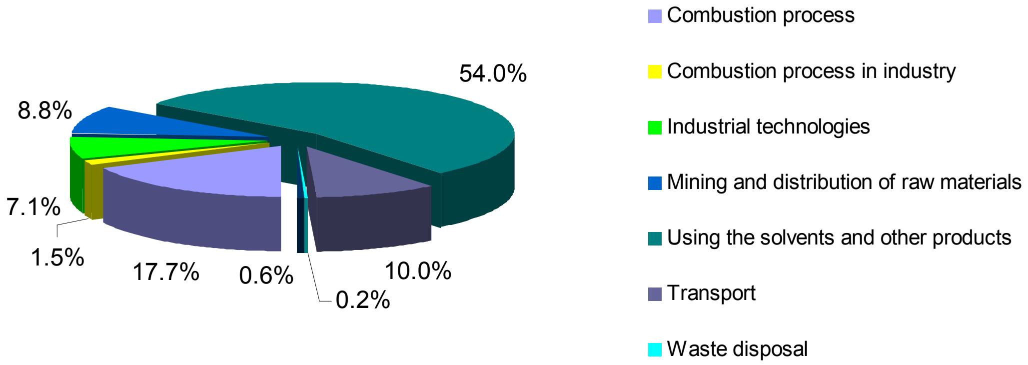
Decline in total NMVOC emissions was caused by a number of measures, such as reduction in using coating compounds and by gradual introduction of low-solvent types of coatings, extensive introduction of measures in the sector of crude oil processing and fuel distribution, introduction of gas technologies into incineration, especially in the energy area, and by the change to the portfolio of cars toward vehicles equipped with the operated catalyser. Since 2000, the NMVOC emissions in the area of paints and glues have increased by 54%, since the use of these products is part of a wide spectrum of industrial activities and various technological operations. The consumption and import of printer colours and solvent-based paint systems has been continually increasing. In 2004 and 2005 there was a growth in the production of cars, many paint shops were opened, thus increasing also the consumption of paint substances. In 2007 came into effect **Council Directive 1999/13/EC of 11 March 1999 on the limitation of emissions of volatile organic compounds due to the use of organic solvents in certain activities and installations** which obliged the operators to comply with the emission limits. In 2007, data over the entire time progression in the sector of chemical cleaning and degreasing were recalculated. In 2008, the entire time progression in the sector of waste land-filling and incineration was recalculated on the basis of the updated input data. Similarly, emissions from road transport were also recalculated due to the use of an updated version of COPERT IV model. In 2009, there was a decline in NMVOC emissions related to decreased industrial production. Emissions from road transport were recalculated as back as to 1990 due to the use of a newer version of the COPERT IV model in the inventory. Until the year 2010, trend in NMVOC emissions showed reducing values. In 2011, there was recorded a slight increase with total volume of NMVOC emissions reaching the volume of 68,285.859 tonnes.

Trend in NMVOC emissions with regard to fulfilling of the international agreements



Source: SHMI

The contribution of the NMVOC emission according to sector of their origin in 2011



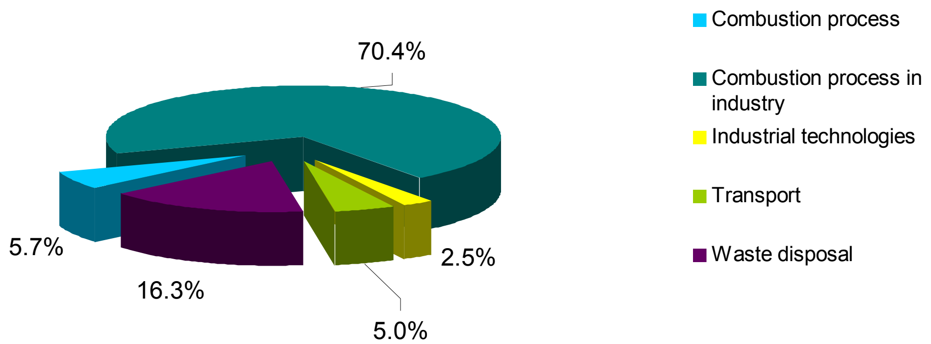
Source: SHMI

- **Balance of heavy metals emissions**

Heavy metal emissions have decreased significantly since 1990. Besides shutting off a number of old-fashioned and non-effective productions, this trend has been influenced by extensive reconstructions of separation equipment, change in raw material used, and, most of all, by transition to using unleaded petrol types since 1996. Since 2004, the register of heavy metals from household fuel burning has included the burning of wood. Trends in the heavy metal emissions over the recent years are characteristic for slight fluctuations. In 2007, lead and mercury emissions dropped, compared to the 2006 figures, due to a reduction in the ore agglomeration and glass production. At the same time, cadmium emissions increased in the same year, which related to an increased copper production. In 2008, lead, cadmium, copper, zinc, and selenium emissions increased due to an increased volume of incinerated industrial waste and increased emissions in the area of industrial, municipal power management , and system power industry.

In 2009, there was a reduction in heavy metal emissions which related to a reduction in the industrial production. In 2010, there was a recalculation carried out in the sector of waste handling for the years 2002, 2004, 2005, and 2008, due to an update in the input data. A new version of the COPERT IV model was used for the road transport emission analysis; therefore, emissions were recalculated until 2000. Next, cadmium emissions from glass production were calculated for the years 2007 and 2008, due to a revised emission factor for colour glass. Decrease in emissions of heavy metals in 2011 is affected by the decline of production in the industrial sector.

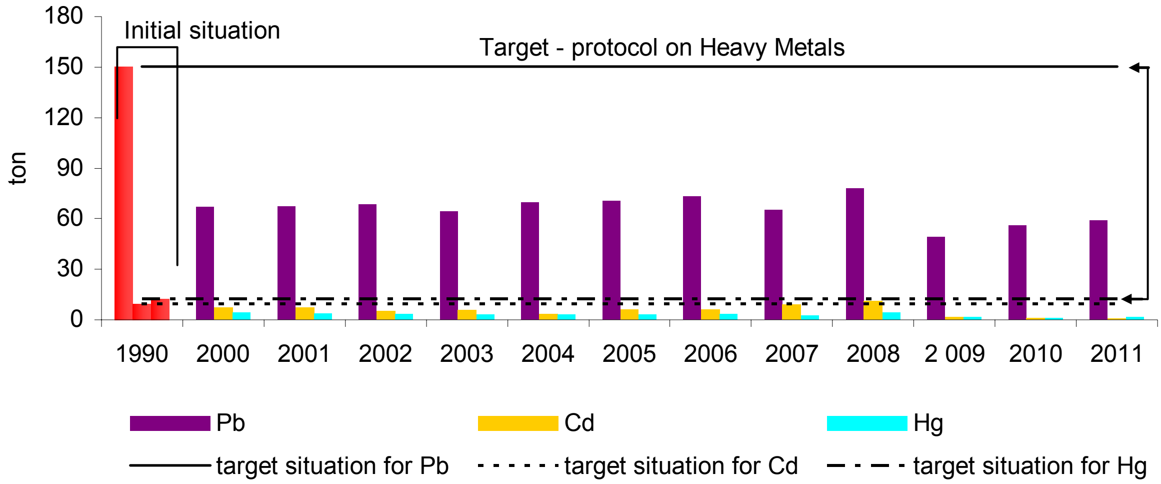
The contribution of the particular sectors in the Pb emission production for year 2011



Source: SHMI

Air-borne heavy metals do not represent an environmental issue of only one country. In 1998, the Protocol on heavy metals was drafted in Aarhus. This document followed the UN ECE Convention on Long - Range Trans-boundary Air Pollution, whose only objective is to decrease heavy metal emissions (Pb, Cd, Hg) to the level of 1990. Slovak Republic signed this Protocol in that same year. This goal is still being followed.

Trend in emissions of heavy metals regarding the fulfilment of the international conventions



Source: SHMI

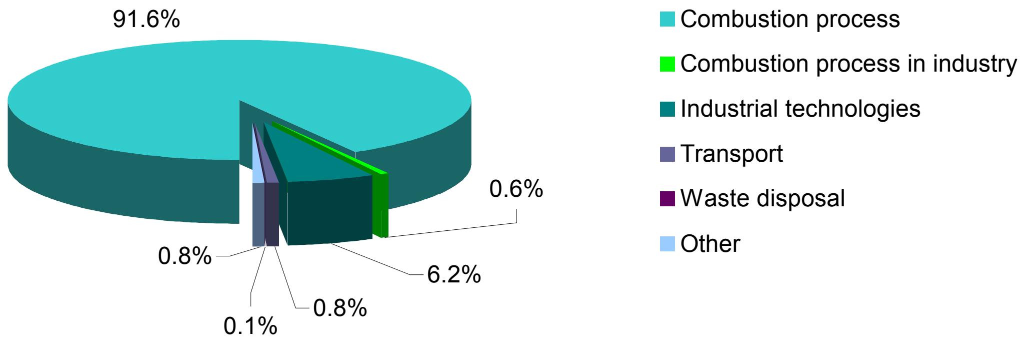
- **Balance of Persistent organic pollutants (POPs)**

Decreasing trend in the POPs emissions was most clearly seen in the 90ties for PAH where the reduction in emissions was mainly caused by a change to the aluminium production technology (using previously burnt anodes). Growth in the PCB emissions (polycyclic biphenyls) over the last years has been influenced primarily by an increased consumption of diesel in road transport and an increased consumption of wood by small sources (heating of households). Increased wood consumption in this sector influenced also the growth in total PAH emissions. PCDD/F emissions have dropped since 2000 due to the reconstruction of a number of installations (municipal waste incineration units). PCDD/F emissions are influenced by the volume of incinerated medical waste, volume of agglomerated iron ore, and by fuel composition in the sector of household heating. A slight increase in the emissions of polychlorinated biphenyls (PCBs) and polycyclic aromatic hydrocarbons (PAH) caused increased volume of modal split in road transport and an increased fuel consumption. Fluctuating emissions of hexachlorbenzene (HCB) reflects the fluctuating production of secondary copper together with a growth in the volume of modal split in road transport.

Fluctuating emissions of hexachlorbenzene (HCB) reflects the fluctuating production of secondary copper together with a growth in the volume of modal split in road transport.

In 2012, emissions from road transport were recalculated.

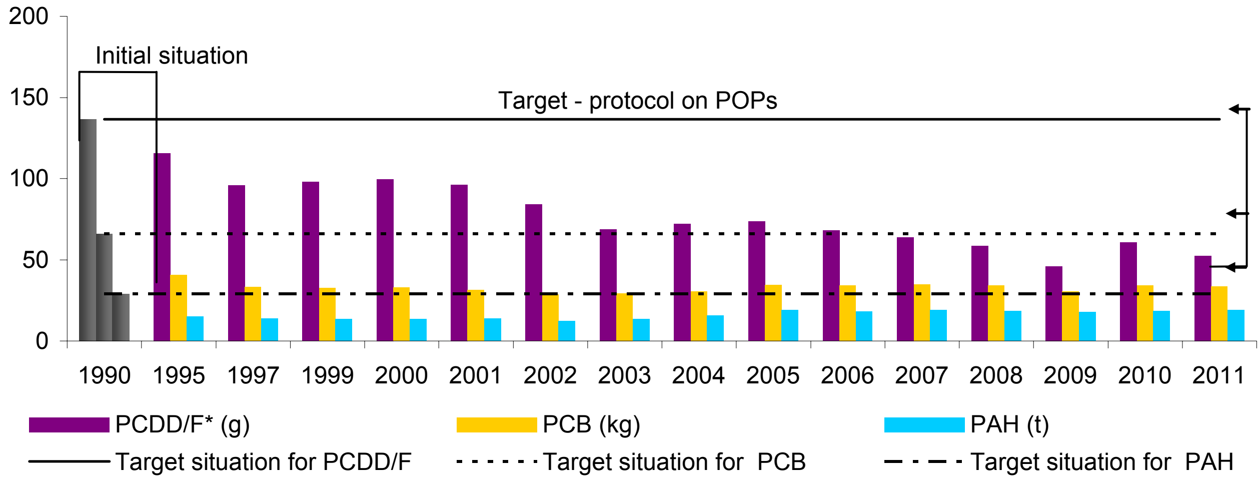
The contribution of the particular sectors in the PAH emission production for year 2011



Source: SHMI

In 1998, Slovak Republic also accessed to Protocol on Limitation of Persistent Organic Compounds (POP) Emissions under the mentioned Convention, whose objective was to reduce POP emissions to the emission level of the year 1990, compared to the reference year of 1990. Slovak Republic signed this Protocol in that same year. This goal is still being followed.

Trend of POPs emissions regarding the fulfilment of the international conventions



Source: SHMI

Air pollution

♦ Air quality and its limits

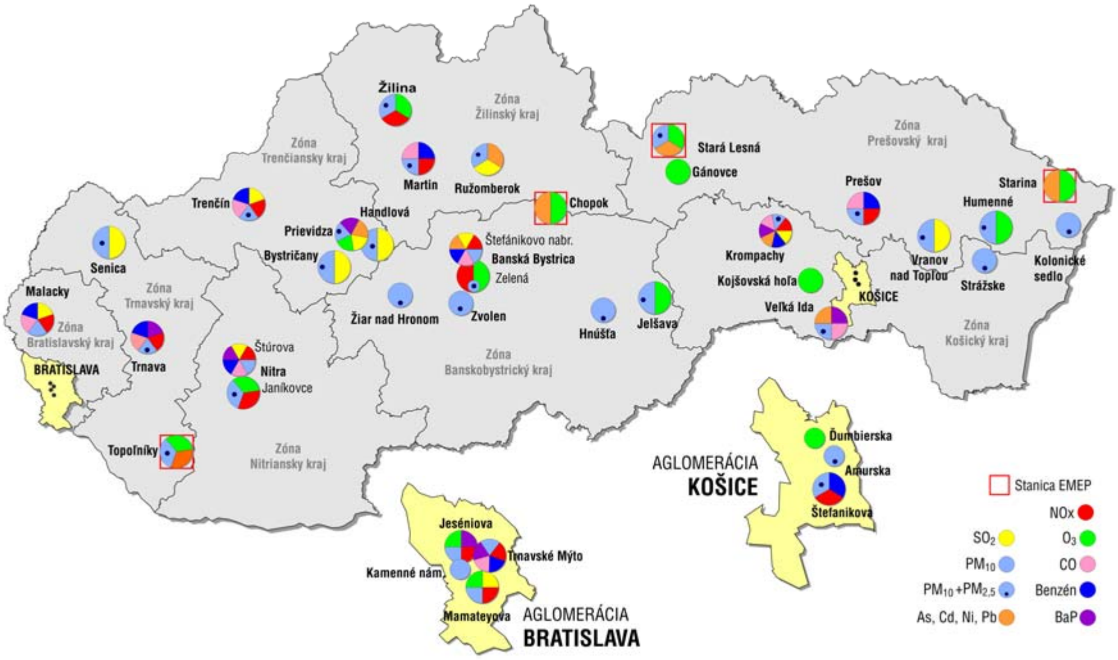
Air quality in general is determined by the contents of airborne pollutants in the upper atmosphere, Air quality assessment has been implemented in **compliance with Act 137/2010 Coll. on air.** Air quality criteria (limit and end values, tolerance thresholds, upper and lower assessment thresholds, and others) are published in **Decree of the Ministry of Environment No. 360/2010 Coll. on air quality.** Assessment of air quality in Slovakia is based on the outcomes of airborne pollutants' concentrations measurements by the Slovak Hydrometeorological Institute at the stations within its National Air Quality Monitoring Network. (NAQMN)

In line with regulations of the act on air protection, the whole Slovak territory was divided into 8 **zones** and 2 **agglomerations** that are further subdivided into 19 **air quality management areas.**

Air quality management area is an agglomeration or a designated part of the zone with exceeded:

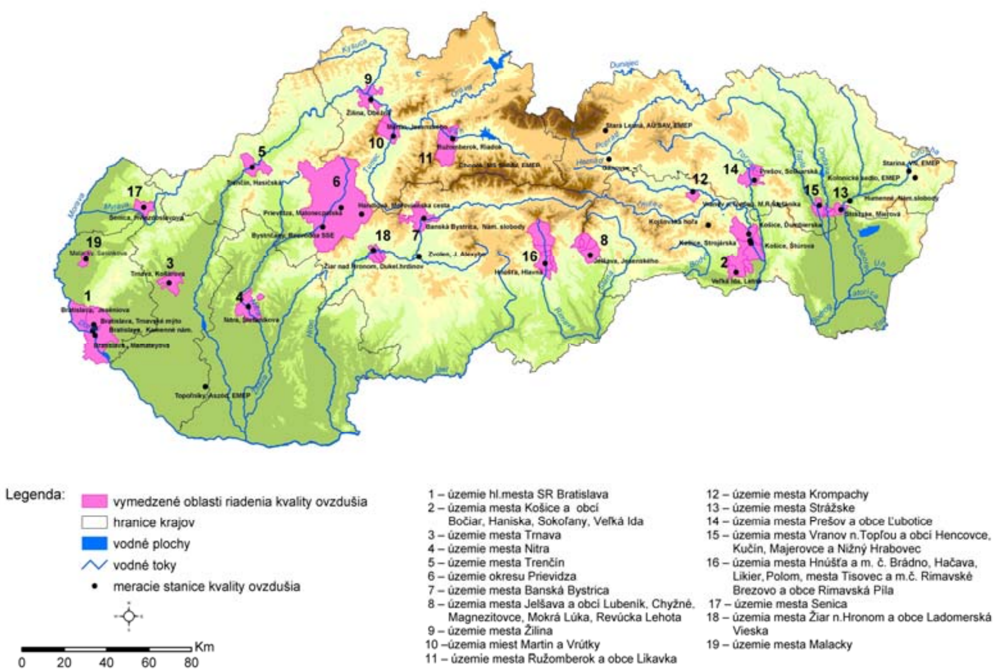
- limit values for one substance or more pollutants increased by tolerance threshold,
- limit value of one substance or more pollutants, if no tolerance threshold is set,
- target value for ozone, $PM_{2,5}$, arsenic, cadmium, nickel, or benzo(a)pyrene.

National monitoring air quality network – 2011



Source: SHMI

Air quality management areas



Source: SHMI

♦ Local Air pollution

Sulphur dioxide

Minimum range of SO_2 monitoring (number and localisation pursuant to Annex 5 to Decree 360/2010 Coll. on air quality) has not been achieved due to lacking measurements in the agglomeration of Košice. Monitoring of sulphur dioxide has been carried out through continual reference method at 12 stations. Required number of valid measured data (90%) was achieved at 7 monitoring stations. No limit values were exceeded in 2012.

Nitrogen dioxide

Minimum range of NO_2 monitoring (number and localisation pursuant to Annex 5 to Decree 360/2010 Coll. on air quality) was achieved. Monitoring of sulphur oxides has been carried out through continual reference method at 15 stations. Required number of valid measured data (90%) was achieved at 9 monitoring stations. In 2012, limit value was exceeded at the monitoring station of Banská Bystrica, Štefánikovo nábrežie.

PM_{10}

Minimum range of PM_{10} monitoring (number and localisation pursuant to Annex 5 to Decree 360/2010 Coll.) has been achieved. PM_{10} monitoring was carried out by equivalent, continual method of oscillation microbalance, by TEOM instruments at 32 stations. Required number of valid measured data (90%) was achieved at 19 monitoring stations.

A number of urban stations implemented equivalence testing through the gravimetric method. Currently, the results are analysed with the objective to have the whole process automated. Also, in 2012, permitted number of measurements with exceeded values at most monitoring sites was exceeded.

$PM_{2.5}$

Range of $PM_{2,5}$ monitoring (number and localisation pursuant to Annex 5 to Decree 360/2010 Coll. on air quality) was achieved. $PM_{2,5}$ monitoring was implemented through the same method as PM_{10} measurements with the use of TEOM instruments at 26 stations. Gravimetric measurements were carried out at one station. As for $PM_{2,5}$ particles, the annual limit of 25 µg/m3 will come into effect as of 01.01.2015, however, this value has been valid since 2010 as the end value that should not be exceeded. Required number of valid measured data (90%) was recorded at 8 monitoring stations and the number of measurements with exceeded values was recorded at 6 stations.

Carbon monoxide

Minimum range of CO monitoring (number and localisation pursuant to Annex 5 to Decree 360/2010 Coll. on air quality) has not been achieved due to lacking measurements in the agglomeration of Košice. Monitoring of carbon monoxide has been carried out through continual reference method at 10 stations. Required number of valid measured data (90%) was achieved at 6 monitoring stations. No limit values were exceeded in 2012.

Benzene

Minimum range of benzene monitoring (number and localisation pursuant to Annex 5 to Decree 360/2010 Coll. on air quality) was achieved. Monitoring of benzene has been carried out through continual reference method at 10 stations. Required number of valid measured data (90%) was achieved at half of the monitoring stations. No limit values were exceeded in 2012.

BaP

The end value that was to be reached by 31. 12. 2012 was in 2011 exceeded at the stations of Veľká Ida-Letná, Krompachy-SNP, and Prievidza-Malonecpalská, and Trnava-Kollárova.

♦ Regional air pollution and atmospheric precipitations

Regional air pollution *is a pollution of a boundary layer of a rural country at a sufficient distance from local industrial and urban sources. The boundary layer of the atmosphere is a mixing layer extending itself from the Earth surface up to a height of about 1 000 m. Residence time of these pollutants in the atmosphere is several days and thus they may be transported in the atmosphere over a distance of several thousand kilometres from the source. Pollutants coming from combustion processes such as sulphur dioxide, oxides of nitrogen, hydrocarbons or heavy metals, play an important role on a regional scale.*

In 2012, Slovakia operated 4 EMEP NAQMN stations for monitoring regional air pollution and chemical composition of precipitation water. All the stations are part of the EMEP network. EMEP represents a programme of cooperation for monitoring and assessment of remote travel of airborne pollutants in Europe under the scheme of UNECE Convention on Long - Range Trans-boundary Air Pollution CLRTAP (Geneva, 1979).

Sulphur dioxide, sulphates

In 2012 regional sulphur dioxide concentrations calculated per sulphur were 0.26 $\mu g.m^{-3}$ at Chopok, and 0.86 $\mu g.m^{-3}$ at Starina. Pursuant to Annex 13 to Regulation no. 360/2010 Coll., critical level for the protection of vegetation is 20 μg $SO_2.m^{-3}$ for the calendar year and the winter season. This level was exceeded neither for the calendar year (Chopok 0.52 μg $SO_2.m^{-3}$ and Starina 1.72 μg $SO_2.m^{-3}$) nor for the winter season (Chopok 0.4 μg $SO_2.m^{-3}$ and Starina 2.6 μg $SO_2.m^{-3}$). Percentage share of sulphates on total particulate matter mass was 12.1% at Chopok and 13.7% at Starina. Sulphates to sulphur dioxide concentration ratios expressed in sulphur was 0.9 at Chopok and 0.76 at Starina.

Nitrogen oxides, nitrates

Concentration of nitrogen oxides at regional stations expressed in NO_2-N were in 2012 0.81 $\mu g.m^{-3}$ at Chopok and 1.24 $\mu g.m^{-3}$ at Starina. Pursuant to Annex 13 to Regulation no. 360/2010 Coll., critical level for the protection of vegetation is 30 μg $NO_X.m^{-3}$ for the calendar year. This level was not exceeded over the last calendar year (Chopok 2.67 μg $NO_X.m^{-3}$ and Starina 4.09 μg $NO_X.m^{-3}$). Airborne nitrates at Chopok and Starina were detected mainly in their particulate form. Compared to gaseous nitrates, the difference recorded at Starina favours particulate nitrates more than at Chopok.

Despite the fact that gaseous and particulate nitrates are trapped and monitored separately, their sum is expressed in line with EMEP, since their phase distribution depends on atmospheric temperature and humidity. Percentage share of nitrates on atmospheric aerosol was 6.9 % at Chopok and 9 % at Starina. Ratio of total nitrates (HNO_3 + NO_3) to NO_X-NO_2, as expressed in nitrogen, was 0.15 at Chopok and 0.27 at Starina.

Ammonia, ammonium ions, and alkali metals

In compliance with the requirements of the EMEP monitoring strategy, measurements of ammonia, ammonium ions, and ions of sodium, potassium, calcium, and magnesium in the air at the station of Stará Lesná were initiated in May 2005. The measurements were completed in 2007. Measurements for these ions began at Starina in July 2007. Table shows average concentrations of the mentioned components (NH_3 and NH_4^+ calculated as per nitrogen) at Starina for the year 2012. For ammonia ions, annual concentration was 0.58 μg N.m^{-3} and their percentage proportion in PM was 5.2 %. For ammonia, the annual concentration is 0.41 μg N.m^{-3} and the ratio of the ammonia ions and ammonium concentration expressed in nitrogen is 1.4.

Ozone

Stará Lesná shows the longest time progression in ozone measurements since 1992. Ozone measurements at Topoľníky, Starina, and at Chopok started in the course of the year 1994. In 2012, the average annual ozone concentration at Chopok 93 μg.m^{-3}, 59 μg.m^{-3} at Topoľníky, 63 μg.m^{3} at Stará Lesná, and 60 μg.m^{-3} at Starina.

Volatile organic compounds

Volatile organic compounds C2-C6 or the so-called light carbohydrates began at the Starina station in the fall of 1994. Starina belongs to the few European stations listed within the EMEP network, with regular monitoring of volatile organic compounds. The compounds are assessed in line with the EMEP methodology under NILU. Their concentrations range from decimals to several ppb units. However, since October 2008 until mid September 2011, it was impossible to detect VOC due to persistent problems with the operation of a new gas chromatograph installed at Testing laboratory. VOC measurements were resumed on 15. 9. 2011. Nowadays, VOC analyses for 2012 represent the first semester of 2012.

Percentage share of heavy metals in Starina 2011

ethane	ethene	propane	propene	i-butane	n-butane	acetylene	i-pentane	n-pentane	isoprene	n-hexane	benzene
1.804	0.884	0.801	0.205	0.885	0.582	0.364	0.172	0.170	0.034	0.114	0.355

Measurements were resumed on 15. 9. 2011 Source: SHMI

Atmospheric precipitations

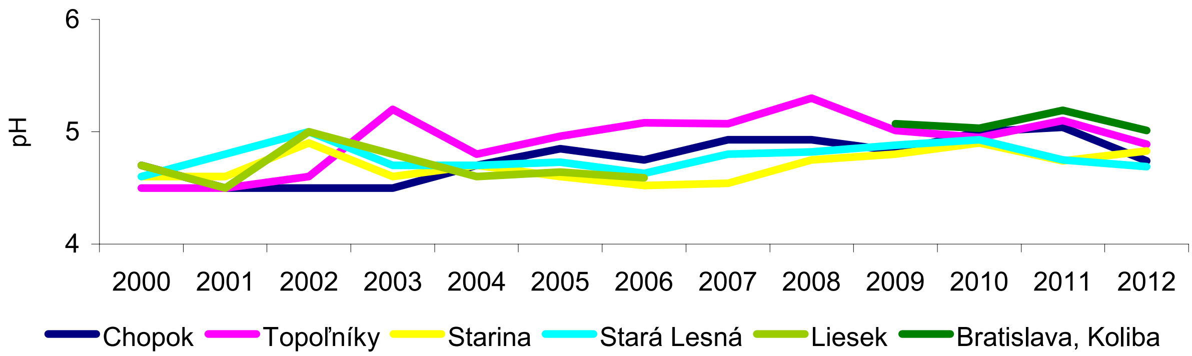
- Major ions, pH, conductivity

In 2012, total atmopheric precipitations at regional stations were between 432 and 993 mm. Upper limit of the interval was detected at the highest located station Chopok, while the lowest limit was detected at the station Topoľníky of the lowest altitude. Acidity of atmospheric precipitations was greatest at Stará Lesná, copying the lower pH limit of 4.69 - 4.89. Time progression along with the pH trend over a longer period show a decrease in acidity. pH values well correspond with the pH values by the EMEP maps.

Dominant sulphates concentrations in precipitation water calculated per sulphur represented the interval between 0.41 - 0.55 mg/l. Sulphates concentrations copy the lower interval limit at Topoľníky and the upper limit at Starina. Chopok, Topoľníky, and Stará Lesná differ in the annual average only at a minimum level. Total decline in sulphates concentrations over a long time progression corresponds to a decline in SO_2 emissions since 1980.

Nitrates that contribute to the acidity of precipitations less than sulphates show concentration interval of 0.25 - 0.39 mg/l calculated as per nitrogen. Chopok and Stará Lesná represent the lower limit of the interval, while Topoľníky copies the upper limit. Ammonium ions also belong to majority ions and their concentration span was 0.30 - 0.48 mg/l.

Trend of pH precipitation



Source: SHMI

- Heavy metals in atmospheric precipitations

Since 2000, programme of heavy metals measurement has been gradually modified and more adopted to reflect relevant requirements of the CCC EMEP monitoring strategy. The station of Bratislava-Koliba introduced measurements of the same of portfolio of heavy metals as at other regional stations in the Slovak Republic; however, this station serves only for comparison purposes and is not assessed as a regional station.

Annual averages of heavy metals in monthly precipitation - 2012

	Precip. mm	Pb µg/l	Cd µg/l	Ni µg/l	As µg/l	Zn µg/l	Cr µg/l	Cu µg/l
Chopok	776	2.13	0.08	0.55	0.29	33.82	0.27	1.18
Topoľníky	429	1.10	0.04	0.30	0.12	8.18	0.23	1.18
Starina	616	1.40	0.07	1.26	0.17	9.70	0.27	1.56
Stará Lesná	633	1.08	0.06	0.57	0.13	7.50	0.08	0.84
Bratislava, Jeséniova	734	1.49	0.06	0.44	0.20	16.41	0.18	3.28

Source: SHMI

Tropospheric ozone

Average annual concentrations of ground ozone in Slovakia in contaminated urban and industrial locations in 2012 were within the interval of 49-93 μg.m^{-3}. Greatest average annual ground ozone concentrations in 2012 were recorded at the Chopok station (93 μg.m^{-3}).

The reason for this is a high ozone concentration within the tropospheric ozone accumulation zone above the territory of Europe located 800 to 1500 metres above the earth's surface.

Target value for ground ozone concentration in terms of public health protection is set by the MoE SR Resolution No. 360/2010 Coll. on air quality at 120 μg.m^{-3} (max. daily 8-hour value). This value must not be exceeded on more than 25 days in of the year, for three consecutive years. The following table shows the summary of exceeding values measured over the period of 2010-2012. Public alarm threshold (240 μg.m^{-3}) and public information threshold (180 μg.m^{-3}) were not exceeded in 2012.

Number of days with exceeded target value for protection of public health

Station	2010	2011	2012	Averaged in 2010-2012
Bratislava, Jeséniova	24	24	48	**32**
Bratislava, Mamateyova	21	27	35	**28**
Košice, Ďumbierska	14	70	25	**36**
Banská Bystrica, Zelená	17	32	53	**34**
Jelšava, Jesenského	4	13	-	-
Kojšovská hoľa	55	58	37	**50**
Nitra, Janíkovce	16	11	43	**30**
Humenné, Nám. slobody	8	10	10	9
Stará Lesná, AÚ SAV, EMEP	15	17	14	15
Gánovce, Meteo. st.	7	25	12	15
Starina, Vodná nádrž, EMEP	2	7	7	5
Prievidza, Malonecpalská	9	14	12	12
Topoľníky, Aszód, EMEP	23	-	31	**27**
Chopok, EMEP	36	68	74	**59**
Žilina, Obežná	20	34	34	**29**

*Values that are **exceeding** the **limiting values** are printed in **bold** letters*

Source: SHMI

Target value for the **AOT 40 vegetation protection exposition index** is 18 000 μg.m^{-3}.h (MoE SR Resolution No. 360/2010 Coll. on air quality). This value applies to the concentrations calculated as the average for the period of five years. Average values for the years 2008-2012 were exceeded at all reference urban and rural stations, with the exception of Bratislava, Jelšava, Humenné, Stará Lesná, Gánovce, Starina, Prievidza, Topoľníky, Chopok, Žilina.

Values for the AOT 40 for vegetation protection - the year 2008 and for the averaged period of 2008-2012

Station	2012	Averaged in 2008-2012
Bratislava, Jeséniova	24 255	**20 300**
Bratislava, Mamateyova	19 200	16 764
Košice, Ďumbierska	18 487	**22 399**
Banská Bystrica, Zelená	27 387	**20 748**

Jelšava, Jesenského	–	13 896
Kojšovská hoľa	20 181	**22 788**
Nitra, Janíkovce	25 206	**23 436**
Humenné, Nám. slobody	13 214	15 866
Stará Lesná, AÚ SAV, EMEP	12 607	14 439
Gánovce, Meteo. st.	11 819	15 438
Starina, Vodná nádrž, EMEP	9 320	10 289
Prievidza. Malonecpalská	16 014	14 289
Topoľníky, Aszód, EMEP	14 871	**19 390**
Chopok, EMEP	30 666	**28 169**
Žilina, Obežná	20 120	17 922

** the station did not measure data for enough years*
*Values that are **exceeding** the **limiting values** are printed in **bold** letters*

Source: SHMI

Ozone layer depletion

- **International liabilities concerning ozone layer protection**

Due to the urgency of this global problem, the international community adopted at its UN platform a number of steps to eliminate the ozone layer depletion. First international forum with the first-ever mentioning of the ozone layer took place in Vienna in 1985, with the **Vienna Convention on the Ozone Layer Protection** signed there. In 1987, this document was closely followed by adopting the first enforcing protocol to the **Montreal Protocol on Ozone-depleting Substances**. Since that year, signatories to the Montreal Protocol met five times (in London (1990), in Copenhagen (1992), in Vienna (1995), in Montreal (1997) and in Beijing (1999), to limit or, if necessary, totally eliminate the production and consumption of substances that deplete the ozone layer.

Slovakia made effective the **Montreal Annex** to the Montreal Protocol on February 1, 2000. This document prohibits Slovakia to import and export all controlled substances, including methyl bromide, from and to non-signatory countries, as well as sets forth the obligation to introduce a licensing system for import and export of controlled substances. In 2002, Act 408/2000 Coll. was adopted, which amends Act 76/1998 Coll. on the Earth's ozone layer protection and on amendment to Act 455/1991 Coll. on small business (Small Business Act) as amended, which transposed the decisive majority of responsibilities stipulated under the European Parliament and Commission Directive 2037/2000 EC and banned the production of brom-chloro-methane, creating conditions for ratification of the **Beijing Annex** of the Montreal Protocol. (for Slovakia effective as from August 20, 2002). Since January 1, 2010, a new Regulation (EC) No 1005/2009 of the European Parliament and of the Council on substances that deplete the ozone layer. In 2012, in relation to the implementation of the European Parliament and of the Council 1005/2009/EC on ozone layer depleting substances, new act no 321/2012 Coll. on the Earth's ozone layer protection was adopted.

- **Consumption of controlled substances**

Sovakia does not produce any ozone-depleting substances. All such consumed substances come from the export. These imported substances are used mainly in cooling agents and detection gases, solvents, and cleaning chemicals.

Group of substances	1986/ 1989#	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
A I - freons	1 710.5	0.996	0.81	0.533	0.758	0.29	0.43	0.46	0.34	0.49	0.19	0.067
A II - halons	8.1	-	-	-	-	-	-	-	-	-	-	-
B I* - freons	0.1	-	-	-	-	-	-	-	-	-	-	-
B II* - CCl_4	91	0.01	0.009	0.047	0.258	0.045	0	0.016	0.099	0.119	0.039	0.072
B III* - 1,1,1 trichloroethane	200.1	-	-	-	-	-	-	-	-	-	-	-
C I*	49.7	71.5	52.91	38.64	48.76	43.94	41.32	34.35	31.12	0.578	-	0.496
C II - HBFC22B1	-	-	-	-	-	-	-	-	-	-	-	-
E** - CH_3Br	10.0	0.48	0.48	0.48	-	-	-	-	-	-	-	-
Total	2 019.5	72.986	54.21	39.7	49.78	44.28	41.75	34.83	31.56	1.187	1.229	0.635

Initial usage

Source: MoE SR

* Initial year 1989

** Initial year 1991

Note 1*: 0.48 tons of methyl bromide were imported in 2001-2004 for Slovakofarma as a raw material for the production of medications, which is not considered as consumption, according to the valid methodology.*

Note 2*: Consumption of C1 substances in 2010 and 2012 represents the import of regenerated R22. As from January 1, 2010, Regulation no. 1005/2009/EC allows to introduce to the market and use only recycled or regenerated substances for the maintenance and service of mechanisms; import, introduction and use of pure C1 substances is prohibited.*

Usage of substances under control in 2012 (t)

Usage	Group of substances							
	A I	A II	BI	B II	B III	C I	C II	E
Coolant						0.496		
Detection gases, diluents, detergents	0.67			0.072				

Source: MoE SR

- **Total atmospheric ozone and ultraviolet radiation**

SHMU Aerological and Radiation centre in Gánovce pri Poprade has measured atmospheric ozone above the territory of Slovakia through the ozone spectro-photometer since 1993. Besides total ozone, this instrument regularly measures also the intensity of solar ultraviolet radiation within the spectre of 290 to 325 nm by individual time steps of 0.5 nm.

The average annual value of total atmospheric ozone in 2012 was 320.0 Dobson units (D.U.), which is 5.4% under the long-term average from measurements in Hradec Králové in 1962-1990. Values from these measurements have been used also for our territory as the long-term normal value.

Average monthly devations within 2012

Month	1	2	3	4	5	6	7	8	9	10	11	12	Year
Average (DU)	324	362	347	356	343	325	314	301	288	278	293	311	**320.0**
Deviation (%)	-5	-2	-9	-8	-8	-9	-8	-7	-4	-3	2	0	**-5.4**

Source: SHMI

Total sum of daily doses of ultraviolet erythema radiation

Total sum of daily doses of ultraviolet erythema radiation over the period of April 1 to September 30 measured at Gánovce was 450 644 J/m^2, which is by 4% less than the sum over the same period in 2011. Total sum of 479 411 J/m^2 detected at the station Bratislava-Koliba was 3% lower than in 2011.