Slovak
Hydrometeorological Institute

Ministry of Environment
of the Slovak Republic

AIR POLLUTION

IN THE SLOVAK REPUBLIC

2014

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C O N T E N T

AMBIENT AIR

EMISSIONS

AMBIENT AIR

1

REGIONAL AIR POLLUTION AND QUALITY OF PRECIPITATION

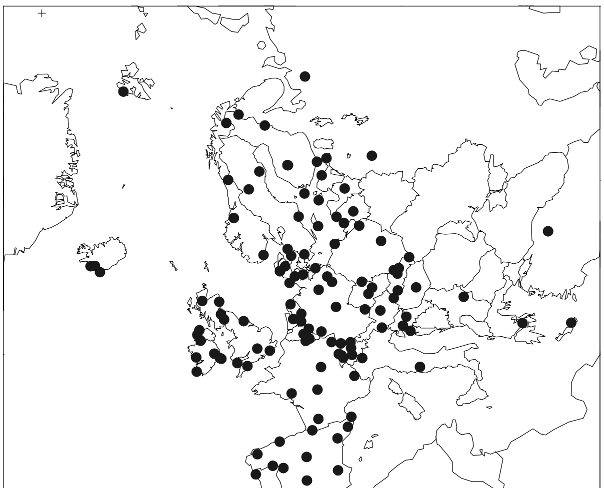
1.1 REGIONAL AIR POLLUTION AND QUALITY OF PRECIPITATION

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. In regional positions, the industrial emissions are more or less evenly vertically dispersed in the entire boundary layer and ground level concentrations are smaller than those in cities.

The UN ECE Convention on Long Range Transboundary Air Pollution (CLRTAP) was signed in 1979. Since its entry into force in 1983 the Convention has been extended by eight protocols: Protocol on Long-term Financing of the Co-operative Programme for Monitoring and Evaluation of the Long-range Transmission of Air Pollutants in Europe (EMEP) (Geneva, 1984); Protocol on the Reduction of Sulphur Emissions or their Transboundary Fluxes by at least 30 Per Cent (Helsinky, 1985); Protocol Concerning the Control of Emissions of Nitrogen Oxides or their Transboundary Fluxes (Sofia 1988); Protocol Concerning the Control of Emissions of Volatile Organic Compounds or their Transboundary Fluxes (Geneva 1991); Protocol on Further Reduction of Sulphur Emissions (Oslo, 1994); Protocol on Heavy Metals (Aarhus, 1998); Protocol on Persistent Organic Pollutants (Aarhus, 1998); The 1999 Protocol to Abate Acidification, Eutrophication and Ground-level Ozone (Gothenburg, 1999). The commitment to the first sulphur Protocol represented a 30% reduction of European sulphur dioxide emissions by 1993 as compared to 1980. The Slovak Republic has fulfilled this commitment. Reduction of European emissions has already been manifested in a decrease of acidity in precipitation over the territory of Slovakia. In compliance with the second sulphur Protocol, the European sulphur dioxide emissions had to be reduced 60% by 2000, 65% by 2005 and 72% by 2010, as compared to 1980. According to the last Protocol (Gothenburg, 1999) the Slovak Republic had to reduce sulphur dioxide emissions 80% by 2010 as compared to 1980, those oxides of nitrogen 42%, ammonia 37% and volatile organic compounds 6% as compared to 1990. For the time being three last protocols of CLRTAP undergo revision. As an addendum to the POP Protocol seven substances shall be revised and evaluated for the new or revised protocol. Concerning heavy metal Protocol the priority remains on three main metals, cadmium, lead and mercury. The Gothenburg Protocol (1999) to abate acidification, eutrophization a ground level ozone undergoes revision and particulate matter might be addressed either via the HM Protocol, or revised Gotheburg Protocol.

Implementation of the Co-operative Programme for Monitoring and Evaluation of the Long Range Transmission of Air Pollutants in Europe - EMEP is a part of the Convention. In accordance to the Convention, the EMEP is mandatory to all European countries. Its goal is to monitor, model and evaluate the long-range transport of air pollutants in Europe and elaborate foundations for the strategy to reduce European emissions. The EMEP monitoring network (Fig. 1.1) comprises approximately 200 regional stations and four stations in the territory of Slovakia belonging to the national monitoring network of the Slovak Hydrometeorological Institute are at the same time also a part of EMEP network. The EMEP monitoring programme has been gradually extended. The monitoring

Fig. 1.1 **Network of EMEP monitoring stations**



of sulphur compounds and precipitation has been enhanced for oxides of nitrogen, ammonium in ambient air, particulate matter and ozone. In 1994, the measurements of volatile organic compounds (VOCs) have begun to be carried out under the auspices of Chemical Coordinating Centre - NILU (Norwegian Institute for Air Research). Later on also heavy metals (HMs) and persistent organic pollutants (POPs) have been included into the measurement programme. In 2003 the new monitoring strategy has been adopted classifying stations into three levels (more details on www.emep.int).

1.2 EMEP STATIONS OF NATIONAL AIR QUALITY MONITORING NETWORK

In 2014, there were 4 EMEP stations of National Air Quality Monitoring Network in operation in the Slovak Republic to monitor regional air and precipitation quality. At the Bratislava-Koliba station the same precipitation monitoring programme is in operation as on regional stations, serving for comparison to the regional stations. Locations and elevations of the individual stations are indicated in Figure 1.2.

Chopok

Meteorological observatory of the Slovak Hydrometeorological Institute, located on the crest of the Low Tatras mountains, 2 008 m above sea level, 19°35'32" longitude, 48°56'38" latitude. Measurements started in 1977. Since 1978 the station has become a part of the EMEP network and GAW/WMO network.

Stará Lesná

Station is situated in the area of the Astronomic Institute of the Slovak Academy of Sciences on the south-eastern edge of TANAP (National Park of the Tatras), 2 km north from the Stará Lesná village, 808 m above sea level, 20°17'28" longitude, 49°09'10" latitude. The station started measurements in 1988. Since 1992 the station has become a part of the EMEP network.

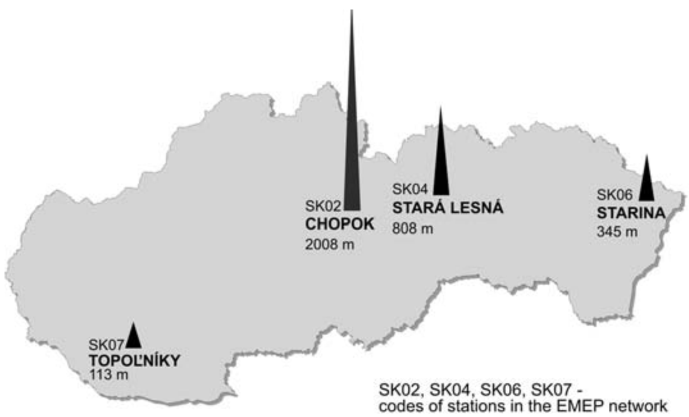
Topoľníky

The Aszód pump station on the small Danube river, 7 km south-east of the Topoľníky village, in plain terrain of the Danube lowlands, 113 m above sea level, 17°51'38" longitude, 47°57'36" latitude. Only family houses for employees of the pump station are situated nearby. Measurements have been carried out since 1983. Since 2000 the station has become a part of the EMEP network.

Starina

Station is situated in the region of the Starina water reservoir, 345 m above sea level, 22°15'35" longitude, 49°02'32" latitude. Nearby are located only the buildings of the Bodrog river and Hornád river watershed. The station started to be operated in 1994. The same year the station has become a part of the EMEP network.

Fig. 1.2 **EMEP stations in the Slovak Republic – 2014**



Measurement programme

AMBIENT AIR	Ozone (O_3)	Sulphur dioxide (SO_2)	Oxides of nitrogen (NOx)	Sulphates (SO_4^{2-})	Nitrates (NO_3^-)	Nitric acid (HNO_3)	Ammonia, ammon. ions (NH_3, NH_4^+)	Alkali ions (K^+, Na^+, Ca^{2+}, Mg^{2+})	VOC	PM_{10}	TSP	Lead (Pb)	Arsenic (As)	Cadmium (Cd)	Nickel (Ni)	Chromium (Cr)	Copper (Cu)	Zinc (Zn)
Chopok	x	x	x	x	x	x					x	x	x	x	x	x	x	x
Topoľníky	x									x		x	x	x	x	x	x	x
Starina	x	x	x	x	x	x	x	x	x	x		x	x	x	x	x	x	x
Stará Lesná	x									x		x	x	x	x	x	x	x

** TSP – Total suspended particles in ambient air*

PRECIPITATION	pH	Conductivity	Sulphates (SO_4^{2-})	Nitrates (NO_3^-)	Chlorides (Cl^-)	Ammonium ions (NH_4^+)	Alkali ions (K^+, Na^+, Ca^{2+}, Mg^{2+})	Lead (Pb)	Arsenic (As)	Cadmium (Cd)	Nickel (Ni)	Chromium (Cr)	Copper (Cu)	Zinc (Zn)
Chopok	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Topoľníky	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Starina	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Stará Lesná	x	x	x	x	x	x	x	x	x	x	x	x	x	x

Methods of determination

		Collection	Determination
AMBIENT AIR	**SO_4^{2-}, NO_3^-, Cl^-, NH_4^+, K^+, Na^+, Mg^{2+}, Ca^{2+}**	cellulose filter W40	IC - Dionex
	NOx	after oxidation into NaOH absorption solution with guajacol	spectrophotometry, modified Salzman method
	SO_2, HNO_3	cellulose filter W40 impregnated by KOH solution	IC - Dionex
	NH_3	cellulose filter W40 impregnated by citric acid	IC - Dionex
	O_3	registration by analyzer	principle - UV absorption
	VOCs C_2 - C_6	stainless steel canister	GC FID
	PM weight mass	nitrocellulose filter Sartorius	Gravimetrically
	Heavy metals - Pb, Cd, Cu, Cr, Ni, Zn, As	nitrocellulose filter Sartorius	after digestion in MW-oven by ICP-MS
PRECIPITATION	**pH**	"wet only" - rain gauges WADOS "bulk" - NILU sampling PE vessel	pH meter
	Conductivity		conductometer
	SO_4^{2-}, NO_3^-, Cl^-, NH_4^+, K^+, Na^+, Mg^{2+}, Ca^{2+}		IC - Dionex
	Zn, Cu, Cr, Ni, Pb, Cd, As		AAS - in flame or graphite atomizer and MHS

1.3 ASSESSMENT OF RESULTS FROM MEASUREMENTS IN 2014

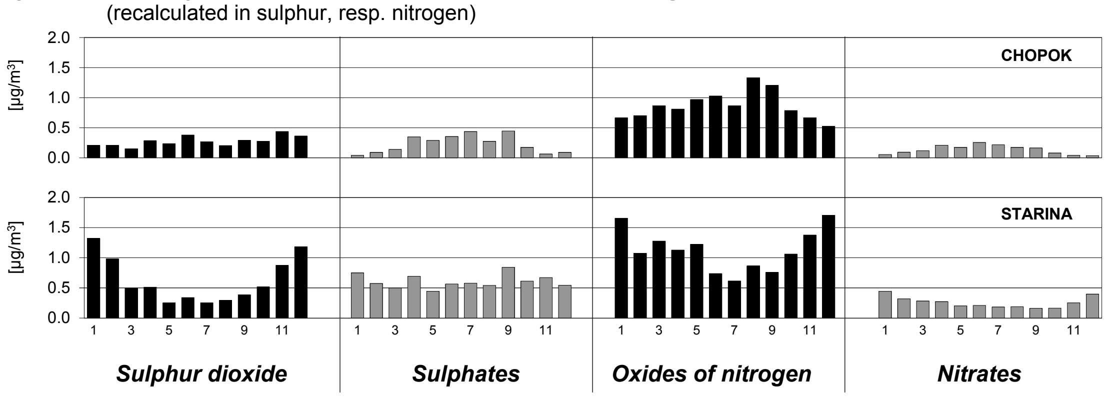
SO_2, sulphates

Background concentrations of sulphur dioxide recalculated in sulphur (Tab. 1.1.) was 0.28 μg.m^{-3} on the Chopok station and 0,62 μg.m^{-3} on the Starina station, in 2014. ***In coincidence with the Annex 13 to the Decree of the Ministry of Environment of the Slovak Republic No 360/2010 on air quality, the critical value for protection of vegetation is 20 μg SO_2.m^{-3} in calendar year and winter season. This value has been exceeded neither at the calendar year (Chopok 0.56 μg $S0_2$.m^{-3} and Starina 1.24 μg $S0_2$.m^{-3}), nor in winter season (Chopok 0.3 μg $S0_2$.m^{-3} and Starina 1.5 μg $S0_2$.m^{-3}).*** Sulphates contributed to the total weight mass of particulate matter 14.4% on the Chopok station and 14.5% on the Starina station. Concentration ratio of sulphates to sulphur dioxide, recalculated in sulphur represented 0.82 on the Chopok station and 0.98 on the Starina station.

NO_x, nitrates

Background level of concentrations of oxides of nitrogen, recalculated in nitrogen (Tab. 1.1) presented 0.87 μg.m^{-3}on the Chopok station and 1.13 μg.m^{-3} on the Starina station, in 2014. ***In coincidence with the Annex 13 to the Decree of the Ministry of Environment of the Slovak Republic No 360/2010 on air quality, the critical value for protection of vegetation is 30 μg NO_x.m^{-3} in calendar year. This value was not exceeded in calendar year (Chopok 2.87 μg NO_x.m^{-3} a Starina 3.73 μg NO_x.m^{3}).*** Nitrates in ambient air on the Chopok and Starina stations occurred predominantly in the form of particles in 2014, as compared to gaseous nitrates, the difference on the Starina station is more distinctive than on the Chopok station. Both these forms of nitrogen are collected on filters separately and also measured separately and their phase division is dependent upon the ambient air temperature and humidity. Nitrates contributed to the total mass of particulate matter 18.4 % on the Chopok station and 11.5 % on the Starina station. Concentration ratio of total nitrates ($HNO_3 + NO_3$) to NO_x-NO_2 recalculated in nitrogen represented the value of 0.23 at the Chopok station and 0.29 at the Starina station.

Fig. 1.3 **Monthly mean concentrations of sulpur and nitrogen compounds in ambient air – 2014**
(recalculated in sulphur, resp. nitrogen)



Ammonia, ammonium ions and alkali ions

In coincidence with the requests of the EMEP monitoring strategy for the EMEP stations "level one" the measurements of ammonia, ammonium ions, ions of sodium, potassium, calcium and magnesium in ambient air started to be measured in May 2005 on the Stará Lesná station. These measurements were finished in September 2007. Since July 2007 the measurements started to be measured at the Starina station. Annual concentrations of the listed components (NH3 and NH4 recalculated in nitrogen) from the Starina station in 2014 are listed in Table 1. Ammonium ions in annual average 0.67 μgN.m^{-3} share 6.8% of PM. Annual concentration of ammonia represents 0.64 μgN.m^{-3}. Concentration ratio of ammonium ions and ammonia expressed in nitrogen is 1.04.

Tab. 1.1 **Annual averages of gaseous and particulate components in ambient air – 2014**

	SO_2 (S) μg/m³	SO_4^{2-} (S) μg/m³	NO_x (N) μg/m³	NO_3^- (N) μg/m³	HNO_3 (N) μg/m³	Cl^- μg/m³	NH_3 (N) μg/m³	NH_4^+ (N) μg/m³	Na^+ μg/m³	K^+ μg/m³	Mg^{2+} μg/m³	Ca^{2+} μg/m³
Chopok	0.28	0.23	0.87	0.14	0.06		-	-	-	-	-	-
Starina	0.62	0.61	1.13	0.26	0.07		0.64	0.67	0.04	0.10	0.01	0.05

	O_3 μg/m³	PM_{10} μg/m³	Pb ng/m³	Cu ng/m³	Cd ng/m³	Ni ng/m³	Cr ng/m³	Zn ng/m³	As ng/m³
Chopok	52	*4.8	0.99	2.26	0.04	1.00	1.61	3.19	0.10
Topoľníky	51	15.5	8.27	2.94	0.21	0.37	-	16.03	0.71
Starina	55	12.6	4.63	2.04	0.16	0.38	0.39	9.69	0.42
Stará Lesná	56	13.3	4.96	2.46	0.15	0.40	-	10.85	0.36

SO_2, SO_4^{2-} – recalculated in sulphur, *NOx, NO_3^-, HNO_3 – recalculated in nitrogen*
** TSP (total suspended particles)*

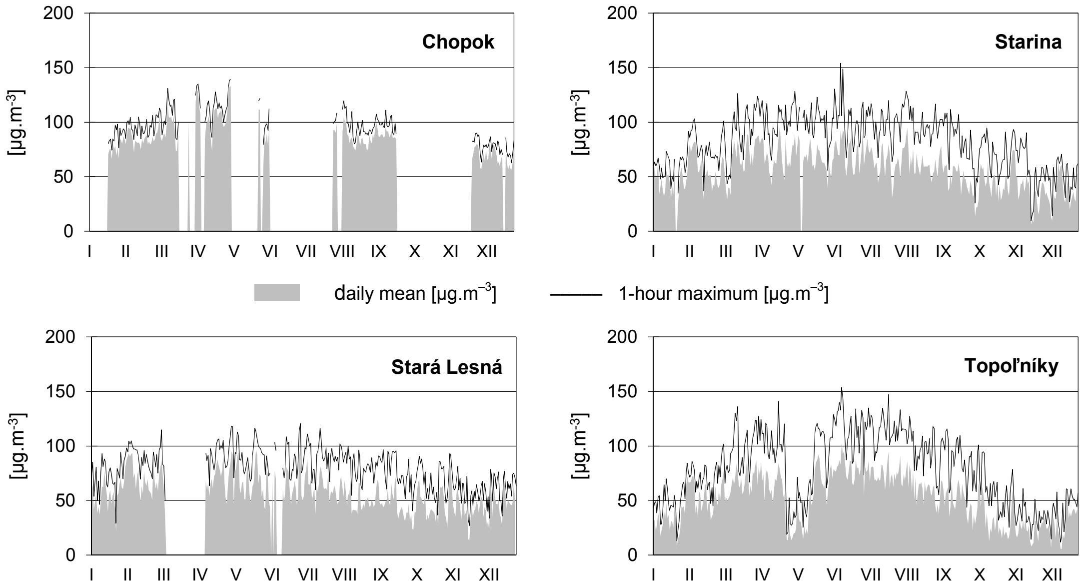
Particulate matter PM_{10}, TSP and heavy metals

In Table 1.1 are presented the concentrations of PM_{10} (Stará Lesná, Starina, Topoľníky), resp. TSP (Chopok) and heavy metals in 2014.

Ozone

In Figure 1.4 the annual course of ground level ozone concentrations at the Chopok, Stará Lesná, Starina and Topoľníky regional stations are depicted. The longest time series of ozone measurements has been at the Stará Lesná station, since 1992. The measurements of ozone in Topoľníky, Starina and Chopok began to be carried out later, in 1994. In 2014, the annual average of ozone concentration at the Chopok station reached 52 μg.m^{-3} (many missing data), at Starina 55 μg.m^{-3}, at Topoľniky 51 μg.m^{-3} and Stará Lesná 56 μg.m^{-3}. Measurements of ozone and exceedances of critical levels are completely assessed in Chapter 3 Atmospheric ozone.

Fig. 1.4 **Ground level ozone [μg.m^{-3}] – 2014**



Volatile organic compounds, VOCs C_2–C_6

VOCs (Volatile Organic Compounds) C_2–C_6, or the so-called light hydrocarbons, started to be sampled in autumn 1994 at the Starina station. Starina is one of the few European stations, included into the EMEP network with regular sampling of volatile organic compounds. They are measured and assessed according to the EMEP method elaborated by CCC-NILU. Their concentrations ranged within one order of magnitude from the tenths of ppb up to several ppb. In Table 1.2 available analyses are for 2014.

Tab. 1.2 **Annual averages of VOC [ppb] in ambient air, Starina – 2014**

etane	etene	propane	propene	i-butane	n-butane	acetylene	i-pentane	n-pentane	izoprene	n-hexane	benzene	toluene	o-xylene
2.699	0.712	0.944	0.247	0.206	0.363	0.120	0.174	0.069	0.104	0.089	0.032	0.206	0.211

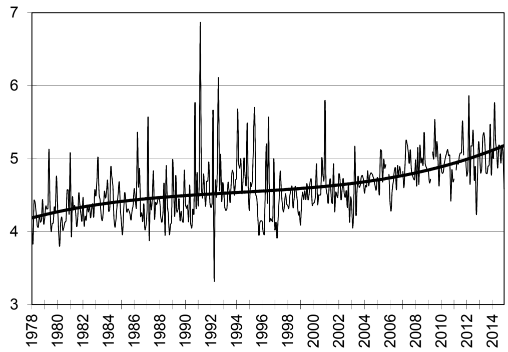
Atmospheric precipitation

Quality of atmospheric precipitation is monitored apart from four EMEP stations also at the Bratislava-Koliba station, which serves as the comparison to the regional stations.

Major ions, pH, conductivity

In 2014 the amount of precipitation recorded at background stations ranged between 656 and 1560 mm. The upper level of amount of precipitation does belong to the highest situated station Chopok and the lower one to Topoľníky with the lowest elevation. Acidity of atmospheric precipitation dominated at the Stará Lesná station with the low level of pH range 4.93 – 5.17 (Tab. 1.3, Fig. 1.6). Time series and trend of pH values within a long-time period indicate clearly the decrease in acidity. Values of pH are in a good coincidence with the pH values according to the EMEP maps.

Fig. 1.5 **pH in daily precipitation – Chopok**



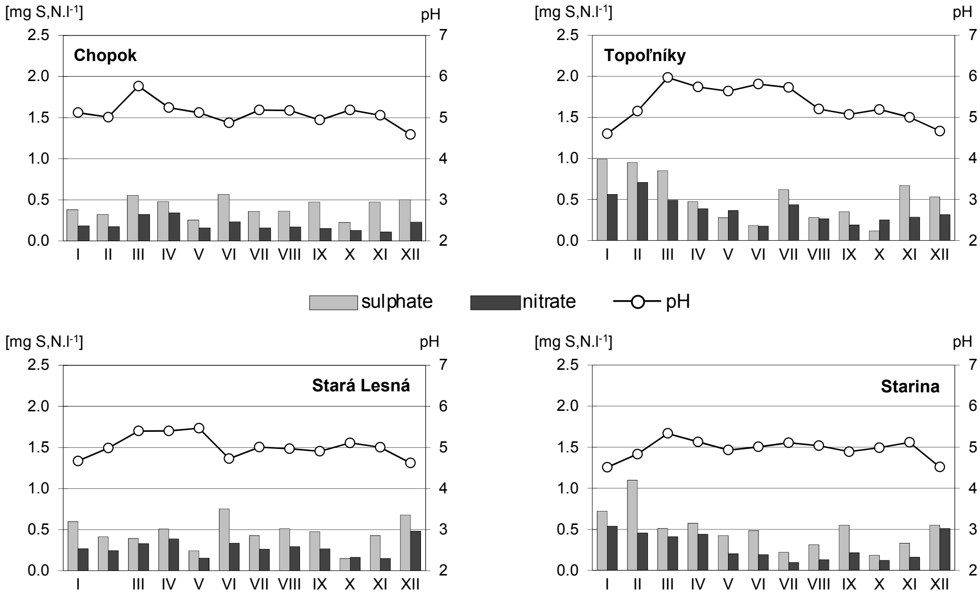
Concentrations of dominant sulphates in precipitation recalculated in sulphur varied within the range 0.39 – 0.45 mg.l^{-1}. Concentrations of sulphates at the Chopok station represent the low value of the pH range while the Starina and Stará Lesná the upper value of the pH range. The annual mean at the Topoľníky station shows minimum difference from the Starina and Stará Lesná stations. Total decrease of sulphates in long-term time series has corresponded to the SO_2 emission reduction since 1980.

The share of nitrate (recalculated in nitrogen) in acidity of precipitation was substantially smaller than those of sulphates and varied within the concentration range 0.19 – 0.33 mg.l^{-1}. The low level of concentration range is represented by the Chopok station, while upper level of this range does belong to the Topoľníky station. Ammonium ions also do belong to the major ions and their concentration range was 0.32 – 0.42 mg.l^{-1}.

Heavy metals in atmospheric precipitation

Since 2000 the measurement programme of heavy metals in precipitation has been gradually modified to meet the requirements of the CCC EMEP monitoring strategy. In Bratislava-Koliba the measurement of the same set of heavy metals in precipitation was implemented as in background stations of Slovakia. This station serves for comparison and is not considered as the background station. The results of annual weighted means of heavy metals concentrations in monthly precipitation in 2014 are presented in Table 1.4. The decrease of heavy metals within the monitored period is most distinctive at lead.

Fig. 1.6 **Daily precipitation – 2014**



Tab.1.3 **Annual averages of main components in daily precipitation – 2014**

	Precip. mm	pH	Cond. µS/cm	SO_4^{2-}(S) mg/l	NO_3^- (N) mg/l	NH_4^+(N) mg/l	Cl^- mg/l	Na^+ mg/l	K^+ mg/l	Mg^{2+} Mg/l	Ca^{2+} mg/l
Chopok	1560	5.10	10.83	0.39	0.19	0.32	0.10	0.09	0.03	0.02	0.15
Topoľníky	656	5.17	12.02	0.44	0.33	0.42	0.16	0.11	0.06	0.05	0.40
Starina	754	4.93	12.73	0.45	0.25	0.34	0.14	0.12	0.10	0.03	0.24
Stará Lesná	998	5.00	12.33	0.45	0.27	0.34	0.14	0.08	0.10	0.04	0.31
Bratislava-Koliba	803	5.25	14.01	0.56	0.38	0.51	0.18	0.14	0.10	0.05	0.43

SO_4^{2-} – recalculated in sulphur, NO_3^-, NH_4^+ – recalculated in nitrogen

Tab. 1.4 **Annual averages of heavy metals in monthly precipitation – 2014**

	precip. mm	**Pb** µg/l	**Cd** µg/l	**Cr** µg/l	**As** µg/l	**Cu** µg/l	**Zn** µg/l	**Ni** µg/l
Chopok	1388	1.31	0.05	0.22	0.15	1.09	14.25	0.45
Topoľníky	615	1.36	0.04	0.12	0.10	0.91	6.45	0.24
Starina	775	1.16	0.05	0.18	0.12	0.96	8.71	0.82
Stará Lesná	908	0.88	0.05	0.05	0.09	0.67	5.73	0.29
Bratislava-Koliba	917	2.26	0.08	0.16	0.17	2.98	15.98	0.28

AMBIENT AIR

LOCAL AIR POLLUTION

2

2.1 LOCAL AIR POLLUTION

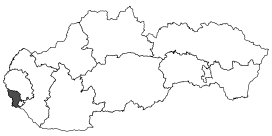
Air quality assessment is claimed by Air Protection Act No. 137/2010 Coll. Criterions for air quality assessment (upper and lower assessment thresholds, margin of tolerance, limit and target values) are given in Decree No. 360/2010 Coll. about Air Quality. Fundamental air quality assessment is performed on the basis of measured data. Slovak Hydrometeorological Institute (SHMÚ) carried out measurements at monitoring stations of National air quality monitoring network (NAQMN).

The SHMÚ has monitored the level of air pollution since 1971, when the first manual stations in Bratislava and Košice were put into operation. In the course of the following years the measurements were gradually extended into the most polluted cities and industrial areas.

In 1991 modernization of the air quality monitoring network began. The manual stations were gradually replaced by automatic ones, which enable the continuous monitoring of pollution and made it possible to evaluate time changes and the extremes of the short-term concentrations. In the course of the last ten years the air quality monitoring network has kept developing. In 2014, 30 stations (without EMEP, rural and ozone stations) were located on the territory of the SR. Most of them monitored the level of pollution caused by the basic pollutants (SO_2, NO_2, NO_x, and PM_{10}, $PM_{2,5}$). In the year 2014 measurements of benzene were carried out at 10. The air pollution monitoring by heavy metals (Pb, Cd, As and Ni) were performed at 5. Concentrations of benzo(a)pyrene were analysed at 7 sites totally.

In accordance to the Air Protection Act the territory of the Slovak Republic was divided into 8 zones and 2 agglomerations for the following pollutants: SO_2, NO_2, NO_x, PM_{10}, $PM_{2.5}$, benzene and CO. The delimitation of zones is identical with the higher administrative units – the regions. From Bratislava and Košice regions were excluded administrative units of cities Bratislava and Košice and these are assessed separately as agglomerations. According to the Decree No. 360/2010 Coll. about Air Quality for pollutants: Pb, As, Cd, Ni, BaP, Hg and O_3 was territory of Slovakia divided only into agglomeration Bratislava and rest of the territory represents zone Slovakia.

2.2 CHARACTERISATION OF ZONES AND AGGLOMERATIONS, WHERE MONITORING IS CARRIED OUT



AGGLOMERATION - BRATISLAVA

AREA: 368 km^2 POPULATION: 419 678

Characterization of area

Bratislava

Bratislava spreads out over an area of 368 km^2 along both banks of the Danube at the boundary-line of the Danube plain and the Little Carpathians and the Bor lowlands at an elevation of 130 – 514 meters. Wind patterns in this area are affected by the slopes of the Little Carpathians, which do interfere into the northern part of the city. Geographical effects enhance the wind speed from prevailing directions. The ventilation of the city is favourably affected by high wind speeds of about 5 m/s. In regard to prevailing north-west wind, the city is properly situated to major air pollution sources, which from which significant part is located in area from the south to north-eastern periphery of Bratislava. The main share in air pollution is from the chemical industry, power generation and car transport. Secondary suspended particles, the level of which depends upon meteorological factors, land use and agricultural activities and characteristics of surface, are significant source of air pollution by particular matter.

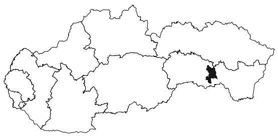
Location of stations

Bratislava - Jeséniova
The station is located in the ground of the SHMÚ, 287 m above sea. It is situated apart from the major city sources of air pollution, in a locality with middle built-up area, where family houses prevail.

Bratislava - Kamenné námestie
The station is situated in the city centre, close to the TESCO supermarket, in an area of middle frequency of transport. Its position represents the central part of the city.

Bratislava - Trnavské mýto
The station is situated near to a busy crossroad formed by Šancová and Trnavská street - Krížna and Vajnorská street. It represents location with extreme high emissions from road transport.

Bratislava - Mamateyova
The station is located at open playing areas in sufficient distant from housing estate built-up area. Among the major sources of air pollution belong traffic, power sources and the petrochemical complex, Slovnaft a.s., Bratislava. The last mentioned contributes to the air pollution mainly under the east wind direction.



AGGLOMERATION - KOŠICE

AREA: 244 km^2 POPULATION: 239 464

Characterization of area

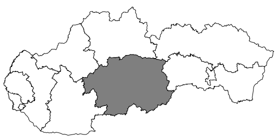
Košice

The city of Košice spreads out in the valley of the Hornád river and its surroundings. According to geographical classification it belongs to the zone of the inner Carpathians. From the south-west, the Slovenský kras intervenes into this area, in the north the Slovenské rudohorie and in the east the Slánske hills spread out. Among these mountain ranges, Košice's basin is situated. The mountain range configuration affects the climate conditions in this area. The prevailing wind from the north is typical by the relatively higher wind speeds, on average 5.7 m.s^{-1}. The annual average wind speed from all directions is 3.6 m.s^{-1}. The major share in air pollution of this area is caused by heavy industry, mainly engineering, non-ferrous and ferrous metallurgy as well as processing of limestone. Energy sources, including the city heating plants and local boiler rooms emit lesser amounts of pollutants.

Location of stations

Košice - Štefánikova
Station is located in urban area predominantly surrounded by family houses separated by green alley from near road.

Košice - Amurská
Station is located in open area 100 m far from housing estate built-up area, which surrounded station from south, west and north directions. Easterly in distance of approximately 120 m is situated a small lake. It is typical urban background station.



ZONE - BANSKÁ BYSTRICA REGION

AREA: 9 454 km^2 POPULATION: 655 359

Characterization of area

Banská Bystrica

The town is located in the Bystrica valley, which is by the northern part of the Zvolen basin surrounded by the Staré Hory hills to the north, by the Horehron valley to the north-east and by the Kremnica hills to the south-east. The annual average temperature is 8 °C. Prevailing wind is from the north and north-east, an average speed 2.1 m.s^{-1} with high occurrence of temperature inversion in valley positions. Air pollution is affected by wood processing industries releasing emissions of suspended particles, but also by a large number of local heating sources. Traffic does contribute to the high level of air pollution in the town centre, as well.

Zvolen

The city is located in the south-western part of Zvolen basin. It is situated in the middle pohronie up to Banská Bystrica and it extends into Slatina, Detva and Sliač basin. Volcanic mountains Štiavnica a Kremnica hills lined the Zvolen basin from west, Javorie south and Poľana from east. The meteorological conditions for dispersion and transportation of pollutants in Zvolen are better in spring and summer periods. In autumn and winter periods the adverse meteorological conditions for dispersion of emission pollutants prevail. In these periods often occur calm and inversion of temperature. Generally lowered ability of pollution transport indicates low wind speeds, which are lower than 1 m.s^{-1} in 45% of days within the year.

Žiar nad Hronom

The area of the Žiar basin is closed from more sides, bordered by the Pohronský Inovec in the south-west, by the Vtáčnik and the Kremnica hills in the west up to the north, and by the Štiavnica hills in the east to the south-east. The area is characterised by the very unfavourable meteorological conditions in regard to the level of air pollution by industrial emissions at a ground level layer. The annual average wind speed in all directions is 1.8 m.s^{-1}. The east and north-west wind directions occur there most frequently within a year.

Hnúšťa

The area is situated in the valley of the Rimava river. Along the quite narrow valley, the individual mountain ranges of relatively great elevation are extended. Short-term measurements confirm the expected low wind speeds of about 1.5 m.s^{-1} on average and a considerable high occurrence of calm.

Jelšava

Jelšava is situated in the area, which lies in the southern part of the Jelšava's mountains, bordered in the north-east by the massive Hrádok, in the south-west by the Železnické foothills and in the south by the Jelšava's kras. The terrain is relatively broken along the central Muráň stream, oriented in a north-west – south-east. Air circulation is indicated by the direction of the Muráň river valley. The annual average wind speed is relatively low 2.5 m.s^{-1}. The frequent occurrence of surface inversions during the night is due to the mountain terrain. Two massifs, Skalka and Slovenská skala, bordering the valley, also contribute to the occurrence of inversions. The major share in air pollution is from the Slovak magnesite plants Jelšava and Lubeník, situated to the north-west of the town and the small predominantly local gas heating system.

Location of stations

Banská Bystrica - Štefánikovo nábrežie

Monitoring station is located closely to the frequented route providing transport into the eastern region of Slovakia. In the vicinity of about 100 m are situated housing estate buildings and hotel Lux. From the larger size scale the monitoring station is located in a valley part of city at the river Hron. This unfavourable location implicates adverse dispersion conditions of pollutants.

Banská Bystrica - Zelená

The station is located in the ground of the SHMÚ, 427 m above sea. In close vicinity the combination of housing estate buildings and family houses is presented. It is located apart from major pollution sources.

Zvolen - J. Alexyho

The station is located in the area of elementary school which is segment of the large housing estate Sekier in the south-eastern part of the city. In the vicinity of about 300 m is situated a frequented route into the Metropolis of Eastern Slovakia Košice. Besides of traffic the main contribution to air pollution represents emissions from wood processing industry.

Hnúšťa - Hlavná

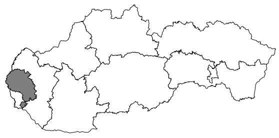
The station is situated in open middle building area on the north edge of the town, approximately 50 m far from state road No. 531.

Jelšava - Jesenského

The station is situated in the peripheral part of the city, in kindergarten, on a hill which is open to the major polluter (SZM Jelšava) from one side. From distance of about 100 m of the other side the building estate is located.

Žiar nad Hronom - Jilemnického

The station is placed at the suburban part of the city in the vicinity of 4-storey buildings. Approximately in the distance of 100 m is located main route towards Prievidza. Close to the station is high voltage electricity line under which is the ground covered with low vegetation.



Zone - Bratislava region

AREA: 1 685 km^2 POPULATION: 205 489

Characterization of area

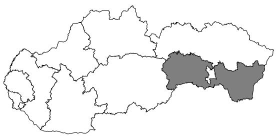
Malacky

Region Malacky spreads out northerly from the capital of the Slovak Republic, Bratislava. It is located in the southern part of Zahorie lowland, on western side borders it Morava river, which is as well bordering line with Austria and on the east are situated Low Carphatian mountains. Administrative centre as well the largest town of the region is Malacky. The east-west and north-west wind directions occur there most frequently within a year. Annual average wind speed is about 2.7 $m.s^{-1}$.

Location of stations

Malacky - Sasinkova

Monitoring station is located close to city centre. In the vicinity are located supermarkets and family houses. Stations is located 5 m from the kerbside of relative frequented roads leading from the town towards the highway D2.



ZONE - KOŠICE REGION

AREA: 6 511 km^2 POPULATION: 556 101

Characterization of area

Krompachy

Krompachy is located in the valley system with good local circulation of air. Southern part of the city is situated in valley of the Slovinský potok surrounded by hills of about 350 m above sea level high. The northern part is placed in the valley of Hornád, which is oriented to east-west direction. The average wind speed is low, approximately 1.4 m.s^{-1}. The main polluter is ferrous metal plant Kovohuty in Krompachy. To the air pollution contributes also the local heating systems.

Strážske

Strážske is located easterly from Vihorlat in northern part of the Eastslovak lowland in area called Brekovská brána, which strengths wind speed from north directions. Annual average of the wind speed is 3.4 m.s^{-1}. The daily course of wind speed is significantly emphasized with minimum during night hours. The main source of air pollution is local chemical industry.

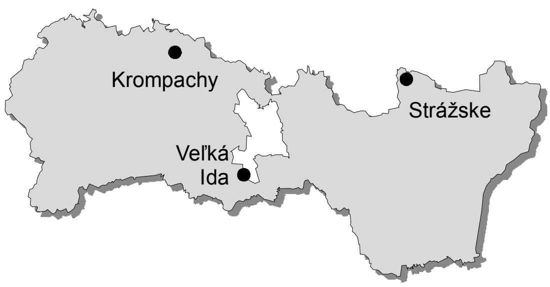
Veľká Ida

The station is located at the border line of Košice's basin and Moldava lowland. The area is surrounded from south by Abov hills, from western by Slovenský kras and from northern by Slovenské rudohorie. The prevailing winds are from north-east and south-west directions. The annual average of wind speed is about 2.5 m.s^{-1}. The main air pollution source is the ferrous metallurgy complex and surrounding large dumps from extracted ores.

Location of stations

Krompachy - SNP

Monitoring station is located close to the main route Košice - Spišská Nová Ves. The surrounding built-up area comprises multi-storey houses.

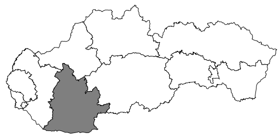


Strážske - Mierová

Monitoring station is situated in the centre of town. It is placed in an open area among buildings, gardens and green areas approximately 1.5 km east-south-east out from the Chemko Strážske plant. In the vicinity is a middle frequented first class road Michalovce-Prešov, which is separated from stations by tree alley.

Veľká Ida - Letná

The station is located in the south-eastern part of the Veľká Ida municipality, near the US Steel Košice ferrous metallurgy complex, in a relatively open area. In the vicinity of station are located family houses, gardens, railway stations and waste dumps of slag, which is not fully covered by grass.



ZONE - NITRA REGION

AREA: 6 344 km^2 POPULATION: 684 922

Characterization of area

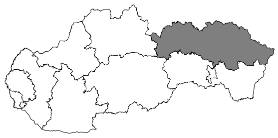
Nitra

Major part of the region interferes into Danube plain and the differences of high are very small in the whole area, higher altitudes in the north-east part are caused only by Danube upland. Prevailing winds are from north-east and south-west directions with a small occurrence of calm situations.

Location of stations

Nitra - Štúrova
Monitoring station is located on the right site in distance of 100 m of traffic circle towards to the centre of the town Nitra. In the vicinity are 4-storey buildings and green places.

Nitra - Janíkovce
Monitoring station is located in the area of elementary school Veľké Janíkovce. It is situated at cascade slope. Opposite is open area with airport Nitra.



ZONE - PREŠOV REGION

AREA: 8 974 km^2 POPULATION: 819 977

Characterization of area

Prešov

Prešov lies in the northern promontory of Košice's basin. The surrounding mountains of the Šariš's highland and the Slánske mountain range reach an altitude of 300 – 400 m above sea level. The highest hill Stráža, which is located in the north of the town, protects the town from the invasion of cool Arctic air. In the course of a year the northern air circulation prevails which is also the strongest among all of directions. The next most frequently occurred wind directions are from south. Good ventilation of the town is provided by the widening of the valley itself at the confluence of the Sečkov and Torysa. The main air pollution sources in town constitute from municipal boilers, partly lacking separation techniques, traffic, wood industry as well as secondary suspended particles.

Humenné

Humenné lies in the valley of the river Laborec, which is protected in the north by a wide zone of the Carphatians and in the south by the Vihorlat mountain range. The valley is north-east oriented. Because of the complexity in geography, the prevailing wind direction is not so uniquely determined. The occurrence of calm is relatively high. The local chemical industry is the main air pollution source in this area. The main polluter is the heating plant Chemes a.s., Humenné.

Vranov nad Topľou

Vranov nad Topľou lies in the valley of the river Topľa, which passes into the East Slovakian lowlands. The location is bordered in the west by the Slánske hills and in the north by the wide zone of the Carpathians. Air circulation is influenced by the north-west orientation of the Topľa river valley. The main air pollution sources in the area are the local wood processing industry and local heating systems.

Location of stations

Humenné - Nám. slobody

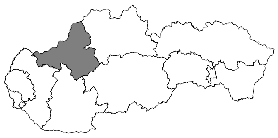
The station is located in the southern part of the town centre in open area at the edge of a pedestrian zone with minimum car transport. The surrounding buildings are connected to the central heating system of Chemes a.s., Humenné plant which is located approximately 2 km west from monitoring station.

Prešov - Arm. gen. L. Svobodu

Monitoring station is located in south-east part of the city in an open area close to the Arm. gen. L. Svobodu road, with high frequency of transport. Station is located 2 m from kerbside.

Vranov nad Topľou - M. R. Štefánika

The station is situated in the town centre which is built up with a mixture of family houses and 2–3 storey residential houses approximately 2 km north-west out from the Bukocel a.s., Hencovce plant. It is distant from the main road, of about 30 m.



ZONE - TRENČÍN REGION

AREA: 4 502 km^2 POPULATION: 591 233

Characterization of area

Horná Nitra

This area includes a part of the Horná Nitra basin from Prievidza to Bystričany. The direction of wind is affected considerably by the geography and orientation of the basin. The most frequent winds occur there from the north and north-east directions. A low value of annual wind speed 2.3 m.s^{-1} indicates the unfavourable conditions for emission dispersion and transport. The dominant cause of air pollution in this area is power generation. To a lesser extent emissions from sources of chemical industry and local heating contribute as well. The low quality of fuel for power generation sources contributes to air pollution in this area significantly. The coal in use contains apart from sulphur also arsenic.

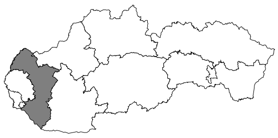
Location of stations

Prievidza - Malonecpalská
The station is located at the edge of town inside elementary school in open area. In the vicinity is situated local road No. 64 towards Žilina.

Handlová - Morovianska cesta
The station is located in a predominantly family house built-up area in territory of elementary school close to the municipal road. The major polluters are power generators and industrial sources.

Bystričany - Rozvodňa SSE
The station is directly placed in object of control room of SSE which is situated at agricultural area among fruit trees. The Nováky power plant (ENO) is in distance of 8 km northerly from the monitoring station.

Trenčín - Hasičská
Station is located between stadium and commercial buildings at the main street leading from Trenčín to Trenčianska Teplá.



ZONE - TRNAVA REGION

AREA: 4 147 km^2 POPULATION: 557 608

Characterization of area

Senica

The town itself is located on the southern slopes of Myjava hills in the altitude of 208 m. From western and partly northern side as well, the territory is bordered by the Little Carpathians. It is open only alongside Myjava river from east side, where the promontory of Záhorie lowlands intervenes. From the standpoint of emission transport and dispersion the wind conditions are favourable under the prevailing north-west wind, as this is associated with the relatively higher wind speeds.

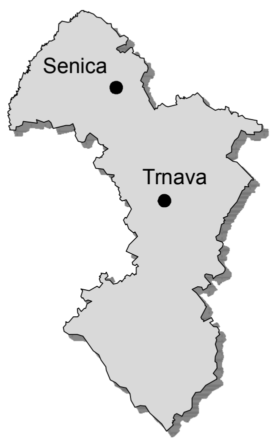
Trnava

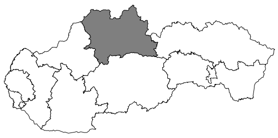
Trnava is located in the centre of the Trnava downs, at an altitude of 146 m, 45 km from the capital of the Slovak Republic, Bratislava. The prevailing wind is from the north-west, the second highest wind frequency is from south-east. The location is well ventilated with small occurrence of calm situations.

Location of stations

Senica - Hviezdoslavova
Station is placed 5 m from kerbside of main route to Kúty with a relative high heavy-duty fraction of traffic. In distance of 40 m in south direction are located multi-storey buildings.

Trnava - Kollárova
Station is located at open area close to the crossroad with high frequency of traffic. It is located in the immediate vicinity of large parking area near a railway station.





ZONE - ŽILINA REGION

AREA: 6 809 km^2 POPULATION: 690 449

Characterization of area

Ružomberok

The location of the city comprises the area of the western part of the Liptov basin, on the confluence of rivers Váh, Revúca and Likavka. The Veľká Fatra mountains constitute the border in the west, the Choč mountains in the north and the Low Tatras in the south. The most frequently occur winds from west sector, at an average speed 1.6 m.s^{-1}.

Žilina

The town itself is spread in the central valley of the Váh river, in the basin of central Považie. Žilina basin is classified as a moderately high basin. From the east the Little Fatra mountains intervene into the area, from the south the White Carpathians and from the north-west the Javorníky mountains. In a basin area, the relative humidity of air is higher and also the number of foggy days is the highest throughout the year. Slight windiness of average wind speed 1.3 m.s^{-1} and the up to 60% occurrences of calm characterise this area. From the standpoint of potential air pollution, the wind conditions in the Žilina basin are very unfavourable and thus relatively smaller sources of emissions caused to the high level of air pollution at the ground level layer.

Martin

The town of Martin is situated in the Turčianska basin at the confluence of the rivers Turiec and Váh, and surrounded by the Veľká and Malá Fatra mountain ranges. The basin area is located between high mountains and has unfavourable climatic conditions from the standpoint of pollutant emission dispersion. The frequent occurrence of temperature inversions, low average wind speed 2.8 m.s^{-1} and high relative humidity contribute to higher level of pollution.

Location of stations

Žilina - Obežná

The station is situated in the north-eastern part of the town at the edge of housing estate in relative open area close to the local roads with small traffic frequency. The position is open in all directions and representative for wind speeds and wind directions measurements.

Ružomberok - Riadok

The station is located in the kindergarten close to a low traffic route way. In the surrounding built-up area low family housing prevails.

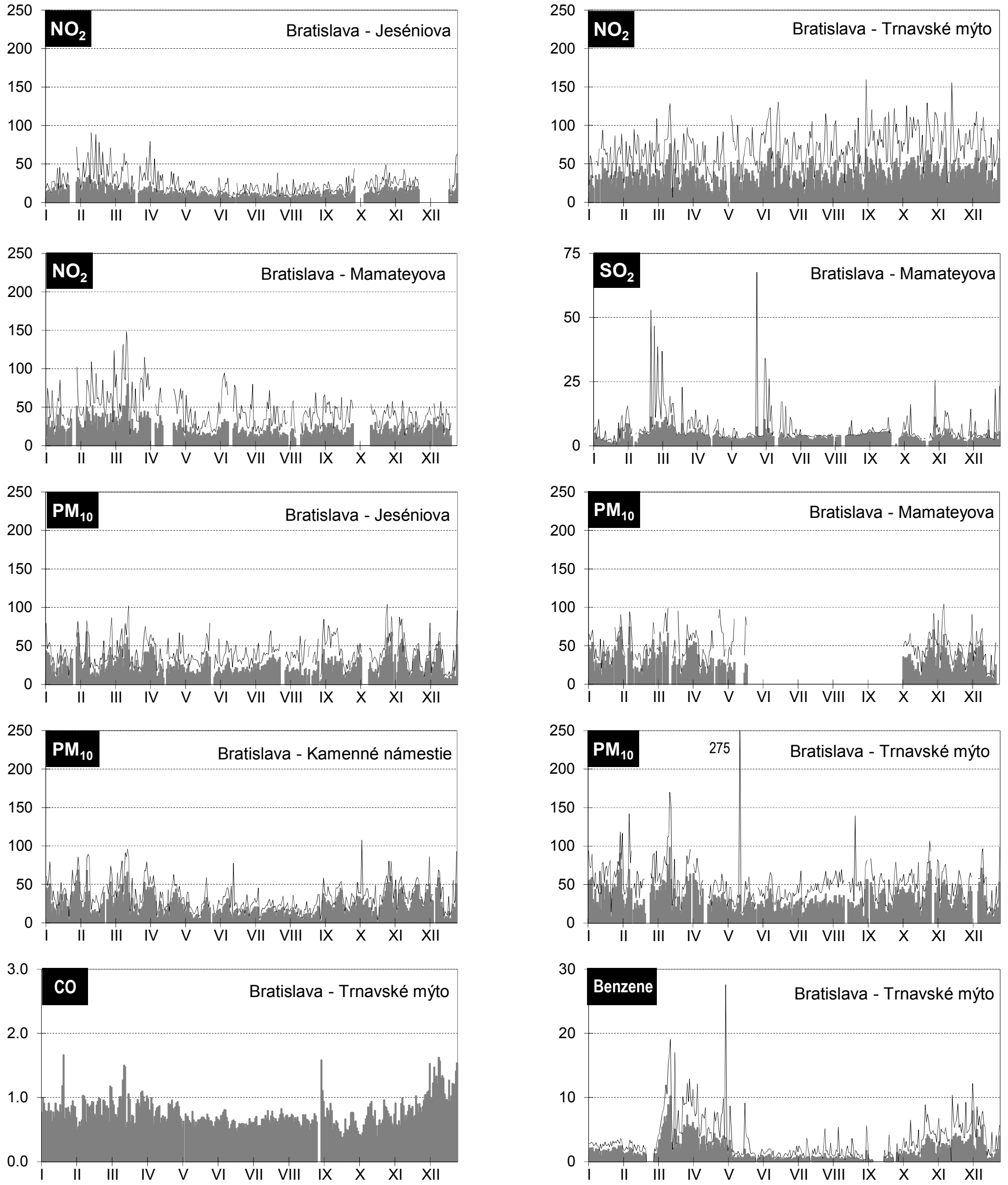
Martin - Jesenského

The station is located 5 m from the kerbside of the main street. Station is located in the southern part of the city in area mainly build up by family houses.

Tab. 2.1 **Geographical co-ordinates of monitoring stations and list of pollutants monitored in – 2014**

AGGLOMERATION/ zone		Longitude	Latitude	Altitude [m]	PM_{10}	$PM_{2,5}$	NO_2	SO_2	CO	C_6H_6	Pb	Cd	Ni	As	BaP
BRATISLAVA	Bratislava, Kamenné nám	17°06'48"	48°08'41"	139	*										
	Bratislava, Trnavské mýto	17°07'43"	48°09'30"	136	*		*		*	*					*
	Bratislava, Jeséniova	17°06'22"	48°10'05"	287	*		*								*
	Bratislava, Mamateyova	17°07'32"	48°07'30"	138	*		*	*							
KOŠICE	Košice, Amurská	21°17'11"	48°41'28"	201	*	*									
	Košice, Štefánikova	21°15'33"	48°43'34"	209	*	*	*			*					
Banská Bystrica region	Banská Bystrica, Štefánikovo nábr.	19°09'16"	48°44'07"	346	*		*	*	*	*	*	*	*	*	
	Banská Bystrica, Zelená	19°06'55"	48°44'00"	425		*	*								
	Jelšava, Jesenského	20°14'26"	48°37'52"	289	*	*									
	Hnúšťa, Hlavná	19°57'06"	48°35'02"	320	*	*									
	Zvolen, J. Alexyho	19°09'24"	48°33'29"	321	*	*									
	Žiar nad Hronom, Jilemnického	18°50'32"	48°35'58"	296	*	*									
Bratislava region	Malacky, Mierové nam.	17°01'11"	48°26'12"	197	*		*	*	*	*					
Košice region	Veľká Ida, Letná	21°10'30"	48°35'32"	209	*	*			*		*	*	*	*	*
	Strážske, Mierová	21°50'15"	48°52'26"	133	*	*									
	Krompachy, SNP	20°52'26"	48°54'57"	372	*	*	*	*	*	*	*	*	*	*	*
Nitra region	Nitra, Štúrova	18°04'10"	48°18'00"	143	*		*	*	*	*					*
	Nitra, Janíkovce	18°08'27"	48°17'00"	149	*	*	*								
Prešov region	Humenné, Nám. slobody	21°54'50"	48°55'51"	160	*	*									
	Prešov, Arm. gen. L. Svobodu	21°16'03"	48°59'36"	252	*	*	*		*	*					
	Vranov nad Topľou, M. R. Štefánika	21°41'15"	48°53'11"	133	*	*		*							
Trenčín region	Bystričany, Rozvodňa SSE	18°30'51"	48°40'01"	261	*	*		*							
	Handlová, Morovianska cesta	18°45'23"	48°43'59"	448	*	*		*							
	Prievidza, Malonecpalská	18°37'40"	48°46'58"	276	*	*		*			*	*	*	*	*
	Trenčín, Hasičská	18°02'28"	48°53'47"	214	*	*	*	*	*	*					
Trnava region	Senica, Hviezdoslavova	17°21'48"	48°40'50"	212	*	*		*							
	Trnava, Kollárova	17°35'06"	48°22'16"	152	*	*	*		*	*					*
Žilina region	Martin, Jesenského	18°55'17"	49°03'35"	383	*	*	*		*	*					
	Ružomberok, Riadok	19°18'10"	49°04'44"	475	*	*		*			*	*	*	*	
	Žilina, Obežná	18°46'15"	49°12'41"	356	*	*	*								

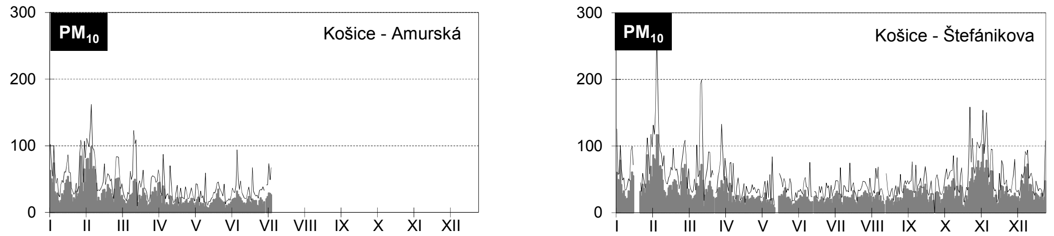
Fig. 2.1 **Concentrations of NO_2, SO_2, PM_{10}, benzene and CO – agglomeration Bratislava – 2014**



concentrations: NO_2, SO_2, PM_{10}, benzene - daily average [$\mu g.m^{-3}$] CO - daily maximum of 8 h means [$mg.m^{-3}$]

— 1 h maximum concentrations: NO_2, SO_2, PM_{10}, benzene [$\mu g.m^{-3}$]

Fig. 2.2 **Concentrations of NO_2, PM_{10}, $PM_{2.5}$ and benzene – agglomeration Košice – 2014**



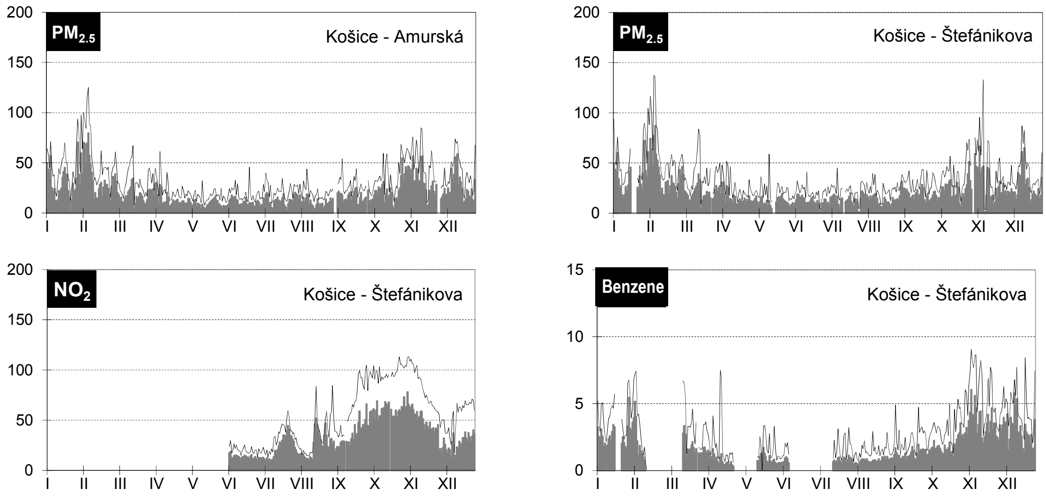
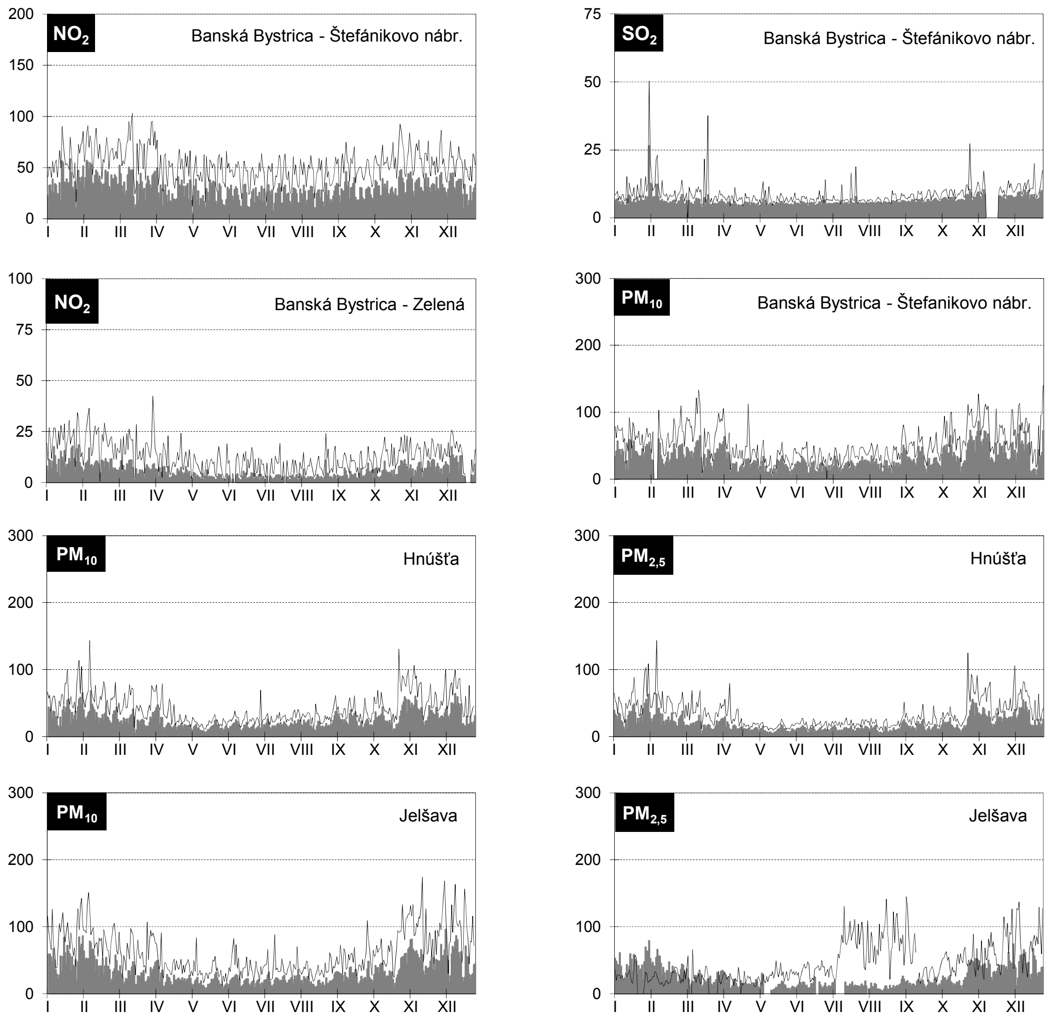


Fig. 2.3 **Concentrations of NO_2, SO_2, PM_{10}, $PM_{2,5}$, CO and benzene – zone Banská Bystrica region – 2014**



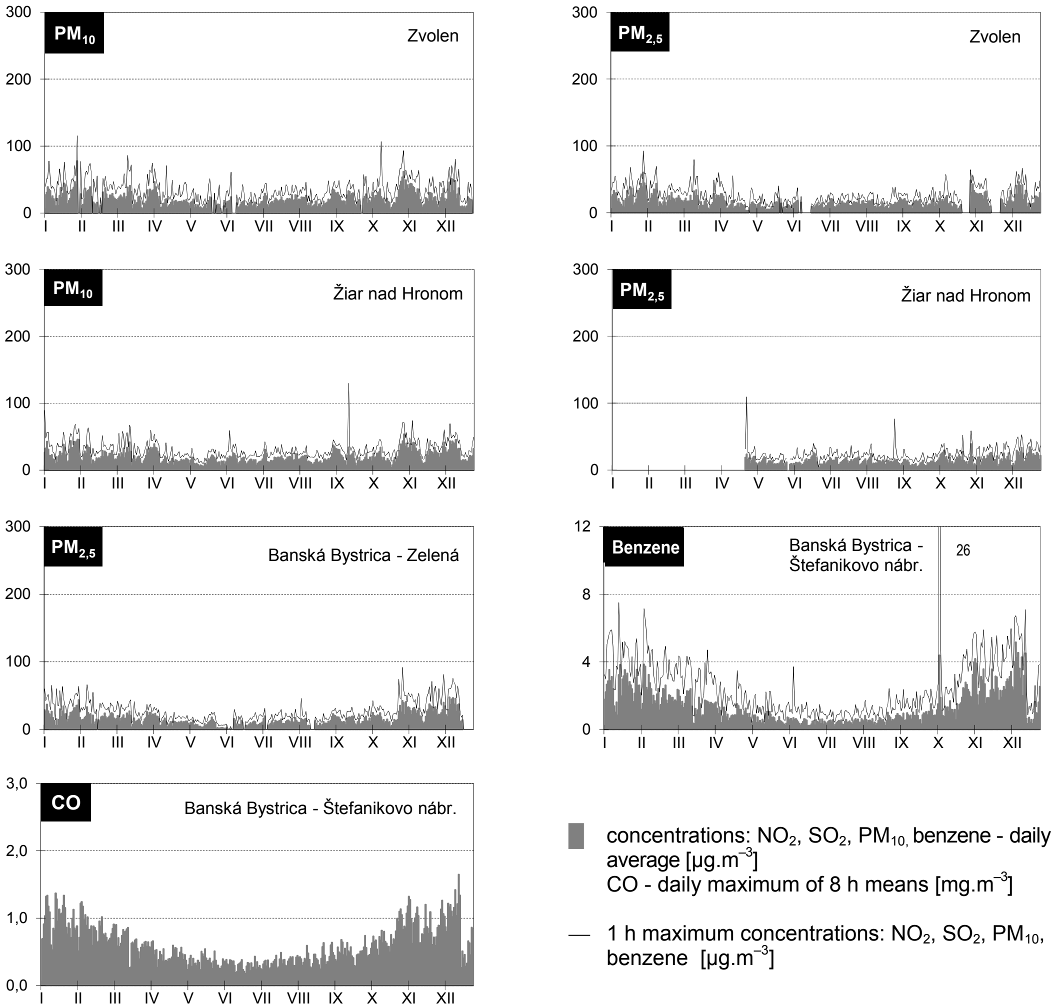
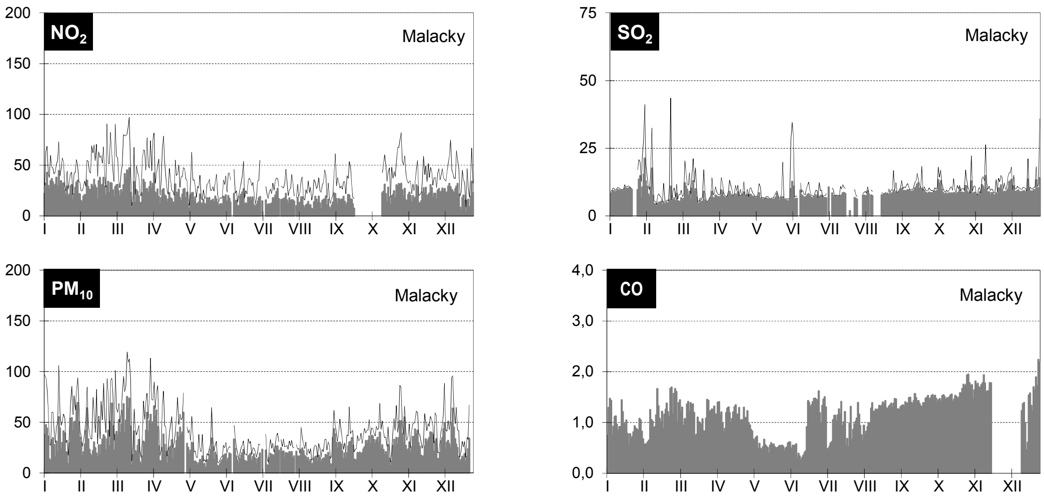
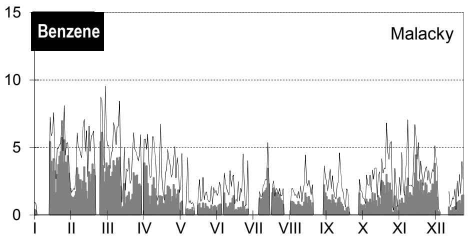


Fig. 2.4 **Concentrations of NO_2, SO_2, PM_{10}, CO and benzene – zone Bratislava region – 2014**

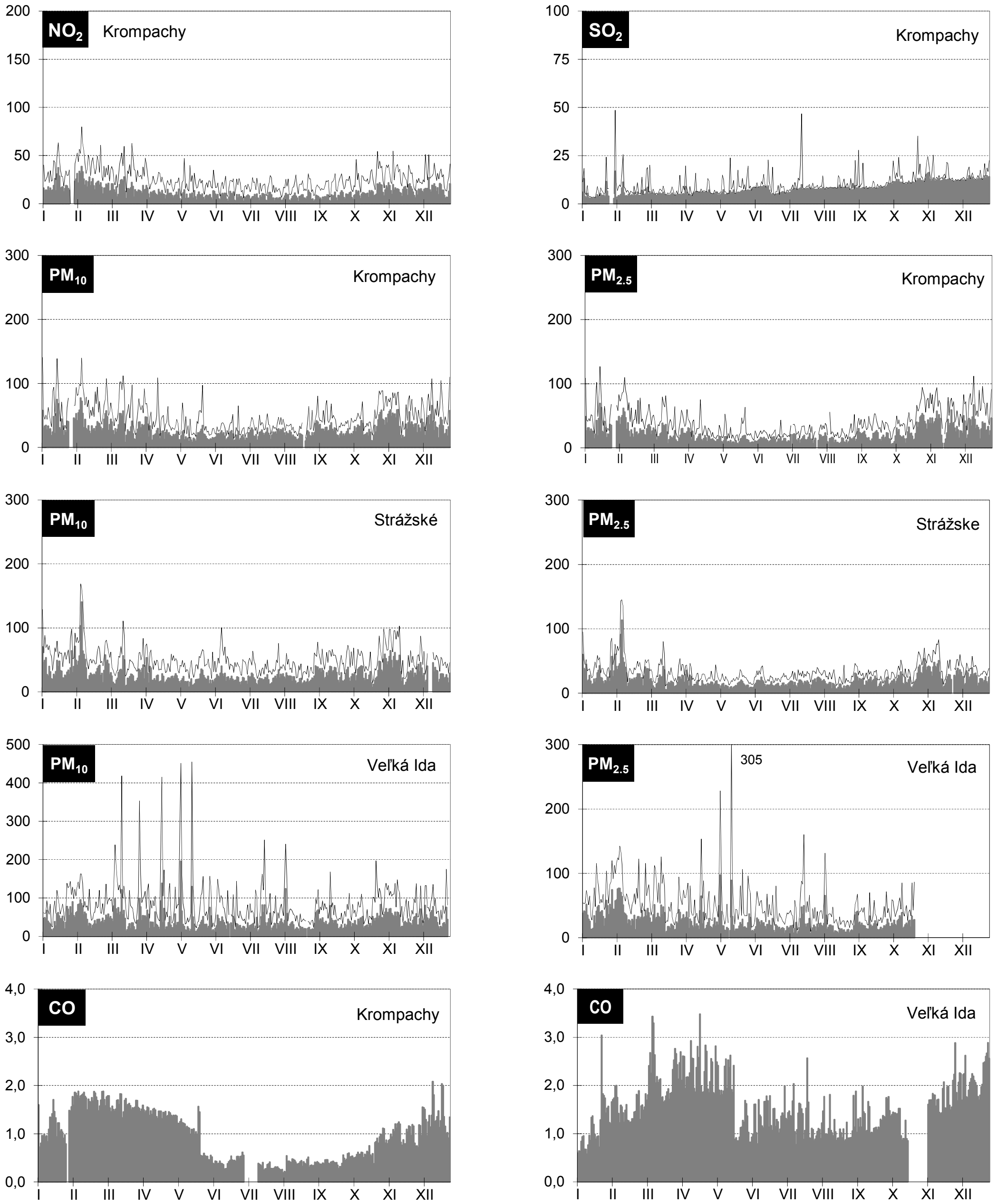


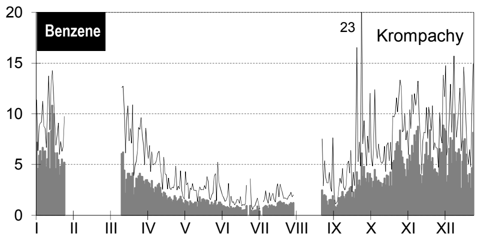


concentrations: NO_2, SO_2, PM_{10}, benzene - daily average [μg.m^{-3}]
CO - daily maximum of 8 h means [mg.m^{-3}]

— 1 h maximum concentrations: NO_2, SO_2, PM_{10}, benzene [μg.m^{-3}]

Fig. 2.5 **Concentrations of NO_2, SO_2, PM_{10}, $PM_{2,5}$, CO and benzene – zone Košice region – 2014**

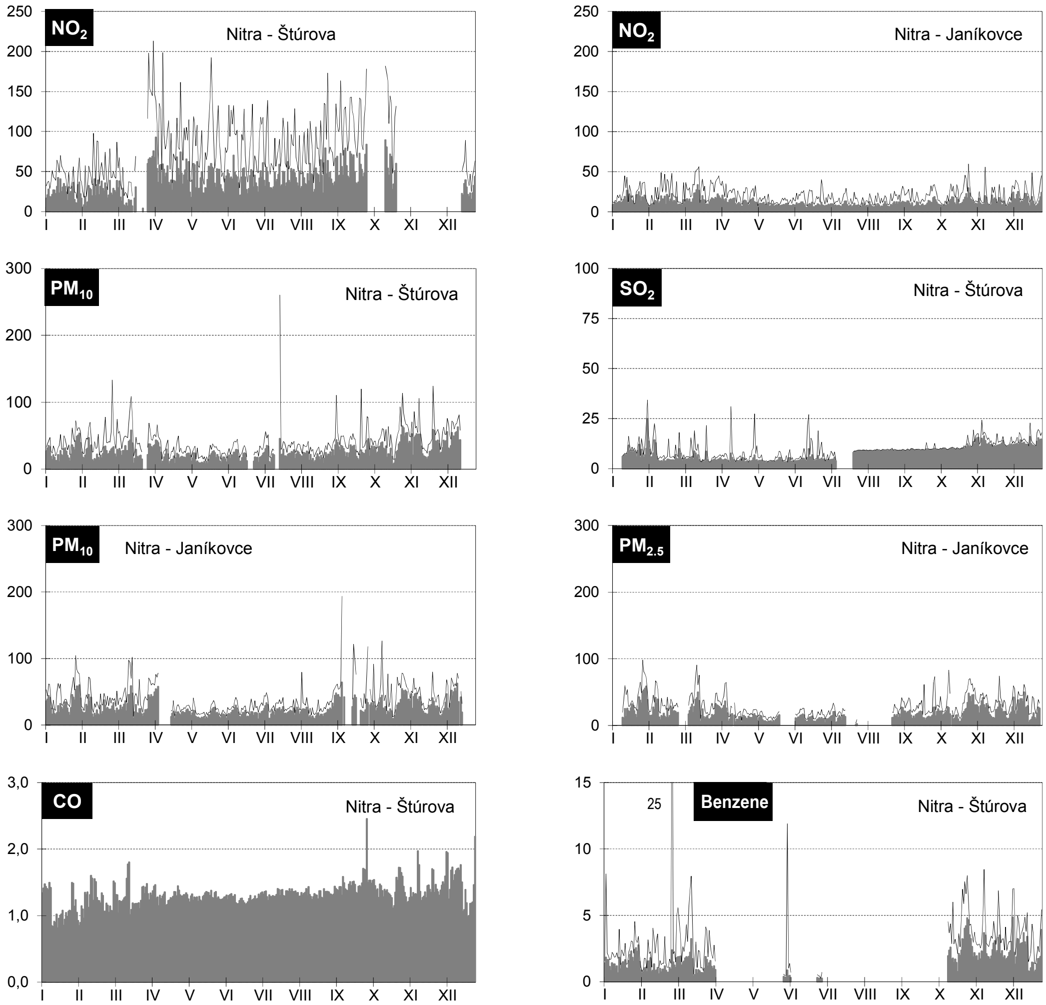




▮ concentrations: NO_2, SO_2, PM_{10}, $PM_{2.5}$, benzene - daily average [µg.m^{-3}]
CO - daily maximum of 8 h means [mg.m^{-3}]

— 1 h maximum concentrations: NO_2, SO_2, PM_{10}, $PM_{2,5}$, benzene [µg.m^{-3}]

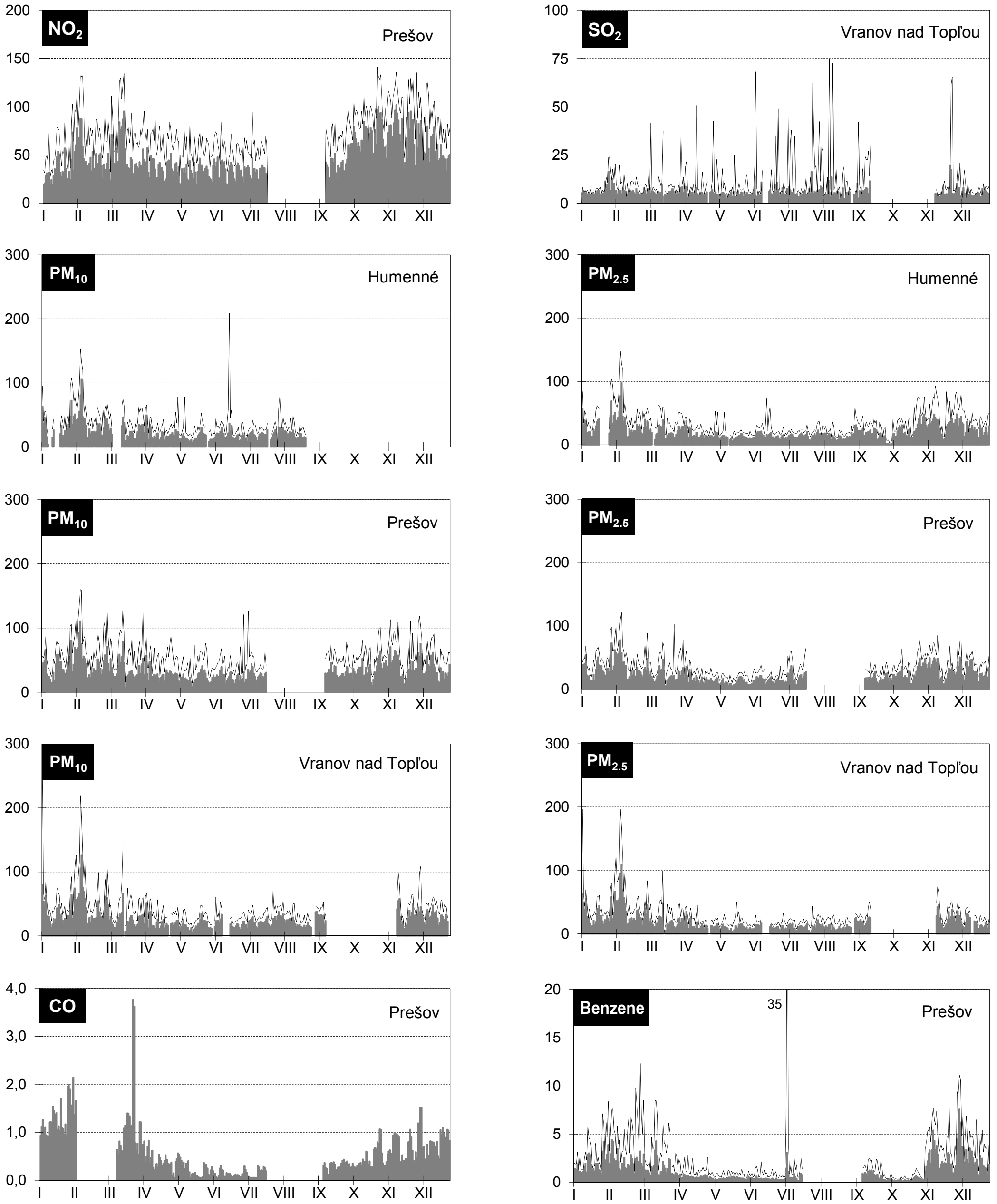
Fig. 2.6 **Concentrations of NO_2, SO_2, PM_{10}, $PM_{2.5}$, CO and benzene – zone Nitra region – 2014**



▮ concentrations: NO_2, SO_2, PM_{10}, $PM_{2.5}$, benzene - daily average [µg.m^{-3}]
CO - daily maximum of 8 h means [mg.m^{-3}]

— 1 h maximum concentrations: NO_2, SO_2, PM_{10}, benzene [µg.m^{-3}]

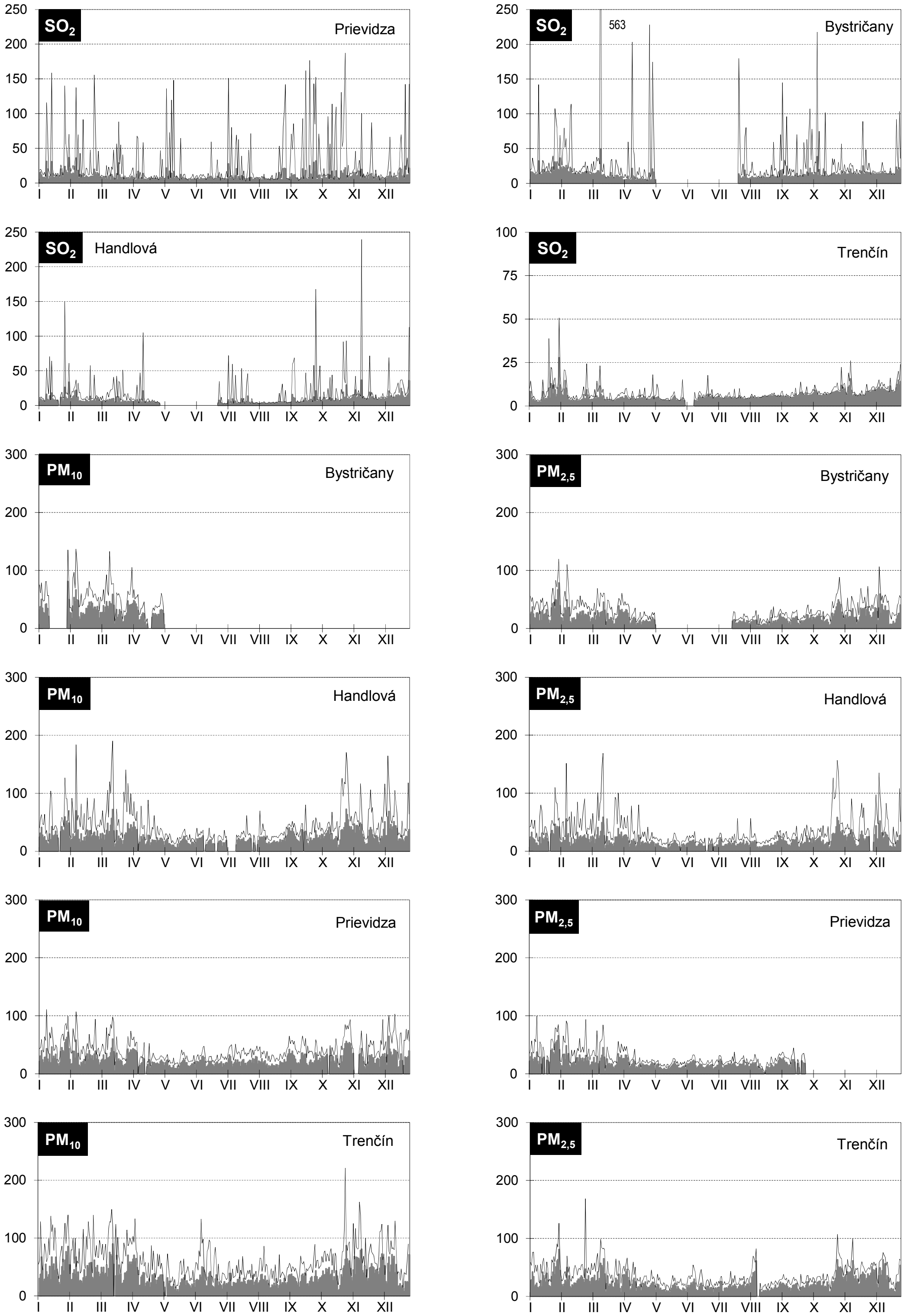
Fig. 2.7 **Concentrations of NO_2, SO_2, PM_{10}, $PM_{2.5}$, CO and benzene – zone Prešov region – 2014**



concentrations: NO_2, SO_2, PM_{10}, $PM_{2.5}$, benzene - daily average [μg.m^{-3}]
CO - daily maximum of 8 h means [mg.m^{-3}]

— 1 h maximum concentrations: NO_2, SO_2, PM_{10}, benzene [μg.m^{-3}]

Fig. 2.8 **Concentrations of NO_2, SO_2, PM_{10}, $PM_{2.5}$, CO and benzene – zone Trenčín region – 2014**



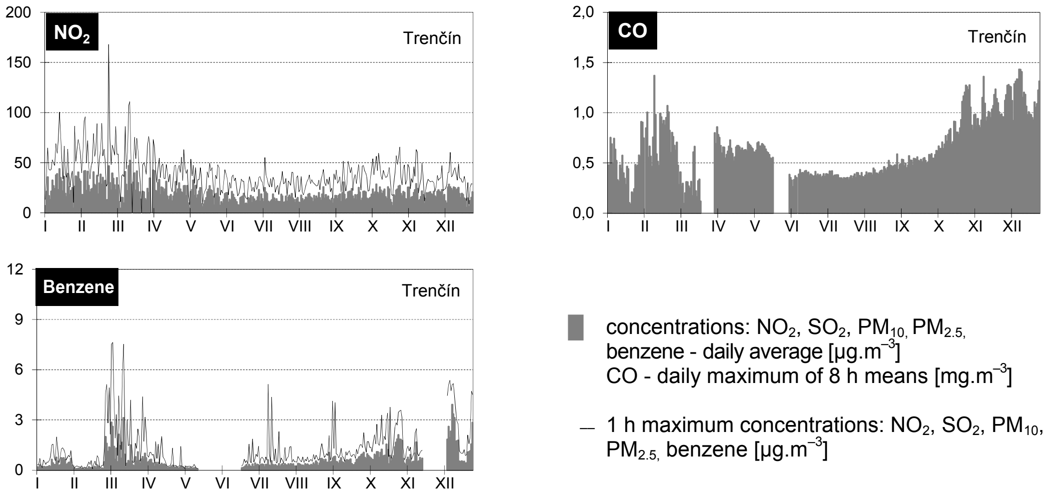


Fig. 2.9 **Concentrations of NO_2, SO_2, PM_{10}, $PM_{2.5}$, CO and benzene – zone Trnava region – 2014**

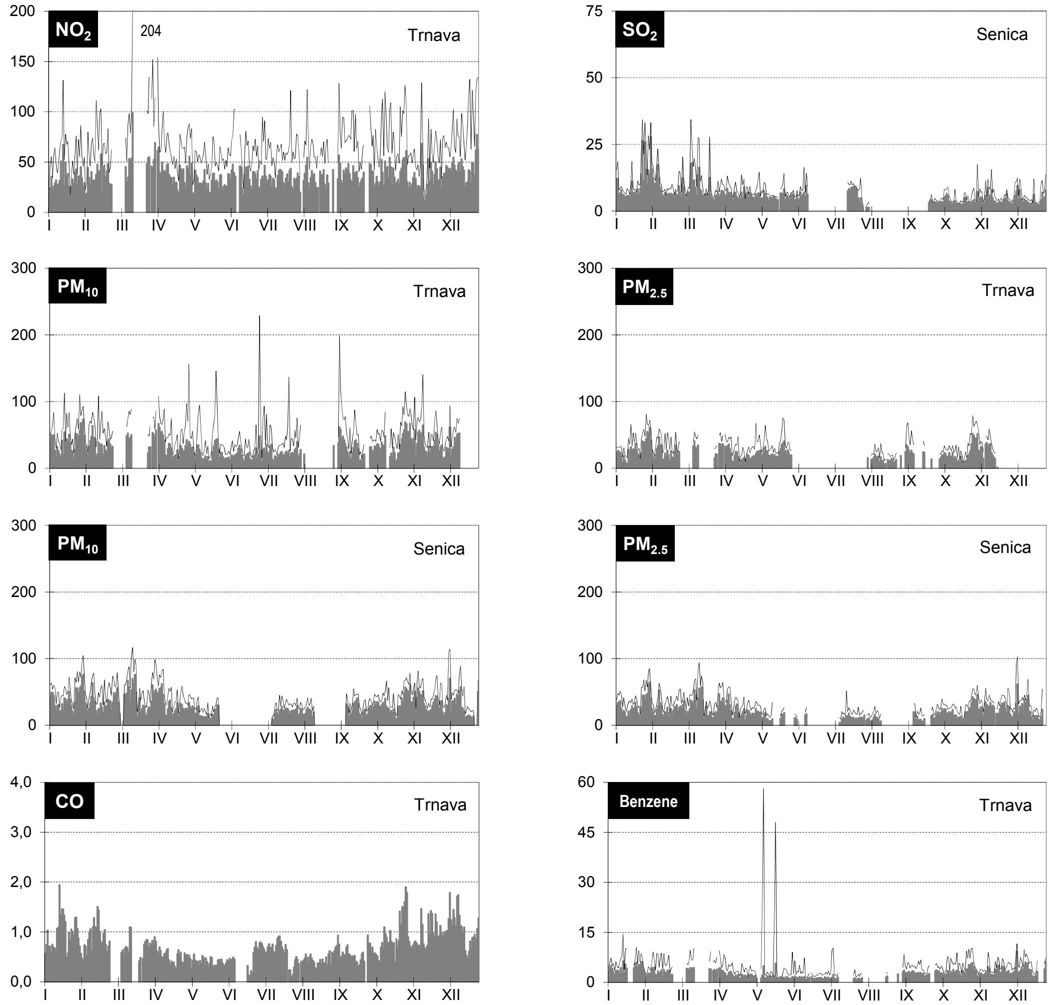
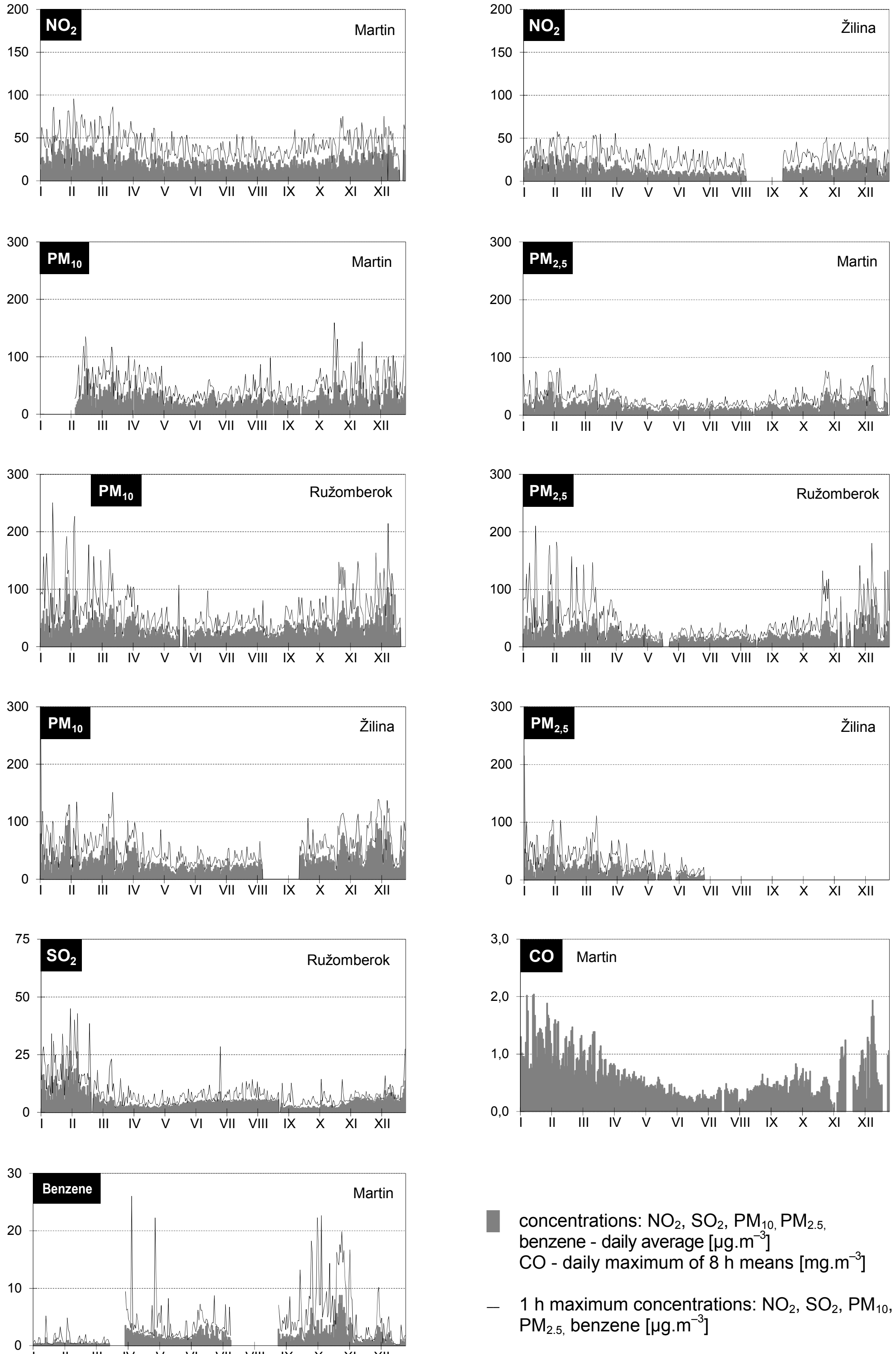


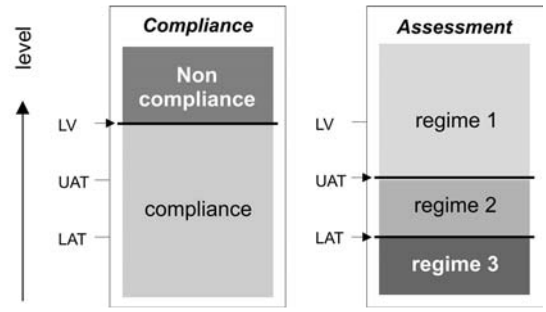
Fig. 2.10 **Concentrations of NO_2, SO_2, PM_{10}, $PM_{2.5}$, CO and benzene – zone Žilina region – 2014**



2.3 PROCESSING OF MEASUREMENT RESULTS ACCORDING TO LIMIT VALUES

The Air Protection Act 137/2010 Coll. the air quality assessment is carried out at whole territory of the Slovak Republic in each zone and agglomerations. On the basis of air quality assessment each zone/agglomeration the monitoring regimes are defined. This assessment performed for the period of the last five years distinguishes three particular monitoring regimes. These are schematically illustrated on Figure 2.12 and in Table 2.2 are specified requirements for air quality assessment for specific regimes.

Fig. 2.12 **Regimes of air quality assessment in relation to LV[1], UAT[2] a LAT[3]**



Tab. 2.2 **Requirements for assessment in three different regimes**

Maximum level of pollution in agglomerations and zones	Requirements for assessment
REGIME 1 **Above upper assessment threshold**	High quality of measurements is obligatory. Measured data can be supplemented by further information, model computations including.
REGIME 2 **Below upper assessment threshold, but above lower assessment threshold**	Measurements are obligatory, however to a lesser extent, or to a lesser intensity, under the premise that the data are supplemented by other reliable sources of information.
REGIME 3 **Below lower assessment threshold**	Model computations, expert estimates and indicative measurements are sufficient.

For some pollutants margin of tolerance were set up. Limit values, upper and lower assessment thresholds defined in Decree No. 360/2010 Coll. about Air Quality are presented in tables 2.3 and 2.4. Alert thresholds values were set up for:

SO_2 – 500 μg.m^{-3} and NO_2 – 400 μg.m^{-3}.

Alert thresholds values are exceeded if each of 3 consecutive 1 hour concentration exceeds the particular level given above.

But these limit values are assumed to be exceeded only in case, if the polluted area is larger than 100 km^2 or represent the whole zone. The stringer criteria is taken into account.

Results from continuous measurements are presented in graphical and tabular form. For illustration the concentrations and wind roses were evaluated for one station from west, middle and east part of Slovakia (Fig. 2.11).

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[1] *Limit value as defined in Decree No. 360/2010 Coll.*
[2] *Upper assessment threshold as defined in Decree No. 360/2010 Coll.*
[3] *Lower assessment threshold, as defined in Decree No. 360/2010 Coll.*

Statistical characteristics were processed for all monitoring stations in Slovakia. The stations, where the limit values and limit values plus margin of tolerance were exceeded, are highlighted in tables in bold (Tab. 2.5 – 2.7).

Sulphur dioxide In the year 2014 in none of agglomeration or zone the hourly or daily limit values were exceeded in more cases than it is allowed. In the year 2014 there wasn't any case of exceedance of warning or alert threshold.

Nitrogen dioxide Hourly limit value has not been exceeded at any station. The maximal level was below the alert threshold. The annual limit value was not exceeded at the monitoring station. Prešov-Arm. gen. L. Svobodu. In the year 2014 there was any exceedance of threshold values.

PM_{10} The major air pollution problem in Slovakia similarly to the whole Europe is pollution by particulate matter. In the year 2014 daily limit value was exceeded at 9 stations. The annual limit value was exceeded at any of the monitoring stations Veľká Ida as well.

$PM_{2,5}$ For $PM_{2,5}$ is given only annual limit 25 $\mu g.m^{-3}$, which come in force in 1. 1. 2015. For the year 2014 is put in force limit value and margin of tolerance 26 $\mu g.m^{-3}$ (Commission implementing Decision 2011/850/EU, ANNEX 1, bod 5). In 2014 was not exceeded this value at any stations and target limit at 25 $\mu g.m^{-3}$ at the 2 stations, what represent significant decrease in comparison to the year 2013.

Carbon monoxide The level of pollution by carbon monoxide is considerably low and the limit value was not exceeded at any of the monitoring stations.

Benzene The highest annual concentration 3.2 $\mu g.m^{-3}$ in Krompachy is below the limit value 5 $\mu g.m^{-3}$.

BaP The target value was exceeded at stations Veľká Ida-Letná, Krompachy-SNP and Prievidza-Malonecpalská.

Pb, As, Ni, Cd Neither limit value for Pb nor target value for As, Cd and Ni were exceeded in 2014.

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Tab. 2.3 **Limit values plus limits of tolerance for respective years**

	Interval of averaging	Limit value* [µg.m⁻³]	To be met by	Margin of tolerance	Limit value + margin of tolerance [µg.m⁻³] Since 31/12/00	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
SO_2	1h	350 (24)	1.1.2005	150 µg/m³	500	470	440	410	380	350	350	350	350	350	350	350	350	350	350
SO_2	24h	125 (3)	1.1.2005	-															
SO_2^v	1y, W[1]	20 (-)	1.1.2003	-															
NO_2	1h	200 (18)	1.1.2010	50 %	300	290	280	270	260	250	240	230	220	210	200	200	200	200	200
NO_2	1y	40 (-)	1.1.2010	50 %	60	58	56	54	52	50	48	46	44	42	40	40	40	40	40
NO_x^v	1y	30 (-)	1.1.2003	-															
PM_{10}	24h	50 (35)	1.1.2005	50 %	75	70	65	60	55	50	50	50	50	50	50	50	50	50	50
PM_{10}	1y	40 (-)	1.1.2005	20 %	48	46	45	43	42	40	40	40	40	40	40	40	40	40	40
Pb	1y	0.5 (-)	1.1.2005	100 %	1,0	0,9	0,8	0,7	0,6	0,5	0,5	0,5	0,5	0,5	0,5	0,5	0,5	0,5	0,5
CO	max. 8 hour daily value	10000 (-)	1.1.2005	6000 µg/m³	16000	16000	16000	14000	12000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000
Benzén	1y	5 (-)	1.1.2010	100 %	10	10	10	10	10	10	9	8	7	6	5	5	5	5	5
$PM_{2.5}$	1y	25	1. 1. 2008	5 µg/m³										30	29	28	27	26	26
$PM_{2.5}^{**}$	1y	25	1. 1. 2015	-															

[1] *winter period (October 1 - March 31)*

^{v} *critical level for protection of vegetation*

* *allowed exceedances per year are in brackets*

** *target value*

	Interval of averaging	Target value [ng/m³]	To be met by
As	1y	6	31. 12. 2012
Cd	1y	5	31. 12. 2012
Ni	1y	20	31. 12. 2012
BaP	1y	1	31. 12. 2012

Tab. 2.4 **Limit values, upper and lower assessment threshold**

	Receptor	Interval of averaging	Limit value [µg.m⁻³]	Assessment threshold [µg.m⁻³] upper*	lower*
SO_2	Human health	1h	350 (24)		
SO_2	Human health	24h	125 (3)	75 (3)	50 (3)
SO_2	Vegetation	1y. 1/2y	20 (-)	12 (-)	8 (-)
NO_2	Human health	1h	200 (18)	140 (18)	100 (18)
NO_2	Human health	1y	40 (-)	32 (-)	26 (-)
NO_x	Vegetation	1y	30 (-)	24 (-)	19.5 (-)
PM_{10}	Human health	24h	50 (35)	35 (35)	25 (35)
PM_{10}	Human health	1y	40 (-)	28 (-)	20 (-)
Pb	Human health	1y	0.5 (-)	0.35 (-)	0.25 (-)
CO	Human health	8h (maximum)	10 000 (-)	7 000 (-)	5 000 (-)
Benzene	Human health	1y	5 (-)	3.5 (-)	2 (-)
$PM_{2,5}$	Human health	1y	25**	17	12

* *allowed exceedances per year are in brackets* ***valid since 1st January 2015*

Tab. 2.5 **Assessment of air quality according to limit values for protection of human health – 2014**

AGLOMERATION / Zone		Human protection									VP [2)]	
	Pollutant	SO_2		NO_2		PM_{10}		$PM_{2.5}$	CO	Benzene	SO_2	NO_2
	Time of averaging	1 hour	24 hour	1 hour	1 year	24 hour	1 year	1 year	8 hour [1)]	1 year	3 subsequent hour	3 subsequent hour
	Limit value [μg.m⁻³] *(počet prekročení)*	350 *(24)*	125 *(3)*	200 *(18)*	40	50 *(35)*	40	25	10000	5	500	400
BRATISLAVA	Bratislava, Kamenné nám.					15	23					
	Bratislava, Trnavské mýto			0	37	**41**	32		1664	1.9		0
	Bratislava, Jeséniova			0	14	12	25					0
	Bratislava, Mamateyova	0	0	0	23	21	32				0	0
KOŠICE	Košice, Štefánikova			0	33	**42**	31	21		1.8		0
	Košice, Amurská					15	26	20				
Banská Bystrica region	Banská Bystrica, Štefánik.nábr.	0	0	0	29	**52**	31	22	1649	1.4	0	0
	Banská Bystrica, Zelená			0	6			16				0
	Jelšava, Jesenského					**67**	32	24				
	Hnúšťa, Hlavná					15	25	19				
	Zvolen, J. Alexyho					4	22	17				
	Žiar n/H, Jilemnického					1	20	15				
Bratislava region	Malacky, Mierové nam.	0	0	0	21	27	27		2237	1.6	0	0
Košice region	Veľká Ida, Letná					**97**	**41**	25	3478			
	Strážske, Mierová					21	28	21				
	Krompachy, SNP	0	0	0	12	30	28	22	2083	3.2	0	0
Nitra region	Nitra, Janíkovce			0	12	15	26	18				0
	Nitra, Štúrova	0	0	1	39	18	26	21	2453	1.7	0	0
Prešov region	Humenné, Nám. slobody					6	23	21				
	Prešov, Arm. gen. L. Svobodu			0	**46**	**43**	34	23	3764	1.2		0
	Vranov n/T, M. R. Štefánika	0	0			21	27	18			0	
	Stará Lesná, AÚ SAV, EMEP [3)]					0	18	10				
	Kolonické sedlo, Hvezdáreň [3)]					0	18	13				
Trenčín region	Prievidza, Malonecpalská	0	0			13	25	19			0	
	Bystričany, RozvodňSSE	1	0			4	32	20			0	
	Handlová, Morovianskcesta	0	0			12	25	18			0	
	Trenčín, Hasičská	0	0	0	20	**67**	35	24	1431	0.6	0	0
Trnava region	Senica, Hviezdoslavova	0	0			33	30	21			0	
	Trnava, Kollárova			1	37	35	31	22	1939	2.8		0
	Topoľníky, Aszód, EMEP [3)]					5	28	22				
Žilina region	Martin, Jesenského			0	23	20	27	17	2038	1.6		0
	Ružomberok, Riadok	0	0			**51**	34	23			0	
	Žilina, Obežná			0	14	**51**	33	20				0

[1)] *maximal 8 hour value of moving average* [2)] *alert threshold limit values*
[3)] *stations located in rural background areas*

Pollutants which exceeded limit values are in bold

Data coverage: (green shading) *≥ 85 % of valid values*

Tab. 2.6 **Assessment of air quality according to target and limit values for As, Cd and Ni for the protection of human health in 2014**

AGLOMERATION/ zone	Pollutant	As	Cd	Ni	Pb
	Target value [ng.m^{-3}]	6.0	5	20	
	Limit value [ng.m^{-3}]				500
	Upper assessment threshold [ng.m^{-3}]	3.6	3	14	350
	Lower assessment threshold [ng.m^{-3}]	2.4	2	10	250
Slovakia	Banská Bystrica, Štefánikovo nábr.	1.0	0.4	1.0	10.0
	Veľká Ida, Letná	1.3	0.5	0.7	49.2
	Krompachy, SNP	0.9	2.5	0.4	83.3
	Prievidza, Malonecpalská	4.4	0.2	0.5	7.5
	Ružomberok, Riadok	1.6	0.3	1.0	9.3

Tab. 2.7 **Assessment of air quality according to target values for BaP for the protection of human health in 2014**

AGLOMERATION / zone	Pollutant	BaP
	Target value [ng.m^{-3}]	1.0
	Upper assessment threshold [ng.m^{-3}]	0.6
	Lower assessment threshold [ng.m^{-3}]	0.4
BRATISLAVA	Bratislava, Trnavské mýto	0.6
	Bratislava, Jeséniova	0.7
Slovakia	Veľká Ida, Letná	4.1
	Krompachy, SNP	2.1
	Prievidza, Malonecpalská	1.5
	Trnava, Kollárova	0.7

3

ATMOSPHERIC OZONE

3.1 ATMOSPHERIC OZONE

Most of the atmospheric ozone (approximately 90%) is in the stratosphere (11 – 50 km), the rest in the troposphere. Stratospheric ozone protects our biosphere against lethal ultra-violet UV-C radiation and to a considerable degree weakens UV-B radiation, which may cause the whole range of unfavourable biological effects such as skin cancer, cataracts, etc. The depletion of stratospheric ozone and thus total ozone as well, observed since the end of the 1970s, is associated with the increase in intensity and doses of UV-B radiation in the troposphere and on the Earth's surface. The main share in stratospheric ozone depletion is due to the emissions of freons and halons, which are the source of active chlorine and bromine in the stratosphere. The concentration of active chlorine in troposphere culminated in the mid-1990s. At present the culmination in stratosphere is supposed. A slow recovery of ozone layer to the pre-industrial level is expected in the middle of this century.

The growth of ozone concentrations in the troposphere approximately 1 $\mu g.m^{-3}$ annually was observed over the industrial continents of the Northern Hemisphere by the end of 1980s. It is associated with the increasing emission of ozone precursors (NOx, VOCs, CO) from car transport, power generation and industry. Since the early 1990s no trend of the average concentration level of ground level ozone in Slovakia, like as in many European countries, has been observed. In spite of considerable decrease of ozone precursor emission reduction in Slovakia and in surrounding countries during nineties the effect was not adequate. Only ozone peaks decreased significantly. It was shown the average level of ozone concentration is more controlled by large scale processes (downward mixing from the free troposphere, long-range transport and global warming). The extremely warm and dry year 2003 represented the absolute exception from these trends. Most of the ozone level indicators reached the highest values at all Slovak suburban, rural and mountain stations in the period 1993 – 2003. The level of concentrations in 2014 was lower as in 2003. The high ground level ozone concentrations, mainly during photochemical smog episodes in summer, impact unfavourably on human health (mainly on the respiratory system of human beings), vegetation (mainly on agricultural crops and forests) and various materials.

3.2 GROUND LEVEL OZONE IN THE SLOVAK REPUBLIC DURING 2009 – 2014

Target and thresholds values for ground level ozone

In Table 3.1 the target values for ground level ozone are listed according to the Act 137/2010 Coll. on Air, information and alert thresholds. If ground level ozone concentration exceeds some of the threshold values the population has to be informed or warned.

Tab. 3.1 **Target values for ground level ozone, information and alert thresholds**

Target resp. threshold values	Concentration O_3 [$\mu g.m^{-3}$]	Averaging/accumulation time
Target value for the protection of human health	120*	8 hour
Target value for the protection of vegetation AOT40**	18 000 [$\mu g.m^{-3}.h$]	1 May – 31 July
Information threshold	180	1 hour
Alert threshold	240	1 hour

* *Maximum daily 8-hour average 120 $\mu g.m^{-3}$ not to be exceeded on more than 25 days per calendar year averaged over three years.*

** *AOT40, expressed in $\mu g.m^{-3}$.hours, means the sum of the difference between hourly concentrations greater that 80 $\mu g.m^{-3}$ (= 40 ppb) and 80 $\mu g.m^{-3}$ over a given period using only the 1 hour values measured between 8:00 and 20:00 of Central European Time each day, averaged over five years.*

Assessment of ground level ozone in Slovakia during 2009 – 2014

The measurement of ground level ozone concentrations in Slovakia started in 1992, within the operation of monitoring network under the Slovak Hydrometeorological Institute. The number of monitoring stations has been gradually extended. The stations at Stará Lesná, Starina (in operation since 1994) Topoľníky and Chopok (in operation since 1995) are part of the EMEP monitoring network. For monitoring of ground level ozone concentrations, the ozone analysers have been used. All these analysers operate on the principle of UV absorption. In 1994, the secondary national ozone standard was installed in the Slovak Hydrometeorological Institute and regular audits by portable calibrator started to be carried out in the stations. A secondary standard of the Slovak Hydrometeorological Institute is regularly compared with the primary ozone standard in the Czech Hydrometeorological Institute in Prague. In 2014 the number of missing data did not exceed 10% at most of the stations (Tab. 3.2). Large gaps were only at the Chopok and Humenné.

Tab. 3.2 **Number of missing daily averages of ground level ozone concentrations [%]**

Station	2009	2010	2011	2012	2013	2014
Banská Bystrica, Zelená	*42.5	0.03	0.1	0.6	8.8	4.0
Bratislava, Jeséniova	0.1	0.2	1.3	1.6	0.3	8.3
Bratislava, Mamateyova	7.2	6.2	4.9	3.9	21.3	9.0
Humenné, Nám. Slobody	0.1	3.8	7.5	0.7	0.3	34.5
Jelšava, Jesenského	3.0	2.8	61.6	73.1	31.8	5.6
Košice, Ďumbierska	2.1	0.4	0.1	3.3	3.9	0.8
Nitra, Janíkovce	*13.7	22.5	-	11.8	26.7	10.2
Prievidza, Malonecpalská	3.4	0.5	4.6	1.9	11.3	0.8
Žilina, Obežná	1.5	0.1	0.4	3.1	25.4	10.1
Gánovce, Meteo. st.	0.1	0.4	0.2	2.4	16.1	0.3
Chopok, EMEP	0.3	2.6	2.2	3.4	22.0	47.6
Kojšovská hoľa	0.1	14.2	2.5	4.2	1.5	13.4
Stará Lesná, AÚ SAV, EMEP	0.6	0.4	2.2	3.2	0.8	10.8
Starina, Vodná nádrž, EMEP	0.8	0.1	0.2	1.6	5.0	0.7
Topoľníky, Aszód, EMEP	0.6	2.9	-	18.9	30.1	0.1

** ozone measurement introduced in 2009 - long-term failure*

Tab. 3.3 **Annual averages of ground level ozone concentration [μg.m^{-3}]**

Station	2009	2010	2011	2012	2013	2014
Banská Bystrica, Zelená	53	56	60	66	66	58
Bratislava, Jeséniova	60	61	63	65	62	60
Bratislava, Mamateyova	48	46	51	53	48	46
Humenné, Nám. Slobody	59	53	53	55	60	40
Jelšava, Jesenského	49	44	-	-	41	36
Košice, Ďumbierska	81	63	73	62	61	55
Nitra, Janíkovce	74	53	-	62	58	52
Prievidza, Malonecpalská	50	49	51	52	50	53
Žilina, Obežná	48	47	48	49	53	42
Gánovce, Meteo. st.	62	63	64	66	67	58
Chopok, EMEP	90	87	96	93	96	52
Kojšovská hoľa	85	90	87	83	78	75
Stará Lesná, AÚ SAV, EMEP	61	67	65	63	71	56
Starina, Vodná nádrž, EMEP	58	51	59	60	64	55
Topoľníky, Aszód, EMEP	59	55	-	59	64	51

- long-term failure

In 2014, the annual average concentrations of ground level ozone in urban and industrial locations of Slovakia ranged within the interval 36 – 60 μg.m^{-3} (Tab. 3.3). The concentrations in the rest of the territory ranged between 51 and 75 μg.m^{-3}, mainly depending on the altitude. The highest annual average of ground level ozone concentrations was reached at the station Kojšovská hoľa (75 μg.m^{-3}). The year 2014, according to vegetation period averages, belongs to the photochemically less active years. Annual averages of ground level ozone concentration in 2014 were lower than in record year 2003.

In Figure 3.1, the seasonal cycle of daily ozone concentrations in Stará Lesná during 1992 – 2014 is depicted. The seasonal course is typical for lowlands and valley (not summit) positions of industrial continents. Original spring maximums of ozone concentrations, associated with the transport of ozone from upper atmospheric layers, is extended for the whole summer period, as a consequence of photochemical ozone formation in a atmospheric boundary layer.

The daily average course of ground level ozone concentration in August in Stará Lesná is depicted in Figure 3.2 (higher values for this month are mostly of anthropogenic origin). The figure documents the increase in daily maximum values of ozone concentrations about 30 – 40 μg.m^{-3} in photochemically active years (1992, 1994, 1995, 1999, 2000, 2002, 2003 and 2007) as compared to those in less favourable years.

The number of exceedances of ozone threshold values in Slovakia during 2009 – 2014 is summarised in Tables 3.4 – 3.6. The alert threshold when the public must be warned (240 μg.m^{-3}) was not exceeded in 2014 (Table 3.4). Also the information threshold to the public (180 μg.m^{-3}) was in 2014 not exceeded.

Fig. 3.1 **Seasonal variability of ground level ozone concentration in Stará Lesná during 1992 – 2014**

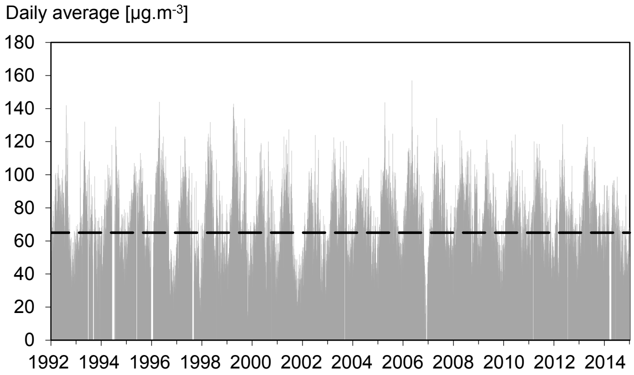
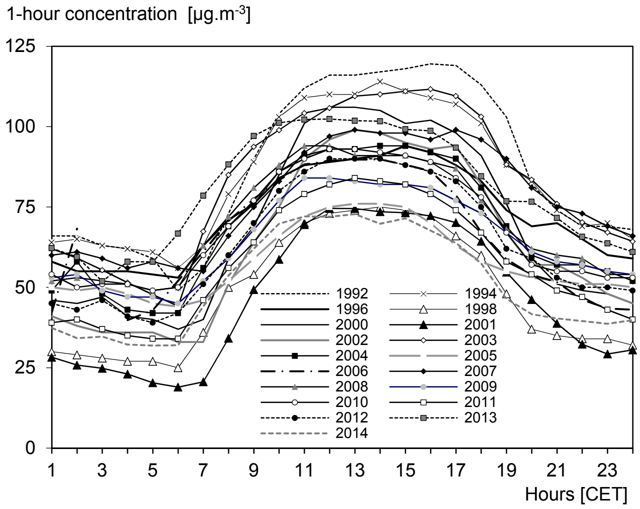


Fig. 3.2 **Average daily cycles of ground level ozone concentration in Stará Lesná, in August 1992 – 2014**



Tab. 3.4 **Number of exceedances of ozone information threshold (IT) and alert threshold (AT) to the public during 2009 – 2014**

Station	AT = 240 μg.m^{-3}						IT = 180 μg.m^{-3}					
	2009	2010	2011	2012	2013	2014	2009	2010	2011	2012	2013	2014
Banská Bystrica, Zelená	0	0	0	0	0	0	0	0	0	0	0	0
Bratislava, Jeséniova	0	12	0	0	0	0	0	39	3	0	3	0
Bratislava, Mamateyova	0	0	0	0	0	0	2	3	0	0	0	0
Humenné, Nám. Slobody	0	0	0	0	0	0	0	0	0	0	0	0
Jelšava, Jesenského	0	0	0	0	0	0	0	0	0	0	0	0
Košice, Ďumbierska	0	0	0	0	0	0	0	0	0	0	0	0
Nitra, Janíkovce	0	0	-	0	0	0	1	0	-	0	0	0
Prievidza, Malonecpalská	0	0	0	0	0	0	0	0	0	0	0	0
Žilina, Obežná	0	0	0	0	0	0	0	0	0	0	0	0
Gánovce, Meteo. st.	0	0	0	0	0	0	0	0	0	0	0	0
Chopok, EMEP	0	0	0	0	0	0	0	0	0	0	0	0
Kojšovská hoľa	0	0	0	0	0	0	0	0	0	0	3	0
Stará Lesná, AÚ SAV, EMEP	0	0	0	0	0	0	0	0	0	0	0	0
Starina, Vodná nádrž, EMEP	0	0	0	0	0	0	0	0	0	0	0	0
Topoľníky, Aszód, EMEP	0	0	-	0	0	0	0	0	-	0	0	0

In Table 3.5 is presented the number of exceedances of ozone target value for protection of human health (8 h mean 120 μg.m^{-3}) averaged over 2012 – 2014. The target value not to be exceeded on more than 25 days per calendar year averaged over three years. In 2012 – 2014 was the number of 25 days overstepped at seven monitoring stations. The highest exceedance was observed at Chopok (60 days) station.

Tab. 3.5 **Number of exceedances of ozone target value for protection of human health (8 h average 120 μg.m^{-3}) during 2012 – 2014**

Station	2012	2013	2014	Average 2012 – 2014
Banská Bystrica, Zelená	54	36	30	**40**
Bratislava, Jeséniova	48	38	20	**35**
Bratislava, Mamateyova	36	*19	16	**26**
Humenné, Nám. slobody	10	20	*0	15
Jelšava, Jesenského	-	*6	0	0
Košice, Ďumbierska	27	17	11	18
Nitra, Janíkovce	44	26	11	**27**
Prievidza, Malonecpalská	14	*10	12	13
Žilina, Obežná	34	*26	8	21
Gánovce, Meteo. st.	12	*11	5	9
Chopok, EMEP	74	46	*7	**60**
Kojšovská hoľa	38	20	*3	**29**
Stará Lesná, AÚ SAV, EMEP	14	27	0	14
Starina, Vodná nádrž, EMEP	8	21	3	11
Topoľníky, Aszód, EMEP	34	32	16	**27**

- long-term failure

** the year is not included in the average, because of the station's missing valid measurements in the summer time interval*

Table 3.6 shows AOT40 values corrected on the missing data (ANNEX III, Directive 2002/3/EC). The target AOT40 value for the protection of vegetation is 18 000 μg.m^{-3}.h averaged over five years. If five year average cannot be determined the valid data for at least three years can be used. From the table one can see, that AOT40 target value averaged over five years was overstepped at 4 stations.

Tab. 3.6 **AOT40 [μg.m^{-3}.h] (target value for the protection of vegetation is 18 000 μg.m^{-3}.h averaged over five years)**

Station	2012	2013	2014	Average 2010 – 2014
Banská Bystrica, Zelená	27585	19904	26688	**21869**
Bratislava, Jeséniova	24433	19886	*23690	**20863**
Bratislava, Mamateyova	19352	*15274	17336	17046
Humenné, Nám. slobody	13348	14790	*6116	14069
Jelšava, Jesenského	–	*6748	*8974	8635
Košice, Ďumbierska	18651	12305	15591	17871
Nitra, Janíkovce	*25400	18852	*22478	15981
Prievidza, Malonecpalská	16158	*9528	17785	15007
Žilina, Obežná	20280	*37306	14965	17357
Gánovce, Meteo. st.	11959	*14697	13600	14419
Chopok, EMEP	30899	*24263	*22647	**27143**
Kojšovská hoľa	20363	12935	*16676	**20589**
Stará Lesná, AÚ SAV, EMEP	12737	14132	6880	12446
Starina, Vodná nádrž, EMEP	9429	12552	11568	9799
Topoľníky, Aszód, EMEP	14984	21587	18024	17875

- long-term failure

** the year is not included in the average, because of the station's missing valid measurements in the summer time interval*

It may be stated in conclusion, that in the extremely warm, dry and photochemical active year 2003 the highest values of the most ground level ozone indicators in Slovakia were observed from the beginning of observations (since 1992). This reality is to some extend surprising taking into account a massive decrease of anthropogenic precursor emissions (NOx, VOC and CO) in Slovakia (already below Gothenburg ceilings) and in Europe as well during the last 10 – 20 years. It documents the large share of "uncontrollable" ozone at the territory of Slovakia. Downward mixing, long-range transport (including intercontinental transport), formation of ozone from biogenic precursors and climate change apparently play much more significant role as was previously assumed. The ground level ozone over Slovakia is mostly of advective origin. This conclusion demonstrates the limitations of national ozone mitigation strategy. One of the conclusions the European TOR2 project (ended in 2003) is proposal to shift the ground level ozone problem among global issues, for example into Kyoto Protocol. The level of surface ozone concentrations indicators in Slovakia in 2014 was in average below the 2003 level.

3.3 TOTAL ATMOSPHERIC OZONE OVER THE TERRITORY OF THE SLOVAK REPUBLIC IN 2014

Since August 1993 total atmospheric ozone over the territory of Slovakia has been measured with the Brewer ozone spectrophotometer MKIV #097 in the Aerological and Radiation Centre (ARC) of the Slovak Hydrometeorological Institute (SHMÚ) at Gánovce near Poprad (49º02'N, 20º19'E, 706 m a.s.l.). As well the solar UV spectral intensity is regularly scanned at 0.5 nm increments. Since September 2014 after more sophisticated Brewer spectrophotometer MKIII installation the measured spectral area has been extended to 286.5 – 363 nm. Poprad-Gánovce station is a part of the Global Ozone Observing System (GOOS). The results are submitted to the World Ozone Data Centre (WOUDC) in Canada and to the WMO Ozone Mapping Centre in Greece. Poprad-Gánovce station is included to Global Atmosphere Watch (GAW) network for total ozone and solar UV spectral radiation.

Information about the ozone layer state and intensity of harmful solar UV radiation is provided daily to the public by TV, radio, the press and mobile phone services. Since April 2000 the SHMÚ Aerological and Radiation Centre has been providing 24 hour UV Index forecast for the public. Predicted UV Index for selected altitudes and its daily course for Poprad-Gánovce coordinates is presented for clear sky, half covered sky and overcast condition on the SHMÚ internet site: (www.shmu.sk/ozon/) from March 15 to September 30.

The annual mean of the total atmospheric ozone was 330.2 Dobson Units in 2014. This is 2.4% below the long-term average (calculated upon the Hradec Kralove measurements in the period 1962 – 1990).

Since 1994 annual means measured at Poprad-Gánovce station have been available. The 1994 – 2014 long-term average is 327.1 Dobson units. In the mentioned period a deviation of the annual mean in the year 2014 was +0.9%.

Total ozone statistics for the year 2014 (daily means, relative deviations from long term average, monthly means, standard deviations and extremes) are in Table 3.8. Positive differences from the long-term average were in January (+1%) and December (+4%) only. The most significant negative differences were in March (–10%) and April (–5%). In other months differences fitted in the interval of –3% to 0%.

Total ozone weekly averages are shown in Figure 3.3. The graph illustrates the total ozone amount in the year 2014 with respect to long-term mean values and shows significant short-term variations in total column ozone in our geographical region.

Solar ultraviolet (UV) radiation has many biological effects. If UV dose exceeds critical limits for some biological processes it can be very harmful. An active band of wavelengths in range of 290 – 325 nm which is significantly influenced by the total ozone amount in the atmosphere is indicated as UV-B radiation. The wavelength-depending weighting factor is applied on the spectral irradiance to calculate the effective UV-B irradiance causing a particular biological effect. The CIE Erythemal action spectrum is most frequently used to express a detrimental effect on human health. McKinlay and Diffey derived the erythemal action spectrum in 1987. It is internationally accepted and indicated as the CIE (Commission Internationale de l´Eclairage). All values of solar ultraviolet radiation shown in this text and graphs are modified by the CIE erythemal action spectrum.

Figure 3.4. shows the biologically effective irradiance (in units of mW.m^{-2}). Values have been measured at local noon (about 10:39 UTC) when the daily maximal solar elevation is achieved. Daily UV-B maximum on clear sky days should be measured around local noon. A significant variability of values demonstrates the weather condition (especially cloudiness) influence. As the UV irradiance depends on the solar elevation it has a distinctive daily and annual course. Noon UV-B irradiances are more than 10-times lower in winter as compared to summer. Comparable attenuation is also caused by cloudiness and precipitation in summer. The annual course is not symmetrical by solstices after filtering of cloud and aerosol influence. Decreasing phase in annual course of total ozone causes shift in occurrence of the highest UV irradiances toward period after the summer solstice to the last decade of June and early July. Solar UV irradiances observed before summer solstice are lower than those ones measured after the summer solstice by the same solar elevation, cloud and aerosol attenuation due to typical annual course of the total ozone.

Fig. 3.3 **Total atmospheric ozone over the territory of Slovakia in 2014**

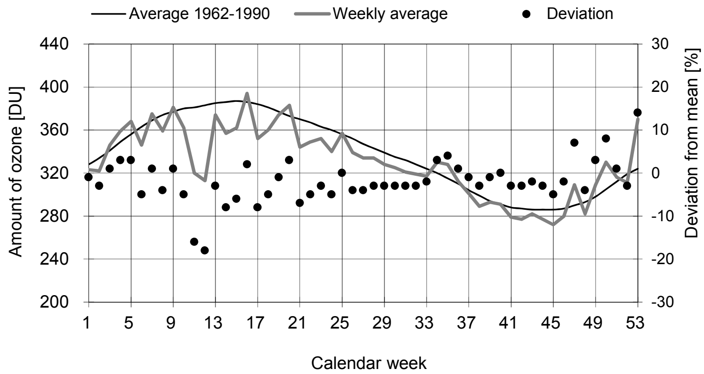
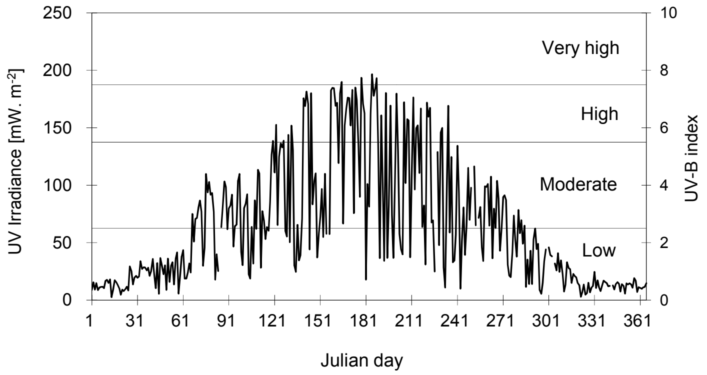


Fig. 3.4 **Annual course of CIE effective irradiance and UV index noon values – Gánovce 2014**



The UV Index is also shown in Figure 3.4. It is a unit to simplify expression of the UV irradiance level relevant to the erythemal effect on human skin and has been standardised by relationship: 1 UV Index = 25 mW.m^{-2} of UV irradiance modified by CIE erythemal action spectrum. Its values are used to express a recommended sunburn time. Individual sunburn time has to be modified depending on skin type and skin adaptation by producing melanin. Values over 5 attained in spring and summer months are classified as high. The sun exposure without protection should be limited to several minutes. Values below 3 attained from October to March are classified as low. Sunburn time over one hour is not dangerous even if the ozone layer is attenuated. The only protective tool should be glasses. However considerably high UV-B radiation doses are relevant in snowy high mountain positions at the beginning of spring. Practical unit to describe a quantity of the erythemal ultraviolet radiation is Minimal Erythemal Dose (MED). 1 MED is defined as the minimal UV dose that causes a reddening of previously unexposed human skin. However, because the sensitivity of human individuals depends on skin type, the relationship between MED and physical units has been defined for the most sensitive skin type. Irradiance 1 MED/hour corresponds to 0.0583 W.m^{-2} for the dose 1 MED = 210 J.m^{-2}. More information about total ozone, solar UV radiation and the protection against a harmful solar radiation are available on the SHMÚ internet site.

Tab. 3.7 **Total atmospheric ozone in Dobson units [DU] and its deviations [%] from long-term average at Poprad-Gánovce in 2014**

Day	I		II		III		IV		V		VI		VII		VIII		IX		X		XI		XII	
	O_3	Dev	O_3	Dev	O_3	Dev	O_3	Dev	O_3	Dev	O_3	Dev	O_3	Dev	O_3	Dev	O_3	Dev	O_3	Dev	O_3	Dev	O_3	Dev
1	320	-2	350	-2	359	-5	352	-9	341	-11	351	-4	348	0	319	-4	322	3	286	-2	267	-6	286	-3
2	301	-8	344	-4	390	3	357	-8	337	-11	367	1	328	-6	327	-1	308	-1	308	6	257	-10	319	7
3	331	1	352	-2	392	3	360	-7	365	-4	357	-2	347	0	331	0	318	2	296	2	259	-9	308	4
4	316	-4	343	-5	382	1	362	-6	385	1	364	0	317	-9	311	-6	315	2	299	3	265	-7	316	6
5	348	6	350	-3	384	1	351	-9	379	0	361	-1	324	-6	320	-3	309	0	297	2	247	-14	310	4
6	309	-7	359	-1	375	-1	358	-8	374	-1	345	-5	328	-5	328	0	312	1	294	2	268	-6	313	4
7	289	-13	324	-11	357	-6	359	-7	370	-2	339	-6	313	-9	330	1	299	-3	289	0	296	3	309	3
8	314	-6	329	-10	306	-20	353	-9	392	4	331	-9	320	-7	326	0	291	-5	269	-7	306	7	329	9
9	350	5	364	-1	339	-11	375	-3	375	0	324	-10	336	-2	308	-6	289	-6	270	-6	261	-9	333	10
10	331	-1	345	-6	321	-16	381	-1	371	-1	329	-9	330	-4	307	-6	310	1	275	-4	271	-6	328	8
11	312	-7	356	-3	330	-13	358	-8	356	-5	332	-8	346	1	306	-6	316	4	277	-4	275	-4	311	2
12	352	5	374	1	301	-21	357	-8	388	3	331	-8	344	1	302	-7	310	2	278	-3	275	-4	325	6
13	316	-7	354	-4	288	-25	353	-9	387	3	335	-7	346	1	300	-8	287	-5	267	-7	289	0	300	-2
14	345	2	432	17	307	-20	392	2	394	5	366	2	335	-2	308	-5	304	1	276	-4	275	-4	386	26
15	388	14	358	-3	366	-4	403	4	397	6	365	2	335	-2	327	1	293	-3	279	-3	285	-1	323	5
16	339	-1	402	8	329	-14	407	5	366	-2	365	2	338	-1	345	7	294	-2	284	-1	292	1	328	6
17	345	1	378	1	273	-29	388	1	373	0	362	1	330	-3	329	2	294	-2	279	-3	325	12	335	8
18	348	1	368	-1	281	-27	374	-3	378	2	363	2	324	-4	331	3	295	-1	295	3	316	10	296	-5
19	344	0	381	2	310	-19	370	-4	375	1	354	0	323	-4	319	-1	288	-4	258	-10	343	18	283	-9
20	378	9	367	-2	303	-21	406	5	359	-3	359	1	311	-8	331	3	282	-5	246	-14	314	8	304	-3
21	353	2	345	-8	318	-17	372	-3	342	-8	352	-1	307	-9	340	6	282	-5	263	-8	288	-1	341	8
22	389	12	341	-9	353	-8	363	-6	323	-13	344	-3	329	-2	322	1	298	1	296	3	297	2	303	-4
23	341	-2	336	-11	356	-7	352	-9	326	-12	347	-2	323	-4	323	1	320	8	295	3	281	-4	253	-20
24	391	12	344	-9	405	5	339	-12	353	-4	342	-3	338	1	343	8	264	-11	296	3	281	-4	265	-17
25	364	4	415	10	446	16	348	-9	327	-11	338	-4	324	-3	352	11	291	-1	289	1	296	2	290	-9
26	294	-17	389	3	392	2	344	-10	332	-10	358	2	329	-2	329	4	315	7	288	1	290	-1	343	7
27	338	-4	364	-4	378	-2	344	-10	342	-7	330	-6	329	-1	330	5	282	-4	269	-6	274	-6	345	8
28	390	10	407	8	359	-7	357	-7	352	-4	331	-5	319	-4	344	9	278	-5	268	-6	272	-8	376	17
29	399	12			319	-17	377	-1	362	-1	328	-6	317	-5	316	0	276	-5	292	2	262	-11	398	23
30	382	7			323	-16	361	-5	354	-3	348	0	313	-6	315	0	278	-5	288	1	296	0	398	23
31	371	4			359	-7			350	-4			320	-3	313	0			295	3			315	-3
∅	345	1	363	-2	345	-10	366	-5	362	-3	347	-3	328	-3	324	0	297	-1	283	-2	284	-2	322	4
Std	30	7	26	6	40	11	18	5	21	5	14	4	11	3	13	5	15	4	14	5	21	7	34	10
Max	399	14	432	17	446	16	407	5	397	6	367	2	348	1	352	11	322	8	308	6	343	18	398	26
Min	289	-17	324	-11	273	-29	339	-12	323	-13	324	-10	307	-9	300	-8	264	-11	246	-14	247	-14	253	-20

O_3 - *total ozone* Dev - *relative deviation from long-term mean (Hradec Králové 1962 – 1990)*
Std - *standard deviation [DU]*

Continuous measurements of the UV radiation have been performed with the broadband UV-Biometers in parallel with discrete spectral Brewer spectrophotometer measurements. Spectral response function of the UV-Biometer is close to CIE-erythemal action spectrum. Stability of the operational UV-Biometers has been checked by regular comparison with the reference UV-Biometer calibrated towards the Brewer spectrophotometer. That procedure ensures compatibility of UV-Biometers and the Brewer spectrophotometer UV radiation measurements. UV-Biometers enable to register the UV irradiances more densely (every 10 s) than with the Brewer spectrophotometer. The 1 min averages of the integral CIE-erythemal UV irradiance have been stored. More frequent recording of the UV radiation enables to determine more realistic daily maxima and daily doses, especially during cloudy days. All UV radiation characteristics below are obtained from UV-Biometer measurements.

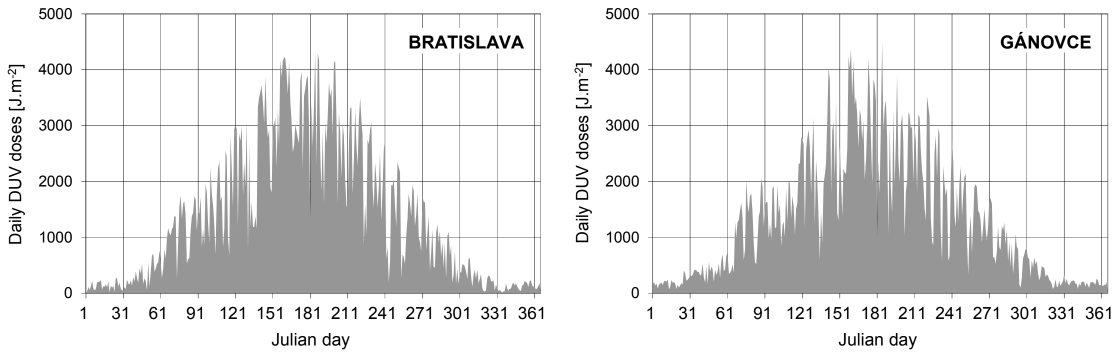
The biggest 1 min average of the CIE-erythemal UV irradiance of 204.8 $mW.m^{-2}$ (3.51 $MED.h^{-1}$) was registered in Bratislava (48º10'N, 17º06'E, 304 m a.s.l.) on June 26. The biggest 1 min average of the CIE-erythemal UV irradiance of 205.3 mW/m^2 (3.52 $MED.h^{-1}$) was registered at Poprad-Ganovce on June 22.

The biggest hourly average of the CIE-erythemal UV irradiance of 176.8 $mW.m^{-2}$ (3.03 $MED.h^{-1}$) was registered in Bratislava on June 26. The biggest hourly average of the CIE-erythemal UV irradiance of 185.5 $mW.m^{-2}$ (3.18 $MED.h^{-1}$) was registered at Poprad-Ganovce on July 4. Deviation of the daily total column ozone from the long-term average was –9% on that day.

Daily doses of the CIE-erythemal UV radiation are presented in Figure 3.5. Maximum daily dose of 4304 J.m^{-2} (which correspondents to 20.5 MED) was measured in Bratislava on July 6. Deviation of the daily total column ozone from the long-term average was –5% on that day. Maximum daily dose of 4507 J.m^{-2} (21.5 MED) was measured at Poprad-Ganovce on July 4.

In the period April-September 2014 total CIE-erythemal UV radiation dose in Bratislava was 426 128 J.m^{-2}. This value is 7.9% lower than the dose in 2013. Total CIE-erythemal dose at Poprad-Ganovce was 395 898 J.m^{-2} for the same period. This value is 9.6% lower than the dose in 2013. Low doses in 2014 were caused by big number of days with short sunshine duration and frequent precipitations. During that period the number of sunshine hours was in Bratislava by 8.7% and in Poprad-Gánovce by 13.8% lower than in the same period in 2013.

Fig. 3.5 **Annual Course of CIE effective UV radiation Daily Doses in 2014**



4

EMISSION AND AIR POLLUTION SOURCE INVENTORY

4.1 EMISSION AND AIR POLLUTION SOURCE INVENTORY

Anthropogenic emissions of pollutants in the atmosphere cause many present and potential problems, such as acidification, ambient air quality deterioration, global warming/climate change, destruction of buildings and constructions, disruption of ozonosphere.

Quantitative information on these emissions and their sources are necessary requirements for:

- Decision making process of the responsible bodies.
- Information service for experts and public.
- Definition of environmental priorities and identification of causes of problems.
- Assessment of environmental impact on different plans and strategies.
- Assessment of environmental costs and benefits on different approaches.
- Monitoring of effects, respective effectiveness of adopted measures.
- Support by agreement with adopted national and international commitments.

STATIONARY SOURCES

In the period 1985 – 1999 information related to stationary sources of air pollution was compiled according to the Act 35/1967 Coll. on air in the EAPSI (Emission and Air Pollution Source Inventory) system. This system was divided by the heating output into 3 subsystems:

EAPSI 1............. Stationary sources of the heating output over 5 MW and selected technologies (updated annually)

EAPSI 2............... Stationary sources of the heating output 0.2 – 5 MW and selected technologies

EAPSI 3............... Stationary (local) sources of the output below 0.2 MW (consumption of fuels for inhabitants)

The changes in the air protection legislations in the 90's raised requirements to create entirely new tool for the evidence of stationary sources of air pollution. Development of the new system, so-called NEIS – National Emission Inventory System, started in year 1997 in the frame of project of the Ministry of Environment in coordination with Slovak Hydrometeorological Institute (SHMÚ) and close cooperation with the regional offices, district offices and selected operators. The NEIS, a multi-modular system, follows requirements of current air protecting legislation and it is based on annual update cycle. Module NEIS BU enables complex data collection and data processing in respective of district offices, as well as the logical verification of emission calculation from the operator's input data. It also serves as a base tool in decision making for determination of pollution charge value. Data acquisition is carried out by a set of printed questionnaires or by the software module NEIS PZ. This module was created for the operators. It enables besides processing of the input data electronically also the emission calculation. Operator's databases are sent to the corresponding district office, where they are imported to the local district NEIS BU database. Subsequently, data from the district databases is fed into the NEIS CU central database at SHMÚ, where the following control is carried out. The NEIS uses the support of standard database products MS ACCESS and MS SQL server.

The function of the system was attested during preliminary testing in the selected regions within all area of the Slovak Republic and the system was accepted by cross-sectoral operative committee.

The NEIS system underwent extensive changes within 2004 – 2005 as a result of implementation of the Decree of Ministry of Environment of the SR No. 61/2004 Coll. In this context, the system has been renamed to National Emission Information System (NEIS). Archiving of the documents issued by district offices has started within the system. Data acquisition was extended also in terms of transposing EU policies and measures into national legislation (VOC sources, waste incineration, service stations and terminals a. o.)

Positive contribution of database NEIS

- Homogeneous system of data processing about sources and their emissions at local, regional and national level.
- Provision of an actual and effective tool to all primary data processors providing uniform level of acquisition, processing, control and verification of data about the sources and their emissions.
- Enhance the transparency of procedure to concede the quantity of emissions by operators of the sources and thus pay taxes for air pollution owing to the built-in control system as well as necessity to provide the input data into the NEIS database exclusively in coincidence with the legislative regulations.
- Establishment of a Slovak national database that enables optimal task fulfilment throughout all levels of the top state administration bodies and provides the input data for international emission inventories, respectively compilation of special emission inventories.
- Availability of information on the Internet website www.air.sk.
- Establishment of the air pollution operators and sources documents archive.

The comparison of the EAPSI and NEIS systems

Changes in the air protection legislation carried out within 1990 – 2000 (e.g. identification/delimitation and definition of sources, change in categorization of sources and their division according to the output or capacity) caused that the EAPSI system is currently comparable with the NEIS module only at the national level. Comparison of the individual parts of EAPSI (1 and 2) with the NEIS module (large, medium-size sources), respectively comparison of individual sources in both systems is difficult.

According to the Act 137/2010 Coll. (§ 15, section 1, chapter e) as amended, the district offices are (according to the § 26, section 3, chapter g,m) obliged to elaborate yearly reports about the operational characteristics of the air pollution sources in their district and provide them electronically by 31st May of the current year at the latest in order to additional processing by SHMÚ, the organization accredited by the Ministry of Environment to manage the central database NEIS CU and provide the data processing at the national level.

The NEIS system includes the sources of air pollution, which are assigned according to the category and input (Decree No. 410/2012 as amended):

Large stationary sources	Technological units containing combustion plants having total rated thermal input more than 50 MW and other technological units with a capacity above the defined limit.
Medium stationary sources	Technological units containing combustion plants having total rated thermal input between 0.3 – 50 MW and other technological units with a capacity under the defined limit for the large sources but over the defined limit for the medium sources.
Small stationary sources	Domestic heating equipment for combustion of solid fuels and natural gas with total rated thermal input less than 0.3 MW.

Results (1990 – 2014) – evaluation

Large sources

EAPSI 1 The EAPSI 1 database has been represented by a coherent set of data since 1990 – 1999. In the year 1999, the 967 air pollution sources, i.e. technological units owned by an operator, defined by the code of the area-administrative unit and the serial number. For each of these units, the data about quantity, type and quality of fuel consumed, technical and technological parameters of combustion and separation technique are updated annually. Using these data, the emissions of CO, NO_x, SO_2 and particulate matter for the individual sources are calculated by using the emission factors. Since 1996, these values for selected sources have been substituted by the data provided by the operators using the recalculations from the results of measurements. Emission data from technologies are provided by the individual sources based on their own findings. Emissions from combustion processes and technologies of individual sources are further summarised at the level of area administrative units. Sources registered in EAPSI 1 are provided by the geographical co-ordinates, which enable the projection of them in a geographical information system.

NEIS Since 2000 the gathering of the selected data on sources and their emissions has been provided in the NEIS. The system contained 902 (735 of it in operation) large point sources in 2014. As the sources of 5 MW and above were included to the evidence of large point sources in the EAPSI system, the comparison of numbers of sources in both systems is not possible.

Medium sources

EAPSI 2 Updating of EAPSI 2 data is carried out in several-year cycle. Inventory and acquisition of data from individual sources were carried out continuously. Summarising was carried out in 1985 and 1989. However, the number of sources registered in EAPSI 2, was growing to such an extent, that the data are not comparable. The third updating was carried out in cooperation with the Offices of Environment within the period 1993 – 1996 and ended in December 1996.

NEIS Since 2000 the data updating in the NEIS system has been provided each year. In 2014, NEIS registered 12851 (10553 it in operation) medium sources. System EAPSI 2 registered only sources of heating output 0.2 – 5 MW and therefore to compare the number of sources in the individual systems is not possible.

Small sources

EAPSI 3 NEIS The emission balance is being processed in the system NEIS CU and is based on the data about the selling of solid fuels for households and retail users (years 2001 – 2003 according to the Decree No. 144/2000, since 2004 according to the Decree No. 53/2004, since 2010 according to the Decree No. 362/2010), consumption of natural gas for the inhabitants (register of SPP, a.s.) and specified emission factors. Local furnaces are assessed as the areal sources on the level of district. In 2004, the emission balance has been revised[1] following the emission recalculation since 1990. Within the revision the emission factors were updated (in coincidence with the valid legislation of air protection) as well the qualitative features of solid fuels (in sense of OTN ZP 2008) and the wood combustion emissions were additionally recalculated as its consumption have not been included in the balance before 2004. In the past the balance has not been carried out regularly (EAPSI 3 system had been updated annually only until 1997), in the missing years the data have been additionally calculated. In such a way the consistent data time series since 1990 have been obtained.

[1] *Balance of the air pollution small sources in the Slovak Republic, Profing 2003*

MOBILE SOURCES

The emissions from category 1.A.3 Transport include subcategories International aviation (1A3ai), Domestic aviation (1A3aii), Road transport (1A3b), Railways (1A3c), International inland waterways (1A3di), National navigation (1A3dii) and Pipeline transport (1A3ei). The emissions of pollutants from other mobile sources are included in Road transport. In this publication, the emissions from Road transport are reported as “Road transport” (RT) and sum of emissions from aviation, railways, navigation and pipeline transport are reported as “Other transport” (OT). Transport has very special position in the energy sector, as it is not included in any legislative regulations, emissions in this category are very difficult to regulate. During recent years the shift from a public transportation to individual passenger cars has been observed. The level of transit transport (HDV) has been increased at the same time. The consumption of fuels in railways is decreasing continuously, while the consumption of fuels in road transportation is sharply increasing.

In 2015, the emissions from the pipeline transport were calculated from 2000 onwards. These emissions were included in “Other transport” (OT) in this report.

In September 2010, the amendment of the national Directive No 362/2010 Coll. that laying down the requirements for the quality of fuels and maintenance of fuel evidence took into force. The content of sulphur in the fuels declined from original 50 mg/kg of fuel to new value of 10 mg/kg of fuel. As a results of the QA/QC process in this category in 2015, the emission factor of SO_X for diesel for the rail transport has been modified in order to reflect the legislative changes and recalculations of SO_X emissions has been performed in the category 1A3c (Railways) for the years 2011 and 2012 and in the categories 1A3b (Road transport) for the years.

VOC emissions in category 1A3bv road transport were improved for the gasoline evaporation and estimated by the model COPERT for the years 2011 onwards.

The Slovak Republic was using the tier 1 methodology for the emissions estimation in aviation, for all relevant pollutants for the time series 2001-2004. This methodology was based on numbers of LTO cycles. These categories are not key categories. In the absence of national data on the exact numbers of domestic and international LTO cycles (only total numbers of LTO cycles is available), the total aviation emissions are reported in Domestic aviation. The numbers of LTO cycles are known from the important Slovak airports (Bratislava, Kosice, Poprad, Sliac, Piestany and Zilina). The airports are managed by the Slovak Management of Airports, except for the airport in Zilina, where exercises with light aircrafts of the Zilina University predominate. Other smaller civil airports (Nitra, Prievidza, Ruzomberok, Lucenec) are operated by aero-clubs with predominating character of sport flights. Emissions estimation was calculated based on data directly provided by the individual airports based on detailed statistics on LTO cycles, aircrafts type, their weights and type of engines. Described approach is maintained for a time series from 2001 to 2004. For time series 2005 – 2014 were used EUROCONTROL data on the number of flights, fuel consumption and division of domestic and international flights. For the years 2005 – 2014 Slovakia decided to proceed to use the data from EUROCONTROL in this submission. The decision follows an analysis of the national data and data obtained from Eurocontrol and the approval by the Ministry of Transport. The data is available on the basis of work of the EEA in collaboration with EUROCONTROL and DG CLIMA. These aggregated national fuel and emissions data is calculated by EUROCONTROL using a Tier 3 methodology applying the Advanced Emissions Model (AEM). For time series 2005 – 2014 were used EUROCONTROL data on the number of flights, fuel consumption and division of domestic and international flights. The emissions of NO_X, SO_2, PMs and CO were taken from Eurocontrol file for LTO and Cruise and reported in Domestic and International Aviation. The emissions of NMVOC were calculated using the EUROCONTROL date on fuel consumption of Aviation Gasoline and Jet Kerosene for LTO and Cruise phase and on numbers of LTO. The used emission factors of NMVOC are in according with EMEP/EEA emission inventory guidebook 2013. For the years 2000 – 2004, we did not received better and more accurate data and that is why we did not recalculated these years.

Software program COPERT 4 has been used for balance calculation of road transport emissions. Since 2008 COPERT 4 is approved and recommended by Executive Committee the UNECE Convention on Long-Range Transboundary Air Pollution. The calculation of emissions from the road transport sector in Slovakia for the year 2013 has been provided in the COPERT 4 version 9.0. Applied input data was activity data such as numbers of vehicles for each category defined in program COPERT 4 and average annual mileage in each category of vehicles. Emissions were calculated according to fuel type as well as vehicle type. Additional input data was levels of pollutants in fuels (gasoline, diesel, LPG, CNG) and fuel consumption including the share of bio-fuels. Model COPERT v.9.0 takes into account the share of biofuels in the energy consumption of different types of vehicles. However, model COPERT does not count Total Suspended Particulates (TSP) from abrasion of tires and brakes neither it does not provide any solid particles from road abrasion. Therefore these missing emissions were calculated separately from the traffic performance in fleet mileage (detected from the COPERT from numbers of vehicles and annual mileage) and emission factors Tier 1 set out in EMEP/EEA air pollutant emission inventory guidebook to complete emission balance.

Railways transport represents the operation of diesel traction using the simple methodology tier 1 according to the EMEP/EEA emission inventory guidebook 2013. The emissions of the pollutants are calculated from the consumed fuels by diesel rail traction multiplied by the appropriate emission factor. The consumption of diesel oil for the motor traction in the Slovak Republic was obtained from the Railways Company, Ltd. for the whole time series. It is assumed that the consumption of diesel oil in motor traction of railways transportation is equal to the diesel oil sold for the railways. The mobile sources of pollution in the railways transport include vehicles of motor traction of the Railways Company Ltd. of the Slovak Republic (ZSSK). This motor traction is divided into 2 basic groups of vehicles: motor locomotives (Traction 70) and motor wagons (Traction 80). The motor traction has been operated by 4 depots in the organizational structure of the Railways Company Ltd. since 2002 (Bratislava, Zvolen, Žilina and Košice). Fuel consumption of the new companies operated on the Slovak rails (REGIOJET) are also included in inventory.

The subcategory National navigation includes emission from shipping between ports on Danube River. This activity represents movements of ships between Slovak ports (Bratislava, Devin and Komarno). The emissions of pollutants are calculated based on fuel consumption. The numbers of movements are used to the model of calculating fuel consumption. The emission factors for off-road transport are used to calculated emissions of pollutants in this category. Because of lack of information on division to domestic and international movements, the total emissions from Danube River are reported under National navigation.

The emissions in the category Pipeline transport are obtained directly from the NEIS database.

4.2 DEVELOPMENT OF TRENDS IN BASIC POLLUTANTS

EMISSIONS OF BASIC POLLUTANTS

Trends in basic pollutants compiled in systems EAPSI and NEIS are listed in Tables 4.1a,b and Figures 4.1 and 4.2.

Particulate matter

Emissions of particulate matter (PM) have been decreasing continuously since 1990. This was caused by the change of the fuel base in favour of high-grade fuels, as well as the improvement of fuel quality characters used and a further spreading of separation techniques used, respectively advancing of its effectiveness. Increase of PM emissions in 2004 and 2005 was caused by the extended wood consumption in the sector small sources (heating households) as a result of growing retail price of natural gas and coal. The decrease of PM emissions in 2006 was achieved mainly by reconstruction of separators in some sources in energy and industry (power plant Slovenské elektrárne, a.s. plant Nováky, U.S. Steel s.r.o. Košice). Another decrease of the PM emissions in 2007 was mostly caused by the power plant Slovenské elektrárne, a.s. in Vojany, of which two low-ecological blocks were terminated. Since 2008, the trend of PM emissions is stable. A slight increase in PM emissions in 2011 occurred in the sector of small sources - households, where the consumption of firewood increased at the expense of natural gas. In years 2012 – 2014 was only an insignificant increase of emissions.

SO_2

The downward trend of SO_2 emissions up to year 2000 was caused by the decreasing consumption of brown coal, hard coal, heavy fuel oil (Slovnaft a.s., Bratislava replaced it with low-sulphur fuel oil). On the decreased emission was significantly contributing the installation of desulphurisation systems in large power sources (power plants in Zemianske Kostoľany and Vojany). The fluctuations of SO_2 emissions within 2001 and 2003 were caused either by their partial or total operation, or by the quality of combusted fuel and volume of production of energetic sources. In 2004 till 2006 another decrease of SO_2 emissions was recorded. This decrease was caused mainly by the combustion of low-sulphur-content fuel oils and coal (Slovnaft a.s. Bratislava; TEKO a.s. Košice) and by the reduction of production volume (power plants in Zemianske Kostoľany and Vojany). Considerable decrease of SO_2 emission of about 77% was observed in road transport category in 2005. This decrease, contrary to the increase in consumption of fuel substances was caused by the implementation of measures referring to the content of sulphur in fuel substances (Decree No. 53/2004). Another decrease of SO_2 emissions in 2007 was mostly caused by the power plant in Vojany, of which two outdated blocks were terminated. Since 2008, the trend of SO_2 emissions is stable. Minor increase of SO_2 emissions from the large sources in 2010 of 8% was caused by the increase of brown coal consumption in Slovenské elektrárne - power plant Nováky, and by the slightly increase of sulphur-content in this fuel. The reduction of SO_2 emissions in 2012 of 14.6% was mainly due to installation of a new desulphurisation unit in the heating plant CM European Power Slovakia, s.r.o. Bratislava. On the reduction was also contributing Slovenské elektrárne, a.s., plant Nováky, where was operated only one boiler. Another decrease in 2013 of 9.5% was caused by residential combustion (less amount of combusted brown coal) and large combustion plants CM European Power Slovakia, s.r.o. Bratislava (lower output concentration of SO_x) and Slovenské elektrárne, a.s., plant Nováky (lower S-content in combusted coal). Decrease of emissions continues in 2014: the record high average temperature influenced the consumption of solid fuels in households. With lowering SO_2 emissions in Slovenské elektrárne a.s., plant Nováky, has decreased the share of this plant on the national emissions of 5% in comparison with the share in previous year.

Oxides of nitrogen

Emissions of nitrogen oxides have showed a smooth decrease since 1990, although in the years 1994 – 1995 they increased slightly in order to the increase in consumption of natural gas. A decrease of emissions of NO_x since 1996 was caused by the change of emission factor, taking into consideration the resent condition of technique and technology in combustion processes. Since 1997, the decrease in solid fuel consumption has led to a further decrease in NO_x emissions. In the further emissions decrease in years 2002 and 2003 participated the denitrification process (power plant Vojany). This decline is related to the reduction of production (power plants in Zemianske Kostoľany and Vojany) and consumption of natural gas (Slovenský plynárenský priemysel – preprava a.s., compressor stations Nitra and Veľké Zlievce). Significant decline of NO_x emissions was achieved in mobile sources, mainly in the road transport. This decrease is connected to the renovation of rolling stock in case of both passenger and good vehicles, and to the use of more accurate emission factor. Significant decrease of emissions in 2009 was mainly due to decrease in iron, steel and magnesite sinter production as a result of economic recession (U. S. Steel Košice, s.r.o., Slovenské magnezitové závody a.s.). Another decrease was occurred in 2012 by the significant reduction in the amount of transported natural gas in pipeline compressor stations operated by eustream, a.s. In 2013 was only an insignificant decrease of emissions. The record high average temperature in year 2014 has impact on the consumption of natural gas in households, therefore the emissions of NO_x are clearly lower.

CO

The downward trend in CO emissions since 1990 has been caused mainly by the decrease in consumption and by the change of composition of fuel combusted by retail consumers. Carbon monoxide emissions from the large sources have been slightly decreasing as well. The iron and steel industry participate most significantly in the total CO emissions, therefore the emission trend is following the iron and steel production volume. 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 2002 is also affected by the quantity of pig iron production as well as the fuel consumption. In 2003 the CO emissions slightly increased mainly at large sources (the CO emissions specified by continuous measurement in U.S. Steel s.r.o., Košice). In 2005 the decrease of CO emissions was mainly caused by cutting down the agglomerate production. 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. Decrease of emissions in 2006 was mainly due to increase of steel and pig iron production. Significant decrease of 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. 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 and 2011 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. Whereas in years 2012-2013 was only insignificant decrease in emissions, in year 2014 raised the agglomerate production in facility U.S. Steel Košice by 20%, this reflects the higher CO emissions.

EMISSIONS OF OTHER POLLUTANTS

The Slovak Republic is bound by the Convention on Long Range Transboundary Air Pollution (1979) to provide inventory of the selected pollutants. The emission inventories of non-methane volatile organic compounds (NMVOC), heavy metals (HMs), persistent organic pollutants (POPs) and particulate matters with aerodynamic diameter less than 10 or 2.5 µm (PM_{10} and $PM_{2.5}$) are processed in accordance with the international methodology using the NFR (Nomenclature for Reporting). Emissions at national level are prepared in cooperation with the external experts and balanced on the base of activity data multiplied by the emission factors and by use of NEIS database. Emissions of abovementioned pollutants as well as the other basic pollutants are transformed into the NFR system.. The last update of sectoral codes was performed in 2014 when the shift from version NFR09 to NFR14 was carried out internationally. This change allowed to separate particular activities into individual categories. Reporting is in line with recommendation of international working group TFEIP (Task Force on Emission Inventories and Projection) as well as in accordance with the recommendation from Review process performed by the international ERT team. Data are annually reported electronically via web tool CDR (Central Data Repository) of EIONET (European Environment Information and Observation Network) to the UNECE secretariat and EEA. Methodological changes in the current annual cycle 2016 (reported years 2014 and earlier) brought wider use of NEIS database, especially for these pollutants. Sectoral approach for inventory enabled the elaboration of more detailed balances for individual NFR categories and the allocation of emissions for specific activities. The key aspect was a review of the categorization of sources to the relevant NFR category and removal of individual underestimation of the reported activities in all sectors.

NMVOC Emission inventory of non-methane organic compounds (NMVOC) is elaborated according to EMEP/EEA (Air Pollutant Emission Inventory Guidebook). The overview of individual sector share in per cents is given in table below.

Sector share in national total [%]	Energy	Combustion in industry	Transport	Other - households, commercial, aff	Fugitive	Industry	Solvents	Agriculture	Waste
2001	2.36	1.79	14.18	7.55	8.31	4.26	37.01	18.63	5.91
2002	2.36	1.57	13.16	6.56	7.73	4.11	39.49	18.77	6.25
2003	2.30	1.57	12.08	6.96	7.52	4.06	40.62	18.44	6.46
2004	3.13	1.64	11.15	7.81	7.51	3.01	41.71	16.98	7.06
2005	1.96	2.44	10.89	10.39	7.42	2.22	41.59	17.42	5.68
2006	2.39	1.56	9.10	9.62	6.75	1.96	44.24	15.78	8.60
2007	2.36	1.78	7.94	10.27	6.59	2.15	45.80	16.09	7.02
2008	1.41	2.17	8.19	11.10	6.65	2.64	46.14	15.60	6.09
2009	1.55	2.03	7.66	11.65	6.95	2.31	44.43	17.60	5.82
2010	1.35	2.03	6.52	12.58	6.77	2.07	46.99	16.41	5.28
2011	1.18	2.40	5.73	13.24	6.51	2.00	47.83	15.58	5.54
2012	1.11	2.51	5.79	14.17	6.13	1.91	45.07	17.53	5.77
2013	1.28	2.71	5.99	15.46	7.47	2.13	39.42	17.92	7.61
2014	1.21	3.04	5.40	15.53	6.83	2.15	41.36	18.66	5.82

Energy – sectoral balance of the NMVOC emissions has long-term decreasing character. The share in national total is 1 – 2%. The categories of 1A1b (Petroleum refining) and 1A1c (Manufacture of solid fuels and other energy industries) were added into the overall energy balance.

Combustion in industry **–** into sectoral balance were added the missing categories (1A1b, 1A1c, 1A2c, 1A2d, 1A2e, 1A2f). The sources in NEIS database were revised from the technological and energy point of view.

Transport – the emissions from road transport were recalculated due to the updated version of the model COPERT IV. Inventory was completed by the category of 1A3bv Road transport: Gasoline evaporation. Data, which were in the previous year available only until 2011, were completed and covers entire time-series. The last submissions was also supplemented by categories 1A3ai(i) for years 2006 – 2014. Recalculations were performed also in 1A3ei. In comparison to previous reporting, values increased due to the reassessment of the NEIS source categorization into relevant NFR categories.

Households – In category 1A4bi (Residential: Stationary) the NMVOC slightly increased due to the wood combustion. In general, this sector has up-surging tendency that reflects the rising use of wood in the individual heating of households.

Fugitive emissions – sector covers categories 1B1a (Fugitive emission from solid fuels: Coal mining and handling), 1B1b (Fugitive emission from solid fuels: Solid fuel transformation), 1B1c (Other fugitive emissions from solid fuels), 1B2ai (Fugitive emissions oil: Exploration, production, transport), 1B2aiv (Fugitive emissions oil: Refining / storage), 1B2av (Distribution of oil products), 1B2b (Fugitive emissions from natural gas (exploration, production, processing, transmission, storage, distribution and other), 1B2c (Venting and flaring (oil, gas, combined oil and gas)), 1B2d (Other fugitive emissions from energy production). In category 1B2av (Distribution of oil products) LPG distribution has been included since 2001. The trend in the fuel distribution category has decreased in long-term point of view. It was caused by the entering into force the Directive 2009/123/EC of The European Parliament and of The Council (transposed into the Act on Air No. 137/2010 as amended and Slovak Ministry of Environment Regulation No. 361/2010 Coll.) that bring mandatory implementation of the recuperation at II. level for gasoline vapour at filling stations with turnover: for new installation – greater than 500 m^3/yr, for existing 1 000 m^3/yr or for new and existing installation with turnover greater than 100 m^3/yr, which are located in the permanent living quarters. Methodological changes and revisions in 2016 were visible in the allocation of the emission. Filling stations of fuel as a source of emissions remain in the category. Stations are also under the control of the Slovak Environmental Inspection (SIZP). Emissions from the Distribution storages with pump through and separate pumping equipment fuels, greases, petrochemicals and other organic liquids having a vapour pressure according to the Regulation 410/2012 Coll. were allocated into the category 2B10b (Storage, handling and transport of chemical products).

Industry – overall trend has decreasing character. Methodological changes has been applied also in this sector.

Solvents – sector share is in range 40 – 50% from the national total in long-term view. The most remarkable changes were performed in this sector. In sense of the effectiveness and wider use of the NEIS database and in accordance to the categorisation of the stationary sources of the Ministry of Environment Regulation No 410/2012 as amended, the emission has been allocated into the NFR categories, that allowed to separate individual activities from the aggregated value provided in the past. These categories were separated: 2D3b (Road paving with asphalt), 2D3e (Degreasing), 2D3f (Dry cleaning) a 2D3h (Printing). Into sectoral balance this year reporting was completed with the data from households 2D3a (Domestic solvent use including fungicides) in entire time-series. Balance was compiled by the relevant emission factor per capita. Since 2001 the inventory NMVOC was extended by the category of 2D3b - Road paving with asphalt that resulted into increased values. In 2004 the emission factor was modified. After the last methodology revision 2016, the emissions are taken from the NEIS database that covers the combustion emissions from fuel used as well as the emissions released from the asphalt mixture in the phase of warming up during the process. In compliance with new methodology, the emission from 2G (Other product use) covering the industrial extraction of the edible oil and fat, were allocated in to the category 2D3i (Other solvent use). But also other activities (Manufacturing and processing of leather, Footwear and shoes production with projected consumption of organic solvents, Adhesive coating - bonding materials other than wood, wood products and agglomerated materials, leather and footwear production with a projected consumption of organic) were added.

Data source for emissions in the categories 2D3b (Road paving with asphalt), 2D3c (Asphalt roofing), 2D3d (Coating applications), 2D3e (Degreasing), 2D3f (Dry cleaning), 2D3g (Chemical products), 2D3h (Printing) and 2D3i (Other solvent use) is NEIS database for large and medium stationary sources of pollution. Coverage of the small sources, other input data and auxiliary parameters is ensures from statistics (Statistical Office of the Slovak Republic) and studies prepared for SHMU by external expert.

Recalculation according to the new methodological procedure
Recalculation is concerning to the entire sector. In comparison to previous submission 2015, the summary values increased throughout time-series. The reasons are firstly the abovementioned removal of underestimations and secondly adding of the new sources and categories. Especially, the use of solvents in households and counting the use of water-based paints that has not been counted before, but also the QA/QC process of used methods and inputs. The change and comparison is shown in following table.

Year / [kt]	Reporting 2015	Reporting 2016	Change 2015/2016
	Emissions from Solvents		
2000	∑	∑	%
2001	28.7262	51.2351	78.36
2002	31.0197	55.1833	77.90
2003	32.2714	54.5398	69.00
2004	32.7566	56.3917	72.15
2005	33.5590	54.1377	61.32
2006	34.6309	60.1789	73.77
2007	33.5749	60.0705	78.91
2008	33.9563	58.6765	72.80
2009	33.3202	51.2573	53.83
2010	31.8540	56.6879	77.96
2011	36.8887	58.0383	57.33
2012	31.0694	51.3538	65.29
2013	32.1608	41.7985	29.97
2014	0.0000	43.8019	-

Trend in sector emissions
Generally, solvents has decreased. Even though the inter-annual trend 2014/2013 has slightly increased by 4.79%, the overall decline from 2001 to 2014 is by 19.71%. The overall trend is not stable and vary throughout the reported year.

The cause is the wide spectre of using the solvents in industry but no less in households. The industry is closely linked to the automotive industry and using of paints and the development reflects the productivity of the concerned industry. The statistical data is used without the smoothing correction, thus there can be more significant dumps or differences among the yearly values.

The driving force for the upward trend in years 2004 – 2007 was the automotive industry. In the years 2004, 2005 and 2006 the prevalence of the automotive industry concerning with the construction of the new automotive plant brought about the upsurge the consumption of the paints and solvents. The sector noticed the increased of the emission. The values “jump” from the 54 kt in 2005 on 60 kt in 2006 within year and kept the next.

In 2007 entered into force the 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. Bear in mind the recent legislative changes, the operators had to adapt the installations to the legal requirements. The significant drop in emissions in 2009 was generally linked to the financial crises with the peak in 2009 when economic activity were considerably influenced and the drop in emissions was -12.64%. In years 2010 and 2011 is visible increased values, however, the sector has never returned to such high emission values also due to the environmental protection measures.

Year / [kt]	Emissions from Solvents ∑	Inter-annual change
2000	54.557	0.00%
2001	51.235	-6.09%
2002	55.183	7.71%
2003	54.540	-1.17%
2004	56.392	3.40%
2005	54.138	-4.00%
2006	60.179	11.16%
2007	60.071	-0.18%
2008	58.677	-2.32%
2009	51.257	-12.64%
2010	56.688	10.59%
2011	58.038	2.38%
2012	51.354	-11.52%
2013	41.799	-18.61%
2014	43.802	4.79%

Agriculture – in the emission inventory 2016 were for the first time added the emissions NMVOC from the agriculture for entire time-series. By completing and accounting this source the overall national total was essentially influenced due to the significant share (from 15.58% to 18.77%, what is 19,9 – 25,8 kt) of this sector. So, it is the second major contributor to the national total after the solvents. Sector includes the categories of manure management: 3B1a (Dairy cattle), 3B1b (Non-dairy cattle), 3B2 (Sheep), 3B3 (Swine), 3B4d (Goats), 3B4e (Horses), 3B4gi (Laying hens), 3B4giii (Broilers), 3B4giii (Turkeys), 3B4giv (Other poultry), 3B4h (Other animals). Animals in categories 3B4a (Buffalo) and 3B4f (Mules and asses) are not farmed at Slovak territory. From the rest of 14 categories included in the sector (for example: Inorganic N-fertilizers (includes also urea application), Animal manure applied to soils, Sewage sludge applied to soils etc., is relevant only category 3Db (Indirect emissions from managed soils).

Emissions of NMVOC originated from several sources. One part have risen from at enteric fermentation. This emission are producing in stomach by fermentation of partially digestible and non-digestible fats, carbohydrates and proteins. This pollutions are emitted by breathing and in form of flatus. Another part is emitted by storage of silage and dang. Cattle emitted the most emissions of NMVOC in all farm animals (73%), followed poultry (18%), Swine (4%) and other animal that contributed to NMVOC less than 1%. Value of emissions depends from temperature, speed of wind and direction.

By crop production are NMVOC emitted mostly during changes in temperature and light intensity, during the growth phase of plants in air pollution and the aging plants. Specifically observed were substances: alcohols, aldehydes monoterpenes, isoprene, ethane and others (EEA, 3.D Crop production and agricultural soils, 2013).

Waste – Sector of waste management was revised in QA/QC procedure. Except of the reported categories 5A (Biological treatment of waste - Solid waste disposal on land), 5C1bi (Industrial waste incineration), 5C1biii (Clinical waste incineration), this year were added the emissions originated from cremation 5C1bv (Cremation), waste water treatments (5D1 - Domestic wastewater handling, 5D2 - Industrial wastewater handling, 5D3 - Other wastewater treatment). Thus the entire time-series reflect the methodological change and new sources. Emissions in 5B1 (Biological treatment of waste – Composting) are available since 2012. The share of the sector in national total is on the level around 5% to 7.5%. Recalculations were done in time-series for disposal due to the revision of the activity data (updated last year) and methodology. Emissions from the 5C1a (Municipal waste incineration) are allocated to the energy sector due to the energy recovery. Category 5C1bi (Industrial waste incineration) was completed for the part of energy recovered waste and allocated to the energy sector.

Year / [kt]	Emissions from Waste ∑	Inter-annual change
2001	8.18299	0.00%
2002	8.73587	6.76%
2003	8.67256	-0.72%
2004	9.54453	10.05%
2005	7.39878	-22.48%
2006	11.69325	58.04%
2007	9.20138	-21.31%
2008	7.74640	-15.81%
2009	6.71344	-13.33%
2010	6.36646	-5.17%
2011	6.72409	5.62%
2012	6.57444	-2.23%
2013	8.07378	22.81%
2014	6.16887	-23.59%

In the overall emission inventory of the Slovak Republic, the share of waste sector is up to 5% in all reported time range except on NMVOC that vary in range up to 8%. Therefore it is not considered as a key sector. The overall trend dramatically decline since 2001 by 23.59% due to the continual development of the legislative The period of the recent 6 years has stable character with not significant decreasing tendency, except of the 2013, where the increase was recorded. The data sources for the balance of NMVOC are statistics and NEIS database.

POPs

Emission inventory of POPs (PCB, DIOX, PAH-benzo(a)pyrene, benzo(k)fluoranthene, benzo(b)fluoranthene and indeno(1,2,3-cd)pyrene) for the Slovak Republic are elaborated according to EMEP/EEA Air Pollution Emission Inventory Guidebook and in coincidence with requirements of the respective of working group for emission inventory (UN ECE Task Force on Emission Inventory).

The individual sectors are defined in the sense of the SNAP nomenclature. In the sense of the requirements for the NFR reporting the NFR codes were assigned to the individual sectors upon the base of SNAP nomenclature. Emission factors for the emission estimation have been taken over from literature, Standardized Toolkit for Identification and Quantification of Dioxin and Furan Releases, UNEP Chemicals) and smaller amount comes from the measurements on sources in the SR, Poland and Czech

Republic and from EMEP/EEA Air Pollution Emission Inventory Guidebook. Emissions of polychlorinated dioxins and furans (PCDD/F) and polycyclic aromatic hydrocarbons (PAH) from road transport were recalculated by model COPERT IV.

Emissions trend in POPs mostly influenced by changes in Slovak industry. Emissions of PCDD/F have declined because of reconstruction of some technologies (waste incineration, iron ore agglomeration), increase in 2014 reflects the increase of iron ore agglomeration. Downward trend of PAHs emissions to the air proved to be most remarkable in in the 90-ties, when it was caused mostly by the change of aluminium production technology (use of pre-baked anodes). After year 2000 there is slightly increase of PAHs emissions, from the year 2005 PAHs emissions are stabilize. Emissions of HCB in 90-ties and after 2000 decreased because of reconstruction of waste incineration plants. The greatest change in this sector occurred in 2006, when those plants, which did not proved compliance with emissions limit for PCDD/F were closed. Recent variations of HCB emissions are given mainly by changes in production of secondary copper. Slightly increased emissions of polychlorinated biphenyls (PCB) were influenced by the increase of consumption in crude oil in the road transport and using wood in the residential sector. Increased consumption of wood in this sector influenced also total emission of PAHs. The significant impact on POPs emission in industry sector has PCB emissions from secondary lead production, which arise within the improvement of inventory.

HMs

Emission inventory of heavy metals (HMs) is estimated according to the EMEP/EEA (Air Pollutant Emission Inventory Guidebook). In 2004 wood burning was included in the residential sector and emissions since 1990 were revised. Heavy metals emissions markedly decreased compared to the emission value from year 1990. Except the ceasing of several obsolete ineffective metallurgy plants this trend has been effected by a broad reconstruction of electrostatic precipitators and other dust control equipment, by a change of raw materials used, and in particular by the elimination of leaded petrol since 1996. The Pb emissions increased since 2004 as a result of the increase of production in sector of ore agglomeration and copper production. In recent years slight variations in value have been typical for emission trends of HMs. In year 2007 emissions of Pb and Hg decreased in comparison to 2006 due to decrease in sector of ore agglomeration and glass production. At this stage we noticed increase of Cd emissions due to copper production increase. In 2008 increased emissions of lead, cadmium, mercury, copper, zinc and selenium due to increase of amount of incinerated industrial waste and due to increase of emissions in public electricity and heat production, combustion in manufacturing industry. In 2008 were recalculated time series in sector land-filling and incineration of waste based on updated input data. Road transport emissions were recalculated because of update version of the COPERT IV was used in inventory. In 2009 there was a decrease of emissions of heavy metals associated with the decrease in industrial production. Emissions from road transport were recalculated until 2000, because the new version of the model COPERT IV was used in inventory. Due to updating of activity data, were emissions from waste sector recalculated for years 2008, 2005, 2004 and 2002. Furthermore were recalculated emissions of cadmium from glass production. Recalculation was done for years 2007 and 2008 because of revision of emission factor for coloured glass. In 2010 there was an increase of emissions of heavy metals compared to year 2009 due to increase of metal and glass production. Changes and updates in the waste incineration sector led into recalculations of emissions within 2000 – 2010. In 2011 the slight abatement in HM`s emissions was noticed compare to recalculated year 2010 as well as in waste incineration sector. In the other of sectors, the increase was identified. The latest emission recalculation in the waste sector which was performed in the submission 2015 has influence also to the HMs emissions. The entire time series of activity data were updated in range of years

1990 to 2013 and consequently the emissions. The update of input data was concerned to the amounts of incinerated and landfilled waste in downscale type portioning at industrial, municipal and clinical (only incineration) waste. The sector was not completely revised according to methodological changes already applied in last reporting cycle. The planned revision will be performed during the next reporting cycles.

PM_{10}, $PM_{2,5}$

Emissions of PM_{10} and $PM_{2.5}$ have been processed annually on the base of requirements of EMEP/EEA (Air Pollutant Emission Inventory Guidebook), starting from the base year 2000. Emissions of PM_{10} and $PM_{2.5}$ are estimated based on the amount of TSP from database NEIS and they are calculated according to the IIASA methodology. Emissions from the road transport are calculated by the COPERT IV model. The most important contribution to emissions of PM_{10} and $PM_{2.5}$ in the sector of road transport is from diesel engines; the contribution of abrasion to emission of PM_{10} and $PM_{2.5}$ is less important than in total PM (Tab. 4.2 a, b, c). The most important contribution to total emissions of PM_{10} and $PM_{2.5}$ can be found in the residential sector, increased emissions in this sector are caused by the increased consumption in wood as a consequence of increased price of natural gas and coal. (Tab. 4.9, Fig. 4.6).

Calculation of emissions PM_{10} and $PM_{2.5}$ was elaborated using default indicators. Considering the fact that on the EU level are studies to determine the emission ceilings in Member States in accordance with GAINS[2] model (IIASA), the SR has decided to establish new methodology of emission estimation for PM_{10} and $PM_{2.5}$ in accordance with the GAINS model (input data, emission factors). GAINS model uses the data aggregated from energy balance of the SR from Slovak Statistical Office; whereas country specific methodology uses the input data from NEIS database. The estimated emissions of PM_{10} and $PM_{2.5}$ by country specific methodology are fully consistent with TSP emissions. This is a basic requirement for estimation of emission projections. The entire calculation is already programmed in NEIS database.

Share of individual sectors in total emissions of the Slovak Republic in 2014

Figure 4.2 represents the contribution of stationary and mobile sources to air pollution. The graphs show that the share of transport in air pollution by oxides of nitrogen and carbon monoxide is significant. On the other hand, combustion processes and industry contribute to air pollution mainly by sulphur oxides and particulate matters. Table 4.3 shows the total emissions in individual agglomerations and zones (in sense of the Annex 17 to the Decree No. 360/2010 Coll.).

Most important sources of air pollution in the Slovak Republic in 2014

Table 4.4 introduces twenty the most important air pollution sources in the SR. The share of these sources in the total air emissions of the SR varies from 74.04% to 96.74%. Table 4.5 lists top ten sources in administrative regions according to the amount of emissions of basic pollutants.

Specific territorial emissions in 2014

Table 4.6 and Figure 4.3 provide information that gives some idea about the territorial distribution of the emitted pollutants. However, it is necessary to distinguish between the amount of pollutants emitted from the respective territory and the ambient air concentrations, because the pollutants emitted may impact more distant areas, depending on the stack height and meteorological conditions.

[2] *Emission estimation of PM_{10} and $PM_{2.5}$ was performed with RAINS model, which has been replaced by GAINS model*

4.3 VERIFICATION OF THE RESULTS

Verification of the data gathered during the emission inventory was carried out in comparison with:

- Updated data from previous years and by the verification of reasons for their changes (e.g. change in fuel base, respectively fuel quality characters, technology, separation technique, etc.).
- Data listed in the EAPSI 1 questionnaires compared to the data provided by operators to the district offices for identification of a tax height. Differences appeared mostly in fuel quality characters and this may significantly affect the quantity of the emission calculated in dependence on the quantity of fuel consumed. Further differences arose as a consequence of the fact that district offices enabled sources to report the emission quantity calculated on their own measurements. In some cases the differences between the levels found out in the balance calculation and the recalculation from the results of measurements were significant. In the 1996 and 1999 EAPSI balance, for the selected sources such measurement results were taken into account, where the level of results measured as well as the procedure of recalculation were satisfactory.
- Module NEIS BU enables the control of emissions estimated on the district level and its implementation decreased the uncertainty of national emission estimates.

Note: The inventory results of the basic pollutants emitted in year N are completed to the 31th October (N+1) and the inventory results of the other pollutants emitted in year N are completed to the 15th February (N+2).

Tab. 4.1a **Emissions of basic pollutants [thous. t] in the SR within 1990 – 1999**

		1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
PM	EAPSI 1	208.075	153.590	110.545	79.925	52.335	55.770	38.461	36.646	31.168	34.813
	EAPSI 2	36.425	[1]36.425	[1]36.425	[1]36.425	[1]17.097	[1]17.097	9.478	[2]9.478	[2]9.478	[2]9.478
	EAPSI 3	34.795	35.710	31.968	29.386	26.077	24.582	24.539	20.170	21.039	20.234
	EAPSI 4	4.103	3.358	2.943	2.674	2.798	2.945	2.891	2.823	2.956	2.710
	Total	**283.398**	**229.083**	**181.881**	**148.410**	**98.307**	**100.394**	**75.369**	**69.117**	**64.641**	**67.235**
SO_2	EAPSI 1	421.983	347.084	296.036	246.413	182.747	188.590	197.308	176.564	153.723	147.111
	EAPSI 2	37.509	[1]37.509	[1]37.509	[1]37.509	[1]27.091	[1]27.091	10.577	[2]10.577	[2]10.577	[2]10.577
	EAPSI 3	63.197	58.173	53.697	42.124	33.069	28.117	20.173	14.994	17.088	14.489
	EAPSI 4	2.968	2.402	2.135	1.978	2.101	2.254	2.293	2.326	2.498	1.088
	Total	**525.657**	**445.168**	**389.377**	**328.024**	**245.008**	**246.052**	**230.351**	**204.461**	**183.886**	**173.265**
NO_x	EAPSI 1	146.474	135.389	127.454	122.169	111.616	118.040	76.853	70.583	74.322	65.436
	EAPSI 2	4.961	[1]4.961	[1]4.961	[1]4.961	[1]5.193	[1]5.193	3.960	[2]3.960	[2]3.960	[2]3.960
	EAPSI 3	13.331	13.077	12.243	10.583	9.456	9.023	8.845	7.784	8.355	8.201
	EAPSI 4	61.479	50.718	45.652	43.586	44.843	46.585	45.618	44.841	45.889	42.718
	Total	**226.245**	**204.145**	**190.310**	**181.299**	**171.108**	**178.841**	**135.276**	**127.168**	**132.526**	**120.315**
CO	EAPSI 1	162.047	160.591	132.874	160.112	168.561	165.715	129.388	141.636	118.581	122.149
	EAPSI 2	27.307	[1]27.307	[1]27.307	[1]27.307	[1]11.409	[1]11.409	12.037	[2]12.037	[2]12.037	[2]12.037
	EAPSI 3	161.905	152.335	139.809	113.629	92.663	81.778	66.759	51.933	56.990	51.171
	EAPSI 4	164.003	151.872	151.295	161.360	165.921	163.931	153.841	153.968	155.118	144.215
	Total	**515.262**	**492.105**	**451.285**	**462.408**	**438.554**	**422.833**	**362.025**	**359.574**	**342.726**	**329.572**

EAPSI 1–3 – stationary sources *EAPSI 4 – mobile sources (road and other transport)*
[1] *data based on expert estimate* [2] *the 1996 data*

Tab. 4.1b **Emissions of basic pollutants [thous. t] in the SR within 2000 – 2008**

			2000	2001	2002	2003	2004	2005	2006	2007	2008
PM	**Stationary sources – NEIS**	LS [1]	29.923	29.722	25.037	20.166	17.670	18.719	13.992	6.020	5.406
		MS [1]	4.958	4.405	3.767	3.259	2.748	2.392	2.281	1.979	1.764
		SS [2]	19.877	20.550	17.217	18.300	21.504	28.709	26.980	26.821	26.921
	Mobile sources	RT	1.834	2.036	2.212	2.225	2.375	2.849	2.610	3.074	2.791
		OT	0.399	0.404	0.366	0.329	0.343	0.357	0.335	0.352	0.322
	Total		**56.991**	**57.117**	**48.599**	**44.279**	**44.640**	**53.026**	**46.198**	**38.246**	**37.204**
SO_2	**Stationary sources – NEIS**	LS [1]	101.956	109.822	91.461	95.283	87.932	81.592	80.104	64.974	64.059
		MS [1]	8.083	6.655	3.964	3.620	2.652	2.107	1.902	1.598	1.246
		SS [2]	16.055	13.764	7.127	6.384	5.381	5.073	5.524	3.735	3.844
	Mobile sources	RT	0.670	0.675	0.730	0.150	0.159	0.189	0.177	0.204	0.210
		OT	0.189	0.196	0.065	0.059	0.064	0.077	0.080	0.085	0.088
	Total		**126.953**	**131.112**	**103.347**	**105.496**	**96.188**	**89.038**	**87.787**	**70.596**	**69.447**
NO_x	**Stationary sources – NEIS**	LS [1]	54.484	51.653	46.412	44.605	44.244	42.424	39.038	35.762	34.488
		MS [1]	8.052	7.751	6.356	6.620	4.926	4.377	4.992	3.542	3.575
		SS [2]	7.993	8.391	7.137	7.356	7.582	8.866	8.336	7.819	7.979
	Mobile sources	RT	32.027	35.072	35.495	34.914	37.794	41.473	39.561	43.838	43.249
		OT	9.011	7.899	8.267	7.632	9.202	9.137	7.752	8.259	8.606
	Total		**107.416**	**107.766**	**103.667**	**101.127**	**103.748**	**106.277**	**99.679**	**99.22**	**97.897**
CO	**Stationary sources – NEIS**	LS [1]	120.609	115.177	122.225	141.047	147.317	133.787	147.318	141.062	136.530
		MS [1]	10.779	10.280	9.150	9.394	7.531	5.853	5.350	5.330	4.518
		SS [2]	53.792	50.178	33.815	33.811	34.753	41.766	40.882	37.018	37.367
	Mobile sources	RT	113.171	127.348	123.273	106.268	101.161	89.077	77.516	59.244	65.068
		OT	2.345	1.968	1.994	1.810	1.894	1.739	1.585	1.621	1.590
	Total		**300.070**	**304.609**	**290.457**	**292.330**	**292.656**	**272.222**	**272.651**	**244.275**	**245.073**

LS - large sources, MS - medium sources, SS - small sources, RT - road transport, OT - other transport

[1] *According to the Decree of MŽP SR No. 410/2012 Coll. as amended*
[2] *According to the Decree of MŽP SR No.144/2000 Coll. (2001 – 2003), according to the Decree of MŽP SR No. 53/2004 Z. z. (2004 – 2009), according to the Decree of MPŽPaRR No. 362/2010 Z. z.(since 2010)*

Emissions from road and other transport estimated to April 30th 2015,
emissions from other sectors to December 4th 2014.

Tab. 4.1c **Emissions of basic pollutants [thous. t] in the SR within 2009 – 2014**

			2009	2010	2011	2012	2013	2014
PM	**Stationary sources – NEIS**	LS [1]	4.966	4.936	5.139	5.283	5.417	5.449
		MS [1]	1.554	1.474	1.404	1.348	1.306	1.271
		SS [2]	27.083	26.214	28.507	28.745	29.298	28.405
	Mobile sources	RT	2.470	2.741	2.579	2.733	2.665	2.673
		OT	0.293	0.383	0.328	0.318	0.123	0.124
	Total		**36.366**	**35.748**	**37.957**	**38.427**	**38.809**	**37.922**
SO_2	**Stationary sources – NEIS**	LS [1]	59.739	64.798	64.321	54.235	49.013	42.118
		MS [1]	0.991	0.906	0.839	0.894	0.945	0.906
		SS [2]	3.116	3.424	3.102	3.169	2.802	2.168
	Mobile sources	RT	0.194	0.042	0.041	0.042	0.040	0.042
		OT	0.072	0.085	0.060	0.039	0.037	0.039
	Total		**64.112**	**69.213**	**68.363**	**58.379**	**52.837**	**45.273**
NO_x	**Stationary sources – NEIS**	LS [1]	31.333	31.466	31.199	27.465	25.818	24.759
		MS [1]	3.389	3.485	3.716	3.978	4.259	4.356
		SS [2]	7.990	8.076	8.215	8.241	8.334	7.737
	Mobile sources	RT	37.638	40.487	37.191	37.070	37.076	40.028
		OT	7.025	7.935	7.348	5.371	5.218	4.817
	Total		**87.375**	**91.449**	**87.669**	**82.125**	**80.705**	**81.697**
CO	**Stationary sources – NEIS**	LS [1]	106.635	125.475	136.615	133.264	130.608	146.879
		MS [1]	4.104	4.446	4.680	4.913	5.098	4.894
		SS [2]	36.181	35.953	37.710	38.172	38.113	35.701
	Mobile sources	RT	59.568	53.217	46.722	44.871	42.930	36.483
		OT	1.291	1.556	1.318	1.290	1.165	1.157
	Total		**207.779**	**220.647**	**227.045**	**222.51**	**217.914**	**225.114**

LS - large sources, MS - medium sources, SS - small sources, RT - road transport, OT - other transport

[1] *According to the Decree of MŽP SR No. 410/2012 Coll. as amended*
[2] *According to the Decree of MŽP SR No.144/2000 Coll. (2001 – 2003), according to the Decree of MŽP SR No. 53/2004 Z. z. (2004 – 2009), according to the Decree of MPŽPaRR No. 362/2010 Z. z.(since 2010)*

Emissions from road and other transport estimated to March 15th 2016, emissions from other sectors to December 4th 2015.

Tab. 4.2a **Emissions of PM [t] from road transport in the SR in 2001, 2005 and within 2010 – 2013**

	2001	2005	2010	2011	2012	2013	2014
Emissions from diesel engine	1025	1488	1219	1147	1198	1173	1168
Emissions from petrol engine	51	44	24	23	22	21	18
Emissions from LPG engine	1	1	1	1	1	1	1
Emissions from CNG engine	0	0	0	0	0	0	0
Total emissions from exhaust	**1077**	**1533**	**1244**	**1171**	**1221**	**1195**	1187
Abrasion emissions	959	1315	1497	1461	1513	1470	1485
Total	**2036**	**2849**	**2741**	**2632**	**2734**	**2665**	**2673**

Tab. 4.2b **Emissions of PM_{10} [t] from road transport in the SR in 2001, 2005 and within 2010 – 2014**

	2001	2005	2010	2011	2012	2013	2014
Emissions from diesel engine	1025	1488	1219	1147	1198	1173	1168
Emissions from petrol engine	51	44	24	23	22	21	18
Emissions from LPG engine	-	-	1	1	1	1	1
Emissions from CNG engine	-	-	0	0	0	0	0
Total emissions from exhaust	**1076**	**1532**	**1244**	**1171**	**1221**	**1195**	**1187**
Abrasion emissions	637	866	948	928	964	932	933
Total	**1713**	**2398**	**2192**	**2099**	**2185**	**2127**	**2120**

Tab. 4.2c **Emissions of $PM_{2,5}$ [t] from road transport in the SR in 2001, 2005 and within 2010 – 2014**

	2001	2005	2010	2011	2012	2013	2014
Emissions from diesel engine	1025	1488	1219	1147	1198	1173	1168
Emissions from petrol engine	51	44	24	23	22	21	18
Emissions from LPG engine	-	-	1	1	1	1	1
Emissions from CNG engine	-	-	0	0	0	0	0
Total emissions from exhaust	**1076**	**1532**	**1244**	**1171**	**1221**	**1195**	**1187**
Abrasion emissions	340	462	506	496	516	498	499
Total	**1416**	**1994**	**1750**	**1667**	**1737**	**1693**	**1686**

Emissions estimated to March 15th 2016.

Fig. 4.1 **Development trends in basic pollutant emissions within 1990 – 2014**

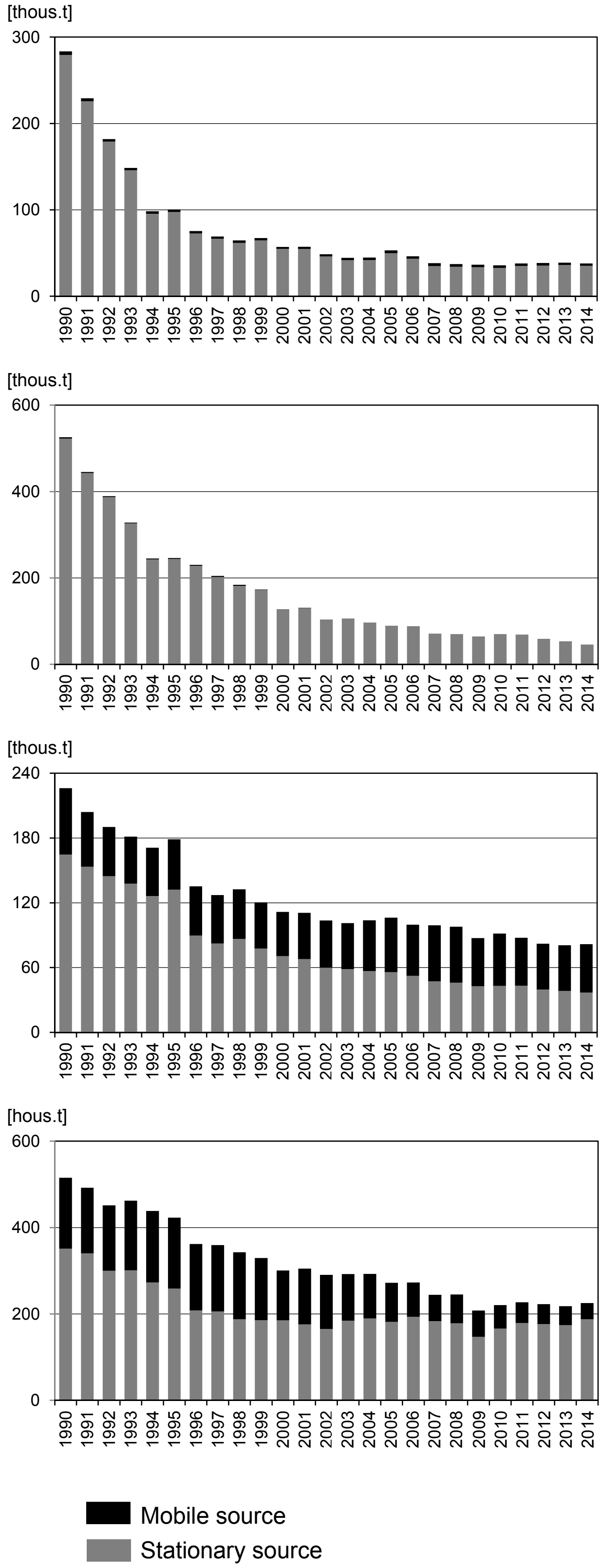
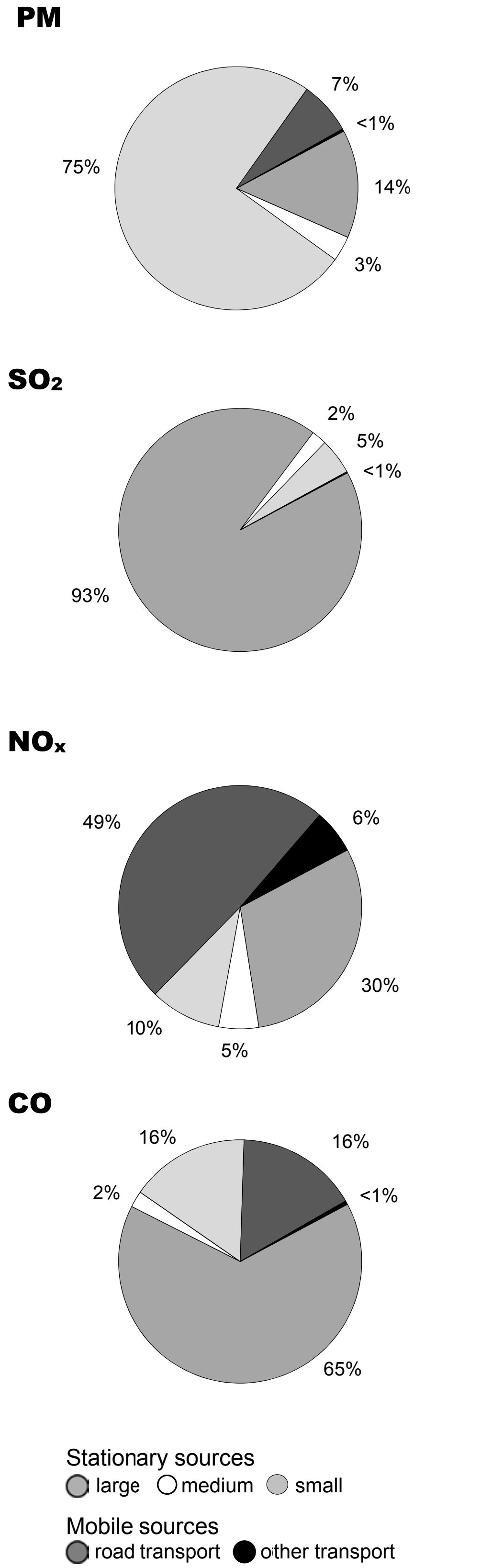


Fig. 4.2 **Emissions of basic pollutants in 2014**



Tab. 4.3 **Stationary source emissions of basic pollutants [t] in agglomerations and zones* in 2001, 2005 and within 2010 – 2014**

PM		2001	2005	2010	2011	2012	2013	2014
Aglome-ration	Bratislava	477	472	327	309	281	283	226
	Košice	17173	4362	3245	3268	3443	3467	3511
Zone	Bratislava region	546	506	447	482	485	492	507
	Trnava region	1518	1935	1742	1902	1886	1934	1894
	Trenčín region	4820	5280	3843	4197	4171	4301	4275
	Nitra region	2921	3414	2896	3194	3176	3255	3145
	Žilina region	6271	7076	6238	6831	6875	7080	6782
	Ban. Bystrica region	6355	7378	6328	6772	6854	6918	6731
	Prešov region	4266	5556	4345	4671	4800	4846	4722
	Košice region	10331	13842	3213	3422	3404	3445	3334
Total		**54677**	**49820**	**32625**	**35050**	**35376**	**36021**	**35125**

SO_2		2001	2005	2010	2011	2012	2013	2014
Aglome-ration	Bratislava	13594	9285	10276	7422	3239	2074	2284
	Košice	12607	12526	9671	9247	9920	8837	7742
Zone	Bratislava region	380	377	160	191	246	201	202
	Trnava region	2051	1037	472	494	498	602	576
	Trenčín region	45187	40937	37232	40144	33947	31490	25105
	Nitra region	4749	2336	532	382	400	390	358
	Žilina region	10237	5035	2949	2606	2598	2306	2073
	Ban. Bystrica region	10043	6197	4157	4978	4212	4165	4060
	Prešov region	8082	4856	2474	1487	1988	1788	1919
	Košice region	23310	6185	1203	1310	1250	908	875
Total		**130242**	**88772**	**69127**	**68262**	**58298**	**52760**	**45193**

NO_x		2001	2005	2010	2011	2012	2013	2014
Aglome-ration	Bratislava	5151	4791	4126	3710	3252	2884	2306
	Košice	12172	10929	9323	7883	8286	8538	8611
Zone	Bratislava region	1900	1742	1437	1712	1527	1723	1993
	Trnava region	1966	1667	1487	1774	1630	1667	1538
	Trenčín region	10489	7822	6892	7639	6960	6676	6837
	Nitra region	3974	3989	2603	3003	2444	2499	2320
	Žilina region	5170	4674	4757	4964	4857	4365	4105
	Ban. Bystrica region	6666	6281	5399	5840	5203	5263	4843
	Prešov region	3443	3459	2785	2500	2621	2447	2237
	Košice region	16864	10314	4217	4105	2904	2349	2061
Total		**67794**	**55666**	**43027**	**43130**	**39684**	**38410**	**36852**

CO		2001	2005	2010	2011	2012	2013	2014
Aglome-ration	Bratislava	1319	1120	824	868	778	811	812
	Košice	78619	93197	88292	101053	99454	100635	114352
Zone	Bratislava region	1638	1576	3250	3037	1769	2040	2039
	Trnava region	4682	3865	2728	2967	2963	2946	2671
	Trenčín region	10334	9331	11476	11151	10918	10502	11762
	Nitra region	7379	6627	6185	6283	5532	5731	5417
	Žilina region	19287	15924	12059	12370	12528	12223	11732
	Ban. Bystrica region	26301	29375	25728	26445	27266	25649	26257
	Prešov region	11838	9282	6795	7010	7128	7349	6901
	Košice region	14237	11109	8536	7820	8012	5931	5531
Total		**175636**	**181407**	**165874**	**179005**	**176349**	**173819**	**187474**

** According to the Decree of MŽP SR No. 360/2010 Coll., Annex 17*

Tab. 4.4 **The most important air pollution sources in the SR and their share in the emissions of pollutants (NEIS – large and medium sources*) in 2014**

	PM			SO_2		
	Operator – plant locality	**[t]**	**[%]**	**Operator – plant locality**	**[t]**	**[%]**
1	U. S. Steel Košice, s.r.o., Košice	3335.14	49,63	Slovenské elektrárne, a.s., Zemianske Kostoľany	24696.27	57,40
2	Slovenské elektrárne, a.s., Zemianske Kostoľany	277.09	4,12	U. S. Steel Košice, s.r.o., Košice	6623.53	15,39
3	Považská cementáreň, a.s., Ladce	258.27	3,84	Slovalco, a.s., Žiar n/H	2078.52	4,83
4	FORTISCHEM a.s., Nováky	205.78	3,06	SLOVNAFT, a.s., Ružinov	1668.01	3,88
5	Mondi SCP, a.s., Ružomberok	145.91	2,17	BUKÓZA ENERGO, a.s., Hencovce	1413.90	3,29
6	BUKOCEL, a.s., Hencovce	133.25	1,98	Tepláreň Košice, a.s. , Košice	1035.12	2,41
7	DOLVAP, s.r.o., Varín	125.09	1,86	Zvolenská teplárenská, a.s., Zvolen	633.45	1,47
8	Slovalco, a.s., Žiar n/H	118.87	1,77	Slovenské elektrárne, a.s., Vojany	455.71	1,06
9	Duslo, a.s., Šaľa	109.40	1,63	Žilinská teplárenská, a.s., Žilina	431.90	1,00
10	Tepláreň Košice, a.s.	84.70	1,26	CM European Power Slovakia, s.r.o., Ružinov	415.60	0,97
11	Carmeuse Slovakia, s.r.o., Dvorníky - Včeláre	65.56	0,98	OFZ, a.s., Oravský Podzámok	365.55	0,85
12	Holcim (Slovensko) a.s., Rohožník	45.27	0,67	Martinská teplárenská, a.s., Martin	346.37	0,81
13	OFZ, a.s., Oravský Podzámok	44.16	0,66	Knauf Insulation, s.r.o., Nová Bana	286.02	0,66
14	Žilinská teplárenská, a.s., Žilina	41.90	0,62	Mondi SCP, a.s., Ružomberok	229.39	0,53
15	Knauf Insulation, s.r.o., Nová Bana	41.43	0,62	Dalkia Industry Žiar n/H, a.s.	215.38	0,50
16	Slovenské elektrárne, a.s., Vojany	35.31	0,53	SLOVENSKÉ CUKROVARY, s.r.o., Sereď	198.62	0,46
17	SLOVNAFT, a.s., Ružinov	33.47	0,50	Duslo, a.s., Nové Mesto	178.37	0,41
18	CM European Power Slovakia, s.r.o., Ružinov	30.59	0,46	Holcim (Slovensko) a.s. Rohožník	157.41	0,37
19	Energy Edge ZC s.r.o., Žarnovica	29.15	0,43	BUKOCEL, a.s., Hencovce	103.37	0,24
20	BUKÓZA ENERGO, a.s., Hencovce	28.44	0,42	SLOVMAG a.s. Lubeník	90.94	0,21
Spolu		**5188,75**	**77.21**		**41623,42**	**96.74**

	NO_x			CO		
	Operator – plant locality	**[t]**	**[%]**	**Operator – plant locality**	**[t]**	**[%]**
1	U. S. Steel Košice, s.r.o., Košice	6712.75	23,06	U. S. Steel Košice, s.r.o., Košice	113647.27	74,88
2	Slovenské elektrárne, a.s., Zemianske Kostoľany	3271.75	11,24	Slovalco, a.s., Žiar n/H	14062.24	9,27
3	Tepláreň Košice, a.s.	1240.77	4,26	CEMMAC a.s., Horné Srnie	3226.93	2,13
4	Holcim (Slovensko) a.s., Rohožník	1196.69	4,11	Považská cementáreň, a.s., Ladce	2737.21	1,80
5	Považská cementáreň, a.s., Ladce	927.16	3,18	Slovenské magnezitové závody, a.s. Jelšava	2120.77	1,40
6	Mondi SCP, a.s., Ružomberok	913.68	3,14	DOLVAP, s.r.o., Varín	1630.12	1,07
7	Slovenské magnezitové závody, a.s. Jelšava	737.83	2,53	Calmit, spol. s r.o., Žirany	919.21	0,61
8	CM European Power Slovakia, s.r.o., Ružinov	720.48	2,47	Holcim (Slovensko) a.s., Rohožník	913.09	0,60
9	SLOVNAFT, a.s., Ružinov	717.75	2,47	OFZ, a.s., Oravský Podzámok	888.16	0,59
10	Duslo, a.s., Šaľa	601.89	2,07	BUKOCEL, a.s., Hencovce	603.36	0,40
11	CEMMAC a.s., Horné Srnie	567.18	1,95	Mondi SCP, a.s., Ružomberok	411.33	0,27
12	Holcim (Slovensko) a.s., Dvorníky - Včeláre	556.85	1,91	SLOVNAFT, a.s., Ružinov	405.76	0,27
13	BUKÓZA ENERGO, a.s., Hencovce	519.30	1,78	Slovenské elektrárne, a.s., Zemianske Kostoľany	367.16	0,24
14	Slovalco, a.s., Žiar n/H	492.92	1,69	Slovenské elektrárne, a.s., Vojany	338.85	0,22
15	Zvolenská teplárenská, a.s., Zvolen	458.41	1,57	VUM, a.s., Žiar n/H	334.68	0,22
16	IKEA Industry Slovakia s.r.o., Malacky	416.79	1,43	HNOJIVÁ Duslo, s.r.o., Strážske	305.72	0,20
17	Carmeuse Slovakia, s.r.o., Košice	407.63	1,40	SLOVMAG a.s. Lubeník	304.02	0,20
18	OFZ, a.s., Oravský Podzámok	389.99	1,34	FORTISCHEM a.s., Nováky	301.09	0,20
19	Žilinská teplárenská, a.s., Žilina	380.23	1,31	IKEA Industry Slovakia s.r.o., Malacky	296.14	0,20
20	RONA, a.s., Lednické Rovne	325.89	1,12	Železiarne Podbrezová a.s.	272.39	0,18
Spolu		**21555,94**	**74.04**		**144085,50**	**94.93**

** According to the Decree of MŽP SR No. 410/2012 Coll. as amended*

Tab. 4.5 **Sequence of the sources within the region according to the emissions in 2014 (NEIS – large and medium sources*)**

BRATISLAVA REGION

	PM			SO_2		
	Source	**District**	**Emis. [t]**	**Source**	**District**	**Emis. [t]**
1.	Holcim (Slovensko) a.s.	Malacky	45.27	SLOVNAFT, a.s.	Bratislava II	1668.01
2.	SLOVNAFT, a.s.	Bratislava II	33.47	CM European Power Slovakia, s.r.o.	Bratislava II	415.60
3.	CM European Power Slovakia, s.r.o.	Bratislava II	30.59	Duslo, a.s.	Bratislava III	178.37
4.	VOLKSWAGEN SLOVAKIA, a.s.	Bratislava IV	27.95	Holcim (Slovensko) a.s.	Malacky	157.41
5.	IKEA Industry Slovakia s.r.o.	Malacky	26.00	Odvoz a likvidácia odpadu, a.s.	Bratislava II	5.93
6.	TERMMING, a.s.	Bratislava II	7.35	Ministerstvo obrany Slovenskej republiky	Pezinok	5.62
7.	Bratislavská teplárenská, a.s.	Bratislava III	5.36	BPS Senec, s.r.o.	Senec	4.38
8.	Obec Rohožník	Malacky	4.70	Bratislavská teplárenská, a.s.	Bratislava II	3.83
9.	ALAS SLOVAKIA, s.r.o.	Malacky	3.93	Pezinské tehelne - Paneláreň, a.s.	Pezinok	1.49
10.	Veolia Energia Slovensko, a.s.	Bratislava V	3.78	AGROCROP a.s.	Senec	0.85
	NO_x			CO		
	Source	**District**	**Emis. [t]**	**Source**	**District**	**Emis. [t]**
1.	Holcim (Slovensko) a.s.	Malacky	1196.69	Holcim (Slovensko) a.s.	Malacky	913.09
2.	CM European Power Slovakia, s.r.o.	Bratislava II	720.48	SLOVNAFT, a.s.	Bratislava II	405.76
3.	SLOVNAFT, a.s.	Bratislava II	717.75	IKEA Industry Slovakia s.r.o.	Malacky	296.14
4.	IKEA Industry Slovakia s.r.o.	Malacky	416.79	TERMMING, a.s.	Malacky	161.48
5.	Bratislavská teplárenská, a.s.	Bratislava III	117.89	Bratislavská teplárenská, a.s.	Bratislava III	39.52
6.	VOLKSWAGEN SLOVAKIA, a.s.	Bratislava IV	92.88	Obec Rohožník	Malacky	33.43
7.	Odvoz a likvidácia odpadu, a.s.	Bratislava II	91.39	VOLKSWAGEN SLOVAKIA, a.s.	Bratislava IV	29.37
8.	Veolia Energia Slovensko, a.s.	Bratislava V	77.59	Veolia Energia Slovensko, a.s.	Bratislava V	28.96
9.	TERMMING, a.s.	Bratislava II	72.62	TERMMING, a.s.	Bratislava II	21.18
10.	Bratislavská teplárenská, a.s.	Bratislava IV	47.82	Ministerstvo obrany Slovenskej republiky	Pezinok	21.17

TRNAVA REGION

	PM			SO_2		
	Source	**District**	**Emis. [t]**	**Source**	**District**	**Emis. [t]**
1.	AMYLUM SLOVAKIA, spol. s r.o.	Trnava	21.41	SLOVENSKÉ CUKROVARY, s.r.o.	Galanta	198.62
2.	SLOVENSKÉ CUKROVARY, s.r.o.	Galanta	21.10	Johns Manville Slovakia, a.s.	Trnava	88.61
3.	Agropodnik a.s. Trnava	Dun. Streda	19.48	MACH TRADE, spol. s r.o.	Galanta	57.94
4.	Johns Manville Slovakia, a.s.	Trnava	14.90	ZLIEVÁREŇ TRNAVA s.r.o.	Trnava	22.86
5.	Agro Boleráz, s.r.o.	Trnava	5.74	ECO PWR, s.r.o.	Dun. Streda	11.19
6.	PENAM SLOVAKIA, a.s.	Trnava	5.71	RUPOS, s.r.o.	Trnava	6.96
7.	ZLIEVÁREŇ TRNAVA s.r.o.	Trnava	5.18	Baňa Čáry, a.s.	Senica	5.53
8.	Bekaert Slovakia, s.r.o.	Galanta	4.57	ENVIRAL, a.s.	Hlohovec	4.78
9.	Agropodnik a.s. Trnava	Senica	4.13	BioREn s.r.o.	Piešťany	4.72
10.	ENVIRAL, a.s.	Hlohovec	3.96	Ing. Peter Horváth - SHR	Galanta	4.66
	NO_x			CO		
	Source	**District**	**Emis. [t]**	**Source**	**District**	**Emis. [t]**
1.	Johns Manville Slovakia, a.s.	Trnava	146,10	Službyt, spol. s r.o.	Senica	149,81
2.	SLOVENSKÉ CUKROVARY, s.r.o.	Galanta	133,18	Bekaert Slovakia, s.r.o.	Galanta	29,41
3.	ENVIRAL, a.s.	Hlohovec	58,38	IKEA Industry Slovakia s. r. o.	Trnava	26,30
4.	AMYLUM SLOVAKIA, spol. s r.o.	Trnava	50,40	ENVIRAL, a.s.	Hlohovec	19,82
5.	Službyt, spol. s r.o.	Senica	31,39	AMYLUM SLOVAKIA, spol. s r.o.	Trnava	17,31
6.	IKEA Industry Slovakia s. r. o.	Trnava	28,90	SLOVENSKÉ CUKROVARY, s.r.o.	Galanta	17,00
7.	TEPLÁREŇ, a.s., Považská Bystricaa	Dun. Streda	24,52	I.D.C. Holding, a.s.	Galanta	14,11
8.	Bekaert Hlohovec, a.s.	Hlohovec	21,31	ZLIEVÁREŇ T R N A V A s.r.o.	Trnava	11,02
9.	ZLIEVÁREŇ T R N A V A s.r.o.	Trnava	14,26	ASTOM ND, s. r. o.	Dun. Streda	9,46
10.	ELBIOGAS s. r. o.	Dun. Streda	13,23	ELBIOGAS s. r. o.	Dun. Streda	9,07

TRENČÍN REGION

	PM			SO$_2$		
	Source	District	Emis. [t]	Source	District	Emis. [t]
1.	Slovenské elektrárne, a.s.	Prievidza	277.09	Slovenské elektrárne, a.s.	Prievidza	24696.27
2.	Považská cementáreň, a.s.	Ilava	258.27	VETROPACK NEMŠOVÁ, s.r.o.	Trenčín	42.72
3.	FORTISCHEM a.s.	Prievidza	205.78	Hornonitrianske bane Prievidza, a.s.	Prievidza	18.53
4.	Hornonitrianske bane Prievidza, a.s.	Prievidza	17.22	Považská cementáreň, a.s.	Ilava	10.42
5.	Považský cukor a.s.	Trenčín	15.93	CEMMAC a.s.	Trenčín	7.36
6.	TERMONOVA, a.s.	Ilava	15.49	BIOPLYN HOROVCE 3, s.r.o.	Púchov	5.75
7.	CEMEX Aggregates Slovakia, s.r.o.	Púchov	9.61	FORTISCHEM a.s.	Prievidza	5.63
8.	RADSWORTH, a.s. – org.zložka Slovensko	Prievidza	8.65	RONA, a.s.	Púchov	5.14
9.	Kameňolomy, s.r.o.	Trenčín	6.45	BPS Myjava, s.r.o.	Myjava	4.98
10.	KVARTET a.s.	Partizánske	5.61	AGROSERVIS-SLUŽBY, spol. s r.o.	Partizánske	4.53

	NO$_x$			CO		
	Source	District	Emis. [t]	Source	District	Emis. [t]
1.	Slovenské elektrárne, a.s.	Prievidza	3271.75	CEMMAC a.s.	Trenčín	3226.93
2.	Považská cementáreň, a.s.	Ilava	927.16	Považská cementáreň, a.s.	Ilava	2737.21
3.	CEMMAC a.s.	Trenčín	567.18	Slovenské elektrárne, a.s.	Prievidza	367.16
4.	RONA, a.s.	Púchov	325.89	FORTISCHEM a.s.	Prievidza	301.09
5.	VETROPACK NEMŠOVÁ, s.r.o.	Trenčín	178.57	Považský cukor a.s.	Trenčín	170.53
6.	TEPLÁREŇ, a.s., Považská Bystrica	Pov. Bystrica	82.83	Tech. služby mesta Partizánske, spol. s r. o.	Partizánske	99.68
7.	FORTISCHEM a.s.	Prievidza	66.73	TEPLÁREŇ, a.s., Považská Bystricaa	Pov.Bystrica	90.71
8.	TERMONOVA, a.s.	Ilava	44.22	COFELY a.s.	Myjava	89.54
9.	Continental Matador Rubber, s.r.o.	Púchov	40.50	Služby pre bývanie, s r.o.	Trenčín	32.60
10.	Služby pre bývanie, s r.o.	Trenčín	31.07	KVARTET a.s.	Partizánske	31.63

NITRA REGION

	PM			SO$_2$		
	Source	District	Emis. [t]	Source	District	Emis. [t]
1.	Duslo, a.s.	Šaľa	109.40	Calmit, spol. s r.o.	Nitra	26.94
2.	P.G.TRADE, spol. s r.o.	Nové Zámky	10.66	BIONOVES, s.r.o.	Nitra	22.45
3.	PPC Čab, a.s.	Nitra	10.56	Icopal a.s.	Nové Zámky	14.18
4.	Tlmačská energetická, s.r.o.	Levice	9.80	P.G.TRADE, spol. s r.o.	Nové Zámky	13.88
5.	TOP PELET, s.r.o.	Topoľčany	9.38	Bioplyn Cetín, s.r.o.	Nitra	8.85
6.	SLOVINTEGRA ENERGY, a.s.	Levice	9.19	Liaharenský podnik Nitra, a.s.	Levice	8.15
7.	DECODOM, spol. s r. o.	Topoľčany	9.17	BPS Lipová 1 s.r.o.	Nové Zámky	6.40
8.	Prvá energetická a teplárenská spoločnosť, s.r.o.	Zlaté Moravce	8.46	BIOGAS, s.r.o.	Nitra	5.74
9.	MENERT - THERM, s.r.o.	Šaľa	7.43	Tlmačská energetická, s.r.o.	Levice	4.37
10.	SLOVENSKÉ ENERGETICKÉ STROJÁRNE a.s.	Levice	7.29	BPS Veľké Ripňany s.r.o.	Topoľčany	3.61

	NO$_x$			CO		
	Source	District	Emis. [t]	Source	District	Emis. [t]
1.	Duslo, a.s.	Šaľa	601.89	Calmit, spol. s r.o.	Nitra	919.21
2.	BIOENERGY TOPOĽČANY s.r.o.	Topoľčany	128.09	SLOVINTEGRA ENERGY, a.s.	Levice	252.07
3.	SLOVINTEGRA ENERGY, a.s.	Levice	117.47	Bytkomfort, s.r.o.	Nové Zámky	125.60
4.	Bytkomfort, s.r.o.	Nové Zámky	38.59	Duslo, a.s.	Šaľa	78.64
5.	P.G.TRADE, spol. s r.o.	Nové Zámky	21.66	Wienerberger slovenské tehelne, spol. s r.o.	Zlaté Moravce	72.61
6.	Dalkia Vráble a.s.	Nitra	20.52	Secop s.r.o.	Zlaté Moravce	36.46
7.	DECODOM, spol. s r. o.	Topoľčany	20.07	Bioplyn Cetín, s.r.o.	Nitra	14.52
8.	AT GEMER, spol. s r.o.	Nové Zámky	17.40	Roľnícke družstvo Vrbová nad Váhom	Komárno	12.96
9.	Nitrianska teplárenská spoločnosť, a.s.	Nitra	17.08	BIOGAS, s.r.o.	Nitra	12.58
10.	COM-therm, spol. s r.o.	Komárno	16.31	Dalkia Vráble a.s.	Nitra	12.37

ŽILINA REGION

	PM			SO_2		
	Source	District	Emis. [t]	Source	District	Emis. [t]
1.	Mondi SCP, a.s.	Ružomberok	145.91	Žilinská teplárenská, a.s.	Žilina	431.90
2.	DOLVAP, s.r.o.	Žilina	125.09	OFZ, a.s.	Dolný Kubín	365.55
3.	OFZ, a.s.	Dolný Kubín	44.16	Martinská teplárenská, a.s.	Martin	346.37
4.	Žilinská teplárenská, a.s.	Žilina	41.90	Mondi SCP, a.s.	Ružomberok	229.39
5.	TEHOS, s.r.o.	Dolný Kubín	11.80	SOTE s.r.o.	Čadca	77.83
6.	CEMEX Aggregates Slovakia, s.r.o.	Kys. N. Mesto	11.58	ŽOS Vrútky a.s.	Martin	62.28
7.	KIA Motors Slovakia s.r.o.	Žilina	9.63	AFG, s.r.o.	Turč. Teplice	12.83
8.	D O L K A M Šuja, a.s.	Žilina	9.14	DOLVAP, s.r.o.	Žilina	11.37
9.	Amico Drevo, s.r.o.	Dolný Kubín	8.91	BPS BORCOVA, s.r.o.	Turč. Teplice	7.65
10.	CEMEX Aggregates Slovakia, s.r.o.	Bytča	8.78	ZDROJ MT, spol. s r.o.	Martin	7.33
	NO_x			CO		
	Source	District	Emis. [t]	Source	District	Emis. [t]
1.	Mondi SCP, a.s.	Ružomberok	913.68	DOLVAP, s.r.o.	Žilina	1630.12
2.	OFZ, a.s.	Dolný Kubín	389.99	OFZ, a.s.	Dolný Kubín	888.16
3.	Žilinská teplárenská, a.s.	Žilina	380.23	Mondi SCP, a.s.	Ružomberok	411.33
4.	Martinská teplárenská, a.s.	Martin	217.63	LMT, a.s.	Lipt. Mikuláš	171.31
5.	Rettenmeier Tatra Timber, s.r.o.	Lipt. Mikuláš	124.39	SOTE s.r.o.	Čadca	97.05
6.	SPECIALTY MINERALS SLOVAKIA, s.r.o.	Ružomberok	64.76	PELCKO s.r.o.	Ružomberok	87.20
7.	KIA Motors Slovakia s.r.o.	Žilina	48.61	Rettenmeier Tatra Timber, s.r.o.	Lipt. Mikuláš	59.83
8.	LMT, a.s.	Lipt. Mikuláš	38.45	TURZOVSKÁ DREVÁRSKA FABRIKA s.r.o.	Čadca	53.62
9.	TEHOS, s.r.o.	Dolný Kubín	26.38	Žilinská teplárenská, a.s.	Žilina	46.09
10.	SOTE s.r.o.	Čadca	24.15	ŽOS Vrútky a.s.	Martin	44.39

BAN. BYSTRICA REGION

	PM			SO_2		
	Source	District	Emis. [t]	Source	District	Emis. [t]
1.	Slovalco, a.s.	Žiar n/H	118.87	Slovalco, a.s.	Žiar n/H	2078.52
2.	Knauf Insulation, s.r.o.	Žarnovica	41.43	Zvolenská teplárenská, a.s.	Zvolen	633.45
3.	Energy Edge ZC s.r.o.	Žarnovica	29.15	Knauf Insulation, s.r.o.	Žarnovica	286.02
4.	Zvolenská teplárenská, a.s.	Zvolen	26.67	Dalkia Industry Žiar n/H, a.s.	Žiar n/H	215.38
5.	SLOVMAG a.s. Lubeník	Revúca	13.96	SLOVMAG a.s. Lubeník	Revúca	90.94
6.	Dalkia Industry Žiar n/H, a.s.	Žiar n/H	13.88	KOMPALA a.s.	Ban. Bystrica	77.05
7.	Bučina DDD, spol. s r.o.	Zvolen	9.67	VUM, a.s.	Žiar n/H	48.08
8.	Nemak Slovakia s.r.o.	Žiar n/H	9.58	Slovenské magnezit.závody, a.s. Jelšava	Revúca	37.50
9.	Bytes, spol. s r.o.	Detva	9.34	Družstvo Agrospol, družstvo	Lučenec	12.23
10.	ZLH Plus, a.s.	Brezno	8.83	Ministerstvo obrany Slovenskej republiky	Brezno	11.19
	NO_x			CO		
	Source	District	Emis. [t]	Source	District	Emis. [t]
1.	Slovenské magnezit. závody, a.s. Jelšava	Revúca	737.83	Slovalco, a.s.	Žiar n/H	14062.24
2.	Slovalco, a.s.	Žiar n/H	492.92	Slovenské magnezit. závody, a.s. Jelšava	Revúca	2120.77
3.	Zvolenská teplárenská, a.s.	Zvolen	458.41	VUM, a.s.	Žiar n/H	334.68
4.	Dalkia Industry Žiar n/H, a.s.	Žiar n/H	206.62	SLOVMAG a.s. Lubeník	Revúca	304.02
5.	SLOVMAG a.s. Lubeník	Revúca	174.58	Železiarne Podbrezová a.s.	Brezno	272.39
6.	KOMPALA a.s.	Ban. Bystrica	113.10	Dalkia Industry Žiar n/H, a.s.	Žiar n/H	131.86
7.	Železiarne Podbrezová a.s.	Brezno	111.46	Energy Edge ZC s.r.o.	Žarnovica	131.58
8.	Energy Edge ZC s.r.o.	Žarnovica	101.19	STEFE ECB, s.r.o.	Rim. Sobota	99.74
9.	Bučina DDD, spol. s r.o.	Zvolen	99.49	Calmit, spol. s r.o.	Rim. Sobota	91.32
10.	BUČINA ZVOLEN, a.s.	Zvolen	96.18	Zvolenská teplárenská, a.s.	Zvolen	83.99

PREŠOV REGION

	PM			SO₂		
	Source	District	Emis. [t]	Source	District	Emis. [t]
1.	BUKOCEL, a.s.	Vranov n/T	133.25	BUKÓZA ENERGO, a.s.	Vranov n/T	1413.90
2.	BUKÓZA ENERGO, a.s.	Vranov n/T	28.44	BUKOCEL, a.s.	Vranov n/T	103.37
3.	BIOENERGY BARDEJOV, s.r.o.	Bardejov	13.36	ZEOCEM, a.s.	Vranov n/T	11.65
4.	CHEMES, a.s. Humenné	Humenné	10.65	Roľnícke družstvo v Plavnici	Stará Ľubovňa	9.00
5.	BYTENERG spol. s r.o.	Medzilaborce	8.47	CHEMES, a.s. Humenné	Humenné	7.80
6.	TATRAVAGÓNKA a.s.	Poprad	5.20	MM ENERG, s.r.o.	Vranov n/T	5.31
7.	ZEOCEM, a.s.	Vranov n/T	5.13	AGROKOMPLEX, spol. s r.o. Humenné	Humenné	5.25
8.	Domov sociál. služieb v Spišskom Štvrtku	Levoča	4.04	BPS Ladomirová, s.r.o.	Svidník	4.58
9.	SPRAVBYTKOMFORT a.s. Prešov	Prešov	3.38	BPS Huncovce, s.r.o.	Kežmarok	2.71
10.	JAVORINA, výrobné družstvo	Kežmarok	2.85	Základná škola v Malcove	Bardejov	2.65
	NO_x			CO		
	Source	District	Emis. [t]	Source	District	Emis. [t]
1.	BUKÓZA ENERGO, a.s.	Vranov n/T	519.30	BUKOCEL, a.s.	Vranov n/T	603.36
2.	BUKOCEL, a.s.	Vranov n/T	114.53	Schüle Slovakia, s.r.o.	Poprad	154.91
3.	SPRAVBYTKOMFORT a.s. Prešov	Prešov	85.73	BUKÓZA ENERGO, a.s.	Vranov n/T	138.11
4.	BIOENERGY BARDEJOV, s.r.o.	Bardejov	83.01	Leier Baustoffe SK s.r.o.	Prešov	87.98
5.	CHEMES, a.s. Humenné	Humenné	28.71	CHEMES, a.s. Humenné	Humenné	39.30
6.	CHEMOSVIT ENERGOCHEM, a.s.	Poprad	23.94	SPRAVBYTKOMFORT a.s. Prešov	Prešov	30.07
7.	Dalkia Poprad a.s.	Poprad	17.15	Teplo GGE s.r.o.	Snina	29.00
8.	AGROKOMPLEX, spol. s r.o. Humenné	Humenné	12.55	Spravbytherm s.r.o.	Kežmarok	23.98
9.	Energy Snina, a.s.	Snina	12.27	BYTENERG spol. s r.o.	Medzilaborce	16.52
10.	ZEOCEM, a.s.	Vranov n/T	9.08	CHEMOSVIT FOLIE, a.s.	Poprad	11.29

KOŠICE REGION

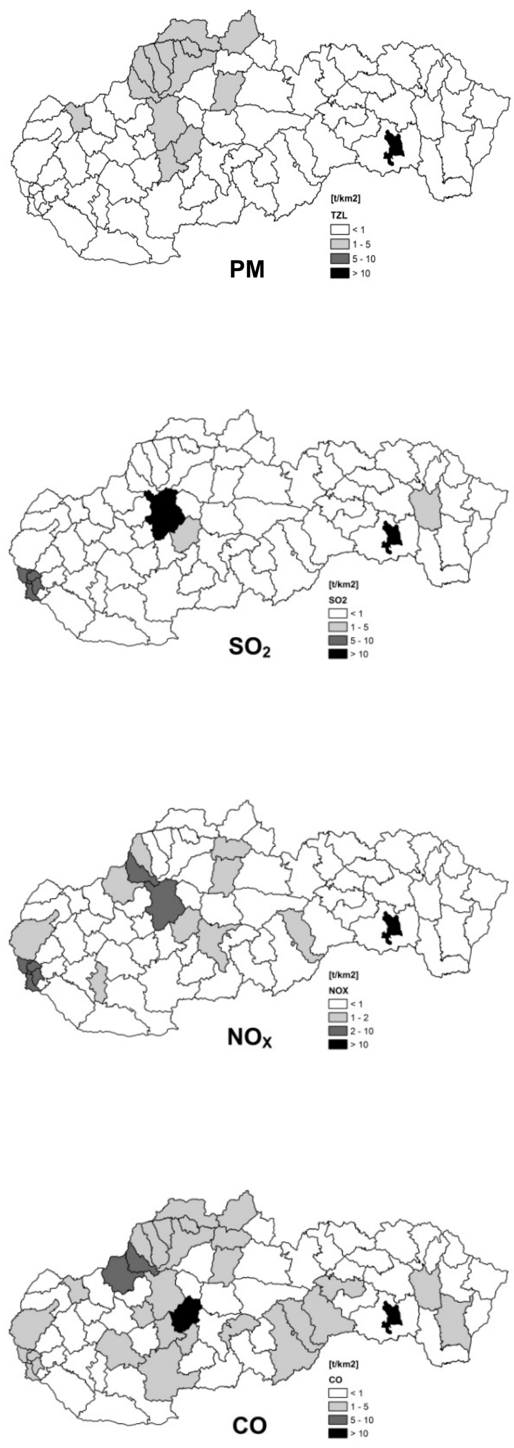
	PM			SO_2		
	Source	District	Emis. [t]	Source	District	Emis. [t]
1.	U. S. Steel Košice, s.r.o.	Košice II	3335.14	U. S. Steel Košice, s.r.o.	Košice II	6623.53
2.	Tepláreň Košice, a.s.	Košice IV	84.70	Tepláreň Košice, a.s.	Košice IV	1035.12
3.	Carmeuse Slovakia, s.r.o.	Košice - okolie	65.56	Slovenské elektrárne, a.s.	Michalovce	455.71
4.	Slovenské elektrárne, a.s.	Michalovce	35.31	TP 2, s.r.o.	Michalovce	71.01
5.	Carmeuse Slovakia, s.r.o.	Košice II	12.29	Slov. magnezitové závody, a.s. Jelšava	Košice II	50.94
6.	Holcim (Slovensko) a.s.	Košice - okolie	10.83	KOVOHUTY, a.s.	Spišská N. Ves	25.16
7.	Mesto Sobrance	Sobrance	9.37	Bioplyn Rozhanovce, s.r.o.	Košice - okolie	20.43
8.	Tepelné hospodárstvo Moldava, a.s.	Košice - okolie	8.78	RMS, a.s. Košice	Košice II	16.21
9.	RMS, a.s. Košice	Košice II	8.75	Holcim (Slovensko) a.s.	Košice - okolie	13.52
10.	Carmeuse Slovakia, s.r.o.	Rožňava	6.12	Poľnohospodárske družstvo VINOHRADY Choňkovce	Sobrance	8.04
	NO_x			CO		
	Source	District	Emis. [t]	Source	District	Emis. [t]
1.	U. S. Steel Košice, s.r.o.	Košice II	6712.75	U. S. Steel Košice, s.r.o.	Košice II	113647.27
2.	Tepláreň Košice, a.s.	Košice IV	1240.77	Slovenské elektrárne, a.s.	Michalovce	338.85
3.	Holcim (Slovensko) a.s.	Košice - okolie	556.85	HNOJIVÁ Duslo, s.r.o.	Michalovce	305.72
4.	Carmeuse Slovakia, s.r.o.	Košice II	407.63	SLOVAKIA STEEL MILLS, a.s.	Michalovce	229.11
5.	eustream, a.s.	Michalovce	175.47	Slov. magnezitové závody, a.s. Jelšava	Košice II	206.76
6.	Slovenské elektrárne, a.s.	Michalovce	99.52	KOVOHUTY, a.s.	Spišská N. Ves	199.67
7.	Košická energetická spoločnosť, a.s.	Košice IV	86.62	Košická energetická spoločnosť, a.s.	Košice IV	176.19
8.	HNOJIVÁ Duslo, s.r.o.	Michalovce	61.47	Carmeuse Slovakia, s.r.o.	Košice II	109.39
9.	SLOVAKIA STEEL MILLS, a.s.	Michalovce	61.38	Tepelné hospodárstvo Moldava, a.s.	Košice - okolie	93.59
10.	KOSIT a.s.	Košice IV	59.10	Tepláreň Košice, a.s.	Košice IV	81.65

**According to the Decree of MŽP SR No. 410/2012 Coll.*

Tab. 4.6 **Stationary source emissions by districts in 2014**

District	Emissions [t.year^{-1}]				Specific territorial emis. [t.year^{-1}.km^{-2}]			
	PM	SO_2	NO_x	CO	PM	SO_2	NO_x	CO
1. Bratislava	226	2284	2306	812	0.61	6.21	6.27	2.21
2. Malacky	296	173	1797	1704	0.31	0.18	1.89	1.79
3. Pezinok	108	15	80	181	0.29	0.04	0.21	0.48
4. Senec	103	13	116	155	0.29	0.04	0.32	0.43
5. Dun. Streda	411	46	258	531	0.38	0.04	0.24	0.49
6. Galanta	281	294	345	413	0.44	0.46	0.54	0.64
7. Hlohovec	129	16	163	194	0.48	0.06	0.61	0.73
8. Piešťany	229	27	128	307	0.60	0.07	0.34	0.80
9. Senica	342	35	144	583	0.50	0.05	0.21	0.85
10. Skalica	219	16	90	277	0.61	0.04	0.25	0.77
11. Trnava	283	142	410	367	0.38	0.19	0.55	0.49
12. Bánovce n/B	237	18	73	302	0.51	0.04	0.16	0.65
13. Ilava	502	33	1071	3064	1.40	0.09	2.99	8.55
14. Myjava	348	32	115	522	1.06	0.10	0.35	1.59
15. Nové Mesto n/V	325	25	123	422	0.56	0.04	0.21	0.73
16. Partizánske	158	19	117	345	0.52	0.06	0.39	1.15
17. Považská Bystrica	599	47	232	837	1.29	0.10	0.50	1.81
18. Prievidza	1199	24780	3597	1608	1.25	25.82	3.75	1.68
19. Púchov	524	64	529	678	1.40	0.17	1.41	1.81
20. Trenčín	384	88	981	3984	0.57	0.13	1.45	5.90
21. Komárno	419	31	224	565	0.38	0.03	0.20	0.51
22. Levice	1067	93	450	1588	0.69	0.06	0.29	1.02
23. Nitra	341	96	289	1417	0.39	0.11	0.33	1.63
24. Nové Zámky	603	85	317	895	0.45	0.06	0.24	0.66
25. Šaľa	251	13	687	250	0.71	0.04	1.93	0.70
26. Topoľčany	215	20	254	281	0.36	0.03	0.43	0.47
27. Zlaté Moravce	248	19	99	419	0.48	0.04	0.19	0.80
28. Bytča	413	31	108	511	1.47	0.11	0.38	1.81
29. Čadca	1190	171	318	1635	1.56	0.22	0.42	2.15
30. Dolný Kubín	376	390	504	1319	0.76	0.79	1.02	2.68
31. Kysucké Nové Mesto	265	19	94	331	1.53	0.11	0.54	1.91
32. Lipt. Mikuláš	621	51	357	1039	0.46	0.04	0.27	0.77
33. Martin	470	453	375	668	0.64	0.62	0.51	0.91
34. Námestovo	1179	105	264	1503	1.71	0.15	0.38	2.18
35. Ružomberok	839	285	1174	1384	1.30	0.44	1.82	2.14
36. Turčianske Teplice	218	39	96	290	0.56	0.10	0.24	0.74
37. Tvrdošín	182	16	71	229	0.38	0.03	0.15	0.48
38. Žilina	1028	513	744	2823	1.26	0.63	0.91	3.46
39. Ban. Bystrica	546	125	405	760	0.67	0.15	0.50	0.94
40. Banská Štiavnica	258	22	61	325	0.88	0.08	0.21	1.11
41. Brezno	643	73	286	1176	0.51	0.06	0.23	0.93
42. Detva	440	35	155	583	0.98	0.08	0.35	1.30
43. Krupina	366	44	105	475	0.63	0.08	0.18	0.81
44. Lučenec	642	61	194	816	0.78	0.07	0.24	0.99
45. Poltár	212	18	63	288	0.45	0.04	0.13	0.61
46. Revúca	519	174	1074	3079	0.71	0.24	1.47	4.22
47. Rim. Sobota	1146	94	429	1615	0.78	0.06	0.29	1.10
48. Veľký Krtíš	521	56	183	722	0.61	0.07	0.22	0.85
49. Zvolen	364	660	775	597	0.48	0.87	1.02	0.79
50. Žarnovica	522	322	278	718	1.23	0.76	0.65	1.69
51. Žiar n/H	550	2377	836	15104	1.06	4.59	1.61	29.18
52. Bardejov	428	35	187	523	0.46	0.04	0.20	0.56
53. Humenné	357	42	139	495	0.47	0.06	0.18	0.66
54. Kežmarok	436	37	140	580	0.69	0.06	0.22	0.92
55. Levoča	221	18	57	271	0.53	0.04	0.14	0.64
56. Medzilaborce	193	14	45	245	0.45	0.03	0.10	0.57
57. Poprad	290	23	173	557	0.26	0.02	0.16	0.50
58. Prešov	484	37	251	727	0.52	0.04	0.27	0.78
59. Sabinov	413	31	115	522	0.76	0.06	0.21	0.96
60. Snina	434	32	136	587	0.54	0.04	0.17	0.73
61. Stará Ľubovňa	531	51	145	670	0.75	0.07	0.20	0.95
62. Stropkov	146	11	38	186	0.38	0.03	0.10	0.48
63. Svidník	275	26	75	349	0.50	0.05	0.14	0.63
64. Vranov n/Topľou	514	1560	738	1187	0.67	2.03	0.96	1.54
65. Gelnica	408	32	97	524	0.70	0.05	0.17	0.90
66. Košice	3511	7742	8611	114352	14.40	31.77	35.33	469.15
67. Košice - okolie	875	107	824	1159	0.57	0.07	0.54	0.75
68. Michalovce	191	544	546	1151	0.19	0.53	0.54	1.13
69. Rožňava	916	72	239	1210	0.78	0.06	0.20	1.03
70. Sobrance	185	30	70	253	0.34	0.06	0.13	0.47
71. Spišská N. Ves	376	56	141	737	0.64	0.09	0.24	1.26
72. Trebišov	384	34	144	498	0.36	0.03	0.13	0.46
Slovakia	35125	45193	36852	187474	0.72	0.92	0.75	3.82

Fig. 4.3 **Specific territorial emission in 2014**



Tab. 4.7 **NMVOC emissions [kt] according to the international NFR* structure in 2001, 2005 – 2013 (Part 1)**

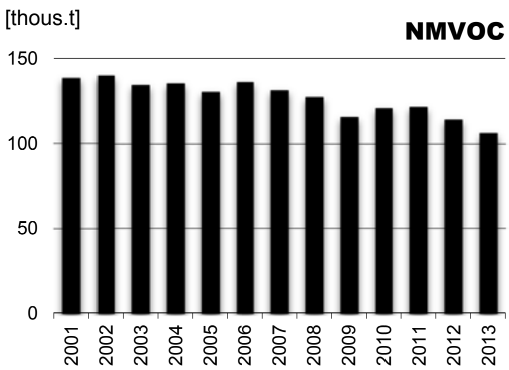
	NFR	Sector name	2001	2005	2006	2007	2008	2009	2010	2011	2012	2013
Energy industry	1A1a	Public electricity and heat production	0.339	0.283	0.261	0.234	0.249	0.245	0.259	0.259	0.247	0.234
	1A1b	Petroleum refining	2.046	1.091	2.241	2.111	1.138	1.166	0.911	0.781	0.685	0.723
	1A1c	Manufacture of solid fuels and other energy industries	0.883	1.174	0.756	0.755	0.402	0.383	0.453	0.386	0.334	0.396
Combustion in industry	1A2a	Iron and steel	0.389	0.792	0.569	0.569	0.534	0.585	0.687	0.747	0.778	0.744
	1A2b	Non-ferrous metals	0.015	0.210	0.118	0.228	0.245	0.219	0.224	0.211	0.120	0.106
	1A2c	Chemicals	1.294	1.275	0.417	0.403	0.827	0.676	0.595	0.902	0.927	1.039
	1A2d	Pulp, Paper and Print	0.262	0.258	0.348	0.362	0.387	0.364	0.311	0.328	0.404	0.406
	1A2e	Food processing, beverages and tobacco	0.097	0.030	0.028	0.024	0.021	0.019	0.018	0.018	0.017	0.016
	1A2f	Non-metallic minerals	0.222	0.286	0.291	0.374	0.378	0.199	0.311	0.381	0.265	0.223
	1A2gviii	Other	0.200	0.326	0.349	0.375	0.370	0.275	0.301	0.328	0.352	0.340
Transport	1A3ai(i)	International aviation LTO (civil)	IE	0.026	0.030	0.032	0.036	0.027	0.025	0.025	0.022	0.021
	1A3aii(i)	Domestic aviation LTO (civil)	0.087	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.002
	1A3bi	Road transport: Passenger cars	12.407	8.499	6.959	5.004	5.730	5.122	4.380	3.763	3.601	3.465
	1A3bii	Road transport: Light duty vehicles	0.416	0.375	0.314	0.294	0.281	0.259	0.284	0.299	0.305	0.276
	1A3biii	Road transport: Heavy duty vehicles and buses	1.493	1.971	2.190	2.505	2.006	1.524	1.587	1.398	1.405	1.432
	1A3biv	Road transport: Mopeds & motorcycles	1.294	1.129	0.899	0.907	0.818	0.421	0.304	0.282	0.276	0.234
	1A3bv	Road transport: Gasoline evaporation	3.388	1.480	1.422	1.166	1.047	0.885	0.614	0.558	0.474	0.404
	1A3c	Railways	0.246	0.171	0.182	0.174	0.160	0.138	0.141	0.136	0.115	0.129
	1A3dii	National navigation (shipping)	0.191	0.243	0.204	0.231	0.211	0.200	0.304	0.244	0.255	0.229
	1A3ei	Pipeline transport	0.110	0.276	0.175	0.098	0.127	0.259	0.227	0.244	0.146	0.164
Other combustion	1A4ai	Commercial/institutional: Stationary	0.864	0.316	0.284	0.236	0.229	0.211	0.217	0.198	0.206	0.231
	1A4bi	Residential: Stationary	8.610	12.202	11.403	11.398	12.042	11.534	11.182	12.100	12.169	12.392
	1A4ci	Agriculture/Forestry/Fishing: Stationary	0.043	0.044	0.026	0.023	0.015	0.015	0.235	0.235	0.235	0.235
	1A5a	Other stationary (including military)	0.930	0.960	1.375	1.807	1.833	1.675	3.537	3.537	3.537	3.537
Fugitive emissions	1B1b	Solid fuel transformation	0.719	0.783	0.787	0.783	0.720	0.450	0.900	0.684	0.662	0.648
	1B2ai	Oil exploration, production, transport	3.848	4.310	4.484	4.267	4.275	4.328	4.040	3.976	3.373	3.921
	1B2aiv	Oil refining / storage	6.306	4.058	3.469	3.166	2.804	2.623	2.585	2.636	2.398	2.808
	1B2av	Distribution of oil products	0.632	0.508	0.448	0.433	0.661	0.614	0.642	0.599	0.550	0.547
Industrial processes	2A6	Other mineral products	0.010	0.008	0.008	0.003	0.003	0.002	0.001	0.001	0.002	0.004
	2B10a	Chemical industry: Other	1.140	0.232	0.232	0.202	0.714	0.411	0.284	0.259	0.178	0.171
	2B10b	Storage, handling and transport of chemical products	3.625	1.785	1.536	1.741	1.662	1.345	1.381	1.363	1.206	1.375
	2C1	Iron and steel production	0.303	0.382	0.408	0.419	0.388	0.331	0.362	0.343	0.353	0.362
	2C2	Ferroalloys production	0.016	0.000	0.011	0.006	0.015	0.011	0.006	0.006	0.008	0.010
	2C7c	Other metal production	0.050	0.044	0.032	0.026	0.037	0.018	0.023	0.078	0.058	0.027
	2D3a	Domestic solvent use including fungicides	4.196	4.202	4.205	4.210	4.217	4.226	4.236	4.208	4.218	4.222
	2D3b	Road paving with asphalt	0.011	0.024	0.035	0.025	0.031	0.019	0.018	0.023	0.019	0.019
	2D3c	Asphalt roofing	0.006	0.006	0.004	0.004	0.003	0.003	0.002	0.002	0.002	0.003
	2D3d	Coating applications	22.542	25.789	30.372	30.372	27.319	23.954	30.506	27.786	26.294	29.306
	2D3e	Degreasing	6.837	6.961	7.143	6.100	5.710	5.145	3.845	8.914	3.220	4.156
	2D3f	Dry cleaning	0.071	0.064	0.064	0.051	0.062	0.051	0.054	0.056	0.045	0.039
	2D3g	Chemical products	9.138	9.698	9.219	10.639	12.704	10.531	9.879	8.406	8.935	0.348
	2D3h	Printing	7.403	6.554	8.305	7.526	7.652	6.540	7.278	7.545	7.570	3.012
	2D3i	Other solvent use	1.031	0.839	0.832	1.142	0.978	0.788	0.870	1.098	1.050	0.692
	2H1	Pulp and paper industry	0.158	0.074	0.070	0.071	0.148	0.133	0.047	0.052	0.055	0.011
	2H2	Food and beverages industry	0.561	0.311	0.311	0.312	0.322	0.324	0.301	0.296	0.289	0.276
	2H3	Other industrial processes	0.031	0.051	0.061	0.043	0.064	0.094	0.093	0.025	0.032	0.024

Tab. 4.7 **NMVOC emissions [kt] according to the international NFR* structure in 2001, 2005 – 2013 (Part 2)**

	NFR	Sector name	2001	2005	2006	2007	2008	2009	2010	2011	2012	2013
Agriculture	3B1a	Manure management - Dairy cattle	9.424	8.346	7.948	7.839	7.676	7.420	7.429	7.317	7.364	7.232
	3B1b	Manure management - Non-dairy cattle	8.621	7.028	6.813	6.742	6.532	6.310	6.190	6.174	6.326	6.334
	3B2	Manure management - Sheep	0.053	0.054	0.056	0.059	0.061	0.064	0.067	0.067	0.692	0.068
	3B3	Manure management - Swine	0.966	0.702	0.697	0.596	0.464	0.459	0.426	0.363	0.394	0.398
	3B4d	Manure management - Goats	0.022	0.021	0.021	0.021	0.020	0.019	0.019	0.018	0.019	0.019
	3B4e	Manure management - Horses	0.034	0.036	0.035	0.034	0.036	0.031	0.030	0.030	0.031	0.031
	3B4gi	Manure mangement - Laying hens	1.273	0.923	0.941	0.953	0.917	1.032	1.034	1.020	1.034	0.937
	3B4gii	Manure mangement - Broilers	3.425	3.851	3.298	3.182	2.531	3.351	3.058	2.321	2.494	2.318
	3B4giii	Manure mangement - Turkeys	0.171	0.088	0.080	0.078	0.062	0.060	0.057	0.060	0.064	0.068
	3B4giv	Manure management - Other poultry	0.140	0.139	0.133	0.135	0.109	0.103	0.103	0.097	0.096	0.110
	3Db	Indirect emissions from managed soils	1.665	1.487	1.450	1.458	1.437	1.456	1.385	1.434	1.455	1.481
Waste management	5A	Biological treatment of waste - Solid waste disposal on land	6.975	6.419	10.969	8.680	7.146	6.367	5.942	6.419	6.263	7.704
	5B1	Biological treatment of waste - Composting	NE	NE	NE	NE	NE	NE	NE	NE	0.001	0.003
	5C1bi	Industrial waste incineration	0.044	0.037	0.078	0.059	0.023	0.015	0.061	0.026	0.055	0.051
	5C1biii	Clinical waste incineration	0.028	0.066	0.021	0.026	0.043	0.014	0.036	0.012	0.013	0.008
	5C1bv	Cremation	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	5D1	Domestic wastewater handling	0.090	0.205	0.228	0.121	0.218	0.219	0.228	0.239	0.213	0.226
	5D2	Industrial wastewater handling	1.046	0.672	0.397	0.316	0.316	0.099	0.100	0.028	0.029	0.082
	TOTAL		**138.4**	**130.2**	**136.0**	**131.2**	**127.2**	**115.4**	**120.6**	**121.3**	**113.9**	**106.0**

Emissions estimated to February 15th 2016.
IE = included in other sector, NE=not estimated
** Nomenclature for reporting (EMEP) corresponding to EMEP/EEA air pollutant emission inventory guidebook 2013*

Fig. 4.4 **Development trends in NMVOC**

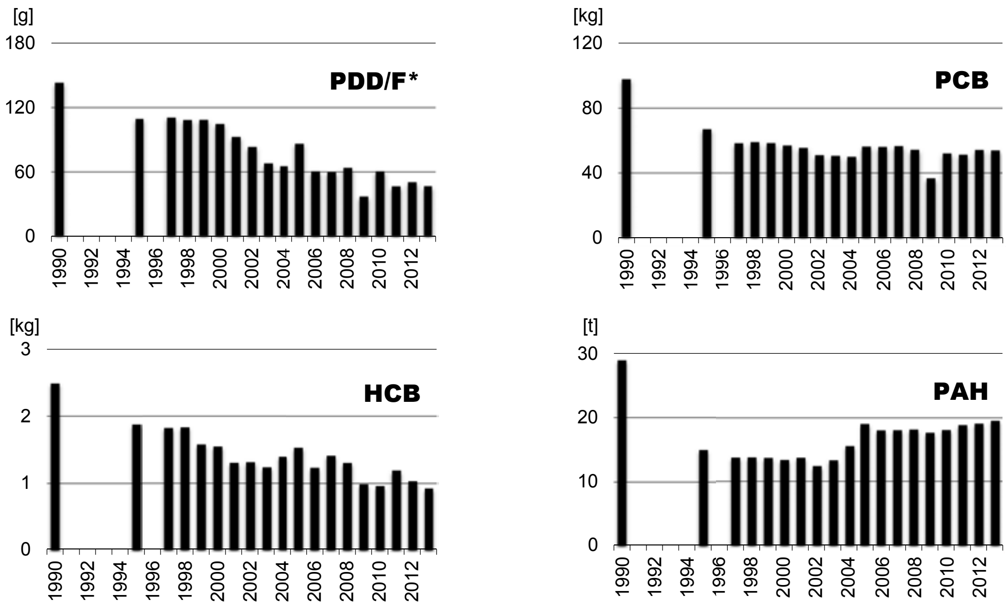


Tab. 4.8 **Emissions of persistent organic pollutants in the SR in 2013**

Sector / Subsector	PCDD/F*	PCB	HCB	PAH				
				sum PAH	B(a)P	B(k)F	B(b)F	I(1,2,3-cd)P
	[g]	[kg]	[kg]	[kg]	[kg]	[kg]	[kg]	[kg]
Combustion processes I	**6.386**	**0.464**	**0.188**	**1433.263**	**247.375**	**376.781**	**376.888**	**432.220**
Public power	1.695	0.427	0.164	14.534	0.076	7.109	7.216	0.133
District heating plants	0.372	0.038	0.024	19.479	0.049	9.672	9.672	0.087
Coke production	4.320	0.000	0.000	1399.250	247.250	360.000	360.000	432.000
Combustion processes II	**3.395**	**9.263**	**0.181**	**16512.250**	**4733.032**	**2055.785**	**6211.502**	**3511.930**
Commercial and institutional plants	0.066	0.007	0.004	2.971	0.010	1.468	1.476	0.017
Residential plants	3.324	9.255	0.177	16509.140	4733.019	2054.259	6209.955	3511.907
Agriculture	0.005	0.001	0.000	0.139	0.004	0.059	0.071	0.006
Combustion processes in industry	**23.079**	**4.118**	**0.205**	**123.933**	**66.231**	**23.488**	**27.045**	**7.158**
Comb. in boilers, gas turb. and stat. eng.	0.672	0.625	0.100	26.205	1.055	9.962	13.473	1.716
Iron production	0.362	0.023	0.000	61.486	61.486	0.000	0.000	0.000
Ore agglomeration	21.422	3.366	0.098	35.714	3.672	13.313	13.313	5.417
Cast iron production	0.099	0.019	0.000	0.016	0.003	0.005	0.005	0.003
Others	0.523	0.085	0.007	0.511	0.014	0.209	0.254	0.023
Production processes	**5.452**	**22.832**	**0.314**	**1329.755**	**479.770**	**394.805**	**403.734**	**51.446**
Aluminium production	0.366	0.061	0.000	599.470	195.955	189.428	189.428	24.658
Steel production	4.155	1.767		78.439	78.439	0.000	0.000	0.000
Carbon mineral production	0.000	0.000	0.000	651.846	205.376	205.376	214.306	26.788
Lead production	0.051	20.348	0,000	0,000	0,000	0,000	0,000	0,000
Others	0.879	0.656	0.314	0.000	0.000	0.000	0.000	0.000
Road transport	**0.350**	**14.935**	**0.012**	**146.142**	**22.193**	**49.056**	**50.013**	**24.880**
Other transport	**0.008**	**0.760**	**0.001**	**9.115**	**2.279**	**1.367**	**3.190**	**2.279**
Waste incineration	**8.632**	**1.589**	**0.037**	**127.835**	**36.342**	**24.923**	**48.429**	**18.140**
Municipal waste	0.069	0.920	0.017	6.750	0.122	3.300	0.030	3.300
Industrial waste	3.830	0.511	0.007	1.985	0.036	0.970	0.009	0.970
Hospital waste	3.994	0.080	0.000	0.311	0.006	0.152	0.152	0.001
Others	0.739	0.078	0.013	118.789	36.179	20.502	48.239	13.869
Total	**47.301**	**53.960**	**0.938**	**19682.293**	**5587.223**	**2926.205**	**7120.801**	**4048.053**

B(a)P - Benzo(a)pyrene, B(k)F - Benzo(k)fluorantene, B(b)F - Benzo(b)fluorantene, I(1,2,3-cd)P - Indeno(1,2,3-cd)pyrene
**Expressed as I-TEQ; I-TEQ is calculated from the values for 2,3,7,8 - substituted co-geners of PCDD and PCDF under using of I-TEF according NATO/CCMS (1988)*
Emissions estimated to March 15th, 2016

Fig. 4.5 **Development trends in POPs emissions**



Tab. 4.9 **PM_{10} and $PM_{2.5}$ emissions [kt] according to the international NFR structure in years 2009 – 2013 (Part 1)**

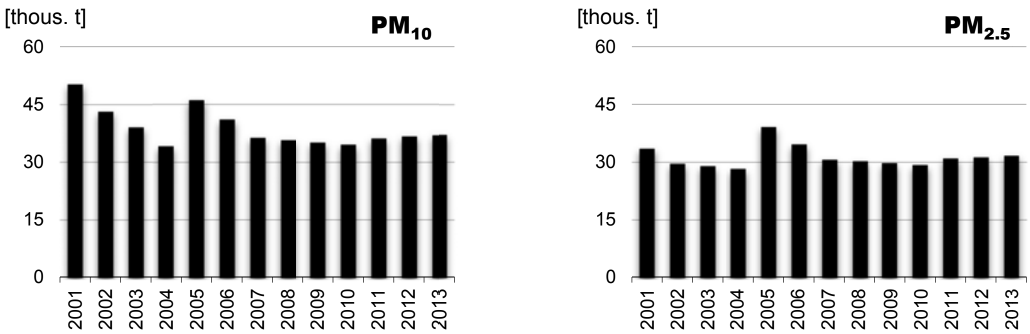
	NFR	Sector name	2009		2010		2011		2012		2013	
			$PM_{2.5}$	PM_{10}	$PM_{2.5}$	PM_{10}	$PM_{2.5}$	PM_{10}	$PM_{2.5}$	PM_{10}	$PM_{2.5}$	PM_{10}
Energy industry	1A1a	Public electricity and heat production	0.518	0.649	0.600	0.703	0.600	0.703	0.528	0.635	0.521	0.608
	1A1b	Petroleum refining	0.066	0.083	0.039	0.049	0.037	0.047	0.045	0.049	0.040	0.050
	1A1c	Manufacture of solid fuels and other energy industries	0.294	0.495	0.316	0.532	0.299	0.503	0.303	0.511	0.297	0.500
Combustion in industry	1A2a	Iron and steel	0.287	0.395	0.376	0.515	0.330	0.484	0.304	0.487	0.312	0.505
	1A2b	Non-ferrous metals	0.155	0.178	0.146	0.169	0.081	0.097	0.085	0.099	0.077	0.090
	1A2c	Chemicals	0.193	0.243	0.183	0.218	0.164	0.195	0.149	0.201	0.161	0.220
	1A2d	Pulp, Paper and Print	0.102	0.149	0.040	0.094	0.057	0.141	0.111	0.208	0.057	0.169
	1A2e	Food processing, beverages and tobacco	0.019	0.036	0.019	0.036	0.018	0.037	0.016	0.034	0.018	0.038
	1A2f	Non-metallic minerals	0.160	0.277	0.154	0.243	0.133	0.214	0.102	0.103	0.106	0.173
	1A2gviii	Other	0.243	0.325	0.174	0.232	0.164	0.216	0.181	0.305	0.149	0.199
Transport	1A3ai(i)	International aviation LTO (civil)	0.006	0.006	0.007	0.007	0.007	0.007	0.005	0.005	0.006	0.006
	1A3aii(i)	Domestic aviation LTO (civil)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	1A3bi	Road transport: Passenger cars	0.203	0.203	0.270	0.270	0.322	0.322	0.374	0.374	0.351	0.351
	1A3bii	Road transport: Light duty vehicles	0.160	0.160	0.188	0.188	0.158	0.158	0.167	0.167	0.147	0.147
	1A3biii	Road transport: Heavy duty vehicles and buses	0.717	0.717	0.779	0.779	0.685	0.685	0.673	0.673	0.691	0.691
	1A3biv	Road transport: Mopeds & motorcycles	0.009	0.009	0.007	0.007	0.007	0.007	0.007	0.007	0.006	0.006
	1A3bvi	Road transport: Automobile tyre and brake wear	0.294	0.552	0.316	0.596	0.300	0.566	0.324	0.610	0.311	0.587
	1A3bvii	Road transport: Automobile road abrasion	0.176	0.325	0.191	0.352	0.179	0.330	0.192	0.354	0.187	0.345
	1A3c	Railways	0.105	0.111	0.107	0.113	0.036	0.038	0.031	0.032	0.038	0.040
	1A3dii	National navigation (shipping)	0.153	0.161	0.162	0.171	0.065	0.068	0.068	0.072	0.006	0.006
Other combustion	1A4ai	Commercial/institutional: Stationary	0.102	0.137	0.114	0.147	0.117	0.147	0.128	0.156	0.105	0.127
	1A4bi	Residential: Stationary	23.311	25.353	22.431	24.508	24.573	26.722	24.734	26.931	25.318	27.483
	1A4ci	Agriculture/Forestry/Fishing: Stationary	0.031	0.068	0.030	0.084	0.030	0.084	0.030	0.084	0.030	0.084
	1A5a	Other stationary (including military)	0.016	0.032	0.023	0.042	0.023	0.042	0.023	0.042	0.023	0.042
Industrial processes	2A2	Lime production	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	2A3	Glass production	0.000	0.000	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
	2A5b	Construction and demolition	NE	NE	0.011	0.106	0.009	0.094	0.010	0.096	0.009	0.092
	2A6	Other mineral products	0.007	0.012	0.001	0.004	0.001	0.004	0.001	0.004	0.002	0.004
	2B10a	Chemical industry: Other	0.034	0.055	0.035	0.056	0.060	0.097	0.053	0.088	0.055	0.091
	2C1	Iron and steel production	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.003	0.004
	2C2	Ferroalloys production	0.010	0.012	0.020	0.025	0.010	0.012	0.008	0.010	0.009	0.012
	2C7c	Other metal production	0.030	0.037	0.038	0.046	0.037	0.045	0.056	0.067	0.052	0.062
	2D3b	Road paving with asphalt	0.000	0.000	0.000	0.000	IE	IE	0.000	0.000	IE	IE
	2D3g	Chemical products	0.008	0.010	0.008	0.011	0.006	0.008	0.005	0.006	0.005	0.006
	2H2	Food and beverages industry	0.003	0.013	0.003	0.014	0.003	0.013	0.003	0.011	0.003	0.012
	2H3	Other industrial processes	0.002	0.008	0.002	0.009	0.003	0.010	0.002	0.010	0.002	0.010
	2L	Other production, consumption, storage, transportation or handling of bulk products	0.001	0.003	0.001	0.002	0.001	0.003	0.001	0.003	0.001	0.002

Tab. 4.9 **PM_{10} and $PM_{2.5}$ emissions [kt] according to the international NFR structure in years 2009 – 2013 (Part 2)**

	NFR	Sector name	2009		2010		2011		2012		2013	
			$PM_{2.5}$	PM_{10}	$PM_{2.5}$	PM_{10}	$PM_{2.5}$	PM_{10}	$PM_{2.5}$	PM_{10}	$PM_{2.5}$	PM_{10}
Agriculture	3B1a	Manure management - Dairy cattle	0.031	0.047	0.031	0.047	0.030	0.046	0.030	0.047	0.030	0.046
	3B1b	Manure management - Non-dairy cattle	0.022	0.034	0.022	0.033	0.022	0.033	0.022	0.034	0.022	0.034
	3B2	Manure management - Sheep	0.006	0.021	0.007	0.022	0.007	0.022	0.007	0.023	0.007	0.022
	3B3	Manure management - Swine	0.052	0.271	0.048	0.252	0.041	0.215	0.044	0.233	0.045	0.235
	3B4d	Manure management - Goats	0.001	0.002	0.001	0.002	0.001	0.002	0.001	0.002	0.001	0.002
	3B4e	Manure management - Horses	0.001	0.002	0.001	0.002	0.001	0.002	0.001	0.002	0.001	0.002
	3B4gi	Manure mangement - Laying hens	0.019	0.156	0.019	0.157	0.019	0.155	0.019	0.157	0.017	0.142
	3B4gii	Manure mangement - Broilers	0.062	0.473	0.056	0.431	0.043	0.327	0.046	0.352	0.043	0.327
	3B4giii	Manure mangement - Turkeys	0.009	0.064	0.008	0.060	0.009	0.064	0.009	0.068	0.010	0.072
	3B4giv	Manure management - Other poultry	0.005	0.033	0.005	0.033	0.004	0.030	0.004	0.031	0.005	0.035
	3De	Cultivated crops	0.135	1.248	0.142	1.150	0.148	1.165	0.156	1.217	0.149	1.176
Waste management	5A	Biological treatment of waste - Solid waste disposal on land	0.000	0.001	0.000	0.001	0.000	0.001	0.000	0.001	0.000	0.001
	5C1bi	Industrial waste incineration	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	5C1biii	Clinical waste incineration	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	5C1bv	Cremation	1.735	1.735	1.840	1.840	1.833	1.833	1.926	1.927	1.969	1.969
	5E	Other waste	0.235	0.235	0.235	0.235	0.250	0.250	0.248	0.248	0.239	0.239
		TOTAL	**29.727**	**35.135**	**29.206**	**34.594**	**30.921**	**36.244**	**31.236**	**36.776**	**31.635**	**37.064**

Emissions estimated to February 15th, 2016
IE = included in other sector, NE=not estimated
** Nomenclature for reporting (EMEP) corresponding to EMEP/EEA air pollutant emission inventory guidebook 2013*

Fig. 4.6 **Development trends in PM_{10} and $PM_{2.5}$ emissions**



Tab. 4.10 **Emissions of heavy metals [t] according to the international NFR* structure for year 2013**

NFR	Sector name	Pb	Cd	Hg	As	Cr	Cu	Ni	Se	Zn
Combustion processes I.		**2.8072**	**0.1204**	**0.0825**	**0.3639**	**0.0489**	**0.0765**	**0.1473**	**0.0092**	**4.0253**
1A1a	Public electricity and heat production	2.8072	0.1204	0.0825	0.3639	0.0489	0.0765	0.1473	0.0092	4.0253
Road transport		**2.8626**	**0.0240**	**-**	**-**	**0.4086**	**10.1739**	**0.1898**	**0.0264**	**4.4996**
1A3bi	Passenger cars	1.8678	0.0083	NA	NA	0.0417	1.4183	0.0584	0.0083	0.8343
1A3bii	Light duty vehicles	0.1590	0.0020	NA	NA	0.0100	0.3386	0.0139	0.0020	0.1992
1A3biii	Heavy duty vehicles and buses	NA	0.0099	NA	NA	0.0493	1.6765	0.0690	0.0099	0.9862
1A3biv	Mopeds & motorcycles	0.0077	0.0000	NA	NA	0.0001	0.0044	0.0002	0.0000	0.0026
1A3bvi	Automobile tyre and brake wear	0.8282	0.0038	NA	NE	0.3074	6.7362	0.0483	0.0062	2.4774
Non-Road transport		**-**	**0.0008**	**-**	**-**	**0.0038**	**0.1307**	**0.0054**	**0.0008**	**0.0769**
1A3c	Railways	NA	0.0003	NA	NA	0.0014	0.0471	0.0019	0.0003	0.0277
1A3dii	National navigation (shipping)	NA	0.0005	NA	NA	0.0025	0.0836	0.0034	0.0005	0.0492
Combustion processes II		**1.5772**	**0.0503**	**0.0436**	**0.4727**	**0.2377**	**0.3759**	**0.2351**	**0.0409**	**4.0674**
1A4ai	Commercial/institutional: Stationary	0.5256	0.0225	0.0151	0.0586	0.0070	0.0140	0.0060	0.0004	0.7552
1A4bi	Residential: Stationary	1.0367	0.0271	0.0281	0.4109	0.2301	0.3612	0.2285	0.0405	3.2905
1A4ci	Agriculture/Forestry/Fishing: Stationary	0.0149	0.0006	0.0004	0.0032	0.0006	0.0008	0.0005	0.0000	0.0218
Industry II		**28.5537**	**0.4239**	**0.5554**	**0.4698**	**2.1613**	**7.6753**	**8.6108**	**7.1059**	**29.7145**
1A2a	Iron and steel production: Fe, aglom.	20.8875	0.2076	0.3600	0.0415	0.9969	6.8969	3.6193	1.0038	18.6079
1A2gviii	Stationary combustion in manufacturing industries and construction: Other	3.4990	0.1611	0.1421	0.3809	0.3460	0.5781	4.3390	0.1190	7.4034
2A1	Cement production	0.1784	0.0005	0.0366	0.0022	0.0195	NA	0.0207	0.0003	0.0455
2A3	Glass production	3.9885	0.0544	0.0166	0.0399	0.7977	0.1994	0.6315	5.9828	3.6562
2C4	Magnesium production	0.0002	0.0004	0.0000	0.0053	0.0012	0.0008	0.0003	NA	0.0014
Production processes		**8.3664**	**0.1393**	**0.2334**	**12.5279**	**0.8405**	**19.3162**	**7.6810**	**1.9150**	**18.9216**
2B10a	Chemical industry: Other	NA	NA	0.1650	NA	NA	NA	NA	NA	NA
2C1	Iron and steel production: steel	1.2739	0.0138	0.0138	0.0692	0.1615	2.5155	2.5432	0.0138	5.3079
2C2	Ferroalloys production	0.1811	0.0046	NA	0.0100	0.0178	0.0032	0.0089	NA	0.4764
2C3	Aluminium production	NA	0.0163	NA	NA	NA	NA	1.6330	NA	1.6330
2C5	Lead production	0.0037	0.0000	NA	0.0000	NA	NA	NA	NA	0.0000
2C7a	Copper production	6.8237	0.1046	0.0004	12.4487	NA	16.4896	NA	1.9012	3.5623
2C7c	Other metal production	0.0840	NA	NA	NA	0.6612	0.3079	3.4960	NA	7.9421
2K	Consumption of POPs and heavy metals	NA	NA	0.0541	NA	NA	NA	NA	NA	NA
Waste incineration		**2.0671**	**0.1772**	**0.1735**	**0.0031**	**0.0285**	**0.1773**	**0.0061**	**0.0038**	**1.2422**
5C1bi	Industrial waste incineration	1.7871	0.1532	0.1532	0.0026	0.0245	0.1532	0.0051	0.0031	1.0723
5C1biii	Clinical waste incineration	0.2796	0.0240	0.0000	0.0004	0.0038	0.0240	0.0008	0.0005	0.1678
5C1bv	Cremation	0.0004	0.0001	0.0203	0.0002	0.0002	0.0002	0.0002	0.0003	0.0022
	National total	**46.2343**	**0.9359**	**1.0884**	**13.8374**	**3.7294**	**37.9258**	**16.8755**	**9.1021**	**62.5475**

Emissions estimated to February 15th 2016
IE = included in other sector, NE=not estimated, NA=not available
** Nomenclature for reporting (EMEP) corresponding to EMEP/EEA air pollutant emission inventory guidebook 2013*

Fig. 4.7 **Development trends in heavy metals emissions**