Slovak
Hydrometeorological Institute

Ministry of Environment
of the Slovak Republic

AIR POLLUTION

IN THE SLOVAK REPUBLIC

2013

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Slovak Hydrometeorological Institute
Department of Emissions and Air Quality Monitoring
Jeséniova 17, 833 15 Bratislava

Responsible:	*Ing. Viliam Pätoprstý, CSc.*
Co-ordination:	*RNDr. Katarína Pukančíková*
Responsible for chapter 1 -	*RNDr. Marta Mitošinková*
2 -	*RNDr. Ľubor Kozakovič*
3 -	*Mgr. Blanka Fógelová*
4 -	*Ing. Monika Jalšovská*
Editorial work:	*RNDr. Katarína Pukančíková*

CONTENT

AMBIENT AIR

EMISSIONS

AMBIENT AIR

1

REGIONAL AIR POLLUTION AND QUALITY OF PRECIPITATION

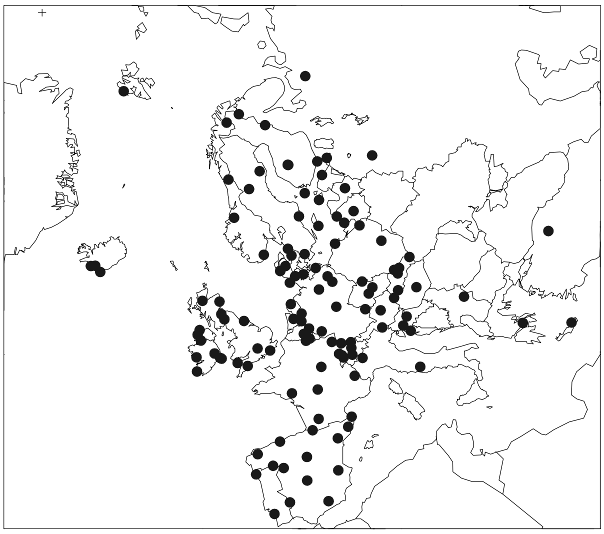
1.1 REGIONAL AIR POLLUTION AND QUALITY OF PRECIPITATION

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 evaluate 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.

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



The EMEP monitoring programme has been gradually extended. The monitoring 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 2013, 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 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.

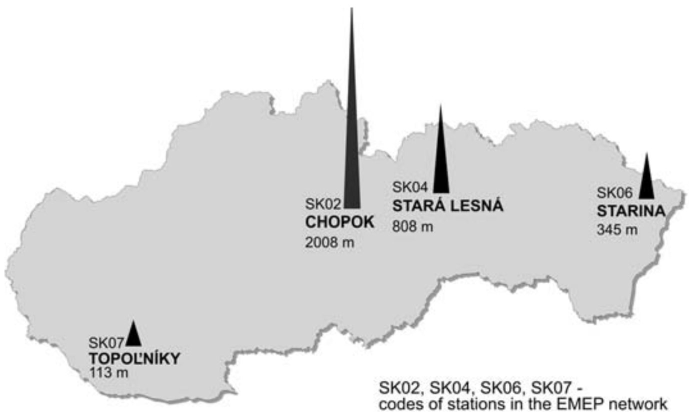
Topoľníky

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 – 2013**



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 absor-ption solution with guajacol	spectrophotometry, modified Salzman method
	SO_2, HNO_3	cellulose filter W40 impregnated by KOH solution	IC - Dionex
	O_3	registration by analyzer	principle - UV absorption
	VOCs C_2 - C_6	stainless steel canister	GC and 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 2013

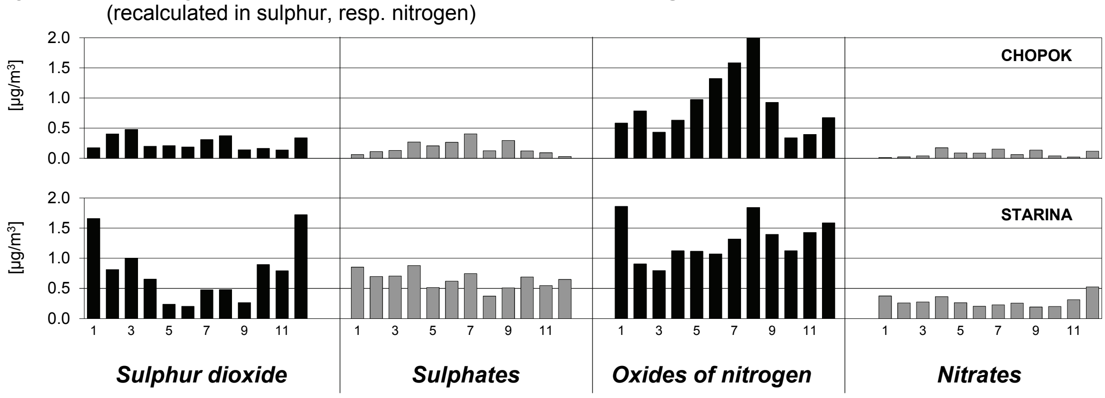
SO_2, sulphates

Background concentrations of sulphur dioxide recalculated in sulphur (Tab. 1.1) was 0.26 µg.m^{-3} on the Chopok station and 0.77 µg.m^{-3} on the Starina station, in 2013. ***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 0.52 µg $S0_2$.m^{-3} and Starina 1.54 µg $S0_2$.m^{-3}), nor in winter season (Chopok 0.6 µg $S0_2$.m^{-3} and Starina 2.1 µg $S0_2$.m^{-3}).*** Sulphates contributed to the total weight mass of particulate matter 15.4% on the Chopok station and 17.4% on the Starina station. Concentration ratio of sulphates to sulphur dioxide, recalculated in sulphur represented 0.69 on the Chopok station and 0.84 on the Starina station.

NO_x, nitrates

Background level of concentrations of oxides of nitrogen, recalculated in nitrogen (Tab. 1.1) presented 0.91 µg.m^{-3}on the Chopok station and 1.30 µg.m^{-3} on the Starina station, in 2013. ***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 3.00 µg NO_x.m^{-3} and Starina 4.29 µg NO_x.m^{3}).*** Nitrates in ambient air on the Chopok and Starina stations occurred predominantly in the form of particles in 2013, 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 10.0% on the Chopok station and 11.4% 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 0.12 at the Chopok station and 0.26 at the Starina station.

Fig. 1.3 **Monthly mean concentrations of sulpur and nitrogen compounds in ambient air – 2013**
(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 (NH_3 and NH_4 recalculated in nitrogen) from the Starina station in 2013 are listed in Table 1.1. Ammonium ions in annual average 0.58 µgN.m^{-3} share 5.8% of PM. Annual concentration of ammonia represents 0.66 µgN.m^{-3}. Concentration ratio of ammonium ions and ammonia expressed in nitrogen is 0.88.

Tab. 1.1 **Annual averages of gaseous and particulate components in ambient air – 2013**

	SO_2 (S) µg.m⁻³	SO_4^{2-} (S) µg.m⁻³	NO_x (N) µg.m⁻³	NO_3^- (N) µg.m⁻³	HNO_3 (N) µg.m⁻³	Cl^- µg.m⁻³	NH_3 (N) µg.m⁻³	NH_4^+ (N) µg.m⁻³	Na^+ µg.m⁻³	K^+ µg.m⁻³	Mg^{2+} µg.m⁻³	Ca^{2+} µg.m⁻³
Chopok	0.26	0.18	0.91	0.08	0.03	0.03	-	-	-	-	-	-
Starina	0.77	0.65	1.30	0.29	0.05	0.09	0.66	0.58	0.05	0.08	0.01	0.05

	O_3 µg.m⁻³	PM_{10} µg.m⁻³	Pb ng.m⁻³	Cu ng.m⁻³	Cd ng.m⁻³	Ni ng.m⁻³	Cr ng.m⁻³	Zn ng.m⁻³	As ng.m⁻³
Chopok	96	*3.5	1.26	2.32	0.04	0.87	1.04	4.69	0.20
Topoľníky	64	16.4	9.01	3.90	0.26	0.83	1.48	20.22	1.19
Starina	64	11.2	4.44	1.91	0.16	1.07	1.91	10.57	0.54
Stará Lesná	71	10.7	4.99	3.55	0.19	1.73	3.77	12.59	0.75

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

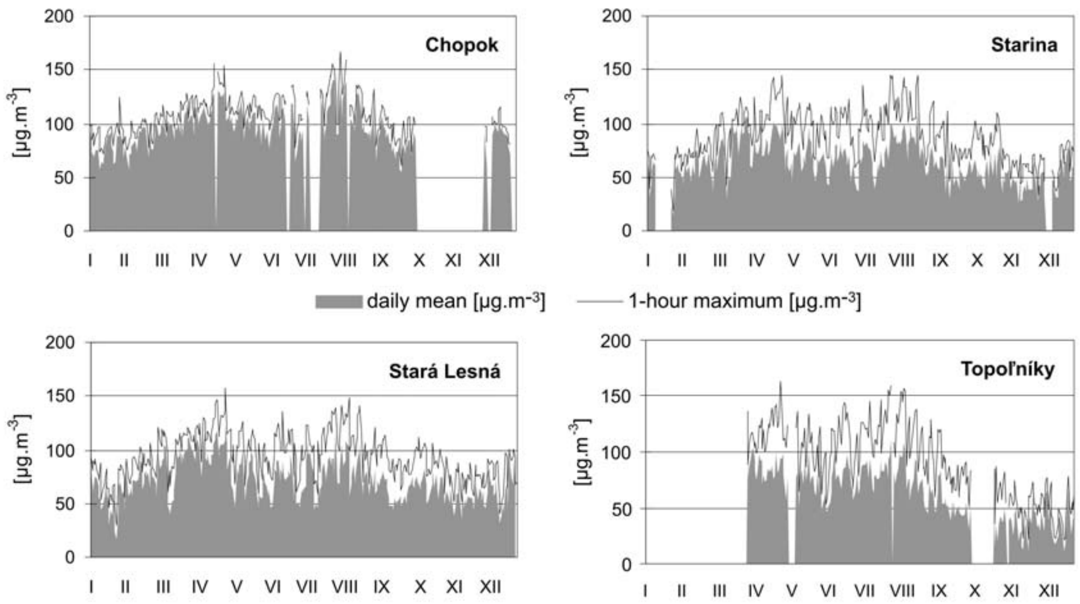
Particulate matter PM_{10}, TSP and heavy metals

In Table 1.1 are presented the concentrations of PM_{10} (Stará Lesná, Starina, Topoľníky), resp. TSP (Chopok) and heavy metals in 2013.

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 2013, the annual average of ozone concentration at the Chopok station reached 96 µg.m⁻³, at Starina 71 µg.m⁻³, at Topoľniky 59 µg.m⁻³ and Stará Lesná 64 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] – 2013**



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 2013, however only since May due to the financial and technical reasons.

Tab. 1.2 **Annual averages of VOC [ppb] in ambient air, Starina – 2013**

etane	etene	propane	propene	i-butane	n-butane	acetylene	i-pentane	n-pentane	izoprene	n-hexane	benzene	toluene	o-xylene
2.534	1.102	0.970	0.479	0.355	0.493	0.278	0.204	0.086	0.111	0.099	0.049	0.221	0.188

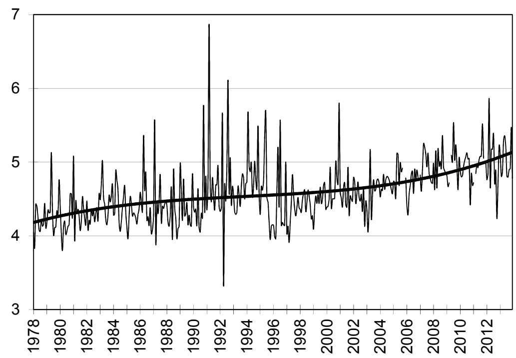
Atmospheric precipitation

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 2013 the amount of precipitation recorded at background stations ranged between 496 and 1329 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 4.73 – 4.99 (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**



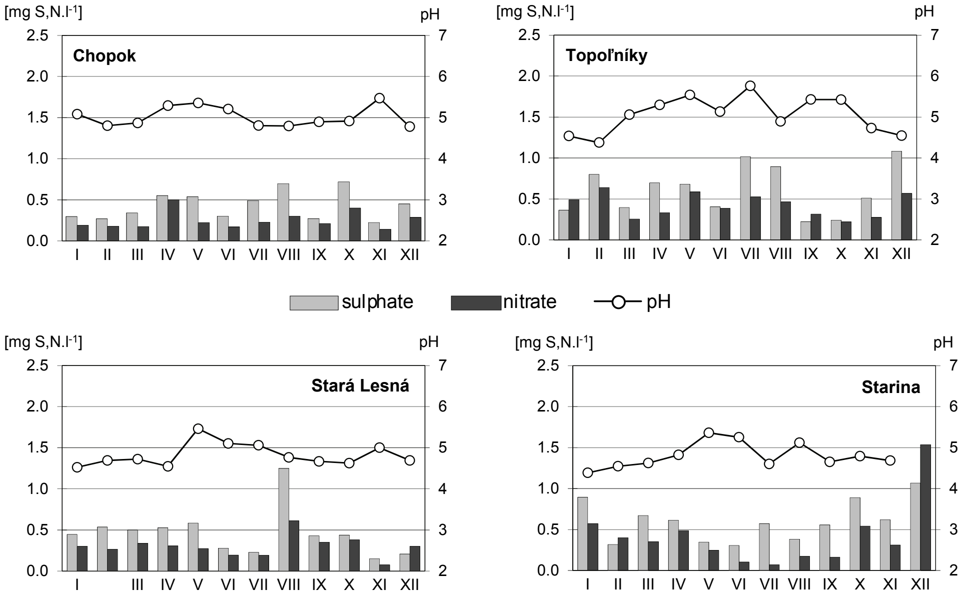
Concentrations of dominant sulphates in precipitation recalculated in sulphur varied within the range 0.38 – 0.55 mg.l^{-1}. Concentrations of sulphates at the Chopok station represent the low value of the pH range while the Starina the upper value of the pH range. The annual mean at the Topoľníky and Starina stations show minimum difference. 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 0.22 – 0.38 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 0.29 – 0.47 mg.l^{-1}.

Heavy metals

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 2013 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 – 2013**



Tab.1.3 Annual averages of main components in daily precipitation – 2013

	Precip. mm	pH	Cond. μS.cm^{-1}	SO_4^{2-}(S) mg.l^{-1}	NO_3^-(N) mg.l^{-1}	NH_4^+(N) mg.l^{-1}	Cl^- mg.l^{-1}	Na^+ mg.l^{-1}	K^+ mg.l^{-1}	Mg^{2+} mg.l^{-1}	Ca^{2+} mg.l^{-1}
Chopok	1329	4.99	10.35	0.38	0.22	0.29	0.19	0.14	0.06	0.03	0.19
Topoľníky	496	4.82	16.23	0.52	0.38	0.47	0.18	0.11	0.05	0.04	0.29
Starina	692	4.73	16.14	0.55	0.31	0.29	0.23	0.18	0.12	0.04	0.40
Stará Lesná	686	4.84	14.23	0.44	0.27	0.36	0.12	0.12	0.05	0.03	0.38
Bratislava-Koliba	737	4.91	16.95	0.65	0.46	0.49	0.17	0.44	0.05	0.03	0.36

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

Tab. 1.4 Annual averages of heavy metals in monthly precipitation – 2013

	precip. mm	Pb μg.l^{-1}	Cd μg.l^{-1}	Cr μg.l^{-1}	As μg.l^{-1}	Cu μg.l^{-1}	Zn μg.l^{-1}	Ni μg.l^{-1}
Chopok	1239	2.15	0.08	0.22	0.18	1.08	18.20	0.88
Topoľníky	538	1.12	0.05	0.19	0.20	0.80	9.01	0.20
Starina	551	1.39	0.05	0.25	0.19	1.62	14.19	1.21
Stará Lesná	713	1.01	0.05	0.08	0.10	0.95	6.10	0.34
Bratislava-Koliba	905	1.53	0.06	0.16	0.21	2.37	12.67	0.35

AMBIENT AIR

LOCAL AIR POLLUTION

2

2.1 LOCAL AIR POLLUTION

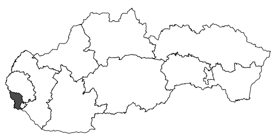
Air quality assessment is claimed by Air Protection Act No. 137/2010 Coll. Criterions for air quality assessment (upper and lower assessment thresholds, margin of tolerance, limit and target values) are given in Decree No. 360/2010 Coll. about Air Quality. Fundamental air quality assessment is performed 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 2013, 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 2013 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 6 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 territory represents zone Slovakia.

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



AGGLOMERATION - BRATISLAVA

AREA: 368 km^2 POPULATION: 417 389

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. 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.

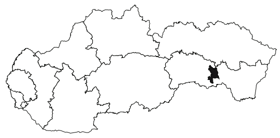
Location of stations

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 area 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: 239 797

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.

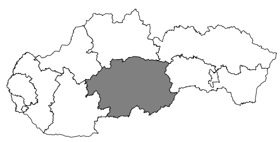
Location of stations

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: 656 813

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

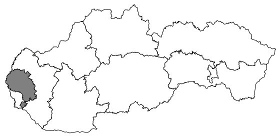
The station is situated in open middle building area on the north edge of the town, approximately 50 m far from state road No. 531.

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: 200 991

Characterization of area

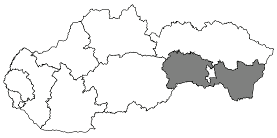
Malacky

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 road leading from the town towards the highway D2.



ZONE - KOŠICE REGION

AREA: 6 511 km^2 POPULATION: 554 959

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.

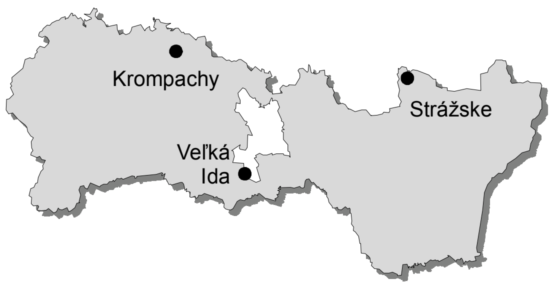
Strážske

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

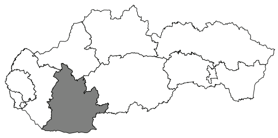
Monitoring station is located close to the main route Košice - Spišská Nová Ves. The surrounding built-up area comprises multi-storey houses.

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: 686 662

Characterization of area

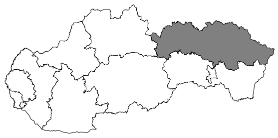
Nitra

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: 818 916

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

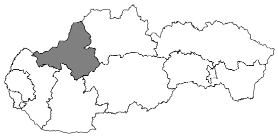
Vranov nad Topľou lies in the valley of the river Topľa, which passes into the East Slovakian lowlands. The location is bordered in the west by the Slánske hills and in the north by the wide zone of the Carpathians. Air circulation is influenced by the north-west orientation of the Topľa river valley. 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: 592 394

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.

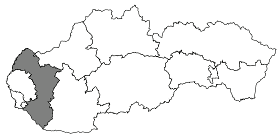
Location of stations

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.

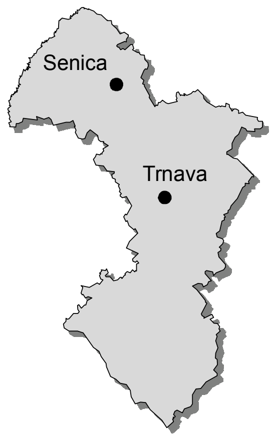
Location of stations

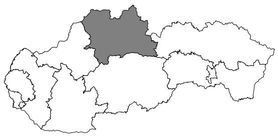
Senica - Hviezdoslavova

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: 690 420

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.

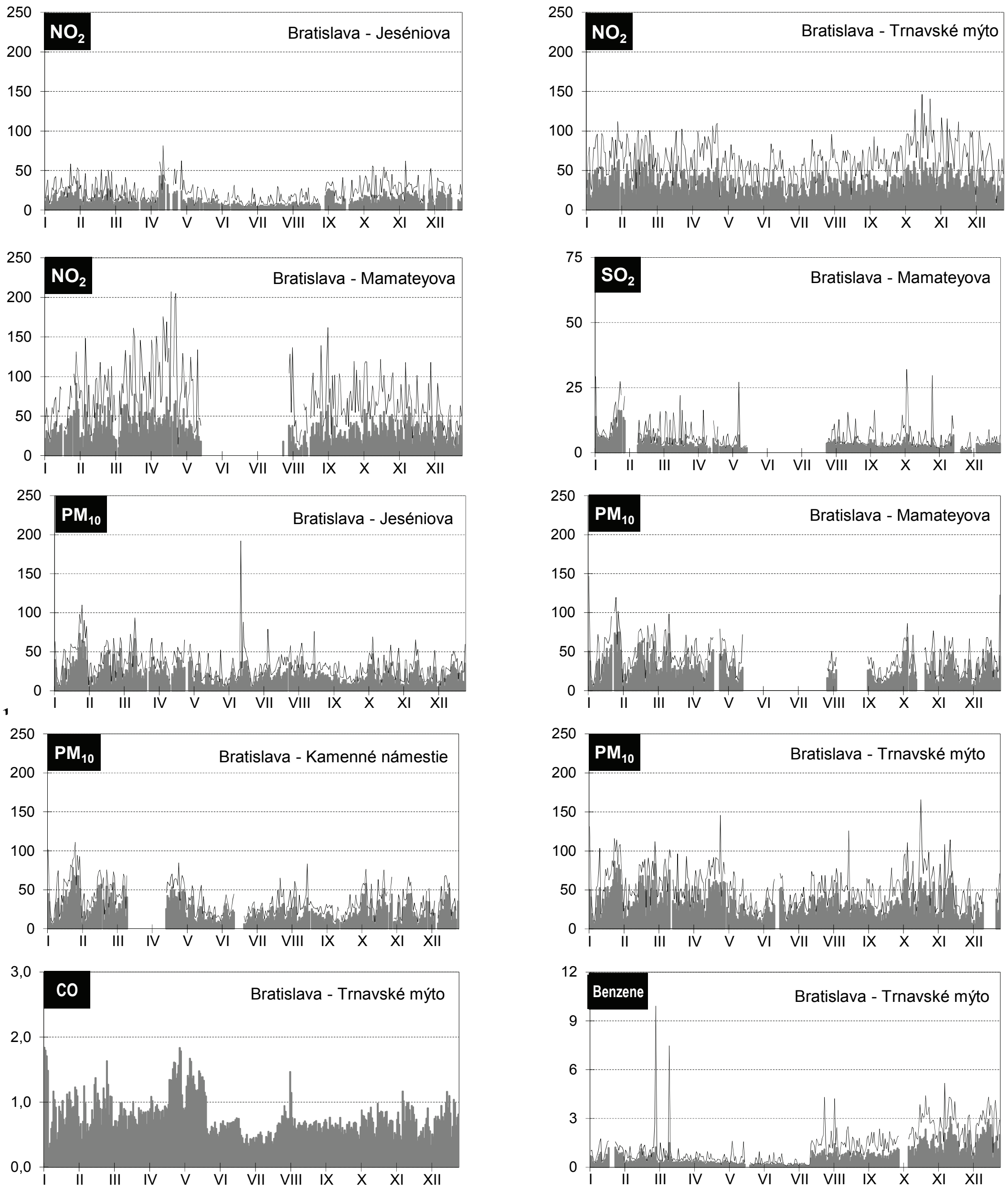
Martin - Jesenského

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 – 2013**

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, Sasinkova	17°01'11"	48°26'15"	198	*		*	*	*	*					
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	*	*	*								

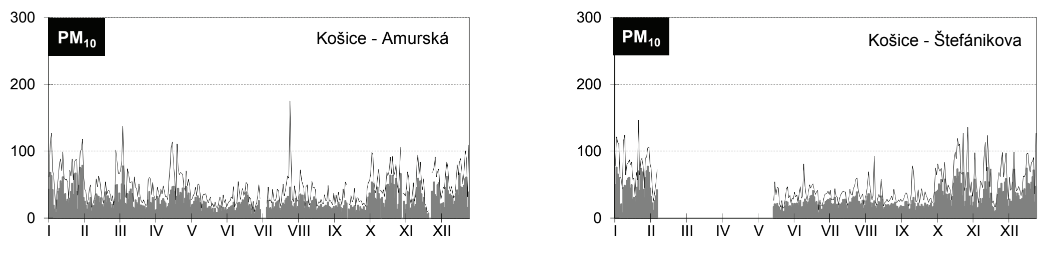
Fig. 2.1 **Concentrations of NO_2, SO_2, PM_{10}, benzene and CO – agglomeration Bratislava – 2013**



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 – 2013**



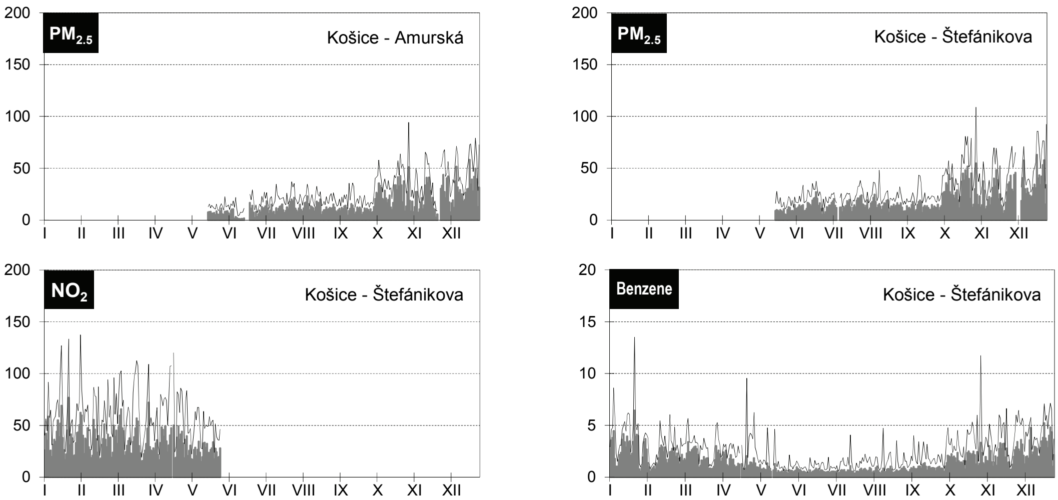
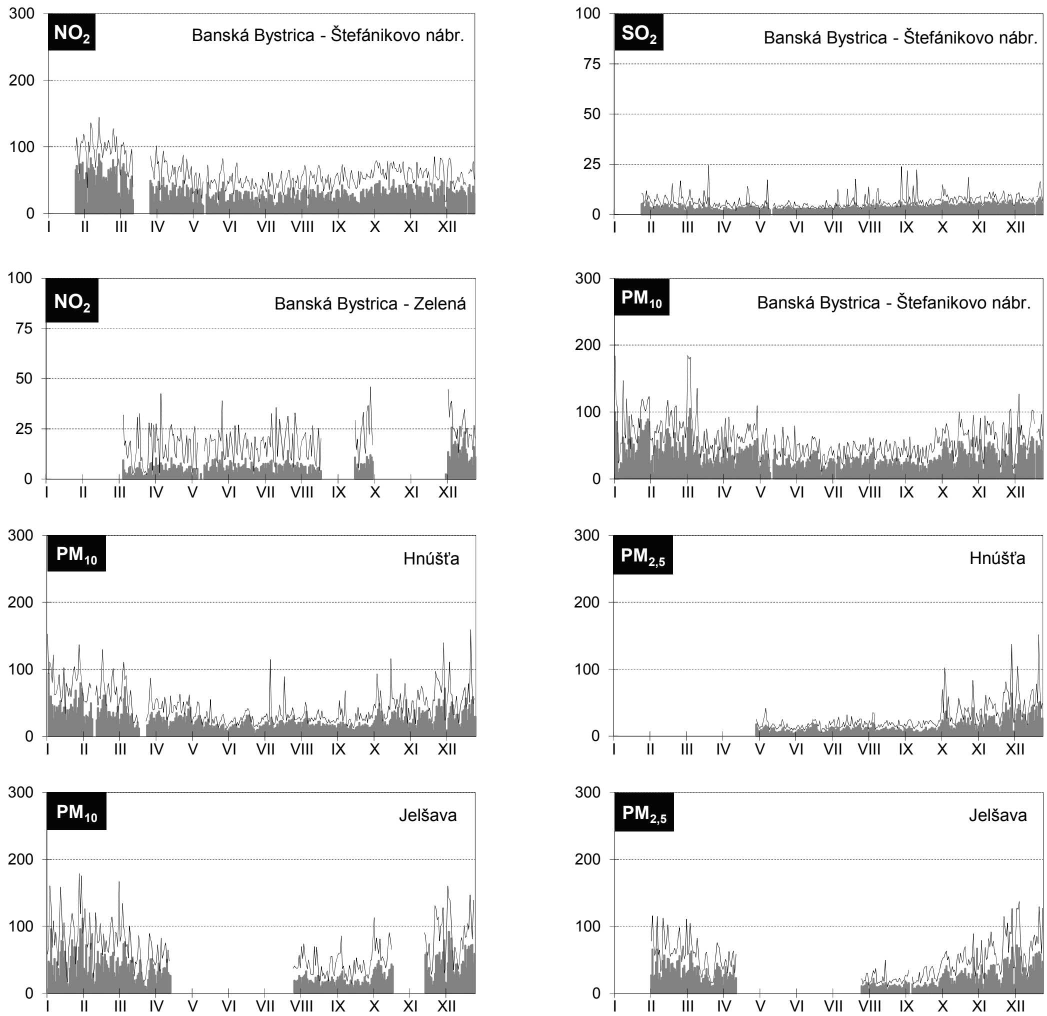


Fig. 2.3 **Concentrations of NO_2, SO_2, PM_{10}, $PM_{2,5}$, CO and benzene – zone Banská Bystrica region – 2013**



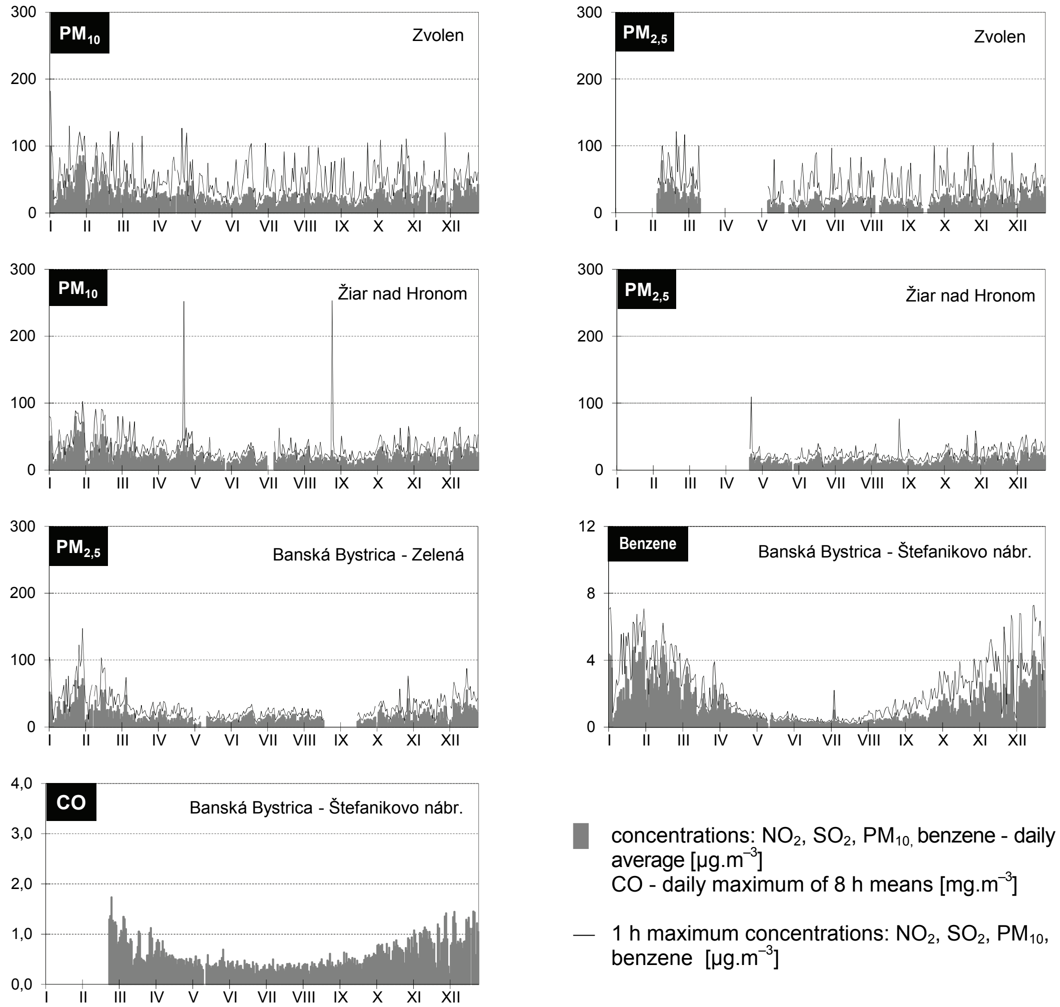
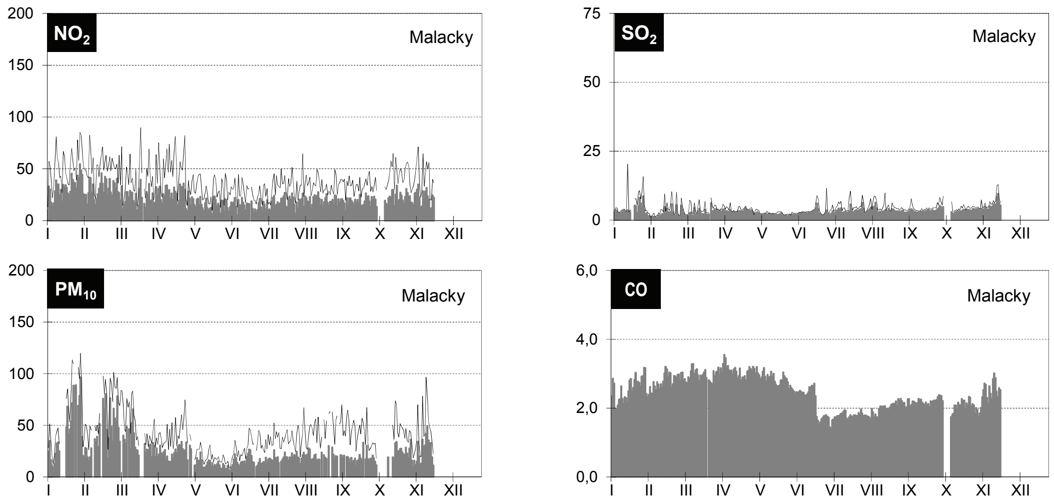
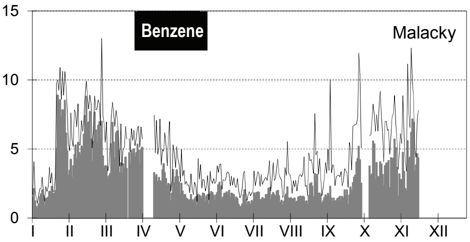


Fig. 2.4 **Concentrations of NO_2, SO_2, PM_{10}, CO and benzene – zone Bratislava region – 2013**

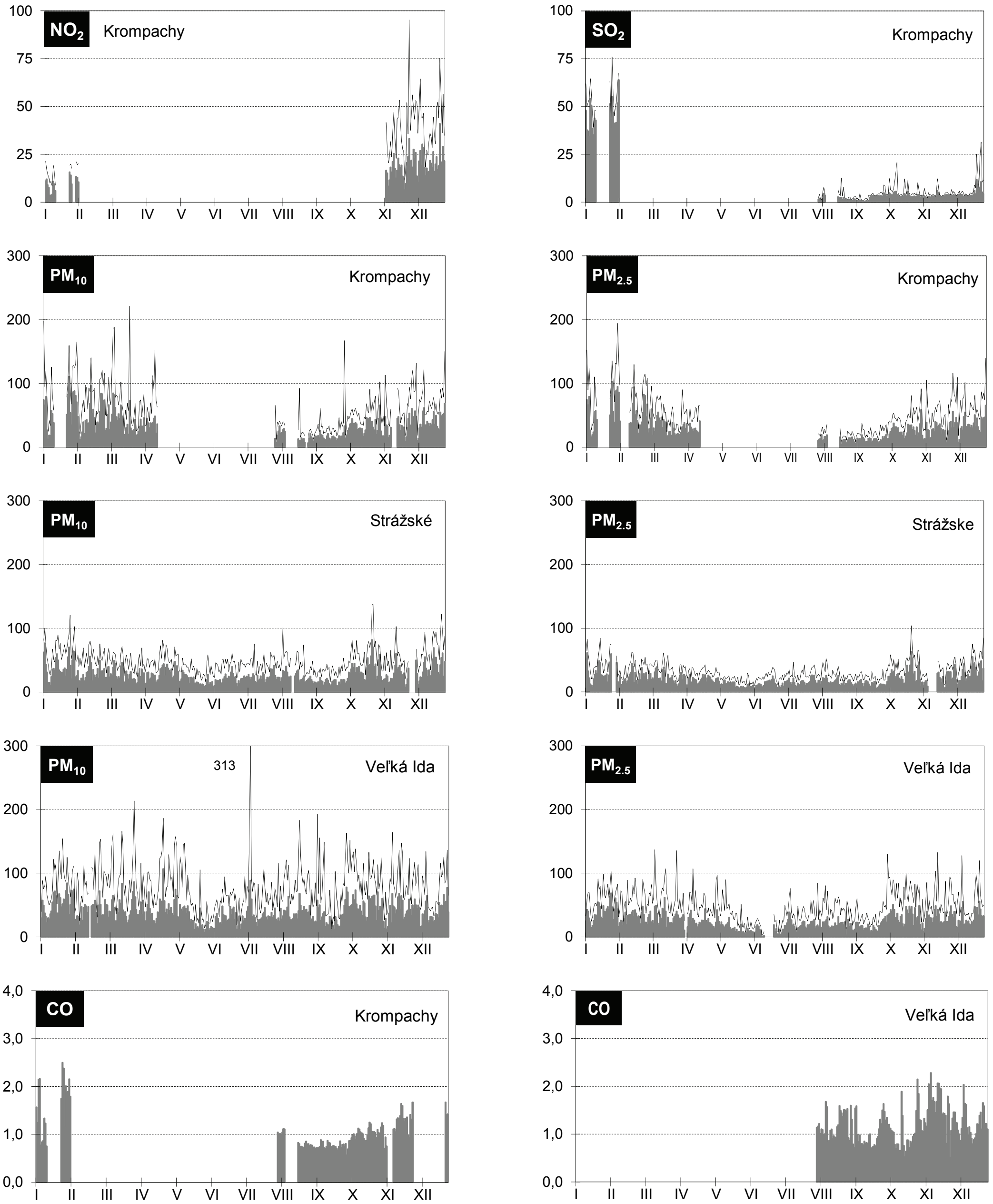


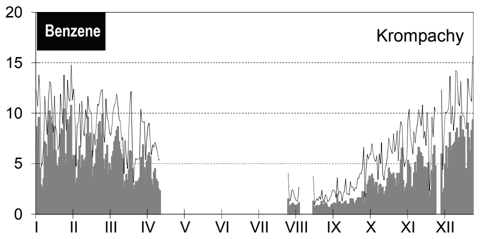


concentrations: NO_2, SO_2, PM_{10}, benzene - daily average [µg.m^{-3}]
CO - daily maximum of 8 h means [mg.m^{-3}]

— 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 – 2013**

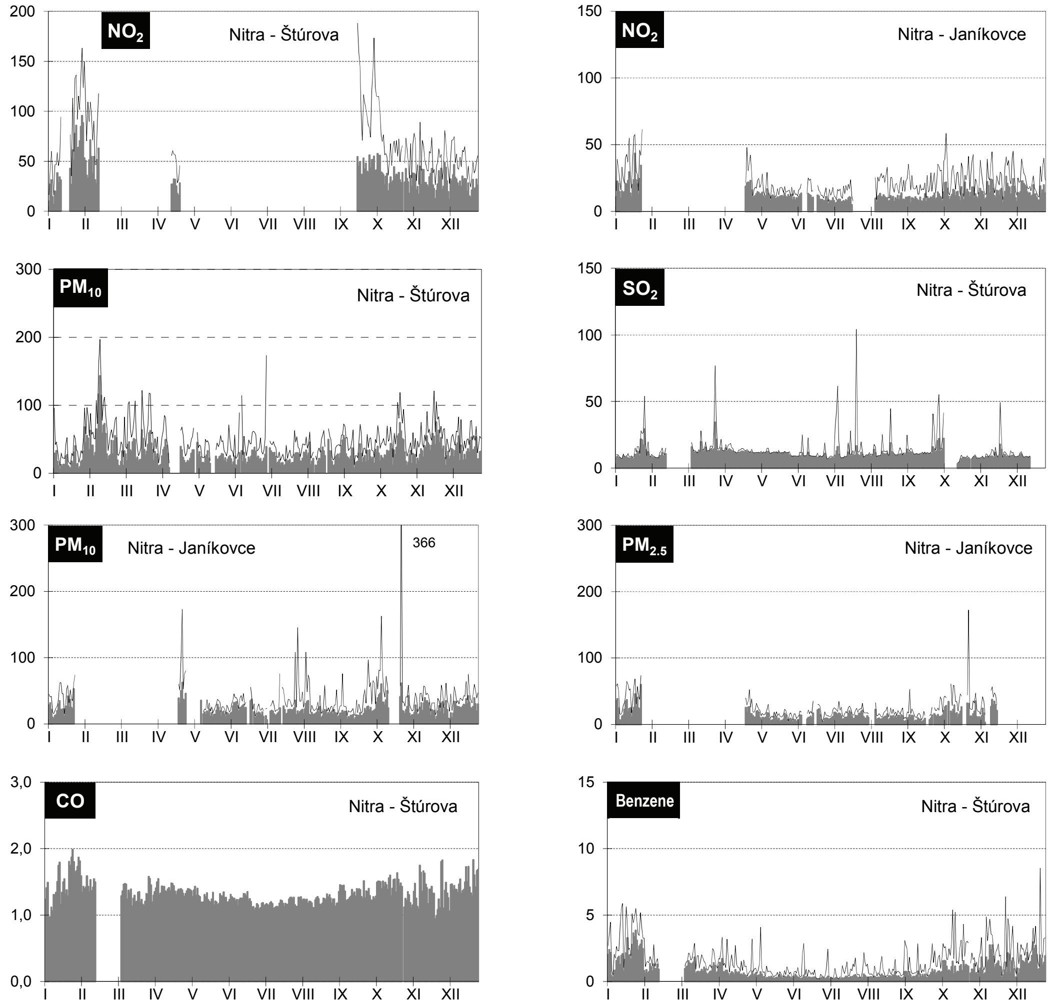




concentrations: NO_2, SO_2, PM_{10}, $PM_{2.5}$, benzene - daily average [µg.m^{-3}]
CO - daily maximum of 8 h means [mg.m^{-3}]

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

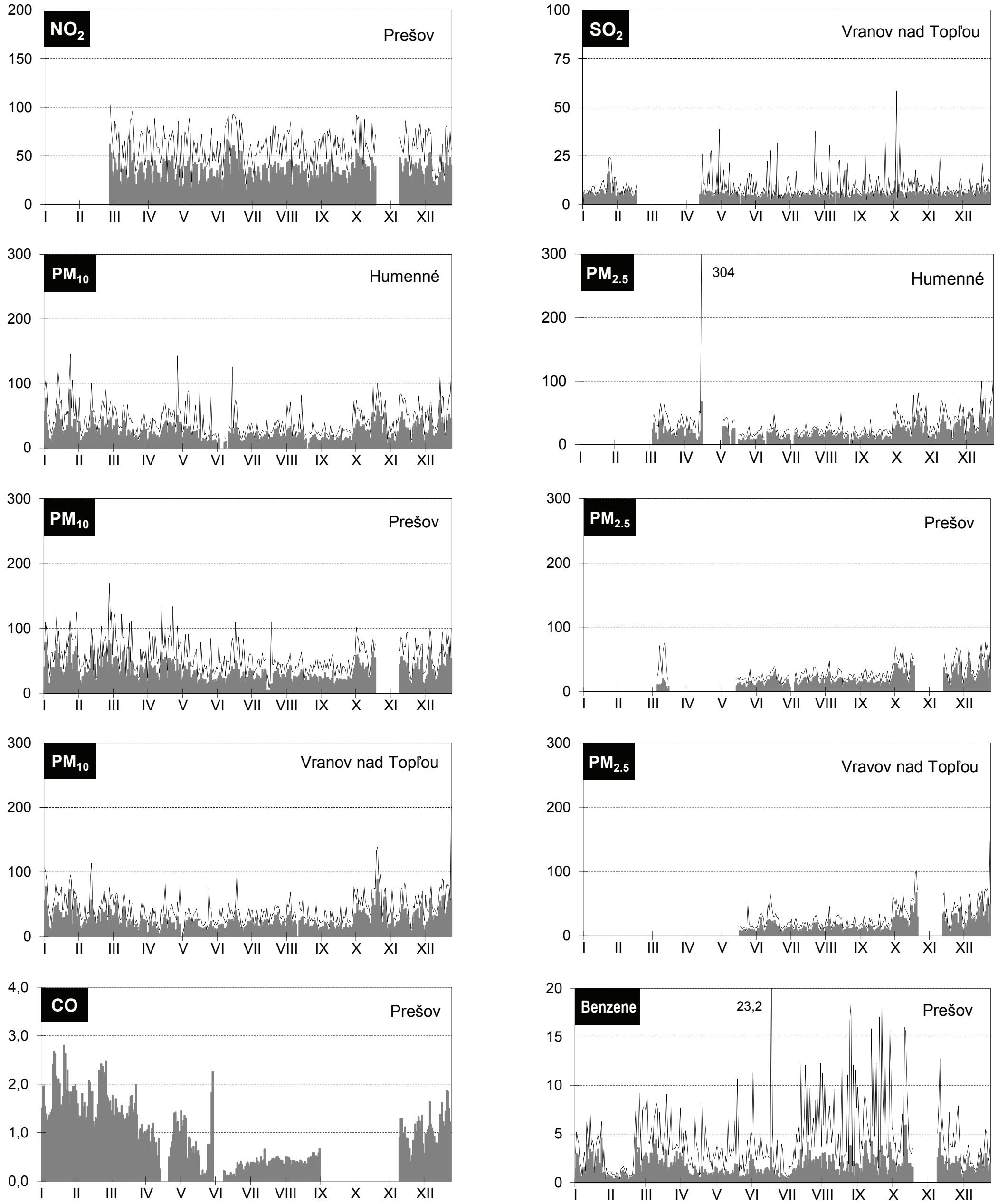
Fig. 2.6 **Concentrations of NO_2, SO_2, PM_{10}, $PM_{2.5}$, CO and benzene – zone Nitra region – 2013**



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}]

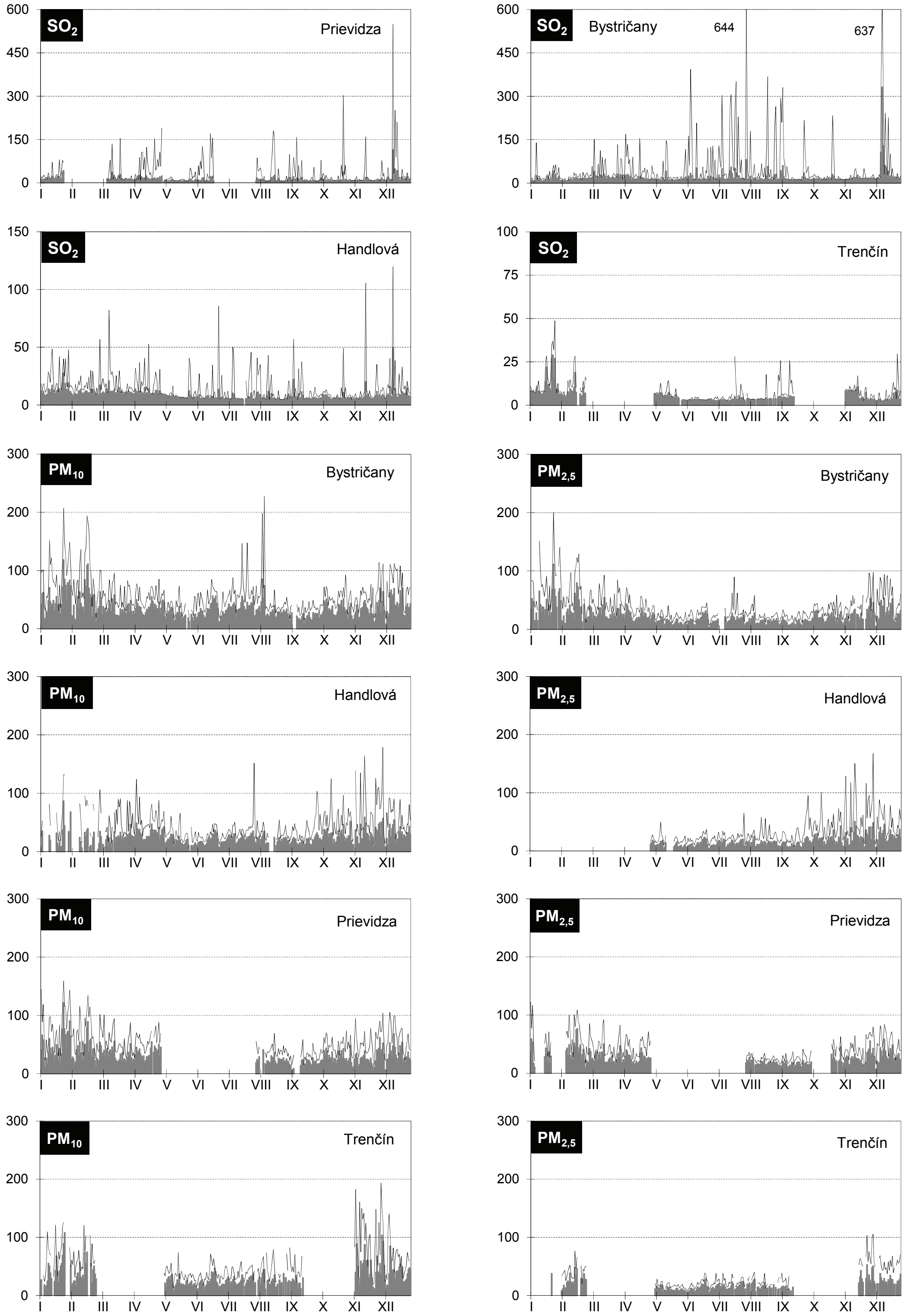
Fig. 2.7 **Concentrations of NO_2, SO_2, PM_{10}, $PM_{2.5}$, CO and benzene – zone Prešov region – 2013**



█ 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 – 2013**



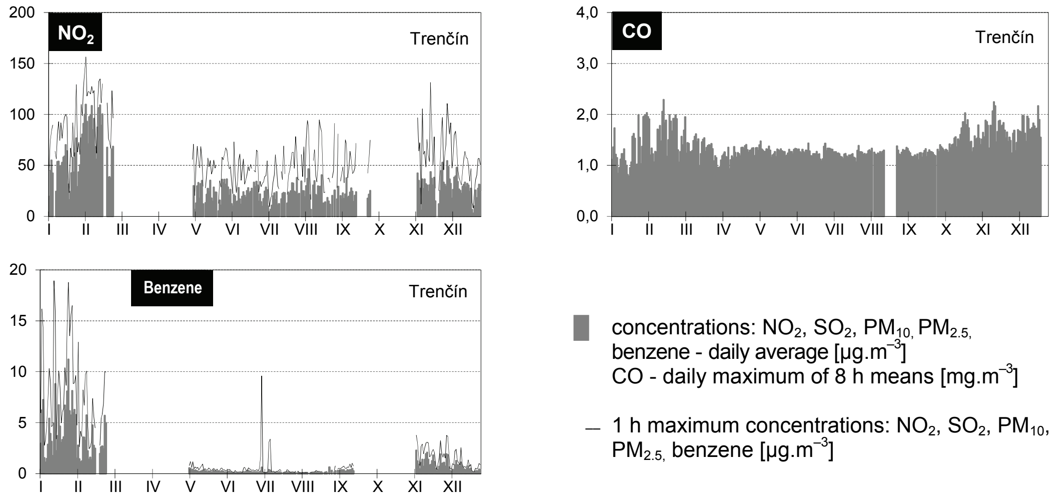


Fig. 2.9 **Concentrations of NO_2, SO_2, PM_{10}, $PM_{2.5}$, CO and benzene – zone Trnava region – 2013**

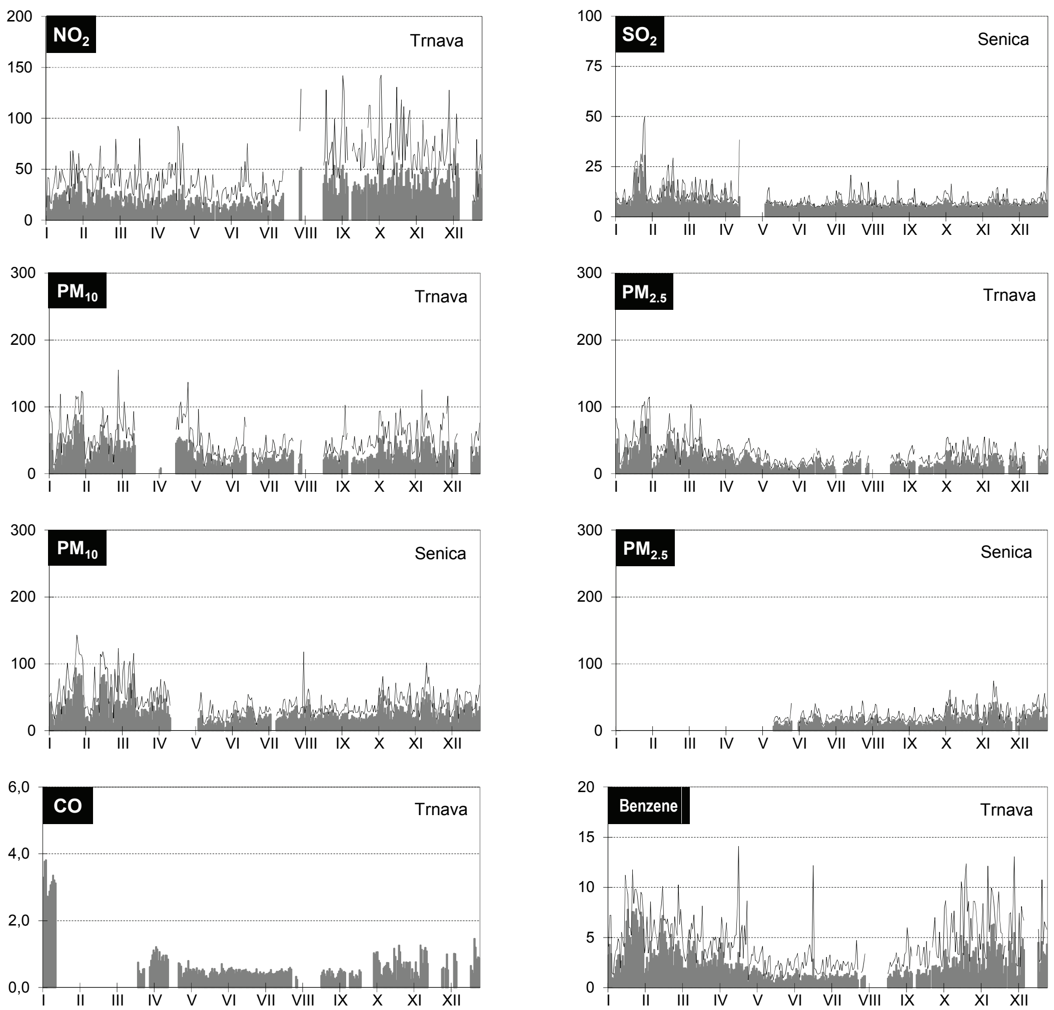


Fig. 2.10 **Concentrations of NO_2, SO_2, PM_{10}, $PM_{2.5}$, CO and benzene – zone Žilina region – 2013**

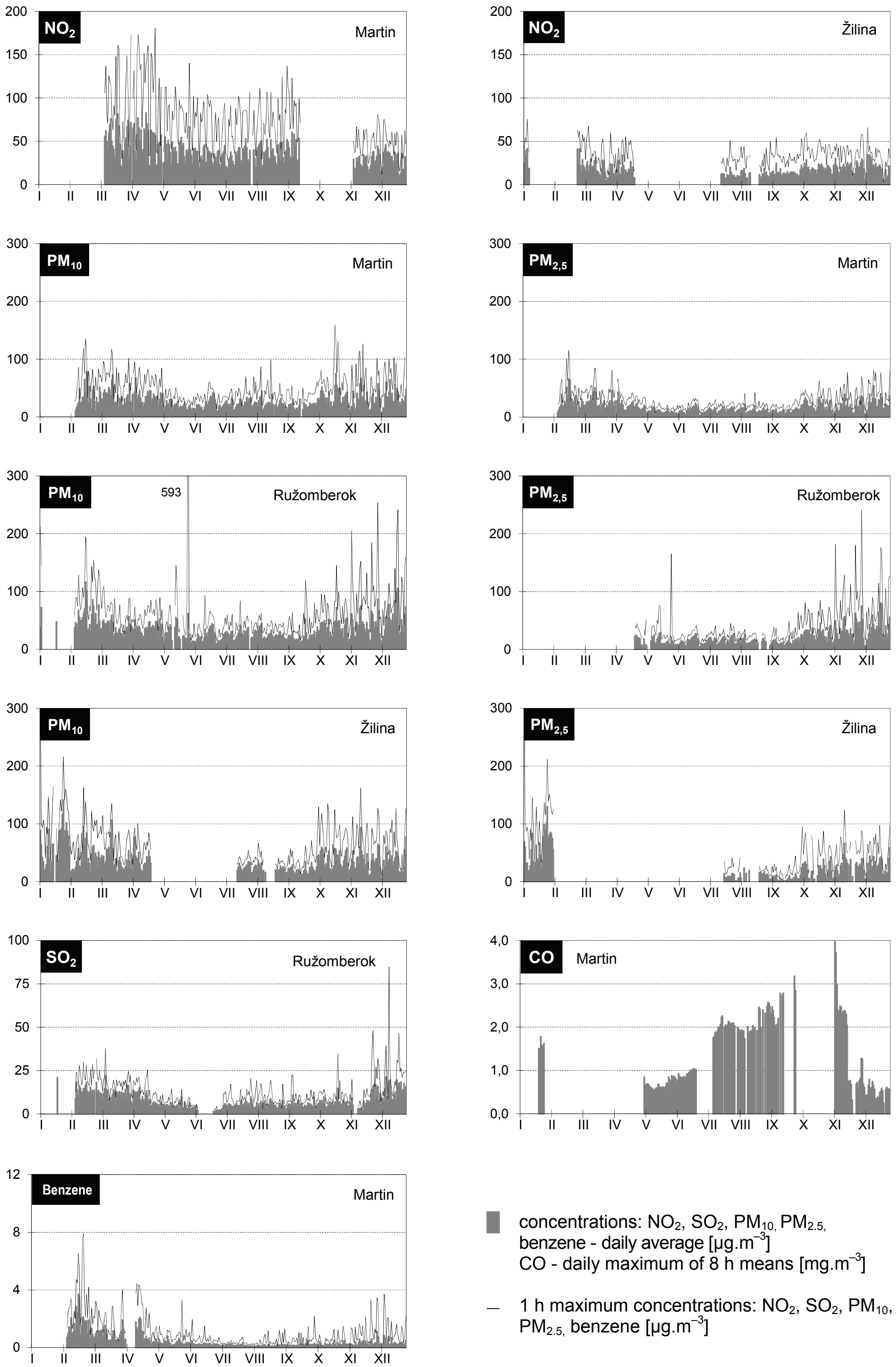
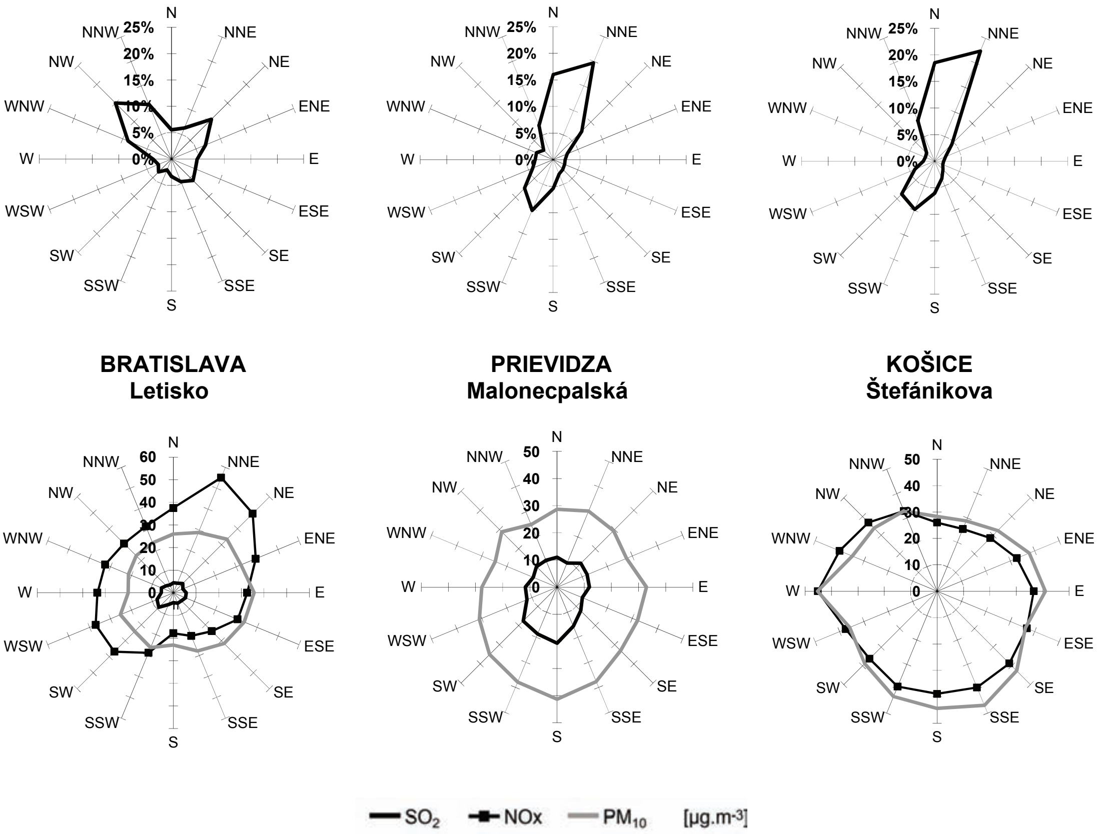


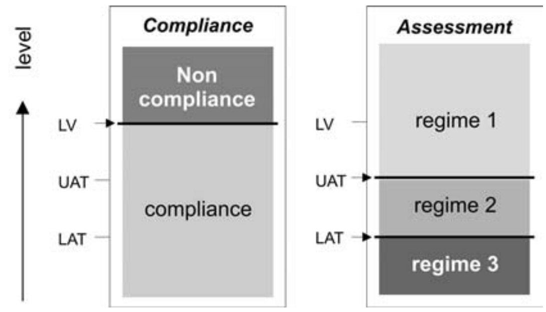
Fig. 2.11 **Wind and concentration roses – 2013**



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).

[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 2013 in none of agglomeration or zone the hourly or daily limit values were exceeded in more cases than it is allowed. The alert threshold was exceeded at the station Bystričany Rozvodňa SSE in 2 cases in total duration of 7 hours. (Tab. 2.8)

Nitrogen dioxide
Hourly limit value has not been exceeded at any station. The maximal level was below the alert threshold.

PM_{10}
The major air pollution problem in Slovakia similarly to the whole Europe is pollution by particulate matter. In the year 2013 daily limit value was exceeded at 10 stations. The annual limit value was not exceeded at any of the monitoring stations.

$PM_{2,5}$
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 2013 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 2013 was this value exceeded at 2 stations and target limit at 25 $\mu g.m^{-3}$ at the same 2 stations, what represent significant decrease in comparison to the year 2012.

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 4.4 $\mu g.m^{-3}$ in Krompachy is below the limit value 5 $\mu g.m^{-3}$.

BaP
The target value was exceeded at stations Bratislava-Trnavské mýto, Trnava-Kollárova, Prievidza-Malonecpalská, Krompachy-SNP and Veľká Ida-Letná.

Pb, As, Ni, Cd
Neither limit value for Pb nor target value for As, Cd and Ni were exceeded in 2013.

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
SO_2	1h	350 (24)	1.1.2005	150 µg/m^3	500	470	440	410	380	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
NO_2	1y	40 (-)	1.1.2010	50%	60	58	56	54	52	50	48	46	44	42	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
PM_{10}	1y	40 (-)	1.1.2005	20%	48	46	45	43	42	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
CO	max. 8 hour daily value	10000 (-)	1.1.2003 (1.1.2005)	6000 µg/m^3	16000	16000	16000	14000	12000	10000	10000	10000	10000	10000	10000	10000	10000	10000
Ben-zene	1y	5 (-)	1.1.2006 (1.1.2010)	100%	10	10	10	10	10	10	9	8	7	6	5	5	5	5
$PM_{2.5}$	1y	25	1. 1. 2008	5 µg/m^3									30	29	29	28	27	26
$PM_{2.5}^{**}$	1y	25	1. 1. 2015	-														

[1] *winter period (October 1 - March 31)*
** allowed exceedances per year are in brackets*
^{v} *critical level for protection of vegetation*
*** target value*

	Interval of averaging	Target value [ng/m^3]	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 – 2013**

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.					[a] 18	[a] 24					
	Bratislava, Trnavské mýto			0	35	**60**	34		1834	0.7		0
	Bratislava, Jeséniova			0	13	9	22					0
	Bratislava, Mamateyova	[b] 0	[b] 0	[a] 2	[a] 35	[b] 24	[b] 29				0	0
KOŠICE	Košice, Štefánikova			[c] 0	[c] 34	[b] **40**	[b] 31	[b] 20		1.5		0
	Košice, Amurská					28	27	[b] 16				
Banská Bystrica region	Banská Bystrica, Štefánik.nábr.	0	0	[a] 0	[a] 34	**57**	35		[a] 1735	1.4	0	0
	Banská Bystrica, Zelená			[b] 0	[b] 6,6			17				0
	Jelšava, Jesenského					[b] **51**	[b] 36	[b] **27**				
	Hnúšťa, Hlavná					23	26	[b] 15				
	Zvolen, J. Alexyho					19	26	[b] 20				
	Žiar n/H, Jilemnického					10	22	[b] 14				
Bratislava region	Malacky, Sasinkova	[a] 0	[a] 0	[a] 0	[a] 22	[a] 19	[a] 25		[a] 3549	[a] 2.9	0	0
Košice region	Veľká Ida, Letná					**79**	40	25	[c] 2281			
	Strážske, Mierová					22	27	20				
	Krompachy, SNP	[c] 0	[c] 0	[c] 0	[c] 17	[b] **42**	[b] 35	[b] **30**	[b] 2497	[b] 4.4	0	0
Nitra region	Nitra, Janíkovce			[b] 0	[b] 13	[b] 4	[b] 23	[b] 15				0
	Nitra, Štúrova	[a] 0	[a] 0	[c] 0	[c] 36	[a] 11	[a] 26		1986	0.8	0	0
Prešov region	Humenné, Nám. slobody					16	25	[b] 18				
	Prešov, Arm. gen. L. Svobodu			[a] 0	[a] 35	**54**	34	[b] 19	[a] 2798	1.7		0
	Vranov n/T, M. R. Štefánika	[a] 0	[a] 0			24	25	[b] 17			0	
	Stará Lesná, AÚ SAV, EMEP [3)]					2	18	12				
	Kolonické sedlo, Hvezdáreň [3)]					3	19	12				
Trenčín region	Prievidza, Malonecpalská	[a] 3	[a] 0			[b] 26	[b] 32	[b] 25			0	
	Bystričany, Rozvodňa SSE	20	2			**48**	35	22			3	
	Handlová, Morovianska cesta	0	0			7	24	[b] 16			0	
	Trenčín, Hasičská	[b] 0	[b] 0	[b] 0	[b] 33	[b] 29	[b] 32	[b] 18	[b] 4217	[b] 1.2	0	0
Trnava region	Senica, Hviezdoslavova	0	0			28	29	[b] 16			0	
	Trnava, Kollárova			[a] 0	[a] 26	[a] 32	[a] 31	[a] 20	[b] 3812	2.5		0
	Topoľníky, Aszód, EMEP [3)]					[b] 4	[b] 21	[b] 16				
Žilina region	Martin, Jesenského			0	38	23	28	17	[a] 1958	[a] 0.5		0
	Ružomberok, Riadok	[a] 0	[a] 0			**47**	35	[b] 21			0	
	Žilina, Obežná			[b] 0	[b] 17	[b] **55**	[b] 36	25				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) > 90%, [a] 75 – 90%, [b] 50 – 75%, [c] < 50% 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 2013**

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.	2.1	0.5	1.4	21.6
	Veľká Ida, Letná	1.3	0.6	1.6	28.3
	Krompachy, SNP	1.9	0.7	1.1	56.0
	Prievidza, Malonecpalská	4.4	0.5	1.1	8.4
	Ružomberok, Riadok	1.6	0.4	1.0	9.3

Tab. 2.7 **Assessment of air quality according to target values for BaP for the protection of human health in 2013**

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	1.1
	Bratislava, Jeséniova	1.0
Slovakia	Veľká Ida, Letná	5.3
	Krompachy, SNP	2.8
	Prievidza, Malonecpalská	1.9
	Trnava, Kollárova	1.3

Tab. 2.8 **Assessment of air quality according to occurrence and duration of exceedances of the alert threshold for SO_2 in 2013**

Station	Number of exceedances					The duration of exceedances in hours				
	Alert threshold					Alert threshold				
	2009	2010	2011	2012	2013	2009	2010	2011	2012	2013
Bystričany, Rozvodna SSE	0	0	0	0	2	0	0	0	0	7

AMBIENT AIR

ATMOSPHERIC OZONE

3

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 alert thresholds 240 $\mu g.m^{-3}$ (the first time since 1995) was overstepped in six cases in south-west Slovakia. The level of concentrations in 2013 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 2008 – 2013

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 than 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 2008 – 2013

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 2013 the number of missing data exceeded 10% at most of the stations (Tab. 3.2). Large gaps were at the Jelšava, Nitra Janíkovce and Topoľníky.

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

Station	2008	2009	2010	2011	2012	2013
Banská Bystrica, Zelená		*42.5	0.03	0.1	0.6	8.8
Bratislava, Jeséniova	1.6	0.1	0.2	1.3	1.6	0.3
Bratislava, Mamateyova	1.1	7.2	6.2	4.9	3.9	21.3
Humenné, Nám. Slobody	0.5	0.1	3.8	7.5	0.7	0.3
Jelšava, Jesenského	0.1	3.0	2.8	61.6	73.1	31.8
Košice, Ďumbierska	0.1	2.1	0.4	0.1	3.3	3.9
Nitra, Janíkovce		*13.7	22.5	-	11.8	26.7
Prievidza, Malonecpalská	0.4	3.4	0.5	4.6	1.9	11.3
Žilina, Obežná	0.05	1.5	0.1	0.4	3.1	25.4
Gánovce, Meteo. st.	1.7	0.1	0.4	0.2	2.4	16.1
Chopok, EMEP	1.7	0.3	2.6	2.2	3.4	22.0
Kojšovská hoľa	1.9	0.1	14.2	2.5	4.2	1.5
Stará Lesná, AÚ SAV, EMEP	0.3	0.6	0.4	2.2	3.2	0.8
Starina, Vodná nádrž, EMEP	2.6	0.8	0.1	0.2	1.6	5.0
Topoľníky, Aszód, EMEP	0.6	0.6	2.9	-	18.9	30.1

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

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

Station	2008	2009	2010	2011	2012	2013
Banská Bystrica, Zelená		53	56	60	66	66
Bratislava, Jeséniova	59	60	61	63	65	62
Bratislava, Mamateyova	48	48	46	51	53	48
Humenné, Nám. Slobody	55	59	53	53	55	60
Jelšava, Jesenského	51	49	44	-	-	41
Košice, Ďumbierska	56	81	63	73	62	61
Nitra, Janíkovce		74	53	-	62	58
Prievidza, Malonecpalská	53	50	49	51	52	50
Žilina, Obežná	46	48	47	48	49	53
Gánovce, Meteo. st.	65	62	63	64	66	67
Chopok, EMEP	92	90	87	96	93	96
Kojšovská hoľa	76	85	90	87	83	78
Stará Lesná, AÚ SAV, EMEP	74	61	67	65	63	71
Starina, Vodná nádrž, EMEP	59	58	51	59	60	64
Topoľníky, Aszód, EMEP	60	59	55	-	59	64

- *long-term failure*

In 2013, the annual average concentrations of ground level ozone in urban and industrial locations of Slovakia ranged within the interval 41 – 66 μg.m^{-3} (Tab. 3.3). The concentrations in the rest of the territory ranged between 64 and 96 μg.m^{-3}, mainly depending on the altitude. The highest annual average of ground level ozone concentrations was reached at the summit station Chopok (96 μg.m^{-3}). The effect of ozone from the accumulation zone (800 – 1500 m over the ground) over the Europe is evident. The year 2013, according to vegetation period averages, belongs to the photochemically less active years. Annual averages of ground level ozone concentration in 2013 were lower than in record year 2003.

In Figure 3.1, the seasonal cycle of daily ozone concentrations in Stará Lesná during 1992 – 2013 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 $\mu g.m^{-3}$ 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 2008 – 2013 is summarised in Tables 3.4 – 3.6. The alert threshold when the public must be warned (240 $\mu g.m^{-3}$) was not exceeded in 2013. The information threshold to the public (180 $\mu g.m^{-3}$) was in 2013 exceded at two stations (Bratislava-Jeséniova and Kojšovská hoľa).

Fig. 3.1 **Seasonal variability of ground level ozone concentration in Stará Lesná during 1992 – 2013**

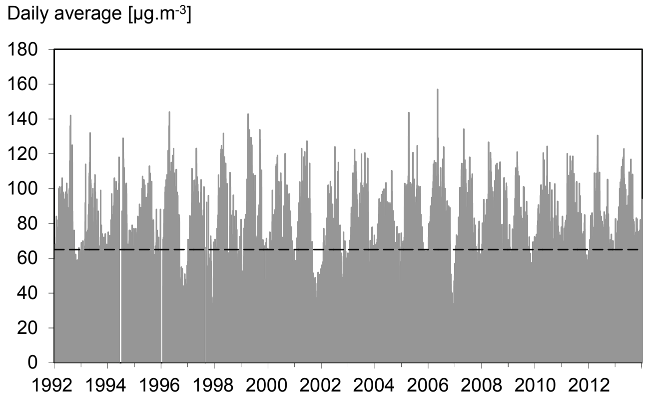
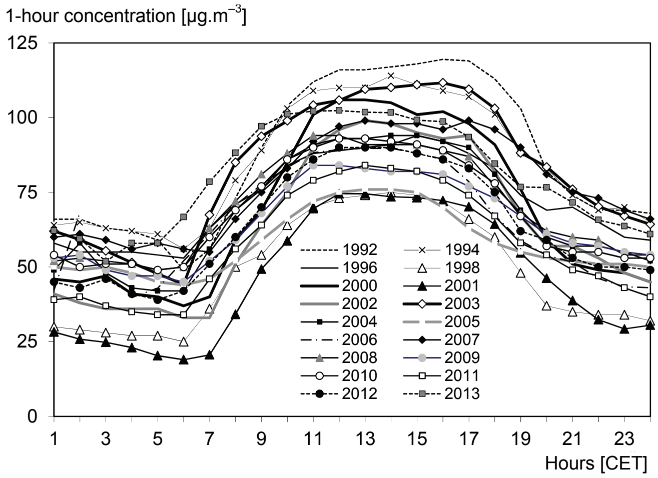


Fig. 3.2 **Average daily cycles of ground level ozone concentration in Stará Lesná, in August 1992 – 2013**



Tab. 3.4 **Number of exceedances of ozone information threshold (IT) and alert threshold (AT) to the public during 2008 – 2013**

Station	AT = 240 $\mu g.m^{-3}$						IT = 180 $\mu g.m^{-3}$					
	2008	2009	2010	2011	2012	2013	2008	2009	2010	2011	2012	2013
Banská Bystrica, Zelená		0	0	0	0	0		0	0	0	0	0
Bratislava, Jeséniova	0	0	12	0	0	0	0	0	39	3	0	3
Bratislava, Mamateyova	0	0	0	0	0	0	1	2	3	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		1	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	2	0	0	0	0	3
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 2011 – 2013. The target value not to be exceeded on more than 25 days per calendar year averaged over three years. In 2011 – 2013 was the number of 25 days overstepped at nine monitoring stations. The highest exceedance was observed at Chopok (63 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 2011 – 2013**

Station	2011	2012	2013	Average 2011 – 2013
Banská Bystrica, Zelená	32	54	36	**41**
Bratislava, Jeséniova	25	48	38	**37**
Bratislava, Mamateyova	28	36	*19	**32**
Humenné, Nám. slobody	10	10	20	13
Jelšava, Jesenského	*13	-	6	6
Košice, Ďumbierska	70	27	17	**38**
Nitra, Janíkovce	*11	44	26	**35**
Prievidza, Malonecpalská	14	14	*10	14
Žilina, Obežná	34	34	*26	**34**
Gánovce, Meteo. st.	25	12	*11	19
Chopok, EMEP	68	74	46	**63**
Kojšovská hoľa	62	38	20	**40**
Stará Lesná, AÚ SAV, EMEP	18	14	27	20
Starina, Vodná nádrž, EMEP	7	7	21	12
Topoľníky, Aszód, EMEP	-	34	32	**33**

- 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 8 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	2011	2012	2013	Average 2009 – 2013
Banská Bystrica, Zelená	19915	27585	19904	**20664**
Bratislava, Jeséniova	17735	24433	19886	**20273**
Bratislava, Mamateyova	16670	19352	15274	16113
Humenné, Nám. slobody	17796	13348	14790	17402
Jelšava, Jesenského	24558	–	6748	11623
Košice, Ďumbierska	30185	18651	12305	**22563**
Nitra, Janíkovce	–	25400	18852	**21431**
Prievidza, Malonecpalská	14093	16158	9528	13780
Žilina, Obežná	17808	20280	37306	**18348**
Gánovce, Meteo. st.	19196	11959	14697	14558
Chopok, EMEP	29525	30899	24263	**27370**
Kojšovská hoľa	25793	20363	12935	**21568**
Stará Lesná, AÚ SAV, EMEP	15455	12737	14132	13403
Starina, Vodná nádrž, EMEP	10267	9429	12552	10558
Topoľníky, Aszód, EMEP	–	14984	21587	**18603**

- long-term failure

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 – 15 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 2013 was in average below the 2003 level.

3.3 TOTAL ATMOSPHERIC OZONE OVER THE TERRITORY OF THE SLOVAK REPUBLIC IN 2013

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 spectra is regularly scanned through the range 290 – 325 nm at 0.5 nm increments. 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 334.8 Dobson Units in 2013. This is 1.0% 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 – 2013 long-term average is 327.0 Dobson units. In mentioned period the annual mean in the year 2013 was the third highest with the deviation of +2.4%.

Total ozone statistics for the year 2013 (daily means, relative deviations from long term average, monthly means, standard deviations and extremes) are in Table 3.8. A short missing data period in May is caused by the spectrophotometer participation in the international calibration campaign.

The highest positive differences of 6% from the long-term average were in January and February. The most significant negative difference of 9% was in May. In other months differences do not exceed +/– 3% (with –4% August exception).

Total ozone weekly averages are shown in Figure 3.3. The graph illustrates the total ozone amount in the year 2013 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.

Fig. 3.3 **Total atmospheric ozone over the territory of Slovakia in 2013**

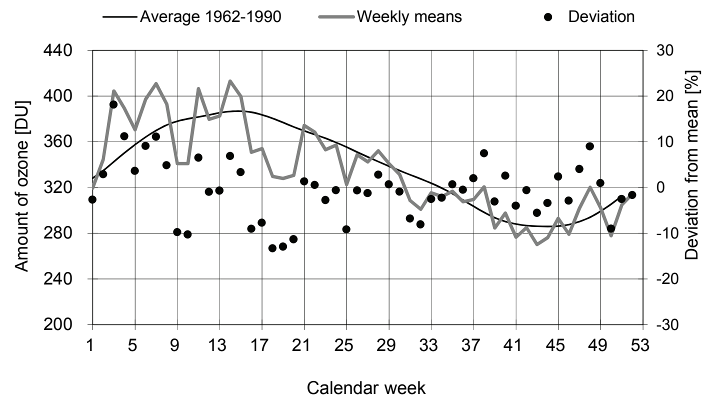


Fig. 3.4 **Annual course of CIE effective irradiance and UV index noon values – Gánovce 2013**

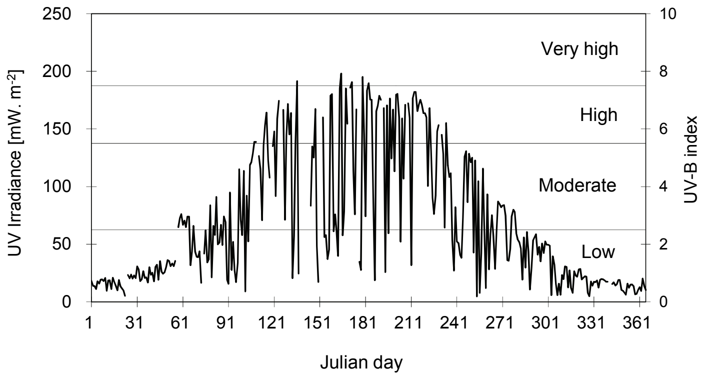


Figure 3.4 shows the biologically effective irradiance (in units of mW.m^{-2}). Values have been measured at local noon (about 10:39 UTC) when the daily maximal solar elevation is achieved. Daily UV-B maximum on clear sky days should be measured around local noon. A significant variability of values 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.

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^{-1} 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 2013**

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	404	13	302	-20	429	11	324	-15	361	-1	344	-1	308	-7	305	-2	303	4	280	-2	292	-1
2	310	-5	392	9	357	-6	382	-1	309	-19	381	5	327	-6	309	-7	317	2	327	12	284	-1	274	-8
3	274	-16	423	17	340	-10	441	14	321	-15	364	0	338	-3	305	-8	316	2	316	9	307	7	274	-8
4	315	-4	375	4	373	-2	428	11	336	-12	367	1	340	-2	297	-10	303	-2	299	3	311	9	275	-8
5	351	6	334	-8	335	-12	379	-2	335	-12	360	-1	346	0	304	-8	308	0	276	-5	323	13	295	-2
6	347	5	402	11	334	-12	403	4	330	-13	339	-7	351	2	302	-8	302	-2	266	-8	281	-2	339	13
7	331	0	404	11	350	-8	430	11	323	-14	346	-5	351	2	300	-9	306	-1	272	-6	255	-11	325	8
8	304	-9	396	9	349	-8	371	-4	344	-9	342	-6	343	0	294	-10	300	-2	274	-5	279	-3	333	10
9	289	-13	424	16	299	-21	387	0	339	-10	352	-3	328	-5	290	-11	314	3	278	-3	282	-2	305	1
10	335	0	444	21	347	-9	434	12	317	-16	360	0	332	-3	311	-5	298	-2	282	-2	321	12	290	-4
11	409	22	464	26	393	3	379	-2	311	-17	397	10	335	-2	306	-6	301	-1	287	0	312	9	276	-9
12	369	10	365	-1	387	1	388	0	332	-12	388	8	385	13	309	-5	315	4	273	-5	270	-6	265	-13
13	373	10	385	4	381	0	427	10	355	-5	342	-5	379	11	307	-6	321	6	270	-6	284	-1	261	-15
14	378	11	413	12	403	5	411	6	344	-8	324	-10	361	6	319	-2	322	7	276	-4	285	-1	261	-15
15	363	7	427	15	429	12	374	-3	333	-11	353	-1	375	10	332	3	294	-2	292	2	272	-6	286	-7
16	415	21	416	12	422	11	364	-6	314	-16	336	-6	340	0	319	-1	289	-4	326	14	267	-8	294	-5
17	430	26	405	9	430	12	360	-7	304	-18	332	-7	328	-3	306	-5	340	13	272	-5	264	-8	291	-6
18	415	21	401	7	375	-2	324	-16	335	-10	325	-9	334	-1	317	-2	334	12	287	0	258	-11	328	5
19	431	25	366	-2	433	13	324	-16			313	-12	341	1	308	-4	349	17	278	-3	276	-5	291	-7
20	399	15	393	5	369	-4	324	-16			321	-10	341	1	308	-4	326	10	264	-8	315	9	292	-7
21	405	17	395	5	366	-5	360	-7			317	-11	328	-3	331	3	313	5	288	1	298	3	320	2
22	401	15	406	8	388	1	388	1			324	-9	326	-3	307	-4	293	-1	287	0	308	6	318	1
23	374	7	402	7	364	-5	375	-3			326	-8	346	3	305	-4	269	-9	271	-5	325	12	314	-1
24	383	9	388	3	363	-6	343	-11			324	-8	353	5	315	-1	265	-10	270	-6	333	14	339	7
25	390	11	371	-2	361	-6	319	-17	372	1	342	-3	339	1	311	-2	269	-9	272	-5	332	14	317	-1
26	366	4	360	-4	401	4	307	-20	376	2	353	1	325	-3	330	4	282	-4	252	-12	352	20	325	2
27	405	15	341	-10	416	8	363	-5	382	4	350	0	319	-4	329	4	301	3	251	-12	333	14	370	15
28	331	-7	315	-17	437	14	385	1	376	2	352	1	313	-6	305	-3	313	7	251	-12	295	0	278	-13
29	363	2			347	-10	361	-5	345	-6	354	1	308	-7	320	2	293	0	255	-11	310	5	257	-20
30	325	-9			346	-10	323	-15	354	-3	365	5	319	-4	318	1	297	2	273	-4	329	11	282	-13
31	356	-1			369	-4			379	4			314	-5	309	-1			282	-1			317	-2
∅	363	6	393	6	373	-2	376	-2	339	-9	347	-3	339	0	311	-4	305	1	280	-3	298	3	299	-3
Std	41	11	32	9	36	9	38	10	23	7	21	5	18	5	10	4	19	6	19	6	26	8	27	8
Max	431	26	464	26	437	14	441	14	382	4	397	10	385	13	332	4	349	17	327	14	352	20	370	15
Min	274	-16	315	-17	299	-21	307	-20	304	-19	313	-12	308	-7	290	-11	265	-10	251	-12	255	-11	257	-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.

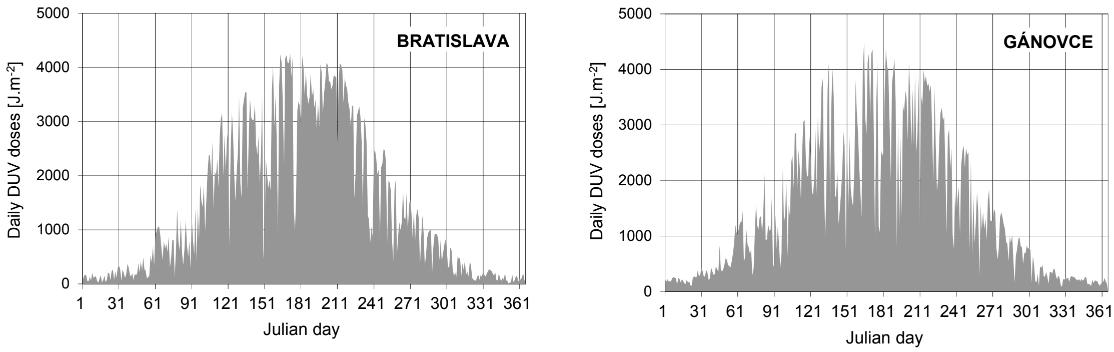
The biggest 1 min average of the CIE-erythemal UV irradiance of 203.6 $mW.m^{-2}$ (3.49 $MED.h^{-1}$) was registered in Bratislava (48º10'N, 17º06'E, 304 m a.s.l.) on July 31, a day with the total ozone amount of 5% below the long term average. The biggest 1 min average of the CIE-erythemal UV irradiance of 214.1 $mW.m^{-2}$ (3.67 $MED.h^{-1}$) was registered at Poprad-Ganovce on June 14. Deviation of the daily total column ozone from the long-term average was –10% on that day.

The biggest hourly average of the CIE-erythemal UV irradiance of 176.5 $mW.m^{-2}$ (3.02 MED h^{-1}) was registered in Bratislava on July 31. The biggest hourly average of the CIE-erythemal UV irradiance of 186.3 $mW.m^{-2}$ (3.419 $MED.h^{-1}$) was registered at Poprad-Ganovce on June 25. Deviation of the daily total column ozone from the long-term average was –3% on that day.

Daily doses of the CIE-erythemal UV radiation are presented in Figure 3.5. Maximum daily dose of 4255 $J.m^{-2}$ (which correspondents to 20.3 MED) was measured in Bratislava on June 21. Maximum daily dose of 4495 $J.m^{-2}$ (21.4 MED) was measured at Poprad-Ganovce on June 14.

In the period April-September 2013 total CIE-erythemal UV radiation dose in Bratislava was 462 895 $J.m^{-2}$. This value is 3.4% lower than the dose in 2012. Total CIE-erythemal dose at Poprad-Ganovce was 438 176 $J.m^{-2}$ for the same period. This value is 2.8% lower than the dose in 2012.

Fig. 3.5 **Annual Course of CIE effective UV radiation Daily Doses in 2013**



EMISSIONS

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.
Middle 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 middle 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 – 2013) – 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 880 (711 of it in operation) large point sources in 2013. 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.

Middle 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 2013, NEIS registered 12825 (10532 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

Emissions estimates from mobile sources have been annually calculated since 1990. Software program COPERT 42 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 biofuels. 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. When comparing data on fuel and energy consumption in the years 2010 to 2013 it shows a very slight fluctuations, slightly decreasing gasoline, diesel is almost stable and increasing consumption of alternative fuels (LPG, CNG).

The evaluation of pollution sources and emissions is carried out also for rail, air and water transport. The methodology for emission calculation from railway transport operations is an accordance with the methodology EMEP/CORINAIR3F for non-road sources and used emission factors are in comply with the methodological manual Emission Inventory Guidebook. Pollution production for the water transport in SR is applied only to the transect of the river Dunaj (Danube) related to Slovak territory where the shipping activity is taken place. The methodology used for determination of annual emission production from operating activities of shipping vessels is simplified method of EMEP/CORINAIR3F for non-road sources based on compilation using average emission factors recommended by working group CORINAIR. In the aviation, the flight altitude is an important factor in emission assessment due to different pollution impacts of aircrafts during the flight at heights compare to the landing or take-off manoeuvres. The methodology for objective impact assessment of air pollutants in larger altitude from aircraft engines has not been clearly developed yet. Therefore emission inventory is based on local pollution produced at major airports in Slovakia. Input is based on operational-statistical data of realized flight (LTO) cycle, fuel consumption and an overview of fuel sold. Innovative methodology is also based on knowledge of emission factors of individual aircraft types.

In 2015, the emissions from the pipeline transport were calculated from 2000 to 2013. These emissions were allocated to category other transport.

A new decree on the quality of motor fuels came into force from September 2010 in Slovakia. The sulfur content of fuels has been reduced from 50 mg/kg of fuel at 10 mg/kg of fuel. Based on the QA/QC process the emission factor for SO_2 was modified in rail transport for oil and the emissions of SO_2 were recalculated for 2011 and 2012. Due to the sulfur content the SO_2 emissions were recalculated also in the road transport for 2011 and 2012. As part of improving inventory the VOC emissions were estimated in category road transport – gasoline evaporation by using COPERT model for the years 2011 – 2013.

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 and 4.1b 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. prevádzka 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 outdated 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 – 2013 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 power plant Slovenské elektrárne 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).

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.

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. In 2012 – 2013 was only an insignificant decrease of 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 matter 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 NFR09 nomenclature and recommendations of TFEIP working groups. Emissions at national level are estimated in cooperation with the external experts and balanced on the base of activity data multiplied by the emission factors. Estimated emissions of pollutants mentioned above as well as the other basic pollutants are transformed into the international NFR system according to the requirements for reporting and annually reported to the UNECE secretariat and EEA by the Ministry of Environment of the SR.

NMVOC Emission inventory of NMVOC is elaborated according to EMEP/EEA (Air Pollutant Emission Inventory Guidebook). In 2001 a new subsector road paving with asphalt was included in the national emission inventory and as a result of this the emissions increased adequately in individual years. In 2004 the emission factor from the mentioned sector was revalued and changed. The previous emission factor was based on the highest emission production. New emission factor respects the fact that asphalt mixture contains 5.5% of asphalt. The rest consists of aggregate. The combustion of wood was for the first time included in the residential sector in 2004. Emissions increased slightly in the mentioned sector. In the sector of fuel distribution, LPG distribution has been included since 2001. The trend in the fuel distribution category has decreased in the long-term point of view. In 2012, the makeable reduction of 84% was noticed. It was caused by 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 the mandatory implementation of 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. Since 1990, the NMVOC emissions have decreased according to the balance. The main drivers of this development were the solvent and paints consumption decrease and the gradual introduction of low solvent paint, broad implementation of measures in the crude oil processing and fuel distribution sectors as well as a change of fuels in the energy sector and alteration of the cars in favour of cars equipped with catalysts. The NMVOC emissions have increased in the sector of paints and glues by about 54% since 2000 because the paints and glues are used as part of a large spectrum of industrial activities and various technological operations. Continually the consumption and import of print's ink and solvent paints has increased, too. In years 2004 and 2005 occurred expansion in automotive industry in Slovakia, many of paintshops was opened and so the consumption of paints has increased. Since 2007, entered into force Council Directive 1999/13/EC of 11 March 1999 with which operators had to adjust to emission limits. In 2007 was recalculated time series from sector dry cleaning and degreasing as a result of refinements counting solvent consumption in the use of paints and glues. In 2008, time series of land-filled and incinerated waste were recalculated on the basis of updated input data. Finally, emissions from road transport were recalculated in order to use an updated version of the model COPERT IV. In 2009 there was a decrease in NMVOC emissions associated with the decrease in industrial production. Emissions from road transport were recalculated until 2000, because of the use of a new version of the model COPERT IV in inventory. Inventory was supplemented in the transport sector by category of gasoline evaporation. Data are available only from 2011, so far. Due to updating of activity data, emissions from waste sector for years 2008, 2005, 2004 and 2002 were recalculated. Decreasing trend of NMVOC emissions is continuing to the year 2010. The most significant decline was in solvents consumption in sector degreasing of metal surfaces and road transport. In 2011 the increment of NMVOC emissions occurred particularly due to higher consumption of solvents in sector of chemical/dry cleaning and degreasing and in household heating sector. Changes and updates in waste incineration sector led in to recalculations of emissions within 2000 – 2010. The latest emission recalculation in the waste sector was performed in the submission 2015. 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. More visible inter-annual decrease of

MVOC emissions 2011 – 2012 was noticed in categories: Commercial and Institutions stationary heating; Industrial waste; Edible fats and oils processing. Otherwise the reduction trend was in the categories: Extraction and distribution of mineral resources; Copper production and Road paving with asphalt.

POPs

Emission inventory of persistent organic pollutants (POPs) is processed according to the methodology, elaborated in the frame of the project Initial Assistance to the Slovak Republic in Meeting Its Obligations Under the Stockholm Convention on Persistent Organic Pollutants, and updated according to the UNEP[2] and methodologies used in the Czech Republic and Poland. Emissions of polychlorinated dioxins and furans (PCDD/F) and polycyclic aromatic hydrocarbons (PAH) from road transport were recalculated by model COPERT IV.

Downward trend of POPs emissions to the air proved to be most remarkable in the area of PAH emissions in the 90-ties, when it was caused also by the change of aluminium production technology (use of pre-baked anodes) (Tab. 4.8, Fig. 4.5). Emissions of polychlorinated biphenyls (PCB) slightly decreased. That fact was mostly influenced by decreased amount of iron ore agglomeration. Increased consumption of wood in the sector of residential heating caused the increase of the emissions of PAHs. Emissions of PCDD/F have declined since 2000 because of reconstruction of some technologies (for example municipal and industrial waste incinerators). Total emissions PCDD/F depend mostly on waste incineration, iron ore agglomeration and domestic heating, decrease in the year 2013 was caused by decreased amount of hospital industrial waste combusted. HCB emissions are influenced by the decrease of secondary cooper production and hospital waste incineration.

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

[2] *Standardized Toolkit for Identification and Quantification of Dioxin and Furan Releases, UNEP Chemicals, February 2005*

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.

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[2] 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). 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[3] 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 2013

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 2013

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 72.58% to 96.97%. Table 4.5 lists top ten sources in administrative regions according to the amount of emissions of basic pollutants.

Specific territorial emissions in 2013

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.

[3] *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	0.359	0.336	0.353	0.325
	Total		**56.991**	**57.117**	**48.599**	**44.279**	**44.640**	**53.028**	**46.199**	**38.247**	**37.207**
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	0.194	0.064	0.059	0.063	0.047	0.044	0.047	0.045
	Total		**126.953**	**131.110**	**103.346**	**105.496**	**96.187**	**89.008**	**87.751**	**70.558**	**69.404**
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	7.548	7.633	9.023	8.557	7.0347	7.570	7.806
	Total		**107.416**	**107.766**	**100.208**	**97.800**	**99.052**	**101.863**	**96.354**	**95.615**	**93.859**
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	1.879	1.810	1.885	1.923	1.668	1.790	1.769
	Total		**300.070**	**304.609**	**290.054**	**291.983**	**292.271**	**272.049**	**272.518**	**244.187**	**244.929**

LS - large sources, MS - middle 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 – 2013**

			2009	2010	2011	2012	2013
PM	Stationary sources – NEIS	LS [1]	4.966	4.936	5.139	5.283	5.417
		MS [1]	1.554	1.474	1.404	1.348	1.306
		SS [2]	27.083	26.214	28.507	28.745	29.298
	Mobile sources	RT	2.470	2.741	2.632	2.734	2.665
		OT	0.295	0.384	0.329	0.320	0.123
	Total		**36.368**	**35.749**	**38.011**	**35.696**	**38.809**
SO_2	Stationary sources – NEIS	LS [1]	59.739	64.798	64.321	54.235	49.013
		MS [1]	0.991	0.906	0.839	0.894	0.945
		SS [2]	3.116	3.424	3.102	3.169	2.802
	Mobile sources	RT	0.194	0.211	0.041	0.042	0.040
		OT	0.041	0.058	0.031	0.014	0.013
	Total		**64.081**	**69.397**	**68.334**	**58.354**	**52.813**
NO_x	Stationary sources – NEIS	LS [1]	31.333	31.466	31.199	27.465	25.818
		MS [1]	3.389	3.485	3.716	3.978	4.259
		SS [2]	7.990	8.076	8.215	8.241	8.334
	Mobile sources	RT	37.638	40.510	37.773	37.087	37.076
		OT	6.439	7.407	6.821	4.907	4.774
	Total		**86.789**	**90.944**	**87.724**	**81.678**	**80.261**
CO	Stationary sources – NEIS	LS [1]	106.635	125.475	136.615	133.264	130.608
		MS [1]	4.104	4.446	4.680	4.913	5.098
		SS [2]	36.181	35.953	37.710	38.172	38.113
	Mobile sources	RT	59.568	53.489	46.880	45.079	42.930
		OT	1.541	1.736	1.448	1.424	1.323
	Total		**208.029**	**221.099**	**227.333**	**222.852**	**218.072**

LS - large sources, MS - middle 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. 4.2a **Emissions of PM [t] from road transport in the SR in 2001, 2005 and within 2010 – 2013**

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

Tab. 4.2b **Emissions of PM_{10} and $PM_{2,5}$ [t] from road transport in the SR in 2001, 2005 and within 2010 – 2013**

	2001		2005		2010		2011		2012		2013	
	PM_{10}	PM_{10}	$PM_{2,5}$	PM_{10}	PM_{10}	$PM_{2,5}$	PM_{10}	$PM_{2,5}$	PM_{10}	$PM_{2,5}$	PM_{10}	$PM_{2,5}$
Emissions from diesel engine	1025	1025	1488	1488	1219	1219	1147	1147	1198	1198	1173	1173
Emissions from petrol engine	51	51	44	44	24	24	23	23	22	22	21	21
Emissions from LPG engine	-	-	-	-	1	1	1	1	1	1	1	1
Emissions from CNG engine	-	-	-	-	0	0	0	0	0	0	0	0
Total emissions from exhaust	**1076**	**1076**	**1532**	**1532**	**1244**	**1244**	**1171**	**1171**	**1221**	**1221**	**1195**	**1195**
Abrasion emissions	637	340	866	462	948	506	928	496	964	516	932	498
Total	**1713**	**1416**	**2398**	**1994**	**2192**	**1750**	**2099**	**1667**	**2185**	**1737**	**2127**	**1693**

Emissions estimated to April 30th 2015.

Fig. 4.1 **Development trends in basic pollutant emissions within 1990 – 2013**

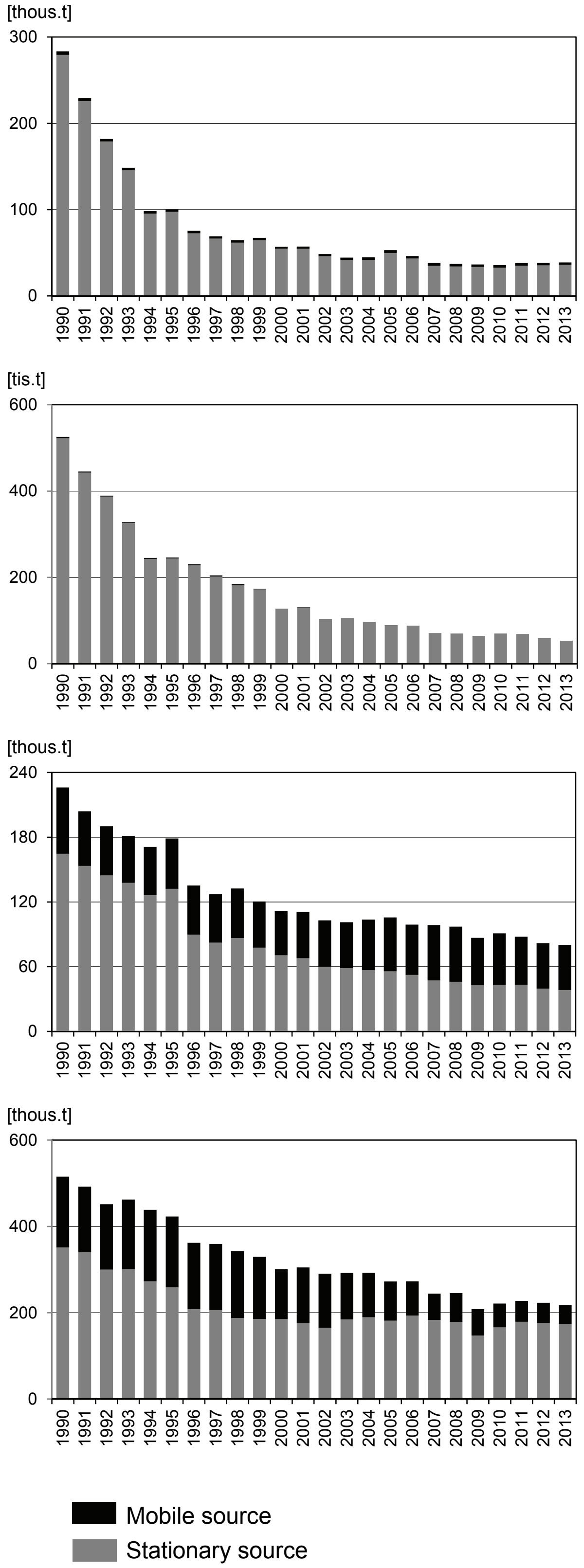
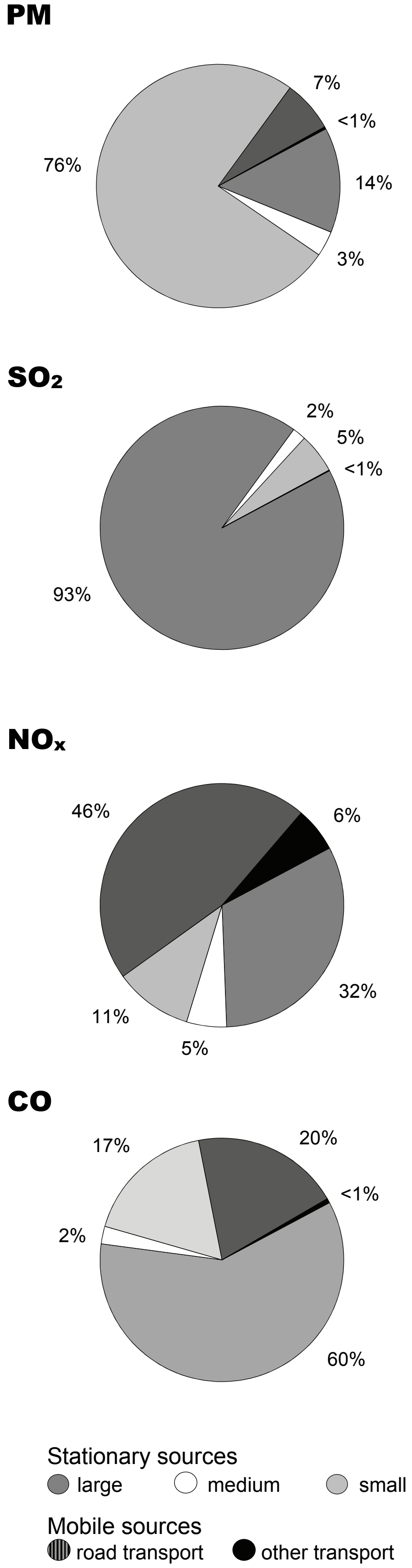


Fig. 4.2 **Emissions of basic pollutants in 2013**



Tab. 4.3 **Stationary source emissions of basic pollutants [t] in agglomerations and zones* within 2001 – 2013**

PM		2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Agglome-ration	Bratislava	477	444	484	470	472	430	353	339	332	327	309	281	283
	Košice	17173	14601	9890	6807	4362	4107	3418	3056	3009	3245	3268	3443	3467
Zone	Bratislava region	546	493	466	457	506	452	469	477	469	447	482	485	492
	Trnava region	1518	1284	1325	1522	1935	1825	1752	1770	1755	1742	1902	1886	1934
	Trenčín region	4820	4199	4331	4804	5280	4712	4464	4312	4145	3843	4197	4171	4301
	Nitra region	2921	2476	2474	2740	3414	3144	3074	3053	2991	2896	3194	3176	3255
	Žilina region	6271	5298	5344	5852	7076	6540	6443	6459	6447	6238	6831	6875	7080
	Banská Bystrica r.	6355	5334	5346	5820	7378	6710	6579	6566	6497	6328	6772	6854	6918
	Prešov region	4266	3491	3667	4588	5556	5158	4606	4514	4608	4345	4671	4800	4846
	Košice region	10331	8400	8398	8862	13842	10176	3663	3545	3349	3213	3422	3404	3445
Total		**54677**	**46022**	**41725**	**41922**	**49820**	**43254**	**34820**	**34090**	**33603**	**32625**	**35050**	**35376**	**36021**

SO_2		2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Agglome-ration	Bratislava	13594	11348	12263	9869	9285	11764	8648	8302	9265	10276	7422	3239	2074
	Košice	12607	10500	10781	13113	12526	11417	10307	9910	9087	9671	9247	9920	8837
Zone	Bratislava region	380	208	150	290	377	207	176	169	178	160	191	246	201
	Trnava region	2051	1166	1077	1141	1037	1039	566	566	423	472	494	498	602
	Trenčín region	45187	38305	46051	44108	40937	39659	33450	36114	33251	37232	40144	33947	31490
	Nitra region	4749	3799	3648	2485	2336	2367	1158	1134	1066	532	382	400	390
	Žilina region	10237	7140	7647	6147	5035	4444	3751	3693	3384	2949	2606	2598	2306
	Banská Bystrica r.	10043	8814	7983	6300	6197	6791	5022	4724	4119	4157	4978	4212	4165
	Prešov region	8082	6320	6719	4864	4856	4204	3407	1811	1945	2474	1487	1988	1788
	Košice region	23310	14952	8969	7649	6185	5639	3823	2727	1128	1203	1310	1250	908
Total		**130242**	**102552**	**105287**	**95966**	**88772**	**87530**	**70307**	**69149**	**63847**	**69127**	**68262**	**58298**	**52760**

NO_x		2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Agglome-ration	Bratislava	5151	5313	5462	5318	4791	4521	4110	4112	4142	4126	3710	3252	2884
	Košice	12172	12140	12355	11107	10929	12222	9975	8665	8167	9323	7883	8286	8538
Zone	Bratislava region	1900	1972	1602	1670	1742	1700	1882	1874	1739	1437	1712	1527	1723
	Trnava region	1966	1684	1675	1644	1667	1608	1470	1563	1381	1487	1774	1630	1667
	Trenčín region	10489	9616	10167	9677	7822	7835	7219	7588	7328	6892	7639	6960	6676
	Nitra region	3974	3843	3921	4356	3989	3653	2979	3465	3220	2603	3003	2444	2499
	Žilina region	5170	4599	4491	4709	4674	4479	4550	4397	4256	4757	4964	4857	4365
	Banská Bystrica r.	6666	6316	5840	6160	6281	5522	5550	5699	4465	5399	5840	5203	5263
	Prešov region	3443	3212	3244	3168	3459	3284	2849	2490	2781	2785	2500	2621	2447
	Košice region	16864	11209	9825	8943	10314	7543	6538	6189	5233	4217	4105	2904	2349
Total		**67794**	**59905**	**58581**	**56752**	**55666**	**52366**	**47122**	**46042**	**42712**	**43027**	**43130**	**39684**	**38410**

CO		2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Agglome-ration	Bratislava	1319	1264	1224	1277	1120	1065	879	821	837	824	868	778	811
	Košice	78619	83700	104605	107218	93197	109060	102663	94378	68477	88292	101053	99454	100635
Zone	Bratislava region	1638	1488	2794	1775	1576	1901	2020	2661	3520	3250	3037	1769	2040
	Trnava region	4682	3591	3399	3493	3865	3563	3459	3306	2627	2728	2967	2963	2946
	Trenčín region	10334	7815	7789	8036	9331	10854	9430	10043	10481	11476	11151	10918	10502
	Nitra region	7379	5470	5586	5672	6627	6459	5690	6849	6385	6185	6283	5532	5731
	Žilina region	19287	16520	16462	17257	15924	14990	14686	14210	11573	12059	12370	12528	12223
	Banská Bystrica r.	26301	24299	25727	27840	29375	26835	27382	29303	27604	25728	26445	27266	25649
	Prešov region	11838	9075	8804	8800	9282	8714	7522	7080	7042	6795	7010	7128	7349
	Košice region	14237	11969	7862	8232	11109	10108	9680	9764	8374	8536	7820	8012	5931
Total		**175636**	**165191**	**184252**	**189601**	**181407**	**193550**	**183410**	**178415**	**146920**	**165874**	**179005**	**176349**	**173819**

* *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 middle sources*) in 2013**

	PM			SO_2		
	Operator – plant locality	**[t]**	**[%]**	**Operator – plant locality**	**[t]**	**[%]**
1	U. S. Steel Košice, s.r.o. - Košice	3302.68	49.12	Slovenské elektrárne, a.s. - Zemianske Kostoľany	31003.01	62.06
2	Slovenské elektrárne, a.s. - Zemianske Kostoľany	262.97	3.91	U. S. Steel Košice, s.r.o. - Košice	7578.60	15.17
3	FORTISCHEM a.s. - Nováky	214.62	3.19	SLOVNAFT, a.s. - Bratislava	1547.71	3.10
4	Mondi scp, a.s. - Ružomberok	178.09	2.65	Slovalco, a.s. - Žiar nad Hronom	1387.91	2.78
5	Považská cementáreň, a.s. - Ladce	161.80	2.41	Tepláreň Košice, a.s. - Košice	1154.35	2.31
6	Duslo, a.s. - Šaľa	147.86	2.20	Zvolenská teplárenská a.s. - Zvolen	1122.39	2.25
7	Obaly SOLO, s.r.o. - Ružomberok	113.61	1.69	BUKÓZA ENERGO, a.s. - Hencovce	1091.64	2.19
8	BUKÓZA ENERGO, a.s. - Hencovce	106.23	1.58	Martinská teplárenská, a.s. - Martin	475.25	0.95
9	Slovalco, a.s. - Žiar nad Hronom	83.10	1.24	Žilinská teplárenská, a.s. - Žilina	425.17	0.85
10	DOLVAP, s.r.o. - Varín	76.93	1.14	Dalkia Industry Žiar nad Hronom, a.s. - Žiar n/H	400.00	0.80
11	Tepláreň Košice, a.s. - Košice	75.98	1.13	Slovenské elektrárne, a.s. - Vojany	378.29	0.76
12	Carmeuse Slovakia, s.r.o. - Včeláre	68.05	1.01	OFZ, a.s. - Oravský Podzámok	352.47	0.71
13	CM European Power Slovakia, s.r.o. - Bratislava	54.37	0.81	CM European Power Slovakia, s.r.o. - Bratislava	319.92	0.64
14	SLOVNAFT, a.s. - Bratislava	53.75	0.80	Knauf Insulation, s.r.o. - Nová Baňa	287.58	0.58
15	Slovenské elektrárne, a.s. - Vojany	47.81	0.71	SLOVENSKÉ CUKROVARY s.r.o. - Sereď	199.34	0.40
16	Zvolenská teplárenská a.s. - Zvolen	46.47	0.69	Duslo, a.s. - Bratislava	180.15	0.36
17	Knauf Insulation, s.r.o. - Nová Baňa	43.88	0.65	Mondi scp, a.s. - Ružomberok	170.33	0.34
18	OFZ, a.s. - Oravský Podzámok	37.09	0.55	Holcim (Slovensko) a.s. - Rohožník	143.02	0.29
19	BUKOCEL, a.s. - Hencovce	32.51	0.48	TP 2, s.r.o. - Strážske	116.65	0.23
20	Volkswagen Slovakia, a.s. - Bratislava	29.82	0.44	BUKOCEL, a.s. - Hencovce	109.02	0.22
Spolu		**5137.59**	**76.42**		**48442.78**	**96.97**

	NO_x			CO		
	Operator – plant locality	**[t]**	**[%]**	**Operator – plant locality**	**[t]**	**[%]**
1	U. S. Steel Košice, s.r.o. - Košice	6476.89	21.53	U. S. Steel Košice, s.r.o. - Košice	99727.44	73.49
2	Slovenské elektrárne, a.s. - Zemianske Kostoľany	3270.16	10.87	Slovalco, a.s. - Žiar nad Hronom	13307.28	9.81
3	Tepláreň Košice, a.s. - Košice	1413.69	4.70	CEMMAC a. s. - Horné Srnie	2249.94	1.66
4	Holcim (Slovensko) a.s. - Rohožník	1245.70	4.14	Slovenské magnezitové závody a.s. - Jelšava	2104.62	1.55
5	CM European Power Slovakia, s.r.o. - Bratislava	874.46	2.91	Považská cementáreň, a.s. - Ladce	2020.51	1.49
6	SLOVNAFT, a.s. - Bratislava	817.98	2.72	DOLVAP, s.r.o. - Varín	1587.14	1.17
7	Považská cementáreň, a.s. - Ladce	776.68	2.58	Holcim (Slovensko) a.s. - Rohožník	1010.86	0.74
8	Slovenské magnezitové závody a.s. - Jelšava	772.45	2.57	OFZ, a.s. - Oravský Podzámok	920.21	0.68
9	Mondi scp, a.s. - Ružomberok	703.72	2.34	Calmit, spol. s r.o. - Žirany	796.14	0.59
10	Duslo, a.s. - Šaľa	691.86	2.30	BUKOCEL, a.s. - Hencovce	637.29	0.47
11	Holcim (Slovensko) a.s. - Turňa nad Bodvou	573.74	1.91	SLOVNAFT, a.s. - Bratislava	426.75	0.31
12	CEMMAC a. s. - Horné Srnie	573.56	1.91	SLOVINTEGRA ENERGY, s.r.o. - Levice	395.54	0.29
13	BUKÓZA ENERGO, a.s. - Hencovce	545.55	1.81	Slovenské elektrárne, a.s. - Zemianske Kostoľany	382.34	0.28
14	Zvolenská teplárenská a.s. - Zvolen	533.39	1.77	SLOVAKIA STEEL MILLS, a.s. - Strážske	355.04	0.26
15	Slovalco, a.s. - Žiar nad Hronom	513.35	1.71	Slovenské elektrárne, a.s. - Vojany	337.44	0.25
16	Carmeuse Slovakia, s.r.o. - Košice	437.22	1.45	FORTISCHEM a.s. - Nováky	336.05	0.25
17	Žilinská teplárenská, a.s. - Žilina	429.45	1.43	Mondi scp, a.s. - Ružomberok	301.39	0.22
18	eustream, a.s. - Veľké Zlievce	410.48	1.36	SLOVMAG, a.s. - Lubeník	278.86	0.21
19	PPC Investments, a.s. - Bratislava	385.60	1.28	Slovenské magnezitové závody a.s. - Bočiar	278.30	0.21
20	OFZ, a.s. - Oravský Podzámok	384.85	1.28	Železiarne Podbrezová a.s. - Podbrezová	275.21	0.20
Spolu		**21830.77**	**72.58**		**127728.34**	**94.12**

** 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 2013 (NEIS – large and middle sources*)**

BRATISLAVA REGION

	PM			SO_2		
	Source	**District**	**Emis. [t]**	**Source**	**District**	**Emis. [t]**
1.	CM European Power Slovakia, s. r. o.	Bratislava II	54.37	SLOVNAFT, a.s.	Bratislava II	1547.71
2.	SLOVNAFT, a.s.	Bratislava II	53.75	CM European Power Slovakia, s. r. o.	Bratislava II	319.92
3.	VOLKSWAGEN SLOVAKIA, a.s.	Bratislava IV	29.82	Duslo, a.s.	Bratislava III	180.15
4.	Holcim (Slovensko) a.s.	Malacky	29.44	Holcim (Slovensko) a.s.	Malacky	143.02
5.	PPC Investments, a.s.	Bratislava III	16.01	Ministerstvo obrany Slovenskej republiky	Pezinok	6.38
6.	Swedspan Slovakia s. r. o.	Malacky	11.83	Bratislavská teplárenská, a.s.	Bratislava II	5.60
7.	TERMMING, a.s.	Bratislava II	5.94	Odvoz a likvidácia odpadu, a.s.	Bratislava II	5.32
8.	Obec Rohožník	Malacky	4.64	UNIVOLT - REMAT s r.o.	Pezinok	3.11
9.	ALAS SLOVAKIA, s.r.o.	Malacky	4.21	BPS Senec, s. r. o.	Senec	3.02
10.	Ministerstvo obrany SR	Pezinok	3.93	PPC Investments, a.s.	Bratislava III	1.92
	NO_x			CO		
	Source	**District**	**Emis. [t]**	**Source**	**District**	**Emis. [t]**
1.	Holcim (Slovensko) a.s.	Malacky	1245.70	Holcim (Slovensko) a.s.	Malacky	1010.86
2.	CM European Power Slovakia, s. r. o.	Bratislava II	874.46	SLOVNAFT, a.s.	Bratislava II	426.75
3.	SLOVNAFT, a.s.	Bratislava II	817.98	TERMMING, a.s.	Malacky	193.17
4.	PPC Investments, a.s.	Bratislava III	385.60	Swedspan Slovakia s. r. o.	Malacky	109.40
5.	VOLKSWAGEN SLOVAKIA, a.s.	Bratislava IV	102.77	VOLKSWAGEN SLOVAKIA, a.s.	Bratislava IV	33.55
6.	Odvoz a likvidácia odpadu, a.s.	Bratislava II	95.87	Obec Rohožník	Malacky	32.98
7.	Swedspan Slovakia s. r. o.	Malacky	75.63	Dalkia a.s.	Bratislava V	24.38
8.	Dalkia a.s.	Bratislava V	70.98	Ministerstvo obrany Slovenskej republiky	Pezinok	24.06
9.	Bratislavská teplárenská, a.s.	Bratislava IV	62.05	NAFTA a.s.	Malacky	20.23
10.	TERMMING, a.s.	Bratislava II	61.73	TERMMING, a.s.	Bratislava II	19.08

TRNAVA REGION

	PM			SO_2		
	Source	**District**	**Emis. [t]**	**Source**	**District**	**Emis. [t]**
1.	AMYLUM SLOVAKIA, spol. s r.o.	Trnava	21.53	SLOVENSKÉ CUKROVARY, s.r.o.	Galanta	199.34
2.	SLOVENSKÉ CUKROVARY, s.r.o.	Galanta	17.92	Johns Manville Slovakia, a.s.	Trnava	93.03
3.	Agropodnik a.s. Trnava	Dunaj. Streda	12.60	MACH TRADE, spol. s r.o.	Galanta	45.02
4.	Johns Manville Slovakia, a.s.	Trnava	9.63	ZLIEVÁREŇ T R N A V A s.r.o.	Trnava	29.55
5.	ZLIEVÁREŇ T R N A V A s.r.o.	Trnava	7.33	ECO PWR, s. r. o.	Dunaj. Streda	9.77
6.	PENAM SLOVAKIA, a.s.	Trnava	5.08	RUPOS, s.r.o.	Trnava	8.75
7.	Agropodnik a.s. Trnava	Senica	4.94	ZF SACHS Slovakia, a.s.	Trnava	4.54
8.	Agro Boleráz, s.r.o.	Trnava	4.80	Baňa Čáry, a.s.	Senica	4.37
9.	Bekaert Slovakia, s.r.o.	Galanta	3.93	BPS Vesele, s. r. o.	Piešťany	3.64
10.	ENVIRAL, a.s.	Hlohovec	3.84	BioREn s. r. o.	Piešťany	3.63
	NO_x			CO		
	Source	**District**	**Emis. [t]**	**Source**	**District**	**Emis. [t]**
1.	Johns Manville Slovakia, a.s.	Trnava	172.50	Službyt, spol. s r.o.	Senica	224.80
2.	SLOVENSKÉ CUKROVARY, s.r.o.	Galanta	134.07	IKEA Industry Slovakia s. r. o.	Trnava	27.82
3.	ENVIRAL, a.s.	Hlohovec	56.44	ZLIEVÁREŇ T R N A V A s.r.o.	Trnava	27.47
4.	Službyt, spol. s r.o.	Senica	45.84	Bekaert Slovakia, s.r.o.	Galanta	23.70
5.	AMYLUM SLOVAKIA, spol. s r.o.	Trnava	44.51	ENVIRAL, a.s.	Hlohovec	18.97
6.	IKEA Industry Slovakia s. r. o.	Trnava	30.14	SLOVENSKÉ CUKROVARY, s.r.o.	Galanta	17.15
7.	E.ON Elektrárne s.r.o.	Hlohovec	29.57	I.D.C. Holding, a.s.	Galanta	15.57
8.	TEPLÁREŇ, a.s., Považská Bystrica	Dunaj. Streda	24.29	AMYLUM SLOVAKIA, spol. s r.o.	Trnava	15.38
9.	ZLIEVÁREŇ T R N A V A s.r.o.	Trnava	23.03	E.ON Elektrárne s.r.o.	Hlohovec	9.92
10.	Bekaert Hlohovec, a.s.	Hlohovec	18.69	Wienerberger slovenské tehelne, s.r.o.	Trnava	9.85

TRENČÍN REGION

	PM			SO₂		
	Source	District	Emis. [t]	Source	District	Emis. [t]
1.	Slovenské elektrárne, a.s.	Prievidza	262.97	Slovenské elektrárne, a.s.	Prievidza	31003.01
2.	FORTISCHEM a. s.	Prievidza	214.62	VETROPACK NEMŠOVÁ, s.r.o.	Trenčín	42.72
3.	Považská cementáreň, a.s.	Ilava	161.80	Hornonitrianske bane Prievidza, a.s. v skratke HBP, a.s.	Prievidza	29.89
4.	Hornonitrianske bane Prievidza, a.s. v skratke HBP, a.s.	Prievidza	26.46	Považská cementáreň, a.s.	Ilava	9.83
5.	Považský cukor a.s.	Trenčín	14.54	Služby pre bývanie, s r.o.	Trenčín	7.30
6.	TERMONOVA, a.s.	Ilava	13.80	FORTISCHEM a. s.	Prievidza	6.01
7.	Kameňolomy CS, s. r. o.	Púchov	10.89	RONA, a.s.	Púchov	4.70
8.	CESTNÉ STAVBY ŽILINA spol. s r.o.	Púchov	9.43	Bioplyn Horovce, s. r. o.	Púchov	4.59
9.	RADSWORTH, a. s. – o.z. Slovensko	Prievidza	8.64	AGROSERVIS-SLUŽBY, spol. s r.o.	Partizánske	4.26
10.	KVARTET a.s.	Partizánske	6.77	Základná škola s materskou školou, Valaská Belá 242	Prievidza	3.68
	NO_x			CO		
	Source	District	Emis. [t]	Source	District	Emis. [t]
1.	Slovenské elektrárne, a.s.	Prievidza	3270.15	CEMMAC a.s.	Trenčín	2249.94
2.	Považská cementáreň, a.s.	Ilava	776.68	Považská cementáreň, a.s.	Ilava	2020.51
3.	CEMMAC a.s.	Trenčín	573.56	Slovenské elektrárne, a.s.	Prievidza	382.34
4.	RONA, a.s.	Púchov	262.24	FORTISCHEM a. s.	Prievidza	336.05
5.	VETROPACK NEMŠOVÁ, s.r.o.	Trenčín	178.58	Považský cukor a.s.	Trenčín	145.23
6.	TEPLÁREŇ, a.s., Považská Bystrica	Považ. Bystrica	61.89	TEPLÁREŇ, a.s., Považská Bystrica	Považ. Bystrica	124.10
7.	FORTISCHEM a. s.	Prievidza	58.16	COFELY a.s.	Myjava	119.99
8.	Continental Matador Rubber, s.r.o.	Púchov	39.94	Tech. služby mesta Partizánske, spol. s r. o.	Partizánske	109.50
9.	TERMONOVA, a.s.	Ilava	35.71	KVARTET a.s.	Partizánske	38.16
10.	Služby pre bývanie, s r.o.	Trenčín	28.94	Služby pre bývanie, s r.o.	Trenčín	37.13

NITRA REGION

	PM			SO_2		
	Source	District	Emis. [t]	Source	District	Emis. [t]
1.	Duslo, a.s.	Šaľa	147.86	Calmit, spol. s r.o.	Nitra	17.17
2.	Tlmačská energetická, s. r. o.	Levice	21.71	Icopal a.s.	Nové Zámky	15.87
3.	PPC Čab, a.s.	Nitra	10.34	Tlmačská energetická, s. r. o.	Levice	14.74
4.	Prvá energet. a teplárenská spol., s.r.o.	Zlaté Moravce	9.94	BIONOVES, s.r.o.	Nitra	9.97
5.	P.G.TRADE, spol. s r.o.	Nové Zámky	9.53	Bioplyn Cetín, s. r. o.	Nitra	8.93
6.	DECODOM, spol. s r. o.	Topoľčany	7.90	Liaharenský podnik Nitra, a.s.	Levice	8.22
7.	SLOV. ENERGETICKÉ STROJÁRNE a.s.	Levice	7.47	BPS Lipová 1 s.r.o.	Nové Zámky	5.93
8.	BIOENERGY TOPOĽČANY s.r.o.	Topoľčany	7.32	BPS Veľké Ripňany s.r.o.	Topoľčany	3.59
9.	SLOVINTEGRA ENERGY, s.r.o.	Levice	6.77	Ministerstvo obrany SR	Nitra	3.26
10.	MENERT - THERM, s.r.o.	Šaľa	6.56	AT GEMER, spol. s r.o.	Nové Zámky	2.39
	NO_x			CO		
	Source	District	Emis. [t]	Source	District	Emis. [t]
1.	Duslo, a.s.	Šaľa	691.86	Calmit, spol. s r.o.	Nitra	796.14
2.	BIOENERGY TOPOĽČANY s.r.o.	Topoľčany	145.73	SLOVINTEGRA ENERGY, s.r.o.	Levice	395.54
3.	SLOVINTEGRA ENERGY, s.r.o.	Levice	126.08	Bytkomfort, s.r.o.	Nové Zámky	139.37
4.	Bytkomfort, s.r.o.	Nové Zámky	43.84	Duslo, a.s.	Šaľa	101.04
5.	SLOV. ENERGETICKÉ STROJÁRNE a.s.	Levice	24.35	Wienerberger slov. tehelne, spol. s r.o.	Zlaté Moravce	77.06
6.	Dalkia Vráble a.s.	Nitra	20.66	Secop s.r.o.	Zlaté Moravce	34.92
7.	Nitrianska teplárenská spoločnosť, a.s.	Nitra	18.95	BIOENERGY TOPOĽČANY s.r.o.	Topoľčany	23.24
8.	DECODOM, spol. s r. o.	Topoľčany	18.21	Liaharenský podnik Nitra, a.s.	Levice	16.15
9.	COM-therm, spol. s r.o.	Komárno	18.05	Bioplyn Cetín, s. r. o.	Nitra	14.62
10.	AT GEMER, spol. s r.o.	Nové Zámky	17.38	Ministerstvo obrany SR	Nitra	13.09

ŽILINA REGION

	PM			SO_2		
	Source	**District**	**Emis. [t]**	**Source**	**District**	**Emis. [t]**
1.	Mondi SCP, a.s.	Ružomberok	178.09	Martinská teplárenská, a.s.	Martin	475.25
2.	Obaly S O L O, s.r.o.	Ružomberok	113.61	Žilinská teplárenská, a.s.	Žilina	425.17
3.	DOLVAP, s.r.o.	Žilina	76.93	OFZ, a.s.	Dolný Kubín	352.47
4.	OFZ, a.s.	Dolný Kubín	37.09	Mondi SCP, a.s.	Ružomberok	170.33
5.	Žilinská teplárenská, a.s.	Žilina	27.48	SOTE s.r.o.	Čadca	105.84
6.	SOTE s.r.o.	Čadca	19.67	ŽOS Vrútky a.s.	Martin	73.76
7.	D O L K A M Šuja, a.s.	Žilina	11.66	AFG, s.r.o.	Turč. Teplice	12.81
8.	TEHOS, s.r.o.	Dolný Kubín	10.38	DOLVAP, s.r.o.	Žilina	9.58
9.	Martinská teplárenská, a.s.	Martin	9.00	ZDROJ MT, spol. s r.o.	Martin	6.89
10.	Bekam, s.r.o.	Žilina	8.82	RABČAN, s.r.o.	Námestovo	5.32
	NO_x			**CO**		
	Source	**District**	**Emis. [t]**	**Source**	**District**	**Emis. [t]**
1.	Mondi SCP, a.s.	Ružomberok	703.72	DOLVAP, s.r.o.	Žilina	1587.14
2.	Žilinská teplárenská, a.s.	Žilina	429.45	OFZ, a.s.	Dolný Kubín	920.21
3.	OFZ, a.s.	Dolný Kubín	384.85	Mondi SCP, a.s.	Ružomberok	301.39
4.	Obaly S O L O, s.r.o.	Ružomberok	310.95	LMT, a. s.	Lipt. Mikuláš	219.13
5.	Martinská teplárenská, a.s.	Martin	240.36	Obaly S O L O, s.r.o.	Ružomberok	97.62
6.	Rettenmeier Tatra Timber, s.r.o.	Lipt. Mikuláš	115.94	SOTE s.r.o.	Čadca	72.65
7.	SPECIALTY MINERALS SLOVAKIA, spol. s r.o.	Ružomberok	65.90	TURZOVSKÁ DREVÁRSKA FABRIKA s.r.o.	Čadca	63.68
8.	KIA Motors Slovakia s.r.o.	Žilina	48.64	ŽOS Vrútky a.s.	Martin	56.68
9.	LMT, a. s.	Lipt. Mikuláš	48.43	Žilinská teplárenská, a.s.	Žilina	56.24
10.	TEHOS, s.r.o.	Dolný Kubín	27.78	Rettenmeier Tatra Timber, s.r.o.	Lipt. Mikuláš	55.77

BANSKÁ BYSTRICA REGION

	PM			SO_2		
	Source	**District**	**Emis. [t]**	**Source**	**District**	**Emis. [t]**
1.	Slovalco, a.s.	Žiar n/Hronom	83.10	Slovalco, a.s.	Žiar n/Hronom	1387.91
2.	Zvolenská teplárenská, a.s.	Zvolen	46.47	Zvolenská teplárenská, a.s.	Zvolen	1122.39
3.	Knauf Insulation, s.r.o.	Žarnovica	43.88	Dalkia Industry Žiar nad Hronom, a.s.	Žiar n/Hronom	400.00
4.	Bučina DDD, spol. s r.o.	Zvolen	29.05	Knauf Insulation, s.r.o.	Žarnovica	287.58
5.	SLOVMAG a.s. Lubeník	Revúca	20.10	SLOVMAG a.s. Lubeník	Revúca	91.05
6.	Harmanec - Kuvert, spol. s r.o.	Brezno	16.68	KOMPALA a.s.	Ban. Bystrica	73.28
7.	Dalkia Industry Žiar nad Hronom, a.s.	Žiar n/Hronom	13.30	VUM, a.s.	Žiar n/Hronom	39.61
8.	Calmit, spol. s r.o.	Rim. Sobota	9.24	SMZ, a.s. Jelšava	Revúca	32.34
9.	Bytes, spol. s r.o.	Detva	8.86	Ministerstvo obrany Slovenskej republiky	Brezno	15.13
10.	Slov. magnezitové závody, akciová spol., Jelšava, v skratke SMZ, a.s. Jelšava	Revúca	8.19	Družstvo Agrospol, družstvo	Lučenec	11.94
	NO_x			**CO**		
	Source	**District**	**Emis. [t]**	**Source**	**District**	**Emis. [t]**
1.	SMZ, a.s. Jelšava	Revúca	772.45	Slovalco, a.s.	Žiar n/Hronom	13307.28
2.	Zvolenská teplárenská, a.s.	Zvolen	533.39	SMZ, a.s. Jelšava	Revúca	2104.62
3.	Slovalco, a.s.	Žiar n/Hronom	513.35	SLOVMAG a.s. Lubeník	Revúca	278.86
4.	eustream, a. s.	Veľký Krtíš	410.48	Železiarne Podbrezová a.s.	Brezno	275.21
5.	Dalkia Industry Žiar nad Hronom, a.s.	Žiar n/Hronom	236.77	VUM, a.s.	Žiar n/Hronom	271.65
6.	SLOVMAG a.s. Lubeník	Revúca	160.44	Zvolenská teplárenská, a.s.	Zvolen	87.54
7.	KOMPALA a.s.	Ban. Bystrica	107.57	STEFE ECB, s.r.o.	Rim. Sobota	85.25
8.	Železiarne Podbrezová a.s.	Brezno	92.91	Kremnické tepelné hospodárstvo, s.r.o.	Žiar n/Hronom	63.58
9.	BUČINA ZVOLEN, a.s.	Zvolen	80.24	Dalkia Industry Žiar nad Hronom, a.s.	Žiar n/Hronom	55.53
10.	Calmit, spol. s r.o.	Rim. Sobota	74.25	ZLH Plus, a.s.	Brezno	52.53

PREŠOV REGION

	PM			SO_2		
	Source	District	Emis. [t]	Source	District	Emis. [t]
1.	BUKÓZA ENERGO, a. s.	Vranov n/Topľou	106.23	BUKÓZA ENERGO, a. s.	Vranov n/Topľou	1091.64
2.	BUKOCEL, a.s.	Vranov n/Topľou	32.51	BUKOCEL, a.s.	Vranov n/Topľou	109.02
3.	CHEMES, a.s. Humenné	Humenné	14.38	Energy Snina, a.s.	Snina	69.57
4.	BIOENERGY BARDEJOV, s.r.o.	Bardejov	13.38	CHEMES, a.s. Humenné	Humenné	35.08
5.	BYTENERG spol. s r.o.	Medzilaborce	10.55	ZEOCEM, a.s.	Vranov n/Topľou	12.37
6.	ZEOCEM, a.s.	Vranov n/Topľou	6.28	Roľnícke družstvo v Plavnici	Stará Ľubovňa	9.06
7.	TATRAVAGÓNKA a.s.	Poprad	4.03	Základná škola v Malcove	Bardejov	2.96
8.	SPRAVBYTKOMFORT a.s. Prešov	Prešov	3.63	BPS Huncovce, s.r.o.	Kežmarok	2.71
9.	LEGNO EXPORT, spol. s r.o.	Svidník	2.73	Základná škola Košarovce	Humenné	2.46
10.	Centrum sociálnych služieb Zátišie	Snina	2.71	Ministerstvo obrany Slovenskej republiky	Prešov	1.85
	NO_x			CO		
	Source	District	Emis. [t]	Source	District	Emis. [t]
1.	BUKÓZA ENERGO, a. s.	Vranov n/Topľou	545.55	BUKOCEL, a.s.	Vranov n/Topľou	637.29
2.	BUKOCEL, a.s.	Vranov n/Topľou	171.45	BUKÓZA ENERGO, a. s.	Vranov n/Topľou	183.32
3.	SPRAVBYTKOMFORT a.s. Prešov	Prešov	90.03	Leier Baustoffe SK s.r.o.	Prešov	138.25
4.	BIOENERGY BARDEJOV, s.r.o.	Bardejov	83.12	Schüle Slovakia, s.r.o.	Poprad	85.13
5.	Energy Snina, a.s.	Snina	62.36	Teplo GGE s. r. o.	Snina	34.09
6.	CHEMOSVIT ENERGOCHEM, a.s.	Poprad	26.21	SPRAVBYTKOMFORT a.s. Prešov	Prešov	32.23
7.	CHEMES, a.s. Humenné	Humenné	25.53	Spravbytherm s.r.o.	Kežmarok	21.88
8.	Dalkia Poprad a.s.	Poprad	19.55	CHEMES, a.s. Humenné	Humenné	21.63
9.	ALLFINE s. r. o.	Humenné	12.39	BYTENERG spol. s r.o.	Medzilaborce	19.85
10.	ZEOCEM, a.s.	Vranov n/Topľou	9.59	Energy Snina, a.s.	Snina	19.20

KOŠICE REGION

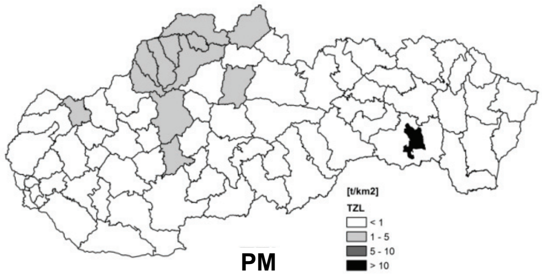
	PM			SO_2		
	Source	District	Emis. [t]	Source	District	Emis. [t]
1.	U. S. Steel Košice, s.r.o.	Košice II	3302.68	U. S. Steel Košice, s.r.o.	Košice II	7578.60
2.	Tepláreň Košice, a.s.	Košice IV	75.98	Tepláreň Košice, a.s.	Košice IV	1154.35
3.	Carmeuse Slovakia, s.r.o.	Košice - okolie	68.05	Slovenské elektrárne, a.s.	Michalovce	378.29
4.	Slovenské elektrárne, a.s.	Michalovce	47.81	TP 2, s.r.o.	Michalovce	116.65
5.	Tepelné hospodárstvo Moldava, a.s.	Košice - okolie	12.21	Slovenské magnezit. závody, akciová spol. Jelšava, v skratke SMZ, a.s. Jelšava	Košice II	68.58
6.	Carmeuse Slovakia, s.r.o.	Košice II	11.88	KOVOHUTY, a.s.	Spišská N. Ves	23.60
7.	Mesto Sobrance	Sobrance	11.24	Bioplyn Rozhanovce, s.r.o.	Košice - okolie	21.08
8.	RMS, a.s. Košice	Košice II	7.68	RMS, a.s. Košice	Košice II	19.22
9.	Holcim (Slovensko) a.s.	Košice - okolie	6.37	Holcim (Slovensko) a.s.	Košice - okolie	17.53
10.	Harsco Metals Slovensko, s.r.o.	Košice II	6.05	SLOVAKIA STEEL MILLS, a.s.	Michalovce	8.67
	NO_x			CO		
	Source	District	Emis. [t]	Source	District	Emis. [t]
1.	U. S. Steel Košice, s.r.o.	Košice II	6476.89	U. S. Steel Košice, s.r.o.	Košice II	99727.44
2.	Tepláreň Košice, a.s.	Košice IV	1413.69	SLOVAKIA STEEL MILLS, a.s.	Michalovce	355.04
3.	Holcim (Slovensko) a.s.	Košice - okolie	573.74	Slovenské elektrárne, a.s.	Michalovce	337.44
4.	Carmeuse Slovakia, s.r.o.	Košice II	437.22	Slovenské magnezit. závody, akciová spol. Jelšava, v skratke SMZ, a.s. Jelšava	Košice II	278.30
5.	eustream, a. s.	Michalovce	241.88	Košická energetická spoločnosť, a.s.	Košice IV	270.28
6.	Slovenské elektrárne, a.s.	Michalovce	171.13	KOVOHUTY, a.s.	Spišská N. Ves	243.50
7.	SLOVAKIA STEEL MILLS, a.s.	Michalovce	100.26	HNOJIVÁ Duslo, s.r.o.	Michalovce	240.34
8.	TP 2, s.r.o.	Michalovce	79.80	Carmeuse Slovakia, s.r.o.	Košice II	147.41
9.	HNOJIVÁ Duslo, s.r.o.	Michalovce	54.87	Tepelné hospodárstvo Moldava, a.s.	Košice - okolie	130.18
10.	Košická energetická spoločnosť, a.s.	Košice IV	50.69	Tepláreň Košice, a.s.	Košice IV	94.25

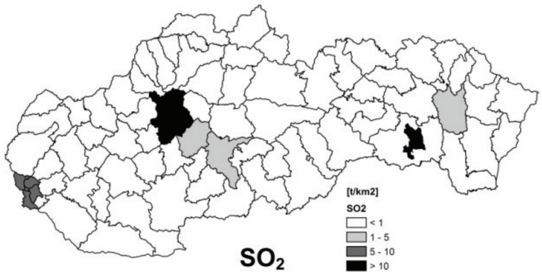
**According to the Decree of MŽP SR No. 410/2012 Coll.*

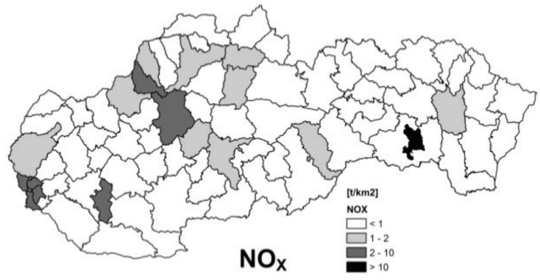
Tab. 4.6 **Stationary source emissions by districts in 2013**

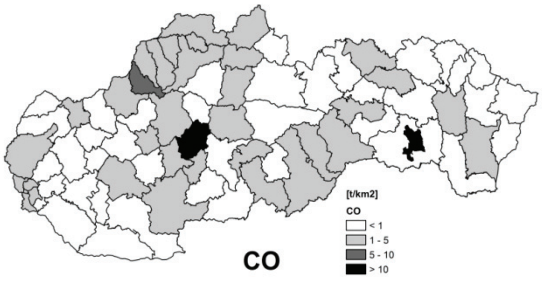
District	Emissions [t.year^{-1}]				Specific territorial emis. [t.year^{-1}.km^{-2}]			
	PM	SO_2	NO_x	CO	PM	SO_2	NO_x	CO
1. Bratislava	283	2074	2884	811	0.77	5.64	7.85	2.21
2. Malacky	272	166	1513	1680	0.29	0.17	1.59	1.77
3. Pezinok	115	21	84	193	0.31	0.06	0.22	0.51
4. Senec	105	14	125	167	0.29	0.04	0.35	0.46
5. Dunajská Streda	419	52	274	571	0.39	0.05	0.26	0.53
6. Galanta	284	282	347	439	0.44	0.44	0.54	0.68
7. Hlohovec	133	17	191	213	0.50	0.06	0.71	0.80
8. Piešťany	236	29	135	327	0.62	0.08	0.35	0.86
9. Senica	352	41	163	687	0.52	0.06	0.24	1.00
10. Skalica	226	21	96	296	0.63	0.06	0.27	0.83
11. Trnava	284	159	461	413	0.38	0.22	0.62	0.56
12. Bánovce n/B	246	23	80	324	0.53	0.05	0.17	0.70
13. Ilava	411	34	918	2362	1.15	0.10	2.56	6.59
14. Myjava	358	38	123	580	1.09	0.12	0.38	1.77
15. Nové Mesto n/V	334	32	138	451	0.58	0.05	0.24	0.78
16. Partizánske	165	26	126	379	0.55	0.09	0.42	1.26
17. Považská Bystrica	618	61	221	941	1.33	0.13	0.48	2.03
18. Prievidza	1229	31111	3605	1735	1.28	32.42	3.76	1.81
19. Púchov	550	70	469	718	1.47	0.19	1.25	1.91
20. Trenčín	389	94	994	3012	0.58	0.14	1.47	4.46
21. Komárno	426	39	221	592	0.39	0.04	0.20	0.54
22. Levice	1105	127	484	1826	0.71	0.08	0.31	1.18
23. Nitra	342	74	303	1310	0.39	0.08	0.35	1.50
24. Nové Zámky	620	86	325	962	0.46	0.06	0.24	0.71
25. Šaľa	289	14	778	281	0.81	0.04	2.19	0.79
26. Topoľčany	217	24	276	314	0.36	0.04	0.46	0.52
27. Zlaté Moravce	257	25	111	446	0.49	0.05	0.21	0.86
28. Bytča	420	40	119	548	1.49	0.14	0.42	1.95
29. Čadca	1248	225	334	1717	1.64	0.30	0.44	2.26
30. Dolný Kubín	377	385	506	1377	0.77	0.78	1.03	2.80
31. Kysucké Nové Mesto	271	24	102	351	1.56	0.14	0.59	2.02
32. Liptovský Mikuláš	645	65	371	1136	0.48	0.05	0.28	0.85
33. Martin	487	603	409	732	0.66	0.82	0.56	0.99
34. Námestovo	1218	140	276	1599	1.76	0.20	0.40	2.32
35. Ružomberok	1003	245	1272	1348	1.55	0.38	1.97	2.08
36. Turčianske Teplice	225	36	88	307	0.57	0.09	0.22	0.78
37. Tvrdošín	185	18	69	243	0.39	0.04	0.14	0.51
38. Žilina	1001	525	819	2863	1.23	0.64	1.01	3.51
39. Banská Bystrica	564	131	409	817	0.70	0.16	0.51	1.01
40. Banská Štiavnica	266	30	66	346	0.91	0.10	0.23	1.18
41. Brezno	679	97	279	1231	0.54	0.08	0.22	0.97
42. Detva	447	43	164	615	1.00	0.10	0.36	1.37
43. Krupina	379	43	102	501	0.65	0.07	0.17	0.86
44. Lučenec	661	75	201	879	0.80	0.09	0.24	1.06
45. Poltár	218	22	64	300	0.46	0.05	0.13	0.63
46. Revúca	539	181	1088	3099	0.74	0.25	1.49	4.24
47. Rimavská Sobota	1179	123	451	1643	0.80	0.08	0.31	1.12
48. Veľký Krtíš	539	63	565	745	0.64	0.07	0.67	0.88
49. Zvolen	412	1156	786	588	0.54	1.52	1.04	0.78
50. Žarnovica	515	333	189	650	1.21	0.78	0.44	1.53
51. Žiar n/H	518	1868	899	14236	1.00	3.61	1.74	27.50
52. Bardejov	442	45	193	558	0.47	0.05	0.21	0.60
53. Humenné	371	75	139	509	0.49	0.10	0.18	0.67
54. Kežmarok	449	46	145	615	0.71	0.07	0.23	0.98
55. Levoča	224	23	61	297	0.53	0.05	0.14	0.71
56. Medzilaborce	201	18	48	264	0.47	0.04	0.11	0.62
57. Poprad	299	28	187	512	0.27	0.03	0.17	0.46
58. Prešov	501	49	273	829	0.54	0.05	0.29	0.89
59. Sabinov	425	40	120	555	0.78	0.07	0.22	1.02
60. Snina	447	112	187	638	0.56	0.14	0.23	0.79
61. Stará Ľubovňa	548	64	152	715	0.77	0.09	0.21	1.01
62. Stropkov	151	14	40	198	0.39	0.04	0.10	0.51
63. Svidník	284	28	73	365	0.52	0.05	0.13	0.66
64. Vranov n/Topľou	505	1247	828	1294	0.66	1.62	1.08	1.68
65. Gelnica	422	41	102	560	0.72	0.07	0.17	0.96
66. Košice	3467	8837	8538	100635	14.23	36.25	35.03	412.88
67. Košice - okolie	903	121	850	1297	0.59	0.08	0.55	0.84
68. Michalovce	207	520	759	1243	0.20	0.51	0.75	1.22
69. Rožňava	937	91	235	1232	0.80	0.08	0.20	1.05
70. Sobrance	192	27	66	259	0.36	0.05	0.12	0.48
71. Spišská Nová Ves	388	63	174	806	0.66	0.11	0.30	1.37
72. Trebišov	397	44	163	535	0.37	0.04	0.15	0.50
Slovensko	36021	52760	38410	173819	0.73	1.08	0.78	3.54

Fig. 4.3 **Specific territorial emission in 2013**







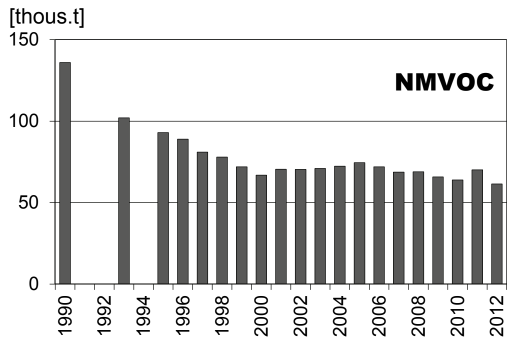


Tab. 4.7 **NMVOC emissions [t] in the SR in 1990, 1995, 2000, 2005 – 2012**

Sector / Subsector	1990	1995	2000	2005	2006	2007	2008	2009	2010	2011	2012
Combustion processes I	**335**	**258**	**201**	**185**	**174**	**158**	**172**	**157**	**159**	**158**	**153**
Public power	223	187	139	140	131	121	130	119	121	126	123
District heating plants	112	71	62	46	43	37	42	38	39	32	30
Combustion processes II	**12641**	**9618**	**7913**	**11933**	**11162**	**11114**	**11174**	**11274**	**10957**	**11904**	**12060**
Commercial and institutional plants	226	150	26	28	27	29	33	49	67	80	148
Agriculture	IE	IE	6	11897	11127	11078	11135	11218	10885	11819	11906
Residential plants	12415	9468	7881	9	8	6	6	6	5	6	6
Combustion processes in industry	**981**	**805**	**584**	**806**	**898**	**881**	**884**	**661**	**940**	**997**	**918**
Comb. in boilers, gas turb. and stat. eng.	206	150	158	121	117	94	94	90	87	84	82
Iron production	32	29	28	33	37	36	32	27	33	30	32
Ore agglomeration	438	358	396	384	390	367	338	213	273	321	346
Copper production	305	268	2	268	353	384	420	332	548	562	458
Production processes	**27029**	**11129**	**8717**	**6433**	**5820**	**5473**	**4901**	**4337**	**4841**	**4790**	**4548**
Processes in petroleum industries	17188	7474	6627	4058	3469	3166	2804	2623	2693	2585	2398
Coke production	1053	834	719	783	787	783	720	450	900	684	662
Steel production	43	36	34	41	47	47	42	36	45	39	41
Rolling mills	233	297	300	341	361	372	347	295	318	304	312
Aluminium production	0	0	0	0	0	0	0	0	0	0	0
Proc. in organic chemical industries	6437	1369	651	870	845	793	667	609	584	881	846
Food production	2073	1118	385	340	311	312	322	324	301	296	289
Road paving with asphalt	2	1	1	1	1	1	1	1	1	1	1
Exploitation&distrib. of natural resour.	**8822**	**8535**	**5929**	**7105**	**6276**	**6170**	**6362**	**6207**	**5864**	**6039**	**3705**
Exploitation&distribution of crude oil	5198	4298	3750	4281	4472	4266	4272	4324	4037	3975	3373
Distribution of fuel	3624	4237	2179	2824	1804	1904	2091	1883	1827	2064	332
Solvent and other products use	**52875**	**37065**	**26978**	**33558**	**34630**	**33574**	**33955**	**33319**	**31853**	**36888**	**31069**
Use of paints and glues	32811	20687	13214	18918	19522	20003	20385	20365	20279	20251	20106
Dry cleaning and degreasing	11500	7695	5092	6101	6600	5057	5052	4412	3005	8101	2394
Processing of fat and oil	332	363	299	189	152	148	138	144	152	169	187
Products	8232	8320	8374	8350	8356	8367	8381	8398	8418	8367	8382
Road transport	**27334**	**24129**	**14041**	**11974**	**10362**	**8710**	**8834**	**7325**	**6596**	**6979**	**6566**
Other transport	**953**	**599**	**528**	**514**	**467**	**505**	**479**	**429**	**528**	**457**	**447**
Waste incineration	**4631**	**388**	**190**	**1618**	**1764**	**1734**	**1796**	**1681**	**1725**	**1527**	**1572**
Municipal waste	71	107	147	1207	1233	1247	1282	1326	1324	1240	1201
Industrial waste	281	281	43	345	510	461	472	341	366	275	359
Hospital waste	IE	IE	0	66	21	26	43	14	36	12	13
Agricultural waste*	4279										
Agriculture	**651**	**436**	**436**	**436**	**437**	**437**	**438**	**439**	**440**	**437**	**438**
Total	**136252**	**92962**	**65517**	**74564**	**71991**	**68755**	**68997**	**65830**	**63905**	**70177**	**61476**

Emissions estimated to February 15th 2014.
IE = included in other sector
** Agricultural waste combustion is prohibited since 1994*
Because of changeover from EAPSI to NEIS in year 2000 some changes of source appointment have to be done in the framework of subsectors combustion in boilers, gas turbines and stationary engines; commercial and institutional plants and new sector agriculture (sector non-industrial combustion plants) was established.

Fig. 4.4 **Development trends in NMVOC**

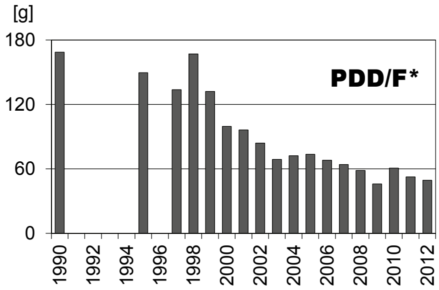


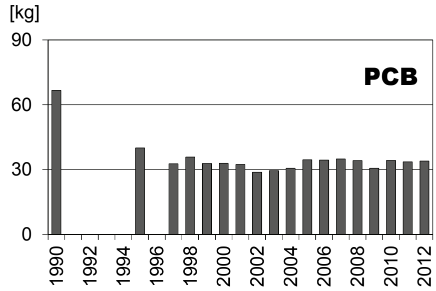
Tab. 4.8 **Emissions of persistent organic pollutants in the SR in 2012**

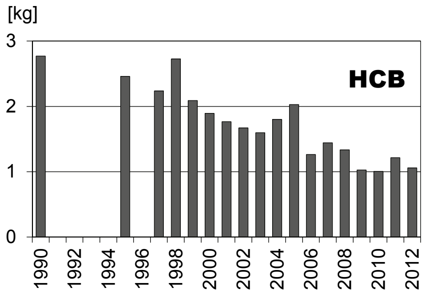
Sector / Subsector	PCDD/F*	PCB	HCB	PAH				
				sum PAH	B(a)P	B(k)F	B(b)F	I(1,2,3-cd)P
	[g]	[kg]	[kg]	[kg]	[kg]	[kg]	[kg]	[kg]
Combustion processes I	**6.482**	**0.528**	**0.195**	**1 352.195**	**146.832**	**381.974**	**382.155**	**441.235**
Public power	1.756	0.494	0.175	13.129	0.094	6.346	6.527	0.162
District heating plants	0.316	0.034	0.020	16.370	0.041	8.128	8.128	0.073
Coke production	4.410			1 322.697	146.697	367.500	367.500	441.000
Combustion processes II	**3.403**	**9.228**	**0.178**	**16 177.598**	**4 633.035**	**2 016.477**	**6 081.419**	**3 446.667**
Commercial and institutional plants	0.057	0.007	0.004	2.445	0.008	1.207	1.215	0.015
Residential plants	3.343	9.221	0.175	16 175.035	4 633.025	2 015.217	6 080.144	3 446.649
Agriculture	0.004	0.000	0.000	0.118	0.002	0.053	0.060	0.003
Combustion processes in industry	**26.145**	**4.641**	**0.221**	**127.727**	**65.290**	**25.046**	**29.164**	**8.227**
Comb. in boilers, gas turb. and stat. eng.	0.596	0.624	0.099	26.008	1.191	9.444	13.439	1.934
Iron production	0.352	0.022		59.836	59.836			
Ore agglomeration	24.638	3.872	0.113	41.076	4.224	15.311	15.311	6.230
Cast iron production	0.101	0.019		0.016	0.003	0.005	0.005	0.003
Others	0.458	0.103	0.009	0.791	0.037	0.286	0.409	0.060
Production processes	**5.784**	**1.817**	**0.414**	**1 290.202**	**466.134**	**382.821**	**391.362**	**49.884**
Aluminium production	0.200	0.033		589.796	192.795	186.371	186.371	24.260
Steel production	4.581	1.732		76.889	76.889			
Carbon mineral production				623.516	196.450	196.450	204.992	25.624
Wood impregnation								
Others	1.004	0.051	0.414					
Road transport	**0.367**	**15.293**	**0.012**	**151.888**	**23.632**	**50.293**	**51.651**	**26.312**
Other transport	**0.007**	**0.722**	**0.001**	**8.667**	**2.167**	**1.300**	**3.034**	**2.167**
Waste incineration	**7.184**	**1.655**	**0.035**	**110.860**	**31.111**	**22.061**	**45.785**	**11.902**
Municipal waste	0.067	0.890	0.017	6.528	0.118	3.191	3.191	0.029
Industrial waste	5.060	0.675	0.009	2.623	0.047	1.282	1.282	0.011
Hospital waste	1.414	0.028	0.000	0.110	0.002	0.054	0.054	0.000
Others	0.643	0.062	0.009	101.600	30.944	17.535	41.259	11.862
Total	**49.373**	**33.884**	**1.057**	**19 219.137**	**5 368.201**	**2 879.972**	**6 984.570**	**3 986.394**

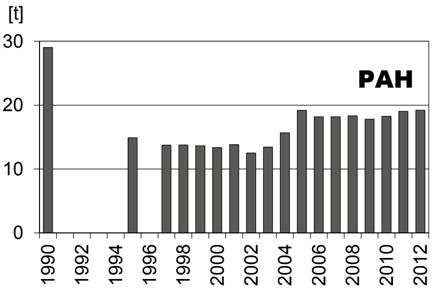
B(a)P - Benzo(a)pyrene, B(k)F - Benzo(k)fluorantene, B(b)F - Benzo(b)fluorantene, I(1,2,3-cd)P - Indeno(1,2,3-cd)pyrene
**Expressed as I-TEQ; I-TEQ is calculated from the values for 2,3,7,8 - substituted co-geners of PCDD and PCDF under using of I-TEF according NATO/CCMS (1988)*
Emissions estimated to February 15th, 2014

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







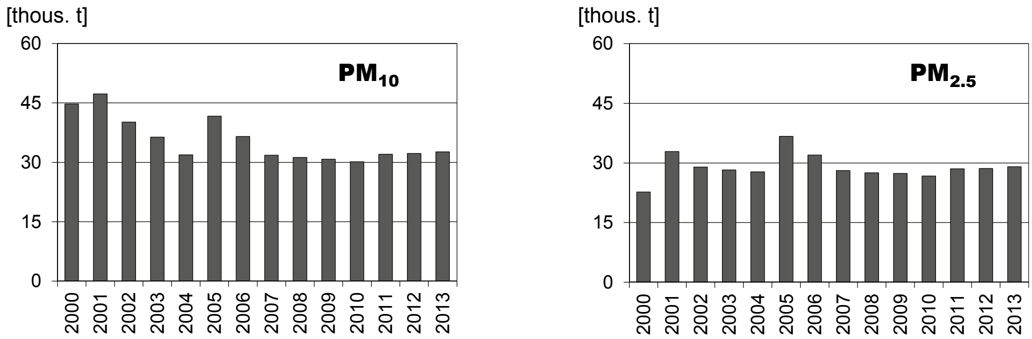


Tab. 4.9 **PM_{10} and $PM_{2.5}$ emissions [thous. t] in the SR in 2008 – 2013**

Sector / Subsector	2008		2009		2010		2011		2012		2013	
	PM_{10} [Gg]	$PM_{2,5}$ [Gg]	PM_{10} [Gg]	$PM_{2,5}$ [Gg]	PM_{10} [Gg]	$PM_{2,5}$ [Gg]	PM_{10} [Gg]	$PM_{2,5}$ [Gg]	PM_{10} [Gg]	$PM_{2,5}$ [Gg]	PM_{10} [Gg]	$PM_{2,5}$ [Gg]
Combustion processes I	**1.307**	**0.939**	**1.227**	**0.878**	**1.200**	**0.877**	**1.253**	**0.936**	**1.193**	**0.869**	**1.158**	**0.857**
Public Electricity and Heat Production	0.696	0.561	0.649	0.518	0.619	0.522	0.703	0.600	0.635	0.528	0.608	0.521
Petroleum refining	0.076	0.061	0.083	0.066	0.049	0.039	0.047	0.037	0.047	0.037	0.050	0.040
Coke production	0.535	0.317	0.495	0.294	0.532	0.316	0.503	0.299	0.511	0.303	0.500	0.297
Combustion processes II	**25.431**	**23.145**	**25.589**	**23.460**	**24.773**	**22.594**	**26.993**	**24.739**	**27.193**	**24.907**	**27.714**	**25.466**
Commercial and institutional plants	0.173	0.124	0.137	0.102	0.147	0.114	0.147	0.117	0.156	0.128	0.127	0.105
Residential plants	25.137	22.967	25.353	23.311	24.508	22.431	26.722	24.573	26.931	24.734	27.483	25.318
Agriculture	0.077	0.035	0.068	0.031	0.081	0.034	0.088	0.035	0.069	0.030	0.071	0.029
Other combustion processes	0.044	0.020	0.032	0.016	0.036	0.016	0.036	0.014	0.037	0.015	0.033	0.013
Combustion processes in industry	**1.762**	**1.295**	**1.603**	**1.158**	**1.506**	**1.092**	**1.383**	**0.946**	**1.436**	**0.948**	**1.393**	**0.880**
Production of iron and steel	0.470	0.324	0.395	0.287	0.515	0.376	0.484	0.330	0.487	0.304	0.505	0.312
Production of non-ferrous metals	0.193	0.166	0.178	0.155	0.169	0.146	0.097	0.081	0.099	0.085	0.090	0.077
Chemical industry	0.226	0.187	0.243	0.193	0.218	0.183	0.194	0.164	0.201	0.149	0.220	0.161
Production of paper and cellulose	0.082	0.049	0.149	0.102	0.094	0.040	0.141	0.057	0.208	0.111	0.169	0.057
Food production	0.042	0.022	0.036	0.019	0.036	0.019	0.037	0.018	0.034	0.016	0.038	0.018
Other combustion processes in industry	0.748	0.546	0.601	0.404	0.475	0.329	0.429	0.296	0.407	0.283	0.372	0.255
Transport	**2.583**	**2.113**	**2.247**	**1.826**	**2.485**	**2.028**	**2.213**	**1.776**	**2.295**	**1.842**	**2.244**	**1.805**
Civil aviation	0.012	0.012	0.009	0.009	0.008	0.008	0.008	0.008	0.007	0.007	0.006	0.006
Road transport	1.299	1.299	1.089	1.089	1.244	1.244	1.171	1.171	1.221	1.221	1.195	1.195
Road transport - abrasion	0.976	0.521	0.876	0.470	0.948	0.506	0.928	0.496	0.964	0.516	0.932	0.498
Railways	0.128	0.122	0.111	0.105	0.113	0.107	0.038	0.036	0.032	0.031	0.040	0.038
Navigation	0.169	0.160	0.161	0.153	0.171	0.162	0.068	0.065	0.072	0.068	0.071	0.067
Industrial technologies	**0.148**	**0.058**	**0.124**	**0.052**	**0.120**	**0.051**	**0.156**	**0.075**	**0.136**	**0.067**	**0.142**	**0.070**
Mineral products	0.043	0.004	0.033	0.003	0.033	0.003	0.029	0.002	0.023	0.002	0.027	0.002
Chemical industry	0.063	0.039	0.058	0.036	0.057	0.035	0.098	0.060	0.088	0.053	0.093	0.056
Paper and pulp	0.001	0.001	0.001	<0.001	0.001	<0.001	0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Other industrial processes	0.041	0.015	0.032	0.013	0.029	0.012	0.028	0.012	0.025	0.011	0.022	0.011
Total	**31.230**	**27.551**	**30.790**	**27.374**	**30.083**	**26.642**	**31.998**	**28.472**	**32.253**	**28.633**	**32.651**	**29.077**

Emissions estimated to January 31st, 2015

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



Tab. 4.10 **Emissions of heavy metals [t] in the SR in 2012**

Sector / Subsector	Pb	As	Cd	Cr	Cu	Hg	Ni	Se	Zn
Combustion processes I	**2.345**	**0.355**	**0.101**	**0.060**	**0.077**	**0.070**	**0.233**	**0.010**	**3.375**
Public power	0.028	0.181	0.001	0.057	0.042	0.004	0.231	0.009	0.062
District heating plants	2.318	0.174	0.099	0.003	0.036	0.066	0.002		3.313
Combustion processes II	**1.482**	**0.517**	**0.047**	**0.249**	**0.382**	**0.041**	**0.243**	**0.040**	**3.898**
Commercial and institutional plants	0.446	0.058	0.019	0.009	0.014	0.013	0.007	0.001	0.643
Residential plants	1.020	0.456	0.027	0.240	0.366	0.028	0.235	0.040	3.233
Agriculture	0.015	0.003	0.001	0.001	0.001		0.001		0.022
Combustion processes in industry	**39.947**	**18.629**	**0.479**	**2.035**	**36.317**	**0.495**	**9.055**	**10.873**	**29.52**
Comb. in boilers, gas turb. and stat. engines	1.798	0.299	0.083	0.321	0.172	0.096	4.916	0.126	2.378
Iron production	0.120	0.011	0.190	0.905	0.070	0.303	3.013	0.039	7.536
Glass production	3.613	0.036	0.050	0.723	0.181	0.015	0.572	5.420	3.312
Ore agglomeration	21.317	0.031	0.013	0.069	7.006	0.05	0.537	0.990	11.153
Copper production	12.954	18.243	0.143		28.887	0.001		4.298	5.101
Cement production	0.144	0.002		0.016		0.030	0.017		0.037
Aluminium oxide production									
Magnesite production		0.007		0.002	0.001				0.002
Production processes	**1.568**	**0.082**	**0.036**	**0.754**	**2.738**	**0.177**	**7.144**	**0.014**	**14.452**
Steel production	1.248	0.068	0.014	0.158	2.463	0.014	2.491	0.014	5.198
Aluminium production			0.016				1.607		1.607
Ferro alloys production	0.132	0.009	0.004	0.003	0.005		0.001		0.639
Pig iron production	0.115	0.005	0.002	0.019			0.010		0.082
Galvanizing	0.066			0.574	0.198		3.036		5.742
Alloys (Cu-Zn) production	0.007				0.071				1.185
Inorganic chemical industry						0.163			
Road transport	**3.021**		**0.025**	**0.423**	**10.535**		**0.197**	**0.027**	**4.667**
Other transport			**0.001**	**0.004**	**0.123**		**0.005**	**0.001**	**0.072**
Waste incineration	**9.918**	**0.012**	**0.622**	**0.788**	**1.244**	**0.511**	**0.460**	**0.006**	**4.272**
Municipal waste	7.557	0.008	0.42	0.756	1.041	0.302	0.453	0.002	2.855
Industrial waste	2.262	0.003	0.194	0.031	0.194	0.194	0.006	0.004	1.357
Hospital waste	0.099		0.008	0.001	0.008	0.008			0.059
Cremation						0.006			
Total	**58.281**	**19.595**	**1.310**	**4.313**	**51.415**	**1.293**	**17.337**	**10.970**	**60.255**

Emissions estimated to February 15th 2014

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