Slovak Hydrometeorological Institute

Ministry of Environment of the Slovak Republic

AIR POLLUTION

IN THE SLOVAK REPUBLIC

2007

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Report was elaborated by

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C O N T E N T

AMBIENT AIR

EMISSIONS

AMBIENT AIR

1

REGIONAL AIR POLLUTION AND QUALITY OF PRECIPITATION

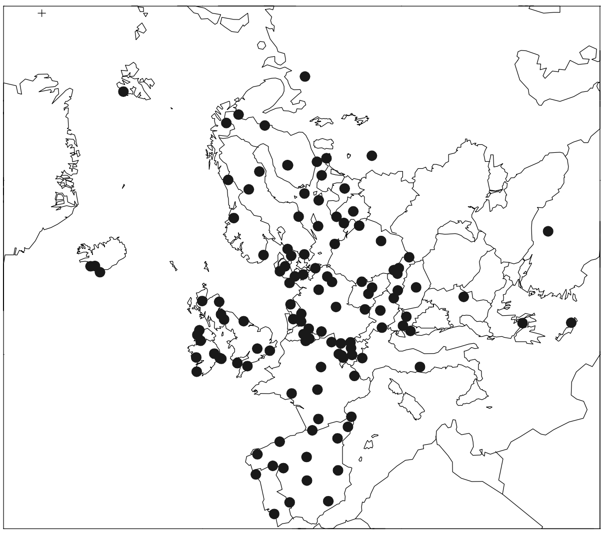
1.1 REGIONAL AIR POLLUTION AND QUALITY OF PRECIPITATION

Regional air pollution is a pollution of a boundary layer of a rural country at a sufficient distance from local industrial and urban sources. The boundary layer of the atmosphere is a mixing layer extending itself from the Earth surface up to a height of about 1 000 m. In regional positions, the industrial emissions are more or less evenly vertically dispersed in the entire boundary layer and ground level concentrations are smaller than those in cities.

The UN ECE Convention on Long Range Transboundary Air Pollution (CLRTAP) was signed in 1979. Since its entry into force in 1983 the Convention has been extended by eight protocols: Protocol on Long-term Financing of the Co-operative Programme for Monitoring and Evaluation of the Long-range Transmission of Air Pollutants in Europe (EMEP) (Geneva, 1984); Protocol on the Reduction of Sulphur Emissions or their Transboundary Fluxes by at least 30 Per Cent (Helsinky, 1985); Protocol Concerning the Control of Emissions of Nitrogen Oxides or their Transboundary Fluxes (Sofia 1988); Protocol Concerning the Control of Emissions of Volatile Organic Compounds or their Transboundary Fluxes (Geneva 1991); Protocol on Further Reduction of Sulphur Emissions (Oslo, 1994); Protocol on Heavy Metals (Aarhus, 1998); Protocol on Persistent Organic Pollutants (Aarhus, 1998); The 1999 Protocol to Abate Acidification, Eutrophication and Ground-level Ozone (Gothenburg, 1999). The commitment to the first sulphur Protocol represented a 30 % reduction of European sulphur dioxide emissions by 1993 as compared to 1980. The Slovak Republic has fulfilled this commitment. Reduction of European emissions has already been manifested in a decrease of acidity in precipitation over the territory of Slovakia. In compliance with the second sulphur Protocol, the European sulphur dioxide emissions had to be reduced 60 % by 2000, 65 % by 2005 and have to be reduced 72 % by 2010, as compared to 1980. According to the last Protocol (Gothenburg, 1999) the Slovak Republic shall 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 HM Protocol the priority remains on three main metals, cadmium, lead and mercury. The Gothenburg Protocol (1999) to abate acidification, eutrophization a ground level ozone undergo revision and PM 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 100 regional stations and four stations in the teritory of Slovakia belonging to the national monitoring network of the Slovak Hydrometeorological Institute are at the same time also a part of EMEP network. The EMEP monitoring programme has been gradually extended. The monitoring of sulphur compounds and precipitation

Fig. 1.1 **Network of EMEP monitoring stations - 2006**



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 CCC - NILU. 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 2007, there were 4 stations of National Monitoring Network in operation in the Slovak Republic to monitor regional air pollution and chemical composition of precipitation. Station Liesek has been shut down and monitoring programme on the rest of stations reduced. Locations and elevations of the individual stations are indicated in Figure 1.2. All these stations are part of the EMEP network. Apart from the above mentioned, monthly precipitation have been sampled in the meteorological garden of the Slovak Hydrometeorological Institute in the Bratislava-Jeséniova station, in elevation 286 m, and analyzed on pH, conductivity, major ions and heavy metals.

EMEP stations

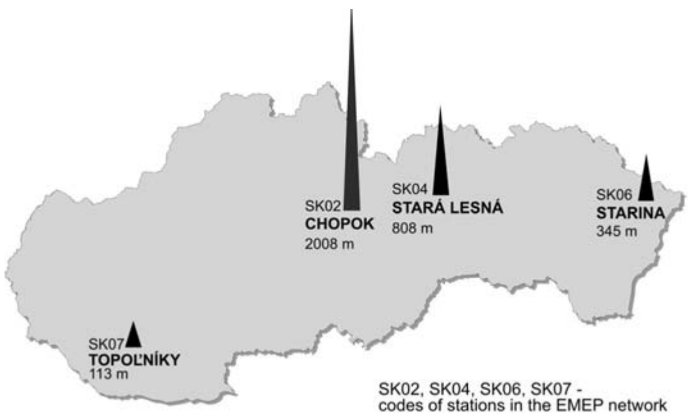
Chopok-EMEP, SK505001
Meteorological observatory of the Slovak Hydrometeorological Institute, located on the crest of the Low Tatras mountains, 2 008 m above sea level, 19°35'32" longitude, 48°56'38" latitude. Measurements started in 1977. Since 1978 the station has been a part of the EMEP network and GAW/BAPMoN WMO network.

Stará Lesná-AÚ SAV, EMEP, SK70300
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-Aszód, EMEP, SK201001
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-Vodná nádrž, EMEP, SK709001
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 – 2007**



Measurement programme

AMBIENT AIR

Station	Continously				Manually																	
	PM_{10}	$PM_{2.5}$	Oxides of nitrogen (NOx)	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+})	Ozone precursors (VOC)	PM_{10} [1]	TSP* [1]	Lead (Pb)	Arsenic (As)	Cadmium (Cd)	Nickel (Ni)	Chromium (Cr)	Copper (Cu)	Zinc (Zn)	Polyaromatic hydrocarbons (BaP)
Chopok, EMEP				x	x	x	x	x	x					x	x	x	x	x	x	x	x	
Topoľníky, Aszód, EMEP	x	x	x	x									x		x	x	x	x	x	x	x	x
Starina, Vod. nádrž, EMEP				x	x	x	x	x	x	x	x	x	x		x	x	x	x	x	x	x	x
Stará Lesná, AÚ SAV, EMEP			x	x									x		x	x	x	x	x	x	x	

** TSP – Total suspended particles in ambient air* [1] *weekly sampling*

ATMOSPHERIC PRECIPITATION

Station	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, EMEP	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Topoľníky, Aszód	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Starina, Vodná nárdrž, EMEP	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Stará Lesná, AÚ SAV, EMEP	x	x	x	x	x	x	x	x	x	x	x	x	x	x

1.3 ASSESSMENT OF RESULTS FROM MEASUREMENTS IN 2007

SO_2, sulphates

Background concentrations of sulphur dioxide recalculated in sulphur (Tab. 1.1, Fig. 1.3) ranged between 0.18 $\mu g.m^{-3}$ on the Chopok station and 0.8 $\mu g.m^{-3}$ on the Starina station, in 2007. ***In coincidence with the Annex 1 to the Decree of the Ministry of Environment of the Slovak Republic No 705/2002 on air quality, the limit value for protection of ecosystems is 20 µg $SO_2.m^{-3}$ in calendar year and winter season. This value has been exceeded neither at the calendar year (Chopok 0.4 µg $S0_2.m^{-3}$ and Starina 1.6 µg $S0_2.m^{-3}$), nor in winter season (Chopok 0.5 $S0_2.m^{-3}$ and Starina 3.3 $S0_2.m^{-3}$).*** Sulphates contributed to the total weight mass of particulate matter (Fig. 1.4) 16 % on the Chopok station and 15 % on the Starina station. Concentration ratio of sulphates to sulphur dioxide, recalculated in sulphur represents interval 1.5 on the Chopok station and 1.1 on the Starina station.

NOx, nitrates

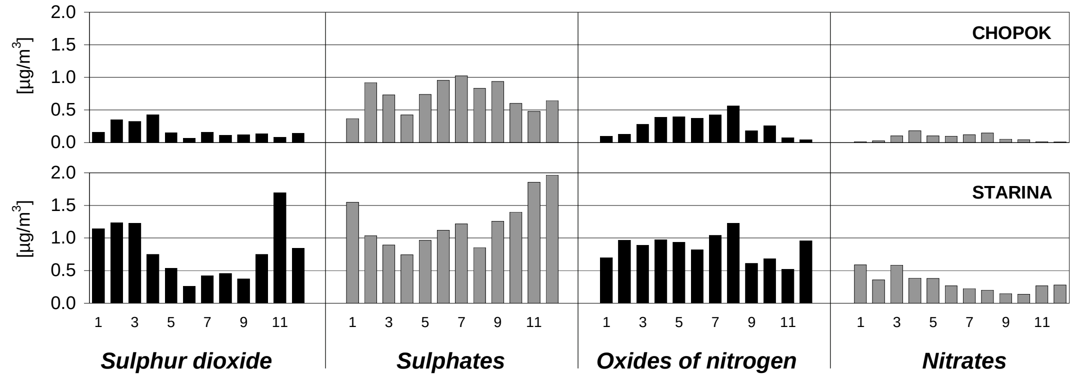
Background level of concentrations of oxides of nitrogen, recalculated in nitrogen (Tab. 1.1, Fig. 1.3) presented 0.72 $\mu g.m^{-3}$ on the Chopok station and 1.24 on the Starina station, in 2007. ***In coincidence with the Annex 1 to the Decree of the Ministry of Environment of the Slovak Republic No 705/2002 on air quality, the limit value for protection of vegetation is 30 µg $NO_X.m^{-3}$ in calendar year. This limit value was not exceeded in calendar year. (Chopok 2.4 µg $NOx.m^{-3}$ a Starina 4.1 µg $NOx.m^{-3}$).*** Nitrates in ambient air on the Chopok and Starina stations occurred predominantly in the form of particles in 2007. Concentrations of nitric acid were substantially lower in 2007 as compared to particulate nitrates on both stations. 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 7 % on the Chopok station and 8% on the Starina station. Concentration ratio of total nitrates ($HNO_3 + NO_3$) to NOx-NO_2 recalculated in nitrogen represented the value of 0.13 at the Chopok station and 0.27 at the Starina station.

Tab. 1.1 **Annual averages of gaseous and particulate components in ambient air, 2005–2007**

		SO_2 (S) µg/m³	SO_4^{2-} (S) µg/m³	NOx (N) µg/m³	NO_3^- (N) µg/m³	HNO_3 (N) µg/m³	O_3 µg/m³	PM_{10} µg/m³	Pb ng/m³	Cu ng/m³	Cd ng/m³	Ni ng/m³	Cr ng/m³	Zn ng/m³	As ng/m³
Chopok EMEP	2005	0.43	0.48	0.69	0.16	0.03	95	*6.0	2.44	0.68	0.06	0.64	1.35	4.47	0.25
	2006	0.27	0.33	0.59	0.09	0.02	**96	*7.0	2.67	1.24	0.08	0.60	0.97	6.40	0.22
	2007	0.18	0.27	0.72	0.08	0.01	92	5.1	1.59	0.84	0.05	0.44	0.60	4.14	0.13
Topoľníky Aszód EMEP	2005	1.31	1.31	2.64	0.98	0.05	60	*19.6	14.44	3.44	0.33	1.02	1.41	19.46	1.00
	2006	1.34	1.37	2.80	0.97	0.04	60	*24.5	13.10	3.59	0.31	2.83	2.94	20.84	1.26
	2007	-	-	-	-	-	58	23.2	11.09	4.11	0.28	1.15	1.01	19.44	0.83
Starina Vod. nádrž EMEP	2005	1.07	1.09	1.06	0.36	0.04	66	18.4	12.43	1.75	0.44	0.75	1.11	14.34	0.72
	2006	1.36	1.23	1.24	0.38	0.05	**62	19.2	11.18	1.99	0.31	0.69	0.72	16.32	0.76
	2007	0.80	0.86	1.24	0.32	0.02	63	17.7	8.46	2.10	0.29	0.58	0.59	12.61	0.45
St. Lesná AÚ SAV EMEP	2005	0.64	0.85	1.64	0.26	0.03	70	14.7	8.14	2.08	0.25	0.52	1.08	12.83	0.70
	2006	0.77	1.01	1.52	0.34	0.05	73	14.9	9.36	2.21	0.23	0.51	0.64	16.32	0.67
	2007	-	-	-	-	-	68	12.6	5.92	2.39	0.20	0.44	0.48	13.03	0.52

SO_2, SO_4^{2-} – recalculated in sulphur, *NOx, NO_3^-, HNO_3 – recalculated in nitrogen*
** TSP (total suspended particles)* *** 50–75 % of measurements*

Fig. 1.3 **Monthly mean concentrations in ambient air – 2007**
(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. Averaged concentrations of these components (NH_3 and NH_4^+ recalculated in nitrogen) for years 2005, 2006 a 2007 are listed in Table. In the Stará Lesná station these ions has been measured until the beginning of September 2007 and since July 2007 the measurements started to be measured at the Starina station.

Station	Year	NH_3 (N) [µg/m³]	NH_4^+ (N) [µg/m³]	Na^+ [µg/m³]	K^+ [µg/m³]	Mg^{2+} [µg/m³]	Ca^{2+} [µg/m³]
Stará Lesná	2005*	0.39	0.88	0.18	0.16	0.02	0.15
	2006	0.36	1.05	0.19	0.18	0.02	0.15
	2007**	0.40	0.77	0.09	0.15	0.03	0.14
Starina	2007***	0.18	0.80	0.08	0.14	0.02	0.08

** since May 2005* *** until September 2007* **** since July 2007*

Particulate matter PM_{10}, respectively TSP and heavy metals

In Tab. 1.1 are presented the concentrations of PM_{10} (Stará Lesná, Starina, Topoľníky), variating within range of 12.6–23.2 $\mu g.m^{-3}$ and TSP 5.1$\mu g.m^{-3}$ (Chopok) in 2007. Concentrations of heavy metals from PM10, resp. TSP are listed in Table 1.1 and Figure 1.4. The share of the sum of all measured metals in mass weight of suspended particles (PM_{10}, resp. TSP) varied at regional stations within 0.15–0.18 %. BaP has been measured at the Starina (annual average 0.20 $ng.m^{-3}$) and Topoľníky stations (annual average 0.49 $ng.m^{-3}$).

Fig. 1.4 **Heavy metals in ambient air – 2007**

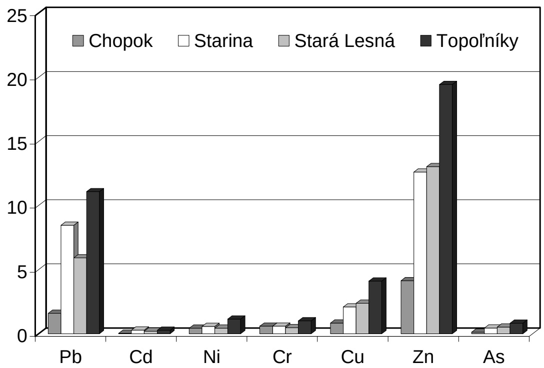
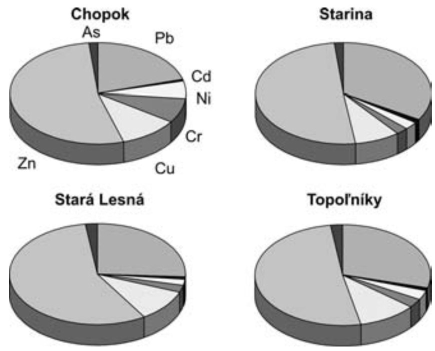


Fig. 1.5 **Proportional share of heavy metals – 2007**

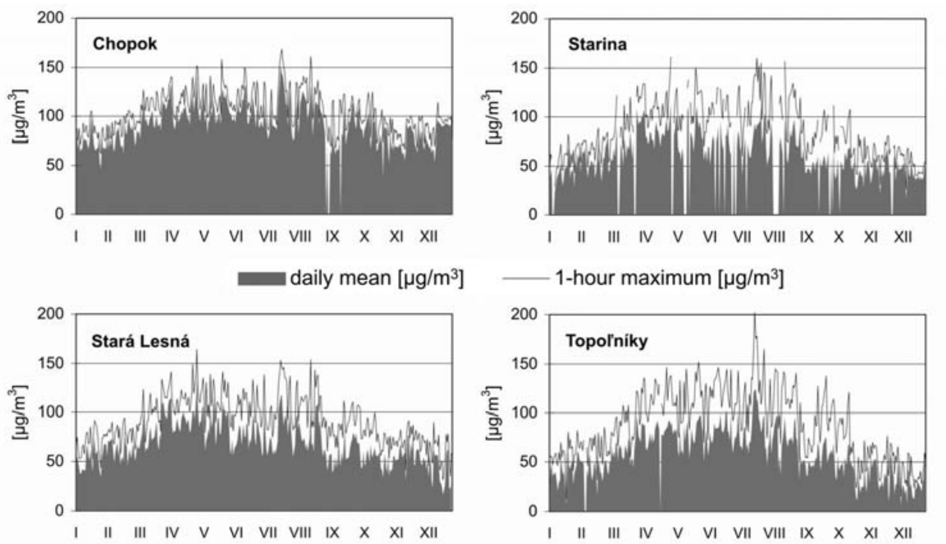


Ozone

In Figures 1.6 the annual course of ground level ozone concentrations at the regional stations Chopok, Stará Lesná, Starina and Topoľníky 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 2007, the annual average of ozone concentration at the Chopok station reached 92 $\mu g.m^{-3}$, at Starina 63 $\mu g.m^{-3}$, Stará Lesná 68 $\mu g.m^{-3}$, and Topoľníky 58 $\mu g.m^{-3}$. Measurements of ozone and exceedances of critical levels are completely assessed in Chapter 3 Atmospheric Ozone.

An increase in ozone concentrations was observed within 1970–1990, on average 1 $\mu g.m^{-3}$ annually. After 1990 the increase slowed down or stopped in compliance with the other European observations. This trend does correspond to the European development of ozone precursors.

Fig. 1.6 **Ground level ozone [$\mu g.m^{-3}$] – 2007**



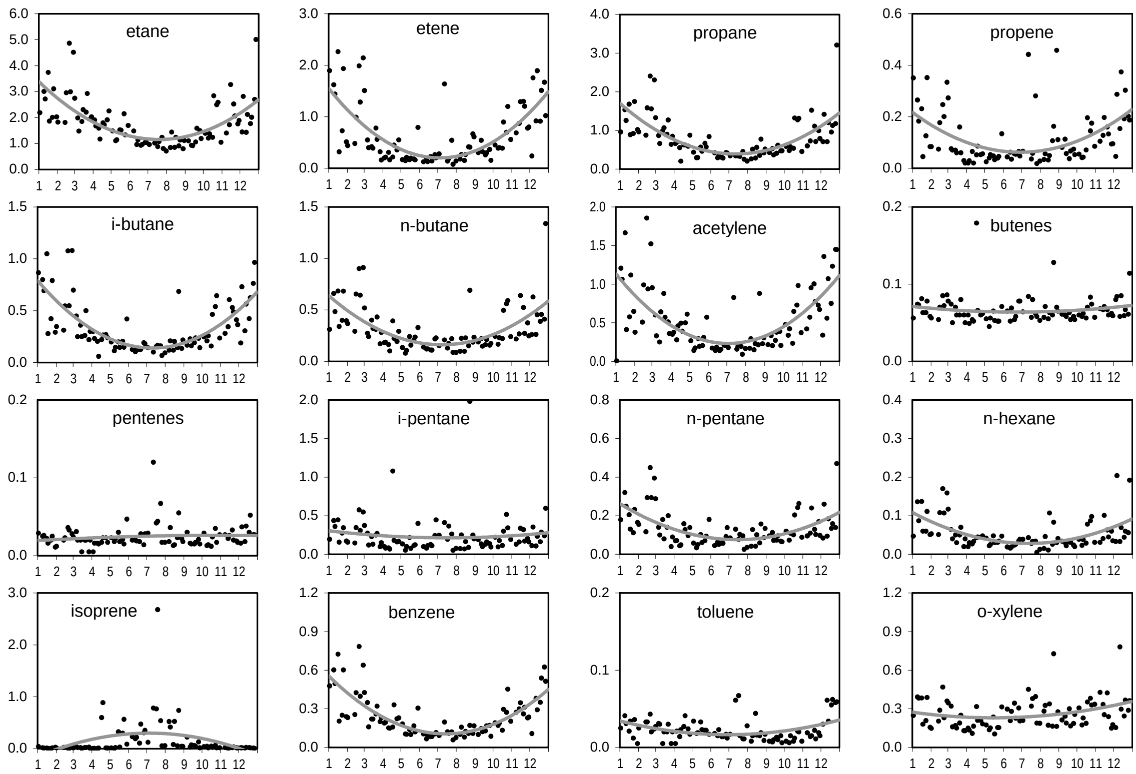
VOCs C_2–C_6

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 tenth of ppb up to several ppb (Tab. 1.2, Fig. 1.7). Etane is the most abundant, then propane and acetylene. Remarkable is presence of isoprene releasing from the near forest.

Tab. 1.2 **Annual averages of VOC [ppb] in ambient air, Starina, 2005–2007**

	etane	etene	propane	propene	i-butane	n-butane	acetylene	butene	pentene	i-pentane	n-pentane	izoprene	n-hexane	benzene	toluene	o-xylene
2005	2.046	0.662	0.974	0.192	0.243	0.379	1.291	0.058	0.038	0.422	0.225	0.127	0.104	0.351	0.090	0.366
2006	2.034	0.746	0.915	0.119	0.284	0.350	0.879	0.048	0.035	0.270	0.160	0.107	0.085	0.334	0.043	0.247
2007	1.804	0.648	0.797	0.117	0.343	0.314	0.534	0.067	0.024	0.241	0.132	0.150	0.053	0.240	0.023	0.262

Fig. 1.7 **VOCs [ppb] – Starina – 2007**



Atmospheric precipitation

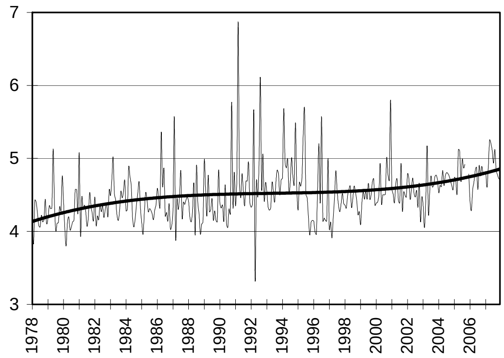
Major ions, pH, hydrogen ions, conductivity

In 2007 the amount of precipitation recorded at background stations ranged between 551 and 1087 mm. The upper level does belong to the highest situated station Chopok and lower to Topoľníky with the lowest elevation. Acidity of atmospheric precipitation ranged from 4.54–5.07 (Tab. 1.3, Fig. 1.9). Figure 1.9 illustrates the annual courses of pH, sulphates and nitrates at the Chopok station based upon the daily sampling. Time series and trend of pH values within a long-time period indicate clearly the decrease in acidity (Fig. 1.8). Values of pH are in a good coincidence with the pH values according to the EMEP maps.

Concentrations of dominant sulphates in precipitation recalculated in sulphur varied within the range 0.49–0.54 mg.l^{-1}. Concentrations of sulphates on the three higher situated stations are the same in annual mean and only slightly lower at the lowlands Topoľníky station. Total decrease of sulphates in long-term time series has corresponded to the SO_2 emission reduction since 1980.

The share of nitrate in acidity of precipitation was substantially smaller than those of sulphates and varied within the concentration range, calculated in nitrogen 0.28–0.38 mg.l^{-1}. Ammonium ions also do belong to the major ions and their concentration range was 0.32–0.58 mg.l^{-1}.

Fig. 1.8 **pH in daily precipitation – Chopok**

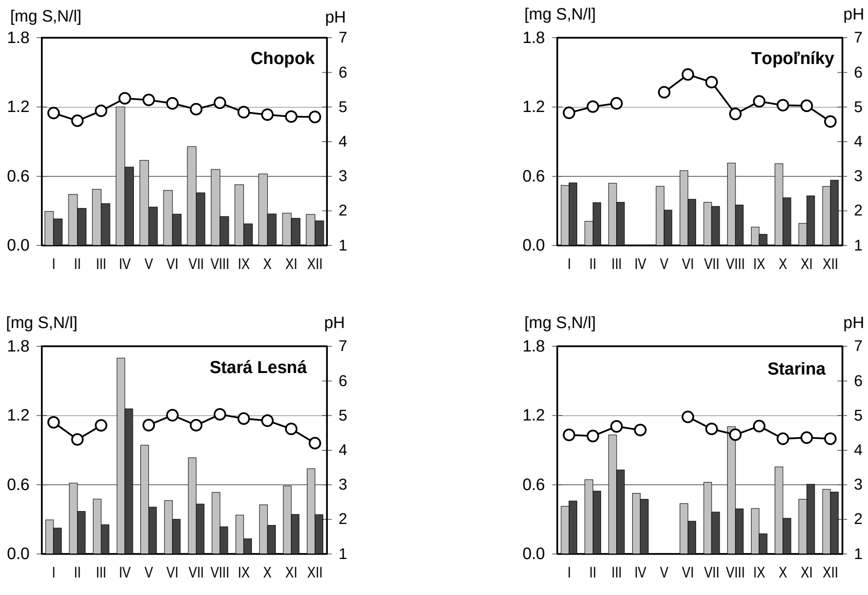


Tab.1.3 **Annual averages of main components in daily precipitation - 2005–2007**

		Precip. mm	pH	Cond. µS/cm	SO_4^{2-} (S) mg/l	NO_3^- (N) mg/l	NH_4^+ (N) mg/l	Cl^- mg/l	Na^+ mg/l	K^+ mg/l	Mg^{2+} mg/l	Ca^{2+} mg/l
Chopok, EMEP	2005	1155	4.85	10.9	0.41	0.25	0.37	0.15	0.14	0.08	0.019	0.15
	2006	908	4.75	12.9	0.48	0.31	0.48	0.14	0.08	0.06	0.02	0.09
	2007	1087	4.93	13.34	0.54	0.30	0.43	0.19	0.23	0.07	0.04	0.15
Topoľníky, Aszód, EMEP	2005	619	4.96	15.2	0.52	0.35	0.52	0.25	0.20	0.13	0.073	0.41
	2006	456	5.08	14.2	0.47	0.40	0.54	0.19	0.13	0.07	0.06	0.25
	2007	551	5.07	13.33	0.49	0.34	0.49	0.18	0.14	0.10	0.06	0.31
Starina, Vodná nádrž, EMEP	2005	893	4.60	17.6	0.58	0.40	0.39	0.26	0.21	0.15	0.035	0.27
	2006	788	4.52	17.3	0.49	0.40	0.39	0.17	0.14	0.12	0.05	0.20
	2007	738	4.54	18.44	0.54	0.38	0.32	0.19	0.19	0.08	0.03	0.18
Stará Lesná, AÚ SAV, EMEP	2005	854	4.73	13.8	0.48	0.28	0.36	0.20	0.18	0.13	0.030	0.30
	2006	609	4.63	15.3	0.52	0.35	0.42	0.31	0.24	0.07	0.04	0.21
	2007	790	4.80	16.45	0.54	0.28	0.58	0.28	0.25	0.18	0.04	0.26

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

Fig. 1.9 **Daily precipitation – 2007**



Heavy metals

Since 2000 the measurement programme of heavy metals in precipitation has been gradually modified to meet the present requirements of the CCC EMEP monitoring strategy. In Bratislava-Jeséniova the measurement of the same set of heavy metals in precipitation was implemented as in background stations of Slovakia (Table 1.4). This station serves however only for comparison and is not assessed as the background station.

The results of annual weighted means of heavy metals concentrations in monthly precipitation in 2007 are presented in Table 1.4.

Tab. 1.4 **Annual averages of heavy metals in monthly precipitation, 2005–2007**

		precip.	Pb	Cd	Cr	As	Cu	Zn	Ni
		mm	μg/l	μg/l	μg/l	μg/l	μg/l	μg/l	μg/l
Chopok, EMEP	2005	934	2.39	0.09	0.20	0.31	1.40	19.4	0.29
	2006	687	3.60	0.16	0.33	0.60	2.37	33.5	0.61
	2007	941	1.94	0.06	0.13	0.15	0.70	20.36	0.48
Topoľníky, Aszód, EMEP	2005	598	1.55	0.05	0.08	0.28	0.82	5.7	0.71
	2006	502	2.39	0.09	*0.11	*0.30	*1.39	*7.1	*0.77
	2007	571	0.92	0.04	0.07	0.10	1.28	9.21	0.44
Starina, Vodná nádrž, EMEP	2005	891	2.93	0.11	0.07	0.27	1.19	6.5	0.32
	2006	749	2.28	0.09	*0.07	*0.19	*1.19	*8.4	*0.34
	2007	625	1.72	0.06	0.07	0.13	1.93	9.76	0.40
Stará Lesná, AÚ SAV, EMEP	2005	803	1.69	0.19	0.07	0.21	0.78	9.4	0.22
	2006	603	2.24	0.22	*0.09	*0.25	*1.36	*10.8	*0.39
	2007	673	1.18	0.09	0.08	0.13	0.99	10.74	0.28
Bratislava, Jeséniova	2005	683	3.05	0.07	0.08	0.37	1.47	10.5	0.38
	2006	711	2.50	0.09	*0.19	*0.28	*2.84	*16.4	*0.77
	2007	554	2.01	0.07	0.21	0.22	2.31	15.8	1.07

** weighted mean within the period of January to May 2006*

Conclusion

In coincidence with the EMEP measurements the Slovak Republic is situated on the south-east boundary of a territory with the highest regional air pollution and acidity of precipitation in Europe. Development of regional air pollution and chemical composition of precipitation corresponds to the development of European emissions.

AMBIENT AIR

2

LOCAL AIR POLLUTION

2.1 LOCAL AIR POLLUTION

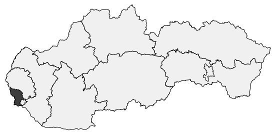
Air quality assessment is claimed by Air Protection Act No 478/2002 Coll. as amended. Criterions for air quality assessment (upper and lower assessment thresholds, margin of tolerance, limit and target values) are given in Decree No 705/2002 Coll. about Air Quality amended by Decree No 351/ 2007 Coll. Fundamental air quality assessment is performed on the basis of measured data. Slovak Hydrometeorological Institute (SHMI) carried out measurements at monitoring stations of National air quality monitoring network (NAQMN).

The SHMI 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 disseminated into the most polluted towns and industrial areas.

In 1991 modernization of the air quality monitoring network began. The manual stations were gradually substituted 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 2007, 27 stations (without EMEP 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}). In the year 2007 measurements of benzene were carried out at 10 and $PM_{2,5}$ at 3 automatic stations. The air pollution monitoring by heavy metals (Pb, Cd, As and Ni) were performed at 10 localities and benzo(a)pyrene on 6 sites.

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, NOx, Pb, PM_{10}, $PM_{2.5}$, benzene and CO. The delimitation of zones is identical with the higher administrative units – regions. From Bratislava and Košice regions geographical extension of cities Bratislava and Košice were selected and these cities are assessed separately as agglomerations. According to the Decree No 705/2002 Coll. about Air Quality amended by Decree No 351/ 2007 Coll. was for pollutants: As, Cd, Ni, BaP, Hg a O_3 set up aglomeration Bratislava and zone Slovensko. Zone Slovensko reprezents the whole territory of the Slovak Republic besides agglomerration Bratislava.

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



AGGLOMERATION - BRATISLAVA

AREA: 368 km^2 POPULATION: 426 927

Characterization of area

Bratislava

Bratislava spreads out over an area of 370 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 are concentrated in a relatively small area between the south and 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 secondary source of air pollution in the city.

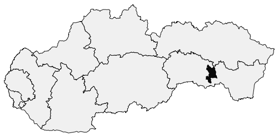
Location of stations

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

Bratislava - Mamateyova
The station is located in open are at 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, Ltd. The last mentioned contributes to the air pollution mainly under an east wind direction.

Bratislava - Trnavské mýto
The station is situated near to a busy crossroad Šancová street - Vajnorská street. As far as traffic emissions are concerned, this location is an extremely polluted one. It represents location with extreme high emissions from road transport.

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 old part of the city. Besides of transport this location is polluted by major sources, mainly Slovnaft, Ltd., with a south-east wind direction.



AGGLOMERATION - KOŠICE

AREA: 245 km^2 POPULATION: 234 237

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. Energy sources, including the city heating plants and local boiler rooms emit lesser amounts of pollutants.

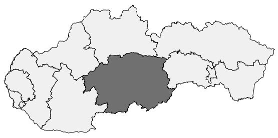
Location of stations

Košice - Štúrova

This is a city centre station. It is placed in an open area, at the edge of large parking area and small park. The station is located at a distance of about 10 m north from the inner circle roads and 50 m south from the second route of this circle.

Košice - Strojárska

Station is situated in open area 10 m far from 2-storey buildings, separated by green alley from near road which is in distance of about 15 m.



ZONE - BANSKÁ BYSTRICA REGION

AREA: 9 455 km^2 POPULATION: 654 668

Characterization of area

Banská Bystrica

The town is located in the Bystrické valley, which is by the northern part of the Zvolenská basin surrounded by the Starohorské hills to the north, by the Horehronské valley to the north-east and by the Kremnické 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.

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 Kremnické hills in the west up to the north, and by the Štiavnické 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. The major share in air pollution is due to aluminium production and power generation.

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 - Nám. slobody

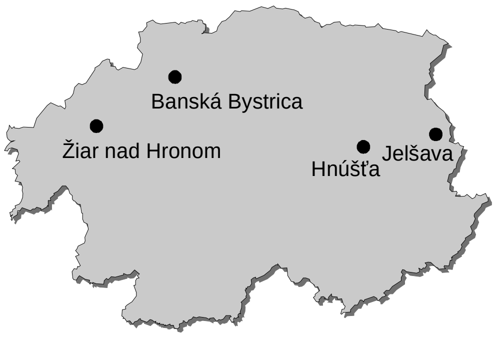
The station is located in the city centre, 100 m from a local busy road junction at a distance of 50 m from one and two storey housing area. The station is located in the valley part of the city with poor dispersion conditions.

Žiar nad Hronom - Dukelských hrdinov

The station is placed on a boundary-line between 4-storey housing and an open space, passing down, out of the station.

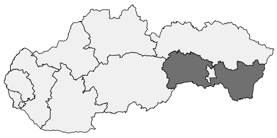
Hnúšťa - Hlavná

The station is situated in open 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.



ZONE - BRATISLAVA REGION

AREA: 1 685km^2 POPULATION: 183 923

Characterization of area

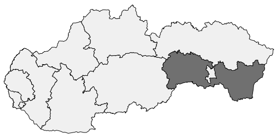
Malacky

Region Malacky spreads out northerly from the capital of the Slovak Republic, Bratislava. It is located in the southern part of Záhorska 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 and north-west wind directions occur there most frequently within a year. Annual average wind speed is about 2.7 m/s.

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: 6 508 km^2 POPULATION: 539 866

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 and northern 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.

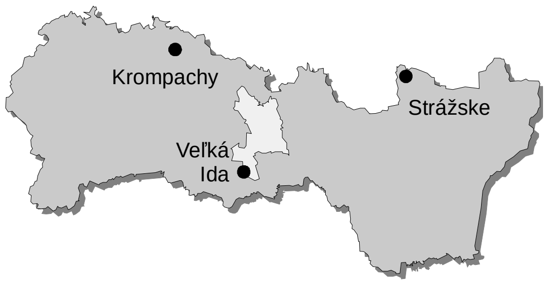
Strážske

Strážske is located easterly from Vihorlat in northern part of the Eastslovak lowland in area called Brekovska brana, 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 Abovské 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 of extracting ores.

Location of stations



Krompachy - Lorenzova

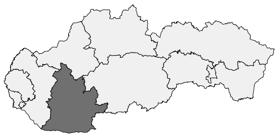
The station is located in the valley of the Slovinský potok, on the western edge of the town 2 km south-west of the ferrous metal plant Kovohuty Krompachy. The surrounding built-up area comprises multi-storey houses. It is a valley position with an increased occurrence of inversions.

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 are not fully grassed.

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.



ZONE - NITRA REGION

AREA: 6 343 km^2 POPULATION: 706 758

Characterization of area

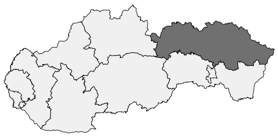
Nitra

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 downs. Prevailing winds are from north-east and south-west directions with a small occurrence of calm situations.

Location of stations

Nitra - Janka Kráľa

Station is situated in the build up are of the town. It is placed at the courtyard of KÚ ŽP Nitra surrounded by 2 storey houses and threes. This location is temporally and it will be placed back on the former place. .



ZONE - PREŠOV REGION

AREA: 8 993 km^2 POPULATION: 801 939

Characterization of area

Prešov

Prešov lies in the northern promontory of Košice's basin. The surrounding mountains of the Šariš's highland and the Slánské 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. The town lies on the slope facing to the south and thus cool air runoff is provided, which settles under the calm at the bottom of the basin. In the course of a year the northern air circulation prevails and is also the strongest. The next highest air circulation belongs to the south direction. Good ventilation of the town is provided by the widening of the valley itself at the confluence of the Sečkov and Torysa. The main cause of air pollution in town is municipal boilers, partly lacking separation techniques, traffic, 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 varies. The occurrence of calm is relatively high. The local chemical industry is the main air pollution source in this area.

Vranov

Vranov 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 valley. The main air pollution sources in the area are the local wood processing industry and local heating systems.

Location of stations

Prešov - Solivarská

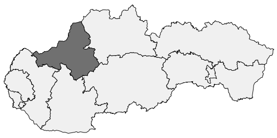
The station is located in the south-eastern part of the town in an open zone of low density buildings in the vicinity of the Solivarská and Arm. gen. L. Svobodu cross-road with high frequency of transport. Station is located 10 m from kerbside.

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 Hencovce plant. It is distant from the main road, of about 30 m.

Humenné - Nám. slobody

The station is located in the southern part of the town centre at the border of a pedestrian zone with minimum car transport. The surrounding buildings are connected to the central heating from Chemes Humenné source which is located approximately 2 km west from AMS.



ZONE - TRENČÍN REGION

AREA: 4 502 km^2 POPULATION: 599 831

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 sources for power generation contributes to air pollution in this area to a greater extent. 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 located a local road N. 64 towards Žilina.

Handlová - Morovianska cesta

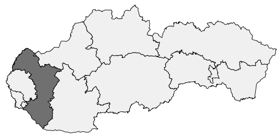
The station is located in a predominantly family house built-up area in territory of elementary school close to the municipal road. Among the major emission sources are power sources and industry.

Bystričany - Rozvodňa SSE

The station is situated in agricultural area among fruit trees. The Nováky power plant (ENO) is of 8 km from the monitoring station.

Trenčín - Hasičská

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



ZONE - TRNAVA REGION

AREA: 4 148 km^2 POPULATION: 557 151

Characterization of area

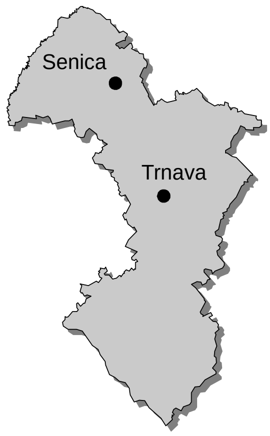
Senica

The town itself is located on the southern slopes of Myjava hills in the altitude of 208 m. From its 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 Záhorska lowlands intervene. 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. Main share in air pollution of the town is due to chemical industry (state enterprise Slovenský hodváb - Slovak Silk), power generation and car transport.

Trnava

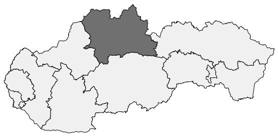
Trnava – one of the most important cities in the Slovak Republic is located in the centre of the Trnava downs, at an altitude of 146 m, 45 km from the capital of the Slovak Republic, Bratislava. The prevailing wind is from the north-west, the second highest wind frequency is from south-east. The location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

Location of stations



Senica - Hviezdoslavova
Station is situated very close to the bus stop. It 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

ROZLOHA: 6 788 km^2 POPULÁCIA: 695 698

Characterization of area

Ružomberok

The location of the city comprises the area of the western part of the Liptovská basin, on the confluence of rivers Váh, Revúca and Likavka. The Veľká Fatra mountains constitute the border in the west, the Chočské mountains in the north and the Low Tatras in the south. The most frequent wind blows from the west, at an average speed 1.6 m.s^{-1}. The North Slovakian pulp and paper processing plants are the largest industrial source of air pollution. A considerable share of this pollution is caused by small local sources, as well. Specific air pollution represents a mixture of predominantly organic-sulphur compounds.

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. According to the climate characteristics the area belongs to a moderately warm region. 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 small sources of emissions lead to the high level of air pollution at the ground level layer. Air pollution by classical pollutants is due to the local heating plant of the Slovak Power Plants, but local chemical operations and mainly heavy traffic in the town centre contribute as well.

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 inversions, average wind speed 2.8 m.s^{-1} and high relative humidity contribute to higher level of pollution. Heavy engineering, local heating plants of the Central Slovakian power plants and car transport are the largest emitters of pollutants.

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 speed and wind direction 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. A major pollution source the Ružomberok Slovak pulp and paper processing plants is situated north-east of the monitoring station.

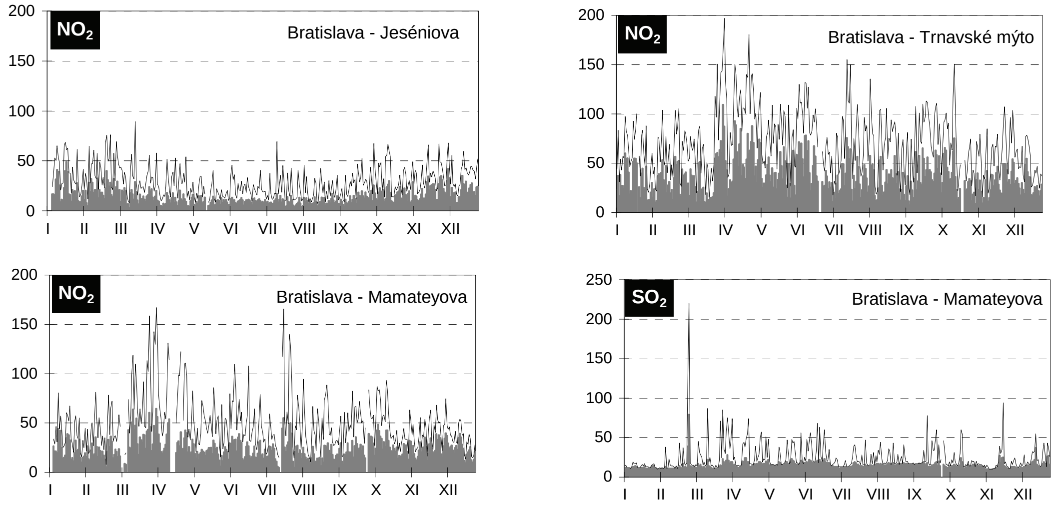
Martin - Jesenského

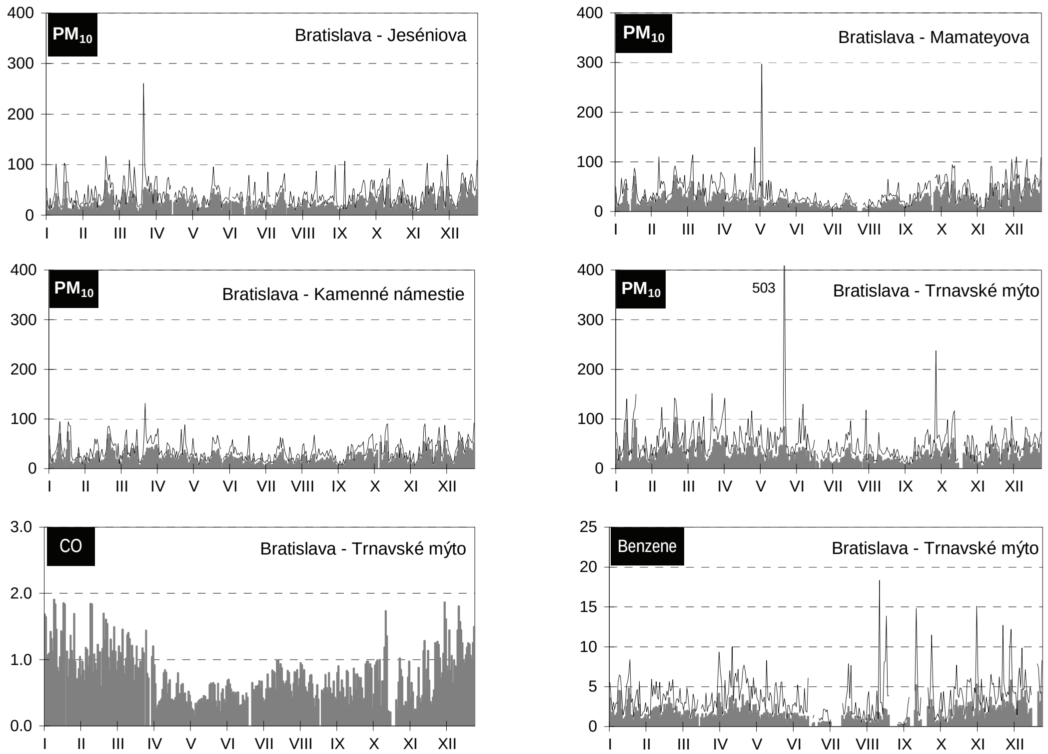
The station is located 5 m from the kerbside of the main street. Station is located in the southern part of the city in area mainly build up by family houses.

Tab. 2.1 **Geographical co-ordinates of monitoring stations and list of pollutants monitored in 2007**

AGGLOMERATION/ zone		Longitude	Latitude	Altitude [m]	SO_2	NO_2	PM_{10}	$PM_{2.5}$	CO	C_6H_6	Pb	Cd	Ni	As	BaP
BRATISLAVA	Bratislava, Kamenné nám	17°06'49"	48°08'41"	139			*								
	Bratislava, Trnavské mýto	17°07'44"	48°09'31"	136		*	*		*	*					*
	Bratislava, Jeséniova	17°07'00"	48°10'00"	287		*	*								*
	Bratislava , Mamateyova	17°07'32"	48°07'30"	138	*	*	*				*	*	*	*	
KOŠICE	Košice, Štúrova	21°15'39"	48°43'02"	199		*	*		*	*					
	Košice, Strojárska	21°15'07"	48°43'36"	202			*								
Banskobystrický kraj	Banská Bystrica, Nám. slobody	19°09'30"	48°44'12"	372	*	*	*		*	*	*	*	*	*	
	Jelšava, Jesenského	20°14'25"	48°37'52"	289			*								
	Hnúšťa, Hlavná	19°57'06"	48°35'01"	320			*								
	Žiar nad Hronom, Dukelských hrdinov	18°51'01"	48°35'09"	285			*								
Bratislavský kraj	Malacky, Sasinkova	17°01'10"	48°26'15"	133	*	*	*		*	*					
Košický kraj	Veľká Ida, Letná	21°10'31"	48°35'32"	209			*		*		*	*	*	*	*
	Strážske, Mierová	21°50'15"	48°52'27"	133			*								
	Krompachy, Lorenzova	20°52'21"	48°54'44"	387	*	*	*		*	*	*	*	*	*	*
Nitriansky kraj	Nitra, Janka Kráľa	18°04'29"	48°18'39"	142	*	*	*		*	*					
Prešovský kraj	Humenné, Nám. slobody	21°54'49"	48°55'51"	160		*	*								
	Prešov, Solivarská	21°15'52"	48°58'40"	258		*	*		*	*					
	Vranov nad Topľou, M. R. Štefánika	21°41'15"	48°53'11"	133	*		*								
Trenčiansky kraj	Prievidza, Malonecpalská	18°37'41"	48°46'57"	276	*		*	*			*	*	*	*	
	Bystričany, Rozvodňa SSE	18°30'51"	48°40'01"	261	*		*								
	Handlová, Morovianska cesta	18°45'23"	48°43'59"	448	*		*								
	Trenčín, Hasičská	18°02'29"	48°53'47"	214	*	*	*		*	*					
Trnavský kraj	Senica, Hviezdoslavova	17°21' 48"	48°40'50"	212	*		*								
	Trnava, Kollárova	17°35'06"	48°22'16"	152		*	*		*	*					*
Žilinský kraj	Martin, Jesenského	18°55'19"	49°04'01"	383		*	*	*	*	*					
	Ružomberok, Riadok	19°18'09"	49°04'45"	475	*		*				*	*	*	*	
	Žilina, Obežná	18°46'16"	49°12'43"	356		*	*	*							

Fig. 2.1 **Concentrations of NO_2, SO_2, PM_{10}, CO and benzene – Agglomeration Bratislava – 2007**

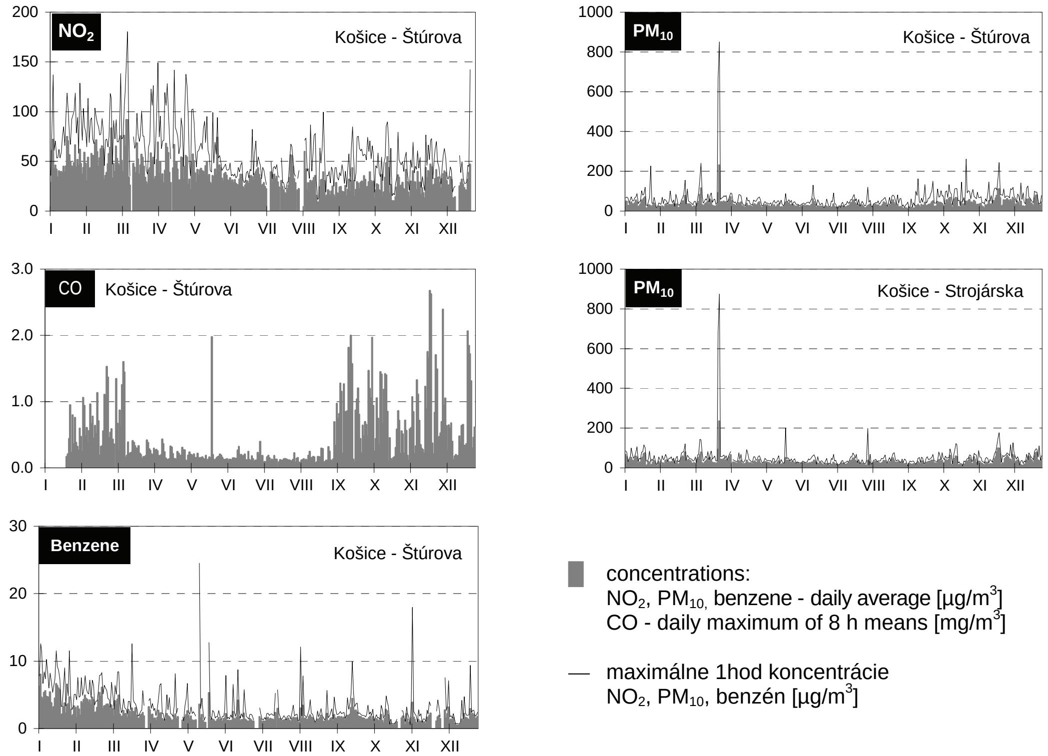




concentrations: NO_2, SO_2, PM_{10}, benzene - daily average [µg.m^{-3}] CO - daily maximum of 8 h means [mg.m^{-3}]

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

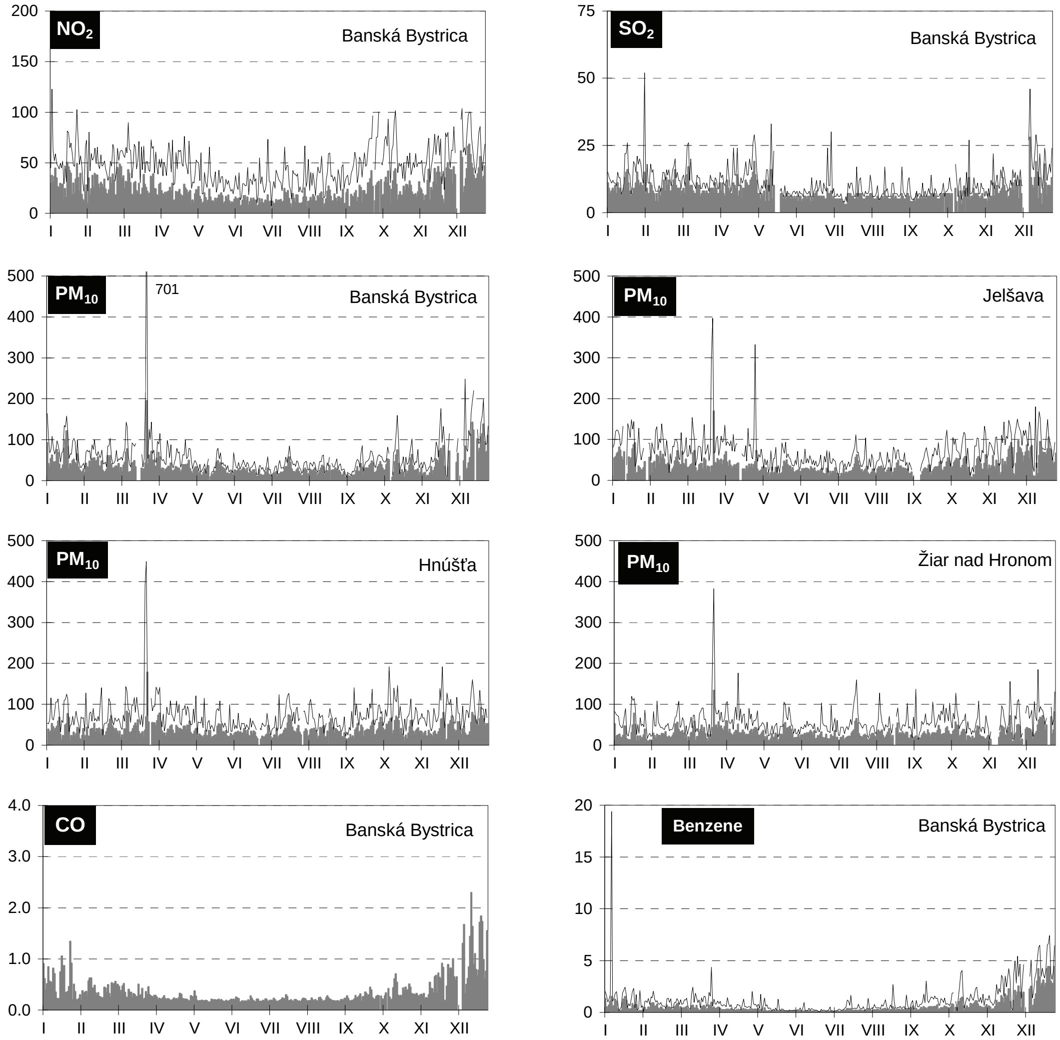
Fig. 2.2 **Concentrations of NO_2, PM_{10}, CO and benzene – Agglomeration Košice – 2007**



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

— maximálne 1hod koncentrácie
NO_2, PM_{10}, benzén [µg/m^3]

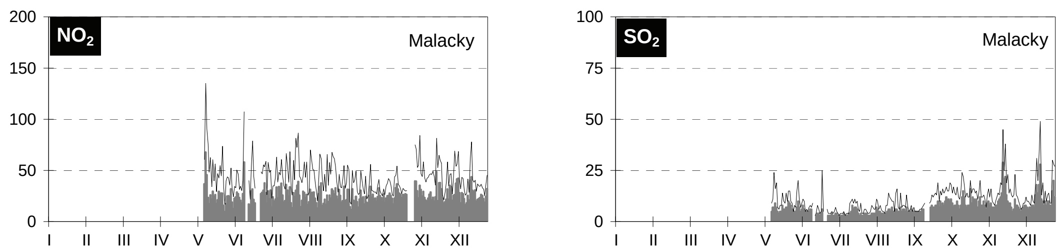
Fig. 2.3 **Concentrations of NO_2, SO_2, PM_{10}, CO and benzene – zone Banská Bystrica region – 2007**



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 concentration NO_2, SO_2, PM_{10}, benzene [µg.m^{-3}]

Fig. 2.4 **Concentrations of NO_2, SO_2, PM_{10} , CO and benzene – zone Bratislava region – 2007**



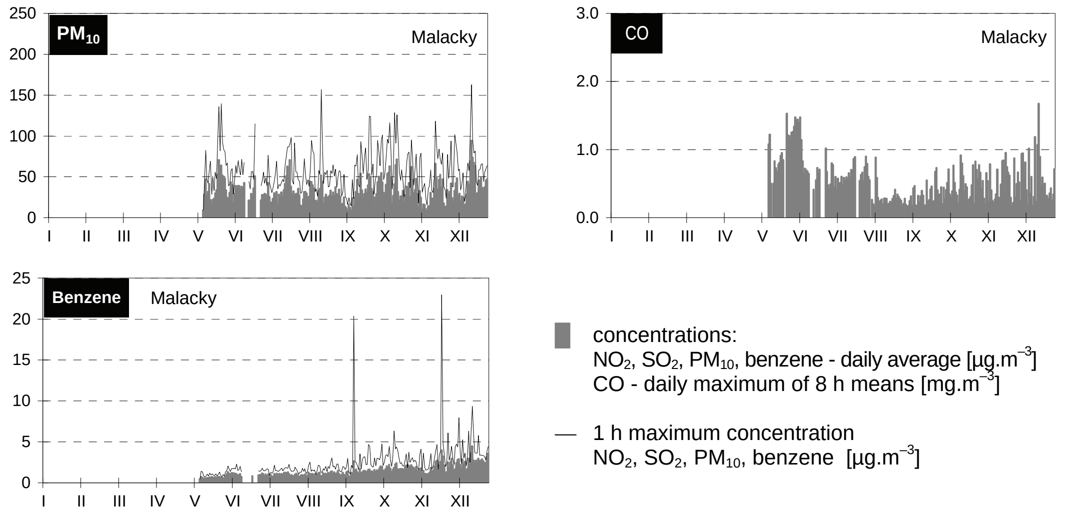


Fig. 2.5 **Concentrations of NO_2, SO_2, PM_{10}, CO and benzene – zone Košice region – 2007**

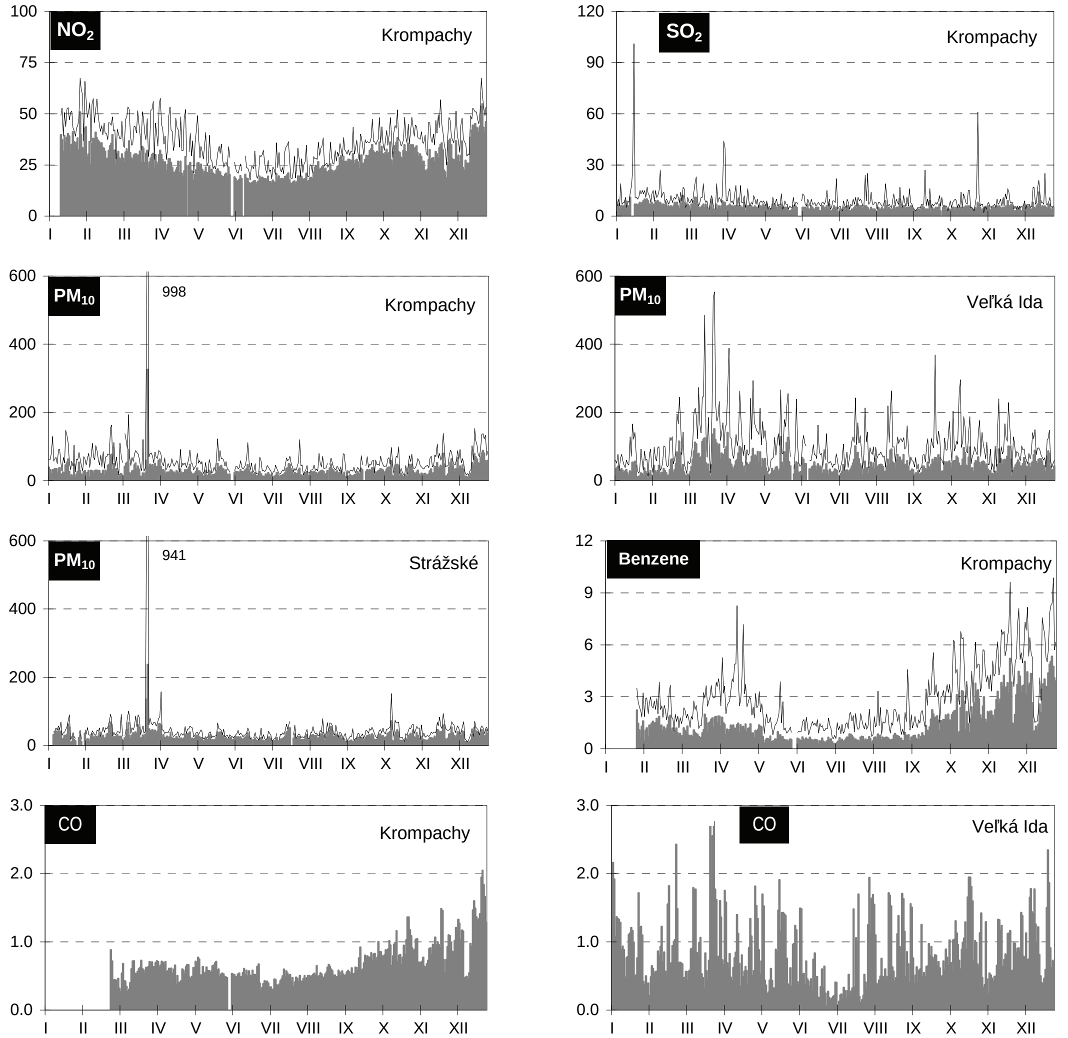


Fig. 2.6 **Concentrations of NO_2, SO_2, PM_{10}, CO and benzene – zone Nitra region – 2007**

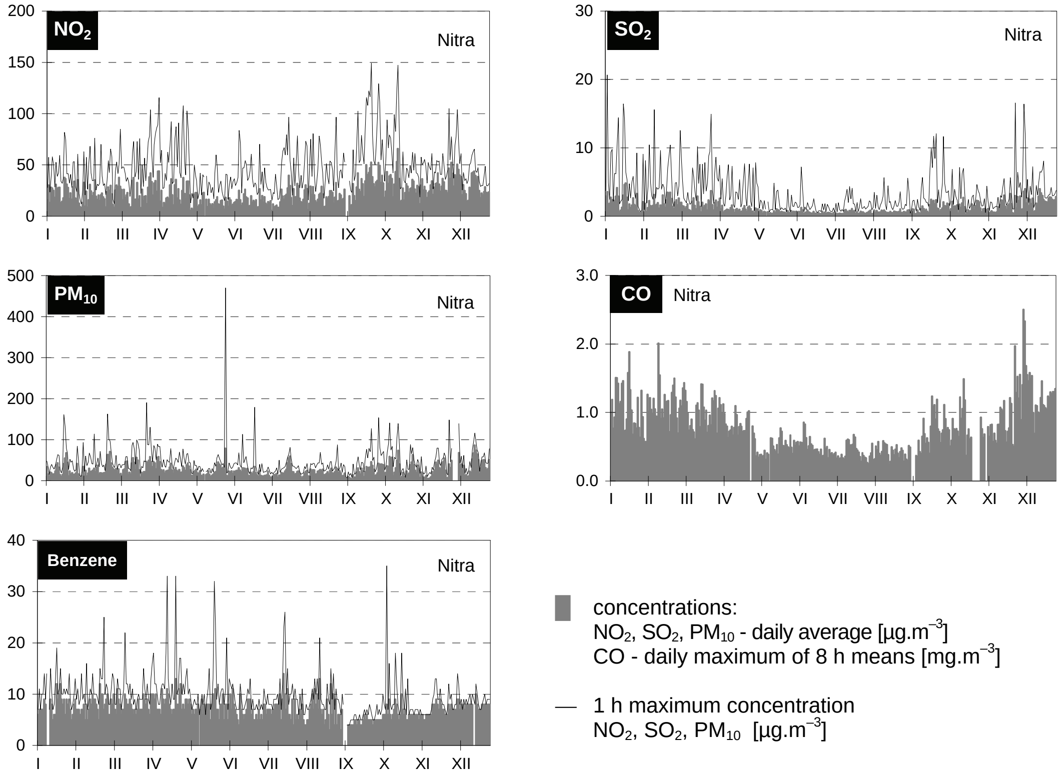
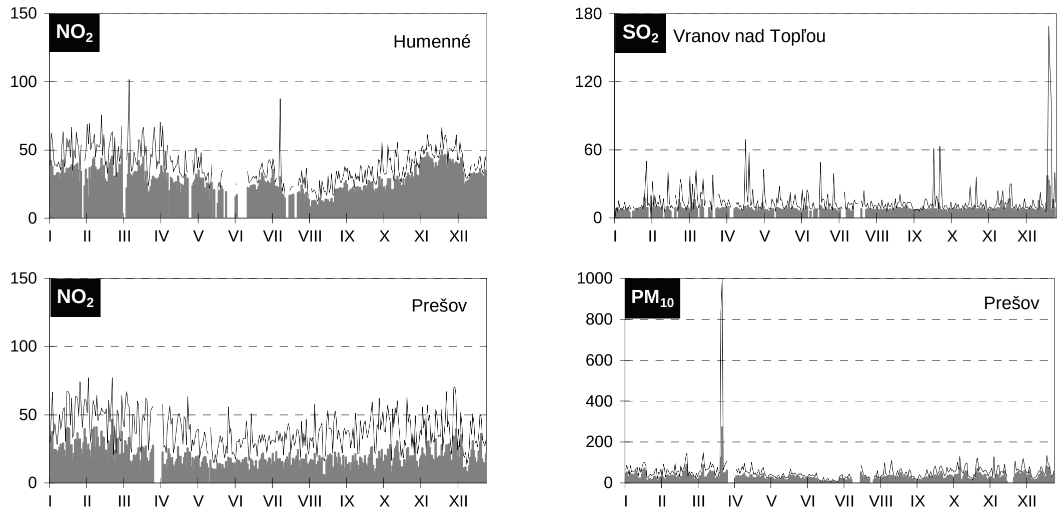
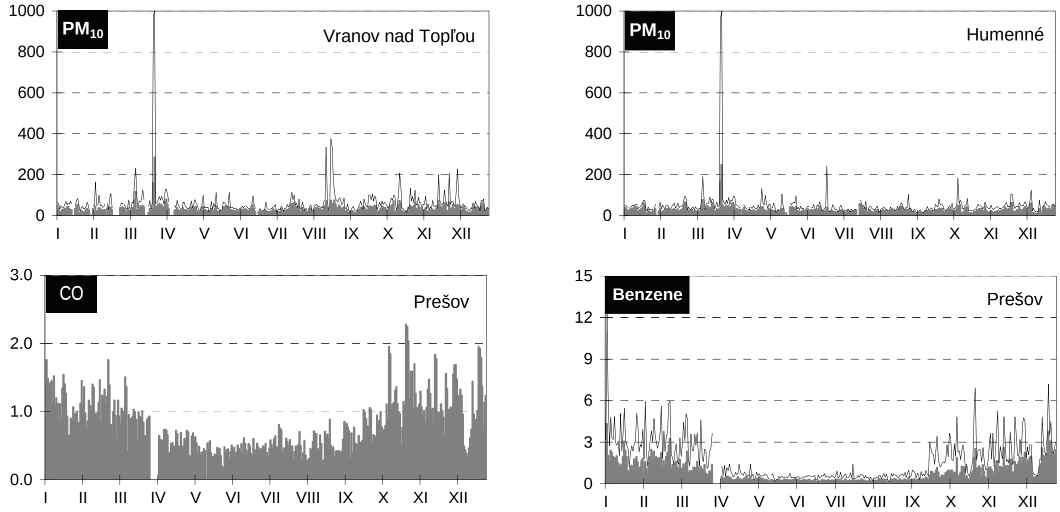


Fig. 2.7 **Concentrations of NO_2, SO_2, PM_{10}, $PM_{2.5}$, CO and benzene – zone Prešov region – 2007**

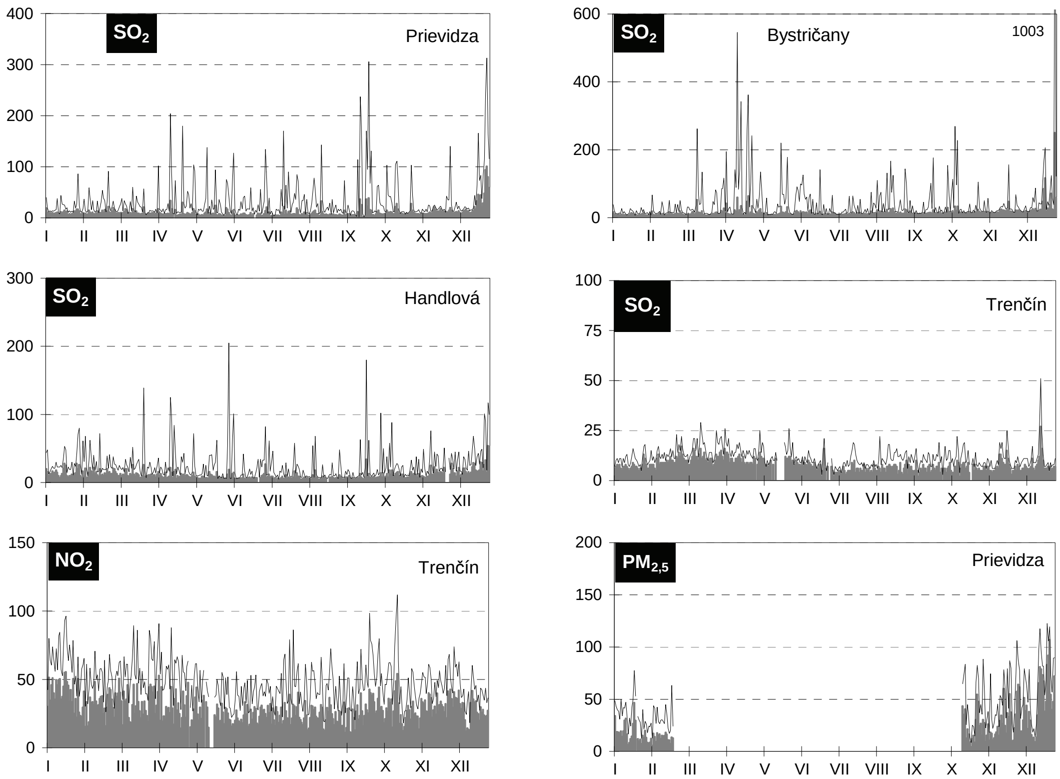


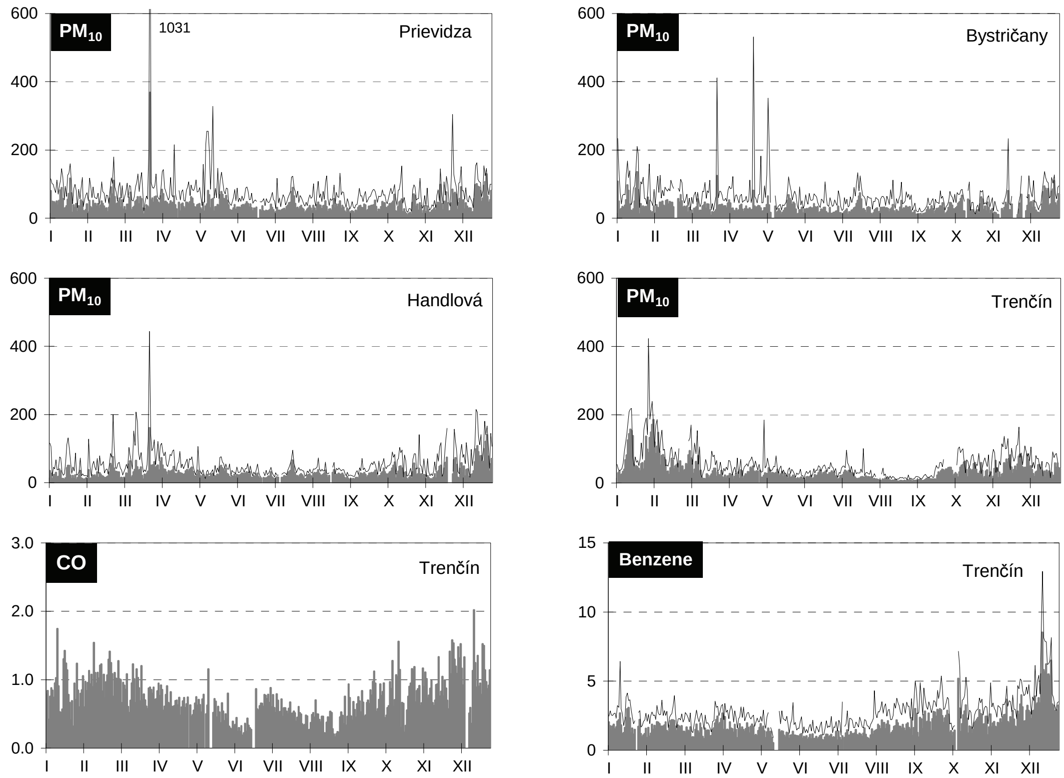


concentrations: NO_2, SO_2, PM_{10}, benzene - daily average [µg.m^{-3}]
CO - daily maximum of 8 h means [mg.m^{-3}]

— 1 h maximum concentration 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 – 2007**

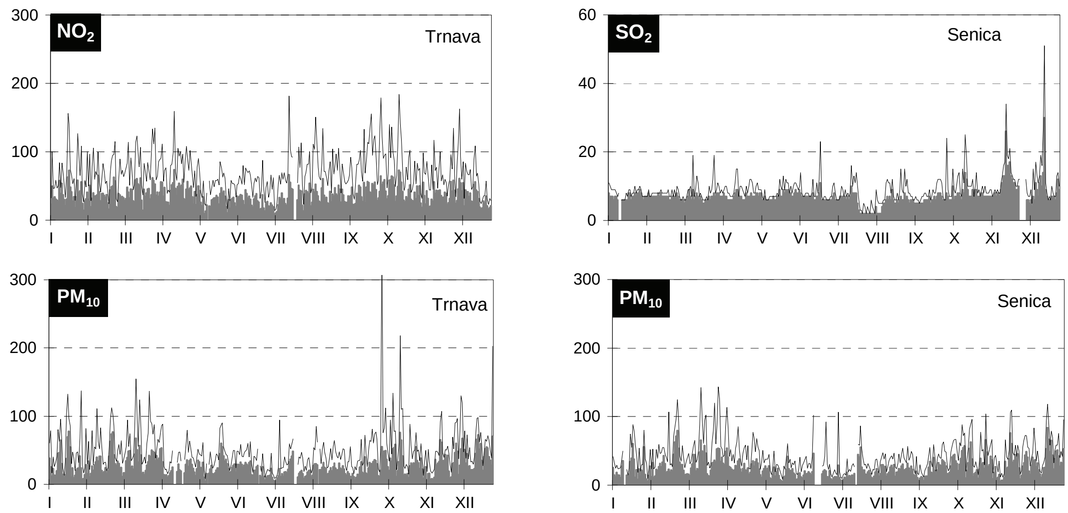


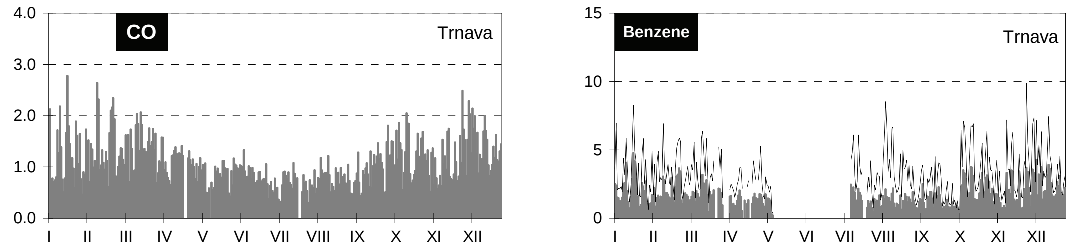


concentrations: NO_2, SO_2, PM_{10}, benzene - daily average [$\mu g.m^{-3}$]
CO - daily maximum of 8 h means [$mg.m^{-3}$]

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

Fig. 2.9 **Concentrations of NO_2, SO_2, PM_{10}, $PM_{2.5}$, CO and benzene – zone Trnava region – 2007**

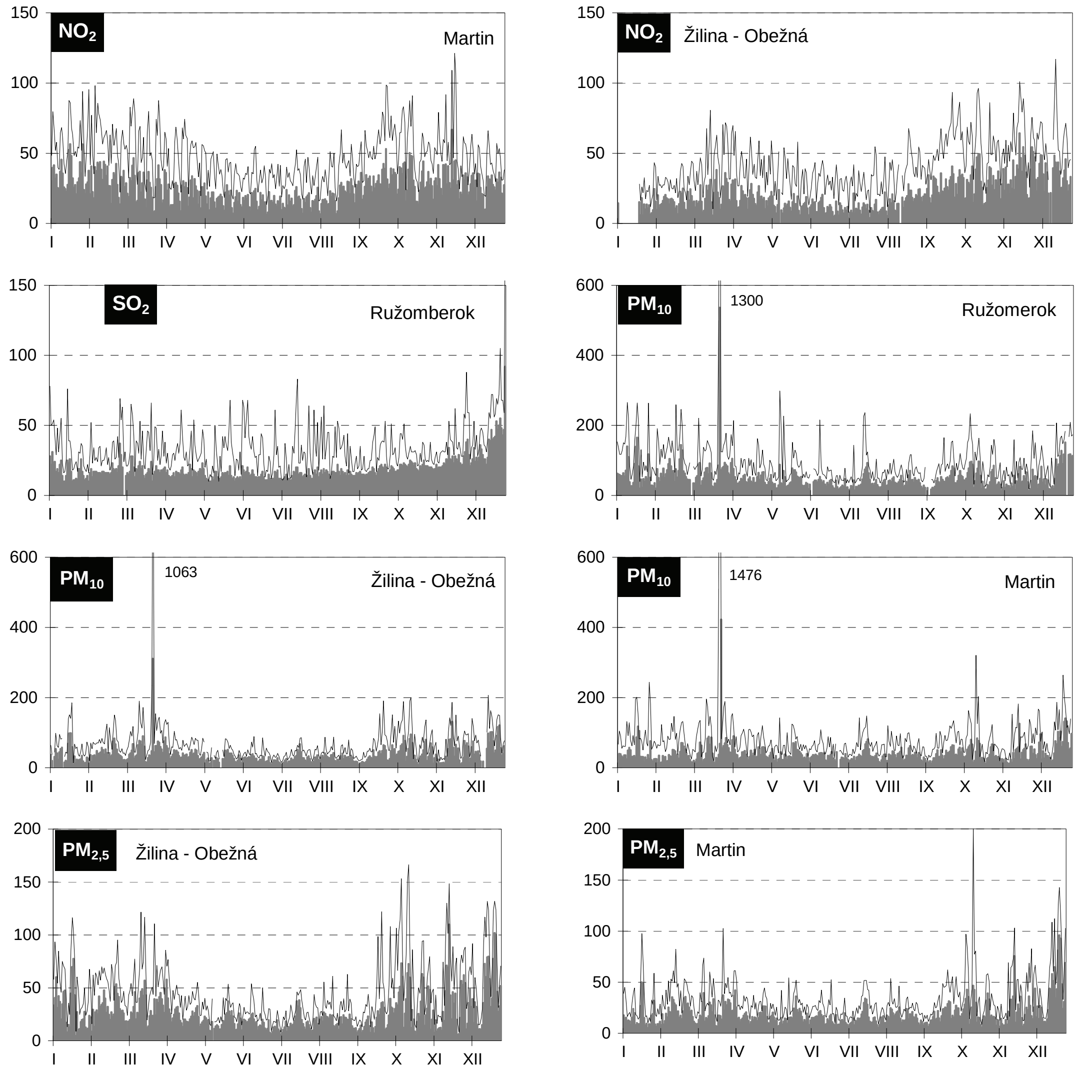


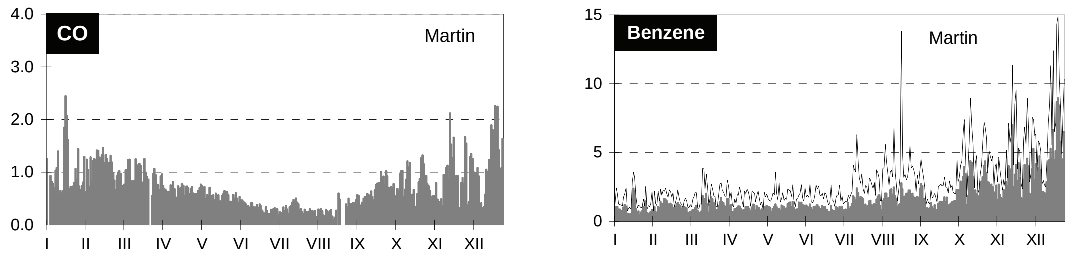


concentrations: NO_2, SO_2, PM_{10}, benzene - daily average [µg.m^{-3}]
CO - daily maximum of 8 h means [mg.m^{-3}]

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

Fig. 2.10 **Concentrations of NO_2, SO_2, PM_{10}, $PM_{2.5}$, CO and benzene – zone Žilina region – 2007**

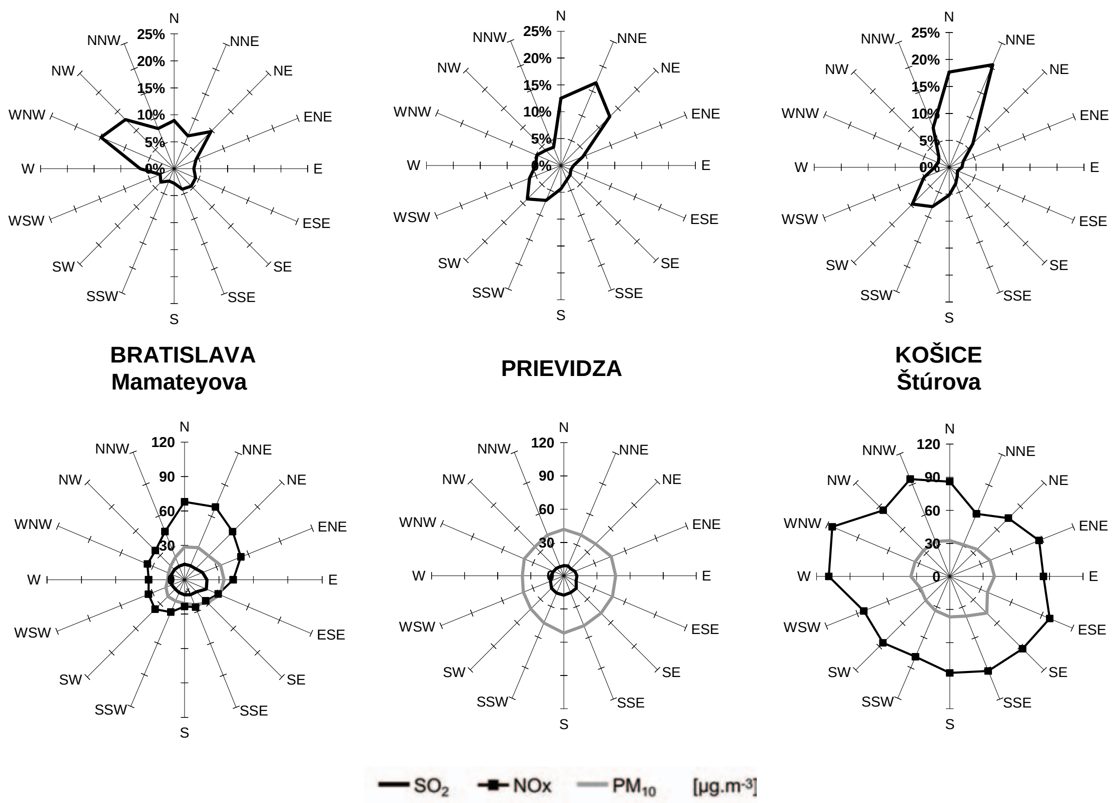




concentrations: NO_2, SO_2, PM_{10}, benzene - daily average [µg.m^{-3}]
CO - daily maximum of 8 h means [mg.m^{-3}]

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

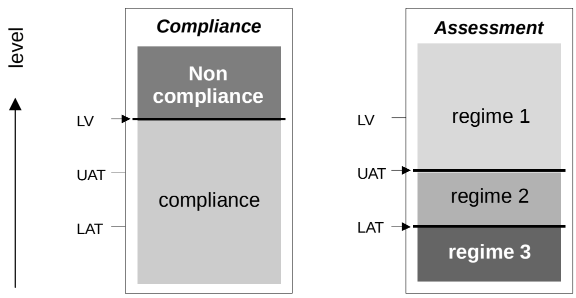
Fig. 2.11 **Wind and concentration roses – 2007**



2.3 PROCESSING OF MEASUREMENT RESULTS ACCORDING TO LIMIT VALUES

The Air Protection Act 478/2003 harmonized the principles of air quality assessment with the EU AQ legislation. The whole territory of the Slovak Republic was divided into zones and agglomerations and on the basis of air quality assessment in each zone/agglomeration the monitoring regimes were defined. This assessment performed for the period of the last five years distinguishes three particular monitoring regimes. These are schematically illustrated on the picture 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**	
In agglomerations, only for pollutants, for which an alert threshold has been set	At least one measurement station is required in each agglomeration combined with the model computations, expert estimate and indicative measurements. Those are measurements based on simple methods, or operated in limited time. These are less accurate than continuous measurements, but may be used to control relatively low level of pollution and as supplementary measurements in other areas.
In all types of zones, apart from agglomeration zones, for all pollutants for which an alert threshold has been set	Model computations, expert estimates and indicative measurements are sufficient.

For several pollutants the margins of tolerance (MoT) were set up, table 2.3. The margins of tolerance are gradually decreasing since, they will meet the zero value at the date when limit values will come into force. In the year 2006 margin of tolerance was given only for annual limit values of NO_2 and benzene. Limit values, upper and lower assessment thresholds defined in Decree No 705/ 2002 Coll. about Air Quality are presented in tables 2.3 and 2.4. Alert thresholds and limit values for signals “INFORMATION” and “REGULATION” were set up for:

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[1] *Limit value as defined in Decree No 705/2002 Coll. about Air Quality amended by Decree No 351/2007Coll.*
[2] *Upper assessment threshold as defined in Decree No 705/2002 Coll. about Air Quality amended by Decree No 351/2007Coll.*
[3] *Lower assessment threshold, as defined in Decree No 705/2002 Coll. about Air Quality amended by Decree No 351/2007Coll.*

Signal **Information**: If the values of moving average concentrations during 3 hours are above:

- SO_2 - 400 µg.m^{-3} NO_2 - 250 µg.m^{-3}

Signal **Regulation**: If the values of concentrations during 3 hours are above:

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

These limit values are assumed to be exceeded 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 purposes the concentrations and wind roses were evaluated for one station from west, middle and east part of Slovakia (Fig. 2.11).

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 (Tables 2.5–2.7).

Sulphur dioxide In the year 2007 in none agglomeration or zone the hourly or daily limit values were not exceeded in more cases than it is allowed. Limit value for signal regulation was exceeded one time at station Previdza, J. Holleho.

Nitrogen dioxide Annual limit value for protection of human health was exceeded at station Košice - Štúrova. however it was bellow limit values plus margin of tolerance.

PM_{10} In 2007 PM_{10} was monitored at 27 urban and suburban stations. Parallel measurements of $PM_{2.5}$ fraction were carried out at 3 stations. Air pollution by particulates PM_{10} is presently the major problem not only in Slovakia but also in most European countries. In the year 2007 the general decrease of PM_{10} air pollution level was observed at the whole territory. This was a result of favourable meteorological conditions in winter 2007, which was very mild. The average monthly temperatures in February 2007 were in some regions of 7 °C higher in comparison to the long term normal values. Despite of this the daily limit value was exceeded at 14 stations and at 4 from them also annual limit value as well.

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

Benzene In all monitored sites the air pollution level was bellow annual limit value 5 µg.m^{-3} which has to be met in the year 2010. The highest concentrations at stations Bratislava, Mamateyova and Trenčín, Hasičská reached 2,0 µg.m^{-3}.

Pb At present air pollution by lead does not represent a serious problem in the Slovak Republic and does not exceed the upper assessment threshold.

As, Ni, Cd In the year 2007 none of these pollutants exceeded the target value at any station.

BaP Based on the preliminary assessment the target value was exceeded at stations Veľká Ida-Letná, Prievidza-Malonecpalská a Krompachy-Lorenzova.

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
SO_2	1h	350 (24)	1/1/05	150 µg.m^{-3}	500	470	440	410	380	350					
SO_2	24h	125 (3)	1/1/05	-											
SO_2[e]	1r, W[1]	20 (-)	19/07/01	-											
NO_2	1h	200 (18)	1/01/10	50 %	300	290	280	270	260	250	240	230	220	210	200
NO_2	1r	40 (-)	1/01/10	50 %	60	58	56	54	52	50	48	46	44	42	40
NOx[e]	1r	30 (-)	19/07/01	-											
PM_{10}	24h	50 (35)	1/01/05	50 %	75	70	65	60	55	50					
PM_{10}	1r	40 (-)	1/01/05	20 %	48	46	45	43	42	40					
Pb	1r	0.5 (-)	1/01/05	100 %	1.0	0.9	0.8	0.7	0.6	0.5					
Pb[2]	1r	0.5 (1.0) (-)	1/1/10 (1/1/05)	100 %	1.0	1.0	0.9	0.9	0.8	0.8	0.7	0.7	0.6	0.6	0.5
CO	max. 8 hour daily value	10 000 (-)	1/1/2003 (1/1/2005)		16 000	16 000	16 000	14 000	12 000	10 000					
Benzene	1r	5 (-)	1/1/2006 (1/1/2010)	100 %	10	10	10	10	10	10	9	8	7	6	5

[1] *winter period (October 1 - March 31)*
[2] *only for specific point sources*
[e] *for protection of vegetation*
** allowed exceedances per year are in brackets*

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 (-)
NOx	Vegetation	1y	30 (-)	24 (-)	19,5 (-)
PM_{10}	Human health	24h	50 (35)	30 (7)	20 (7)
PM_{10}	Human health	1y	40 (-)	14 (-)	10 (-)
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 (-)

** allowed exceedances per year are in brackets*

	Interval of averaging	Target value [ng/m^3]	To be met by
As	1r	6	31.12.2012
Cd	1r	5	31.12.2012
Ni	1r	20	31.12.2012
BaP	1r	1	31.12.2012

Tab. 2.5 **Assessment of air quality according to limit values and limit values plus margin of tolerance (MT) in 2007**

	Pollutant	Protection of health													AT 2)	
		SO_2		NO_2		NO_2+MT		PM_{10}		*PM_{10}		CO	Ben-zene	Ben. +MT	SO_2	NO_2
	Time of averaging	1 hour	24 hour	1 hour	1 year	1 hour	1 year	24 hour	1 year	24 hour	1 year	8 hour 1	1 year	1 year	3 subsequent hour	3 subsequent hour
	Limit value [µg.m^{-3}] *(number of exceedances)*	350 *(24)*	125 *(3)*	200 *(18)*	40	230 *(18)*	46	50 *(35)*	40	50 *(35)*	40	10000	5	8	500	400
BRATISLAVA	Bratislava, Kamenné nám.							16	22.8	7	21.0					
	Bratislava, Trnavské mýto			0	36.9	0	36.9	38	29.1	24	25.9	1910	a 1.7	a 1.7		0
	Bratislava, Jeséniova			0	14.6	0	14.6	23	25.2	20	25.0					
	Bratislava, Mamateyova	0	0	0	24.7	0	24.7	26	23.6	22	22.9				0	0
KOŠICE	Košice, Štúrova			0	44.2	0	44.2	51	34.1	41	31.3	2673	2.0	2.0		0
	Košice, Strojárska							40	30.8	35	29.1					
Banská Bys-trica region	Banská Bystrica, Nám. slobody	0	0	0	23.0	0	23.0	57	35.4	46	32.9	2292	0.6	0.6	0	0
	Jelšava, Jesenského							78	37.4	76	36.9					
	Hnúšťa, Hlavná							72	37.7	68	37.0					
	Žiar nad Hronom, Dukelských hrdinov							25	29.5	22	29.0					
Bratislava region	Malacky, Sasinkova	b 0	b 0	b 0	b 26.0	b 0	b 26.0	b 28	b 33.6	b 27	b 33.6	b 1677	b 1.5	b 1.5	0	0
Košice region	Veľká Ida, Letná							145	48.2	143	47.6	2911				
	Strážske, Mierová							20	27.8	18	26.6					
	Krompachy, Lorenzova	0	0	0	27.4	0	27.4	31	30.0	28	28.8	a 2048	1.4	1.4	0	0
Nitra region	Nitra, J. Kráľa	0	0	0	23.3	0	23.3	29	26.7	22	25.4	2503	1.3	1.3	0	0
Prešov region	Humenné, Nám. slobody			0	28.3	0	28.3	15	27.3	13	26.1					0
	Prešov, Solivarská			0	19.4	0	19.4	32	30.2	25	27.9	2279	0.9	0.9		0
	Vranov nad Topľou, M. R. Štefánika	a 0	a 0					33	33.0	31	31.6				0	
Trenčín region	Prievidza, Malonecpalská	0	0					80	41.8	73	40.1				0	
	Bystričany, Rozvodňa SSE	8	1					48	33.4	46	33.0				6	
	Handlová, Morovianska cesta	0	0					41	29.8	38	29.4				0	
	Trenčín, Hasičská	0	0	0	29.1	0	29.1	47	31.9	38	29.6	2021	2.0	2.0	0	0
Trnava region	Senica, Hviezdoslavova	0	0					26	26.1	19	24.7				0	
	Trnava, Kollárova			0	37.0	0	37.0	35	28.0	27	26.2	2778	1.3	a 1.3		0
Žilina region	Martin, Jesenského			0	25.6	0	25.6	92	41.8	80	38.5	2445	1.8	1.8		0
	Ružomberok, Riadok	0	0					135	50.9	128	48.7				0	
	Žilina, Obežná			0	20.9	0	20.9	81	38.5	75	36.9					0

1) *maximal 8 hour value of moving average* 2) *alert threshold limit values*

Pollutants which exceeded limit values are in bold

Data coverage: [grey] > 90%, a 75–90 %, b 50–75 %, c < 50 % of valid values

Tab. 2.6 **Assessment of air quality according limit values, limit values plus margin of tolerance (MT) and target values**

	Pollutant	Pb					As				
	Year	2003	2004	2005	2006	2007	2003	2004	2005	2006	2007
	Limit value [ng.m⁻³] **+ MT**	700	600	500	500	500					
	Target value [ng.m⁻³]								6.0	6.0	6.0
	Upper assessment threshold [ng.m⁻³]			350	350	350			3.6	3.6	3.6
	Lower assessment threshold [ng.m⁻³]			250	250	250			2.4	2.4	2.4
BRATISLAVA	Bratislava, Mamateyova 1)	43	27	31	18	10	2.5	0.9	1.7	1.1	0.7
Banská Bystrica region	Banská Bystrica, Námestie slobody 1)	50	54	58	55	43	7.1	4.5	5.1	3.6	2.4
Košice region	Veľká Ida, Letná 1)	150	127	67	46	54	3.1	2.2	2.6	1.7	1.8
	Krompachy, Lorenzova 1)	145	186	97	138	121	11.3	13.0	**6.4**	4.7	4.3
Prešov region	Stará Lesná, AÚ SAV, EMEP 1)	10	8	8	9	6	1.1	0.7	0.7	0.7	0.5
	Starina, Vodná nádrž, EMEP 1)	14	13	12	11	8	0.8	0.6	0.7	0.8	0.5
Trenčín region	Prievidza, J. Hollého / Malonecpalská 1)	19	14	19	18	12	9.0	8.3	5.6	**7.9**	5.3
Trnava region	Topoľníky, Aszód, EMEP 3)	18	12	14	13	11	2.1	1.0	1.0	1.0	0.8
Žilina region	Chopok, EMEP 2)	3	2	2	3	2	0.2	0.2	0.2	0.2	0.1
	Ružomberok, Riadok 1)	17	15	17	20	18	5.6	5.5	4.0	5.0	2.6

	Pollutant	Cd					Ni				
	Year	2003	2004	2005	2006	2007	2003	2004	2005	2006	2007
	Limit value [ng.m⁻³] **+ MT**										
	Target value [ng.m⁻³]			5	5	5			20	20	20
	Upper assessment threshold [ng.m⁻³]			3	3	3			14	14	14
	Lower assessment threshold [ng.m⁻³]			2	2	2			10	10	10
BRATISLAVA	Bratislava, Mamateyova 1)	1.6	0.3	0.4	0.3	0.2	2.4	2.1	2.9	1.9	1.3
Banská Bystrica region	Banská Bystrica, Námestie slobody 1)	1.3	1.4	1.3	1.2	1.0	1.1	2.0	4.4	5.6	1.7
Košice region	Veľká Ida, Letná 1)	5.2	3.1	1.9	1.1	1.1	2.3	1.9	2.3	1.6	1.8
	Krompachy, Lorenzova 1)	2.3	2.9	2.7	2.6	1.3	1.1	1.8	2.8	3.6	1.6
Prešov region	Stará Lesná, AÚ SAV, EMEP 1)	0.3	0.3	0.2	0.2	0.2	0.7	0.8	0.5	0.5	0.4
	Starina, Vodná nádrž, EMEP 1)	0.5	0.5	0.4	0.3	0.3	0.7	0.7	0.8	0.7	0.6
Trenčín region	Prievidza, J. Hollého / Malonecpalská 1)	0.5	0.4	0.5	0.4	0.3	1.2	1.6	1.4	1.0	1.3
Trnava region	Topoľníky, Aszód, EMEP 3)	0.5	0.3	0.3	0.3	0.3	1.9	1.1	1.0	3.0	1.2
Žilina region	Chopok, EMEP 2)	0.1	0.1	0.1	0.1	0.05	0.8	0.6	0.6	0.6	0.4
	Ružomberok, Riadok 1)	0.4	0.4	0.5	0.5	0.4	1.3	3.4	1.5	1.5	1.3

1) *from PM_{10}* 2) *from TSP* 3) *2003-2006 from TSP, 2007 from PM_{10}*

Tab. 2.7 **Assessment of air quality according target value for BaP in 2007**

	Component	BaP
	Limit value [ng.m⁻³]	1.0
	Upper assessment threshold [ng.m⁻³]	0.6
	Lower assessment threshold [ng.m⁻³]	0.4
BRATISLAVA	Bratislava, Trnavské mýto	0.38
	Bratislava, Jeséniova	0.36
Košice region	Veľká Ida, Letná	**2.15**
	Krompachy, Lorenzova	**1.47**
Trenčín region	Prievidza, J. Hollého	**1.41**
Trnava region	Trnava, Kollárova	0.60

AMBIENT AIR

3

ATMOSPHERIC OZONE

3.1 ATMOSPHERIC OZONE

Most of the atmospheric ozone (approximately 90 %) is in the stratosphere (11–50km), 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 2007 was only slightly 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 2002–2007

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 478/2002 Coll. on air protection, that in accordance with EU legislation have to be fulfilled to 2010, and information and alert thresholds. If ground level ozone concentration exceeds some of the threshold values the population has to be informed or warned.

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

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

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

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

Assessment of ground level ozone in Slovakia during 2002–2007

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 2007 the number of missing data did not exceed 10 % at all stations (Tab. 3.2). Large gaps were only at the Humenné, Jelšava and Starina stations.

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

Station	2002	2003	2004	2005	2006	2007
Bratislava, Jeséniova	3.0	2.5	2.2	5.8	16.8	0.6
Bratislava, Mamateyova	1.6	3.6	2.7	6.3	2.3	0.8
Humenné, Nám. slobody	2.5	1.9	0.3	0.3	10.3	9.5
Jelšava, Jesenského	8.2	4.1	0	0.3	8.2	5.0
Košice, Ďumbierska	4.1	1.4	0.5	8.6	44.4	1.1
Prievidza, J. Hollého	10.4	2.7	2.2	13.2	2.0	1.9
Žilina, Obežná	6.8	2.7	0.3	0.5	0.5	1.0
Gánovce, Meteo. st.	4.7	1.4	24.9	15.9	7.8	0.01
Chopok, EMEP	6.0	45.5	9.6	1.9	29.0	1.0
Kojšovská hoľa	1.1	9.9	1.1	9.9	6.3	0.7
Stará Lesná, AÚ SAV, EMEP	0.8	4.7	0.5	0.3	10.9	0.2
Starina, Vodná nádrž, EMEP	0.5	2.2	17.3	7.1	24.8	6.6
Topoľníky, Aszód, EMEP	1.1	1.4	3.6	6.6	1.7	1.4

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

Station	2002	2003	2004	2005	2006	2007
Bratislava, Jeséniova	56	71	64	68	66	59
Bratislava, Mamateyova	49	53	48	53	50	49
Humenné, Nám. slobody	56	66	58	60	62	56
Jelšava, Jesenského	48	55	51	52	55	56
Košice, Ďumbierska	64	68	60	67	*49	57
Prievidza, J. Hollého	43	51	47	46	46	48
Žilina, Obežná	46	48	42	41	44	44
Gánovce, Meteo. st.	59	68	66	67	68	60
Chopok, EMEP	97	*109	91	95	*96	91
Kojšovská hoľa	86	91	86	86	84	79
Stará Lesná, AÚ SAV, EMEP	56	67	62	70	73	68
Starina, Vodná nádrž, EMEP	64	73	66	66	*62	62
Topoľníky, Aszód, EMEP	47	67	59	60	60	58

** 50–75% of valid measurements*

In 2007, the annual average concentrations of ground level ozone in urban and industrial locations of Slovakia ranged within the interval 44–59 μg.m^{-3} (Tab. 3.3). The concentrations in the rest of the territory ranged between 58 and 91 μg.m^{-3}, mainly depending on the altitude. The highest annual average of ground level ozone concentrations was reached at the summit station Chopok (91 μg.m^{-3}). The effect of ozone from the accumulation zone (800–1500 m over the ground) over the Europe is evident. The year 2007, according to vegetation period averages, belongs to the photochemically active years. Annual averages of ground level ozone concentration in 2007 were slightly lower than in record year 2003.

In Figure 3.1, the seasonal cycle of daily ozone concentrations in Stará Lesná during 1992–2007 is depicted. The seasonal course is typical for lowlands and valley (not summit) positions of industrial continents. Original spring maximums of ozone concentrations, associated with the transport of ozone from upper atmospheric layers, is extended for the whole summer period, as a consequence of photochemical ozone formation in a atmospheric boundary layer.

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

The number of exceedances of ozone threshold values in Slovakia during 2002–2007 is summarised in Tables 3.4–3.6. The alert threshold when the public must be warned (240 µg.m^{-3}) was exceed only once in 2007 (Tables 3.4). The information threshold to the public (180 µg.m^{-3}) in 2007 was exceeded at six stations, most frequent in both Bratislava stations.

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 2005 –2007. The target value not to be exceeded on more than 25 days per calendar year averaged over three years. In 2005–2007 was the number of 25 days overstepped at thirteen monitoring stations. The highest exceedance was observed at Chopok station (65 days) and Kojšovská hoľa (66 days).

Fig. 3.1 **Seasonal variability of ground level ozone concentration in Stará Lesná during 1992–2007**

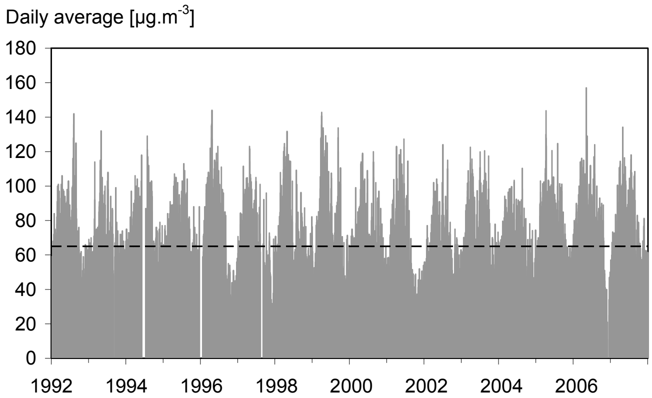
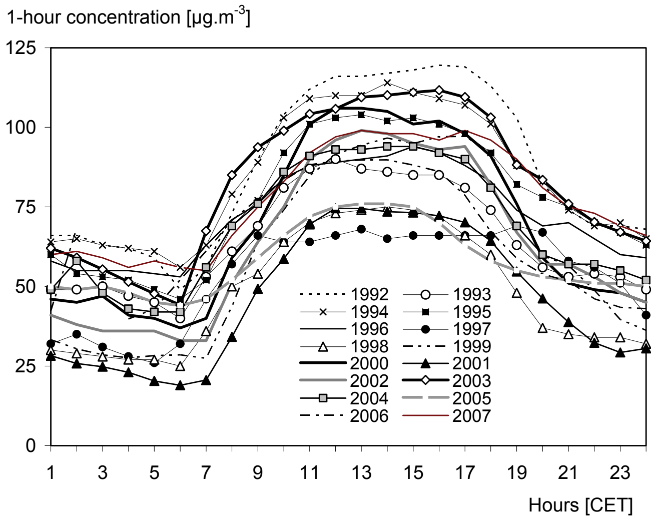


Fig. 3.2 **Average daily cycles of ground level ozone concentration in Stará Lesná, in August 1992–2007**



Tab. 3.4 **Number of exceedances of ozone information threshold (IT) and alert threshold (AT) to the public during 2002–2007**

Station	AT = 240 µg.m^{-3}						IT = 180 µg.m^{-3}					
	2002	2003	2004	2005	2006	2007	2002	2003	2004	2005	2006	2007
Bratislava, Jeséniova	0	3	0	0	0	0	0	42	0	6	19	10
Bratislava, Mamateyova	0	3	0	0	0	1	0	32	0	8	11	17
Humenné, Nám. slobody	0	0	0	0	0	0	0	0	0	0	1	0
Jelšava, Jesenského	0	0	0	0	0	0	0	5	0	0	3	6
Košice, Ďumbierska	0	0	0	0	0	0	0	0	2	0	0	0
Prievidza, J. Hollého	0	0	0	0	0	0	0	0	0	0	0	1
Žilina, Obežná	0	0	0	0	0	0	0	0	0	0	8	0
Gánovce, Meteo. st.	0	0	0	0	0	0	0	0	0	0	0	0
Chopok, EMEP	0	0	0	0	0	0	2	3	1	0	1	0
Kojšovská hoľa	0	0	0	1	0	0	0	0	0	2	1	2
Stará Lesná, AÚ SAV, EMEP	0	0	0	0	0	0	0	0	0	0	1	0
Starina, Vodná nádrž, EMEP	0	0	0	0	0	0	0	0	0	0	3	0
Topoľníky, Aszód, EMEP	0	0	0	0	0	0	0	18	0	0	0	4

Tab. 3.5 **Number of exceedances of ozone target value for protection of human health (8 h average 120 μg.m^{-3}) during 2005–2007**

Station	2005	2006	2007	Average 2005–2007
Bratislava, Jeséniova	52	50	31	**44**
Bratislava, Mamateyova	42	34	37	**38**
Humenné, Nám. slobody	41	35	31	**36**
Jelšava, Jesenského	13	31	50	**31**
Košice, Ďumbierska	33	*0	20	**26**
Prievidza, J. Hollého	12	18	21	17
Žilina, Obežná	19	30	40	**30**
Gánovce, Meteo. st.	29	39	25	**31**
Chopok, EMEP	77	*53	66	**65**
Kojšovská hoľa	59	63	74	**66**
Stará Lesná, AÚ SAV, EMEP	30	44	36	**37**
Starina, Vodná nádrž, EMEP	39	*27	18	**28**
Topoľníky, Aszód, EMEP	47	41	46	**45**

** 50–75% of valid measurements*

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 all urban background and regional background stations (with the exception of Prievidza).

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	2005	2006	2007	Average 2003–2007
Bratislava, Jeséniova	26278	32180	20654	25322
Bratislava, Mamateyova	23398	23968	22900	20775
Humenné, Nám. slobody	21575	26739	21608	22150
Jelšava, Jesenského	17543	22732	25987	21440
Košice, Ďumbierska	20028	–	18397	*19963
Prievidza, J. Hollého	15948	15044	17466	15580
Žilina, Obežná	15069	26498	21891	19252
Gánovce, Meteo. st.	20565	25550	19028	22360
Chopok, EMEP	30514	33118	26477	30777
Kojšovská hoľa	23565	31802	29146	26506
Stará Lesná, AÚ SAV, EMEP	19123	25258	20505	18800
Starina, Vodná nádrž, EMEP	15209	–	19320	*19531
Topoľníky, Aszód, EMEP	23065	27430	26102	25863

* *data from 2006 are not included in the average, because of the station's missing valid measurements in the summer time interval*

– station did not measure in monitored interval

It may be stated in conclusion, that in the extremely warm, dry and photochemical active year 2003 the highest values of the most ground level ozone indicators in Slovakia were observed from the beginning of observations (since 1992). This reality is to some extend surprising taking into account a massive decrease of anthropogenic precursor emissions (NOx, VOC and CO) in Slovakia (already below Gothenburg ceilings) and in Europe as well during the last 10–15 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 2007 was in average close below the 2003 level.

3.3 TOTAL ATMOSFERIC OZONE OVER THE TERRITORY OF THE SLOVAK REPUBLIC IN 2007

Since August 1993 total atmospheric ozone over the territory of Slovakia has been measured with the Brewer ozone spectrophotometer MKIV #097 in the Centre of Aerology and Ozone Measurements of the Slovak Hydrometeorological Institute (SHMI) at Gánovce near Poprad. 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 regularly 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 via the SR Press Agency and by mobile phone service. Since April 2000 the SHMI Centre of Aerology and Ozone Measurements has been providing 24 hour UV Index forecast for the public. During the period March 15 – September 30 predicted UV Index daily course for clear day, half covered sky and overcast is presented on the SHMI Web site: (www.shmu.sk/ozon/).

The annual mean of the total atmospheric ozone was 325.7 Dobson Units in 2007. This is 3.7 % below the long-term average (calculated upon the Hradec Kralove measurements in the period 1962–1990).

Since 1994 annual means measured at Poprad-Ganovce station have been available. The 1994–2007 long-term average is 326.4 Dobson units. In mentioned period the year 2007 is close to average. In comparison with the year 2006 the annual mean was higher by 0.3 %.

Total ozone statistics for the year 2007 (daily means, relative deviations from long term averages, monthly means, standard deviations and extremes) are in Table 3.7. Gaps in February and March data are caused by instrument failure. In period 13–18 May the instrument took part in calibration campaign in Hradec Kralove.

The monthly mean below an average was observed from January to August, in the rest of year it was slightly above the average. The most significant negative monthly deficiencies of –7 % were in April and July and in May and June (–6 %). A big variability in total ozone is typical for winter months. Frequent changes of positive and negative deviations depend on prevalent atmospheric conditions.

Total ozone weekly averages are in Figure 3.3. The graph illustrates a behaviour of the ozone layer in the year 2007 and shows significant short-term variations in total ozone amount in our geographical region. Solar ultraviolet radiation has many biological effects. If UV exceeds some critical limits it can be very harmful. An active band of 290–325 nm which is significantly influenced by the total ozone amount in the atmosphere is indicated as UV-B radiation. To calculate an UV-B irradiance caused a particular biological effect indicated as the effective irradiance, wavelength-depending weighting factor to the spectral irradiance is applied. To express a detrimental effect on human health CIE Erythemal action spectrum is most frequently used. McKinlay and Diffey derived the erythemal action spectrum in 1987.

It is internationally accepted and indicated as CIE (Commission Internationale de l´Eclairage). All values of solar ultraviolet radiation shown in this text and graphs are modified by CIE erythemal action spectra.

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. During a day of clear sky daily UV-B maximum should be measured. A significant scattering of values demonstrates the weather condition influence. Clouds depending on their optical depth can significantly reduce the UV irradiance. As the UV irradiance depends on the solar elevation it has a distinctive daily and annual course. UV-B values in winter are more than 10-times lower as compared to summer. Comparable attenuation is also caused by cloudiness and precipitation in summer. After filtering of cloud, precipitation and aerosol influence the annual course is not symmetrical by solstices. Decreased annual course of total ozone causes the highest UV irradiance after solstice in last decade of June and early July.

Fig. 3.3 **Total Atmospheric Ozone over the Territory of Slovakia in 2007**

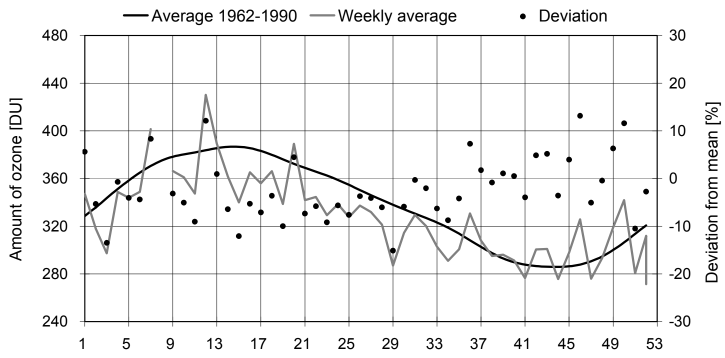


Fig. 3.4 **Annual Course of CIE Effective Irradiance Noon Values Gánovce 2007**

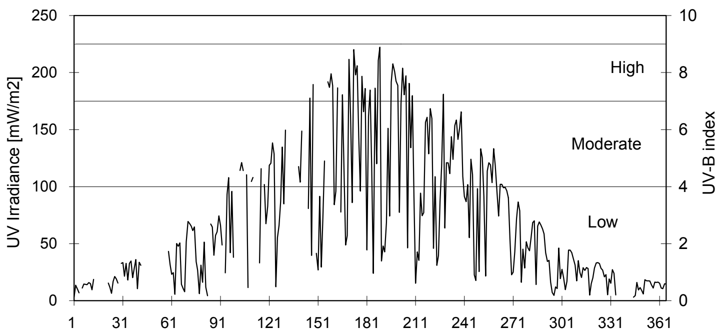
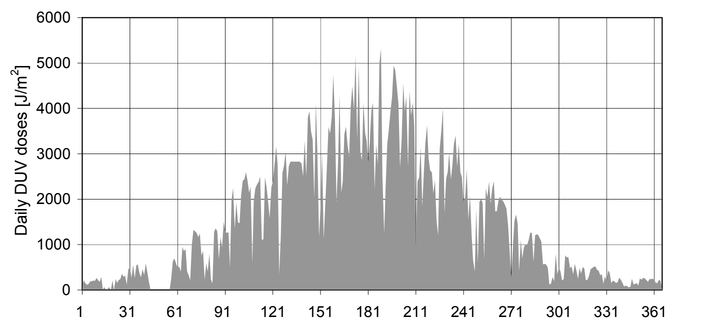


Fig. 3.5 **Annual Course of CIE Daily Doses – Gánovce 2007**



The UV Index is also shown in Figure 3.4. It is a unit to simply express 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. 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 7 attained in spring and summer months are classified as high. The sun exposure without protection should be limited to several minutes. Values below 4 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 Erythema 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. 1 MED/hour corresponds to 0.0583 W/m^2 for 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 SHMI Web site.

Tab. 3.7 **Total atmospheric ozone [DU] in 2007 and the deviations from long-term average**

Day	I		II		III		IV		V		VI		VII		VIII		IX		X		XI		XII	
	O_3	RO	O_3	RO	O_3	RO	O_3	RO	O_3	RO	O_3	RO	O_3	RO	O_3	RO	O_3	RO	O_3	RO	O_3	RO	O_3	RO
1	274	–16	368	3	381	1	398	3	376	–1	346	–5	326	–7	337	2	305	–2	287	–1	262	–8	253	–14
2	312	–4	304	–16	411	8	366	–5	368	–3	374	3	328	–6	306	–7	315	1	279	–4	266	–7	305	3
3	416	27	374	4	397	5	341	–12	332	–13	339	–7	342	–1	308	–7	308	–1	302	4	263	–8	323	9
4	374	14	342	–5	364	–4	439	14	351	–7	324	–11	340	–2	356	8	340	10	289	0	299	4	325	9
5	398	21	335	–8	349	–8	347	–10	407	7	318	–13	365	6	319	–3	360	16	289	0	298	4	303	1
6	329	–1	359	–1	365	–4	326	–16	350	–8	331	–9	341	–1	320	–3	321	4	300	4	298	4	278	–7
7	326	–2	353	–3	354	–7	344	–11	354	–6	338	–7	310	–10	327	0	347	13	294	2	294	3	315	5
8	347	4	362	–1	353	–7	369	–5	340	–10	323	–11	297	–14	329	0	309	1	267	–7	283	–1	330	9
9	285	–15	329	–10	360	–5	348	–10	360	–4	331	–9	289	–16	315	–4	331	8	273	–5	285	–1	359	19
10	280	–16	333	–9	394	3	356	–8	337	–10	341	–6	307	–11	310	–5	316	4	280	–3	316	10	333	10
11	331	–1	372	1	353	–7	330	–15	324	–14	334	–7	344	0	318	–2	337	11	278	–4	309	8	344	13
12	378	12	449	22	321	–16	331	–15	317	–16	337	–6	362	6	323	–1	324	7	270	–6	331	15	364	19
13	298	–12	354	–4	326	–15	338	–13			335	–7	340	0	335	3	298	–2	293	2	335	17	316	3
14	306	–10			334	–13	329	–15			336	–6	304	–11	311	–4	296	–2	276	–4	331	15	344	12
15	314	–8			353	–8	348	–10			347	–3	303	–11	304	–6	303	1	275	–4	324	13	355	15
16	307	–10			339	–11	359	–7			337	–6	288	–15	282	–13	281	–6	282	–2	348	21	337	9
17	305	–11			397	4	349	–10			344	–4	286	–16	276	–14	279	–7	283	–1	329	14	294	–5
18	288	–16			363	–5	364	–6			336	–6	288	–15	310	–4	294	–2	288	0	282	–2	277	–11
19	310	–10					363	–6	407	9	328	–8	284	–16	303	–6	300	1	322	12	264	–9	267	–14
20	278	–20			429	12	373	–3	372	0	322	–9	287	–15	305	–5	307	3	329	15	265	–9	291	–7
21	278	–20					377	–2	357	–4	318	–10	290	–14	317	–1	293	–1	325	13	281	–3	254	–19
22	314	–10			476	24	370	–4	351	–5	311	–12	285	–15	286	–10	297	0	320	12	271	–7	265	–16
23	301	–14			449	17	342	–11	351	–5	346	–2	316	–6	273	–14	296	0	296	3	273	–6	317	0
24	349	0					368	–4	339	–8	333	–6	303	–10	274	–14	297	1	304	6	273	–6	292	–8
25	360	2			367	–5	380	–1	340	–8	325	–8	342	2	297	–7	296	1	319	12	306	5	303	–5
26	374	6	342	–9	373	–3	366	–4	328	–11	322	–8	311	–7	284	–10	282	–4	285	0	340	16	306	–4
27	392	11	352	–7	392	2	351	–8	327	–11	352	0	311	–7	282	–11	293	0	294	3	358	22	325	1
28	351	–1	318	–16	394	2	336	–12	325	–11	345	–1	304	–9	290	–8	303	4	288	1	239	–19	336	5
29	420	18			412	7	349	–9	330	–10	345	–1	316	–5	299	–5	308	6	274	–4	250	–15	313	–3
30	290	–19			377	–2	379	–1	356	–3	347	–1	339	2	314	0	294	1	279	–2	308	4	307	–5
31	309	–14			378	–2			343	–6			342	3	299	–4			286	0			317	–3
Ø	329	–4	353	–4	377	–1	358	–7	350	–6	335	–6	316	–7	307	–5	308	2	291	1	296	2	311	1
Std	42	12	31	9	35	9	23	6	23	6	12	4	24	7	20	5	19	5	17	6	31	11	29	10
Max	420	27	449	22	476	24	439	14	407	9	374	3	365	6	356	8	360	16	329	15	358	22	364	19
Min	274	–20	304	–16	321	–16	326	–16	317	–16	311	–13	284	–16	273	–14	279	–7	267	–7	239	–19	253	–19

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

4

EMISSION AND AIR POLLUTION SOURCE INVENTORY

4.1 EMISSION AND AIR POLLUTION SOURCE INVENTORY

Anthropogenic emissions of pollutants into 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:

- the information of the responsible bodies, expert and lay public,
- the definition of environmental priorities and identification of causes of problems,
- the assessment of environmental impact on different plans and strategies,
- the assessment of environmental costs and benefits on different approaches,
- the monitoring of effect, respective effectiveness of adopted measures,
- the support by agreement with adopted commitments.

STATIONARY SOURCES

Information related to stationary sources of air pollution was in period 1985–1999 compiled according the Air act No 35/1967 in system EAPSI (Emission and Air Pollution Source Inventory). This system was divided according to 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)

According to the changes in the air protection legislations the amendment of EAPSI was not occurring, therefore was created the new module NEIS (National Emission Inventory System) in 1997 in the frame of project of the Ministry of Environment in coordination with SHMI and close cooperation with the regional offices, district offices and selected operators. The NEIS software product is constructed as a multi-module system, corresponding fully to the requirements of current legislation in air protection. Module NEIS BU enables the execution of complex data acquisition and their processing in respective district offices, as well as carrying out the logical control on correctness of emission calculation on input data and provides the decision about the height of tax. It enables the feeding of the input data on sources exclusively in a way corresponding to the legislation. Data acquisition is carried out by a set of questionnaires, but it is possible also to use software module NEIS PZ, which also enables filling the questionnaires in electronic form and also emission calculation and data feeding from respective operators into the NEIS BU district databases. Data from district databases are then fed into the NEIS CU central database. NEIS employs the support of standard database products MS ACCESS and MS SQL server.

The function of system was attested during preliminary testing in the selected regions within all area of the Slovak Republic and the system was accepted by interdepartmental 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. In this context also the system has been renamed on National Emission Information System.

Positive contribution of 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.
- Better 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 NEIS exclusively in coincidence with the legislative regulations.
- Establishment of a Slovak national database that enables the top state administration bodies to fulfil the tasks optimally at all levels and provides the input data for international emission inventories, respectively compilation of special emission inventories.
- Information available on the Internet website www.shmu.sk
- Establishment of air pollution 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 source, change in categorization of sources and their division upon the output caused that the EAPSI system may be compared with the NEIS module only on the national level. Comparison of the individual parts of EAPSI (EAPSI 1and EAPSI 2) with the NEIS module (large, medium-size sources), respectively comparison of individual sources in both systems is difficult.

According to the Act No 478/2002 Act. Coll. as amended, the district offices are obliged to elaborate yearly reports about the operational characteristics of air pollution sources in their district and provide them electronically at the latest till May 31 of the current year for the next processing to SHMI, the organization accredited by the Ministry of Environment to manage the central database NEIS CU and provide the data processing at the national level (Bulletin of MoE No 6/2000).

The NEIS system includes the sources of air pollution, which are assigned following the input and category according to the Decree No 706/2002, Act. Coll.

Large sources	Stationary sources containing stationary combustion units having cumulative heating input over 50 MW and other processes

Middle sources	Stationary sources containing stationary combustion units having cumulative heating input 0.3–50 MW and other processes

Small sources	Stationary equipment – domestic heating equipment for combustion of fuels (solid, natural gas) with heating input less than 0.3 MW (According to the Decree of MoE SR No 53/2004)

Results 1990–2007 – evaluation

Large sources

REZZO 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. the area-administrative units, defined according to the organisation inventory number, were in operation. 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, NOx, 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. New system contained 866 large point sources from 79 the NEIS BU district databases in 2006. 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 difficult.

Middle sources

REZZO 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 2006 system NEIS registered 12 287 medium sources from 79 the NEIS BU district database. 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 difficult.

Small sources

REZZO 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 in sense of the Decree No 144/2000, since 2004 in sense of the Decree No 53/2004), consumption of natural gas for the inhabitants (register of SPP, a.s) and respective 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 1990–2006 have been obtained.

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

MOBILE SOURCES

Emissions from mobile sources were estimated since 1990 each year until 2006. The emissions from road transport were estimated using model COPERT III[2], which is the model recommended by expert panel of UNECE Convention on long-range trans-boundary air pollution[3]. This methodology is used for different vehicle categories with available technical data and country specific parameters. The characteristics parameters are fleet composition, age of vehicles, character of operation or climate conditions. The model estimation is based on five main types of input parameters: the total fuel consumption, vehicle fleet, driving mode, emission factors and others parameters.

In addition to the road transport the emissions for non-road transport (railways, shipping and aviation transport) were estimated since 1990-2006. EMEP/CORINAIR[4] Guidebook for the non – road sources methodology was used for the railways transport emission estimation with application average emissions factors.

The emission inventory for aviation transport was estimated according to the local pollution from the important airports in the Slovak Republic. The operation information and statistical date can be used for estimation. The movements of aircrafts, LTO cycles, fuel consumption or fuel sold were used for the estimation every year.

The emission balance of PM_{10} and $PM_{2.5}$ from road transport was completed for the first time in 2004 back to the base year 1990. According to the requirements of the updated method EMEP/CORINAIR[5] and to the requirement for reporting of these emissions for UNECE (NFR[6]) the emissions from exhausts of gasoline engines and abrasive emissions (abrasion of road surface, tyres and brake facing) were evaluated. The method and emission factors were recommended by the TNO-MEP agency (The environmental agency of Netherlands). The results of PM_{10} and $PM_{2.5}$ emissions from road transport are summarized in Tables 4.2a and 4.2b.

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 and SO_2

Emissions of particulate matter and sulphur dioxide have been decreasing continuously since 1990. Apart from the decrease in energy production and consumption, 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. A further spreading of separation techniques used, respectively advancing of its effectiveness shared in the particulate matter emission reduction. The downward trend of sulphur dioxide emissions up to 1996 continued also in 2000 and was caused by the decreasing consumption of brown coal, hard coal, heavy fuel oil, use of low-sulphur fuel oil (Slovnaft Ltd., Bratislava) and installation of the desulphurisation systems for the large power sources (Power plants in Zemianske Kostoľany and Vojany). The fluctuations of

[2] http://lat.eng.auth.gr/copert
[3] http://www.unece.org/env/lrtap/
[4] http://reports.eea.europa.eu/EMEPCORINAIR5/
[5] *Emission Inventory Guidebook – 3rd edition*
[6] *New format for reporting*

SO_2 emissions within 2001 and 2003 were caused either by their partial or total operation, or by the quality of combustion fuel and volume of production. In 2004, 2005 and 2006 the decrease of SO_2 emissions was recorded mainly at large sources. This decrease was caused mainly by the combustion of low-sulphur-content fuel oils and coal (Slovnaft Ltd., Bratislava, TEKO Ltd., Košice) and by the reduction of volume production (Power plants in Zemianske Kostoľany and Vojany). 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 price for natural gas and coal. 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). In 2006 the decrease of particulate matter emissions was achieved mainly by reconstruction of separators in some sources of energy and industry (Power plants in Zemianske Kostoľany, U.S. Steel Ltd., Košice). The decrease of the particulate matter and SO_2 emissions in 2007 for the large stationary sources was caused by the giving of several sources out of operation (Power plants in Vojany)

Oxides of nitrogen

Emissions of nitrogen oxides have showed a smooth decrease since 1990. A slight emission increase in 1995 was associated with the increase in consumption of natural gas. A decrease of emissions of nitrogen oxides in 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 NOx emissions. The further emissions decrease in years 2002 and 2003 was caused by denitrification process (Power plant Vojany). In 2006 nitrogen oxides emissions decreased mainly at large and middle stationary sources. This decline relates with reduction of production (Power plants in Zemianske Kostoľany and Vojany) and consumption of solid fuel and natural gas (Power plants in Zemianske Kostoľany, Slovak Gas Industry Ltd. Nitra). Significant decline of nitrogen oxides emissions was achieved in mobile sources, mainly in the road transport. This decrease connected with reduction of consumption liquid hydrocarbons fuels as in 2005 and renovation of vehicles fleet.

CO

A downward trend in carbon monoxide emissions since 1990 has been caused mainly by the decrease in consumption and by the change of fuel composition in the sphere of retail consumers. Carbon monoxide emissions originating from combustion processes of the major sources have been slightly decreasing, as well. The iron and steel industry participate most significantly in the total carbon monoxide emissions from major sources. Carbon monoxide emission's decrease in 1992 was due to a decrease in iron and steel production volume. In 1993, when the iron and steel production increased again, reaching the 1990 level, the carbon monoxide emissions increased proportionally. A decrease in carbon monoxide emissions in 1996 was due to the effects of measures (determined on the results of measurements) being taken to limit carbon dioxide emissions in the most important source in this sector. The fluctuation of CO emissions within 1997 and 2003 is connected also with the quantity of pig iron production as well as the fuel consumption. In 2004 the CO emissions slightly increased mainly at large sources (the amount of CO emissions specified upon the continuous measurement in U.S. Steel Ltd., Košice). The emission decrease in the sector road transport within 2004–2005 is associated with onward renovation of vehicle fleet by the generational new vehicles equipped by the three-way catalysts. In 2005, the decrease of CO emissions was announced at large sources too, mainly as a consequence of agglomerate production cutting down in U.S. Steel Ltd., Košice and by implementation of a new technology with effective combustion at lime production (Dolvap Ltd., Varín). In 2005 the CO emission increase was achieved only in the sector small sources (residential) and it is related with the increase of wood as fuel caused by price increase for natural gas and coal. In 2006, the trend of total CO emissions decrease continued mainly in the sector mobile sources due to the consumption of liquid hydrocarbon fuels decreased in the road transport in comparison with 2005 and renovation of vehicle fleet. The increase of CO emissions despite of total decrease emissions was achieved only at large stationary sources in 2006, where the increase was influenced significantly by sector iron and steel production in consequence of increase of fuel consumption.

EMISSIONS OF OTHER POLLUTANTS

The Slovak Republic is bound by the Convention on Long Range Transboundary Air Pollution to provide inventory of the selected pollutants. The emission inventories of non-methane volatile organic compounds (NMVOC), heavy metals (HM), persistent organic pollutants (POPs) and particulate matter with aerodynamic diameter less than 10 or 2.5 µm (PM_{10} or $PM_{2.5}$) are processed in accordance with the international methodology using the SNAP 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 others are transformed into the international NFR system according to the requirements for reporting and annually reported to the UNECE secretariat through the Ministry of Environment of the SR.

NMVOC

Emission inventory of NMVOC is elaborated according to Joint EMEP/CORINAIR Atmospheric Emission Inventory Guidebook. In 2001 a new subsector road paving with asphalt was included in the national emission inventory and the emissions adequate increased in each years by this consequence. In 2004 the emission factor from mentioned sector was revalued and changed. The previous emission factor was based on highest emission production. New emission factor respects that asphalt mixture contains 5.5 % of asphalt and others is create by aggregate. The combustion of wood was included in the sector residential for the first time in 2004. Emissions increased slightly in mentioned sector. In the sector fuel distribution was included LPG distribution since 2001. The NMVOC emissions have decreased since 1990 according to the general balance. This development was caused by decreased consumption of solvent based paints and the step-by-step introduction of low solvent paint, broad introduction 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 (Table 4.7, Figure 4.4). The NMVOC emissions increased in sector use of paints and glues about 47 % since 2000 in consequence of industrial production increasing especially in engineering but also increasing of print's ink consumption and import of solvent paints.

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 to meet its obligations under the Stockholm Convention on Persistent Organic Pollutants,* and updated according to the *Standardized Toolkit for Identification and Quantification of Dioxin and Furan Releases, UNEP Chemicals, February 2005* and methodologies used in the Czech Republic and Poland. Emissions of polychlorinated dioxins and furans (PCDD/F) and polycyclic aromatic hydrocarbons (PAH) from road transportation were calculated by model COPERT III.

Downward trend of POPs emissions to the air is the most remarkable at PAH emissions in the 90-ties, when it was caused mostly by change of technology of aluminium production (use of pre-baked anodes) (Table 4.8, Figure 4.5). Increased emissions of polychlorinated biphenyls (PCB) were influenced by the increasing of consumption in crude oil in the road transport and using wood in residential sector. Increased consumption of wood in this sector influenced also total emission of PAHs. Emissions of PCDD/F have declined since 2000 because of reconstruction of some technologies (for example municipal waste incinerators). In 2005 emissions of PCDD/F increased because of increased amount of incinerated medical waste. In 2006, amount of incinerated medical waste slightly decreased and agglomeration of iron ore slightly increased. In comparison with 2005, the share of different fuels in residential sector remained nearly without changes. As a result of all these factors, total emissions PCDD/F decreased, hexachlorbenzene (HCB) slightly increased and PCB and PAH slightly decreased.

HMs

Emission inventory of heavy metals is elaborated according to the Joint EMEP/ CORINAIR Atmospheric Emission Inventory Guidebook. In 2004 was included combustion of wood the sector residential and emissions since 1990 were revised. Heavy metals emissions markedly decreased compared to emission value from year 1990. Beside 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, a change of raw materials used and in particular by the elimination of leaded petrol (Table 4.10, Figure 4.7) since 1996. The Pb emissions increased since 2004 in consequence of increasing of production in sector ore agglomeration and copper production.

PM_{10}, $PM_{2.5}$

Emissions of PM_{10} and $PM_{2.5}$ are processed annually on the base of requirements of UNECE Task Force on Emission Inventory, starting from the base year 2000. Emissions of PM_{10} and $PM_{2.5}$ are elaborated from amount of TSP according to methodology US EPA AP 42,[7] Polish methodology gives exhaust emissions from the petrol engines and abrasion, while other emissions of road transportation are calculated by model COPERT III. 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 (Tables 4.2 a, b). The most important contribution to total emissions of PM_{10} and $PM_{2.5}$ has 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. (Table 4.9, Figure 4.6).

Share of individual sectors in total emissions of the Slovak Republic in the year 2007

Figure 4.2 represents the contribution of stationary and mobile sources to air pollution. The graphs show that the share of traffic in air pollution by oxides of nitrogen and carbon monoxide is significant. On the other hand, combustion processes and industry do contribute to air pollution mainly by oxides of sulphur and particulate matter. Table 4.3 shows the total emissions values in individual agglomerations and zones (in sense of the Annex No 8 to the Decree No 705/2002 Act Coll.).

Most important sources of air pollution in the Slovak Republic in the year 2007

Table 4.4 introduces 20 of the most important air pollution sources in the SR. The share of these sources in the total air emissions of the SR varies from 72.02 % to 96.15 %. Table 4.5 lists top ten sources in administrative region according to the amount of emissions.

[7] *http://www.epa.gov/ttn/ch ief/ap42/*

Specific territorial emissions in the year 2007

Table 4.6 and Figure 4.3 provide information about certain imagination of 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 on more distant areas, depending on the stack height and meteorological conditions.

4.3 VERIFICATION OF THE RESULTS

Verification of the data gathered during the emission inventory was carried out by a comparison of:

- 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 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 on the balance calculation and the recalculation from the results of measurements were significant. In the 1996 and 1999 EAPSI 1 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 to control emissions estimated on the district level and its implementation decreased the uncertainty of national emission estimates.

Note: The inventory results for the year N are completed to the 31 October (N+1) and the inventory results of the basic pollutants for the year N are completed to the 31 Decmeber (N+1).

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	10.764	8.852	7.980	7.641	8.544	8.755	8.940	9.142	9.509	8.766
	Total	290.059	234.577	186.918	153.377	104.053	106.204	81.418	75.436	71.194	73.291
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	3.423	2.733	2.389	2.175	2.313	2.490	2.536	2.554	2.724	1.088
	Total	526.112	445.499	389.631	328.221	245.220	246.288	230.594	204.689	184.112	173.265
NOx	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	56.850	47.509	43.738	42.362	43.535	45.453	45.038	44.915	46.210	43.225
	Total	221.616	200.936	188.396	180.075	169.800	177.709	134.696	127.242	132.847	120.822
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	154.199	142.872	140.621	150.676	154.804	156.743	151.133	153.216	153.946	144.655
	Total	505.458	483.105	440.611	451.724	427.437	415.645	359.317	358.822	341.554	330.012

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 2000–2007**

			2000	2001	2002	2003	2004	2005	2006	2007
PM	**Stationary sources – NEIS**	Large sources [1]	29.923	29.722	25.037	20.166	17.670	18.719	13.992	6.020
		Middle sources [1]	4.958	4.405	3.767	3.259	2.748	2.392	2.281	1.977
		Small sources [2]	19.877	20.550	17.217	18.300	21.504	28.708	26.980	26.767
	Mobile sources	Road transport	7.648	8.567	8.866	8.910	9.480	10.689	10.563	12.127
		Other transport	0.399	0.404	0.366	0.329	0.343	0.359	0.336	0.353
	Total		62.805	63.648	55.253	50.964	51.745	60.867	54.152	47.244
SO_2	**Stationary sources – NEIS**	Large sources [1]	101.955	109.823	91.461	95.283	87.932	81.592	80.104	64.974
		Middle sources [1]	8.083	6.655	3.964	3.620	2.652	2.107	1.902	1.597
		Small sources [2]	16.055	13.764	7.127	6.384	5.382	5.073	5.524	3.735
	Mobile sources	Road transport	0.670	0.750	0.733	0.750	0.827	0.189	0.177	0.204
		Other transport	0.189	0.194	0.064	0.059	0.063	0.047	0.044	0.048
	Total		126.952	131.186	103.349	106.096	96.856	89.008	87.751	70.558
NOx	**Stationary sources – NEIS**	Large sources [1]	54.485	51.653	46.412	44.605	44.244	42.424	39.038	35.762
		Middle sources [1]	8.052	7.751	6.356	6.620	4.926	4.377	4.992	3.496
		Small sources [2]	7.993	8.391	7.137	7.356	7.582	8.866	8.336	7.808
	Mobile sources	Road transport	33.438	35.719	36.063	34.814	36.443	37.106	29.334	31.091
		Other transport	4.860	4.899	4.808	4.305	4.506	4.722	4.427	4.654
	Total		108.828	108.413	100.776	97.700	97.701	97.495	86.127	82.811
CO	**Stationary sources – NEIS**	Large sources [1]	120.609	115.177	122.225	141.047	147.317	133.787	147.318	141.062
		Middle sources [1]	10.779	10.280	9.150	9.394	7.531	5.853	5.350	5.315
		Small sources [2]	53.792	50.178	33.815	33.811	34.753	41.766	40.882	36.961
	Mobile sources	Road transport	120.190	131.954	119.757	116.050	111.602	107.122	86.904	83.873
		Other transport	1.719	1.626	1.591	1.463	1.509	1.566	1.452	1.533
	Total		307.089	309.215	286.538	301.765	302.712	290.094	281.906	268.744

[1] *according to the Decree of MoE SR No 706/2002 Act. Coll.*
[2] *according to the Decree of MoE SR No144/2000 Act. Coll. (2001–2003),*
according to the Decree of MoE SR No 53/2004 Act. Coll. (2004 and 2006)
Emissions estimated to October 31, 2008

Tab. 4.2a **Emissions of PM [t] from road transport in the SR within 1990–2007**

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Emissions from diesel engine	2916	2339	2040	1889	2020	2200	2263	2292	2397	2260
Emissions from petrol engine	376	348	335	354	346	346	321	302	283	238
Total emissions from exhaust	3292	2687	2375	2243	2366	2546	2584	2594	2680	2498
Abrasion emissions	6737	5587	5102	5000	5765	5761	5897	6114	6324	5823
Total	10029	8274	7477	7243	8131	8307	8481	8708	9004	8321

	2000	2001	2002	2003	2004	2005	2006	2007
Emissions from diesel engine	1975	2167	2329	2262	2473	2461	1762	1866
Emissions from petrol engine	208	220	188	168	156	130	108	89
Total emissions from exhaust	2183	2387	2517	2430	2629	2591	1870	1955
Abrasion emissions	5465	6180	6349	6480	6852	8098	8693	10172
Total	7648	8567	8866	8910	9480	10689	10563	12127

Tab. 4.2b **Emissions of PM_{10} and $PM_{2.5}$ [t] from road transport in the SR within 2000–2007**

	2000		2001		2002		2003		2004		2005		2006		2007	
	PM_{10}	$PM_{2.5}$	PM_{10}	$PM_{2.5}$	PM_{10}	$PM_{2.5}$	PM_{10}	$PM_{2.5}$	PM_{10}	$PM_{2.5}$	PM_{10}	$PM_{2.5}$	PM_{10}	$PM_{2.5}$	PM_{10}	$PM_{2.5}$
Emissions from diesel engines	1975	1975	2167	2167	2329	2329	2262	2262	2473	2473	2461	2461	1762	1762	1866	1866
Emissions from petrol engines	208	208	220	220	188	188	168	168	156	156	130	130	108	108	89	89
Sum of exhaust emissions	2183	2183	2387	2387	2517	2517	2430	2430	2629	2629	2591	2591	1870	1870	1955	1955
Emissions from abrasion	437	168	497	190	514	198	526	203	560	217	669	261	619	242	720	284
Total	2620	2351	2884	2577	3031	2715	2956	2633	3189	2846	3260	2852	2488	2112	2676	2239

Emissions estimated to October 31, 2008

Fig. 4.1 Development trends in basic pollutant emissions within 1990–2007

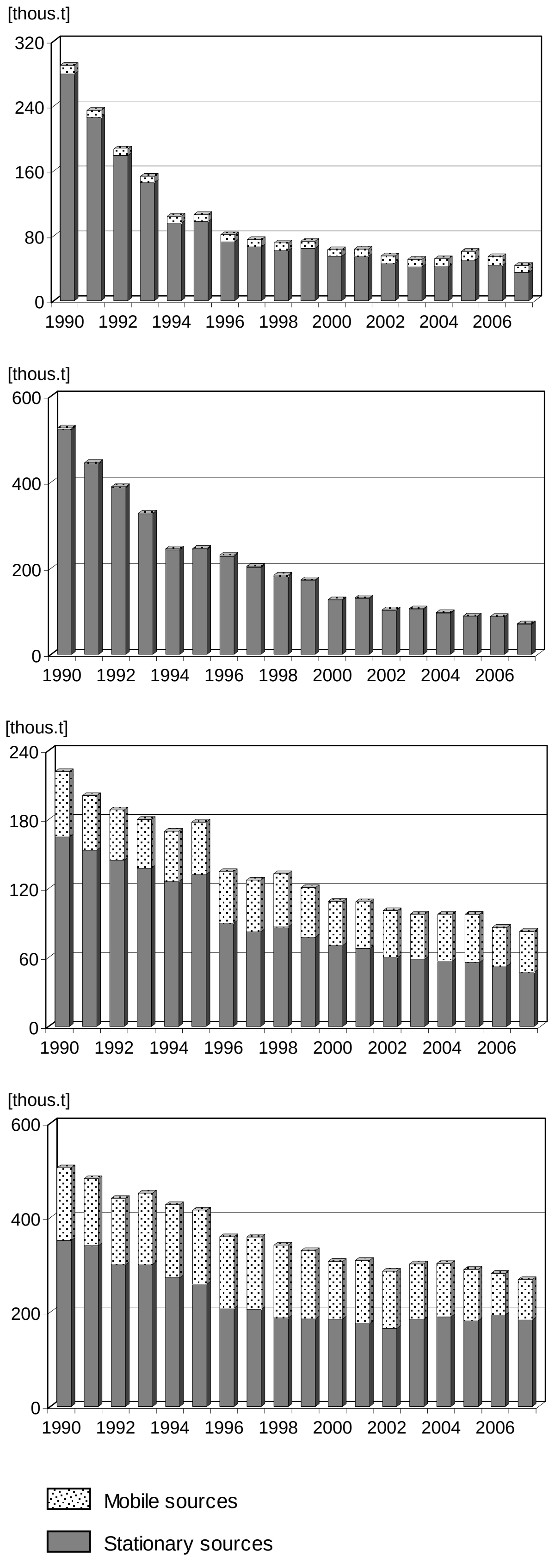
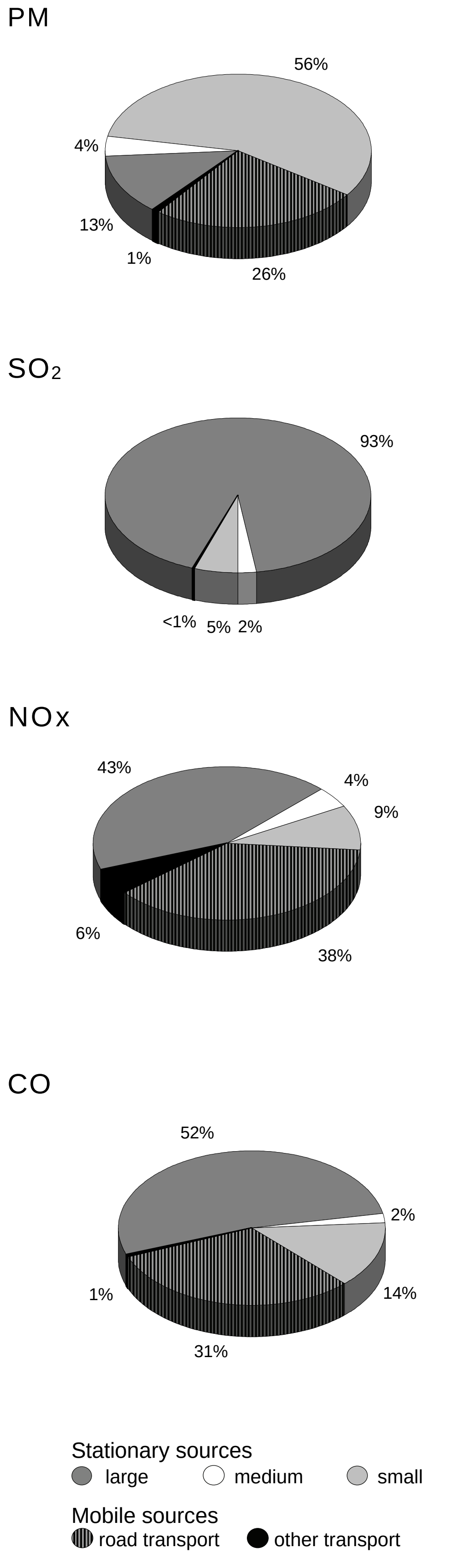


Fig. 4.2 Emissions of basic pollutants in 2007



Tab. 4.3 **Stationary source emissions of basic pollutants [t] in agglomerations and zones* within 2000–2007**

PM		2000	2001	2002	2003	2004	2005	2006	2007
Agglomeration	Bratislava	942	477	444	482	467	472	430	351
	Košice	15758	17173	14601	9890	6806	4362	4107	3418
Zone	Bratislava region	501	546	493	465	456	506	452	468
	Trnava region	1518	1518	1284	1325	1522	1935	1825	1748
	Trenčín region	4607	4820	4199	4332	4804	5280	4712	4457
	Nitra region	3057	2921	2476	2478	2744	3414	3144	3069
	Žilina region	6585	6271	5298	5343	5852	7076	6540	6431
	Banská Bystrica region	6320	6355	5334	5346	5819	7378	6710	6567
	Prešov region	4207	4266	3491	3666	4588	5556	5158	4598
	Košice region	11262	10331	8400	8397	8864	13842	10176	3657
Total		54758	54677	46022	41725	41922	49820	43253	34764

SO_2		2000	2001	2002	2003	2004	2005	2006	2007
Agglomeration	Bratislava	13240	13594	11348	12263	9869	9285	11764	8648
	Košice	18307	12608	10500	10781	13113	12526	11417	10307
Zone	Bratislava region	384	380	208	150	289	377	207	176
	Trnava region	2160	2051	1166	1077	1141	1037	1039	566
	Trenčín region	28625	45187	38305	46051	44108	40937	39659	33450
	Nitra region	4752	4749	3799	3648	2485	2336	2367	1158
	Žilina region	10775	10237	7140	7647	6147	5035	4444	3751
	Banská Bystrica region	10654	10043	8814	7983	6300	6197	6791	5022
	Prešov region	8372	8082	6320	6719	4864	4856	4204	3407
	Košice region	28825	23310	14952	8969	7650	6185	5639	3823
Total		126094	130242	102552	105287	95966	88772	87530	70307

NOx		2000	2001	2002	2003	2004	2005	2006	2007
Agglomeration	Bratislava	6393	5151	5313	5414	5260	4791	4521	4064
	Košice	12382	12172	12140	12343	11092	10929	12222	9975
Zone	Bratislava region	1792	1900	1972	1590	1650	1742	1700	1882
	Trnava region	2012	1966	1684	1670	1652	1667	1608	1470
	Trenčín region	9083	10489	9616	10198	9687	7822	7835	7218
	Nitra region	3905	3974	3843	3993	4424	3989	3653	2978
	Žilina region	5433	5170	4599	4483	4700	4674	4479	4548
	Banská Bystrica region	6541	6666	6316	5843	6146	6281	5522	5548
	Prešov region	3279	3443	3212	3224	3173	3459	3284	2847
	Košice region	19710	16864	11209	9824	8967	10314	7543	6537
Total		70530	67794	59905	58581	56752	55667	52366	47066

CO		2000	2001	2002	2003	2004	2005	2006	2007
Agglomeration	Bratislava	1528	1319	1264	1204	1254	1120	1065	863
	Košice	84544	78619	83700	104600	107212	93197	109060	102663
Zone	Bratislava region	1951	1638	1488	2789	1767	1576	1901	2019
	Trnava region	4746	4682	3591	3397	3496	3865	3563	3456
	Trenčín region	11684	10334	7815	7801	8040	9331	10854	9423
	Nitra region	7964	7379	5470	5615	5700	6627	6459	5684
	Žilina region	19357	19287	16520	16459	17253	15924	14990	14673
	Banská Bystrica region	26309	26301	24299	25729	27834	29375	26835	27370
	Prešov region	12170	11838	9075	8796	8802	9282	8714	7513
	Košice region	14927	14237	11969	7861	8242	11109	10108	9674
Total		185180	175635	165191	184252	189601	181406	193550	183338

** according to the Decree No 705/2002 Annex 8.*

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 2007**

No	PM		SO_2		NOx		CO	
	Source	[%]	Source	[%]	Source	[%]	Source	[%]
1	U.S. Steel, s.r.o. Košice	39.76	SE, a.s., Bratislava, o.z. ENO Zem. Kostoľany	48.25	U.S. Steel, s.r.o. Košice	19.82	U.S. Steel, s.r.o. Košice	69.70
2	SE, a.s., Bratislava, o.z. ENO Zem. Kostoľany	7.22	U.S. Steel, s.r.o. Košice	13.52	SE, a.s., Bratislava, o.z. ENO Zem. Kostoľany	9.07	SLOVALCO, a.s. Žiar nad Hronom	8.84
3	SLOVNAFT a.s. Bratislava	2.19	SLOVNAFT a.s. Bratislava	12.67	SE, a.s., Bratislava, Elektráreň Vojany I a II	7.58	DOLVAP, s.r.o. Varín	2.00
4	Považská cementáreň, a.s. Ladce	2.17	SIDERIT Nižná Slaná	3.30	SLOVNAFT a.s. Bratislava	6.40	KOVOHUTY, a.s. Krompachy	1.87
5	Kronospan SK, s.r.o. Prešov	2.16	BUKOCEL a.s. Hencovce	3.26	TEKO a.s. Košice	3.69	Slovenské magnezitové závody a.s. Jelšava	1.44
6	SE, a.s., Bratislava, Elektráreň Vojany I a II	2.12	SLOVALCO, a.s. Žiar nad Hronom	1.99	Holcim , a.s. Rohožník	3.43	Calmit, s.r.o. Bratislava, prev. Tisovec	1.28
7	Novácke chemické závody, a.s. Nováky	2.11	Žilinská teplárenská, a.s. Žilina	1.90	Mondi scp, a.s. Ružomberok	2.81	OFZ, a.s., Istebné	1.26
8	SIDERIT Nižná Slaná	1.86	Zvolenská teplárenská a.s. Zvolen	1.78	SPP - PREPRAVA , prev. Veľké Kapušany	2.34	CEMMAC, a. s. Horné Srnie	1.17
9	Carmeuse Slovakia s.r.o., zavod Včeláre	1.70	TEKO a.s. Košice	1.67	SPP - preprava, prev. Veľké Zlievce	2.23	Považská cementáreň, a.s. Ladce	1.06
10	Duslo Šaľa	1.47	SE, a.s., Bratislava, Elektráreň Vojany I a II	1.59	Považská cementáreň, a.s. Ladce	2.18	Holcim (Slovensko) , a.s. Rohožník	0.67
11	SES a.s. Tlmače	1.34	Martinská teplárenská, a.s. Martin	1.06	SPP - preprava, a.s. Blava, prev. Jabloňov nad Turňou	1.94	SE, a.s., Bratislava, Elektráreň Vojany I a II	0.61
12	SLOVALCO, a.s. Žiar nad Hronom	1.23	Smurfit Kappa Štúrovo, a.s.	1.04	V.S.H., a.s Turňa nad Bodvou	1.54	CALMIT spol. s r.o. Bratislava, prev. Žírany	0.58
13	DOLVAP, s.r.o. Varín	1.08	Slovenské magnezitové závody a.s. Jelšava	0.98	Duslo a.s. Šaľa	1.54	BUKOCEL a.s. Hencovce	0.46
14	KVARTET, a.s. Partizánske	1.08	CHEMES, a.s., HUMENNÉ	0.72	CHEMES, a.s., HUMENNÉ	1.50	Slovmag a.s. Lubenik	0.44
15	Mondi scp, a.s. Ružomberok	1.04	ZSNP, a.s. Žiar nad Hronom	0.53	Slovenské magnezitové závody a.s. Jelšava	1.46	Wienerberger Slov.tehelne s.r.o., závod Boleráz	0.42
16	Knauf Insulation, s.r.o. Nová Bana	0.85	Wienerberger-Slov. tehelne spol. s r.o. Ružomberok	0.52	CEMMAC, a. s. Horné Srnie	1.46	SIDERIT Nižná Slaná	0.38
17	Carmeuse Slovakia s.r.o., zavod Košíce	0.78	Knauf Insulation, s.r.o. Nová Bana	0.42	SLOVALCO, a.s. Žiar nad Hronom	1.42	Kronospan SK, s.r.o. Prešov	0.32
18	TEKO a.s. Košice	0.69	KVARTET, a.s. Partizánske	0.39	Smurfit Kappa Štúrovo, a.s.	1.42	SLOVNAFT a.s. Bratislava	0.31
19	Slovenské magnezitové závody a.s. Jelšava	0.61	Slovenské cukrovary, a.s., Sereď	0.29	BUKOCEL a.s. Hencovce	1.32	Wienerberger-Slov. tehelne spol. s r.o. Ružomberok	0.31
20	BUKOCEL a.s. Hencovce	0.57	SOTE Čadca	0.26	Žilinská teplárenská, a.s. Žilina	1.30	Mondi scp, a.s. Ružomberok	0.25
Total		72.02		96.15		74.46		93.36

** according to the Decree of MoE SR No 706/2002 Act. Coll.*

Tab. 4.5 **Sequence of the sources within the region according to the amount of emissions – 2007 (NEIS – large and middle sources*)**

BRATISLAVA REGION

	PM		SO_2	
	Source	District	Source	District
1.	SLOVNAFT a.s. Bratislava	Bratislava II	SLOVNAFT a.s. Bratislava	Bratislava II
2.	Holcim (Slovensko) , a.s. Rohožník	Malacky	Duslo, a. s. odštepný závod ISTROCHEM Bratislava	Bratislava III
3.	VOLKSWAGEN SLOVAKIA,a.s.,Bratislava	Bratislava IV	Holcim (Slovensko) , a.s. Rohožník	Malacky
4.	Swedwood Slovakia s.r.o.OZ Malacky	Malacky	Slovnaft Petrochemicals, s.r.o. Bratislava	Bratislava II
5.	Slovnaft Petrochemicals, s.r.o. Bratislava	Bratislava II	Bratislavská vodárenská spoločnosť, a.s. Bratislava	Bratislava V
6.	Paroplynový cyklus a.s. Bratislava	Bratislava III	PSB Bratislava, kotolne Viničné a Sl. Grob	Pezinok
7.	ALAS Slovakia, s. r. o.kameňolom Sološnica	Malacky	Technické služby - čistenie, s. r. o. Bratislava	Bratislava II
8.	PSB Bratislava, kotolne Viničné a Sl. Grob	Pezinok	Swedwood Slovakia s.r.o.OZ Malacky	Malacky
9.	PPC POWER, a.s. Bratislava	Bratislava III	Univolt-Remat s.r.o. Pezinok	Pezinok
10.	KARPATY plus spol. s r.o. Senec	Senec	NAFTA Gbely	Malacky
	NOx		**CO**	
	Prevádzkovateľ / zdroj	Okres	Prevádzkovateľ / zdroj	Okres
1.	SLOVNAFT a.s. Bratislava	Bratislava II	Holcim (Slovensko) , a.s. Rohožník	Malacky
2.	Holcim (Slovensko) , a.s. Rohožník	Malacky	SLOVNAFT a.s. Bratislava	Bratislava II
3.	Slovnaft Petrochemicals, s.r.o. Bratislava	Bratislava II	Swedwood Slovakia s.r.o.OZ Malacky	Malacky
4.	Paroplynový cyklus a.s. Bratislava	Bratislava III	Termming, a. s. Bratislava, Malacky	Malacky
5.	Swedwood Slovakia s.r.o.OZ Malacky	Malacky	Slovnaft Petrochemicals, s.r.o. Bratislava	Bratislava II
6.	PPC POWER, a.s. Bratislava	Bratislava III	Bratislavská teplárenská, a.s., Bratislava, Tepl. západ	Bratislava IV
7.	Odvoz a likvidácia odpadu, a. s. Bratislava	Bratislava II	PSB Bratislava, kotolne Viničné a Sl. Grob	Pezinok
8.	Bratislavská teplárenská, a.s., Bratislava, Tepl.	Bratislava IV	VOLKSWAGEN SLOVAKIA,a.s.,Bratislava	Bratislava IV
9.	VOLKSWAGEN SLOVAKIA,a.s.,Bratislava	Bratislava IV	NAFTA Gbely	Malacky
10.	Dalkia a.s. Bratislava	Bratislava V	Dalkia a.s. Bratislava, zdroje v okrese	Bratislava V

TRNAVA REGION

	PM		SO_2	
	Source	District	Source	District
1.	Amylum Slovakia spol. s r. o. Boleráz	Trnava	Slovenské cukrovary, a.s., Sereď	Galanta
2.	Johns Manville Slovakia a. s. Trnava	Trnava	Johns Manville Slovakia a. s. Trnava	Trnava
3.	Slovenské cukrovary, a.s., Sereď	Galanta	Wienerberger Slov.tehelne s.r.o., závod Boleráz	Trnava
4.	BELAR a.s. Dunajská Streda	Dunajská Streda	Mach-Trade Sereď	Galanta
5.	Zlieváreň Trnava s. r. o	Trnava	Eastern Sugar Slovensko a.s. Dunajská Streda	Dunajská Streda
6.	PENAM, a. s., Nitra, prev. Trnava	Trnava	Baňa Záhorie, a.s. Čáry	Senica
7.	PCA Slovakia TRNAVA	Trnava	Zlieváreň Trnava s. r. o	Trnava
8.	ŽOS Trnava, a. s.	Trnava	COMP - LET, spol. s r. o. Hlboké	Senica
9.	Výroba kameňa a pieskov, spol. s r. o. Buková	Trnava	Obec Lakšárska Nová Ves, ZŠ Lakšárska Nová Ves	Senica
10.	KERKOSAND Šajdíkové Humence	Senica	PD Siladice	Hlohovec
	NOx		**CO**	
	Prevádzkovateľ / zdroj	Okres	Prevádzkovateľ / zdroj	Okres
1.	Johns Manville Slovakia a. s. Trnava	Trnava	Wienerberger Slov.tehelne s.r.o., závod Boleráz	Trnava
2.	Slovenské cukrovary, a.s., Sereď	Galanta	Zlieváreň Trnava s. r. o	Trnava
3.	Amylum Slovakia spol. s r. o. Boleráz	Trnava	Johns Manville Slovakia a. s. Trnava	Trnava
4.	Eissmann Automotive Slovensko spol s r.o. Holíč	Skalica	I.D.C. Holding, a.s., Pečivárne Sereď	Galanta
5.	Wienerberger Slov.tehelne s.r.o., závod Boleráz	Trnava	BEKAERT Hlohovec, a.s.	Hlohovec
6.	Swedwood Slovakia s.r.o.OZ Malacky prev. Trnava	Trnava	Medea-S, s.r.o. Sládkovičovo	Galanta
7.	PCA Slovakia TRNAVA	Trnava	Swedwood Slovakia s.r.o.OZ Malacky prev. Trnava	Trnava
8.	ENVIRAL Leopoldov	Hlohovec	Amylum Slovakia spol. s r. o. Boleráz	Trnava
9.	Mach-Trade Sereď	Galanta	Slovenské cukrovary, a.s., Sereď	Galanta
10.	BEKAERT Hlohovec, a.s.	Hlohovec	COMP - LET, spol. s r. o. Hlboké	Senica

NITRA REGION

	PM		SO_2	
	Source	District	Source	District
1.	Duslo a.s., Šaľa	Šaľa	Smurfit Kappa Štúrovo, a.s.	Nové Zámky
2.	SES a.s. Tlmače	Levice	Icopal a.s., Štúrovo	Nové Zámky
3.	Smurfit Kappa Štúrovo, a.s.	Nové Zámky	BYTREAL Tlmače s.r.o.	Levice
4.	Lencos s.r.o. Levice	Levice	Wienerberger Slov. tehelne spol. s r. o. Zl. Moravce	Zlaté Moravce
5.	BYTREAL Tlmače s.r.o.	Levice	Duslo a.s., Šaľa	Šaľa
6.	CALMIT spol. s r.o. Bratislava, prev. Žírany	Nitra	MO SR Posádková správa budov Nitra	Nitra
7.	P.G.TRADE spol. s r.o. Komárno, zdroje v okrese	Nové Zámky	N-ADOVA, spol. s r.o. Nitra	Nitra
8.	PPC ČAB akciová spoločnosť Nové Sady	Nitra	EMGO Slovakia Nové Zámky	Nové Zámky
9.	Kameňolomy a štrkopieskovne , lom Pohranice	Nitra	CESTY NITRA A.S. NITRA, prev. Práznovce	Topoľčany
10	Liaharenský podnik Nitra a.s. Močenok	Nitra	MJ Agro Marcelová	Levice
	NOx		CO	
	Prevádzkovateľ / zdroj	Okres	Prevádzkovateľ / zdroj	Okres
1.	Duslo a.s., Šaľa	Šaľa	CALMIT spol. s r.o. Bratislava, prev. Žírany	Nitra
2.	Smurfit Kappa Štúrovo, a.s.	Nové Zámky	Wienerberger Slov. tehelne spol. s r. o. Zl. Moravce	Zlaté Moravce
3.	SPP - preprava, a.s. , prev. Ivánka pri Nitre	Nitra	SES a.s. Tlmače	Levice
4.	SES a.s. Tlmače	Levice	Duslo a.s., Šaľa	Šaľa
5.	Bytkomfort s.r.o.Nové Zámky	Nové Zámky	DANFOSS COMPRESSORS, s.r.o. Zlaté Moravce	Zlaté Moravce
6.	OPM2SR Nitra	Nitra	Smurfit Kappa Štúrovo, a.s.	Nové Zámky
7.	N-ADOVA, spol. s r.o. Nitra	Nitra	Komárňanské tlačiarne spol. s r.o Komárno	Komárno
8.	Nitrianska teplárenská spoločnosť Nitra	Nitra	SPP - preprava, a.s. , prev. Ivánka pri Nitre	Nitra
9.	DECODOM s.r.o. Topoľčany	Topoľčany	MO SR Posádková správa budov Nitra	Nitra
10	COM-therm Komárno	Komárno	DECODOM s.r.o. Topoľčany	Topoľčany

TRENČÍN REGION

	PM		SO_2	
	Source	District	Source	District
1.	SE, a.s., Bratislava, o.z. ENO Zem. Kostoľany	Prievidza	SE, a.s., Bratislava, o.z. ENO Zem. Kostoľany	Prievidza
2.	Považská cementáreň, a.s. Ladce	Ilava	KVARTET, a.s. Partizánske	Partizánske
3.	Novácke chemické závody, a.s. Nováky	Prievidza	TEPLÁREŇ, a.s. Považská Bystrica	Považská Bystrica
4.	KVARTET, a.s. Partizánske	Partizánske	VETROPACK NEMŠOVÁ, S.R.O.	Trenčín
5.	VETROPACK NEMŠOVÁ, S.R.O.	Trenčín	HBP, a.s., Banská mech. a elektrifikácia Nováky	Prievidza
6.	HBP, a.s., Banská mech. a elektrifikácia Nováky	Prievidza	TSM Partizánske	Partizánske
7.	TSM Partizánske	Partizánske	Handlovská energetika, s.r.o. Handlová	Prievidza
8.	CEMMAC, a. s. Horné Srnie	Trenčín	MO SR, zdroje v okrese Trenčín	Trenčín
9.	Považský cukor a. s., Trenčianska Teplá	Trenčín	Prefabetón Koš, a.s. Nováky	Prievidza
10.	TERMONOVA Nová Dubnica	Ilava	Považská cementáreň, a.s. Ladce	Ilava
	NOx		CO	
	Prevádzkovateľ / zdroj	Okres	Prevádzkovateľ / zdroj	Okres
1.	SE, a.s., Bratislava, o.z. ENO Zem. Kostoľany	Prievidza	CEMMAC, a. s. Horné Srnie	Trenčín
2.	Považská cementáreň, a.s. Ladce	Ilava	Považská cementáreň, a.s. Ladce	Ilava
3.	CEMMAC, a. s. Horné Srnie	Trenčín	SE, a.s., Bratislava, o.z. ENO Zem. Kostoľany	Prievidza
4.	RONA a.s. Lednické Rovne	Púchov	Novácke chemické závody, a.s. Nováky	Prievidza
5.	VETROPACK NEMŠOVÁ, S.R.O.	Trenčín	Považský cukor a. s., Trenčianska Teplá	Trenčín
6.	TEPLÁREŇ, a.s. Považská Bystrica	Považská Bystrica	KVARTET, a.s. Partizánske	Partizánske
7.	Novácke chemické závody, a.s. Nováky	Prievidza	TEPLÁREŇ, a.s. Považská Bystrica	Považská Bystrica
8.	KVARTET, a.s. Partizánske	Partizánske	Handlovská energetika, s.r.o. Handlová	Prievidza
9.	TERMONOVA Nová Dubnica	Ilava	TSM Partizánske	Partizánske
10.	Handlovská energetika, s.r.o. Handlová	Prievidza	MO SR, zdroje v okrese Trenčín	Trenčín

BANSKÁ BYSTRICA REGION

	PM		SO_2	
	Source	District	Source	District
1.	SLOVALCO, a.s. Žiar nad Hronom	Žiar nad Hronom	SLOVALCO, a.s. Žiar nad Hronom	Žiar nad Hronom
2.	Knauf Insulation, s.r.o. Nová Bana	Žarnovica	Zvolenská teplárenská a.s. Zvolen	Zvolen
3.	Slovenské magnezitové závody a.s. Jelšava	Revúca	Slovenské magnezitové závody a.s. Jelšava	Revúca
4.	Slovmag a.s. Lubenik	Revúca	ZSNP, a.s. Žiar nad Hronom	Žiar nad Hronom
5.	BUČINA DDD, spol. s r.o. Zvolen	Zvolen	Knauf Insulation, s.r.o. Nová Bana	Žarnovica
6.	BLOOMSBURY PACIFIC SLOVAKIA a.s. Lučenec	Lučenec	Slovmag a.s. Lubenik	Revúca
7.	Zvolenská teplárenská a.s. Zvolen	Zvolen	VUM, a.s. Žiar nad Hronom	Žiar nad Hronom
8.	Smrečina HOLD a.s. Banská Bystrica	Banská Bystrica	Baňa Dolina a.s. Veľký Krtíš	Veľký Krtíš
9.	ZSNP, a.s. Žiar nad Hronom	Žiar nad Hronom	Ipeľské tehelne a.s. Lučenec, záv. Poltár	Poltár
10.	Calmit, s.r.o. Bratislava, prev. Tisovec	Rimavská Sobota	PETROCHEMA, a.s., Dubová	Brezno
	NOx		CO	
	Prevádzkovateľ / zdroj	Okres	Prevádzkovateľ / zdroj	Okres
1.	SPP - preprava, prev. Veľké Zlievce	Veľký Krtíš	SLOVALCO, a.s. Žiar nad Hronom	Žiar nad Hronom
2.	Slovenské magnezitové závody a.s. Jelšava	Revúca	Slovenské magnezitové závody a.s. Jelšava	Revúca
3.	SLOVALCO, a.s. Žiar nad Hronom	Žiar nad Hronom	Calmit, s.r.o. Bratislava, prev. Tisovec	Rimavská Sobota
4.	Zvolenská teplárenská a.s. Zvolen	Zvolen	Slovmag a.s. Lubenik	Revúca
5.	Slovmag a.s. Lubenik	Revúca	VUM, a.s. Žiar nad Hronom	Žiar nad Hronom
6.	ZSNP, a.s. Žiar nad Hronom	Žiar nad Hronom	Železiarne Podbrezová a.s.	Brezno
7.	SLOVGLASS, a. s. Poltár	Poltár	Ipeľské tehelne a.s. Lučenec, záv. Poltár	Poltár
8.	Železiarne Podbrezová a.s.	Brezno	Knauf Insulation, s.r.o. Nová Bana	Žarnovica
9.	Knauf Insulation, s.r.o. Nová Bana	Žarnovica	INTOCAST Slovakia, a.s. Košice	Rimavská Sobota
10.	Bučina Zvolen a.s.	Zvolen	SPP - preprava, prev. Veľké Zlievce	Veľký Krtíš

ŽILINA REGION

	PM		SO_2	
	Source	District	Source	District
1.	DOLVAP, s.r.o. Varín	Žilina	Žilinská teplárenská, a.s. Žilina	Žilina
2.	Mondi scp, a.s. Ružomberok	Ružomberok	Martinská teplárenská, a.s. Martin	Martin
3.	Žilinská teplárenská, a.s. Žilina	Žilina	Wienerberger-Slov. tehelne spol. s r.o. Ružomberok	Ružomberok
4.	OFZ, a.s., Istebné	Dolný Kubín	SOTE Čadca	Čadca
5.	SOTE Čadca	Čadca	Mondi scp, a.s. Ružomberok	Ružomberok
6.	Martinská teplárenská, a.s. Martin	Martin	ŽOS Vrútky a.s.	Martin
7.	DOLKAM Šuja ,a.s. Rajec	Žilina	OFZ, a.s., Istebné	Dolný Kubín
8.	TATRA nábytkáreň, a.s. Martin	Martin	VELVETEX Litovský Mikuláš	Liptovský Mikuláš
9.	KIA Motors Slovakia s.r.o. Žilina	Žilina	DOLVAP, s.r.o. Varín	Žilina
10.	Swedwood Slovakia s.r.o. prev. Závažná Poruba	Liptovský Mikuláš	ZDROJ MT s.r.o. Martin - Priekopa	Martin
	NOx		CO	
	Prevádzkovateľ / zdroj	Okres	Prevádzkovateľ / zdroj	Okres
1.	Mondi scp, a.s. Ružomberok	Ružomberok	DOLVAP, s.r.o. Varín	Žilina
2.	Žilinská teplárenská, a.s. Žilina	Žilina	OFZ, a.s., Istebné	Dolný Kubín
3.	OFZ, a.s., Istebné	Dolný Kubín	Wienerberger-Slov. tehelne spol. s r.o. Ružomberok	Ružomberok
4.	Martinská teplárenská, a.s. Martin	Martin	Mondi scp, a.s. Ružomberok	Ružomberok
5.	SPECIALITY MINERALS SLOVAKIA Ružomberok	Ružomberok	SOTE Čadca	Čadca
6.	Rettenmeier Tatra Timber s.r.o. Liptovský Hrádok	Liptovský Mikuláš	Žilinská teplárenská, a.s. Žilina	Žilina
7.	KIA Motors Slovakia s.r.o. Žilina	Žilina	Rettenmeier Tatra Timber s.r.o. Liptovský Hrádok	Liptovský Mikuláš
8.	SOTE Čadca	Čadca	ŽOS Vrútky a.s.	Martin
9.	KYSUCA s.r.o. Kysucké Nové Mesto	Kysucké N. Mesto	Turzovská drevárska fabrika Turzovka	Čadca
10.	VELVETEX Liptovský Mikuláš	Liptovský Mikuláš	DREVOMAX ,s.r.o,Lipt. Mikuláš prev. Raj. Teplice	Žilina

PREŠOV REGION

	PM		SO_2	
	Source	District	Source	District
1.	Kronospan SK, s.r.o. Prešov	Prešov	BUKOCEL a.s. Hencovce	Vranov n/Topľou
2.	BUKOCEL a.s. Hencovce	Vranov n/Topľou	CHEMES, a.s., HUMENNÉ	Humenné
3.	CHEMES, a.s., HUMENNÉ	Humenné	Energy Snina,a.s.	Snina
4.	Legno Export spol. s r.o. Beňadikovce	Svidník	Zeocem Bystré a.s.	Vranov n/Topľou
5.	IS - Lom Maglovec s.r.o. Vyšná Šebastová	Prešov	Zastrova a.s. Spišská Stará Ves	Kežmarok
6.	TATRY-TEPLO, s r.o. Tatranská Lomnica	Poprad	Tehelne Vranov s.r.o Vranov n. Topľou	Vranov n/Topľou
7.	Tehelne Vranov s.r.o Vranov n. Topľou	Vranov n/Topľou	FECUPRAL sro Veľký Šariš	Prešov
8.	VSK MINERAL s.r.o Vechec	Vranov n/Topľou	Ministerstvo obrany SR, Posádková správa budov	Prešov
9.	WIZARD Stropkov	Stropkov	ZŠ Malcov	Bardejov
10.	Zeocem Bystré a.s.	Vranov n/Topľou	DSS Spišský Št. Spišský Štvrtok	Levoča
	NOx		**CO**	
	Prevádzkovateľ / zdroj	Okres	Prevádzkovateľ / zdroj	Okres
1.	CHEMES, a.s., HUMENNÉ	Humenné	BUKOCEL a.s. Hencovce	Vranov n/Topľou
2.	BUKOCEL a.s. Hencovce	Vranov n/Topľou	Kronospan SK, s.r.o. Prešov	Prešov
3.	Kronospan SK, s.r.o. Prešov	Prešov	CHEMES, a.s., HUMENNÉ	Humenné
4.	Energy Snina,a.s.	Snina	ZLIEVAREŇ SVIT, a.s.	Poprad
5.	SPRAVBYT a.s. Prešov	Prešov	TENERGO BRNO a.s., prev. Snina	Snina
6.	DALKIA POPRAD a.s. Poprad	Poprad	CHEMOSVIT FOLIE, a.s. Svit	Poprad
7.	CHEMOSVIT ENERGOCHEM, a.s., SVIT	Poprad	Energy Snina,a.s.	Snina
8.	BARDTERM Bardejov	Bardejov	SPRAVBYT a.s. Prešov	Prešov
9.	Zeocem Bystré a.s.	Vranov n/Topľou	Zeocem Bystré a.s.	Vranov n/Topľou
10.	TATRAVAGÓNKA a.s. POPRAD	Poprad	Inžinierske stavby, a.s. Obaľovačka Veľká Lomnica	Kežmarok

KOŠICE REGION

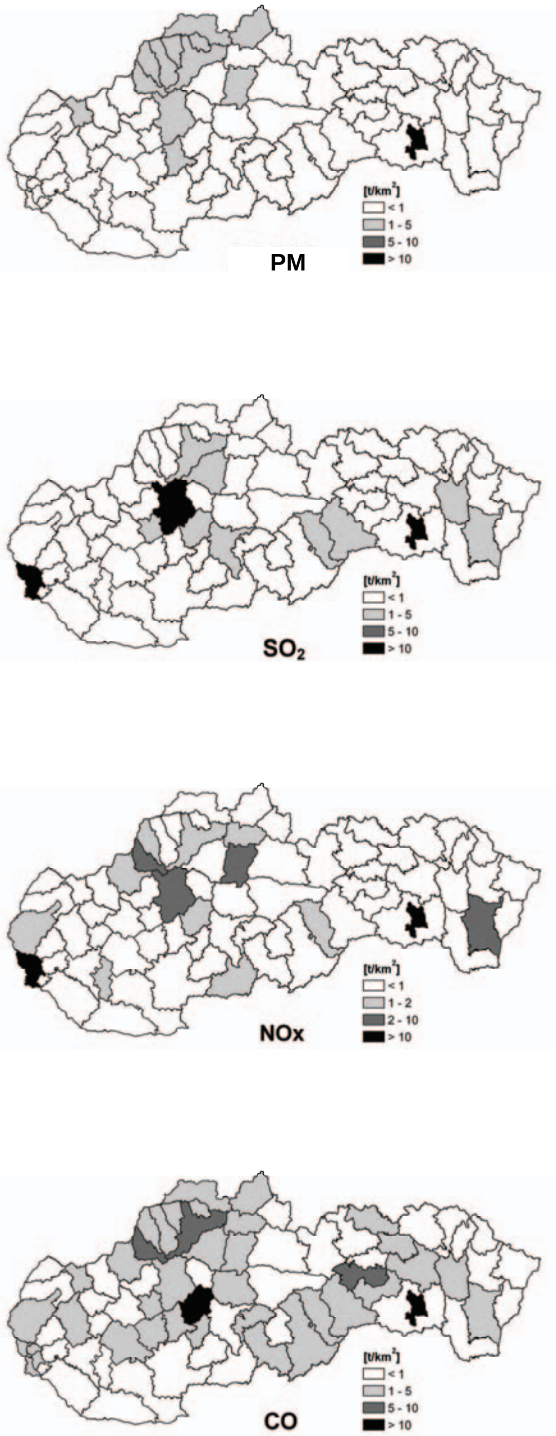
	PM		SO_2	
	Source	District	Source	District
1.	U.S. Steel, s.r.o. Košice	Košice II	U.S. Steel, s.r.o. Košice	Košice II
2.	SE, a.s., Bratislava, Elektráreň Vojany I a II	Michalovce	SIDERIT Nižná Slaná	Rožňava
3.	SIDERIT Nižná Slaná	Rožňava	TEKO a.s. Košice	Košice IV
4.	Carmeuse Slovakia s.r.o., zavod Včeláre	Košice - okolie	SE, a.s., Bratislava, Elektráreň Vojany I a II	Michalovce
5.	Carmeuse Slovakia s.r.o., zavod Košíce	Košice II	Slovenské magnezitové závody a.s. závod Bočiar	Košice II
6.	TEKO a.s. Košice	Košice IV	KOVOHUTY, a.s. Krompachy	Spišská N. Ves
7.	KOVOHUTY, a.s. Krompachy	Spišská N. Ves	Refrako, s.r.o. Košice	Košice II
8.	V.S.H., a.s Turňa nad Bodvou	Košice - okolie	Reliningserv Košice	Košice II
9.	Eurocast Košice, spol. s.r. o	Košice II	V.S.H., a.s Turňa nad Bodvou	Košice - okolie
10.	KERKO Michalovce	Michalovce	ŽSR Bratislava, zdroje v okrese Trebišov	Trebišov
	NOx		**CO**	
	Prevádzkovateľ / zdroj	Okres	Prevádzkovateľ / zdroj	Okres
1.	U.S. Steel, s.r.o. Košice	Košice II	U.S. Steel, s.r.o. Košice	Košice II
2.	SE, a.s., Bratislava, Elektráreň Vojany I a II	Michalovce	KOVOHUTY, a.s. Krompachy	Spišská N. Ves
3.	TEKO a.s. Košice	Košice IV	SE, a.s., Bratislava, Elektráreň Vojany I a II	Michalovce
4.	SPP - preprava , prev. Veľké Kapušany	Michalovce	SIDERIT Nižná Slaná	Rožňava
5.	SPP - preprava, a.s., prev. Jabloňov nad Turňou	Rožňava	Calmit, s.r.o. Bratislava, prev. Margecany	Gelnica
6.	V.S.H., a.s Turňa nad Bodvou	Košice - okolie	HNOJIVÁ DUSLO, s.r.o. STRÁŽSKE	Michalovce
7.	Carmeuse Slovakia s.r.o., zavod Košíce	Košice II	Carmeuse Slovakia s.r.o., zavod Košíce	Košice II
8.	Slovenské magnezitové závody a.s. závod Bočiar	Košice II	V.S.H., a.s Turňa nad Bodvou	Košice - okolie
9.	SIDERIT Nižná Slaná	Rožňava	Slovenské magnezitové závody a.s. závod Bočiar	Košice II
10.	Refrako, s.r.o. Košice	Košice II	SPP - preprava, a.s. Bratislava, prev. Jabloňov n/T	Rožňava

**according to the Decree of MoE SR No 706/2002 Act. Coll.*

Tab. 4.6 **Stationary source emissions by districts in 2007**

District	Emissions [t/year]				Specific territorial emis. [t/year.km²]			
	PM	SO_2	NOx	CO	PM	SO_2	NOx	CO
1. Bratislava	351	8648	4064	863	0.95	23.50	11.04	2.35
2. Malacky	266	141	1705	1677	0.28	0.15	1.80	1.77
3. Pezinok	107	23	93	181	0.28	0.06	0.25	0.48
4. Senec	95	13	84	162	0.26	0.03	0.23	0.45
5. Dunajská Streda	371	61	202	531	0.35	0.06	0.19	0.49
6. Galanta	249	241	283	423	0.39	0.38	0.44	0.66
7. Hlohovec	119	18	102	194	0.45	0.07	0.38	0.73
8. Piešťany	214	30	122	313	0.56	0.08	0.32	0.82
9. Senica	322	58	140	470	0.47	0.09	0.20	0.69
10. Skalica	204	29	121	284	0.57	0.08	0.34	0.80
11. Trnava	269	129	498	1240	0.36	0.17	0.67	1.67
12. Bánovce n/B	233	33	84	329	0.50	0.07	0.18	0.71
13. Ilava	401	38	1011	1904	1.12	0.11	2.82	5.32
14. Myjava	328	46	94	458	1.00	0.14	0.29	1.40
15. Nové Mesto n/V	309	42	137	439	0.53	0.07	0.24	0.76
16. Partizánske	248	371	138	464	0.82	1.23	0.46	1.54
17. Považská Bystrica	565	227	271	1001	1.22	0.49	0.58	2.16
18. Prievidza	1469	32409	3930	1642	1.53	33.76	4.09	1.71
19. Púchov	493	77	493	687	1.31	0.20	1.32	1.83
20. Trenčín	412	207	1060	2500	0.61	0.31	1.57	3.70
21. Komárno	388	54	214	597	0.35	0.05	0.19	0.54
22. Levice	1105	154	358	1541	0.71	0.10	0.23	0.99
23. Nitra	321	53	650	1352	0.37	0.06	0.75	1.55
24. Nové Zámky	594	802	831	881	0.44	0.60	0.62	0.65
25. Šaľa	239	22	689	275	0.67	0.06	1.93	0.77
26. Topoľčany	195	33	140	297	0.33	0.05	0.23	0.50
27. Zlaté Moravce	227	40	96	740	0.44	0.08	0.18	1.42
28. Bytča	386	57	108	539	1.37	0.20	0.38	1.91
29. Čadca	1176	343	326	1744	1.55	0.45	0.43	2.29
30. Dolný Kubín	339	121	526	2278	0.69	0.25	1.07	4.63
31. Kysucké Nové Mesto	247	35	94	345	1.42	0.20	0.54	1.98
32. Liptovský Mikuláš	604	137	334	929	0.45	0.10	0.25	0.69
33. Martin	469	855	448	745	0.64	1.16	0.61	1.01
34. Námestovo	1141	199	261	1561	1.65	0.29	0.38	2.26
35. Ružomberok	741	537	1413	1744	1.14	0.83	2.18	2.69
36. Turčianske Teplice	206	33	55	288	0.53	0.08	0.14	0.73
37. Tvrdošín	177	30	65	279	0.37	0.06	0.14	0.58
38. Žilina	947	1405	918	4223	1.16	1.72	1.13	5.18
39. Banská Bystrica	539	78	348	841	0.67	0.10	0.43	1.04
40. Banská Štiavnica	254	42	65	340	0.87	0.14	0.22	1.16
41. Brezno	639	148	292	1178	0.51	0.12	0.23	0.93
42. Detva	412	65	172	620	0.92	0.15	0.38	1.38
43. Krupina	349	54	86	488	0.60	0.09	0.15	0.84
44. Lučenec	640	87	204	897	0.77	0.10	0.25	1.09
45. Poltár	213	60	241	416	0.45	0.13	0.51	0.87
46. Revúca	552	871	1070	3381	0.76	1.19	1.47	4.63
47. Rimavská Sobota	1087	156	289	3407	0.74	0.11	0.20	2.32
48. Veľký Krtíš	496	103	1010	750	0.58	0.12	1.19	0.88
49. Zvolen	382	1259	657	570	0.50	1.66	0.87	0.75
50. Žarnovica	503	337	204	687	1.18	0.79	0.48	1.61
51. Žiar n/H	501	1763	909	13794	0.97	3.40	1.75	26.63
52. Bardejov	395	59	136	558	0.42	0.06	0.15	0.60
53. Humenné	346	524	688	539	0.46	0.69	0.91	0.72
54. Kežmarok	412	68	132	586	0.49	0.08	0.16	0.70
55. Levoča	210	34	65	302	0.59	0.09	0.18	0.85
56. Medzilaborce	175	25	43	239	0.41	0.06	0.10	0.56
57. Poprad	293	37	207	514	0.27	0.03	0.19	0.46
58. Prešov	642	73	349	1146	0.69	0.08	0.37	1.23
59. Sabinov	389	58	124	543	0.80	0.12	0.26	1.12
60. Snina	412	148	190	630	0.51	0.18	0.24	0.78
61. Stará Ľubovňa	507	76	141	722	0.81	0.12	0.23	1.16
62. Stropkov	144	19	42	197	0.37	0.05	0.11	0.51
63. Svidník	276	38	79	373	0.50	0.07	0.14	0.68
64. Vranov n/T	398	2249	650	1162	0.52	2.92	0.85	1.51
65. Gelnica	402	61	103	880	0.69	0.10	0.18	1.51
66. Košice	3418	10307	9975	102663	14.07	42.42	41.05	422.48
67. Košice - okolie	936	129	848	1327	0.61	0.08	0.55	0.87
68. Michalovce	339	1082	4101	1535	0.33	1.06	4.02	1.51
69. Rožňava	1027	2324	1079	1855	0.88	1.98	0.92	1.58
70. Sobrance	170	27	51	243	0.32	0.05	0.09	0.45
71. Spišská Nová Ves	405	143	175	3297	0.69	0.24	0.30	5.62
72. Trebišov	378	57	180	536	0.35	0.05	0.17	0.50
Slovakia	34764	70307	47066	183338	0.71	1.43	0.96	3.74

Fig. 4.3 **Specific territorial emission – 2007**



Tab. 4.7 **NMVOC emissions [t] in the SR**

Sector / Subsector	1990	1995	2000	2001	2002	2003	2004	2005	2006
Combustion on energy and transformation industries	335	258	201	221	215	214	203	185	174
Public power	223	187	139	159	147	161	156	139	131
District heating plants	112	71	62	62	67	53	47	46	43
Non-industrial combustion plants	12641	9618	7913	8305	7070	7505	8931	11934	11162
Commercial and institutional plants	226	150	26	27	23	24	25	28	27
Agriculture	IE	IE	6	7	7,5	7	7	9	8
Residential plants	12415	9468	7881	8271	7040	7474	8899	11897	11127
Combustion in manufacturing industry	981	805	585	772	647	704	753	806	898
Comb. in boilers, gas turb. and stat. engines	206	150	159	231	146	169	121	121	117
Iron production	32	29	28	29	32	35	34	33	37
Ore aglomeration	438	358	396	403	383	409	403	384	390
Copper production	305	268	2	109	85	91	195	268	353
Production processes	27029	11129	8717	8343	7727	7149	7103	6434	5823
Processes in petroleum industries	17188	7474	6627	6306	5571	4671	4617	4058	3469
Coke production	1053	834	719	719	765	801	800	783	787
Steel production	43	36	34	37	40	42	41	41	47
Rolling mills	233	297	300	267	304	336	329	341	361
Aluminium production	0,101	0,049	0,165	0,165	0,165	0,167	0,235	0,2	0,2
Proc. in organic chemical industries	6437	1369	651	644	690	941	970	870	845
Food production	2073	1118	385	370	357	358	346	340	311
Road paving with asphalt	2.4	1.0	0.5	0.5	0.5	0.6	0.5	0.7	1.0
Exploitation&distrib. of natural resour.	8822	8535	5929	6161	6024	7431	7696	7105	6276
Exploitation&distribution of crude oil	5198	4298	3750	3848	3801	3999	4149	4281	4472
Distribution of fuel	3624	4237	2179	2313	2223	3432	3547	2824	1804
Solvent and other products use	52875	37315	28844	32579	35671	37151	38419	36687	37959
Use of paints and glues	32811	20687	13214	14025	15110	16369	18457	18918	19522
Dry cleaning and degreasing	11500	7945	6957	10026	11983	12287	11481	9227	9925
Processing of fat and oil	332	363	299	191	240	156	134	189	152
Products	8232	8320	8374	8337	8338	8339	8347	8353	8360
Road traffic	32611	32373	24479	26079	23292	25513	24224	18247	14994
Other traffic	953	599	528	524	500	460	469	488	449
Waste treatment and disposal	4538	259	208	180	320	192	204	231	226
Incineration of municipal waste	102	102	133	93	75	115	130	128	134
Incineration of industrial waste	157	157	66	81	204	43	53	66	72
Incineration of hospital waste	IE	IE	9	6	42	34	21	37	20
Agricultural waste*	4279								
Agriculture	651	436	436	436	436	436	436	436	436
Total	141438	101328	77840	83600	81902	86766	88438	82 553	78397

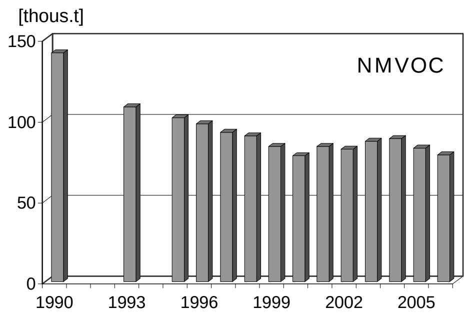
Emissions estimated to February 15, 2008

* *agricultural waste combustion is prohibited from the year 1994*

IE = included in other source category

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…, commercial and institutional plants and new sector agriculture (sector non-industrial combustion plants) was established.

Fig. 4.4 **Development trends in NMVOC emissions**

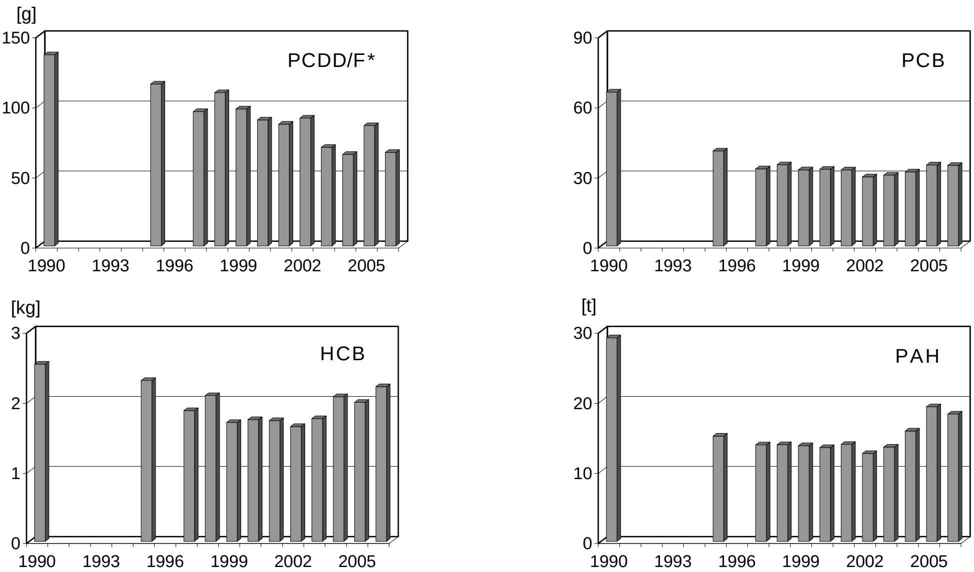


Tab. 4.8 **Emissions of persistent organic pollutants in the SR in 2006**

Sector / Subsector	PCDD/F* [g]	PCB [kg]	HCB [kg]	PAH sum PAH [kg]	B(a)P [kg]	B(k)F [kg]	B(b)F [kg]	I(1,2,3-cd)P [kg]
Combustion on energy and transformation industries	6.988	1.127	0.221	1457.051	55.380	438.368	438.583	524.720
Public power	1.666	1.119	0.216	0.875	0.058	0.284	0.435	0.099
District heating plants	0.075	0.008	0.005	1.988	0.023	0.931	0.995	0.038
Coke production	5.246			1454.188	55.299	437.153	437.153	524.583
Non-industrial combustion plants	3.683	9.941	0.172	15048.001	4281.257	1876.522	5620.102	3270.121
Commercial and institutional plants	0.031	0.008	0.002	0.404	0.006	0.186	0.203	0.010
Residential plants	3.648	9.929	0.169	15047.288	4281.230	1876.245	5619.736	3270.077
Agriculture	0.005	0.003	0.001	0.310	0.021	0.092	0.163	0.034
Combustion in manufacturing industry	27.302	7.071	0.465	149.011	76.866	27.592	34.803	9.750
Comb. in boilers, gas turb. and stat. eng.	0.735	0.898	0.141	32.398	1.722	11.028	16.853	2.795
Iron production	0.415	0.026		70.470	70.470			
Ore agglomeration	24.859	3.904	0.114	41.421	4.259	15.440	15.440	6.282
Cast iron production	0.113	0.022		0.018	0.003	0.006	0.006	0.003
Others	1.181	2.220	0.211	4.703	0.411	1.118	2.505	0.669
Production processes	6.406	2.128	0.541	1279.863	470.808	375.860	384.218	48.977
Aluminium production	0.397	0.066		581.092	189.947	183.621	183.621	23.902
Steel production	4.733	1.997		88.622	88.622			
Carbon mineral production				610.149	192.239	192.239	200.597	25.075
Wood impregnation								
Others	1.276	0.065	0.541					
Road traffic	0.129	11.438	0.009	105.995	14.050	36.758	37.377	17.809
Other traffic	0.008	0.753	0.001	9.033	2.258	1.355	3.162	2.258
Waste treatment and disposal	22.196	2.013	0.799	134.505	37.815	26.691	55.531	14.468
Incineration of municipal waste	5.729	1.005	0.569	7.373	0.133	3.604	3.604	0.032
Incineration of industrial waste	5.442	0.726	0.218	2.821	0.051	1.379	1.379	0.012
Incineration of hospital waste	10.317	0.206	0.001	0.802	0.014	0.392	0.392	0.004
Others	0.708	0.075	0.011	123.509	37.617	21.316	50.156	14.420
Total	66.711	34.469	2.208	18183.458	4938.435	2783.145	6573.776	3888.103

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 15, 2008

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

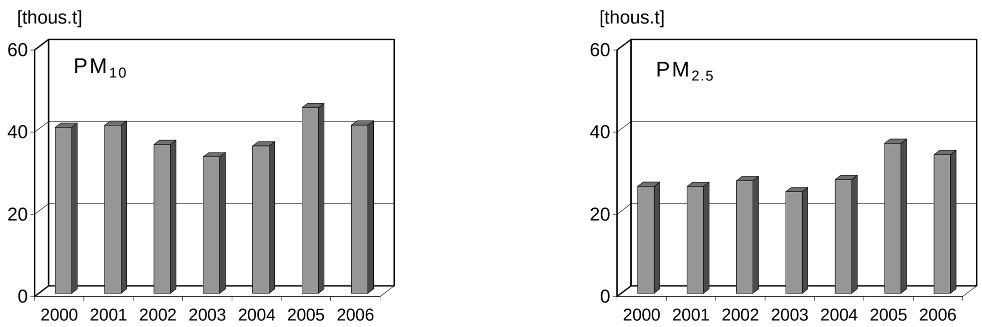


Tab. 4.9 **PM_{10} and $PM_{2.5}$ emissions [thous. t] in the SR**

Sector / Subsector	2001		2002		2003		2004		2005		2006	
	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	5.452	2.355	4.701	1.847	5.206	2.800	5.246	2.598	9.847	5.830	7.390	4.920
Public Electricity and Heat Production	4.595	1.857	4.173	1.593	3.689	1.854	4.175	1.978	9.052	5.194	6.654	4.308
Petroleum refining	0.039	0.016	0.031	0.012	0.095	0.079	0.077	0.058	0.090	0.075	0.069	0.046
Coke production	0.818	0.483	0.498	0.242	1.422	0.867	0.995	0.562	0.705	0.561	0.667	0.566
Combustion processes II	19.021	14.802	16.347	13.676	17.368	14.773	20.435	17.994	27.292	24.552	25.474	22.772
Commercial and institutional plants	0.510	0.286	0.403	0.226	0.453	0.264	0.291	0.166	0.259	0.161	0.184	0.118
Residential plants	18.096	14.290	15.522	13.218	16.563	14.321	19.836	17.644	26.742	24.230	25.016	22.485
Agriculture	0.163	0.095	0.157	0.088	0.124	0.061	0.140	0.074	0.135	0.068	0.114	0.058
Other combustion processes	0.252	0.130	0.266	0.145	0.228	0.126	0.168	0.111	0.156	0.093	0.160	0.111
Combustion processes in industry	12.513	5.437	11.165	8.411	6.866	3.903	6.218	3.633	4.062	2.357	3.935	2.462
Production of iron and steel	9.141	3.196	8.105	6.347	3.953	1.982	2.676	1.324	1.382	0.682	1.528	0.699
Production of non-ferrous metals	0.169	0.126	0.147	0.106	0.128	0.100	0.133	0.110	0.176	0.143	0.121	0.100
Chemical industry	0.927	0.611	0.744	0.582	0.611	0.451	1.158	0.910	0.576	0.409	0.433	0.315
Production of paper and cellulose	0.293	0.201	0.306	0.209	0.360	0.265	0.530	0.232	0.331	0.194	0.457	0.432
Food production	0.109	0.067	0.094	0.061	0.079	0.045	0.091	0.061	0.099	0.069	0.086	0.059
Other combustion processes in industry	1.873	1.237	1.768	1.107	1.735	1.061	1.630	0.996	1.498	0.860	1.311	0.857
Transportation	3.268	2.941	3.379	3.045	3.269	2.930	3.515	3.156	3.601	3.177	2.807	2.415
Civil aviation	0.006	0.006	0.006	0.006	0.007	0.007	0.008	0.008	0.009	0.009	0.010	0.010
Road transport	2.387	2.387	2.517	2.517	2.430	2.430	2.629	2.629	2.591	2.591	1.869	1.869
Road transport - abrasion	0.497	0.190	0.514	0.198	0.526	0.203	0.560	0.217	0.669	0.261	0.619	0.242
Railways	0.197	0.186	0.184	0.174	0.147	0.140	0.141	0.134	0.137	0.130	0.145	0.139
Navigation	0.181	0.172	0.159	0.150	0.158	0.150	0.177	0.168	0.195	0.185	0.163	0.155
Industrial technologies	0.651	0.490	0.640	0.439	0.513	0.346	0.473	0.294	0.414	0.237	0.404	0.218
Mineral products	0.158	0.047	0.171	0.050	0.147	0.044	0.169	0.050	0.183	0.054	0.200	0.059
Chemical industry	0.142	0.118	0.124	0.103	0.132	0.110	0.146	0.120	0.082	0.066	0.111	0.086
Paper and pulp	0.0003	0.0002	0.0002	0.0001	0.0002	0.0002	0.0002	0.0002	0.0003	0.0002	0.001	0.0003
Other industrial processes	0.350	0.324	0.345	0.286	0.233	0.193	0.157	0.124	0.148	0.116	0.092	0.073
Total	40.905	26.025	36.233	27.419	33.223	24.751	35.886	27.674	45.216	36.152	40.010	32.788

Emissions estimated to February 15, 2008

Fig. 4.6 **Development tends in PM_{10} a $PM_{2.5}$ emissions**

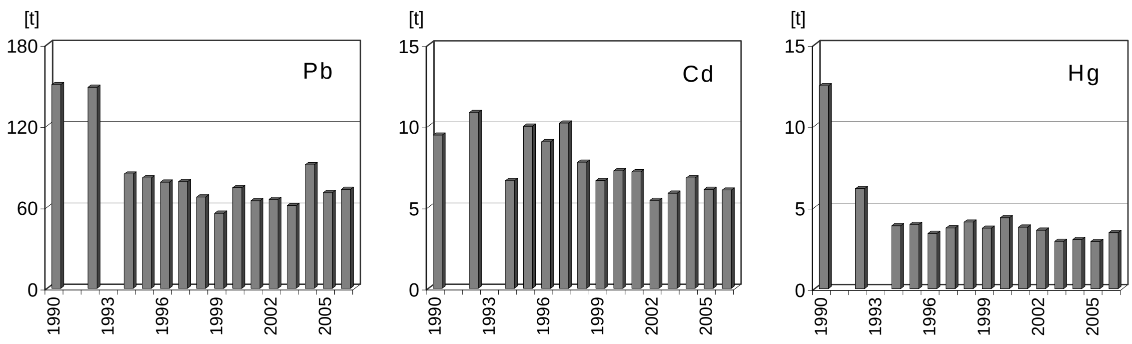


Tab. 4.10 **Emissions of heavy metals [t] in the SR in 2006**

Sector / Subsector	Pb	As	Cd	Cr	Cu	Hg	Ni	Se	Zn
Combustion on energy and transformation industries	0.758	1.029	0.031	0.837	0.761	0.039	0.988	0.181	1.384
Public power	0.414	0.982	0.016	0.826	0.749	0.029	0.908	0.179	0.893
District heating plants	0.343	0.046	0.015	0.011	0.013	0.011	0.081	0.002	0.491
Non-industrial combustion plants	1.098	0.848	0.032	0.365	0.466	0.033	0.406	0.047	3.247
Commercial and institutional plants	0.086	0.093	0.004	0.032	0.030	0.003	0.027	0.003	0.141
Residential plants	0.981	0.744	0.027	0.326	0.432	0.028	0.301	0.042	3.063
Agriculture	0.031	0.011	0.001	0.007	0.004	0.002	0.078	0.002	0.043
Combustion in manufacturing industry	55.648	24.556	5.176	2.988	35.794	2.348	12.074	9.333	39.401
Comb. in boilers, gas turb. and stat. engines	3.792	0.562	0.171	0.504	0.300	0.175	7.192	0.190	5.154
Iron production	0.141	0.012	0.224	1.065	0.083	0.357	3.548	0.046	8.875
Glass production	11.661	1.655	4.526	0.727	0.182	0.015	0.575	5.449	3.330
Ore agglomeration	30.022	0.686	0.0177	0.661	9.867	1.800	0.757	1.394	15.708
Copper production	9.802	21.611	0.188		25.358	0.001		2.254	6.268
Cement production	0.228	0.003	0.047	0.025		0.0007	0.0003	0.0004	0.058
Aluminium oxide production									
Magnesite production	0.001	0.027	0.002	0.006	0.004	0.0001	0.001		0.007
Production processes	1.854	0.095	0.040	1.008	3.280	0.399	8.701	0.016	19.110
Steel production	1.439	0.078	0.016	0.183	2.841	0.016	2.872	0.016	5.995
Aluminium production			0.016				1.583		1.583
Ferro alloys production	0.173	0.012	0.005	0.003	0.007		0.002		0.836
Pig iron production	0.134	0.005	0.003	0.022			0.012		0.096
Galvanizing	0.092			0.800	0.276		4.232		8.004
Alloys (Cu-Zn) production	0.016				0.156				2.596
Inorganic chemical industry						0.383			
Road traffic	1.877		0.018	0.088	3.003		0.124	0.018	1.766
Other traffic			0.0008	0.004	0.128		0.005	0.0008	0.076
Waste treatment and disposal	11.798	0.014	0.754	0.898	1.456	0.625	0.521	0.008	5.182
Incineration of municipal waste	8.536	0.009	0.474	0.854	1.176	0.341	0.512	0.003	3.225
Incineration of industrial waste	2.540	0.004	0.218	0.035	0.218	0.218	0.007	0.004	1.524
Incineration of hospital waste	0.722	0.001	0.062	0.010	0.062	0.062	0.002	0.001	0.433
Cremation						0.004			
Total	73.033	26.542	6.050	6.188	44.888	3.444	22.819	9.603	70.165

Emissions estimated to February 15, 2008

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



5

GREENHOUSE GAS EMISSIONS

5.1 GREENHOUSE GAS EMISSIONS

Framework Convention on Climate Change (UN FCCC)

Global climate change due to the anthropogenic emission of greenhouse gases is the most important environmental problem in the history of mankind. The framework Convention on Climate Change (UN FCCC)[1] - the basic international legal instrument to protect global climate was adopted at the UN conference on the environment and sustainable development (Rio de Janeiro 1992). The final goal of the Convention is to achieve stabilisation of greenhouse gas concentrations in the atmosphere at a level that has not yet developed any dangerous interference in the climate system.

In the Slovak Republic, the UN Convention came into force on March 21, 1994. The Slovak Republic accepted all the commitments of the Convention. The Framework Convention ratified 183 countries including the European Union until present. Most members of the Organization for Economic Cooperation and Development (OECD) as well as the Slovak Republic – known collectively as Annex I countries – committed themselves to adopting policies and measures to reduced their greenhouse gas (GHG) emissions under the Convention.

Kyoto protocol

The Kyoto Protocol, adopted by consensus at the third session of the Conference of the Parties (COP-3) in Kyoto, December 1997, enforced the international responsibility for the climate change. The all Annex I countries which ratified the Kyoto Protocol (KP), formally defined their reduction targets in articles of the KP. The Kyoto Protocol came into force on February 16, 2005 after compliance of requirement determined in Article 25, paragraph 1; it means after signing of more than one-half of Annex I countries, that representing of minimum 55 % of total CO_2 emissions of Annex I countries in 1990 (the signature of the Russian Federation ensured the majority). The Slovak Republic and the most countries of Central and East Europe agreed to reduce base year level of all six GHG emissions by 8 % during period 2008–2012. Up to date, 183 countries and one regional integration organisation (the European Community) had ratified, accepted, approved or acceded to the Kyoto Protocol. A meeting of the commitments gain high priority in the EU.

The KP targets for the "old" EU member states represent the 8 % reduction of all GHGs against base year for the 2008–2012 period. The different emission or reduction targets were agreed for each „old“ member state with the EU approval as „burden-sharing agreement“ (Article 4, KP).[2]

The new member states have individual targets under the Kyoto Protocol. The Czech Republic, Estonia, Bulgaria, Latvia, Lithuania, Romania, Slovakia and Slovenia have reduction targets of 8 % from the base year, while Hungary and Poland have reduction targets of 6 %. Cyprus and Malta have no Kyoto target, while Croatia has a reduction target of 5 %. The additional EEA member countries Norway and Iceland are allowed to increase emissions under the Kyoto Protocol, by 1 % and 10 % respectively, from their base year emissions. The candidate country Turkey has ratified the UNFCCC, but not the Kyoto Protocol. Lichtenstein and Switzerland have a reduction target of 8 %.

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[1] http://www.unfccc.de

[2] *In the Council decision (2002/358/EC) on the approval by the EU of the Kyoto Protocol the various commitments of the Member States are expressed as percentage changes from the base-year. In 2006 the respective emission levels were expressed in terms of tonnes of CO_2-equivalent in the Commission Decision 2006/944/EC. In connection with Council decision 2002/358/EC, the Council of Environment Ministers and the Commission have, in a joint statement all community and MS initial reports which have been reviewed under the Kyoto Protocol.*

In the context of joining of the Slovak Republic the European Union (May 1, 2004), raised the new requirements for legislative implementation in the field of air protection. The European Union considers the area of climate change for the one of the four environmental priorities.[3] The Slovak Republic submit the data about GHG emissions in the relevant extend to the January 15, annually according to the Decision No 280/2004/EC of the European Parliament and of the Council concerning a Mechanism for Monitoring Community GHG emissions and for implementing the Kyoto Protocol.[4] The ground for the implementing of the decision were the following criteria:

1. Monitoring of the all anthropogenic emissions of GHGs in the EU member states.
2. Ensure the progress in the fulfilling the reduction targets UNFCCC and the Kyoto Protocol.
3. Implement Convention and Kyoto Protocol in the view of the national programs, GHGs inventory, national system and register EU and the member states.
4. Ensure completeness, transparency, consistency, accuracy, comparability and the timing in the EC reporting.

In spring 2007, the European Council adopted the unilateral commitment to reduce EU GHG emissions by at least 20 % by 2020 compared to 1990 levels. Furthermore, the EU would increase this reduction to 30 %, provided that other developed countries commit themselves to comparable emission reductions and economically more advanced developing countries to contributing adequately according to their responsibilities and respective capabilities.

As a follow up to its commitment, the European Commission put forward in January 2008 the climate change and energy package[5] including new legislative measures covering the main sectors of the EU economy. Separate targets are proposed for the sectors covered under the EU emissions trading system (ETS) and those not covered by the EU ETS. Emissions covered by the EU ETS are to be reduced by 21 % from 2005 levels by 2020. A single EU-wide cap on ETS emissions would be set, and free allocation of emission allowances would be progressively replaced by auctioning of allowances by 2020. Emissions not covered by the EU ETS (agriculture, buildings, transport, waste) are to be reduced by 10 % from 2005 levels by 2020, with differentiated targets per MS according to relative levels of current and extended GDP/capita.

The climate change and energy package included following policies and measures:

1. EU ETS: A legislative proposal to expand, stengthen and improve the functioning of the EU ETS post-2012.
2. Effort Sharing: A legislative proposal for a framework for national commitments to reduce emissions which are outside the scope of the EU ETS.
3. Renewables: A legislative proposal to increase the share of renewable energy in the EU’s final energy consumption to 20 % by 2020, and of biofuels in transport to 10 %.
4. CCS: Policies to encourage early demonstration of capture and geological storage of carbon including a legislative proposal for a regulatory framework.

Greenhouse effect of the atmosphere

The greenhouse effect of the atmosphere is a similar effect to that which may be observed in greenhouses, however the function of glass in the atmosphere is taken over by the "greenhouse gases" (international abbreviation GHGs). Short wave solar radiation is transmitted freely through the greenhouse gases, falling to the earth's surface and heating it. Long wave (infrared) radiation, emitted by the earth's surface, is caught by these gases in a major way and partly reemitted towards the earth's surface. As a consequence of this effect, the average temperature of the surface atmosphere is 30 °C warmer than it would be without the greenhouse gases. Finally, this enables the life on our planet.

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[3] *New environmental action program: Environment 2010 Our Future, Our Choice*

[4] *OJ L 49, 19.2.2004, p. 1.*

[5] *Communication from the Commission: Progress Towards Achieving the Kyoto Objectives, Brussels, 7 August 2008.*

Greenhouse gases

The most important greenhouse gas in the atmosphere is water vapour (H_2O), which is responsible for approximately two thirds of the total greenhouse effect. Its content in the atmosphere is not directly affected by human activity, in principle it is determined by the natural water cycle, expressed in a very simple way, as the difference between evaporation and precipitation. Carbon dioxide (CO_2) contributes to the greenhouse effect more than 30 %, methane (CH_4), nitrous oxide (N_2O) and ozone (O_3), all three together 3 %. The group of man-made (artificial) substances - chlorofluorocarbons (CFCs), their substitutes, hydrofluorocarbons (HCFCs, HFCs) and others such as perfluorocarbons (PFCs) and SF_6, also belong to the greenhouse gases, but their presence in atmosphere is caused by anthropogenic activity. There are other photochemical active gases as well, such as carbon monoxide (CO), oxides of nitrogen (NO_x) and non-methane organic compounds (NMVOCs), which do not belong to the greenhouse gases, but contribute indirectly to the greenhouse effect of the atmosphere. They are registered together as the precursors of ozone in the atmosphere, as they influence the formation and disintegration of ozone in the atmosphere.

The UNFCC defines an obligation to register and inventory the emission of greenhouse gases (CO_2, CH_4, N_2O and F-gases, included HFCs, PFCs and SF_6) according to the adopted IPCC methodology.[6] The growth in concentrations of greenhouse gases in the atmosphere (caused by anthropogenic emission) leads to the strengthening of the greenhouse gas effect and thus to the additional warming of the atmosphere. The present climate models estimate that global average temperature will rise by about 1.4–5.8 °C by the year 2100.

Concentrations of greenhouse gases in the atmosphere are formed by the difference between their emission (release into the atmosphere) and sink. It follows then that the increase of their content in the atmosphere operates by two mechanisms:

- emissions into the atmosphere
- weakening of natural sink mechanisms

Stabilizing atmospheric concentrations of greenhouse gases will demand a major effort. Without emissions – control policies motivated by concerns about climate change, atmospheric concentrations of carbon dioxide are expected to rise from today's 367 ppm to 490–1 260 ppm by the year 2100. This would represent a 75–350 % increase since the year 1750. Stabilizing concentrations at, for example, 450 ppm would require world-wide emissions to fall below 1990 levels within the next few decades. Carbon dioxide is currently responsible for over 60 % of the "enhanced" greenhouse effect. This gas occurs naturally in the atmosphere, but burning coal, oil and natural gas is releasing the carbon stored in these "fossil fuels" at an unprecedented rate. Likewise, deforestation releases carbon stored in trees. Current annual emissions amount to over 23 billion m^3 of CO_2, or almost 1 % of the total mass of carbon dioxide in the atmosphere.

A second important human influence on climate is aerosols. These clouds of microscopic particles are not a greenhouse gas, but in addition to various natural sources, they are produced from sulphur dioxide emitted mainly by power stations. Aerosols settle out of the air after only a few days, but they have a substantial impact on climate.

Methane levels have already increased by a factor of two and a half during the industrial era and currently contribute 20 % of the enhanced greenhouse effect. The rapid rise in methane started more recently due to intensive agriculture (mainly rice fields), animal husbandry, coal mining, natural gas mining, its transport and use as well as the biomass burning are all anthropogenic activities. As

[6] *Intergovernmental panel (IPCC - Intergovernmental panel on Climate Change http://www.ipcc.ch) was established in 1988 commonly by ECE (UNEP) and World Meteorological Organisation (WMO). Its task is to reach the authoritative international consensus in the scientific opinions on climate change. The working groups of IPCC (under the participation of the scientists from the whole world) prepare regular updated information for COP (Conference of Parties), where the latest knowledge in association with the global warming is included.*

distinct from CO_2, the disintegration of methane in the atmosphere is via chemical reactions (by OH radical). Residence time of methane in the atmosphere is 10–12 years. At present, the annual total anthropogenic methane emission is said to be approximately 0.4 billion tons, but the global growth rate of methane budget seemed to have been at steady-state.

Nitrous oxide (with an “adjustment-time” of 114 years), a number of industrial gases and ozone contribute the remaining 20 % of the enhanced greenhouse effect. Nitrous oxide levels have risen by 16 %, mainly due to intensive agriculture, overusing of fertilizers and inconvenient agriculture-technical procedures. Fuel combustion, some industrial technologies, large-scale livestock breeding and sewage are the sources of N_2O emissions. Global anthropogenic emission is estimated to be 3–7 million tons of nitrogen per year. Natural sources are approximately twice as large as anthropogenic ones. While chlorofluorocarbons (CFCs) are stabilizing due to emission controls introduced under Montreal Protocol to protect the stratospheric ozone layer, levels of long-lived gases such as HFCs, PFCs and sulphur hexafluoride are increasing. They are used as carrier gases for sprays, fillings in cooling and extinguishing systems, as insulating substances, as solvents at the production of semiconductors, etc. Apart from the fact that they attack atmospheric ozone, they are very inert gases so that even minor emissions have a great negative effect.

5.2 GREENHOUSE GAS EMISSIONS IN THE SLOVAK REPUBLIC

Total EU-27 greenhouse gas emissions were equal to 5 143 Mt CO_2-equivealents in 2006, this represent a slight decrease (–0.3 %) compared to 2005, bringing emissions 7.7 % below the 1990 level without LULUCF. By 2010, total EU-27 greenhouse gas emissions are projected to be 7.5 % lower than in 1990. This projection is based on member states estimates which take into account all existing domestic policies and measures. The projected decrease, compared to 1990, can reaches 11 % if additional domestic policies and measures are taken into account. In the long term, and in the absence of any current global post-Kyoto agreement, projected emissions by 2020 for EU-27 can be compared to the commitment target of a 20 % reduction, unilaterally decided by the European Council in March 2007. Between 1990 and 2006, EU-27 per capita emissions declined to 10.4 % tonnes CO_2 equivalents. The main decrease occurred particularly in the early 1990s. All new member states, except Cyprus, Malta and Slovenia have decreased their per capita emissions substantially since 1990. In 2006, the aggregated emissions of new member states were 36.9 % below 1990 levels. During the 1990s total emissions have declined substantially in almost all new member states, mainly due to introduction of market economies and the consequent restructuring or closure of heavily polluting and energy-intensive industries. After a decrease in the first half of the 1990s, emissions from transport have been increasing since 1995. Not only in the Slovak Republic the effective strategy of implementation of policies and measures is needed for the further decreasing of GHGs emissions.

The emissions of greenhouse gases in the Slovak Republic are estimated in accordance with the requirements of the UN FCCC[1] and the Kyoto Protocol. The values listed in Tables are updated annually if information provided in the Statistical Yearbook of the Slovak Republic is revised and/or if methodology is changed. Emissions were estimated in compliance with the methods provided in the IPCC Guidelines,[7] Good Practice Guidance (GPG)[8] and in the SHMÚ’s reports. The Fourth National Communication of the SR on the Climate Change was submitted on December 31, 2005 to the secretariat of the UNFCCC, completed with the Report on Demonstrable Progress to the Kyoto Protocol. The Communication is accessible on the web page www.enviro.gov.sk and was revised by

[7] *Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventory, Volume 1-3*

expert review team. In March 2007, the National Inventory System of the Slovak Republic[9] was revised under the in-depth review for the Initiation report of the SR by expert review team under responsibility of the secretariat of UNFCCC. The list of potential problems was published into the outcome report from the review for the information for Ministry of Environment of the SR and SHMU. The in-depth revision was a tool for the analysis of current status in the parties of the KP and to get eligibility for participation of the Kyoto flexible mechanisms after 2008. The final report IRR is published on the official web site of the National Inventory System of the Slovak Republic www.ghg-inventory.gov.sk.

Total GHG emission represented 48 902.42 Gg in 2006 (without sinks from land use, land use change and forestry (LULUCF)). This represents a reduction by more than 33 % in comparison with the reference year 1990. In comparison with 2005, the emissions decreased by 1 % (430 Gg). The emissions signified in the literature as net emissions with the sinks from LULUCF in 2006 were 45 873.70 Gg and decreased against previous year by 6 % caused by higher sinks in LULUCF and removing the consequences from the storm calamity in the High Tatra mountains. According to the decision of the Convention body the strictly recommended reporting software is CRFReporter, which generate automatically the required CRF Tables. The new reporting program was used also for recalculation the time series in the consistency way. The base year was agreed by national authority (Ministry of Environment). Total GHG emissions in the Slovak Republic are stable or slightly increasing due to recovery of economic activities, increase in transport, and expected increase in actual emissions of F-gases (mainly HFCs and SF_6). This indicates that achieving the Kyoto Protocol 2008–2012 is feasible, however in order to reach sustainability, additional strategies and measures should be endorsed. (Table 5.1).

Tab. 5.1 **Aggregate[10] anthropogenic emissions of GHG [Tg] in Slovakia in 1990–2006**

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Net CO_2	59.43	52.02	47.78	43.41	42.12	41.22	39.95	39.92	39.98	39.59	37.79	36.42	34.73	36.53	36.81	38.23	36.95
CO_2*	61.84	55.53	51.93	47.69	45.44	43.92	42.37	41.33	41.92	41.23	40.20	41.64	39.98	41.36	41.07	39.11	40.00
CH_4	5.40	5.15	4.85	4.47	4.45	4.64	4.58	4.63	4.86	5.07	4.68	4.73	5.33	4.96	4.93	4.63	4.63
N_2O	6.17	4.97	4.15	3.51	3.85	4.08	4.21	4.10	3.70	3.25	3.52	3.72	3.68	3.72	3.82	3.79	4.04
HFCs, PFCs, SF_6	0.27	0.27	0.25	0.16	0.14	0.15	0.08	0.11	0.08	0.09	0.10	0.11	0.13	0.17	0.19	0.21	0.26
Total (with net CO_2)	71.29	62.41	57.05	51.55	50.58	50.11	48.83	48.78	48.64	48.03	46.11	44.99	43.89	45.39	45.77	46.89	45.89
Total*	73.68	65.91	61.19	55.83	53.88	52.79	51.24	50.16	50.57	49.65	48.50	50.20	49.12	50.21	50.00	47.74	48.92

Emissions, as determinated to April 15, 2008
** GHG emissions without sinks from LULUCF*

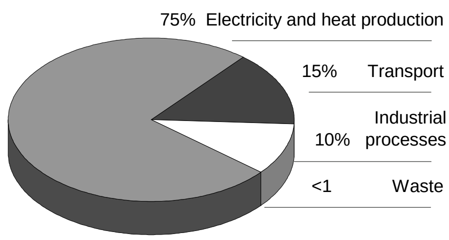
[8] *Good Practice Guidance and Uncertainty Management in National GHGs Inventories, IPCC 2000*
[9] *Vestnik MZP SR, 2007, 3, pages 19-45*
[10] *According to the currently valid convention the emission reduction expressed in CO_2 equivalent should be reported, Climate Change 1995, The Science of Climate Change GWP100: CO_2=1, CH_4=21, N_2O=310, F-gases =140-23 900*

CO_2 – carbon dioxide

Emissions

A most important anthropogenic source of CO_2 emissions in the atmosphere is combustion and transformation of fossil fuels, which account for about 90 % of the total CO_2 emissions in the SR. In addition, carbon dioxide arises during technological processes during the production of cement, lime, magnesite and using of limestone. The balance includes also the production of coke, iron and steel, as well as CO_2 emissions arising during aluminium and ammonia production. Emission factors, estimated on the carbon content in fuels, were used. Carbon dioxide enters the atmosphere via the conversion of grasslands and forest areas into agricultural land, and forest fires (Figure 5.1).

Fig. 5.1 **CO_2 emissions in 2006**



Total net CO_2 emissions decreased moderate in 2006 compared with the previous year, totally decreased by more than 35 % compared with the reference year 1990. The most feasible explanation of the significant CO_2 reduction is gradual decrease in energy demands in certain heavy energy demanding sectors (except for metallurgy) from 1993, higher share of services in the generation of the GDP, higher share of gas fuels in the primary energy resources consumption, restructuring of industries and the impact of air protection legislative measures influencing directly or indirectly the generation of greenhouse gas emissions.

At the same time, the moderate increasing trend in the CO_2 emissions is observed from 2000. This year is considered for the break year in the regeneration of the economy. It is expected the long-time increasing of the CO_2 emissions, approved by national projections.[11] Among the most important reasons appears the recovery of the Slovak economy, followed by new sources of pollution, and a shift to solid fuels due to the increased prices of natural gas. Similarly, increased trend in CO_2 emissions is also at the transport sector. It is anticipated a gradual increase of CO_2 emissions in this sector not only at the regional level, but it is a European problem, too.

Sinks

The Slovak Republic covers a territory of 49 036 km^2, of which 41 % is forest areas. Since the beginning of the century part of the agricultural land has been gradually transformed into forest. In the period 1950–2006, the amount of carbon fixed in the forests of the SR was increased approximately to the more than 50 Tg as a consequence of the forest area enlargement and an increase in hectare yield of wood mass. Fixation of carbon in forest ecosystems of the SR was estimated on the carbon balance in the part of the forest above the ground (trees, plant canopy, overlying humus) and that, under the ground (roots, humus in soil) including an assessment of wood exploitation and forest fires (Table 5.2). The new IPPC methodology[12] was implemented in the last inventory year for the estimation the sinks in the LULUCF sector according the good practice. According the recommendations and requirements amended in the COP7, were in the sense of the time series consistency the emissions and sinks recalculated for the 1990–2006. The changes and the base year were evaluated. Total emissions and sinks are balanced as changes in the area of the following categories: forest, cropland (arable land), grassland, wetlands, settlements and other land. The special category is biomass burning controlled and wild forest fires. All GHGs are estimated in these categories.

[11] *The Biennial Report 2007 according Decision 280/2004/EC*
[12] *IPCC Good Practice Guidance for Land Use, Land-Use Change and Forestry. 2003*

Tab. 5.2 **Total emissions and sinks of CO_2 [Gg] within 1990–2006**

	1990	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Net CO_2	59 432	41 221	39 950	39 925	39 981	39 594	37 792	36 416	34 729	36 526	36 814	39 827	36 933
CO_2*	61 838	43 917	42 372	41 327	41 921	41 230	40 195	41 642	39 972	41 359	41 065	40 704	39 984
Fossil fuel combustion	57 931	40 692	39 136	38 014	37 904	37 183	36 628	37 981	36 285	37 971	36 879	36 567	35 837
Electricity and heat prod.	53 039	36 433	34 824	33 534	33 141	32 527	32 445	33 226	31 394	32 975	31 604	30 353	30 036
Transport	4 892	4 258	4 313	4 480	4 763	4 656	4 182	4 755	4 892	4 996	5 275	6 214	5 801
Industrial processes	3 840	3 158	3 168	3 264	3 921	3 980	3 501	3 605	3 647	3 355	4 161	4 125	4 124
Mineral products	2 942	2 342	2 250	2 331	3 032	3 052	2 522	2 590	2 602	2 303	2 983	2 967	3 014
Chemical industry	356	380	407	405	360	360	399	407	396	350	403	422	351
Production of metals	542	437	512	528	528	567	580	608	649	703	775	737	760
LULUCF	-2 407	-2 696	-2 422	-1 402	-1 939	-1 636	-2 403	-5 225	-5 243	-4 833	-4 251	-877	-3 051
Forest	-4 454	-4 399	-3 968	-2 717	-3 130	-2 800	-4 318	-5 551	-5 641	-5 156	-3 995	-701	-3 097
Cropland	3 287	2 063	2 063	3 226	1 798	1 711	4 394	1 002	1 174	1 416	-14	1	1
Grassland	536	256	93	-50	70	-126	-797	-880	-874	-1 363	-373	-442	-439
Other land	-1 775	-615	-609	-1 861	-677	-420	-1 682	204	98	269	132	264	484
Waste	67	67	67	48	97	67	67	55	39	33	25	13	23
Waste incineration	67	67	67	48	97	67	67	55	39	33	25	13	23
Burning biomass**	314	125	107	95	89	87	80	99	129	98	121	172	190
International bunkers**	128	103	102	76	84	52	45	69	72	79	86	91	132

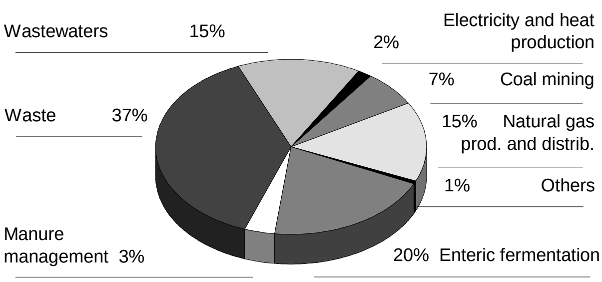
Emissions, as determinated to April 15, 2008
* *CO_2 emissions without sinks from LULUCF*
** *CO_2 emissions are not being accounted into the total emissions*

CH_4 – methane

Agriculture, large-scale beef cattle and pig breeding, are major sources of methane on our territory. The CH_4 does arise as the direct product of the metabolism in herbivores and as the product of organic degradation in animal excrement. Calculations of emissions for the Slovak Republic are based on the data listed in the Statistical Yearbooks and the Green Report of the Slovak Ministry of Agriculture. Leaks of natural gas in the distribution networks are a very important source of methane. Methane is also leaking into the atmosphere in brown coal mining and biomass burning. In addition, municipal waste dumps and sewage (predominantly septic tanks) are also important methane sources. Methane arises without the direct access of oxygen (Figure 5.2).

Total methane emissions reached in 2006 220.4 Gg, what is comparable to the previous year. Emissions decreased by 14 % compared to the reference year 1990. The most important changes were recorded in the sector of solid waste disposal sites (SWDS). The revision of emission factors and selection of appropriate parameters were carried out. The revision dealt with the data from 1960. The cooperation of sectoral expert with the expert for uncertainty was established. Using the Tier 2 method - First Order Decay, the total revision of methane emissions from solid waste disposal sites for time series 1960–2006 was performed. The uncertainty for the methane emissions from solid waste disposal site was decreased and accuracy was increased. The implementation of the kinetic model for SWDS´s emission balance was one of requirement for the acceptation of annual inventory for base year by expert review team during in-depth review.

Fig. 5.2 **CH_4 emissions in 2006**



The important methodology change in agricultural sector was performed based on Tier 2 methodology and regional input activity data in enteric fermentation of the key animal categories (cattle, sheep, swine), as well as. The methane emissions decreased in all sub-sectors except LULUCF and waste, caused by implementation of new methodologies. (Table 5.3).

Tab. 5.3 Total emissions of CH_4 [Gg] within 1990–2006

	1990	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Total CH_4 emissions	256.9	221.2	217.9	220.3	231.6	241.5	223.1	225.4	253.8	236.1	234.6	220.4	220.4
Energy	73.9	69.6	68.6	68.0	71.2	68.8	70.9	68.8	65.1	62.7	59.2	53.2	51.8
Fossil fuel combustion	22.3	10.8	8.8	7.4	8.0	7.3	8.0	7.6	5.6	5.6	5.2	5.1	5.0
Electricity and heat prod.	21.2	9.6	7.7	6.2	6.7	6.0	6.9	6.3	4.4	4.4	3.9	3.7	3.9
Transport	1.0	1.1	1.2	1.2	1.3	1.3	1.1	1.3	1.2	1.2	1.3	1.3	1.1
Fugitive emissions	51.6	58.8	59.8	60.6	63.2	61.5	62.9	61.2	59.4	57.0	54.1	48.1	46.8
Coal mining	27.2	29.7	30.1	30.6	31.2	29.5	28.8	26.3	25.7	21.1	19.8	16.2	14.7
Natural gas produc.&distrib.	24.5	29.1	29.7	30.0	32.0	32.0	34.1	34.9	33.7	35.9	34.3	32.0	32.1
Industrial processes	0.039	0.041	0.044	0.044	0.039	0.039	0.043	0.048	0.042	0.037	0.043	0.043	0.038
Chemical industry	0.039	0.041	0.044	0.044	0.039	0.039	0.043	0.048	0.042	0.037	0.043	0.043	0.038
Agriculture	112.3	80.2	75.3	67.7	63.1	60.6	59.4	61.1	59.5	56.9	52.1	52.6	51.7
Enteric fermentation	94.8	66.9	62.7	56.1	52.9	50.8	49.9	51.4	49.8	47.6	44.2	44.9	44.2
Manure management	17.6	13.3	12.6	11.6	10.2	9.9	9.5	9.6	9.7	9.3	7.8	7.7	7.5
LULUCF	0.7	0.5	0.5	0.5	0.5	0.6	0.7	0.7	0.7	0.7	0.8	1.1	0.9
Forest	0.7	0.5	0.5	0.5	0.5	0.6	0.7	0.7	0.7	0.7	0.8	1.1	0.9
Waste	70.6	71.4	74.0	84.6	97.3	112.0	92.7	95.5	129.2	116.5	123.2	114.6	116.8
Solid waste disposal sites	22.4	30.9	33.8	44.1	58.0	72.2	57.5	59.9	93.5	84.2	91.0	81.8	83.9
Wastewaters	48.2	40.4	40.0	40.3	39.1	39.6	35.1	35.4	35.5	32.1	32.0	32.7	32.7
Composting	0.1	0.1	0.1	0.2	0.2	0.2	0.1	0.2	0.2	0.2	0.2	0.1	0.2
International bunkers *	0.006	0.004	0.004	0.003	0.003	0.001	0.001	0.002	0.002	0.002	0.002	0.002	0.003

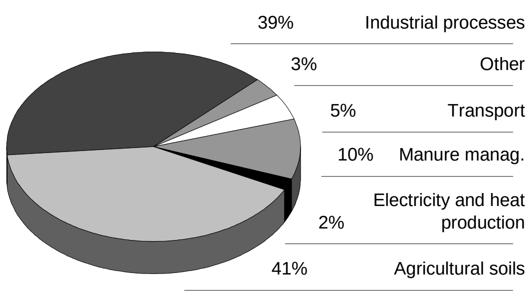
Emissions, as determinated to April 15, 2008

** CH_4 emissions are not being accounted into the total emissions*

N_2O – nitrous oxide

In comparison to the other greenhouse gases, the mechanism of nitrous oxide emissions and sinks is not explored fully. The values are charged with a relatively considerable degree of uncertainty. Surpluses of mineral nitrogen in soil (consequence of intense fertilizing) and unfavourable aerial soil conditions (heavy mechanical tillage) are the main cause of N_2O emissions. Emissions in power industry and traffic were estimated on the balance in fossil fuel consumption, by applying the default emission factors according to the IPCC methodology.[7,8] The N_2O emission arising by manipulation of sewage and sludge has been estimated also for municipal and industrial wastewater treatment plants (Figure 5.3).

Fig. 5.3 **N_2O emissions in 2006**



In 2006, the total N_2O emissions slightly increased compared with the year 2005 and reached 13.03 Gg. However, the drop compared to the reference year 1990 is more than 34 %. The N_2O emissions raised from 2000, continuously. The most substantial increase was recorded in transport sector by more than 44 % and industrial processes sector (chemical industry). The later regards to increase in chemical production (nitric acid). The higher increase of N_2O emissions is observed in waste, sector , the emissions raised about 90 % from base year. This relates to the amount of industrial wastewater treatment and detailed methodology and changes in the consideration of the waste categories. Emissions of N_2O are show the higher level of uncertainty and the time series is slightly inconsistent comparable with other gases (Table 5.4).

Tab. 5.4 **Total emissions of N_2O [Gg] within 1990–2006**

	1990	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Total N_2O emissions	19.91	13.17	13.57	13.24	11.95	10.50	11.35	11.98	11.87	11.99	12.32	12.23	13.03
Fossil fuel combustion	0.98	0.65	0.65	0.67	0.71	0.72	0.69	0.77	0.76	0.80	0.79	0.88	0.84
Electricity and heat prod.	0.58	0.32	0.30	0.28	0.28	0.27	0.28	0.28	0.27	0.29	0.28	0.27	0.27
Transport	0.39	0.33	0.35	0.39	0.43	0.44	0.41	0.49	0.49	0.51	0.52	0.61	0.57
Industrial processes	3.71	3.63	4.24	4.01	3.41	2.56	3.33	3.77	3.37	3.73	4.26	4.13	5.05
Chemical industry	3.71	3.63	4.24	4.01	3.41	2.56	3.33	3.77	3.37	3.73	4.26	4.13	5.05
Solvent use	0.06	0.10	0.11	0.09	0.07	0.07	0.06	0.10	0.18	0.19	0.26	0.28	0.27
Agriculture	15.09	8.73	8.50	8.40	7.68	7.08	7.21	7.25	7.41	7.15	6.88	6.82	6.70
Manure management	3.53	2.36	2.18	2.00	1.76	1.68	1.64	1.59	1.58	1.53	1.43	1.38	1.34
Agricultural soils	11.56	6.37	6.32	6.40	5.92	5.40	5.56	5.66	5.84	5.62	5.46	5.45	5.36
LULUCF	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.02	0.01
Forest	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.02	0.01
Waste	0.09	0.07	0.07	0.07	0.07	0.07	0.06	0.09	0.15	0.12	0.12	0.12	0.17
Wastewaters	0.06	0.04	0.04	0.04	0.04	0.04	0.03	0.06	0.11	0.08	0.09	0.09	0.13
Waste incineration	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.03	0.02	0.02	0.02
Composting	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.02
International bunkers *	0.004	0.026	0.023	0.014	0.019	0.005	0.001	0.013	0.014	0.011	0.006	0.003	0.016

Emissions, as determinated to April 15, 2008
* *N_2O emissions are not being accounted into the total emission*

HFCs, PFCs, SF_6

Sources and emissions of the so-called F-gases have been assessed on the territory of the Slovak Republic. The procedure was carried out in coincidence with the methodology IPCC[7,8] and the actual and potential emissions were estimated within 1995–2006 (Table 5.5). These gases have not been produced in the SR. Sources of emissions are in their usage as coolants, extinguishing agents, foam substances, solvents, SF_6 as insulating gas in transformers and in the metallurgical industry. CF_4 and C_2F_6 arise in aluminium production. Using of HFCs, PFCs and SF_6 has risen since 1995 and this trend is expected in the future, as well.

Tab. 5.5 **Total emissions of HFCs, PFCs and SF_6 within 1990–2006**

	GWP		1990	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	
Total emissions CO_2 *eq.*		[Gg]	271.40	146.38	82.85	107.16	78.60	91.41	100.49	111.86	130.88	169.00	188.68	209.20	251.87
HFCs emissions CO_2 *eq.*		[Gg]	0.00	22.15	37.58	61.20	40.96	65.12	75.59	82.43	102.35	131.96	152.88	172.34	198.90
HFC-23	11 700	[Mg]		<0.01	0.06	0.06	0.05	0.05	0.06	0.06	0.04	0.08	0.08	0.08	0.08
HFC-32	650	[Mg]			0.02	0.10	0.10	0.10	0.30	0.56	1.15	1.85	2.39	3.55	5.02
HFC-41	150														
HFC-43-10mee	1 300														
HFC-125	2 800	[Mg]		0.01	0.07	0.19	0.41	0.73	1.85	3.27	5.58	7.91	9.85	12.48	15.98
HFC-134	1 000														
HFC-134a	1 300	[Mg]		9.17	22.77	38.60	27.76	43.88	45.94	42.75	47.19	60.07	66.49	70.69	76.57
HFC-152a	140	[Mg]			<0.01	0.13	0.29	0.60	0.83	1.02	1.21	1.36	1.22	1.22	1.22
HFC-143	300														
HFC-143a	3 800	[Mg]			0.11	0.30	0.44	0.78	1.85	3.37	5.35	7.20	8.70	10.21	12.51
HFC-227ea	2 900	[Mg]		3.52	2.29	2.92	0.48	0.80	0.80	0.80	0.44	0.23	0.01	0.00	0.01
HFC-236fa	6 300								0.05	0.22	0.38	0.22	0.50	0.53	0.43
HFC-245ca	560														
PFCs emissions CO_2 *eq*		[Gg]	271.37	114.32	34.51	34.62	25.40	13.60	11.65	15.59	13.75	21.65	19.91	20.25	35.82
CF_4	6 500	[Mg]	36.60	15.44	4.68	4.70	3.45	1.88	1.57	2.18	1.90	2.93	2.69	2.73	4.83
C_2F_6	9 200	[Mg]	3.60	1.53	0.45	0.44	0.32	0.15	0.15	0.15	0.15	0.28	0.26	0.27	0.48
C_3F_8	7 000														
C_4F_{10}	7 000														
$c\text{-}C_4F_8$	8 700														
C_5F_{12}	7 500														
C_6F_{14}	7 400														
SF_6 emissions CO_2 *eq.*		[Gg]	0.03	9.91	10.76	11.34	12.24	12.69	13.25	13.84	14.78	15.39	15.89	16.61	17.15
SF_6	23 900	[Mg]	0.00	0.42	0.45	0.47	0.51	0.53	0.56	0.58	0.62	0.64	0.67	0.70	0.72

Emissions, as determinated to April 15, 2008

In 2006, total F-gases emissions considerable increased. This trend was expected due to a special feature of the emissions. They have a long lifespan and both actual and potential emissions are taken into account. Compared with 2005, the emissions increased by 20 %. However, compared to the reference year 1990, the decease is more than 8 %. The most significant increase of emissions was recorded in the case of HFCs that substituted use of the PFCs. Emissions of CF_4 a C_2F_6 together with emissions of SF_6 are released in the production of aluminium. Their concentrations increased due to an increased production capacity (Table 5.5).

5.3 ASSESSMENT

In accordance with the generally expected results, the aggregated emission of GHGs in year 2006 are approximately at the same level from 2000 (without LULUCF). There is the significant decreasing of aggregated emission against the base year (1990) about approximately 24 776 Gg it means the decreasing about more then 34 % without sinks from LULUCF. A major share of aggregated emission covers the energy sector by about 76 %, the industrial processes sector covers about 12 %, the agriculture sector about 7 % and the waste sector more than 5 %. The solvent use sector covers less than 1 % of the total emissions. These shares are determined as emissions in CO_2 of aggregated equivalents[7] (Table 5.6).[10]

The GHG emission inventory should be assessed based upon its complexity due to uncertainty. These are caused and influenced by uncertainties of statistical data on fuel consumption. The applied emissions factors are another source of uncertainty. An additional error in calculation of the other GHG emissions may occur as a result of less exact methods and it can not be quantified. In spite of this, the uncertainty analysis determined by the Tier 1 method of the IPCC[8] estimated that the GHG emission inventory of 2006 is 12.7 % (according level assessment) and 7.8 % (according trend assessment). The calculation uncertainty by using the more sophisticated Tier 2 - Monte Carlo method is evaluated for the solid waste disposal site category. The essential result from our study is fact that total uncertainty was reduced comparable to IPCC default recommended value by Tier 1 (50 %). This value is 42 % for total methane emissions from SWDS according the time series from 1960.

In order to reduce uncertainty of emission inventory, it is necessary to determine and classify key sources and categories. The key sources were selected according to a cumulative contribution to the total emissions. They represent more than 95 % of total GHG emissions. Key sources and categories were determined according to the IPCC[8] method with and without LULUCF sector. In 2006, the Slovak Republic determined 17 key sources without LULUCF and 11 key sources with LULUCF to be assessed according to the level. According to anticipated trends was assessed 11 key sources without LULUCF and 17 with LULUCF. The most important key categories are combustion of fossil fuels, road transport, and agricultural emissions, waste disposal, enteric fermentation, production of nitric acid, cement, iron and steel productions. Composition of key sources has not been changed.

The GHG emissions reached the highest level at the end of 80-ies. In the period of 1990–1994 the reduction was about 25 %. From 1994, the emissions have been stable. In 2000, a significant decrease was recorded. In recent years, emissions increased, mainly emissions of $CO_{2,}$ due to recovery of the industrial production, transport and changes in fuels used (Figure 5.4).

A comparison of the GDP trend with the trend of aggregate emissions of greenhouse gasses shows that the SR is one of few countries where the trend of emissions is decoupled from the GDP increase. However, by international comparison, the generation of greenhouse gasses per capita still remains one of the highest in Europe. Without introduction of effective measures the Slovak Republic will contribute to further increase of GHG emissions due to anticipated growth of the GDP and recovery of economic activities. Therefore, the investment strategy to tackle GHG emissions is one of the most important objectives.

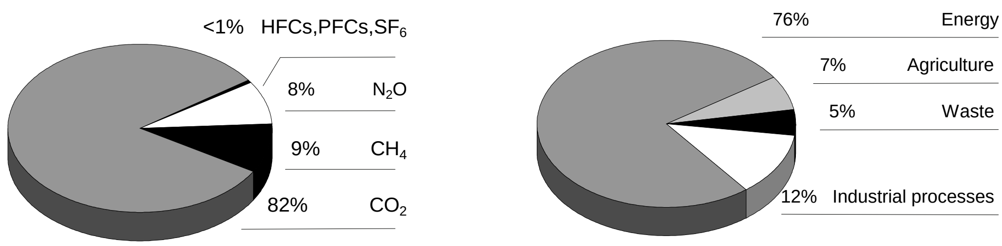
Concerning the actual and proposed dynamics of GDP growth in the Slovak Republic there exist legitimate assumption that GHG emissions will increase in line with it. Due to this scenario there is necessary to prepare investment strategies and programmes that allow us to achieve permanent distribution of GDP growth and emissions growth with the regards to the further the post-Kyoto reduction goals. The EC commitments include 20 % reduction the GHG emissions after 2020 against 1990. For the Slovak Republic is the strategic target within this connection to apply low-energy effective technologies for the energy production (for the new sources), emission trading, restructuring of industry and agriculture, development of service sector and the improvement of the industry and public awareness in the environment issues.

Tab. 5.6 **Aggregated emissions of GHGs according the sectors in CO_2 *eq*. [Tg] within 1990–2006**

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Energy*	59.79	54.27	50.59	46.54	44.02	42.35	40.78	39.65	39.62	38.85	38.33	39.67	37.89	39.54	38.37	37.96	37.19
Industrial Processes**	5.26	4.04	3.97	3.43	4.12	4.43	4.57	4.62	5.06	4.87	4.63	4.89	4.82	4.68	5.67	5.62	5.94
Solvent Use	0.02	0.02	0.02	0.02	0.02	0.03	0.03	0.03	0.02	0.02	0.02	0.03	0.06	0.06	0.08	0.09	0.08
Agriculture	7.04	6.04	5.09	4.39	4.22	4.39	4.22	4.02	3.71	3.47	3.48	3.53	3.55	3.41	3.23	3.22	3.16
LULUCF	-2.39	-3.50	-4.14	-4.27	-3.31	-2.68	-2.41	-1.39	-1.93	-1.62	-2.39	-5.21	-5.23	-4.81	-4.23	-0.85	-3.03
Waste	1.58	1.54	1.52	1.45	1.52	1.59	1.64	1.85	2.16	2.44	2.03	2.09	2.80	2.52	2.65	2.45	2.53
Total with LULUCF	71.29	62.41	57.05	51.55	50.58	50.11	48.83	48.78	48.64	48.03	46.11	44.99	43.89	45.39	45.77	48.48	45.87

Emissions, as determinated to April 15, 2008 **Including transport* ***Including F-gases*

Fig. 5.4 **Aggregated emissions of GHGs in 2006**



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