Slovak
Hydrometeorological Institute

Ministry of Environment
of the Slovak Republic

AIR POLLUTION

IN THE SLOVAK REPUBLIC

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REGIONAL AIR POLLUTION AND QUALITY OF PRECIPITATION

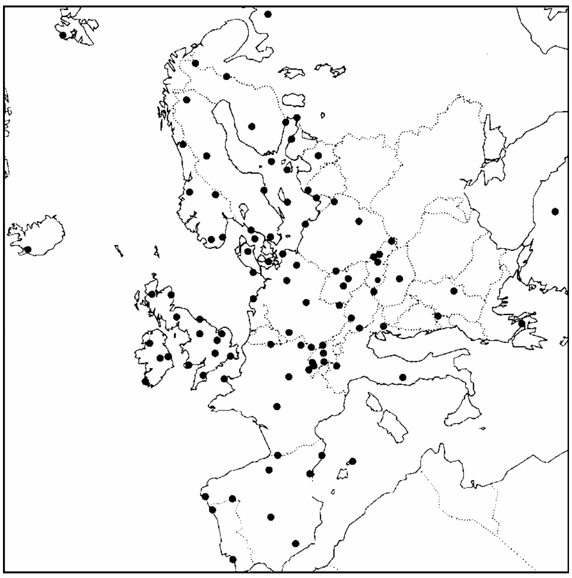
1.1 REGIONAL AIR POLLUTION AND QUALITY OF PRECIPITATION

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.

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 with 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. Five stations in the territory of Slovakia belonging to the national monitoring network of the Slovak Hydrometeorological Institute are at the same time also a part of EMEP network. The EMEP monitoring programme of sulphur compounds and precipitation has been gradually extended 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 under the measurement programme. In 2003 the new monitoring strategy has been adopted classifying stations into three levels (more details on www.emep.int).

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



1.2 EMEP STATIONS OF NATIONAL AIR QUALITY MONITORING NETWORK

In 2006, there were 5 stations of National Monitoring Network in operation in the Slovak Republic to monitor regional air pollution and chemical composition of precipitation. 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 the content of 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.

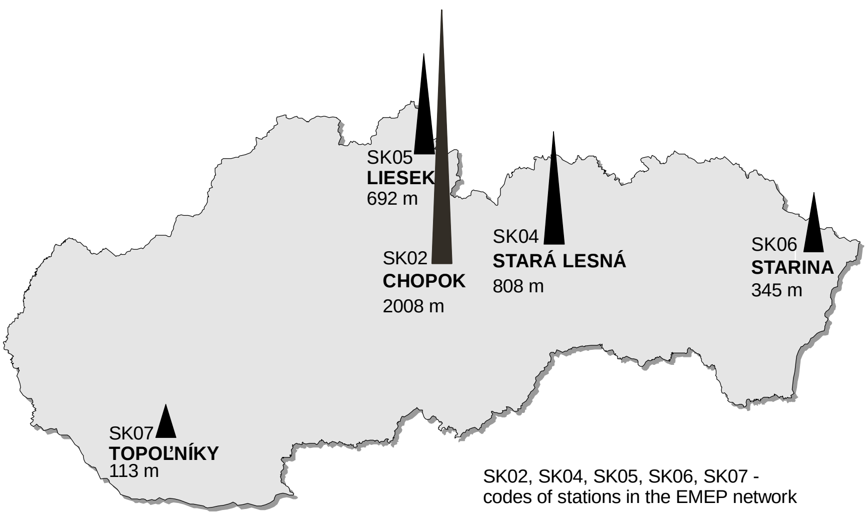
Liesek-Meteo. st., EMEP, SK510001
Meteorological observatory of the Slovak Hydrometeorological Institute on east-western side of the Roháče mountains, nearby to the Liesek village, 692 m above sea level, 19°40'46" longitude, 49°22'10"latitude. Measurements started to be carried out in 1988. Since 1992 the station has become a part of the EMEP 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 – 2006**



Measurement programme

AMBIENT AIR

Station	Continously				Manually																	
	PM_{10}	$PM_{2.5}$	Oxides of nitrogen (NOx)	Ozone (O_3)	PM_{10}	TSP*	Lead (Pb)	Arsenic (As)	Cadmium (Cd)	Nickel (Ni)	Chromium (Cr)	Copper (Cu)	Zinc (Zn)	Manganese (Mn)	Sulphur dioxide (SO_2)	Oxides of nitrogen (NOx)	Nitric acid (HNO_3)	Sulphates (SO_4^{2-})	Nitrates (NO_3^-)	Ozone precursors (VOC)	Ammonia, ammon. ions (NH_3, NH_4^+)	Alkali ions (K^+, Na^+, Ca^{2+}, Mg^{2+})
Chopok, EMEP				x		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	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		
Stará Lesná, AÚ SAV, EMEP			x	x	x		x	x	x	x	x	x	x	x	x	x	x	x	x		x	x
Liesek, Meteo. st., EMEP				x	x		x	x	x	x	x	x	x	x	x	x	x	x	x			

** TSP – Total suspended particles in ambient air*

ATMOSPHERIC PRECIPITATION

Station	pH	Hydrogen ions (H^+)	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	x
Topoľníky, Aszód	x	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	x
Stará Lesná, AÚ SAV, EMEP	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Liesek, Meteo. st., EMEP	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x

1.3 ASSESSMENT OF RESULTS FROM MEASUREMENTS IN 2006

SO_2, sulphates

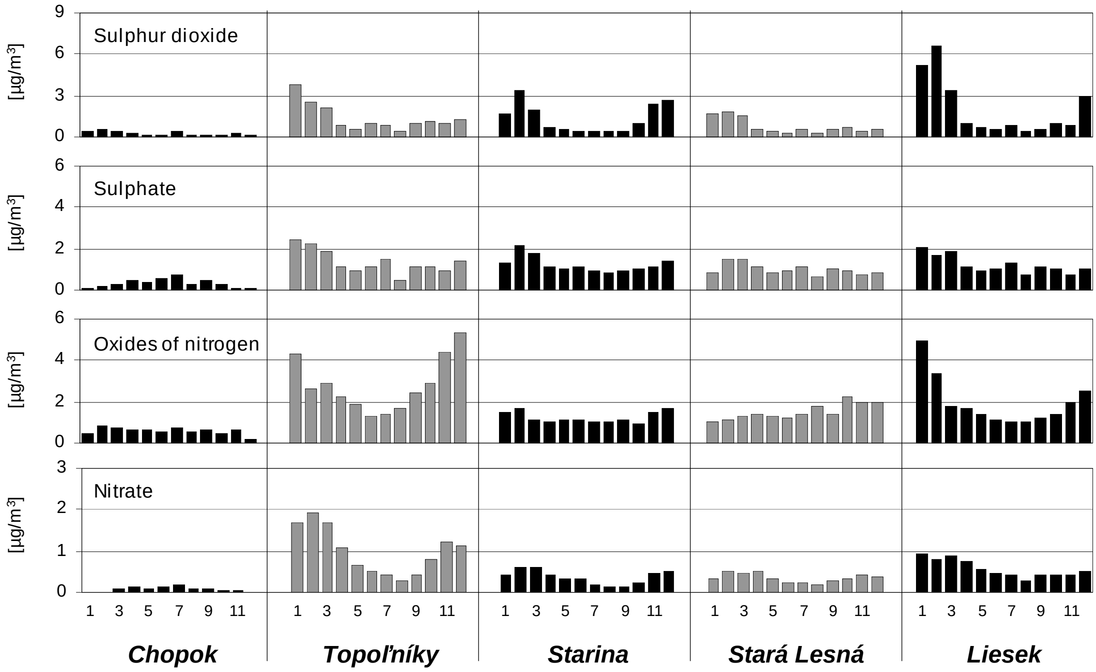
Background concentrations of sulphur dioxide recalculated in sulphur (Tab. 1.1, Fig. 1.3) ranged between 0.27 µg.m^{-3} (Chopok) and 2.0 µg.m^{-3} (Liesek), in 2006. Stations with lower elevation Topoľníky, Starina and Liesek showed higher concentrations of sulphur dioxide, exceeding 1 µg.m^{-3} and opposite the stations situated in higher positions Stará Lesná and Chopok showed values lower than 1 µg.m^{-3}. ***In coincidence with the Annex 1 to the Decree of the Ministry of Environment of the Slovak Republic No 705/2002 on air quality in wording of Decree n. 351/2007, limit value for protection of ecosystems is 20 µg SO_2.m^{-3} in calendar year and winter season. This value has not been exceeded at any of the stations. The highest value from all the listed stations 4 µg SO_2.m^{-3} (Liesek) presented in calendar year 2006 only one fifth of this limit value and in winter season (1.10.2005–31.3.2006) value 6.1 µg.m^{-3} (Liesek) represented less than one third of the mentioned limit value.*** Background concentration of sulphates in 2006 (Tab. 1.1, Fig. 1.3) was the lowest one at the Chopok station 0.33 µg.m^{-3} and the highest one at the Topoľníky station 1.37 µg.m^{-3}. Sulphates contributed to the total weight mass of particulate matter (Fig. 1.4) 14–20 %. Concentration ratio of sulphates to sulphur dioxide, recalculated in sulphur represents interval 0.61-1.31, corresponding to the background level of pollution.

Tab. 1.1 **Annual averages of gaseous and particulate components in ambient air, 2003–2006**

		SO_2 (S)	SO_4^{2-} (S)	NOx (N)	NO_3^- (N)	HNO_3 (N)	O_3	PM_{10}	Pb	Mn	Cu	Cd	Ni	Cr	Zn	As
		µg/m³	µg/m³	µg/m³	µg/m³	µg/m³	µg/m³	µg/m³	ng/m³	ng/m³	ng/m³	ng/m³	ng/m³	ng/m³	ng/m³	ng/m³
Chopok EMEP	2004	0.44	0.40	0.95	0.05	0.03	91	*7.6	2.38	1.50	0.40	0.07	0.60	1.04	5.13	0.19
	2005	0.43	0.48	0.69	0.16	0.03	95	*6.0	2.44	1.50	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	2.66	1.24	0.08	0.60	0.97	6.40	0.22
Topoľníky Aszód EMEP	2004	1.81	1.22	2.76	0.95	0.06	59	*20.2	11.62	6.56	3.00	0.28	1.12	1.23	17.21	0.97
	2005	1.31	1.31	2.64	0.98	0.05	60	*19.6	14.44	6.64	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	6.92	3.59	0.31	2.83	2.94	20.84	1.26
Starina Vod. nádrž EMEP	2004	1.24	1.09	1.57	0.34	0.05	66	16.3	12.78	3.89	1.72	0.51	0.71	0.62	17.49	0.60
	2005	1.07	1.09	1.06	0.36	0.04	66	18.4	12.43	4.10	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	5.83	1.99	0.31	0.69	0.72	16.32	0.76
St. Lesná AÚ SAV EMEP	2004	0.66	1.17	2.15	0.24	0.04	62	13.8	8.46	4.03	1.68	0.25	0.79	1.35	16.44	0.67
	2005	0.64	0.85	1.64	0.26	0.03	70	14.7	8.14	4.75	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	4.76	2.21	0.23	0.51	0.64	16.32	0.67
Liesek Meteo.st. EMEP	2004	1.76	1.00	1.87	0.46	0.03	62	17.9	11.66	20.2	2.05	0.41	0.71	0.61	30.70	1.91
	2005	1.74	1.14	1.84	0.54	0.04	67	22.3	13.76	18.51	2.52	0.43	0.69	0.99	26.61	1.56
	2006	2.00	1.21	1.94	0.57	0.06	66	23.4	14.41	23.08	2.71	0.41	0.85	0.84	26.65	1.71

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 – 2006**
(recalculated in sulphur, resp. nitrogen)



NOx, nitrates

Background level of concentrations of oxides of nitrogen, recalculated in nitrogen (Tab. 1.1, Fig. 1.3) varied from 0.59 µg.m^{-3} (Chopok) to 2.80 µg.m^{-3} (Topoľníky) in 2006. ***In coincidence with the Annex 1 to the Decree of the Ministry of Environment of the Slovak Republic No 705/2002 on air quality in wording of the Decree n. 351/2007, the annual limit value for protection of vegetation is 30 µg NO_x.m^{-3} in calendar year. This limit value was not exceeded at any of the stations. The highest value from all the stations 9.2 µg NO_x.m^{-3} (in Topoľníky) is below 31 % of the limit annual value for protection of vegetation.*** Nitrates in ambient air occurred predominantly in the form of particles (Tab. 1.1, Fig. 1.3) in 2006. Concentrations of nitric acid (Tab. 1.1) in 2006 were substantially lower at all the 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 6–17 % (Fig. 1.5). Concentration ratio of total nitrates ($HNO_3 + NO_3$) to NOx-NO_2 recalculated in nitrogen represented the range 0.17–0.36.

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) are as follows:

	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, AÚ SAV, EMEP	0.36	1.05	0.19	0.18	0.02	0.15

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

In Tab. 1.1 the concentrations of PM_{10} (Stará Lesná, Liesek, Starina) and TSP (Topoľníky and Chopok) in 2006 measured manually are presented. Since 2005 the continuous PM_{10} monitoring at Topoľníky has been in operation.

In Table 1.1 and Figure 1.4 are introduced concentrations of heavy metals in PM_{10}, respectively TSP. The share of the sum of all measured metals in mass weight of suspended particles (PM_{10}, resp. TSP) varied at regional stations within 0.20–0.30 % (Fig. 1.5).

Fig. 1.4 **Heavy metals in ambient air – 2006**

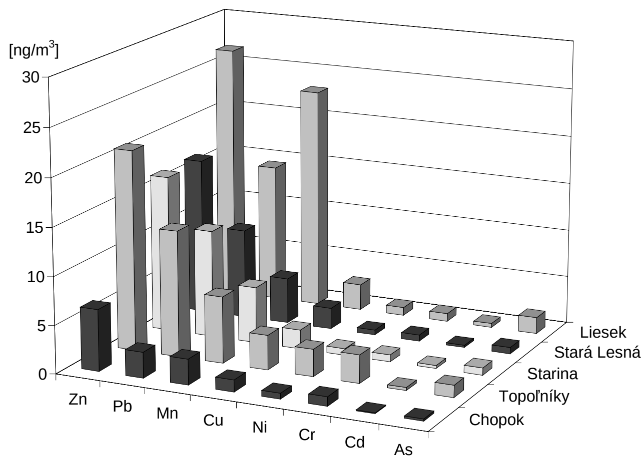
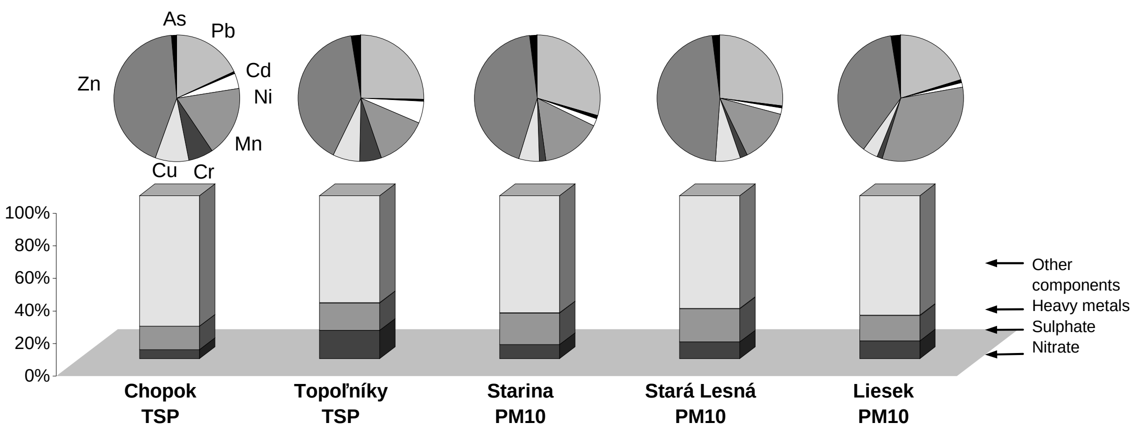


Fig. 1.5 **Composition of PM mass and proportional share of heavy metals – 2006**

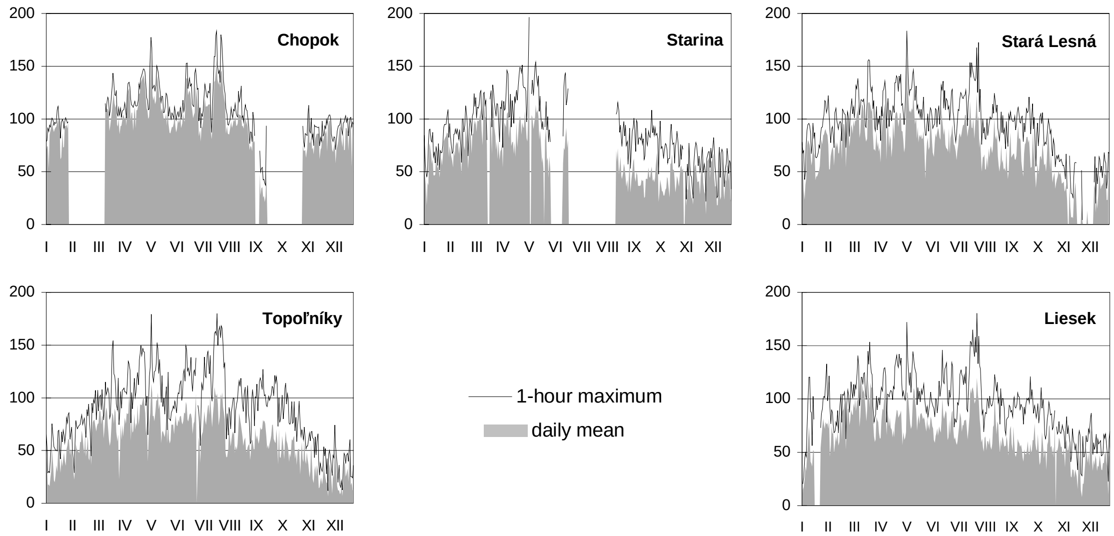


Ozone

In Figures 1.6 the annual course of ground level ozone concentrations at 5 regional stations Chopok, Stará Lesná, Starina, Topoľníky and Liesek are depicted. The longest time series of ozone measurements is at the Stará Lesná station, since 1992. The measurements of ozone in Topoľníky, Starina and Chopok began to be carried out later, in 1994 and in Liesek in 2004. In 2006, the annual average of ozone concentration at the Chopok station reached 96 μg.m^{-3}, at Starina 62 μg.m^{-3}, Stará Lesná 73 μg.m^{-3}, Topoľníky 60 μg.m^{-3} and Liesek 66 μg.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 μg.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 [μg.m^{-3}] – 2006**



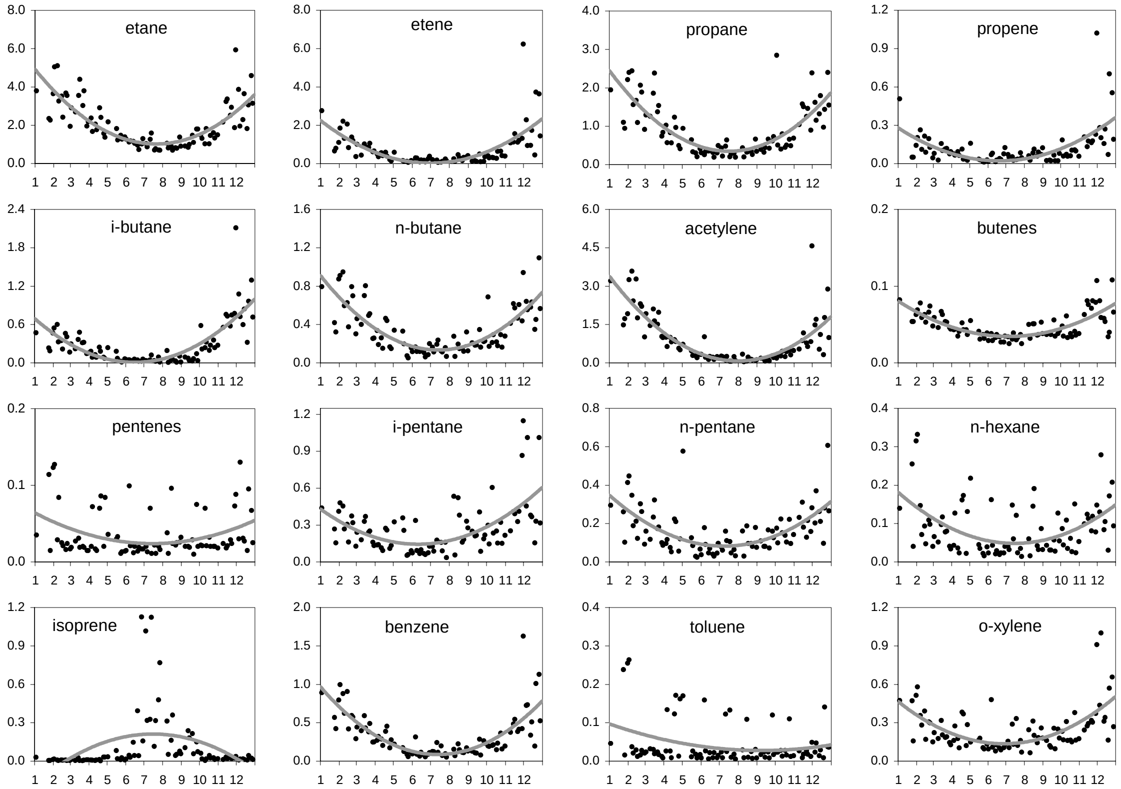
VOCs C_2–C_6

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 a 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 acetylene and propane. Remarkable is presence of isoprene releasing from the near forest.

Tab. 1.2 **Annual averages of VOC [ppb] in ambient air, Starina, 2004–2006**

	etane	etene	propane	propene	i-butane	n-butane	acetylene	butene	pentene	i-pentane	n-pentane	izoprene	n-hexane	benzene	toluene	o-xylene
2004	1.904	0.539	0.976	0.181	0.250	0.431	1.209	0.509	0.043	0.535	0.268	0.060	0.066	0.296	0.068	0.362
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

Fig. 1.7 **VOCs [ppb] – Starina – 2006**



Atmospheric precipitation

Major ions, pH, hydrogen ions, conductivity

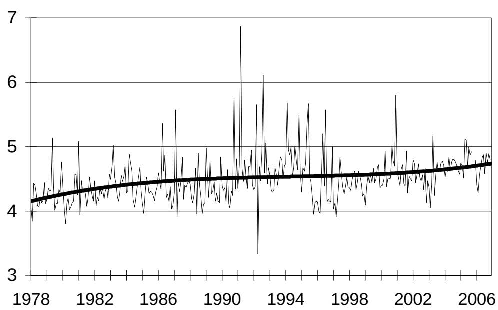
In 2006 the amount of precipitation recorded at background stations ranged between 456 (Topoľníky) and 908 mm (Chopok). Acidity of atmospheric precipitation (Tab. 1.3, Fig. 1.9) ranged from 4.52 (Starina) to 5.08 (Topoľníky). Concentrations of hydrogen ions are determined also by titration, however not regularly from daily samples of precipitation, only in cases when the sample is of sufficient amount enabling to provide titration.

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 0.47–0.58 mg.l^{-1}. Total decrease of sulphates in long-term time series has corresponded to 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 0.31–0.40 mg.l^{-1}.

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

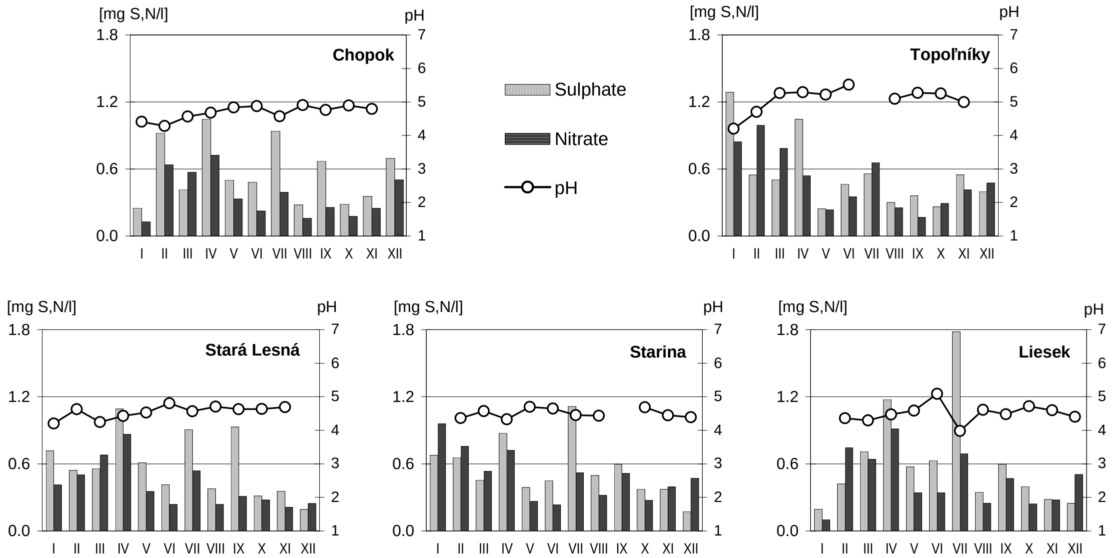


Tab.1.3 **Annual averages of main components in daily precipitation - 2004–2006**

		precip. mm	pH	cond. µS/cm	Na^+ mg/l	K^+ mg/l	Mg^{2+} mg/l	Ca^{2+} mg/l	Cl^- mg/l	NH_4^+-N mg/l	NO_3^--N mg/l	SO_4^{2-}-S mg/l
Chopok, EMEP	2004	1188	4.71	15.0	0.20	0.16	0.025	0.20	0.22	0.39	0.29	0.56
	2005	1155	4.85	10.9	0.14	0.08	0.019	0.15	0.15	0.37	0.25	0.41
	2006	908	4.75	12.9	0.08	0.06	0.018	0.09	0.14	0.48	0.31	0.48
Topoľníky, Aszód, EMEP	2004	571	4.83	16.2	0.31	0.24	0.045	0.33	0.22	0.60	0.39	0.67
	2005	619	4.96	15.2	0.20	0.13	0.073	0.41	0.25	0.52	0.35	0.52
	2006	456	5.08	14.2	0.13	0.07	0.060	0.25	0.19	0.54	0.40	0.47
Starina, Vodná nádrž, EMEP	2004	981	4.67	17.7	0.27	0.26	0.037	0.35	0.28	0.42	0.38	0.64
	2005	893	4.60	17.6	0.21	0.15	0.035	0.27	0.26	0.39	0.40	0.58
	2006	788	4.52	17.3	0.14	0.12	0.051	0.20	0.17	0.39	0.40	0.49
Stará Lesná, AÚ SAV, EMEP	2004	880	4.72	18.2	0.22	0.23	0.035	0.26	0.26	0.44	0.35	0.66
	2005	854	4.73	13.8	0.18	0.13	0.030	0.30	0.20	0.36	0.28	0.48
	2006	609	4.63	15.3	0.24	0.07	0.045	0.21	0.31	0.42	0.35	0.52
Liesek, Meteo. st., EMEP	2004	858	4.65	19.2	0.25	0.22	0.043	0.32	0.37	0.47	0.41	0.67
	2005	802	4.64	18.4	0.21	0.14	0.040	0.28	0.38	0.47	0.39	0.62
	2006	667	4.59	18.2	0.14	0.08	0.054	0.23	0.23	0.45	0.39	0.58

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

Fig. 1.9 **Daily precipitation – 2006**



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 within 2004–2006 are presented in Table 1.4.

Tab. 1.4 **Annual averages of heavy metals in monthly precipitation, 2004–2006**

		precip. mm	Pb µg/l	Cd µg/l	Cr µg/l	As µg/l	Cu µg/l	Zn µg/l	Ni µg/l
Chopok, EMEP	2004	1077	2.57	0.52	0.21	0.28	1.76	18.1	0.54
	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
Topoľníky, Aszód, EMEP	2004	529	1.31	0.06	0.04	0.23	0.51	5.1	0.13
	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
Starina, Vodná nádrž, EMEP	2004	922	3.07	0.17	0.05	0.38	1.64	6.8	0.82
	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
Stará Lesná, AÚ SAV, EMEP	2004	786	2.59	0.22	0.05	0.29	1.55	6.4	0.16
	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
Liesek, Meteo. st., EMEP	2004	802	2.39	0.12	0.08	0.35	1.56	6.4	0.28
	2005	829	1.96	0.07	0.07	0.25	0.65	7.0	0.22
	2006	536	2.61	0.14	0.32	0.41	2.45	11.2	1.30
Bratislava, Jeséniova	2004	537	2.83	0.07	0.15	0.40	2.13	3.9	0.41
	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

** 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

LOCAL AIR POLLUTION 2

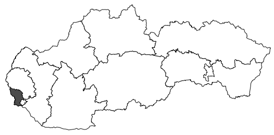
2.1 LOCAL AIR POLLUTION

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 2006, 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 2006 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 21 localities on the whole. In accordance to the Air Protection Act the territory of the Slovak Republic was divided into 8 zones and 2 agglomerations. 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.

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



AGGLOMERATION - BRATISLAVA

AREA: 368 km^2 POPULATION: 426 091

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.

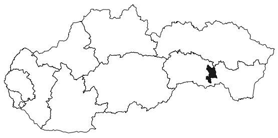
Location of stations

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: 234 596

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.

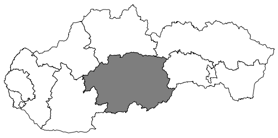
Location of stations

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: 655 762

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

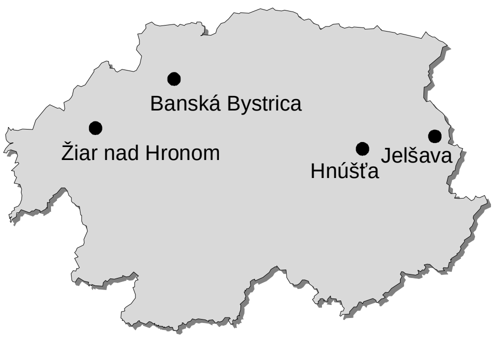
The station is located in the city centre, 100 m from a local busy road junction at a distance of 50 m from one and two storey housing area. The station is located in the valley part of the city with poor dispersion conditions.

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.

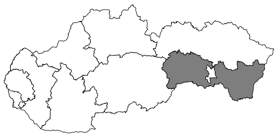
Hnúšťa - Hlavná

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 - KOŠICE REGION

AREA: 6 508 km^2 POPULATION: 538 490

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.

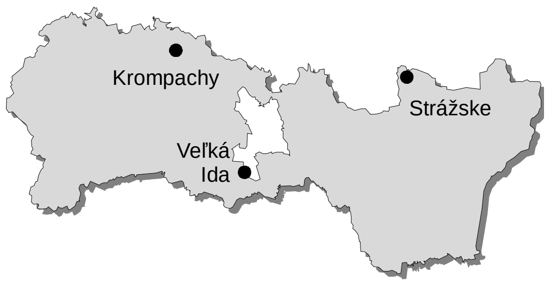
Strážske

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

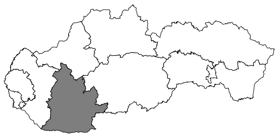
The station is located in the valley of the Slovinský potok, on the western edge of the town 2 km south-west of the ferrous metal plant Kovohuty Krompachy. The surrounding built-up area comprises multi-storey houses. It is a valley position with an increased occurrence of inversions.

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: 707 305

Characterization of area

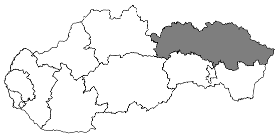
Nitra

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 - Štefánikova

Station is located very close to the crossroad of Štúrova street and Štefánikova trieda with high frequency of traffic.



ZONE - PREŠOV REGION

AREA: 8 993 km^2 POPULATION: 800 483

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

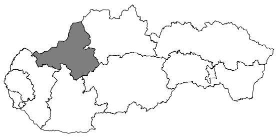
The station is located in the south-eastern part of the town in an open zone of low density buildings in the vicinity of the Solivarská and Arm. gen. L. Svobodu cross-road with high frequency of transport. Station is located 10 m from kerbside.

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: 599 847

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.

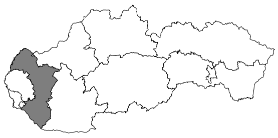
Location of stations

Prievidza - J. Hollého
The station is located in the town centre, close to 4–storey residential houses and buildings of similar height. Near the station, passes slight traffic.

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: 555 075

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.

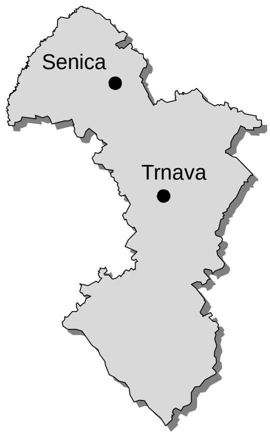
Trnava

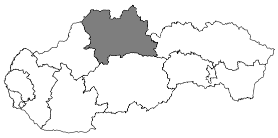
Trnava – one of the most important cities in the Slovak Republic is located in the centre of the Trnava downs, at an altitude of 146 m, 45 km from the capital of the Slovak Republic, Bratislava. The prevailing wind is from the north-west, the second highest wind frequency is from south-east. The location 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: 695 326

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 - Veľká Okružná

The station is located in the town centre in a moderately dense built-up area of 1–5-storey buildings, 10 m from a busy road.

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.

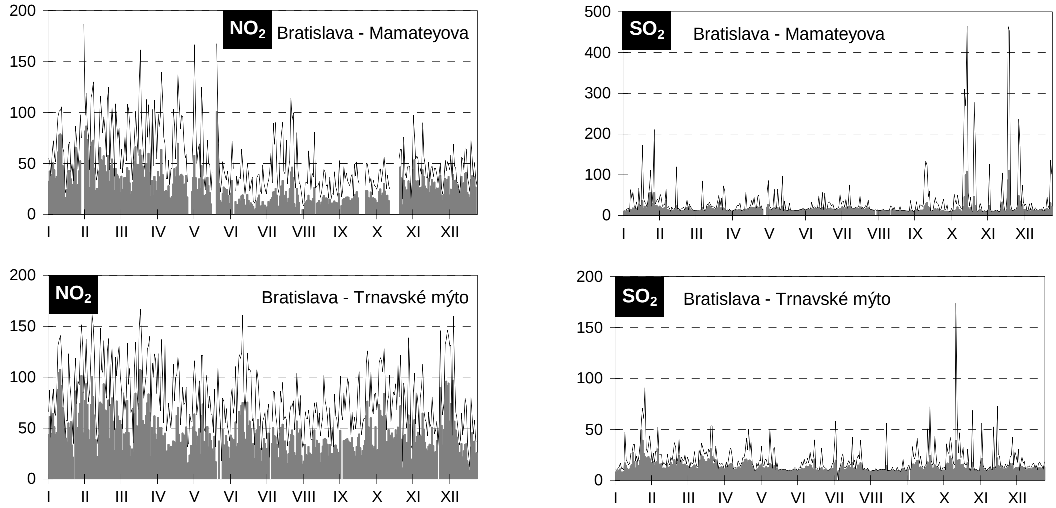
Martin

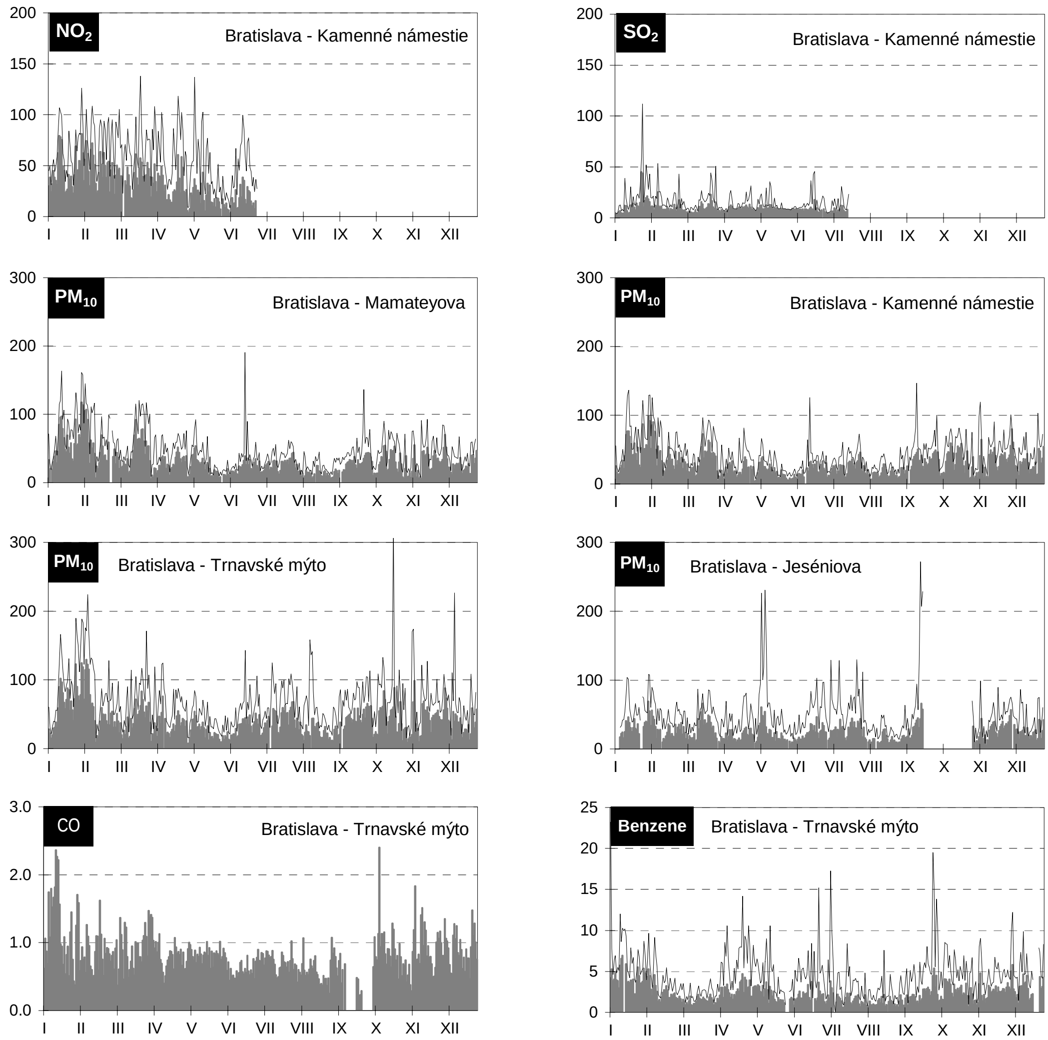
The station is located 5 m from the kerbside of the main street. Station is located in the southern part of the city in area mainly build up by family houses.

Tab. 2.1 **Geographical co-ordinates of monitoring stations and list of pollutants monitored in 2006**

AGGLOMERATION/ zone		Longitude	Latitude	Altitude [m]	SO_2	NO_2	PM_{10}	$PM_{2,5}$	CO	C6H6	Pb	Cd	Ni	As
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	*	*	*		*		*	*	*	*
Banská Bystrica region	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	*	*	*				*	*	*	*
Košice region	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	*	*	*				*	*	*	*
Nitra region	Nitra, Štefánikova	18°05'08"	48°18'28"	142	*	*	*		*	*	*	*	*	*
Prešov region	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	*	*	*				*	*	*	*
Trenčín region	Prievidza, J. Hollého	18°37'23"	48°46'11"	283	*	*	*	*			*	*	*	*
	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	*	*	*		*	*	*	*	*	*
Trnava region	Senica, Hviezdoslavova	17°21' 48"	48°40'50"	212	*	*	*		*		*	*	*	*
	Trnava, Kollárova	17°35'06"	48°22'16"	152	*	*	*		*	*	*	*	*	*
Žilina region	Martin, Jesenského	18°55'19"	49°04'01"	383	*	*	*	*	*	*	*	*	*	*
	Ružomberok, Riadok	19°18'09"	49°04'45"	475	*	*	*				*	*	*	*
	Žilina, Veľká Okružná	18°44'38"	49°13'11"	332	*	*	*		*		*	*	*	*
	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 – 2006**

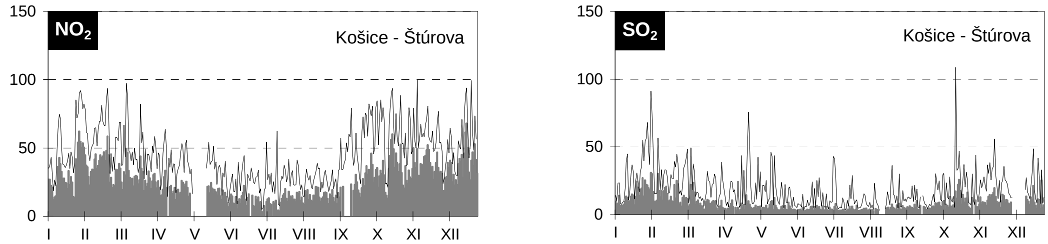




concentrations: NO_2, SO_2, PM_{10}, benzene - daily average [µg.m^{-3}]
CO - daily maximum of 8 h means [mg.m^{-3}]

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

Fig. 2.2 **Concentrations of NO_2, SO_2, PM_{10}, CO and benzene – Agglomeration Košice – 2006**



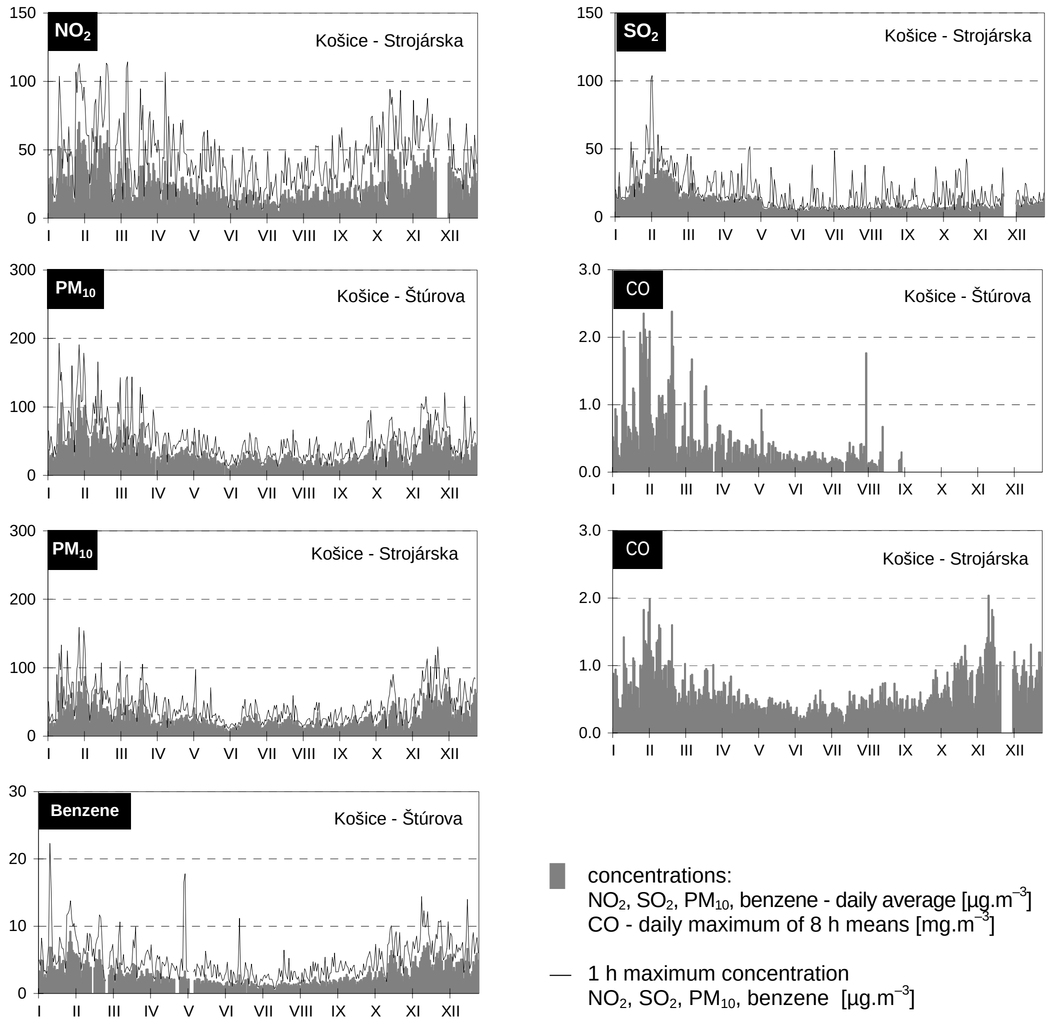
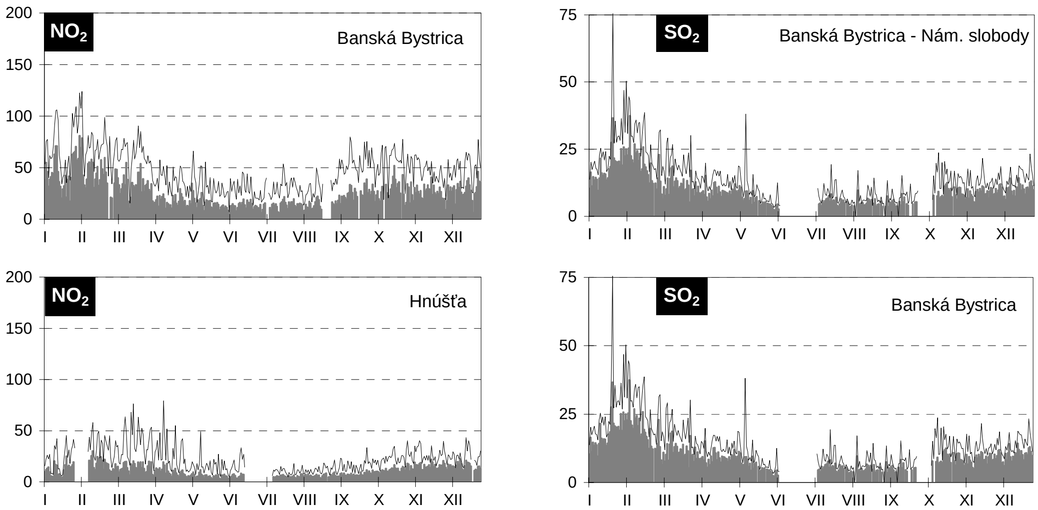


Fig. 2.3 **Concentrations of NO_2, SO_2, PM_{10}, CO and benzene – zone Banská Bystrica region – 2006**



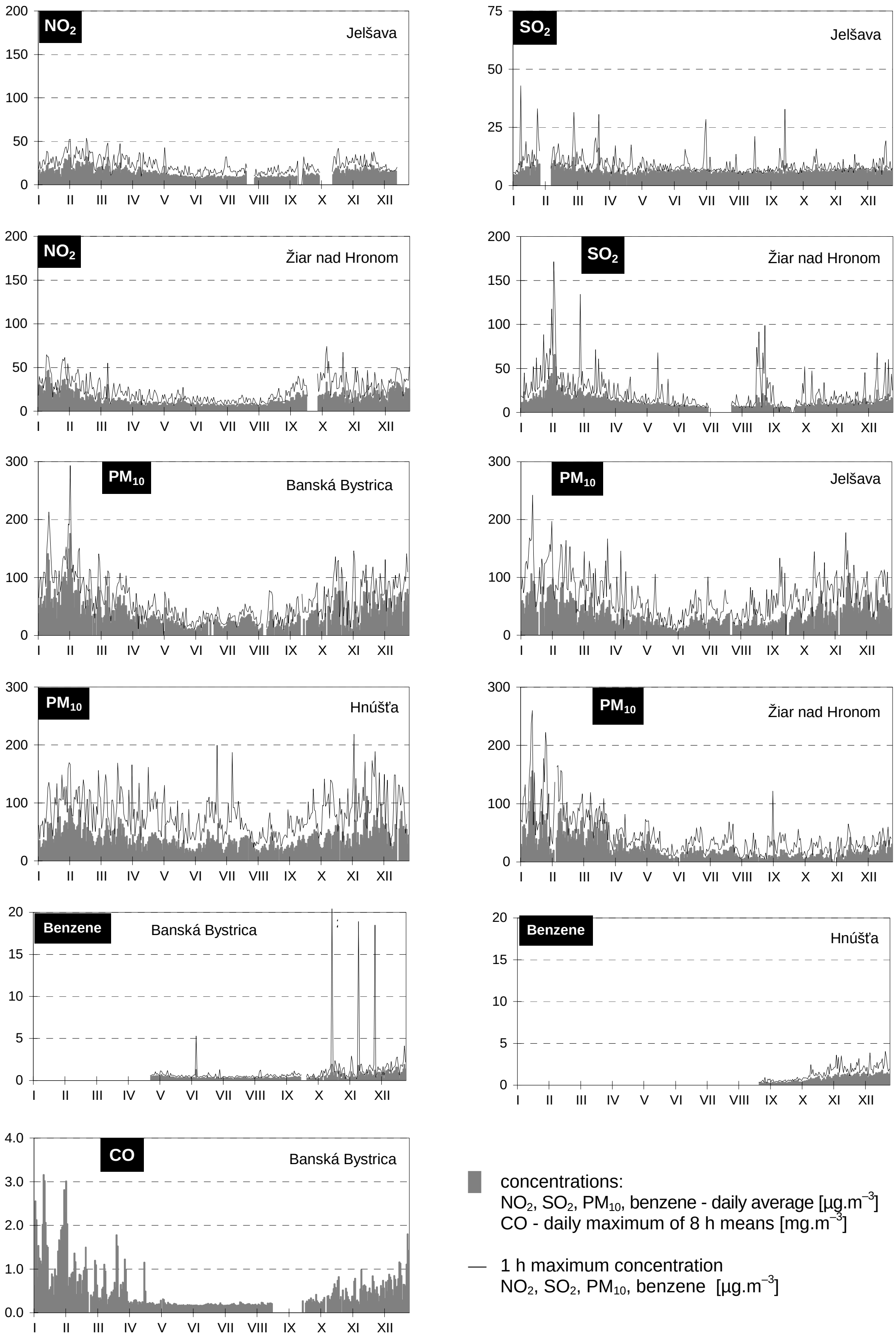

NO2 Jelšava
SO2 Jelšava
NO2 Žiar nad Hronom
SO2 Žiar nad Hronom
PM10 Banská Bystrica
PM10 Jelšava
PM10 Hnúšťa
PM10 Žiar nad Hronom
Benzene Banská Bystrica
Benzene Hnúšťa
CO Banská Bystrica
I II III IV V VI VII VIII IX X XI XII
concentrations:
NO2, SO2, PM10, benzene - daily average [µg.m–3]
CO - daily maximum of 8 h means [mg.m–3]
— 1 h maximum concentration
NO2, SO2, PM10, benzene [µg.m–3]

Fig. 2.4 **Concentrations of NO_2, SO_2, PM_{10}, CO and benzene – zone Košice region – 2006**

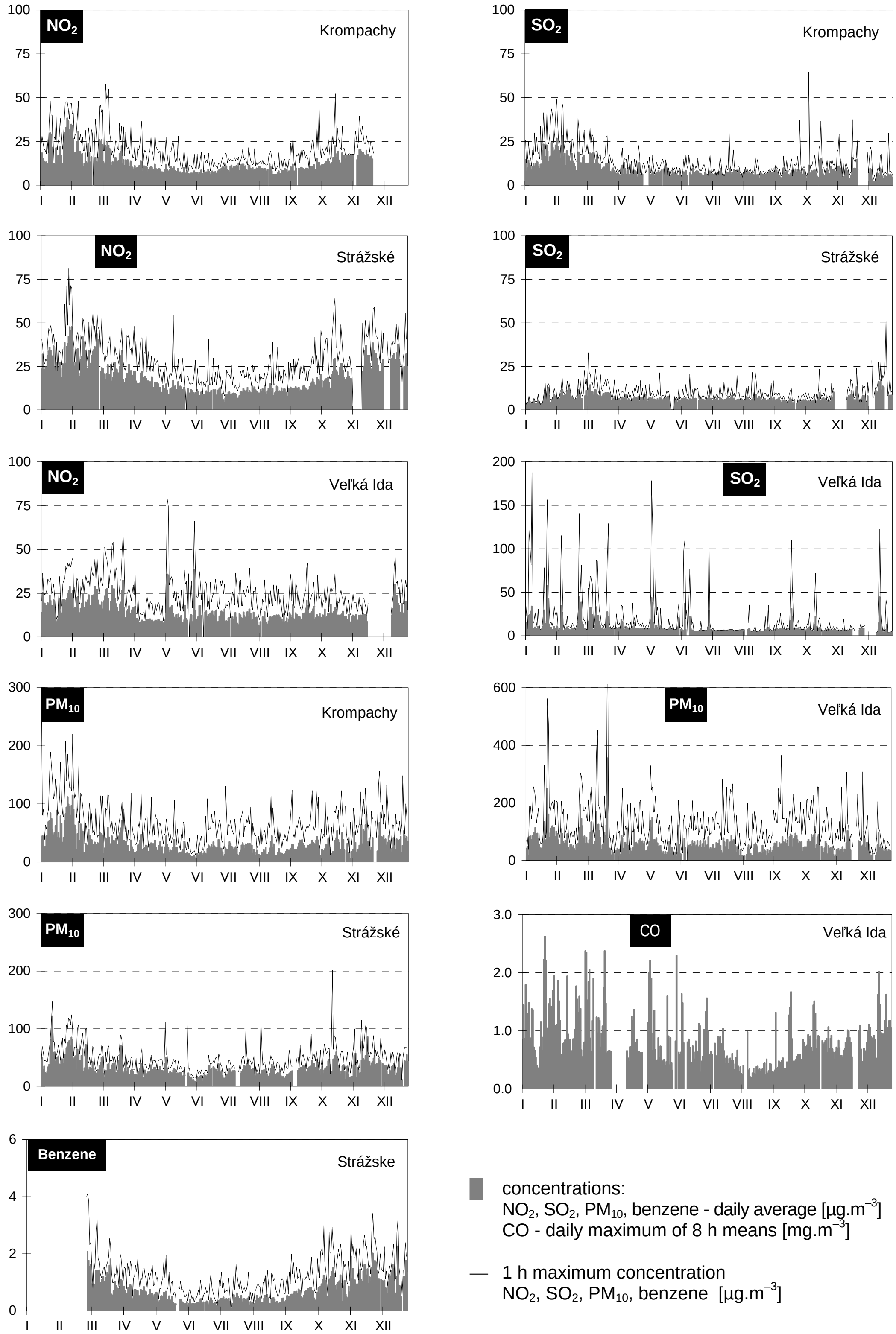


Fig. 2.5 **Concentrations of NO_2, SO_2, PM_{10}, CO and benzene – zone Nitra region – 2006**

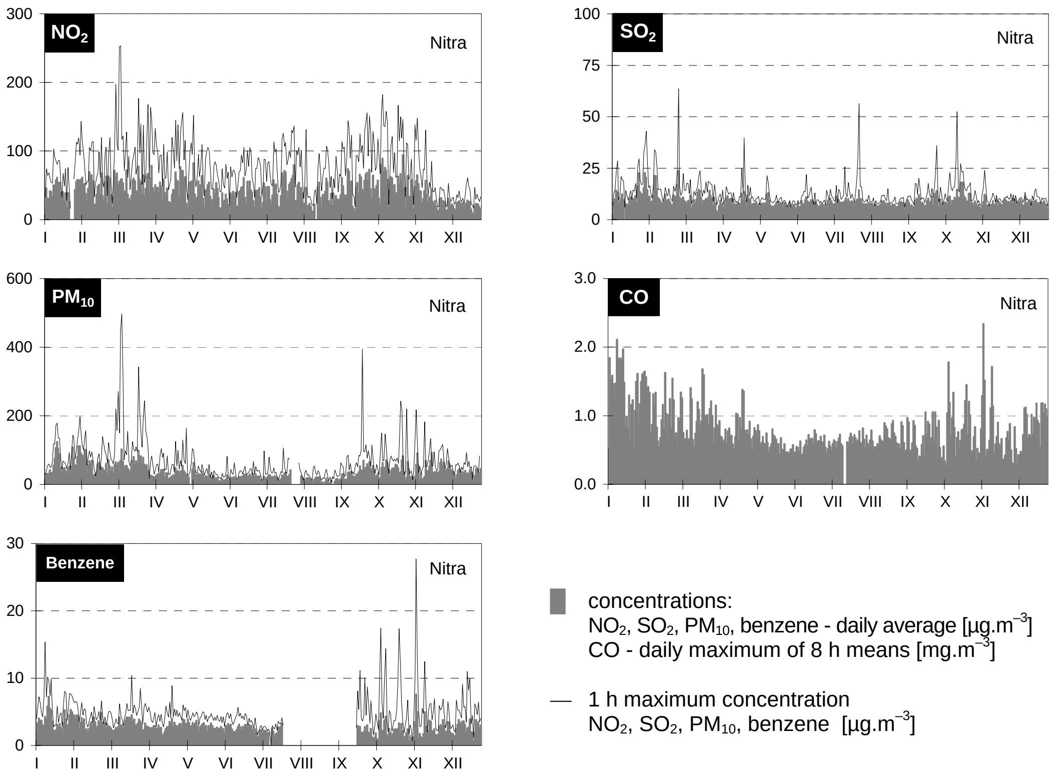
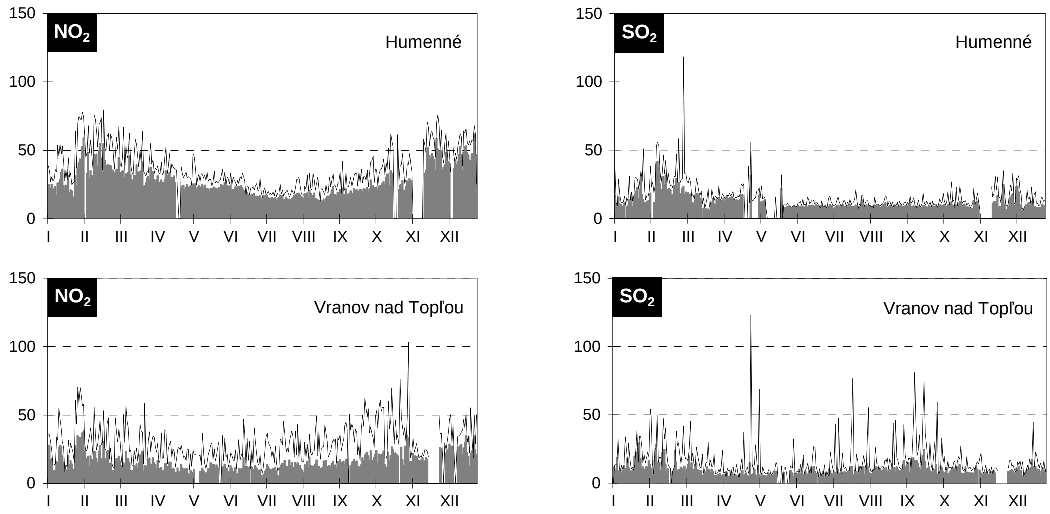


Fig. 2.6 **Concentrations of NO_2, SO_2, PM_{10}, CO and benzene – zone Prešov region – 2006**



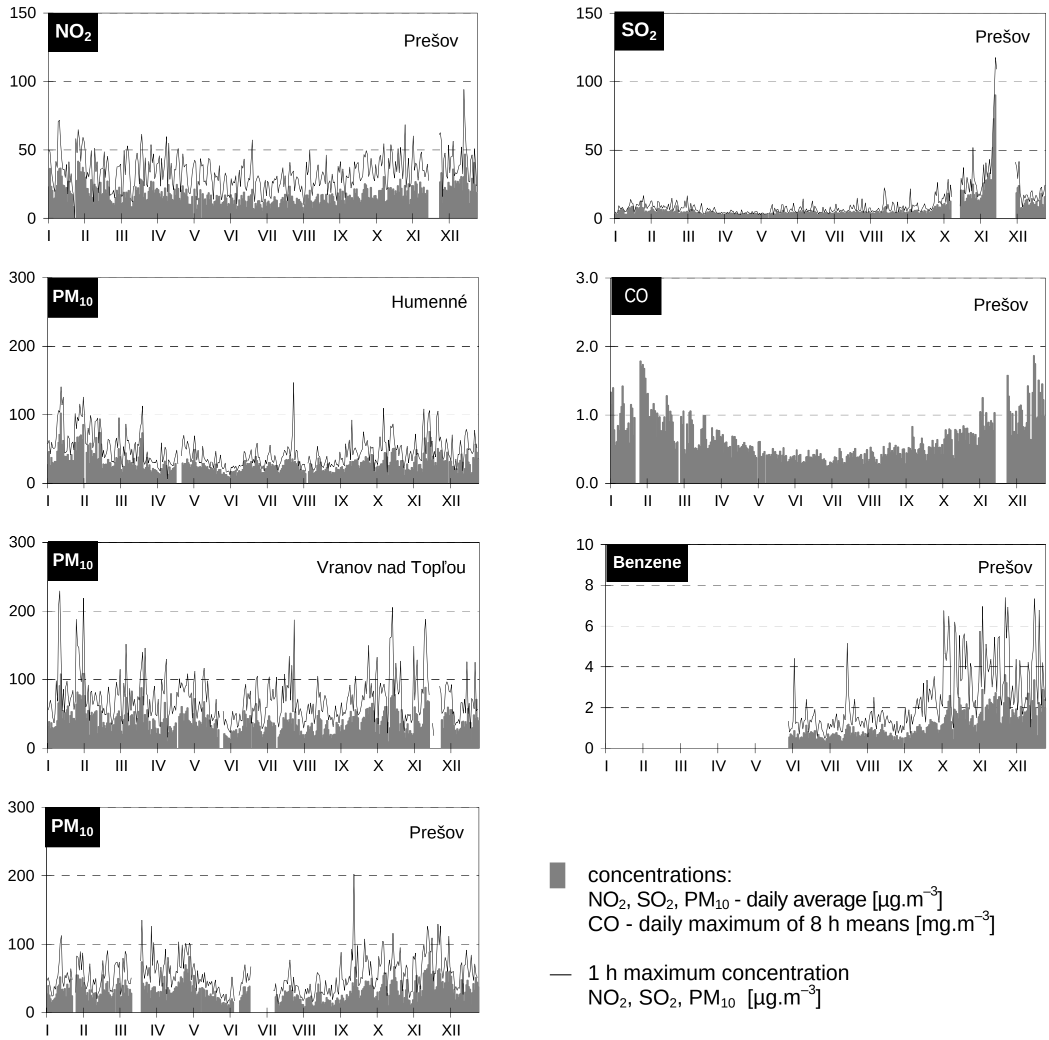
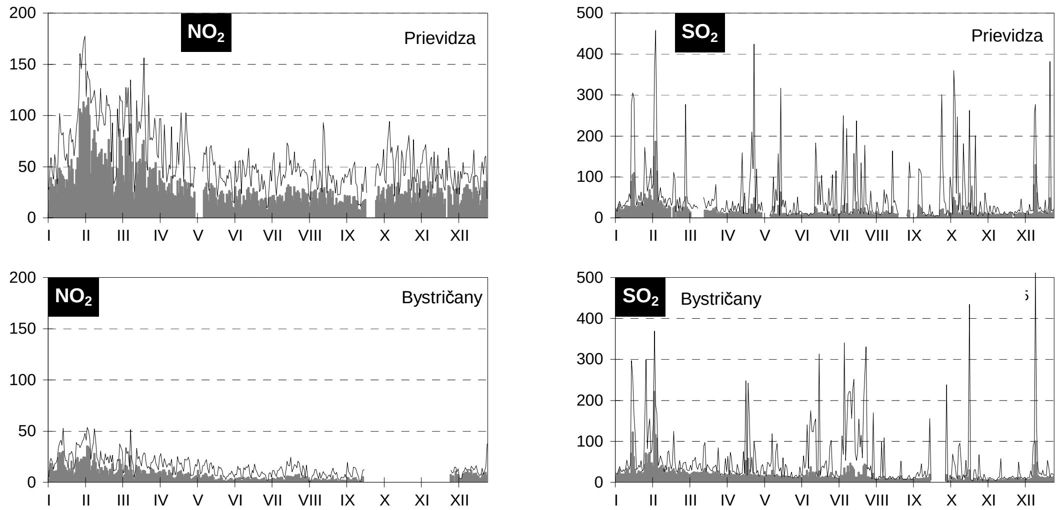
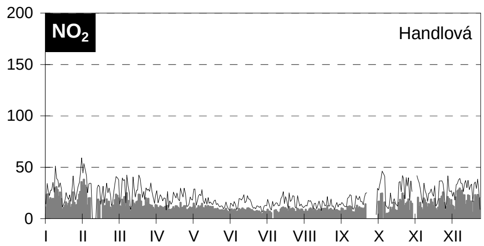
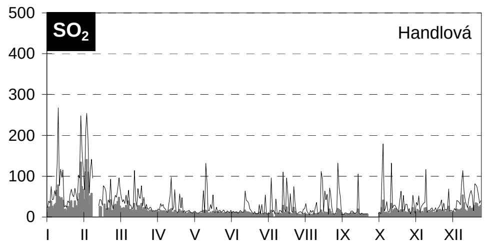
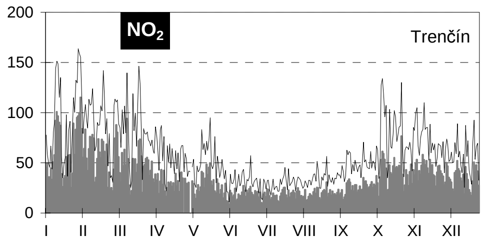


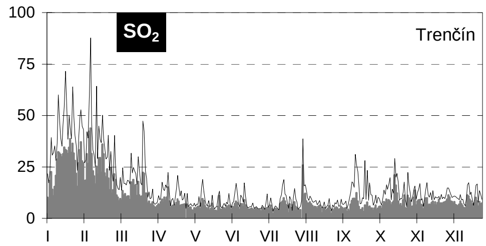
Fig. 2.7 **Concentrations of NO_2, SO_2, PM_{10}, $PM_{2.5,}$ CO and benzene – zone Trenčín region – 2006**

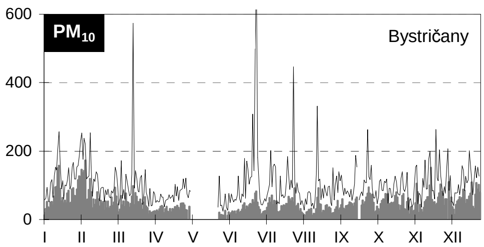


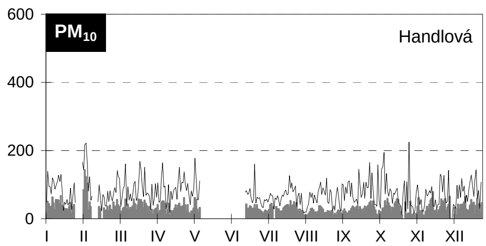


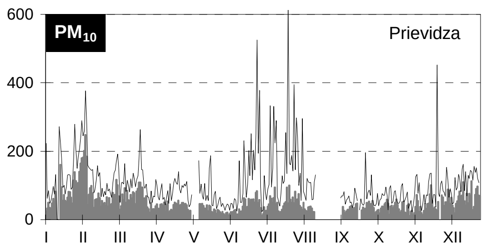


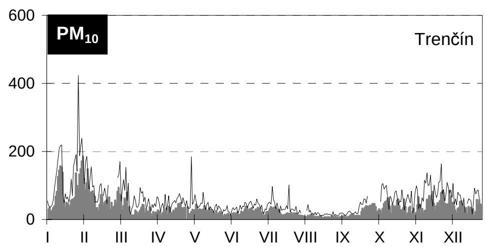


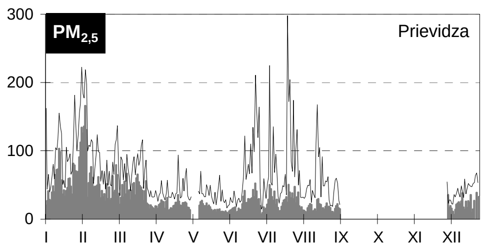


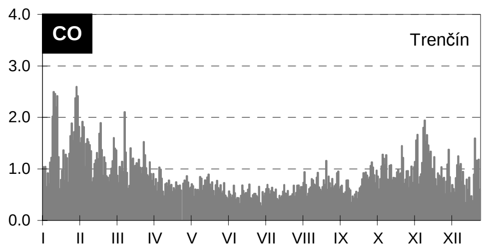


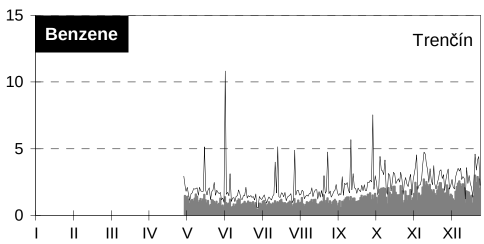












concentrations:
NO_2, SO_2, PM_{10} - daily average [μg.m^{-3}]
CO - daily maximum of 8 h means [mg.m^{-3}]

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

Fig. 2.8 **Concentrations of NO_2, SO_2, PM_{10}, CO and benzene – zone Trnava region – 2006**

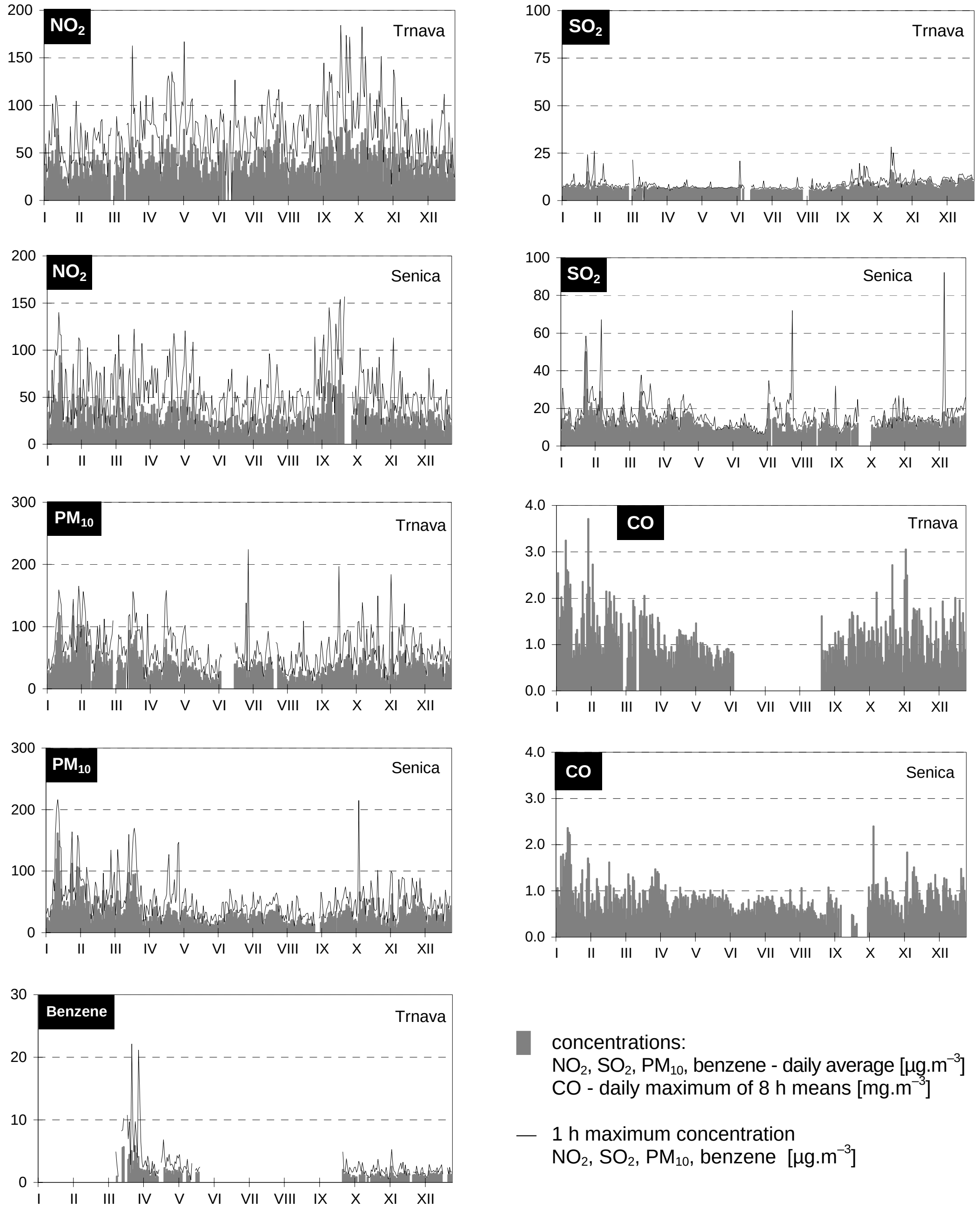
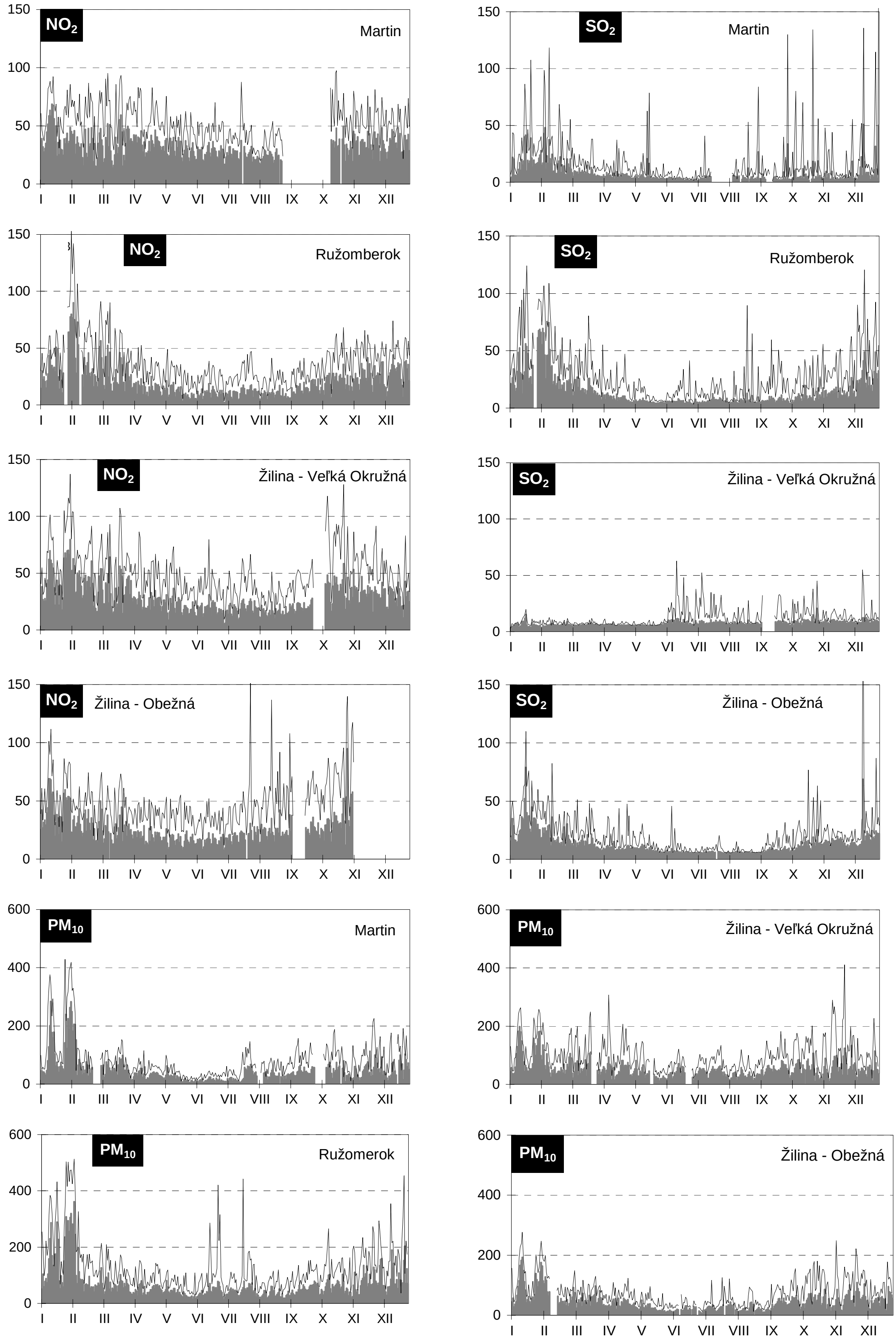


Fig. 2.9 **Concentrations of NO_2, SO_2, PM_{10}, $PM_{2.5}$, CO and benzene – zone Žilina region – 2006**



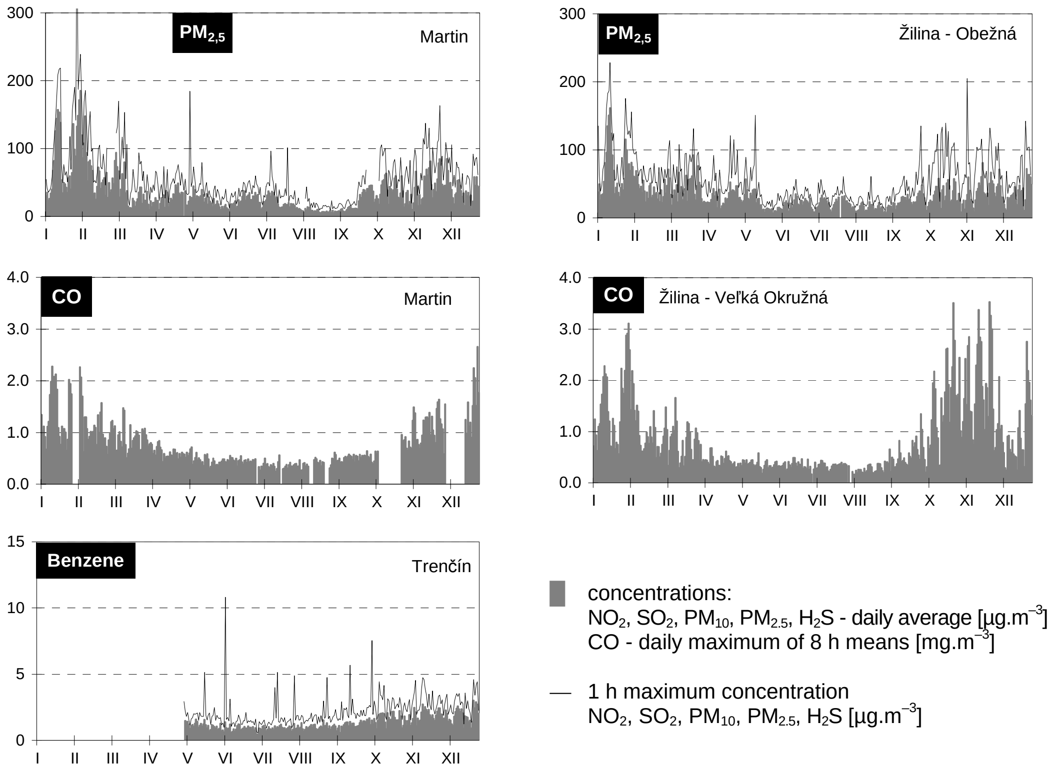
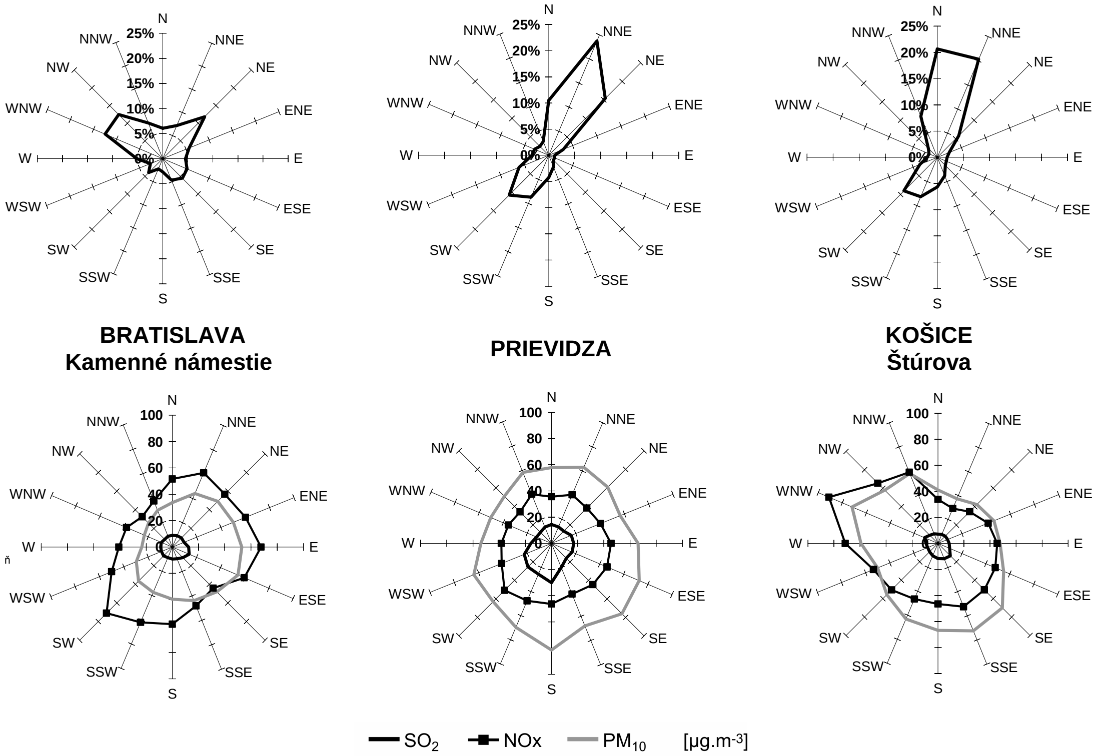


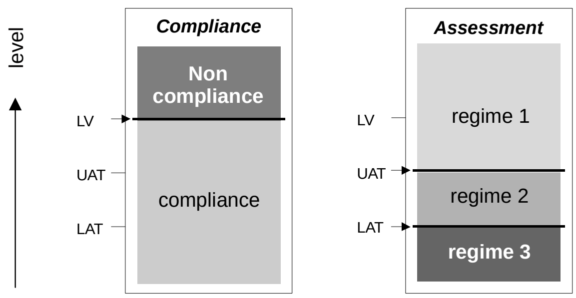
Fig. 2.10 **Wind and concentration roses – 2006**



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 2.11, and in table 2.2 are specified requirements for air quality assessment for specific regimes.

Fig. 2.11 **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.

[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.*

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:

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. 2.10).

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 2.5–2.6).

Sulphur dioxide In the year 2006 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 information was exceeded one time at station Previdza, J. Holleho.

Nitrogen dioxide Annual limit value for protection of human health was exceeded at stations Bratislava Trnavské nýto, Nitra – Štefánikova and Trnava – Kollárova. All these concentrations were bellow limit values plus margin of tolerance.

PM_{10} In 2006 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. Besides of stations Bratislava-Jeséniova, Strážske-Mierová and Humenné-Nám. Slobody the daily limit value was exceeded at all other stations and at 8 of them the annual limit was exceeded 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.

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 From these pollutants only the target value for arsenic was exceeded at station Prievidza-J.Hollého.

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
NO_x[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 (-)
NO_x	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*

Tab. 2.5 **Assessment of pollution according to limit values and limit values plus margin of tolerance (MT) in 2006**

AGGLOMERATION / zone		Protection of health											AT [2)]	
	Component	SO_2		NO_2		NO_2+MT		PM_{10}		CO	Ben-zene	Benzene +MT	SO_2	NO_2
	Time of averaging	1 hour	24 hour	1 hour	1 year	1 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	240 *(18)*	48	50 *(35)*	40	10000	5	9	500	400
BRATISLAVA	Bratislava, Kamenné nám.	[b] *0*	[b] *0*	[c] *0*	[c] 32.9	[c] *0*	[c] 32.9	*39*	29.1				0	0
	Bratislava, Trnavské mýto	*0*	*0*	*0*	44.1	*0*	44.1	*100*	40.7	3019	2.4	2.4	0	0
	Bratislava, Jeséniova							[a] *10*	[a] 25.2					
	Bratislava, Mamateyova	*6*	*0*	*0*	28.0	*0*	28.0	*48*	30.9				0	0
KOŠICE	Košice, Štúrova	[a] *0*	[a] *0*	*0*	26.2	*0*	26.2	*56*	33.4	[b] 2383	2.9	2.9	0	0
	Košice, Strojárska	*0*	*0*	*0*	24.2	*0*	24.2	*39*	28.1	2039			0	0
Banská Bystrica region	Banská Bystrica, Nám. slobody	[a] *0*	[a] *0*	*0*	25.8	*0*	25.8	*92*	38.8	3158	0.5	0.5	0	0
	Jelšava, Jesenského	*0*	*0*	[a] *0*	[a] 14.0	[a] *0*	[a] 14.0	*85*	36.7				0	0
	Hnúšťa, Hlavná	*0*	*0*	[a] *0*	[a] 10.9	[a] *0*	[a] 10.9	*86*	39.1		0.8	0.8	0	0
	Žiar nad Hronom, Dukelských hrdinov	*0*	*0*	*0*	14.2	*0*	14.2	*45*	24.3				0	0
Košice region	Veľká Ida, Letná	*0*	*0*	*0*	14.3	*0*	14.3	*188*	58.6	[a] 2623			0	0
	Strážske, Mierová	[a] *0*	[a] *0*	*0*	18.5	*0*	18.5	*35*	32.5		0.8	0.8	0	0
	Krompachy, Lorenzova	*0*	*0*	[a] *0*	[a] 12.6	[a] *0*	[a] 12.6	*41*	31.5				0	0
Nitra region	Nitra, Štefánikova	*0*	*0*	*4*	40.9	*3*	40.9	*80*	37.1	2340	[a] 2.8	[a] 2.8	0	0
Prešov region	Humenné, Nám. slobody	[a] *0*	[a] *0*	*0*	27.1	*0*	27.1	*26*	29.7				0	0
	Prešov, Solivarská	*0*	*0*	*0*	17.7	*0*	17.7	*36*	31.8	1865	1.2	1.2	0	0
	Vranov nad Topľou, M. R. Štefánika	*0*	*0*	*0*	15.6	*0*	15.6	*76*	39.4				0	0
Trenčín region	Prievidza, J. Hollého	[a] *7*	[a] *3*	*0*	31.0	*0*	31.0	*124*	51.8				0	0
	Bystričany, Rozvodňa SSE	*4*	*1*	[a] *0*	[a] 7.7	[a] *0*	[a] 7.7	*130*	49.6				0	0
	Handlová, Morovianska cesta	*0*	*2*	*0*	13.0	*0*	13.0	[a] *41*	[a] 33.8				0	0
	Trenčín, Hasičská	*0*	*0*	*0*	35.6	*0*	35.6	*64*	35.3	2595	1.3	1.3	0	0
Trnava region	Senica, Hviezdoslavova	*0*	*0*	*0*	29.1	*0*	29.1	*48*	33.5	2400			0	0
	Trnava, Kollárova	*0*	*0*	*0*	41.4	*0*	41.4	*71*	38.9	[a] 3711	[c] 1.6	[c] 1.6	0	0
Žilina region	Martin, Jesenského	*0*	*0*	[a] *0*	[a] 32.5	[a] *0*	[a] 32.5	*107*	46.9	[a] 2660	0.7	0.7	0	0
	Ružomberok, Riadok	*0*	*0*	*0*	20.1	*0*	20.1	*199*	67.8				0	0
	Žilina, Veľká Okružná	*0*	*0*	*0*	28.4	*0*	28.4	*154*	52.7	3524			0	0
	Žilina, Obežná	*0*	*0*	[a] *0*	[a] 25.3	[a] *0*	[a] 25.3	*108*	43.6				0	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 pollution according limit values, limit values plus margin of tolerance (MT) and target values in 2006**

AGGLOMERATION zone		Protection of health			
	Component	Pb	As	Cd	Ni
	Time of averaging	1 year	1 year	1 year	1 year
	Limit value [ng.m⁻³]	500			
	Target value [ng.m⁻³]		6	5	20
BRATISLAVA	Bratislava, Kamenné námestie	20	1.3	0.3	2.5
	Bratislava, Trnavské mýto	21	1.4	0.4	4.5
	Bratislava, Jeséniova	16	1.1	0.3	3.5
	Bratislava, Mamateyova	18	1.1	0.3	1.9
KOŠICE	Košice, Strojárska	30	1.5	0.7	1.7
Banská Bystrica region	Banská Bystrica, Námestie slobody	55	3.6	1.2	5.6
	Jelšava, Jesenského	17	2.4	0.5	3.4
	Žiar nad Hronom, Dukelských hrdinov	18	2.3	0.4	0.6
Košice region	Veľká Ida, Letná	46	1.7	1.1	1.6
	Krompachy, Lorenzova	138	4.7	2.6	3.6
Nitra region	Nitra, Štefánikova	20	3.9	0.4	3.1
Prešov region	Humenné, Námestie slobody	17	0.8	0.5	1.3
	Prešov, Solivarská	28	1.4	0.9	1.3
	Vranov nad Topľou, M. R. Štefánika	24	1.5	0.7	1.3
Trenčiansky kraj	Prievidza, J. Hollého	18	7.9	0.4	1.0
	Trenčín, Hasičská	27	2.2	0.6	2.0
Trnava region	Senica, Hviezdoslavova	14	1.5	0.4	5.0
	Trnava, Kollárova	22	1.9	0.6	2.2
Žilina region	Martin, Jesenského	25	5.1	0.5	1.4
	Ružomberok, Riadok	20	5.0	0.5	1.5
	Žilina, Veľká okružná	37	4.2	0.9	2.2

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 2006 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 2001–2006

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 2001–2006

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 2006 the number of missing data did not exceed 10 % at 13 stations (Tab. 3.2). Large gaps were only at the Bratislava Jeséniova, Chopok, Košice, Starina, Žiar nad Hronom, Veľká Ida and Ružomberok stations.

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

Station	2001	2002	2003	2004	2005	2006
Banská Bystrica, Nám. slobody	9.3	3.8	1.1	1.6	0.3	1.2
Bratislava, Jeséniova	4.7	3.0	2.5	2.2	5.8	16.8
Bratislava, Mamateyova	3.6	1.6	3.6	2.7	6.3	2.3
Hnúšťa, Jesenského	3.3	5.8	6.8	7.9	2.7	2.7
Humenné, Nám. slobody	3.0	2.5	1.9	0.3	0.3	10.3
Jelšava, Jesenského	1.6	8.2	4.1	0	0.3	8.2
Košice, Ďumbierska	4.4	4.1	1.4	0.5	8.6	44.4
Prešov, Solivarská	3.3	1.1	5.5	0.8	1.1	2.7
Prievidza, J. Hollého	13.4	10.4	2.7	2.2	13.2	2.0
Ružomberok, Riadok	7.7	1.9	2.2	17.0	0.3	76.1
Trenčín, Janka Kráľa	*	*	*	*	4.4	0.8
Veľká Ida, Letná	15.0	6.6	40.8	3.6	2.7	74.9
Žiar nad Hronom, Dukelských hrdinov	63.0	5.5	1.1	0.5	0.3	48.6
Žilina, Obežná	1.4	6.8	2.7	0.3	0.5	0.5
Gánovce, Meteo. st.	6.0	4.7	1.4	24.9	15.9	7.8
Chopok, EMEP	66.3	6.0	45.5	9.6	1.9	29.0
Kojšovská hoľa	7.9	1.1	9.9	1.1	9.9	6.3
Liesek, Meteo. st., EMEP	*	*	*	39.1	29.6	3.7
Stará Lesná, AÚ SAV, EMEP	2.4	0.8	4.7	0.5	0.3	10.9
Starina, Vodná nádrž, EMEP	3.6	0.5	2.2	17.3	7.1	24.8
Štrbské Pleso, Helios	11.2	0.8	4.1	3.8	26.7	2.8
Topoľníky, Aszód, EMEP	25.8	1.1	1.4	3.6	6.6	1.7

** station installed later*

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

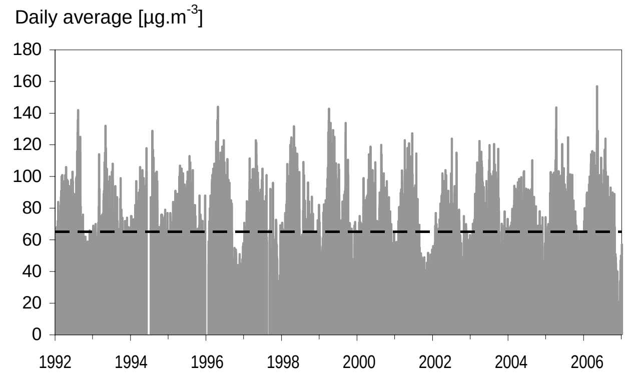
Station	2001	2002	2003	2004	2005	2006
Banská Bystrica, Nám. slobody	44	39	46	42	43	42
Bratislava, Jeséniova	54	56	71	64	68	66
Bratislava, Mamateyova	40	49	53	48	53	50
Hnúšťa, Jesenského	49	53	60	48	50	49
Humenné, Nám. slobody	48	56	66	58	60	62
Jelšava, Jesenského	49	48	55	51	52	55
Košice, Ďumbierska	47	64	68	60	67	**49
Prešov, Solivarská	49	45	51	42	47	48
Prievidza, J. Hollého	45	43	51	47	46	46
Ružomberok, Riadok	46	41	32	46	47	***42
Trenčín, Janka Kráľa	*	*	*	*	48	47
Veľká Ida, Letná	40	43	**31	38	36	***43
Žiar nad Hronom, Dukelských hrdinov	***30	50	58	55	51	**36
Žilina, Obežná	38	46	48	42	41	44
Gánovce, Meteo. st.	51	59	68	66	67	68
Chopok, EMEP	***125	97	**109	91	95	**96
Kojšovská hoľa	89	86	91	86	86	84
Liesek, Meteo. st., EMEP	*	*	*	**62	**67	66
Stará Lesná, AÚ SAV, EMEP	58	56	67	62	70	73
Starina, Vodná nádrž, EMEP	63	64	73	66	66	**62
Štrbské Pleso, Helios	75	78	86	76	**86	81
Topoľníky, Aszód, EMEP	**41	47	67	59	60	60

** station installed later ** 50–75% of valid measurements *** less than 50% of valid measurements*

In 2006, the annual average concentrations of ground level ozone in urban and industrial locations of Slovakia ranged within the interval 36–62 µg.m^{-3} (Tab. 3.3). The concentrations in the rest of the territory ranged between 62 and 96 µg.m^{-3}, mainly depending on the altitude. The highest annual average of ground level ozone concentrations was reached at the summit station Chopok (96 µg.m^{-3}). The effect of ozone from the accumulation zone (800–1500 m over the ground) over the Europe is evident. The year 2006, according to vegetation period averages, belongs to the photochemically active years. Annual averages of ground level ozone concentration in 2006 were slightly lower than in record year 2003.

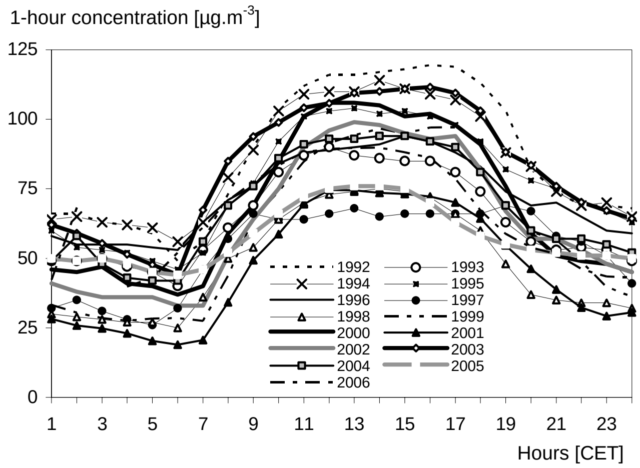
In Figure 3.1, the seasonal cycle of daily ozone concentrations in Stará Lesná during 1992–2006 is depicted. The seasonal course is typical for lowlands and valley (not summit) positions of industrial continents. Original spring maximums of ozone concentrations, associated with the transport of ozone from upper atmospheric layers, is extended for the whole summer period, as a consequence of photochemical ozone formation in a atmospheric boundary layer.

Fig. 3.1 **Seasonal variability of ground level ozone concentration in Stará Lesná during 1992–2006**



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 2006) as compared to those in less favourable years.

Fig. 3.2 **Average daily cycles of ground level ozone concentration in Stará Lesná, in August 1992–2006**



The number of exceedances of ozone threshold values in Slovakia during 2001–2006 is summarised in Tables 3.4–3.6. The alert threshold when the public must be warned (240 µg.m^{-3}) was not exceed in 2006 (Tables 3.4). The information threshold to the public (180 µg.m^{-3}) in 2006 was exceeded at ten 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 2004–2006. The target value not to be exceeded on more than 25 days per calendar year averaged over three years. In 2004–2006 was the number of 25 days overstepped at eleven monitoring stations. The highest exceedance was observed at Chopok station (63 days).

Tab. 3.4 **Number of exceedances of ozone information threshold (IT) and alert threshold (AT) to the public during 2001-2006**

Station	**AT = 240 μg.m^{-3}**						**IT = 180 μg.m^{-3}**					
	2001	2002	2003	2004	2005	2006	2001	2002	2003	2004	2005	2006
Banská Bystrica, Nám. slobody	0	0	0	0	0	0	0	0	0	0	0	0
Bratislava, Jeséniova	0	0	3	0	0	0	6	0	42	0	6	19
Bratislava, Mamateyova	0	0	3	0	0	0	3	0	32	0	8	11
Hnúšťa, Jesenského	0	0	0	0	0	0	0	2	0	0	0	0
Humenné, Nám. slobody	0	0	0	0	0	0	0	0	0	0	0	1
Jelšava, Jesenského	0	0	0	0	0	0	0	0	5	0	0	3
Košice, Ďumbierska	0	0	0	0	0	0	0	0	0	2	0	0
Prešov, Solivarská	0	0	0	0	0	0	0	0	7	0	0	0
Prievidza, J. Hollého	0	0	0	0	0	0	0	0	0	0	0	0
Ružomberok, Riadok	0	0	0	0	0	0	0	0	0	0	0	0
Trenčín, Janka Kráľa	*	*	*	*	0	0	*	*	*	*	0	0
Veľká Ida, Letná	0	0	0	0	0	0	0	0	0	0	0	0
Žiar nad Hronom, Dukelských hrdinov	0	0	0	0	0	0	0	0	0	0	0	0
Žilina, Obežná	0	0	0	0	0	0	0	0	0	0	0	8
Gánovce, Meteo. st.	0	0	0	0	0	0	0	0	0	0	0	0
Chopok, EMEP	0	0	0	0	0	0	0	2	3	1	0	1
Kojšovská hoľa	0	0	0	0	1	0	0	0	0	0	2	1
Liesek, Meteo. st., EMEP	*	*	*	0	0	0	*	*	*	0	0	0
Stará Lesná, AÚ SAV, EMEP	0	0	0	0	0	0	0	0	0	0	0	1
Starina, Vodná nádrž, EMEP	0	0	0	0	0	0	0	0	0	0	0	3
Štrbské Pleso, Helios	*	0	0	0	0	0	0	0	0	0	0	5
Topoľníky, Aszód, EMEP	0	0	0	0	0	0	0	0	18	0	0	0

** station installed later*

Tab. 3.5 **Number of exceedances of ozone target value for protection of human health (8 h average 120 μg.m^{-3}) during 2004–2006**

Station	**2004**	**2005**	**2006**	**Average 2004–2006**
Banská Bystrica, Nám. slobody	11	28	30	23
Bratislava, Jeséniova	28	52	50	**43**
Bratislava, Mamateyova	15	42	34	**30**
Hnúšťa, Jesenského	10	19	21	17
Humenné, Nám. slobody	10	41	35	**29**
Jelšava, Jesenského	12	13	31	19
Košice, Ďumbierska	20	33	**0	**27**
Prešov, Solivarská	3	18	19	13
Prievidza, J. Hollého	7	12	18	12
Ružomberok, Riadok	1	23	***1	12
Trenčín, Janka Kráľa	*	22	22	22
Veľká Ida, Letná	0	4	***0	2
Žiar nad Hronom, Dukelských hrdinov	23	39	**0	**31**
Žilina, Obežná	7	19	30	19
Gánovce, Meteo. st.	7	29	39	25
Chopok, EMEP	58	77	**53	**63**
Kojšovská hoľa	42	59	63	**55**
Liesek, Meteo. st., EMEP	**6	**35	40	**27**
Stará Lesná, AÚ SAV, EMEP	8	30	44	**27**
Starina, Vodná nádrž, EMEP	12	39	**27	**26**
Štrbské Pleso, Helios	6	**27	42	25
Topoľníky, Aszód, EMEP	27	47	41	**38**

***** *station installed later* *** 50–75% of valid measurements* **** less than 50% 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 Prešov, Prievidza and Stará Lesná).

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	2004	2005	2006	Average 2002–2006
Banská Bystrica, Nám. slobody	12927	22479	22840	**19787**
Bratislava, Jeséniova	15411	26278	32180	**25182**
Bratislava, Mamateyova	12608	23398	23968	**19908**
Hnúšťa, Jesenského	13058	14984	17078	**19186**
Humenné, Nám. slobody	14808	21575	26739	**21242**
Jelšava, Jesenského	13827	17543	22732	**20303**
Košice, Ďumbierska	15831	20028	-	***22959**
Prešov, Solivarská	8964	14977	16282	16567
Prievidza, J. Hollého	10100	15948	15044	13812
Ružomberok, Riadok	7788	17764	-	*11348
Trenčín, Janka Kráľa		16417	19778	**18098**
Veľká Ida, Letná	3793	6656	-	*7215
Žiar nad Hronom, Dukelských hrdinov	16698	21642	-	***20160**
Žilina, Obežná	9436	15069	26498	**18536**
Gánovce, Meteo. st.	12232	20565	25550	**23386**
Chopok, EMEP	27275	30514	33118	**32015**
Kojšovská hoľa	21513	23565	31802	**26818**
Liesek, Meteo. st., EMEP	12944	19712	24569	**19075**
Stará Lesná, AÚ SAV, EMEP	12156	19123	25258	17148
Starina, Vodná nádrž, EMEP	16589	15209	29171	**18118**
Štrbské Pleso, Helios	13365	21135	30298	**27055**
Topoľníky, Aszód, EMEP	17497	23065	27430	**21284**

** data from 2006 are not included in the average, because the station did not measure 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 2006 was in average close below the 2003 level.

3.3 TOTAL ATMOSFERIC OZONE OVER THE TERRITORY OF THE SLOVAK REPUBLIC IN 2006

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 324.2 Dobson Units in 2006. This is 4.0 % 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 1994-2006 long-term average is 326.5 Dobson units. In mentioned period the year 2006 is close to average. The annual mean was lower than the average in 5 years (1995, 1996, 1997, 2000, 2004). In 7 years it was higher.

Total ozone statistics for the year 2006 (daily means, relative deviations from long term averages, monthly means, standard deviations and extremes) are in Table 3.7. The monthly mean above an average was observed in February only. The monthly mean in November equalled long-term average. Average ozone deficiencies in six months were 6 % and more. The most significant negative monthly deficiency -9 % was in December. A big variability in total ozone is typical for winter months. Frequent changes of positive and negative deviations depend on prevalent atmospheric conditions.

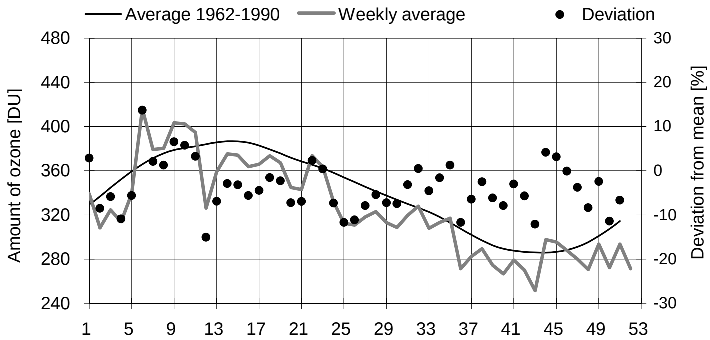
Tab. 3.7 **Total atmospheric ozone [DU] in 2006 and the deviations from long-term average**

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	296	-9	333	-7	429	13	362	-6	383	1	409	12	358	3	316	-4	304	-3	257	-12	268	-6	275	-7
2	351	8	355	-1	456	20	366	-5	366	-4	345	-5	313	-10	306	-7	279	-10	270	-7	313	10	272	-8
3	353	8	347	-4	369	-3	378	-2	372	-2	387	6	314	-10	320	-3	284	-9	242	-16	348	22	283	-5
4	360	9	335	-7	384	1	389	1	380	0	373	3	316	-9	322	-2	270	-13	265	-8	330	15	311	4
5	338	2	370	2	406	7	367	-5	360	-5	356	-2	320	-8	323	-2	265	-14	286	-1	297	4	304	2
6	366	11	426	17	420	11	386	0	389	3	357	-2	315	-9	348	6	260	-16	274	-5	291	2	287	-4
7	302	-9	410	13	411	8	375	-3	365	-3	361	0	317	-8	342	4	260	-16	262	-9	271	-5	260	-13
8	304	-9	375	3	428	13	367	-5	359	-5	366	1	320	-7	336	3	270	-12	267	-8	264	-8	283	-6
9	299	-10	407	11	371	-3	365	-6	359	-5	363	0	326	-5	318	-3	291	-5	269	-7	275	-4	292	-4
10	306	-9	459	25	382	0	353	-9	410	9	394	9	324	-6	318	-3	285	-7	275	-4	348	22	319	5
11	308	-8	404	10	396	4	396	2	374	-1	348	-4	326	-5	327	0	281	-8	276	-4	285	-1	336	10
12	301	-11	431	17	409	7	400	4	354	-6	329	-9	319	-7	326	0	287	-5	266	-7	335	17	269	-12
13	329	-3	438	19	390	2	372	-4	358	-5	342	-5	317	-7	328	1	290	-4	287	0	320	12	266	-13
14	313	-8	396	7	404	6	383	-1	356	-5	343	-4	311	-9	336	4	297	-2	305	6	286	-1	252	-18
15	302	-11	388	5	435	14	371	-4	354	-5	341	-5	334	-2	340	5	272	-10	274	-5	277	-4	255	-17
16	301	-12	338	-9	394	3	344	-11	338	-9	326	-9	331	-3	308	-5	275	-9	272	-5	286	-1	275	-11
17	298	-13	369	-1	403	5	349	-10	350	-6	322	-10	319	-6	303	-6	277	-8	268	-7	293	1	253	-18
18	350	2	358	-4	402	5	374	-3	327	-12	323	-10	311	-8	292	-9	281	-6	259	-10	261	-10	277	-11
19	334	-3	366	-2	334	-13	353	-9	350	-6	326	-8	303	-10	286	-11	284	-5	267	-7	293	1	331	6
20	265	-23	334	-11	269	-30	353	-8	346	-7	315	-11	312	-8	290	-10	288	-3	275	-4	287	-1	311	-1
21	393	13	379	1	297	-22	374	-3	350	-6	319	-10	319	-5	301	-6	285	-4	282	-2	307	6	289	-8
22	331	-5	437	16	323	-16	361	-6	308	-17	302	-15	319	-5	319	0	292	-1	269	-6	315	8	288	-9
23	320	-8	451	20	374	-3	392	2	303	-18	305	-14	308	-8	322	1	295	0	273	-5	290	-1	282	-11
24	302	-14	343	-9	332	-14	388	1	320	-13	312	-12	313	-7	310	-3	300	2	258	-10	259	-11	276	-13
25	285	-19	343	-9	342	-11	382	-1	357	-3	309	-12	308	-8	310	-2	297	1	278	-3	259	-11	263	-17
26	291	-18	375	0	346	-10	379	-1	372	1	299	-15	312	-7	315	-1	290	-1	245	-14	245	-16	254	-21
27	308	-13	391	4	324	-16	363	-5	379	3	302	-14	313	-6	315	0	295	1	236	-18	255	-13	254	-21
28	335	-5	387	3	326	-15	351	-8	361	-2	303	-14	301	-10	316	0	275	-6	231	-19	266	-10	283	-12
29	359	1			396	3	351	-8	357	-3	305	-13	301	-10	356	13	258	-12	239	-16	274	-7	298	-8
30	322	-10			369	-4	348	-9	346	-5	295	-16	314	-5	344	10	250	-14	283	-1	270	-8	285	-12
31	313	-12			370	-4			399	9			302	-9	336	7			246	-14			263	-19
Ø	320	-6	384	4	377	-1	370	-4	358	-4	336	-6	317	-7	320	-1	281	-7	266	-7	289	0	282	-9
Std	28	9	37	10	42	11	15	4	23	6	30	7	11	3	17	5	13	5	16	6	27	10	22	8
Max	393	13	459	25	456	20	400	4	410	9	409	12	358	3	356	13	304	2	305	6	348	22	336	10
Min	265	-23	333	-11	269	-30	344	-11	303	-18	295	-16	301	-10	286	-11	250	-16	231	-19	245	-16	252	-21

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

Total ozone weekly averages are in Figure 3.3. The graph illustrates behaviour of the ozone layer in the year 2006 and shows significant short-term variations in total ozone amount in our geographical region.

Fig. 3.3 **Total Atmospheric Ozone over the Territory of Slovakia in 2006**



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.

Fig. 3.4 **Annual Course of CIE Effective Irradiance Noon Values Gánovce 2006**

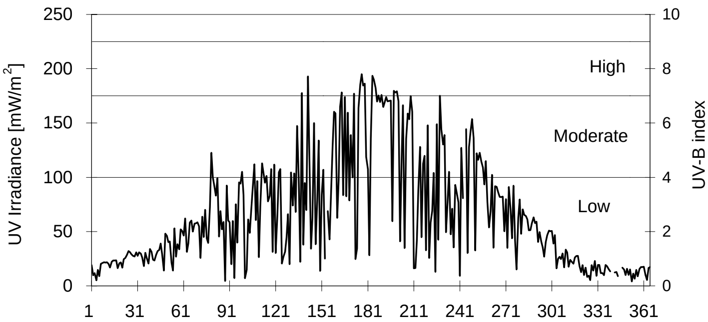


Fig. 3.5 **Annual Course of CIE Daily Doses – Gánovce 2006**

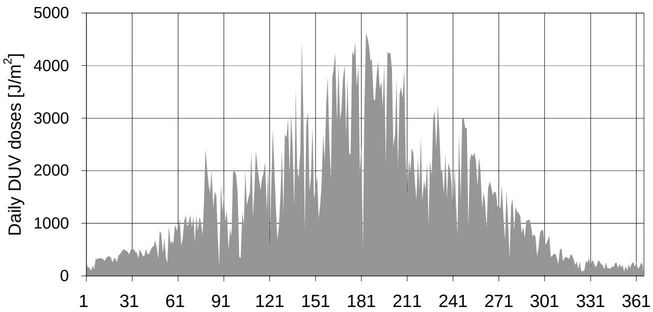


Figure 3.4 shows the biologically effective irradiance (in units of mW/m^2). Values have been measured at local noon (about 10:39 UTC), when the daily maximal solar elevation is achieved. During a day of clear sky daily UV-B maximum should be measured. A significant scattering of values demonstrates 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.

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.

The maximal noon value of CIE-weighted irradiance 194.9 mW/m^2 (which correspondents to 3.34 MED/ hour) was measured on June 26. In that day a deficiency in total ozone of 15 % was measured. The 200 mW/m^2 value was not reached in 2006. Main reason of that is cloudy and rainy weather in June. A high value of 193.0 mW/m^2 measured on May 22 one month before the summer solstice is interesting. During a sunny day the ozone deficiency was 17 %. It has been the maximal May irradiance measured at Poprad-Ganovce since 1994. It was the third highest value in 2006.

UV-B radiation has been monitored every day at regular 1-hour or half an hour increments. The observing schedule was only temporarily stopped during thunderstorms. Daily CIE-erythemal doses are presented in Figure 3.5. A maximum of 4618 J/m^2 (which correspondents to 22.0 MED) was measured on July 3. Next day value was 4520 J/m^2 (21.5 MED). The third highest dose of 4469 J/m^2 (21.3 MED) was measured on May 22.

Total CIE-erythemal dose for the period April–September 2006 was 426 752 J/m^2. This value is 3.0 % lower than in 2005.

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 SR 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 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 archive of documents about sources of air pollution.

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 1990–2006 – 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 system. 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 revised1 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 1990–2005 have been obtained.

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

MOBILE SOURCES

Emissions from mobile sources are calculated since 1990 annually. Emission calculation is being done by the COPERT method, recommended to the signatories of the UN ECE Convention on Long Range Transboundary Transmission of Air Pollutants. It is based on the number of individual types of cars, the amount of kilometers driven and the consumption of individual fuel types. Apart from road transport, inventory of mobile sources includes the railway, air and shipping transport, as well. These emissions are estimated according to the methods provided in IPCC Guidelines. In year 2002 emissions of mobile sources were estimated using COPERT III version based on the latest know-how in this area. In 2004 PM, PM_{10}, $PM_{2.5}$ emission balance from road transport was completed about the emissions from exhausts of petrol engines and about the abrasive emissions (abrasing of road surface, tyres and brake facing) in coincidence with the requests of the updated method EMEP/ CORINAIR[2] and in coincidence with the requests for reporting of these emissions for UN ECE (NFR[3]). For the calculation the method and emission factors recommended by the TNO-MEP agency were used. The results of PM, PM_{10}, $PM_{2.5}$ emission balance from road transport are listed in Table 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 Table 4.1 a,b and Figure 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 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, usage 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 fluctuation of SO_2 emissions within 2001 and 2003 was 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 SO2 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 SO2 emission of about 77 % was observed from road transport 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).

[2] *Emission Inventory Guidebook – 3rd edition*
[3] *New format for reporting*

Oxides of nitrogen

Emissions of oxides of nitrogen 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 oxides of nitrogen in 1996 was caused by the change of emission factor, taking into consideration the present 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 decreasing in years 2002 and 2003 was caused by denitrification process (Power plant Vojany). In 2006 oxides of nitrogen emissions decreased mainly at large and middle stationary sources. This decline relates with reduction of volume production (Power plants in Zemianske Kostoľany and Vojany) and consumption of solid fuel and natural gas (Power plants in Zemianske Kostoľany, Slovenský plynárenský priemysel – preprava a.s. Nitra). Significant decline of oxides of nitrogen emissions was achieved in mobile sources, mainly in sector road transport. This decrease connected with reduction of consumption liquid hydrocarbons fuels as in 2005 and renovation of vehicles.

CO

A downward trend in carbon monoxide emissions since 1990 has been caused mainly by the decrease in consumption and a 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 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, as well. 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 stock by the generational new vehicles equipped by the three-way control catalyser. 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 emission increase of CO was achieved only in the sector small sources (residential) and it is related with the increase of wood consumption in consequence of price increase in natural gas and coal. In 2006 trend of total decrease of CO emissions continued mainly in the sector mobile sources. The consumption of liquid hydrocarbon fuels decreased in the road transport in comparison with 2005 and came to renovation of vehicle stock and decline of emissions in the sector small sources too. 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 in sense of 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 UN ECE secretariat through the Ministry of Environment of 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 emission inventory in consequence of emissions adequate increased in each years. 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 respect that asphalt mixture contains 5.5 % of asphalt and others is create by aggregate. In the sector Residential was included combustion of wood for the first time. Emission increased slightly in mentioned sector. In the sector fuel distribution was included LPG distribution since 2001. The NMVOC emissions have decreased since 1990. 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 catalytic converters (Table 4.7, Figure 4.4). The NMVOC emissions increased in sector Use of paints and glues about 30 % since 2000 in consequence of increasing of industrial production 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 methodology, elaborated in the frame of the project *Initial assistance to the Slovak republic to meet its obligations under Stockholm Convention on Persistent Organic Pollutants*, and updated according to *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 PCDD/F and PAH from road transportation were calculated by program COPERT III. Downward trend of POPs emissions to the air is the most remarkable at the PAHs 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 PCB were influenced by the increased consumption in crude oil in the road transport and 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 incineration). In 2005 emissions of PCDD/F increased because of increased amount of incinerated medical waste.

HMs

Emission inventory of Heavy metals is elaborated according to 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 also show a decreasing trend after 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 2003 in consequence of increasing of production in sector Ore agglomeration and Copper production.

PM_{10}, $PM_{2.5}$ Emission of PM_{10}, $PM_{2.5}$ are processed annually on the base of requirements of UN ECE TF on Emission Inventory, starting from the base year 2000. Emissions of PM_{10}, $PM_{2.5}$ are elaborated from amount of TSP according to methodology US EPA AP 42, Polish methodology and the results of project CEPMEIP, which give exhaust emissions from the petrol engines and abrasion, while other emissions of road transportation are calculated by COPERT III. The most important contribution to emissions of PM_{10}, $PM_{2.5}$ in the sector of road transport is from diesel engines, the contribution of abrasion to emission of PM_{10}, $PM_{2.5}$ is less important than in total PM. (Table 4.2 a, b). The most important contribution to total emissions of PM_{10}, $PM_{2.5}$ 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 2006

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 2006

Table 4.4 introduces 20 of the most important air pollution sources in Slovakia. The share of these sources in the total air emissions of Slovakia varies from 75.14 to 96.08 %. Table 4.5 lists top ten sources in administrative region according to the amount of emissions.

Specific territorial emissions in the year 2006

Table 4.6 and Figure 4.3 provide us with a certain imagination about the territorial distribution of the pollutants emitted. 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 characteristics.

4.3 VERIFICATION OF THE RESULTS

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

- updated data to the 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 will decrease the uncertainty of national 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 15 February (N+2).

Tab. 4.1a **Emissions of basic pollutants [thous. t] in 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	8.855	7.978	7.644	8.544	8.755	8.940	9.142	9.509	8.766
	Total	290.059	234.580	186.916	153.380	104.053	106.204	81.418	75.436	71.194	73.291
SO_2	EAPSI 1	421.981	347.084	296.034	246.411	182.746	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	3.424	2.722	2.390	2.175	2.313	2.490	2.536	2.554	2.724	1.088
	Total	526.111	445.488	389.630	328.219	245.219	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	47.375	43.738	42.362	43.535	45.453	45.038	44.914	46.210	43.225
	Total	221.616	200.802	188.396	180.075	169.800	177.709	134.696	127.241	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	142.135	140.621	150.676	154.804	156.743	151.133	153.216	153.946	144.655
	Total	505.458	482.368	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 SR within 2000–2006**

			2000	2001	2002	2003	2004	2005	2006
PM	**Stationary sources – NEIS**	Large sources [1]	29.923	29.722	25.037	20.166	17.670	18.719	13.992
		Middle sources [1]	4.958	4.405	3.767	3.259	2.748	2.392	2.281
		Small sources [2]	19.877	20.550	17.217	18.300	21.504	28.708	26.980
	Mobile sources	Road transport	7.648	8.567	8.866	8.910	9.480	10.689	10.562
		Other transport	0.399	0.404	0.366	0.329	0.343	0.359	0.336
	Total		62.805	63.648	55.253	50.964	51.745	60.867	54.151
SO_2	**Stationary sources – NEIS**	Large sources [1]	101.955	109.823	91.461	95.283	87.932	81.592	80.104
		Middle sources [1]	8.083	6.655	3.964	3.620	2.652	2.107	1.902
		Small sources [2]	16.055	13.764	7.127	6.384	5.382	5.073	5.524
	Mobile sources	Road transport	0.670	0.750	0.733	0.750	0.827	0.189	0.177
		Other transport	0.189	0.194	0.064	0.059	0.063	0.047	0.044
	Total		126.952	131.186	103.349	106.096	96.856	89.008	87.751
NOx	**Stationary sources – NEIS**	Large sources [1]	54.485	51.653	46.412	44.605	44.244	42.424	39.038
		Middle sources [1]	8.052	7.751	6.356	6.620	4.926	4.377	4.992
		Small sources [2]	7.993	8.391	7.137	7.356	7.582	8.866	8.336
	Mobile sources	Road transport	33.438	35.719	36.063	34.814	36.443	37.106	29.334
		Other transport	4.860	4.899	4.808	4.305	4.506	4.722	4.427
	Total		108.828	108.413	100.776	97.700	97.701	97.495	86.127
CO	**Stationary sources – NEIS**	Large sources [1]	120.609	115.177	122.225	141.047	147.317	133.787	147.318
		Middle sources [1]	10.779	10.280	9.150	9.394	7.531	5.853	5.350
		Small sources [2]	53.792	50.178	33.815	33.811	34.753	41.766	40.882
	Mobile sources	Road transport	120.190	131.954	119.757	116.050	111.602	107.122	86.904
		Other transport	1.719	1.626	1.591	1.463	1.509	1.566	1.452
	Total		307.089	309.215	286.538	301.765	302.712	290.094	281.906

[1] *according to the Decree of MoE SR No 706/2002 Act. Coll.*
[2] *according to Decree of MoE SR No144/2000 Act. Coll. (2001–2003),*
according to Decree of MoE SR No 53/2004 Act. Coll. (2004 and 2006)
Emissions, as they were appointed to October 31, 2007

Tab. 4.2a **Emissions of PM [t] from road transport in the Slovak Republic within 1990–2006**

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Emissions from diesel engine	2916	2339	2040	1889	2020	2200	2263	2292	2397	2260	1975	2167	2329	2262	2473	2461	1762
Emissions from petrol engine	376	348	335	354	346	346	321	302	283	238	208	220	188	168	156	130	108
Total emissions from exhaust	3292	2687	2375	2243	2366	2546	2584	2594	2680	2498	2183	2387	2517	2430	2629	2591	1870
Abrasion emissions	6737	5587	5102	5000	5765	5761	5897	6114	6324	5823	5465	6180	6349	6480	6852	8098	8693
Total	10029	8274	7477	7243	8131	8307	8481	8708	9004	8321	7648	8567	8866	8910	9480	10689	10562

Tab. 4.2b **Emissions of PM_{10} and $PM_{2.5}$ [t] from road transport in SR within 2000–2006**

	2000		2001		2002		2003		2004		2005		2006	
	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
Emissions from petrol engines	208	208	220	220	188	188	168	168	156	156	130	130	108	108
Sum of exhaust emissions	2183	2183	2387	2387	2517	2517	2430	2430	2629	2629	2591	2591	1870	1870
Emissions from abrasion	437	168	497	190	514	198	526	203	560	217	669	261	619	242
Total	2620	2351	2884	2577	3031	2715	2956	2633	3189	2846	3260	2852	2488	2112

Emissions, as they were appointed to October 31, 2007

Fig. 4.1 Development trends in basic pollutant emissions within 1990–2006

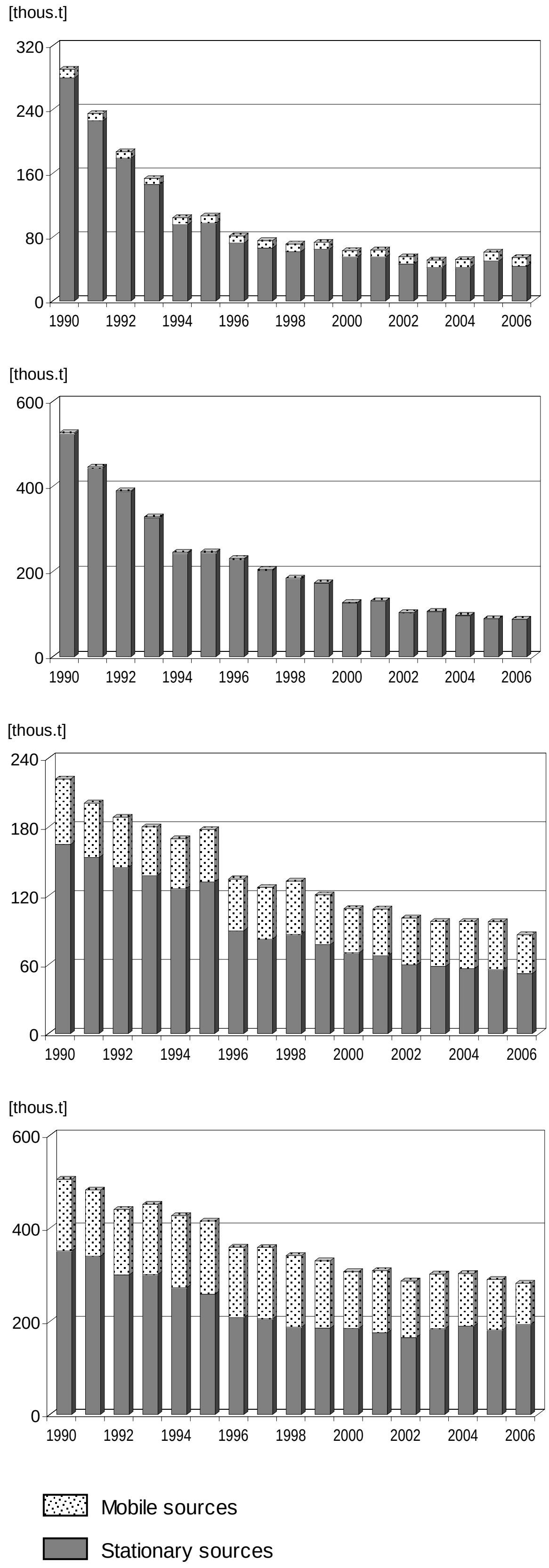
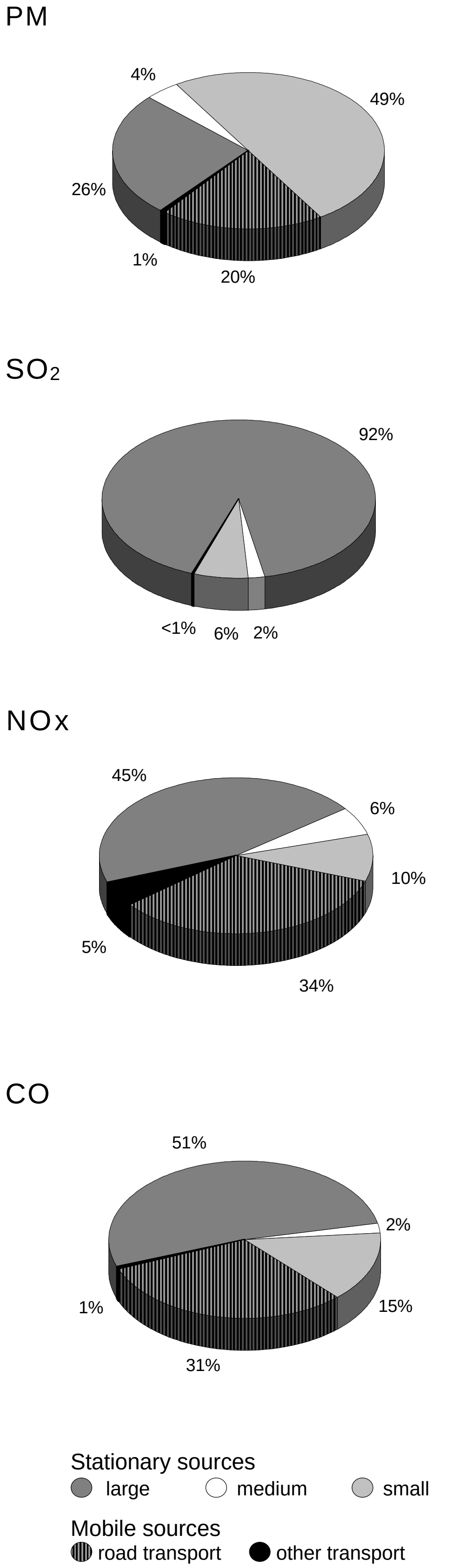


Fig. 4.2 Emissions of basic pollutants in 2006



Tab. 4.3 **Stationary source emissions of basic pollutants [t] in agglomerations and zones* within 2000–2006**

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

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

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

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

** 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 2006**

No	PM		SO_2		NOx		CO	
	Source	[%]	Source	[%]	Source	[%]	Source	[%]
1	SE a.s., Bratislava, Elektráreň Vojany I a II	40.70	SE a.s., Bratislava, ENO Zem. Kostoľany	46.18	U.S.Steel s.r.o., Košice	23.36	U.S.Steel s.r.o., Košice	71.11
2	U.S.Steel s.r.o., Košice	23.90	SLOVNAFT a.s., Bratislava	14.08	SE a.s., Bratislava, Elektráreň Vojany I a II	9.58	SLOVALCO a.s., Žiar nad Hronom	8.49
3	SE a.s., Bratislava, ENO Zem. Kostoľany	3.78	U.S.Steel s.r.o., Košice	13.00	SE a.s., Bratislava, ENO Zemianske Kostoľany	8.14	OFZ a.s., Istebné	1.65
4	BUKOCEL a.s., Hencovce	2.42	SE a.s. Bratislava, Elektráreň Vojany I a II	3.05	SLOVNAFT a.s., Bratislava	6.84	CEMMAC a.s., Horné Srnie	1.43
5	Novácke chemické závo-dy a.s., Nováky	1.88	Zvolenská teplárenská a.s., Zvolen	2.91	TEKO a.s., Košice	2.86	Považská cementáreň a.s., Ladce	1.31
6	SLOVNAFT a.s., Bratislava	1.53	SIDERITs.r.o, Nižná Slaná	2.85	Holcim a.s., Rohožník	2.60	KOVOHUTY a.s., Krompachy	1.30
7	Kronospan SK s.r.o., Prešov	1.12	BUKOCEL a.s., Hencovce	2.68	Považská cementáreň a.s., Ladce	2.47	DOLVAP s.r.o., Varín	1.18
8	Považská cementáreň a.s., Ladce	1.11	Žilinská teplárenská a.s., Žilina	1.78	Mondi business paper scp a.s., Ružomberok	2.41	Slovenské magnezitové závody a.s., Jelšava	1.07
9	Duslo a.s., Šaľa	1.09	SLOVALCO a.s., Žiar nad Hronom	1.61	CHEMES a.s., Humenné	1.76	CALMIT s.r.o. Bratislava, záv. Žírany	0.76
10	Carmeuse Slovakia s.r.o., závod Včeláre	0.98	CHEMES a.s., Humenné	1.13	Slovenské magnezitové závody a.s., Jelšava	1.75	BUKOCEL a.s., Hencovce	0.76
11	SIDERIT s.r.o., Nižná Slaná	0.96	Smurfit Kappa Štúrovo a.s.	1.09	Duslo a.s., Šaľa	1.55	CALMIT s.r.o. Bratislava, záv. Tisovec	0.66
12	CHEMES a.s., Humenné	0.73	Slovenské magnezitové závody a.s., Jelšava	1.04	BUKOCEL a.s., Hencovce	1.48	SE a.s. Bratislava, Elektráreň Vojany I a II	0.62
13	SLOVALCO a.s., Žiar nad Hronom	0.62	Martinská teplárenská a.s., Martin	1.00	CEMMAC a.s., Horné Srnie	1.41	Holcim a.s., Rohožník	0.58
14	KVARTET a.s., Partizánske	0.57	Duslo a.s., Šaľa	0.99	Smurfit Kappa Štúrovo a.s.	1.37	SIDERIT s.r.o., Nižná Slaná	0.52
15	Carmeuse Slovakia s.r.o., závod Košice	0.52	TEKO a.s., Košice	0.69	SPP a.s., Bratislava, závod Ivanka pri Nitre	1.34	HNOJIVÁ a.s., Strážske	0.50
16	DOLVAP s.r.o., Varín	0.49	KVARTET a.s., Partizánske	0.48	SLOVALCO a.s., Žiar nad Hronom	1.29	Slovmag a.s., Lubenik	0.42
17	Mondi business paper scp a.s., Ružomberok	0.44	ZSNP a.s., Žiar nad Hronom	0.47	Žilinská teplárenská a.s., Žilina	1.28	SLOVNAFT a.s., Bratislava	0.36
18	Eastern Sugar Slovensko a.s., Dunajská Streda	0.39	Eastern Sugar Slovensko a.s., Dunajská Streda	0.38	V.S.H. a.s., Turňa nad Bodvou	1.28	Kronospan SK s.r.o., Prešov	0.33
19	Žilinská teplárenská a.s., Žilina	0.32	HBP a.s., Banská mech. a elektrifikácia, Nováky	0.35	SPP a.s., závod Veľké Kapušany	1.20	Wienerberger Slov.tehelne s.r.o., závod Boleráz	0.29
20	HBP a.s., Banská mech. a elektrifikácia, Nováky	0.32	Slovenské cukrovary a.s., Sereď	0.31	Zvolenská teplárenská a.s., Zvolen	1.17	Mondi business paper scp a.s., Ružomberok	0.24
Total		83.88		96.08		75.14		93.59

** 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 – 2006 (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 a.s., Rohožník	Malacky	Duslo a.s., odštepný závod Istrochem Bratislava	Bratislava III
3.	Volkswagen Slovakia a.s., Bratislava	Bratislava IV	Holcim a.s., Rohožník	Malacky
4.	Swedwood Slovakia s.r.o., záv. Malacky	Malacky	Bratislavská teplárenská a.s., Bratislava, výhr. Juh	Bratislava II
5.	Paroplynový cyklus a.s., Bratislava	Bratislava III	Bratislavská vodárenská spoločnosť a.s., Bratislava	Bratislava II
6.	Slovnaft Petrochemicals s.r.o., Bratislava	Bratislava II	PSB Bratislava, kotolňa Viničné	Pezinok
7.	Bratislavská teplárenská a.s., Bratislava, Tepl. západ	Bratislava IV	Technické služby - čistenie s. r. o., Bratislava	Bratislava II
8.	C-TERM s.r.o., Bratislava, zdroje v okrese	Bratislava V	Swedwood Slovakia s.r.o., záv. Malacky	Malacky
9.	ALAS Slovakia s. r. o., kameňolom Sološnica	Malacky	Bratislavská teplárenská a.s. Bratislava, Tepl. západ	Bratislava IV
10.	Bratislavská teplárenská a.s., Bratislava,Výhr. Juh	Bratislava II	Univolt-Remat s.r.o. Pezinok	Pezinok
	NOx		CO	
	Source	District	Source	District
1.	SLOVNAFT a.s., Bratislava	Bratislava II	Holcim a.s., Rohožník	Malacky
2.	Holcim a.s., Rohožník	Malacky	SLOVNAFT a.s., Bratislava	Bratislava II
3.	Paroplynový cyklus a.s., Bratislava	Bratislava III	Swedwood Slovakia s.r.o., záv. Malacky	Malacky
4.	Swedwood Slovakia s.r.o., záv. Malacky	Malacky	Slovnaft Petrochemicals s.r.o., Bratislava	Bratislava II
5.	Slovnaft Petrochemicals s.r.o., Bratislava	Bratislava II	C-TERM s.r.o., Bratislava, zdroje v okrese	Bratislava V
6.	Odvoz a likvidácia odpadu a. s., Bratislava	Bratislava II	Paroplynový cyklus a.s., Bratislava	Bratislava III
7.	C-TERM s.r.o., Bratislava, zdroje v okrese	Bratislava V	Bratislavská teplárenská a.s., Bratislava,Tepl. západ	Bratislava IV
8.	Bratislavská teplárenská, a.s., Bratislava,Tepl. západ	Bratislava IV	Bratislavská teplárenská a.s., Bratislava, Tepláreň II	Bratislava III
9.	Bratislavská teplárenská a.s., Bratislava, Tepláreň II	Bratislava III	Plastic Omnium Auto Exteriors s.r.o., Lozorno	Malacky
10.	Volkswagen Slovakia a.s., Bratislava	Bratislava IV	PSB Bratislava, kotolňa Viničné	Pezinok

TRNAVA REGION

	PM		SO_2	
	Source	District	Source	District
1.	Eastern Sugar Slovensko a.s., Dunajská Streda	Dunajská Streda	Eastern Sugar Slovensko a.s., Dunajská Streda	Dunajská Streda
2.	Johns Manville Slovakia a. s., Trnava	Trnava	Slovenské cukrovary a.s., Sereď	Galanta
3.	Slovenské cukrovary a.s., Sereď	Galanta	Johns Manville Slovakia a. s., Trnava	Trnava
4.	Amylum Slovakia spol. s r. o., Boleráz	Trnava	Wienerberger Slov. tehelne s.r.o., závod Boleráz	Trnava
5.	Zlieváreň Trnava s. r. o.	Trnava	Mach-Trade s.r.o., Sereď	Galanta
6.	Alas Slovakia s.r.o., Trnava	Trnava	Zlieváreň Trnava s. r. o.	Trnava
7.	Kerkosand Šajdíkove Humence	Senica	Baňa Záhorie, Čáry	Senica
8.	ŽOS Trnava a. s.	Trnava	Cesty Nitra a.s., OS Smolenice	Trnava
9.	BELAR a.s., Dunajská Streda	Dunajská Streda	PD Siladice	Hlohovec
10.	Agropodnik a. s., Trnava	Trnava	Obec Lakšárska Nová Ves, ZŠ Lakšárska Nová Ves	Senica
	NOx		CO	
	Source	District	Source	District
1.	Johns Manville Slovakia a. s., Trnava	Trnava	Wienerberger Slov.tehelne s.r.o., závod Boleráz	Trnava
2.	Eastern Sugar Slovensko a.s., Dunajská Streda	Dunajská Streda	Zlieváreň Trnava s. r. o.	Trnava
3.	Slovenské cukrovary a.s., Sereď	Galanta	Johns Manville Slovakia a. s., Trnava	Trnava
4.	Amylum Slovakia s r. o., Boleráz	Trnava	BEKAERT Hlohovec a.s.	Hlohovec
5.	Swedwood Slovakia s.r.o., o.z. Majcichov	Trnava	Cesty Nitra a.s., zdroje v okrese Trnava	Trnava
6.	Wienerberger Slov.tehelne s.r.o., závod Boleráz	Trnava	I.D.C. Holding a.s., Pečivárne Sereď	Galanta
7.	Eissmann Autonotive Slovensko s.r.o., Holíč	Skalica	Swedwood Slovakia s.r.o., o.z. Majcichov	Trnava
8.	PCA Slovakia s.r.o., Trnava	Trnava	Amylum Slovakia s r. o., Boleráz	Trnava
9.	BEKAERT Hlohovec a.s.	Hlohovec	Medea-S s.r.o., Sládkovičovo	Galanta
10.	Mach Trade Sereď s.r.o.	Galanta	Eastern Sugar Slovensko a.s., Dunajská Streda	Dunajská Streda

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	Duslo a.s., Šaľa	Šaľa
3.	CALMIT s r.o., Bratislava, prev. Žírany	Nitra	Icopal a.s., Štúrovo	Nové Zámky
4.	Smurfit Kappa Štúrovo a.s.	Nové Zámky	Wienerberger Slov. tehelne s.r.o., Zl. Moravce	Zlaté Moravce
5.	Lencos s.r.o., Levice	Levice	SES REAL s.r.o., Tlmače	Levice
6.	Kameňolomy a štrkopieskovne a.s., Lom Pohranice	Nitra	CALMIT s r.o. , Bratislava, prev. Žírany	Nitra
7.	SES REAL s.r.o., Tlmače	Levice	PSB Nitra	Nitra
8.	PPC Čab a.s., Nové Sady	Nitra	N-Adova s.r.o., Nitra	Nitra
9.	ELEKTROKARBON a.s., Topoľčany	Topoľčany	EMGO Slovakia s.r.o., Nové Zámky	Nové Zámky
10	Icopal a.s., Štúrovo	Nové Zámky	MJ Agro Marcelová s.r.o.	Lervice
	NOx		CO	
	Source	District	Source	District
1.	Duslo a.s., Šaľa	Šaľa	CALMIT s r.o., Bratislava, prev. Žírany	Nitra
2.	Smurfit Kappa Štúrovo a.s.	Nové Zámky	Wienerberger Slov. tehelne s r. o., Zl. Moravce	Zlaté Moravce
3.	SPP a.s. Bratislava, závod Ivanka pri Nitre	Nitra	SES a.s., Tlmače	Levice
4.	SPP - preprava a.s., prev. Ivanka pri Nitre	Nitra	Duslo a.s., Šaľa	Šaľa
5.	OPM1SR, Nitra	Nitra	Smurfit Kappa Štúrovo a.s.	Nové Zámky
6.	Bytkomfort s.r.o., Nové Zámky	Nové Zámky	DANFOSS COMPRESSORS s.r.o., Zlaté Moravce	Zlaté Moravce
7.	N-Adova s.r.o., Nitra	Nitra	SPP a.s. Bratislava, závod Ivánka pri Nitre	Nitra
8.	Nitrianska teplárenská spoločnosť a.s., Nitra	Nitra	Komárňanské tlačiarne s.r.o, Komárno	Komárno
9.	SES a.s., Tlmače	Levice	PSB Nitra	Nitra
10	Decodom s.r.o., Topoľčany	Topoľčany	Cesty Nitra a.s., prev. Prázdnovce	Topoľčany

TRENČÍN REGION

	PM		SO_2	
	Source	District	Source	District
1.	SE a.s. Bratislava, o.z. ENO Zemianske Kostoľany	Prievidza	SE a.s. Bratislava, o.z. ENO Zemianske Kostoľany	Prievidza
2.	Novácke chemické závody a.s., Nováky	Prievidza	KVARTET a.s., Partizánske	Partizánske
3.	Považská cementáreň a.s., Ladce	Ilava	HBP a.s. Banská mech. a elektrifikácia, Nováky	Prievidza
4.	KVARTET a.s., Partizánske	Partizánske	TEPLÁREŇ a.s., Považská Bystrica	Považská Bystrica
5.	HBP a.s., Banská mech. a elektrifikácia, Nováky	Prievidza	TSM s.r.o., Partizánske	Partizánske
6.	VETROPACK Nemšová s.r.o.	Trenčín	VETROPACK Nemšová s.r.o.	Trenčín
7.	TSM s.r.o., Partizánske	Partizánske	MATADOR a.s., Púchov	Púchov
8.	Považský cukor a. s., Trenčianska Teplá	Trenčín	PSB, Nové Mesto nad Váhom	Trenčín
9.	CEMMAC a. s., Horné Srnie	Trenčín	Prefabetón Koš a.s., Nováky	Prievidza
10.	RONA a.s., Lednické Rovne	Púchov	Považská cementáreň a.s., Ladce	Ilava
	NOx		CO	
	Source	District	Source	District
1.	SE a.s. Bratislava, o.z. ENO Zemianske 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 Zemianske Kostoľany	Prievidza
4.	RONA a.s., Lednické Rovne	Púchov	Novácke chemické závody a.s., Nováky	Prievidza
5.	VETROPACK Nemšová s.r.o.	Trenčín	KVARTET a.s., Partizánske	Partizánske
6.	MATADOR a.s., Púchov	Púchov	TEPLÁREŇ a.s., Považská Bystrica	Považská Bystrica
7.	TEPLÁREŇ a.s., Považská Bystrica	Považská Bystrica	Považský cukor a. s., Trenčianska Teplá	Trenčín
8.	Novácke chemické závody a.s., Nováky	Prievidza	HBP a.s. Banská mech. a elektrifikácia, Nováky	Prievidza
9.	KVARTET a.s., Partizánske	Partizánske	TSM s.r.o, Partizánske	Partizánske
10.	TERMONOVA Nová Dubnica	Ilava	PSB, Nové Mesto nad Váhom	Trenčín

BANSKÁ BYSTRICA REGION

	PM		SO_2	
	Source	District	Source	District
1.	SLOVALCO a.s., Žiar nad Hronom	Žiar nad Hronom	Zvolenská teplárenská a.s., Zvolen	Zvolen
2.	Slovenské magnezitové závody a.s., Jelšava	Revúca	SLOVALCO a.s., Žiar nad Hronom	Žiar nad Hronom
3.	IZOMAT a.s., Nová Baňa	Žarnovica	Slovenské magnezitové závody a.s., Jelšava	Revúca
4.	Zvolenská teplárenská a.s., Zvolen	Zvolen	ZSNP a.s., Žiar nad Hronom	Žiar nad Hronom
5.	Slovmag a.s., Lubenik	Revúca	Slovmag a.s., Lubenik	Revúca
6.	Calmit s.r.o. Bratislava, prev. Tisovec	Rimavská Sobota	IZOMAT a.s., Nová Baňa	Žarnovica
7.	BUČINA Zvolen s r.o.	Zvolen	PETROCHEMA a.s., Dubová	Brezno
8.	Bloomsbury Pacific Slovakia a.s., Lučenec	Lučenec	Lovinit a.s., Lovinobaňa	Lučenec
9.	ZSNP a.s., Žiar nad Hronom	Žiar nad Hronom	Baňa Dolina a.s., Veľký Krtíš	Veľký Krtíš
10.	BUČINA DDD s r.o., Zvolen	Zvolen	Hriňovské tepelné hospodárstvo s.r.o., Hriňová	Detva
	NOx		**CO**	
	Source	District	Source	District
1.	Slovenské magnezitové závody a.s., Jelšava	Revúca	SLOVALCO a.s., Žiar nad Hronom	Žiar nad Hronom
2.	SLOVALCO a.s., Žiar nad Hronom	Žiar nad Hronom	Slovenské magnezitové závody a.s., Jelšava	Revúca
3.	Zvolenská teplárenská a.s., Zvolen	Zvolen	Calmit s.r.o. Bratislava, prev. Tisovec	Rimavská Sobota
4.	Slovmag a.s., Lubenik	Revúca	Slovmag a.s., Lubenik	Revúca
5.	SPP a.s., prev. Veľké Zlievce	Veľký Krtíš	Železiarne Podbrezová a.s.	Brezno
6.	SPP– preprava, závod Veľké Zlievce	Veľký Krtíš	VUM a.s., Žiar nad Hronom	Žiar nad Hronom
7.	ZSNP a.s., Žiar nad Hronom	Žiar nad Hronom	IZOMAT a.s., Nová Baňa	Žarnovica
8.	SLOVGLASS a. s., Poltár	Poltár	INTOCAST Magnezit Hačava a.s., Hnúšťa	Rimavská Sobota
9.	Železiarne Podbrezová a.s.	Brezno	Ipeľské tehelne a.s., Lučenec, záv. Poltár	Poltár
10.	Bučina Zvolen a.s.	Zvolen	Doprastav a.s., Bratislava, OS Badín	Banská Bystrica

ŽILINA REGION

	PM		SO_2	
	Source	District	Source	District
1.	DOLVAP s.r.o., Varín	Žilina	Žilinská teplárenská a.s., Žilina	Žilina
2.	Mondi business paper scp a.s., Ružomberok	Ružomberok	Martinská teplárenská a.s., Tepláreň Martin	Martin
3.	Žilinská teplárenská a.s., Žilina	Žilina	Wienerberger-Slov. tehelne s r.o., Ružomberok	Ružomberok
4.	SOTE s.r.o., Čadca	Čadca	SOTE s.r.o., Čadca	Čadca
5.	OFZ a.s., Istebné	Dolný Kubín	OFZ a.s., Istebné	Dolný Kubín
6.	Rettenmeier Tatra Timber s.r.o., Liptovský Hrádok	Liptovský Mikuláš	Rettenmeier Tatra Timber s.r.o., Liptovský Hrádok	Liptovský Mikuláš
7.	TATRA nábytkáreň a.s., Martin	Martin	Mondi business paper scp a.s., Ružomberok	Ružomberok
8.	DOLKAM Šuja a.s., Rajec	Žilina	ŽOS Vrútky a.s.	Martin
9.	Martinská teplárenská a.s., Tepláreň Martin	Martin	Velvetex a.s.Trenčín, tepláreň Lipt. Mikuláš	Liptovský Mikuláš
10.	Turzovská drevárska fabrika s.r.o., Turzovka	Čadca	VINUTA s.r.o., Rajec	Žilina
	NOx		**CO**	
	Source	District	Source	District
1.	Mondi business paper scp a.s., Ružomberok	Ružomberok	OFZ a.s., Istebné	Dolný Kubín
2.	Žilinská teplárenská a.s., Žilina	Žilina	DOLVAP s.r.o., Varín	Žilina
3.	Martinská teplárenská a.s., Tepláreň Martin	Martin	Mondi business paper scp a.s., Ružomberok	Ružomberok
4.	SPECIALITY MINERALS SLOVAKIA, Ružomberok	Ružomberok	Wienerberger-Slov. tehelne s.r.o., Ružomberok	Ružomberok
5.	OFZ a.s., Istebné	Dolný Kubín	SOTE Čadca	Čadca
6.	Rettenmeier Tatra Timber s.r.o., Liptovský Hrádok	Liptovský Mikuláš	Žilinská teplárenská a.s., Žilina	Žilina
7.	SOTE Čadca	Čadca	ŽOS Vrútky a.s.	Martin
8.	Velvetex a.s., Trenčín	Liptovský Mikuláš	Swedwood Slovakia s.r.o., prev. Zavažná Poruba	Liptovský Mikuláš
9.	Kysuca s.r.o., Kysucké Nové Mesto	Kysucké Nové Mesto	Drevomax s.r.o., prev. Rajecké Teplice	Žilina
10.	Ružomberská energ. spoločnosť a.s., Ružomberok	Ružomberok	Turzovská drevárska fabrika s.r.o., Turzovka	Čadca

PREŠOV REGION

	PM		SO₂	
	Source	District	Source	District
1.	BUKOCEL a.s., Hencovce	Vranov n/Topľou	BUKOCEL a.s., Hencovce	Vranov n/Topľou
2.	Kronospan SK, s.r.o., Prešov	Prešov	CHEMES a.s., HUMENNÉ	Humenné
3.	CHEMES a.s., HUMENNÉ	Humenné	Energy Snina a.s.	Snina
4.	Energy Snina a.s.,	Snina	Zeocem Bystré a.s.	Vranov n/Topľou
5.	TATRAVAGÓNKA a.s., Poprad	Poprad	Zastrova a.s., Spišská Stará Ves	Kežmarok
6.	Legno Export s.r.o., Berňadikovce	Svidník	TP real s r.o., Hrabušice	Poprad
7.	Východoslov. kamenolomy a.s., Novoveská Huta	Vranov n/Topľou	EUROKOV v.d., Orlov	Stará Ľubovňa
8.	TP real s r.o., Hrabušice	Poprad	Tehelne Vranov s.r.o., Vranov nad Topľou	Vranov n/Topľou
9.	Bukoza Progres s.r.o., Hencovce	Vranov n/Topľou	SAD Poprad	Poprad
10.	Zeocem Bystré a.s.	Vranov n/Topľou	Tesla Stará Ľubovňa	Stará Ľubovňa
	NOx		**CO**	
	Source	District	Source	District
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	Energy Snina a.s.	Snina
6.	DALKIA Poprad a.s., Poprad	Poprad	Chemosvit folie a.s., Svit	Poprad
7.	CHEMOSVIT ENERGOCHEM a.s., Svit	Poprad	Spravbyt a.s., Prešov	Prešov
8.	BARDTERM s.r.o., Bardejov	Bardejov	EUROVIA - Cesty a.s., Košice	Poprad
9.	TATRAVAGÓNKA a.s., Poprad	Poprad	Inžinierske stavby a.s. Košice, OS Veľká Lomnica	Kežmarok
10.	Zeocem Bystré a.s.	Vranov n/Topľou	Posádková správa budov Prešov	Prešov

KOŠICE REGION

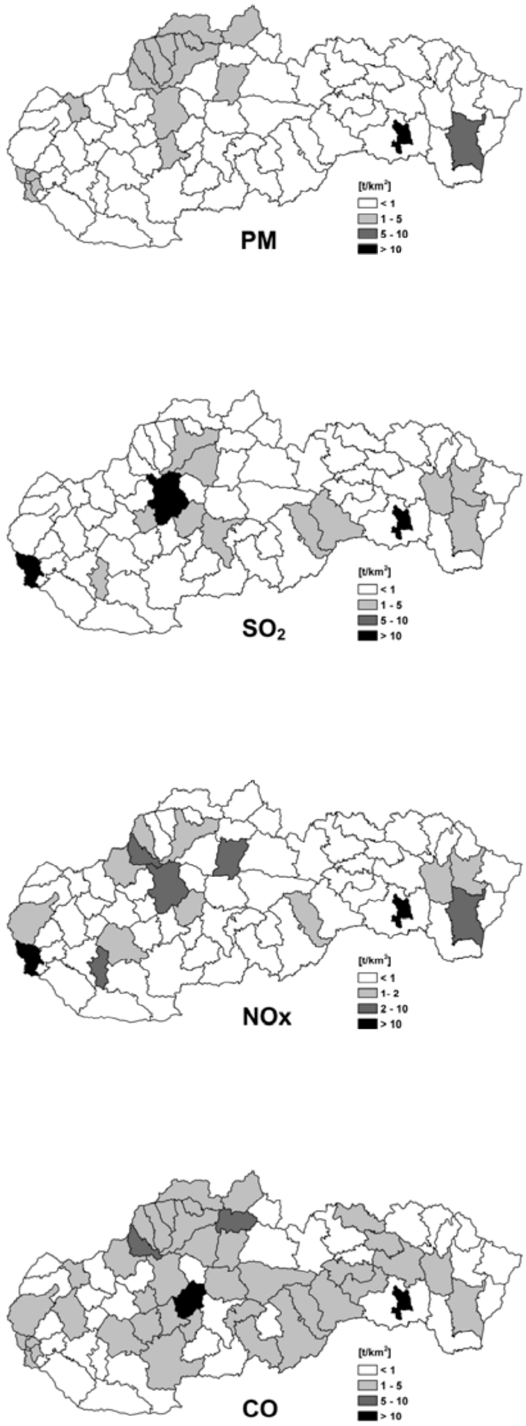
	PM		SO₂	
	Source	District	Source	District
1.	SE a.s. Bratislava, Elektráreň Vojany I a II	Michalovce	U.S.Steel Košice, s.r.o., Košice	Košice II
2.	U.S.Steel Košice, s.r.o. Košice	Košice II	SE a.s. Bratislava, Elektráreň Vojany I a II	Michalovce
3.	Carmeuse Slovakia s.r.o., závod Včeláre	Košice - okolie	SIDERIT s.r.o., Nižná Slaná	Rožňava
4.	SIDERIT s.r.o., Nižná Slaná	Rožňava	TEKO a.s., Košice	Košice IV
5.	Carmeuse Slovakia s.r.o., závod Košice	Košice II	Slovenské magnezitové závody a.s., závod Bočiar	Košice II
6.	Carmeuse Slovakia s.r.o., závod Slavec	Rožňava	KOVOHUTY a.s., Krompachy	Spišská N. Ves
7.	TEKO a.s., Košice	Košice IV	Refrako s.r.o., Košice	Košice II
8.	V.S.H. a.s., Turňa nad Bodvou	Košice - okolie	Reliningserv Košice	Košice II
9.	Kerko a.s. Košice, zdroje v okrese Michalovce	Michalovce	ŽSR Bratislava, zdroje v okrese Trebišov	Trebišov
10.	KOVOHUTY a.s., Krompachy	Spišská N. Ves	V.S.H. a.s., Turňa nad Bodvou	Košice - okolie
	NOx		**CO**	
	Source	District	Source	District
1.	U.S.Steel Košice s.r.o., Košice	Košice II	U.S.Steel Košice 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.	V.S.H. a.s., Turňa nad Bodvou	Košice - okolie	SIDERIT s.r.o., Nižná Slaná	Rožňava
5.	SPP a.s., závod Veľké Kapušany	Michalovce	HNOJIVÁ a.s., STRÁŽSKE	Michalovce
6.	SPP a.s., KS Jabloňov nad Turňou	Rožnava	Zlieváreň SEZ Krompachy a. s.	Spišská N. Ves
7.	Carmeuse Slovakia s.r.o., závod Košice	Košice II	Calmit s.r.o., Bratislava, prev. Margecany	Gelnica
8.	SPP - preprava a.s., prev. Veľké Kapušany	Michalovce	Slovenské magnezitové závody a.s., závod Bočiar	Košice II
9.	SPP - preprava a.s., prev. Jabloňov nad Turňou	Rožnava	Carmeuse Slovakia s.r.o., závod Košice	Košice II
10.	Slovenské magnezitové závody a.s., závod Bočiar	Košice II	V.S.H. a.s., Turňa nad Bodvou	Košice - okolie

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

Tab. 4.6 **Stationary source emissions by districts in 2006**

District	Emissions [t/year]				Specific territorial emis. [t/year.km²]			
	PM	SO_2	NOx	CO	PM	SO_2	NOx	CO
1. Bratislava	430	11764	4521	1065	1.17	32.00	12.30	2.90
2. Malacky	249	157	1508	1526	0.26	0.17	1.59	1.61
3. Pezinok	108	30	100	201	0.29	0.08	0.27	0.54
4. Senec	95	19	92	173	0.26	0.05	0.25	0.48
5. Dunajská Streda	442	387	370	600	0.41	0.36	0.34	0.56
6. Galanta	253	317	267	434	0.39	0.49	0.42	0.68
7. Hlohovec	120	26	86	230	0.45	0.10	0.32	0.86
8. Piešťany	218	44	125	344	0.57	0.12	0.33	0.90
9. Senica	328	76	151	514	0.48	0.11	0.22	0.75
10. Skalica	204	42	115	313	0.57	0.12	0.32	0.88
11. Trnava	262	148	494	1128	0.35	0.20	0.67	1.52
12. Bánovce n/B	235	48	87	367	0.51	0.10	0.19	0.79
13. Ilava	409	54	1248	2411	1.14	0.15	3.48	6.73
14. Myjava	330	68	100	508	1.01	0.21	0.31	1.55
15. Nové Mesto n/V	313	64	149	494	0.54	0.11	0.26	0.85
16. Partizánske	260	523	160	540	0.86	1.74	0.53	1.79
17. Považská Bystrica	571	286	300	1126	1.23	0.62	0.65	2.43
18. Prievidza	1667	38321	3991	1750	1.74	39.93	4.16	1.82
19. Púchov	511	132	659	778	1.36	0.35	1.76	2.07
20. Trenčín	415	162	1141	2881	0.61	0.24	1.69	4.27
21. Komárno	394	79	230	660	0.36	0.07	0.21	0.60
22. Levice	1054	221	367	1644	0.68	0.14	0.24	1.06
23. Nitra	361	81	1144	1767	0.41	0.09	1.31	2.03
24. Nové Zámky	607	1048	895	973	0.45	0.78	0.66	0.72
25. Šaľa	300	836	762	293	0.84	2.35	2.14	0.82
26. Topoľčany	199	47	153	344	0.33	0.08	0.26	0.57
27. Zlaté Moravce	229	55	101	779	0.44	0.11	0.19	1.50
28. Bytča	389	82	115	597	1.38	0.29	0.41	2.12
29. Čadca	1204	428	344	1925	1.58	0.56	0.45	2.53
30. Dolný Kubín	334	163	326	2984	0.68	0.33	0.67	6.09
31. Kysucké Nové Mesto	248	51	102	382	1.43	0.29	0.58	2.20
32. Liptovský Mikuláš	629	258	293	977	0.47	0.19	0.22	0.73
33. Martin	488	982	483	836	0.66	1.34	0.66	1.14
34. Námestovo	1162	289	273	1725	1.68	0.42	0.40	2.50
35. Ružomberok	738	450	1507	1736	1.14	0.70	2.33	2.68
36. Turčianske Teplice	207	46	58	317	0.53	0.12	0.15	0.81
37. Tvrdošín	178	42	70	306	0.37	0.09	0.15	0.64
38. Žilina	963	1652	907	3206	1.18	2.03	1.11	3.93
39. Banská Bystrica	550	126	320	921	0.68	0.16	0.39	1.14
40. Banská Štiavnica	257	58	69	380	0.88	0.20	0.24	1.30
41. Brezno	663	209	305	1289	0.52	0.17	0.24	1.02
42. Detva	410	107	128	644	0.91	0.24	0.28	1.43
43. Krupina	355	83	92	544	0.61	0.14	0.16	0.93
44. Lučenec	659	164	231	997	0.80	0.20	0.28	1.21
45. Poltár	211	57	259	392	0.44	0.12	0.54	0.82
46. Revúca	563	1101	1268	2978	0.77	1.51	1.74	4.08
47. Rimavská Sobota	1119	231	311	2686	0.76	0.16	0.21	1.83
48. Veľký Krtíš	501	144	689	782	0.59	0.17	0.81	0.92
49. Zvolen	420	2484	734	645	0.55	3.27	0.97	0.85
50. Žarnovica	492	224	189	777	1.15	0.53	0.45	1.83
51. Žiar n/H	509	1803	927	13799	0.98	3.48	1.79	26.66
52. Bardejov	401	86	148	618	0.43	0.09	0.16	0.66
53. Humenné	452	998	884	636	0.60	1.32	1.17	0.84
54. Kežmarok	416	94	141	654	0.50	0.11	0.17	0.78
55. Levoča	212	48	70	338	0.59	0.13	0.20	0.95
56. Medzilaborce	176	37	46	265	0.41	0.09	0.11	0.62
57. Poprad	304	68	226	553	0.27	0.06	0.20	0.50
58. Prešov	648	100	382	1251	0.70	0.11	0.41	1.35
59. Sabinov	392	84	131	600	0.81	0.17	0.27	1.24
60. Snina	459	197	188	667	0.57	0.24	0.23	0.83
61. Stará Ľubovňa	518	120	151	812	0.83	0.19	0.24	1.30
62. Stropkov	139	29	44	211	0.36	0.07	0.11	0.54
63. Svidník	280	55	85	414	0.51	0.10	0.15	0.75
64. Vranov n/T	760	2290	787	1696	0.99	2.98	1.02	2.20
65. Gelnica	412	83	110	823	0.71	0.14	0.19	1.41
66. Košice	4106	11417	12222	109060	16.92	47.03	50.34	449.24
67. Košice - okolie	960	175	823	1359	0.63	0.11	0.54	0.89
68. Michalovce	6792	2542	5319	2066	6.67	2.50	5.22	2.03
69. Rožňava	1058	2523	875	2181	0.90	2.15	0.75	1.86
70. Sobrance	170	39	52	252	0.32	0.07	0.10	0.47
71. Spišská Nová Ves	389	185	169	2818	0.66	0.32	0.29	4.80
72. Trebišov	394	91	196	608	0.37	0.08	0.18	0.57
Slovakia	43253	87530	52366	193550	0.88	1.79	1.07	3.95

Fig. 4.3 **Specific territorial emission – 2006**

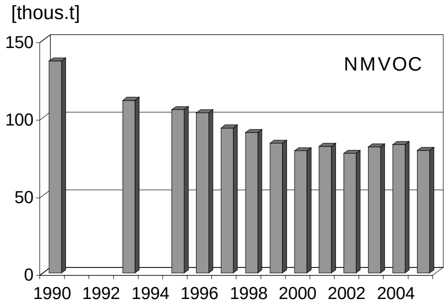


Tab. 4.7 **NMVOC emissions [t] in the Slovak Republic**

Sector / Subsector	1990	1993	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Combustion on energy and transformation industries	335	276	258	257	247	265	228	201	221	215	214	203	152
Public power	223	190	187	189	182	192	166	139	159	147	161	156	115
District heating plants	112	86	71	68	65	73	62	62	62	67	53	47	37
Non-industrial combustion plants	12641	11269	9618	9750	8125	8472	8229	7927	8320	7087	7519	8943	11936
Commercial and institutional plants	226	226	150	134	134	134	134	32	34	32	30	30	31
Agriculture	IE	IE	IE	IE	IE	IE	IE	14	15	15	15	14	9
Residential plants	12415	11043	9468	9616	7991	8338	8095	7881	8271	7040	7474	8899	11896
Combustion in manufacturing industry	981	1049	805	1059	1079	904	546	585	772	648	704	753	759
Comb. in boilers, gas turb. and stat. engines	206	152	150	152	144	126	124	159	231	147	169	121	74
Iron production	32	29	29	26	28	25	27	28	29	32	35	34	33
Ore aglomeration	438	380	358	371	389	354	377	396	403	383	409	403	384
Copper production	305	488	268	510	518	399	19	2	109	85	91	195	268
Production processes	27029	18828	11129	11806	11161	10178	8754	8717	8343	7727	7151	7103	6434
Processes in petroleum industries	17188	12119	7474	8359	7717	7960	6563	6627	6306	5571	4545	4617	4058
Coke production	1053	844	834	769	779	640	681	719	719	765	801	800	783
Steel production	43	35	36	31	31	32	33	34	37	40	42	41	41
Rolling mills	233	250	297	283	301	290	304	300	267	304	336	329	341
Aluminium production	0,101	0,058	0,049	0,167	0,165	0,162	0,164	0,165	0,165	0,165	0,167	0,235	0,2
Proc. in organic chemical industries	6437	3519	1369	1386	1364	870	785	651	644	690	941	970	870
Food production	2073	2060	1118	977	968	386	388	385	370	357	358	346	340
Road paving with asphalt	2,4	1,5	1,0	0,9	0,8	0,8	0,5	0,5	0,5	0,5	0,6	0,5	0,7
Exploitation&distrib. of natural resour.	8822	8868	8535	8104	9336	5854	6606	5929	6161	6024	7431	7696	7105
Exploitation&distribution of crude oil	5198	5194	4298	4296	3803	3801	4193	3750	3848	3801	3999	4149	4281
Distribution of fuel	3624	3674	4237	3808	5533	2053	2412	2179	2313	2223	3432	3547	2824
Solvent and other products use	48025	38294	41209	39840	30835	32302	29519	29759	30574	30855	31629	32737	33153
Use of paints and glues	32811	19349	20687	19122	15653	16035	14365	13214	14025	15110	16369	18457	18918
Dry cleaning and degreasing	6650	10366	11838	12108	6498	7563	6483	7873	8021	7167	6765	6765	5693
Processing of fat and oil	332	308	363	273	332	345	303	299	191	240	156	134	189
Products	8232	8271	8320	8337	8351	8359	8368	8374	8337	8338	8339	8347	8353
Road traffic	32611	30332	32373	31235	31456	31238	28502	24479	26079	23292	25513	24224	18247
Other traffic	953	543	599	609	584	659	571	528	524	500	460	469	488
Waste treatment and disposal	4538	1339	259	147	153	226	180	208	180	320	192	204	231
Incineration of municipal waste	102	102	102	59	77	98	95	133	93	75	115	130	128
Incineration of Industrial waste	157	157	157	74	67	122	79	66	81	204	43	53	66
Incineration of hospital waste	IE	IE	IE	14	9	6	6	9	6	42	34	21	37
Agricultural waste*	4279	1080											
Agriculture	651	436	436	436	436	436	436	436	436	436	436	436	436
Total	136585	111235	105220	103243	93412	90534	83571	78769	81610	77103	81249	82768	78940

Emissions, as they were appointed to February 15, 2007
* *agricultural waste combustion is prohibited from the year 1994* IE *included in other source category*
Because of changeover from EAPSI to NEIS in the 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 subsector Agriculture (sector Non-industrial combustion plants) was established.

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

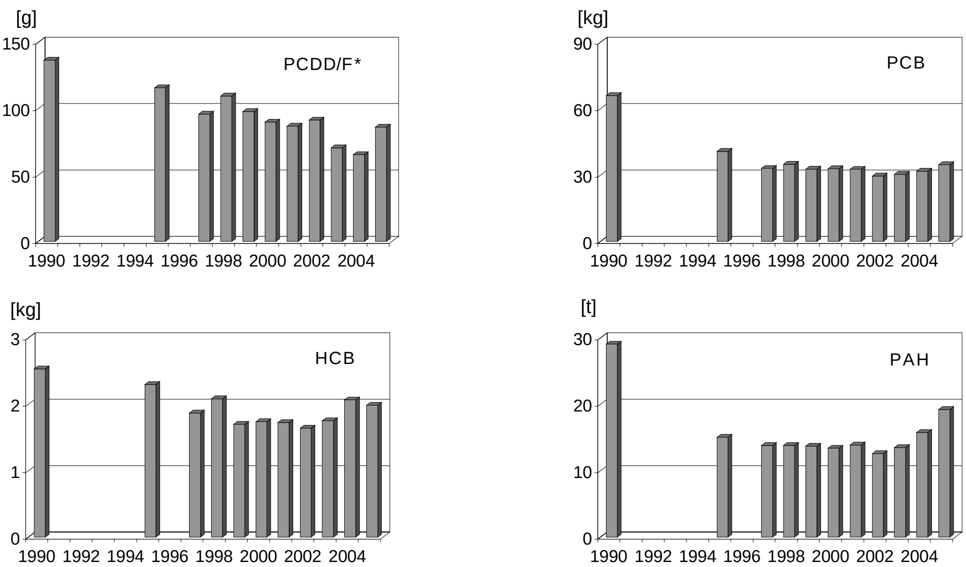


Tab. 4.8 **Emissions of persistent organic pollutants in the SR in 2005**

Sector / Subsector	PCDD/F* [g]	PCB [kg]	HCB [kg]	PAH: sum PAH [kg]	PAH: B(a)P [kg]	PAH: B(k)F [kg]	PAH: B(b)F [kg]	PAH: I(1,2,3-cd)P [kg]
Combustion on energy and transformation industries	7.034	1.129	0.228	1 481.029	87.150	435.731	435.993	522.155
Public power	1.774	1.121	0.225	0.815	0.052	0.273	0.401	0.089
District heating plants	0.039	0.007	0.003	1.157	0.041	0.458	0.592	0.066
Coke production	5.220	0.000	0.000	1 479.058	87.058	435.000	435.000	522.000
Non-industrial combustion plants	3.759	9.856	0.182	16 048.886	4 577.648	2 011.035	6 014.028	3 446.174
Commercial and institutional plants	0.034	0.010	0.003	0.411	0.005	0.192	0.206	0.009
Residential plants	3.716	9.842	0.178	16 048.135	4 577.625	2 010.728	6 013.646	3 446.136
Agriculture	0.009	0.003	0.001	0.339	0.018	0.116	0.176	0.029
Combustion in manufacturing industry	26.690	6.894	0.452	136.931	68.864	25.715	32.782	9.570
Comb. in boilers, gas turb. and stat. eng.	0.712	0.924	0.143	30.061	1.773	9.693	15.719	2.877
Iron production	0.368	0.023	0.000	62.584	62.584	0.000	0.000	0.000
Ore agglomeration	24.476	3.844	0.112	40.781	4.193	15.201	15.201	6.185
Cast iron production	0.094	0.018	0.000	0.015	0.003	0.005	0.005	0.002
Others	1.040	2.085	0.197	3.490	0.310	0.816	1.858	0.506
Production processes	6.252	1.932	0.443	1 253.846	455.451	370.978	379.078	48.339
Aluminium production	0.751	0.125	0.000	584.459	191.045	184.687	184.687	24.040
Steel production	4.417	1.760	0.000	78.115	78.115	0.000	0.000	0.000
Carbon mineral production	0.000	0.000	0.000	591.271	186.291	186.291	194.391	24.299
Wood impregnation	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Others	1.084	0.047	0.443	0.000	0.000	0.000	0.000	0.000
Road traffic	0.152	11.975	0.010	114.211	15.283	39.205	40.189	19.534
Other traffic	0.008	0.809	0.001	9.702	2.426	1.455	3.396	2.426
Waste treatment and disposal	42.039	2.076	0.669	157.214	44.723	30.620	64.756	17.116
Incineration of municipal waste	5.458	0.958	0.542	7.026	0.127	3.434	3.434	0.031
Incineration of industrial waste	2.773	0.370	0.111	1.437	0.026	0.703	0.703	0.006
Incineration of hospital waste	32.981	0.660	0.003	2.564	0.046	1.253	1.253	0.011
Others	0.826	0.089	0.013	146.188	44.524	25.230	59.366	17.068
Total	85.934	34.671	1.984	19 201.820	5 251.545	2 914.740	6 970.222	4 065.315

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, as they were appointed to ***February 15, 2007***

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

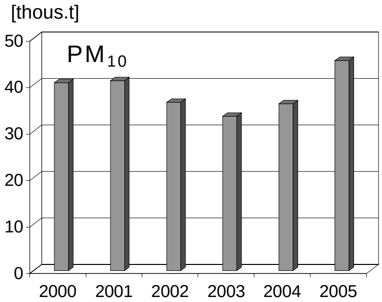


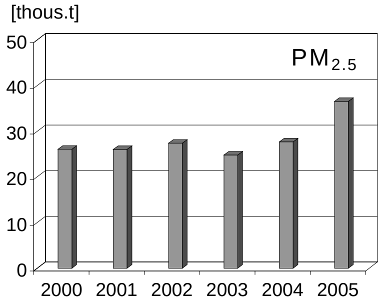
Tab. 4.9 **PM_{10} and $PM_{2.5}$ emissions [thous. t] in the SR**

Sector / Subsektor	2000		2001		2002		2003		2004		2005	
	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	5.845	2.487	5.452	2.355	4.701	1.847	5.206	2.800	5.246	2.598	9.847	5.830
Public Electricity and Heat Production	5.148	2.088	4.595	1.857	4.173	1.593	3.689	1.854	4.175	1.978	9.052	5.194
Petroleum refining	0.043	0.017	0.039	0.016	0.031	0.012	0.095	0.079	0.077	0.058	0.090	0.075
Coke production	0.653	0.382	0.818	0.483	0.498	0.242	1.422	0.867	0.995	0.562	0.705	0.561
Combustion processes II	18.325	13.589	19.021	14.802	16.347	13.676	17.368	14.773	20.435	17.994	27.292	24.552
Commercial and institutional plants	0.602	0.329	0.510	0.286	0.403	0.226	0.453	0.264	0.291	0.166	0.259	0.161
Residential plants	17.221	12.994	18.096	14.290	15.522	13.218	16.563	14.321	19.836	17.644	26.742	24.230
Agriculture	0.168	0.098	0.163	0.095	0.157	0.088	0.124	0.061	0.140	0.074	0.135	0.068
Other combustion processes	0.334	0.169	0.252	0.130	0.266	0.145	0.228	0.126	0.168	0.111	0.156	0.093
Combustion porcesses in industry	12.506	6.715	12.513	5.437	11.165	8.411	6.866	3.903	6.218	3.633	4.062	2.357
Production of iron and steel	8.743	4.329	9.141	3.196	8.105	6.347	3.953	1.982	2.676	1.324	1.382	0.682
Production of non-ferrous metals	0.132	0.107	0.169	0.126	0.147	0.106	0.128	0.100	0.133	0.110	0.176	0.143
Chemical industry	1.137	0.679	0.927	0.611	0.744	0.582	0.611	0.451	1.158	0.910	0.576	0.409
Production of paper and cellulose	0.375	0.275	0.293	0.201	0.306	0.209	0.360	0.265	0.530	0.232	0.331	0.194
Food production	0.091	0.054	0.109	0.067	0.094	0.061	0.079	0.045	0.091	0.061	0.099	0.069
Other combustion processes in industry	2.028	1.272	1.873	1.237	1.768	1.107	1.735	1.061	1.630	0.996	1.498	0.860
Transportation	2.999	2.710	3.268	2.941	3.379	3.045	3.269	2.930	3.515	3.156	3.601	3.177
Road traffic	2.620	2.351	2.884	2.577	3.031	2.715	2.957	2.633	3.189	2.846	3.260	2.852
Other traffic	0.379	0.359	0.384	0.364	0.348	0.330	0.312	0.296	0.326	0.310	0.341	0.324
Industrial technologies	0.761	0.539	0.651	0.490	0.640	0.439	0.513	0.346	0.473	0.294	0.414	0.237
Inorganic chemical industry	0.175	0.053	0.158	0.047	0.171	0.050	0.147	0.044	0.169	0.050	0.183	0.054
Other industrial processes	0.586	0.486	0.493	0.443	0.469	0.389	0.365	0.303	0.304	0.244	0.231	0.183
Total	40.436	26.041	40.905	26.025	36.233	27.419	33.223	24.751	35.886	27.674	45.216	36.152

Emissions, as they were appointed to February 15, 2007

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



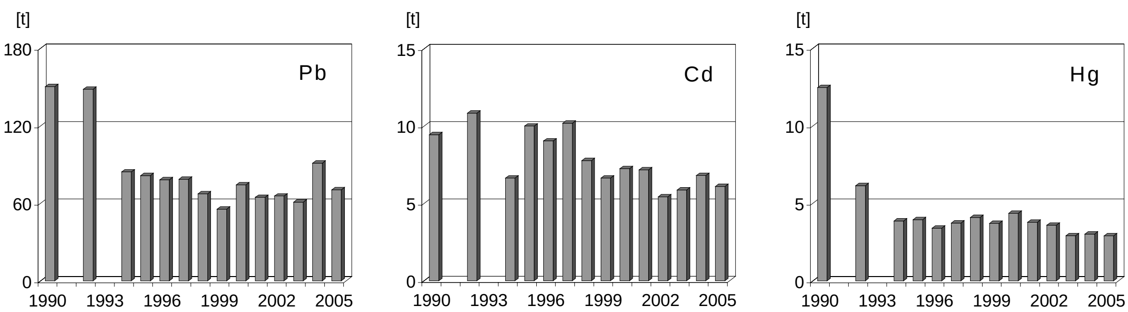


Tab. 4.10 **Emissions of heavy metals [t] in the SR in 2005**

Sector / Subsector	Pb	As	Cd	Cr	Cu	Hg	Ni	Se	Zn
Combustion on energy and transformation industries	0.797	1.527	0.032	1.277	1.158	0.049	1.433	0.277	1.601
Public power	0.632	1.493	0.025	1.261	1.146	0.043	1.266	0.273	1.368
District heating plants	0.165	0.034	0.007	0.016	0.012	0.006	0.166	0.004	0.233
Non-industrial combustion plants	1.168	0.143	0.034	0.350	0.464	0.034	0.380	0.045	3.464
Commercial and institutional plants	0.093	0.114	0.004	0.04	0.038	0.003	0.034	0.003	0.157
Residential plants	1.033	0.027	0.028	0.302	0.420	0.029	0.283	0.04	3.248
Agriculture	0.042	0.002	0.002	0.008	0.006	0.002	0.063	0.002	0.059
Combustion in manufacturing industry	54.767	20.732	5.351	2.797	29.336	1.828	11.862	8.167	35.111
Comb. in boilers, gas turb. and stat. engines	3.300	0.573	0.150	0.537	0.316	0.163	7.452	0.199	4.450
Iron production	0.125	0.011	0.199	0.946	0.074	0.317	3.151	0.040	7.882
Glass production	15.766	2.434	4.829	0.671	0.168	0.014	0.531	5.034	3.076
Ore agglomeration	27.932	0.497	0.0016	0.614	9.180	1.295	0.704	1.297	14.614
Copper production	7.456	17.181	0.154		19.593	0.001		1.597	5.032
Cement production	0.187	0.002	0.001	0.020		0.038	0.022	0.00029	0.048
Aluminium oxide production									
Magnesite production	0.001	0.033	0.002	0.007	0.005	0.00016	0.002		0.009
Production processes	1.615	0.083	0.036	1.050	2.889	0.491	8.550	0.014	17.479
Steel production	1.268	0.069	0.014	0.161	2.504	0.014	2.532	0.014	5.284
Aluminium production			0.016				1.592		1.592
Ferro alloys production	0.134	0.009	0.004	0.036	0.005		0.001		0.654
Pig iron production	0.108	0.004	0.002	0.018			0.009		0.076
Galvanizing	0.096			0.835	0.288		4.416		8.352
Alloys (Cu-Zn) production	0.009				0.091				1.520
Inorganic chemical industry						0.477			
Road traffic	2.1		0.019	0.095	3.220		0.133	0.019	1.894
Other traffic			0.001	0.004	0.137		0.006	0.001	0.081
Waste treatment and disposal	10.141	0.012	0.624	0.841	1.293	0.501	0.494	0.006	4.277
Incineration of municipal waste	8.133	0.009	0.452	0.813	1.121	0.325	0.488	0.002	3.073
Incineration of Industrial waste	0.713	0.001	0.061	0.010	0.061	0.061	0.002	0.001	0.428
Incineration of hospital waste	1.294	0.002	0.111	0.018	0.111	0.111	0.004	0.002	0.776
Cremation						0.004			
Total	70.588	22.497	6.096	6.413	38.497	2.902	22.857	8.528	63.907

Emissions, as they were appointed to February 15, 2007

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



EMISSIONS

GREENHOUSE GAS EMISSIONS

5

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 Co-operation 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, 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 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 greenhouse gases by 8 % during period 2008–2012. As of June 6, 2007, 174 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.

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.[2] The Slovak Republic submit the data about GHG emissions in the relevant extend to the 15. January, annually, according 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.[3] 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 UN FCCC 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.

[1] http://www.unfccc.int
[2] *New environmental action program: Environment 2010 Our Future, Our Choice*
[3] *OJ L 49, 19.2.2004, p. 1.*

The KP targets for the “old” EU-15 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).

The new member states have individual targets under the Kyoto Protocol. The Czech Republic, Estonia, Bulgaria, Latvia, Lithuania, Romania, the Slovak Republic 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 UN FCCC, but not the Kyoto Protocol. Lichtenstein and Switzerland have a reduction target of 8 %.

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.

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 Kyoto Protocol 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.[4] 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[5].

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[4] *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 (Congress of Parties), where the latest knowledge in association with the global warming is included.*

[5] *The IPCC 4th Assessment Report, 2007*

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 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 5 177 Mt CO_2 equivealents in 2005. This represent a slight decrease (–0.7 %) compared to 2004, bringing emissions 7.9 % below the 1990 level. 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 decline compared to 1990 is 11 % if additional domestic policies and measures are also 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 2005, EU-27 per capita emissions declined by 11.7 % (1.4 tonnes per capita). 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 2005, the aggregated emissions of new member states were 28 % 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.[6]

The emissions of greenhouse gases in the Slovak Republic are estimated in accordance with the requirements of 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 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 UN FCCC, 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 expert review team. In March 2007, the National Inventory System of the Slovak Republic[9] under the UN FCCC and Kyoto Protocol was revised under the in-depth review for the Initiation report by expert review team under responsibility of the secretariat of UN FCCC. The list of potential problems was published into the outcome report from the review. The in-depth review was a tool for the analysis of current status in the parties of the KP and to get eligibility for participation on Kyoto flexible mechanisms after 2008. The final report will be published on the official web site of the Slovak National Inventory System www.ghg-inventory.gov.sk.

Total GHG emissions after revision represented 47 866.31 Gg in 2005 (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 2004, the emissions decreased by 1.5 % (729 Gg). The emissions signified in the literature as net emissions with the sinks from LULUCF in 2005 were 47 016.47 Gg and increased against previous year by 6 % caused by lower sinks in LULUCF. According the decision of the Convention body the strictly recommended reporting software is CRFReporter, which generate automatically the required CRF Tables. After in-depth review from March 2007, the extensive recalculation and revaluation took place in the national GHG

[6] *Greenhouse gas emission trends and projections in Europe 2007, EEA, Kodaň 2007*
[7] *Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventory, Volume 1-3*
[8] *Good Practice Guidance and Uncertainty Management in National GHGs Inventories, IPCC 2000*
[9] *Vestnik MZP SR, 2007, 3, pages 19-45*

inventory. The recalculation was provided to the base year 1990 and the inventory year 2004, as well as to the time series 1990–2004. 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 **Aggregated[10] anthropogenic emissions of GHG [Tg] in the Slovak Republic in 1990–2005**

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Net CO_2	57.8	48.4	44.1	41.0	39.0	41.0	41.8	43.1	41.5	40.8	37.0	37.1	35.1	35.8	36.0	38.9
CO_2*	60.2	51.9	48.2	45.3	42.3	43.7	44.3	44.5	43.5	42.5	39.4	42.3	40.3	40.6	40.2	39.8
CH_4	5.4	5.1	4.8	4.4	4.4	4.6	4.7	4.6	4.6	4.6	4.5	4.5	4.6	4.6	4.4	4.2
N_2O	6.2	5.0	4.2	3.5	3.9	4.1	4.2	4.1	3.7	3.3	3.5	3.7	3.7	3.7	3.8	3.7
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
Total (with net CO_2)	69.7	58.7	53.3	49.1	47.5	49.9	50.8	52.0	49.9	48.7	45.1	45.4	43.5	44.3	44.4	47.0
Total*	72.1	62.2	57.4	53.4	50.8	52.5	53.2	53.3	51.8	50.4	47.4	50.6	48.7	49.1	48.6	47.9

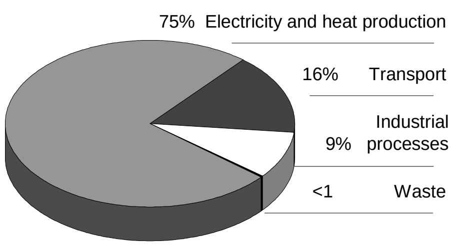
Emissions, as determinated to July 2, 2007
* *GHG emissions without sinks from LULUCF*

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 2005**



Total net CO_2 emissions decreased moderate in 2005 compared with the previous year, totally decreased by 34 % 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.

[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*

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 1950–2005, 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 1990–2005. 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.

Tab. 5.2 **Total emissions and sinks of CO_2 [Gg] within 1990–2005**

	1990	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Net CO_2	57 815	41 020	41 833	43 131	41 517	40 830	36 979	37 069	35 105	35 812	35 993	38 880
CO_2*	60 222	43 716	44 254	44 533	43 457	42 466	39 382	42 294	40 348	40 645	40 244	39 757
Fossil fuel combustion	56 737	40 937	41 493	41673	39 896	38 846	36 124	38 961	36 953	37 466	36 322	36 017
Electricity and heat prod.	51 852	36 685	37 186	37 196	35 136	34 191	31 943	34 209	32 064	32 471	31 049	29 805
Transport	4 885	4 252	4 307	4 478	4 761	4 654	4 181	4 752	4 889	4 995	5 273	6 212
Industrial processes	3 484	2 779	2 761	2 859	3 560	3 620	3 102	3 198	3 251	3 039	3 774	3 594
Mineral products	2 942	2 342	2 250	2 331	3 032	3 052	2 522	2 590	2 602	2 336	2 999	2 858
Production of metals	542	437	512	528	528	567	580	608	649	703	775	737
LULUCF	–2 407	–2 696	–2 422	–1 402	–1 939	–1 636	–2 403	–5 225	–5 243	–4 833	–4 251	–877
Forest	–4 454	–4 399	–3 968	–2 717	–3 130	–2 800	–4 318	–5 551	–5 641	–5 156	–3 995	–701
Cropland	3 287	2 063	2 063	3 226	1 798	1 711	4 394	1002	1 174	1 416	–14	1
Grassland	536	256	93	–50	70	–126	–797	–880	–874	–1 363	–373	–442
Other land	–1 775	–615	–609	–1861	–677	–420	–1 682	204	98	269	132	264
Waste	IE	IE	IE	IE	IE	IE	156	135	143	140	148	146
Waste incineration	IE	IE	IE	IE	IE	IE	156	135	143	140	148	146
Burning biomass**	314	326	316	349	303	269	80	99	129	98	121	172
International bunkers**	128	103	102	76	84	52	45	69	72	79	86	91

Emissions, as determinated to July 2, 2007

* *CO_2 emissions without sinks from LULUCF*

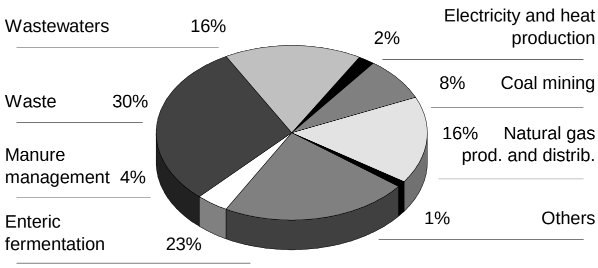
** *CO_2 emissions are not being accounted into the total emissions*

[11] *The Biennial Report 2007 according Decision 280/2004/EC*

[12] *IPCC Good Practice Guidance for Land Use, Land-Use Change and Forestry 2003*

CH_4 – methane

Fig. 5.2 **CH_4 emissions in 2005**



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 2005 198.9 Gg and decreased compared to the previous year by more than 4 %. However, emissions decreased by 23 % 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 1960–2005 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. The methane emissions decreased in all sub-sectors except LULUCF and waste, caused by implementtation of new methodologies. (Table 5.3).

Tab. 5.3 **Total emissions of CH_4 [Gg] within 1990–2005**

	1990	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
CH_4	257.5	220.5	223.3	219.9	218.9	217.9	213.2	216.5	219.3	217.9	208.0	198.9
Energy	73.9	68.6	69.6	70.2	72.2	70.2	70.5	68.6	65.0	62.5	59.1	53.1
Fossil fuel combustion	22.3	9.8	9.8	9.6	9.0	8.7	7.6	7.4	5.5	5.5	5.0	5.0
Electricity and heat prod.	*21.3*	*8.7*	*8.6*	*8.4*	*7.7*	*7.4*	*6.5*	*6.1*	*4.3*	*4.2*	*3.7*	*3.7*
Transport	*1.0*	*1.1*	*1.2*	*1.2*	*1.3*	*1.3*	*1.1*	*1.3*	*1.2*	*1.3*	*1.3*	*1.3*
Fugitive emissions	51.7	58.8	59.8	60.6	63.2	61.5	62.9	61.2	59.4	57.0	54.1	48.1
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*
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*
Agriculture	112.3	80.2	75.3	67.7	63.1	60.7	59.4	61.1	59.5	56.9	52.1	52.6
Enteric fermentation	94.8	66.9	62.7	56.1	52.9	50.8	49.9	51.5	49.8	47.6	44.2	44.9
Manure management	17.6	13.3	12.6	11.6	10.2	9.9	9.5	9.6	9.7	9.3	7.9	7.7
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
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
Waste	70.6	71.2	77.9	81.5	83.0	86.4	82.7	86.2	94.1	97.7	96.0	92.2
Solid waste disposal sites	22.4	30.8	37.9	41.2	43.9	46.8	47.6	50.7	58.6	65.6	64.0	59.5
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
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

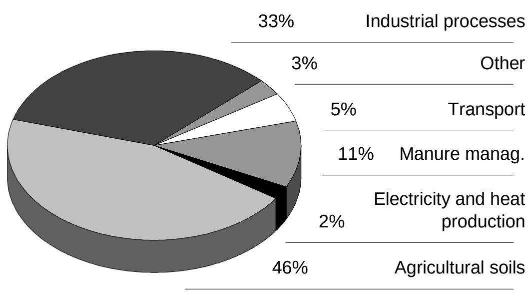
Emissions, as determinated to July 2, 2007

** 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 2005**



In 2005, the total N_2O emissions slightly decreased compared with the year 2004 and reached 12.09 Gg. However, the drop compared to the reference year 1990 is almost 39 %. The N_2O emissions raised from 2000, continuously. The most substantial increase was recorded in transport sector 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 50 % from the 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 shown 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 1990–2005**

	1990	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Total N_2O emissions	19.90	13.12	13.54	13.23	11.94	10.49	11.30	11.97	11.85	11.97	12.30	12.09
Fossil fuel combustion	0.97	0.72	0.74	0.77	0.78	0.78	0.68	0.77	0.75	0.80	0.79	0.87
Electricity and heat prod.	0.58	0.39	0.39	0.38	0.35	0.34	0.27	0.28	0.26	0.29	0.27	0.26
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
Industrial processes	3.77	3.63	4.24	4.01	3.41	2.56	3.33	3.77	3.37	3.73	4.26	4.05
Chemical industry	3.77	3.63	4.24	4.01	3.41	2.56	3.33	3.77	3.37	3.73	4.26	4.05
Solvent use	NE	NE	NE	NE	0.02	0.02	0.03	0.10	0.18	0.19	0.26	0.23
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
Manure management	3.53	2.36	2.18	2.00	1.76	1.68	1.65	1.59	1.57	1.53	1.42	1.37
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
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
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
Waste	0.06	0.04	0.04	0.04	0.04	0.04	0.04	0.07	0.12	0.09	0.10	0.10
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
Waste incineration	IE	IE	IE	IE	IE	IE	0.01	0.01	0.01	0.01	0.01	0.01
International bunkers *	0.004	0.026	0.023	0.014	0.019	0.005	0.002	0.013	0.014	0.011	0.006	0.003

Emissions, as determinated to July 2, 2007

** 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 consistence with the methodology IPCC [7,8] and the actual and potential emissions were estimated within 1995–2005 (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, SF_6 has risen since 1995 and this trend is expected in the future, as well.

In 2005, 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 2004, the emissions increased by 12 %. However, compared to the reference year 1990, the decrease is more than 22 %. 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).

Tab. 5.5 **Total emissions of HFCs, PFCs and SF_6 within 1990–2005**

	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	107.09	78.64	91.48	100.69	108.08	131.63	169.42	189.64	211.51
HFCs emissions CO_2 *eq.*		[Gg]	0.00	22.15	37.59	61.20	41.00	65.19	75.78	82.80	103.10	133.16	154.43	174.65
HFC-23	11 700	[Mg]		<0.01	0.06	0.07	0.05	0.05	0.06	0.06	0.04	0.08	0.08	0.08
HFC-32	650	[Mg]			0.03	0.20	0.13	0.20	0.61	1.13	2.30	3.69	4.78	7.10
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
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
HFC-152a	140	[Mg]			<0.01	0.13	0.29	0.60	0.83	1.02	1.21	1.36	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
HFC-227ea	2 900	[Mg]		3.52	2.29	2.92	0.48	0.80	0.80	0.80	0.44	0.23	0.09	0.02
HFC-236fa	6 300								0.05	0.22	0.38	0.22	0.50	0.53
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
CF_4	6 500	[Mg]	36.6	15.44	4.68	4.70	3.45	1.88	1.57	2.18	1.90	2.93	2.69	2.73
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
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
SF_6	23 900	[Mg]	0.001	0.415	0.450	0.474	0.512	0.531	0.555	0.579	0.618	0.644	0.665	0.695

Emissions, as determinated to July 2, 2007

5.3 ASSESSMENT

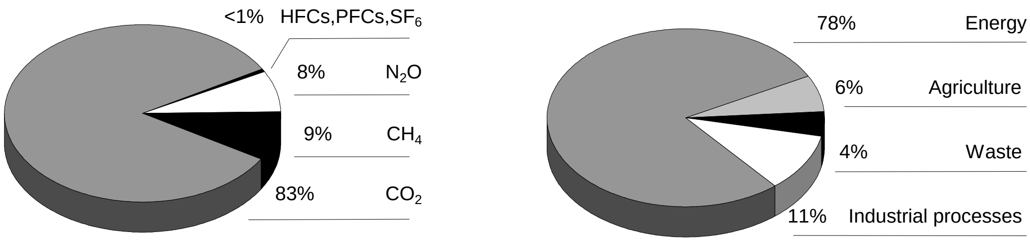
In accordance with the generally expected results, the aggregated emission of GHGs in year 2005 are approximately at the same level from 2000 (without LULUCF). There is the significant decreasing of aggregated emission against the base year (1990) about approximately 24 184 Gg of CO_2 equivalents, it means the decreasing about more then 34 % without sinks from LULUCF. A major share of aggregated emission covers the energy sector by about 79 %, the industrial processes sector covers about 9 %, the agriculture sector about 8 % and the waste sector more than 4 %. The solvent use sector covers less than 1 % of the total emissions. These shares are determined as emissions in CO_2 of aggregated equivalents[10] (Table 5.6).

Tab. 5.6 **Aggregated emissions of GHGs according the sectors in CO_2 *eq*. [Tg] within 1990–2005**

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Energy*	58.59	51.03	47.23	44.37	41.31	42.60	43.19	43.39	41.66	40.56	37.82	40.64	38.55	39.03	37.81	37.40
Industrial Processes**	4.92	3.71	3.65	3.24	3.78	4.05	4.16	4.21	4.70	4.51	4.24	4.48	4.43	4.36	5.29	5.06
Solvent Use	NE	NE	NE	NE	NE	NE	NE	NE	0.01	0.01	0.01	0.03	0.06	0.06	0.08	0.07
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
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
Waste	1.50	1.47	1.44	1.38	1.44	1.51	1.65	1.72	1.76	1.83	1.90	1.97	2.16	2.22	2.19	2.11

Emissions, as determinated to July 2, 2007 **Including transport* ***Including F-gases*

Fig. 5.4 **Aggregated emissions of GHGs in 2005**



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 2005 is 8.4 % (according level assessment) and 6.3 % (according trend assessment). The calculation uncertainty by using the more sophisticated Tier 2 - Monte Carlo method is evaluated for the solid waste disposal site (SWDS) category. The essential result from our pilot 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, too. The key sources were selected according to a cumulative contribution to the total emissions too. 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 2005, the Slovak Republic determined 16 key sources without LULUCF and 14 key sources with LULUCF to be assessed according to the level. According to anticipated trends was assessed 23 key sources without LULUCF and 14 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 Grass Domestic Product trend with the trend of aggregate emissions of greenhouse gasses shows that the Slovak Republic 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 first EC proposals includes 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.

AIR POLLUTION

IN THE SLOVAK REPUBLIC

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