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Hydrometeorological Institute

Ministry of Environment
of the Slovak Republic

AIR POLLUTION

IN THE SLOVAK REPUBLIC

2011

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C O N T E N T

AMBIENT AIR

1. REGIONAL AIR POLLUTION AND QUALITY OF PRECIPITATION

1.1 Regional air pollution and quality of precipitation .... 1 - 1
1.2 EMEP stations of national air quality monitoring network .... 1 - 2
1.3 Assessment of results from measurement in 2011 .... 1 - 4

2. LOCAL AIR POLLUTION

2.1 Local air pollution........ 2 - 1
2.2 Characterization of zones and agglomerations, where monitoring is carried out.... 2 - 2
2.3 Processing of measurement results according to limit values........ 2 - 23

3. ATMOSPHERIC OZONE

3.1 Atmospheric ozone .... 3 - 1
3.2 Ground level ozone in the Slovak Republic during 2006 – 2011 .... 3 - 1
3.3 Total atmospheric ozone over the territory of the Slovak Republic in 2011 .... 3 - 5

EMISSIONS

4. EMISSION AND AIR POLLUTION SOURCE INVENTORY

4.1 Emission and air pollution source inventory .... 4 - 1
4.2 Development of trends in basic pollutants........ 4 - 5
4.3 Verification of the results........ 4 - 9

5. GREENHOUSE GAS EMISSIONS

5.1 Greenhouse gas emissions .... 5 - 1
5.2 Greenhouse gas emissions in the Slovak Republic .... 5 - 5
5.3 Assessment .... 5 - 11

AMBIENT AIR

1

REGIONAL AIR POLLUTION AND QUALITY OF PRECIPITATION

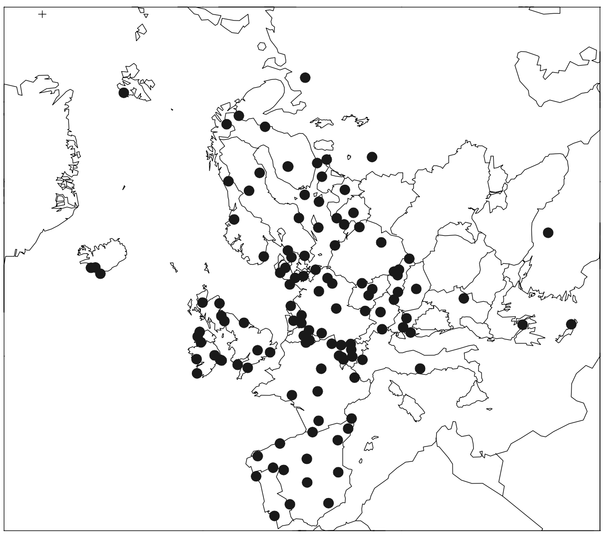
1.1 REGIONAL AIR POLLUTION AND QUALITY OF PRECIPITATION

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

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

Implementation of the Co-operative Programme for Monitoring and Evaluation of the Long Range Transmission of Air Pollutants in Europe - EMEP is a part of the Convention. In accordance to the Convention, the EMEP is mandatory to all European countries. Its goal is to monitor, model and evaluate the long-range transport of air pollutants in Europe and elaborate foundations for the strategy to reduce European emissions. The EMEP monitoring network (Fig. 1.1) comprises approximately 100 regional stations and four stations in the territory of Slovakia belonging to the national monitoring network of the Slovak Hydrometeorological Institute are at the same time also a part of EMEP network. The EMEP monitoring programme has been gradually extended. The monitoring

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



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

1.2 EMEP STATIONS OF NATIONAL AIR QUALITY MONITORING NETWORK

In 2011, there were 4 EMEP stations of National Air Quality Monitoring Network in operation in the Slovak Republic to monitor regional air and precipitation quality. At the Bratislava-Koliba station the same precipitation monitoring programme is in operation as on regional stations, serving for comparison to regional stations. Locations and elevations of the individual stations are indicated in Figure 1.2. Regional stations are part of the European EMEP network.

EMEP stations

Chopok

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

Stará Lesná

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

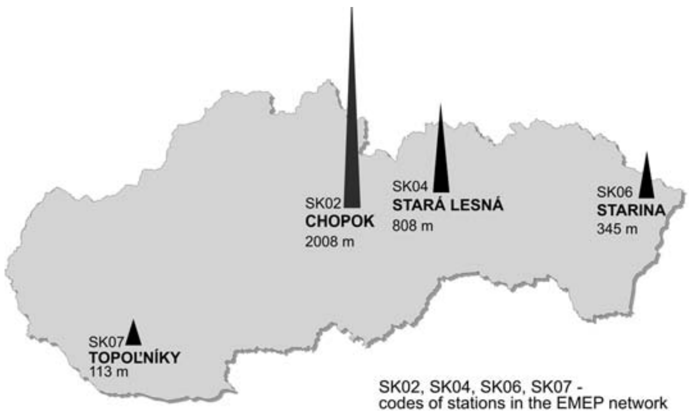
Topoľníky

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

Starina

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

Fig. 1.2 **EMEP stations in the Slovak Republic – 2011**



Measurement programme

AMBIENT AIR	**Gas components**	SO_2, NO_x, HNO_3, NH_3 – 24-hour sampling O_3 - continuous registration by analyzer VOCs C_2 - C_6 10-15 minute sampling 2x weekly at 12.00 noon
	Particulate matter	PM_{10} resp. TSP mass concentration – 7 day sampling interval Pb, Cu, Zn, Cr, Ni, Cd, As – 7 day sampling SO_4^{2-}, NO_3^- Cl^-, NH_4^+, K^+, Na^+, Mg^{2+}, Ca^{2+} – 24-hour sampling
ATMOSPHERIC PRECIPITATION	**Daily and weekly**	pH, conductivity, SO_4^{2-}, NO_3^-, Cl^-, NH_4^+, Na^+, K^+, Ca^{2+}, Mg^{2+}
	Weekly and monthly	Zn, Cu, Cr, Ni, Pb, Cd, As

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

**TSP – Total suspended particles in ambient air*

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

Methods of determination

		Collection	Determination
AMBIENT AIR	**SO_4^{2-}, NO_3^-, Cl^-, NH_4^+, K^+, Na^+, Mg^{2+}, Ca^{2+}**	cellulose filter W40	IC - Dionex
	SO_2, HNO_3	cellulose filter W40 impregnated by KOH solution	IC - Dionex
	NOx	after oxidation into NaOH absor-ption solution with guajacol	spectrophotometry, modified Salzman method
	NH_3	cellulose filter W40 impregnated by citric acid solution	IC - Dionex
	O_3	registration by analyzer	principle - UV absorption
	VOCs C_2 - C_6	stainless steel canister	GC and FID
	PM_{10} resp. TSP	nitrocellulose filter Sartorius	Gravimetrically
	Heavy metals - Pb, Cd, Cu, Cr, Ni, Zn, As	nitrocellulose filter Sartorius	after digestion in MW-oven by ICP-MS
PRECIP.	**pH**	“wet only" - rain gauges WADOS "bulk" - NILU sampling PE vessel	pH meter
	Conductivity		conductometer
	SO_4^{2-}, NO_3^-, Cl^-, NH_4^+, K^+, Na^+, Mg^{2+}, Ca^{2+}		IC - Dionex
	Zn, Cu, Cr, Ni, Pb, Cd, As		AAS - in flame or graphite atomizer and MHS

**TSP – Total suspended particles in ambient air*

1.3 ASSESSMENT OF RESULTS FROM MEASUREMENTS IN 2011

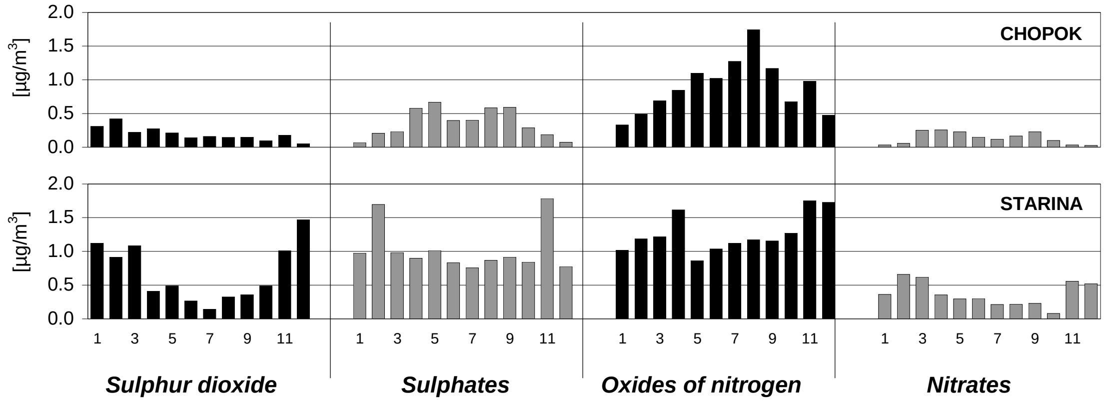
SO_2, sulphates

Background concentrations of sulphur dioxide recalculated in sulphur (Tab. 1.1, Fig. 1.3) reached 0.20 $\mu g.m^{-3}$ on the Chopok station and 0.68 $\mu g.m^{-3}$ on the Starina station, in 2011. ***In coincidence with the Annex 13 to the Decree of the Ministry of Environment of the Slovak Republic No 360/ 2010 on air quality, the critical value for protection of vegetation is 20 µg $SO_2.m^{-3}$ in calendar year and winter season. This value has been exceeded neither at the calendar year (Chopok 0.40 µg $S0_2.m^{-3}$ and Starina 1.36 µg $S0_2.m^{-3}$), nor in winter season (Chopok 0.5 µg $S0_2.m^{-3}$ and Starina 2.3 µg $S0_2.m^{-3}$).*** Sulphates contributed to the total weight mass of particulate matter 18.6% on the Chopok station and 19.5% on the Starina station. Concentration ratio of sulphates to sulphur dioxide, recalculated in sulphur represented 1.8 on the Chopok station and 1.5 on the Starina station.

NO_x, nitrates

Background level of concentrations of oxides of nitrogen, recalculated in nitrogen (Tab. 1.1, Fig. 1.3) presented 0.90 $\mu g.m^{-3}$on the Chopok station and 1.26 $\mu g.m^{-3}$ on the Starina station, in 2011. ***In coincidence with the Annex 13 to the Decree of the Ministry of Environment of the Slovak Republic No 360/2010 on air quality, the critical value for protection of vegetation is 30 µg $NO_x.m^{-3}$ in calendar year. This value was not exceeded in calendar year (Chopok 2.97 µg $NO_x.m^{-3}$ a Starina 4.16 µg $NO_x.m^{-3}$).*** Nitrates in ambient air on the Chopok and Starina stations occurred predominantly in the form of particles in 2011. Concentrations of nitric acid were substantially lower in 2011 as compared to particulate nitrates on both stations. Both these forms of nitrogen are collected on filters separately and also measured separately and their phase division is dependent upon the ambient air temperature and humidity. Nitrates contributed to the total mass of particulate matter 10.6% on the Chopok station and 10.4% on the Starina station. Concentration ratio of total nitrates ($HNO_3 + NO_3$) to NO_x-NO_2 recalculated in nitrogen represented the value of 0.18 at the Chopok station and 0.32 at the Starina station.

Fig. 1.3 **Monthly mean concentrations of sulpur and nitrogen compounds in ambient air – 2011**
(recalculated in sulphur, resp. nitrogen)



Ammonia, ammonium ions and alkali ions

In coincidence with the requests of the EMEP monitoring strategy for the EMEP stations “level one” the measurements of ammonia, ammonium ions, ions of sodium, potassium, calcium and magnesium in ambient air started to be measured in May 2005 on the Stará Lesná station. These measurements were finished in September 2007. Since July 2007 the measurements started to be measured at the Starina station. Annual concentrations of the listed components (NH_3 and NH_4 recalculated in nitrogen) from the Starina station in 2011 are listed in Table 1.1. Ammonium ions in annual average 1,10 µg N.m^{-3} share 9,01% of PM. Annual concentration of ammonia represents 0.39 µg N.m^{-3}. Concentration ratio of ammonium ions and ammonia expressed in nitrogen is 2.8.

Tab. 1.1 **Annual averages of gaseous and particulate components in ambient air – 2011**

	SO_2 (S) µg/m^3	SO_4^{2-} (S) µg/m^3	NO_x (N) µg/m^3	NO_3^- (N) µg/m^3	HNO_3 (N) µg/m^3	NH_3 (N) µg/m^3	NH_4^+ (N) µg/m^3	Na^+ µg/m^3	K^+ µg/m^3	Mg^{2+} µg/m^3	Ca^{2+} µg/m^3
Chopok	0.20	0.36	0.90	0.14	0.02	-	-	-	-	-	-
Starina	0.68	1.02	1.26	0.37	0.03	0.39	1.10	0.11	0.18	0.02	0.10

	O_3 µg/m^3	PM_{10} µg/m^3	Pb ng/m^3	Cu ng/m^3	Cd ng/m^3	Ni ng/m^3	Cr ng/m^3	Zn ng/m^3	As ng/m^3
Chopok	97	*5.8							
Topoľníky	-	21.4							
Starina	60	15.7							
Stará Lesná	65	15.1							

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

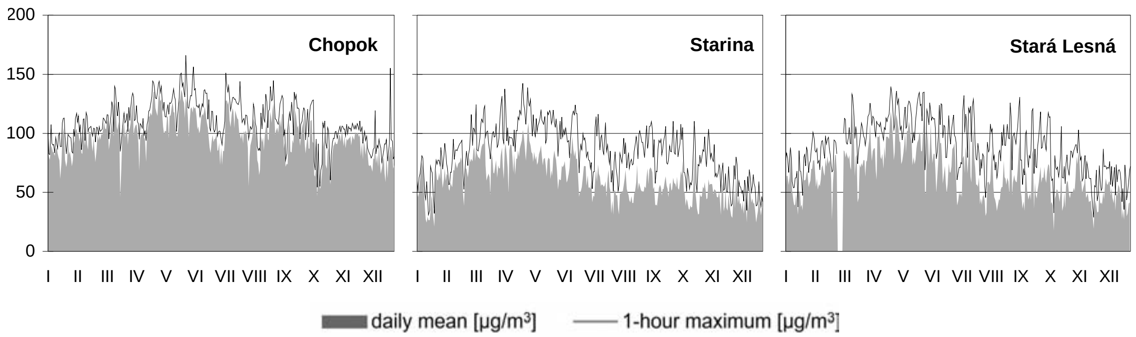
Particulate matter PM_{10}, TSP and heavy metals

In Tab. 1.1 are presented the concentrations of PM_{10} (Stará Lesná, Starina, Topoľníky), variating within range of 15.1–21.4 µg.m^{-3} and TSP 5.8 µg.m^{-3} (Chopok) in 2011. Heavy metals from PM_{10}, resp. TSP could not be completely analyzed for 2011 mainly due to lack of financial means for IPC and AAS to work in standard operation.

Ozone

In Figure 1.4 the annual course of ground level ozone concentrations at the Chopok, Stará Lesná and Starina regional stations are depicted. The longest time series of ozone measurements has been at the Stará Lesná station, since 1992. The measurements of ozone in Starina and Chopok began to be carried out later, in 1994. In 2011, the annual average of ozone concentration at the Chopok station reached 97 µg.m^{-3}, at Starina 60 µg.m^{-3} and Stará Lesná 65 µg.m^{-3}. Measurements of ozone and exceedances of critical levels are completely assessed in Chapter 3 Atmospheric ozone.

Fig. 1.4 **Ground level ozone [µg.m^{-3}] – 2011**



Volatile organic compounds, VOCs C_2–C_6

VOCs (Volatile Organic Compounds) C_2–C_6, or the so-called light hydrocarbons, started to be sampled in autumn 1994 at the Starina station. Starina is one of the few European stations, included into the EMEP network with regular sampling of volatile organic compounds. They are measured and assessed according to the EMEP method elaborated by CCC-NILU. Their concentrations ranged within one order of magnitude from the tenth of ppb up to several ppb. However since October 2008 the VOCs measurements are not available due to long-term lasting problems with the operation of new GC in Tested laboratory. Measurements of VOC have been initiated again in September 15, 2011.

Tab. 1.2 **Annual averages of VOC [ppb] in ambient air, Starina – 2011**

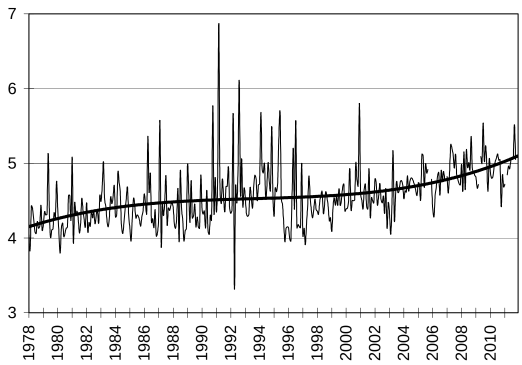
	etane	etene	propane	propene	i-butane	n-butane	acetylene	i-pentane	n-pentane	izoprene	n-hexane	benzene
2011	1.804	0.884	0.801	0.205	0.885	0.582	0.364	0.172	0.170	0.034	0.114	0.355

Atmospheric precipitation

Major ions, pH, conductivity

In 2011 the amount of precipitation recorded at background stations ranged between 367 and 910 mm. The upper level of amount of precipitation does belong to the highest situated station Chopok and the lower one to Topoľníky with the lowest elevation. Acidity of atmospheric precipitation dominated at the Starina station at the low level of pH range 4.74 – 5.10 (Tab. 1.3, Fig. 1.6). Time series and trend of pH values within a long-time period indicate clearly the decrease in acidity (Fig. 1.5). Values of pH are in a good coincidence with the pH values according to the EMEP maps.

Obr. 1.5 **pH in atmospheric precipitation – Chopok**



Concentrations of dominant sulphates in precipitation recalculated in sulphur varied within the range 0.52 – 0.60 mg.l^{-1}. Concentrations of sulphates at the Topoľníky station represent the low value of the pH range while the Stará Lesná the upper value of the pH range. The annual mean at the Chopok and Starina stations show minimum difference in annual mean. Total decrease of sulphates in long-term time series has corresponded to the SO_2 emission reduction since 1980.

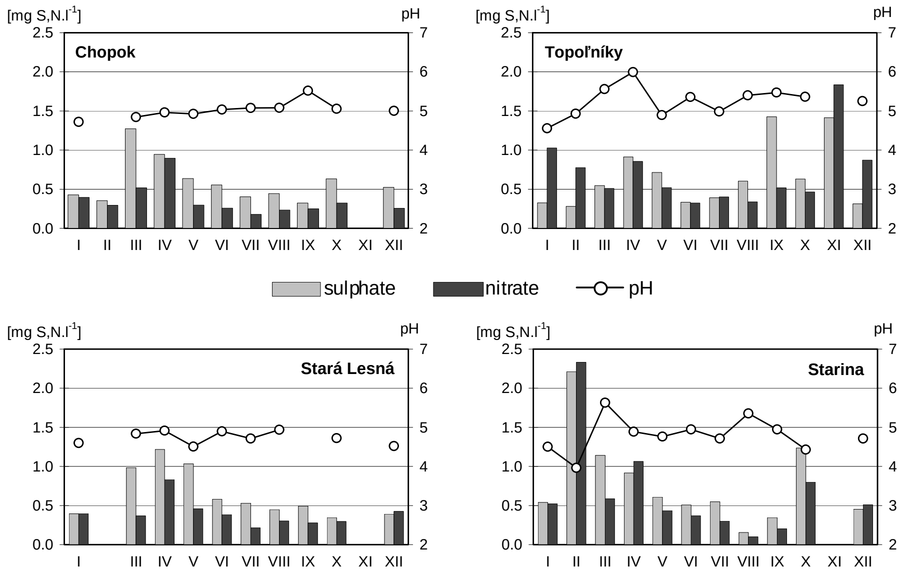
The share of nitrate (recalculated in nitrogen) in acidity of precipitation was substantially smaller than those of sulphates and varied within the concentration range 0.27 – 0.52 mg.l^{-1}., The low level of concentration range is represented by the Chopok and Stará Lesná stations, while upper level of this range does belong to the station Topoľníky. Ammonium ions also do belong to the major ions and their concentration range was 0.34 – 0.62 mg.l^{-1}.

Tab.1.3 **Annual averages of main components in atmospheric precipitation – 2011**

	Precip. mm	pH	Conduc. µS/cm	SO_4^{2-}(S) mg/l	NO_3^- (N) mg/l	NH_4^+(N) mg/l	Cl^- mg/l	Na^+ mg/l	K^+ mg/l	Mg^{2+} mg/l	Ca^{2+} mg/l
Chopok	910	5.04	10.46	0.56	0.27	0.45	0.13	0.16	0.06	0.02	0.20
Topoľníky	367	5.10	14.67	0.52	0.52	0.62	0.14	0.09	0.05	0.06	0.42
Starina	647	4.74	16.38	0.59	0.43	0.43	0.17	0.14	0.08	0.03	0.23
Stará Lesná	676	4.75	15.13	0.60	0.35	0.34	0.13	0.10	0.05	0.03	0.27
Bratislava-Jeséniova	667	5.19	12.15	0.51	0.42	0.54	0.15	0.14	0.10	0.05	0.31

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

Obr. 1.6 **Atmospheric precipitation – 2011**



Heavy metals

Since 2000 the measurement programme of heavy metals in precipitation has been gradually modified to meet the requirements of the CCC EMEP monitoring strategy. In Bratislava-Jeséniova the measurement of the same set of heavy metals in precipitation was implemented as in background stations of Slovakia (Table 1.3). This station serves for comparison and is not considered as the background station. The results of annual weighted means of heavy metals concentrations in monthly precipitation in 2011 are presented in Table 1.4.

Tab. 1.4 Annual averages of heavy metals in atmospheric precipitation – 2011

	Precip. mm	**Pb** µg/l	**Cd** µg/l	**Cr** µg/l	**As** µg/l	**Cu** µg/l	**Zn** µg/l	**Ni** µg/l
Chopok	764	3.32	0.10	0.26	0.22	1.66	41.11	0.60
Topoľníky	400	1.08	0.04	0.17	0.14	0.97	8.77	0.33
Starina	642	1.65	0.08	0.18	0.23	1.18	12.31	0.57
Stará Lesná	668	1.74	0.11	0.10	0.18	1.55	11.32	0.28
Bratislava-Jeséniova	800	1.58	0.06	0.18	0.14	2.55	19.63	0.59

AMBIENT AIR

LOCAL AIR POLLUTION

2

2.1 LOCAL AIR POLLUTION

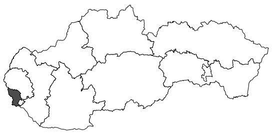
Air quality assessment is claimed by Air Protection Act No. 137/2010 Coll. Criterions for air quality assessment (upper and lower assessment thresholds, margin of tolerance, limit and target values) are given in Decree No. 360/2010 Coll. about Air Quality. Fundamental air quality assessment is performed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

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

In 1991 modernization of the air quality monitoring network began. The manual stations were gradually replaced by automatic ones, which enable the continuous monitoring of pollution and made it possible to evaluate time changes and the extremes of the short-term concentrations. In the course of the last ten years the air quality monitoring network has kept developing. In 2011, 30 stations (without EMEP, rural and ozone stations) were located on the territory of the SR. Most of them monitored the level of pollution caused by the basic pollutants (SO_2, NO_2, NO_x, and PM_{10}, $PM_{2,5}$). In the year 2011 measurements of benzene were carried out at 10. The air pollution monitoring by heavy metals (Pb, Cd, As and Ni) were performed at 5 urban (suburban) and at 4 rural EMEP stations. Concentrations of benzo(a)pyrene were analysed at 6 sites totally.

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

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



AGGLOMERATION - BRATISLAVA

AREA: 368 km^2 POPULATION: 413 192

Characterization of area

Bratislava

Bratislava spreads out over an area of 368 km^2 along both banks of the Danube at the boundary-line of the Danube plain and the Little Carpathians and the Bor lowlands at an elevation of 130 – 514 meters. Wind patterns in this area are affected by the slopes of the Little Carpathians, which do interfere into the northern part of the city. Geographical effects enhance the wind speed from prevailing directions. The ventilation of the city is favourably affected by high wind speeds. In regard to prevailing north-west wind, the city is properly situated to major air pollution sources, which are concentrated in 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.

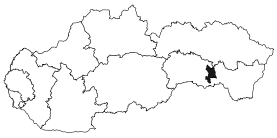
Location of stations

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

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

Bratislava - Trnavské mýto
The station is situated near to a busy crossroad formed by Šancová and Trnavská street - Krížna and Vajnorská street. 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 - Mamateyova
The station is located at open playing area in sufficient distant from housing estate built-up area. Among the major sources of air pollution belong traffic, power sources and the petrochemical complex, Slovnaft a.s., Bratislava. The last mentioned contributes to the air pollution mainly under the east wind direction



AGGLOMERATION - KOŠICE

AREA: 237 km^2 POPULATION: 240 688

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.

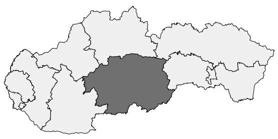
Location of stations

Košice - Štefánikova

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

Košice - Amurská

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



ZONE - BANSKÁ BYSTRICA REGION

AREA: 9 454 km^2 POPULATION: 660 128

Characterization of area

Banská Bystrica

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

Zvolen

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

Žiar nad Hronom

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

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

Banská Bystrica - Zelená

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

Zvolen - J. Alexyho

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

Hnúšťa - Hlavná

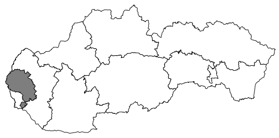
The station is situated in open middle building area on the north edge of the town, approximately 50 m far from state road No. 531.

Jelšava - Jesenského

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

Žiar nad Hronom - Jilemnického

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



ZONE - BRATISLAVA REGION

AREA: 1 685 km^2 POPULATION: 193 345

Characterization of area

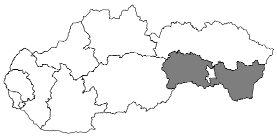
Malacky

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

Location of stations

Malacky - Sasinkova

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



ZONE - KOŠICE REGION

AREA: 6 517 km^2 POPULATION: 552 303

Characterization of area

Krompachy

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

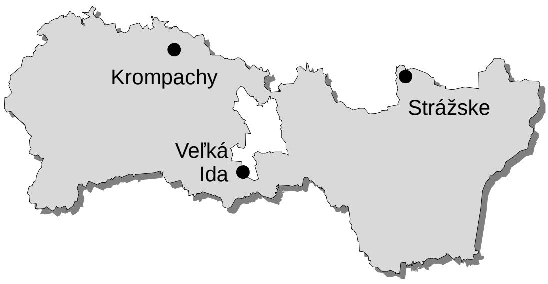
Strážske

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

Veľká Ida

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

Location of stations



Krompachy - SNP

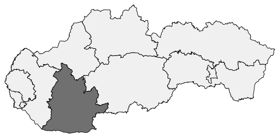
Monitoring station is located close to the main route Košice - Spišská Nová Ves. The surrounding built-up area comprises multi-storey houses.

Strážske - Mierová

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

Veľká Ida - Letná

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



ZONE - NITRA REGION

AREA: 6 344 km^2 POPULATION: 689 564

Characterization of area

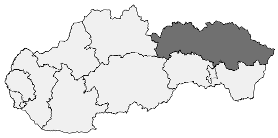
Nitra

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

Location of stations

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

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



ZONE - PREŠOV REGION

AREA: 8 974 km^2 POPULATION: 815 806

Characterization of area

Prešov

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

Humenné

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

Vranov

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

Location of stations

Humenné - Nám. slobody

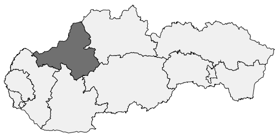
The station is located in the southern part of the town centre in open area at the edge of a pedestrian zone with minimum car transport. The surrounding buildings are connected to the central heating system of Chemes a.s., Humenné plant which is located approximately 2 km west from monitoring station.

Prešov - Arm. gen. L. Svobodu

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

Vranov nad Topľou - M. R. Štefánika

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



ZONE - TRENČÍN REGION

AREA: 4 502 km^2 POPULATION: 594 186

Characterization of area

Horná Nitra

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

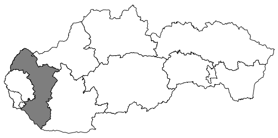
Location of stations

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

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

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

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



ZONE - TRNAVA REGION

AREA: 4 147 km^2 POPULATION: 555 509

Characterization of area

Senica

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

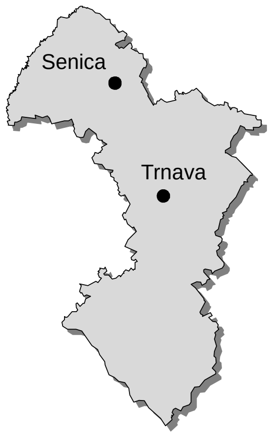
Location of stations

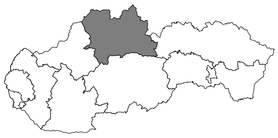
Senica - Hviezdoslavova

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

Trnava - Kollárova

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





ZONE - ŽILINA REGION

AREA: 6 754 km^2 POPULATION: 689 601

Characterization of area

Ružomberok

The location of the city comprises the area of the western part of the Liptov basin, on the confluence of rivers Váh, Revúca and Likavka. The Veľká Fatra mountains constitute the border in the west, the Choč mountains in the north and the Low Tatras in the south. The most frequently occur winds from west sector, at an average speed 1.6 m.s^{-1}. The North Slovakian pulp and paper processing plants (Mondi scp a.s., Ružomberok) are the largest industrial source of air pollution. A considerable share in 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 industry 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 temperature inversions, average wind speed 2.8 m.s^{-1} and high relative humidity contribute to higher level of pollution. Heavy engineering, central and local heating plants and car transport are the largest emitters of pollutants.

Location of stations

Žilina - Obežná

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

Ružomberok - Riadok

The station is located in the kindergarten close to a low traffic route way. In the surrounding built-up area low family housing prevails. A major pollution source pulp and paper processing plant - Mondi scp a.s., Ružomberok is situated north-east of the monitoring station.

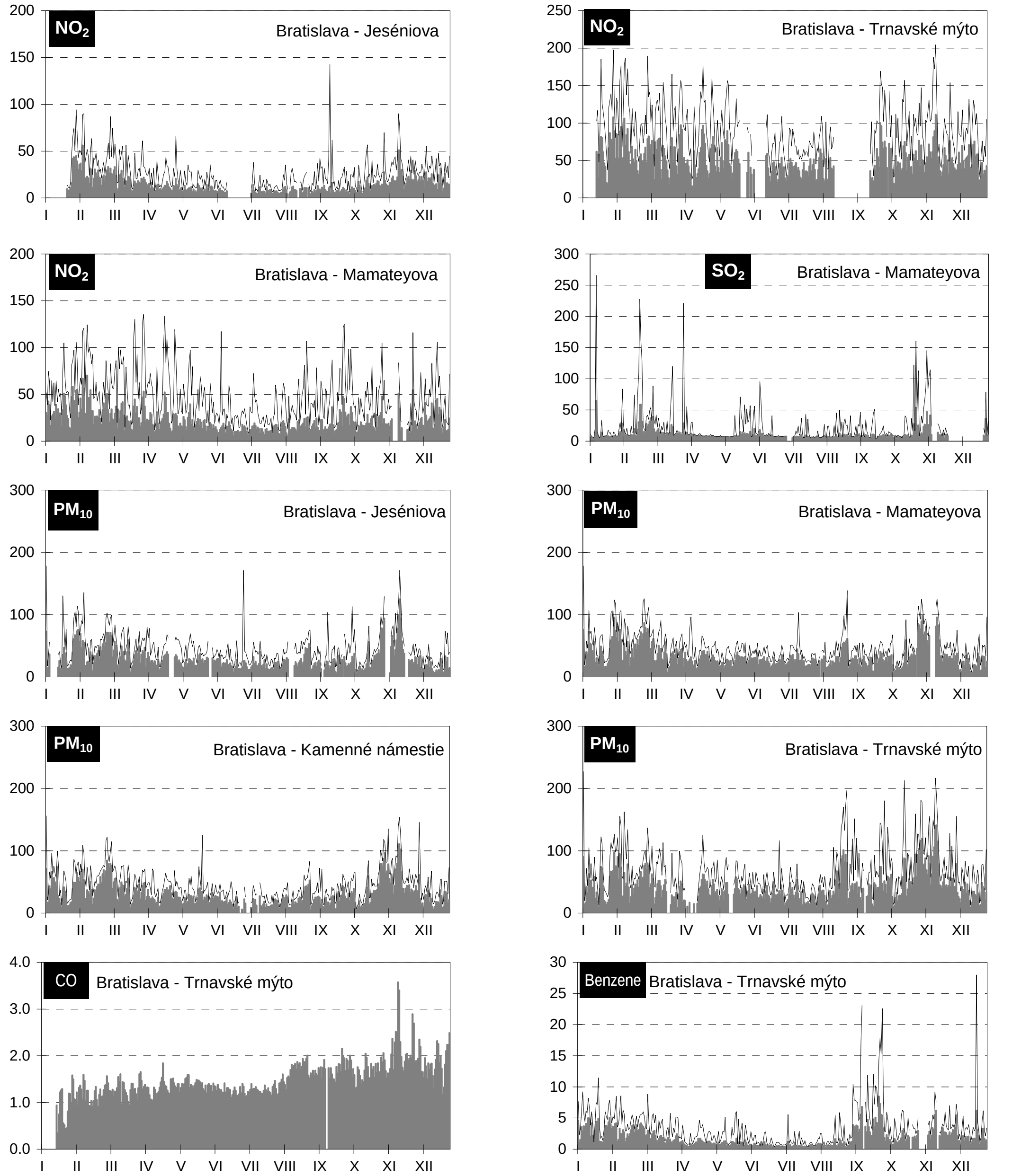
Martin - Jesenského

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

Tab. 2.1 **Geographical co-ordinates of monitoring stations and list of pollutants monitored in – 2011**

AGGLOMERATION/ zone		Longitude	Latitude	Altitude [m]	PM_{10}	$PM_{2,5}$	NO_2	SO_2	CO	C_6H_6	Pb	Cd	Ni	As	BaP
BRATISLAVA	Bratislava, Kamenné nám	17°06'48"	48°08'41"	139	*										
	Bratislava, Trnavské mýto	17°07'43"	48°09'30"	136	*		*		*	*					*
	Bratislava, Jeséniova	17°06'22"	48°10'05"	287	*		*								
	Bratislava, Mamateyova	17°07'32"	48°07'30"	138	*		*	*							
KOŠICE	Košice, Amurská	21°17'11"	48°41'28"	201	*	*									
	Košice, Štefánikova	21°15'33"	48°43'34"	209	*	*	*			*					
Banská Bystrica region	Banská Bystrica, Štefánikovo nábr.	19°09'16"	48°44'07"	346	*	*	*	*	*	*	*	*	*	*	
	Banská Bystrica, Zelená	19°06'55"	48°44'00"	425		*	*								
	Jelšava, Jesenského	20°14'26"	48°37'52"	289	*	*									
	Hnúšťa, Hlavná	19°57'06"	48°35'02"	320	*	*									
	Zvolen, J. Alexyho	19°09'24"	48°33'29"	321	*	*									
	Žiar nad Hronom, Jilemnického	18°50'32"	48°35'58"	296	*	*									
Bratislava region	Malacky, Sasinkova	17°01'11"	48°26'15"	198	*		*	*	*	*					
Košice region	Veľká Ida, Letná	21°10'30"	48°35'32"	209	*	*			*		*	*	*	*	*
	Strážske, Mierová	21°50'15"	48°52'26"	133	*	*									
	Krompachy, SNP	20°52'26"	48°54'57"	372	*	*	*	*	*	*	*	*	*	*	*
Nitra region	Nitra, Štúrova	18°04'10"	48°18'00"	143	*	*	*	*	*	*					*
	Nitra, Janíkovce	18°08'27"	48°17'00"	149	*	*	*								
Prešov region	Humenné, Nám. slobody	21°54'50"	48°55'51"	160	*	*									
	Prešov, Arm. gen. L.Svobodu	21°16'03"	48°59'36"	252	*	*	*		*	*					
	Vranov nad Topľou, M. R. Štefánika	21°41'15"	48°53'11"	133	*	*		*							
Trenčín region	Bystričany, Rozvodňa SSE	18°30'51"	48°40'01"	261	*	*		*							
	Handlová, Morovianska cesta	18°45'23"	48°43'59"	448	*	*		*							
	Prievidza, Malonecpalská	18°37'40"	48°46'58"	276	*	*		*			*	*	*	*	*
	Trenčín, Hasičská	18°02'28"	48°53'47"	214	*	*	*	*	*	*					
Trnava region	Senica, Hviezdoslavova	17°21'48"	48°40'50"	212	*	*		*							
	Trnava, Kollárova	17°35'06"	48°22'16"	152	*	*	*		*	*					*
Žilina region	Martin, Jesenského	18°55'17"	49°03'35"	383	*	*	*		*	*					
	Ružomberok, Riadok	19°18'10"	49°04'44"	475	*	*		*	*		*	*	*	*	
	Žilina, Obežná	18°46'15"	49°12'41"	356	*	*	*								

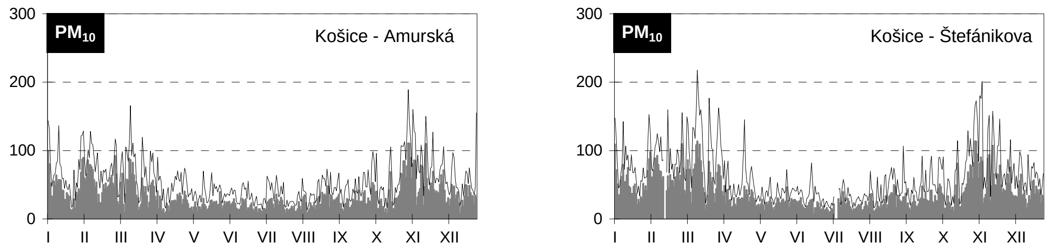
Fig. 2.1 **Concentrations of NO_2, SO_2, PM_{10}, benzene and CO – agglomeration Bratislava – 2011**



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

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

Fig. 2.2 **Concentrations of PM_{10}, $PM_{2.5}$ and benzene – agglomeration Košice – 2011**



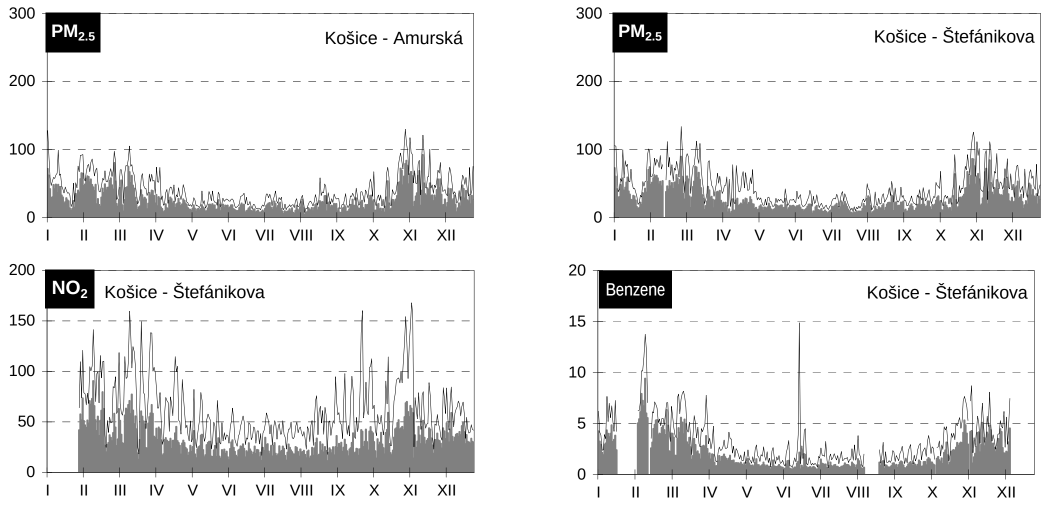
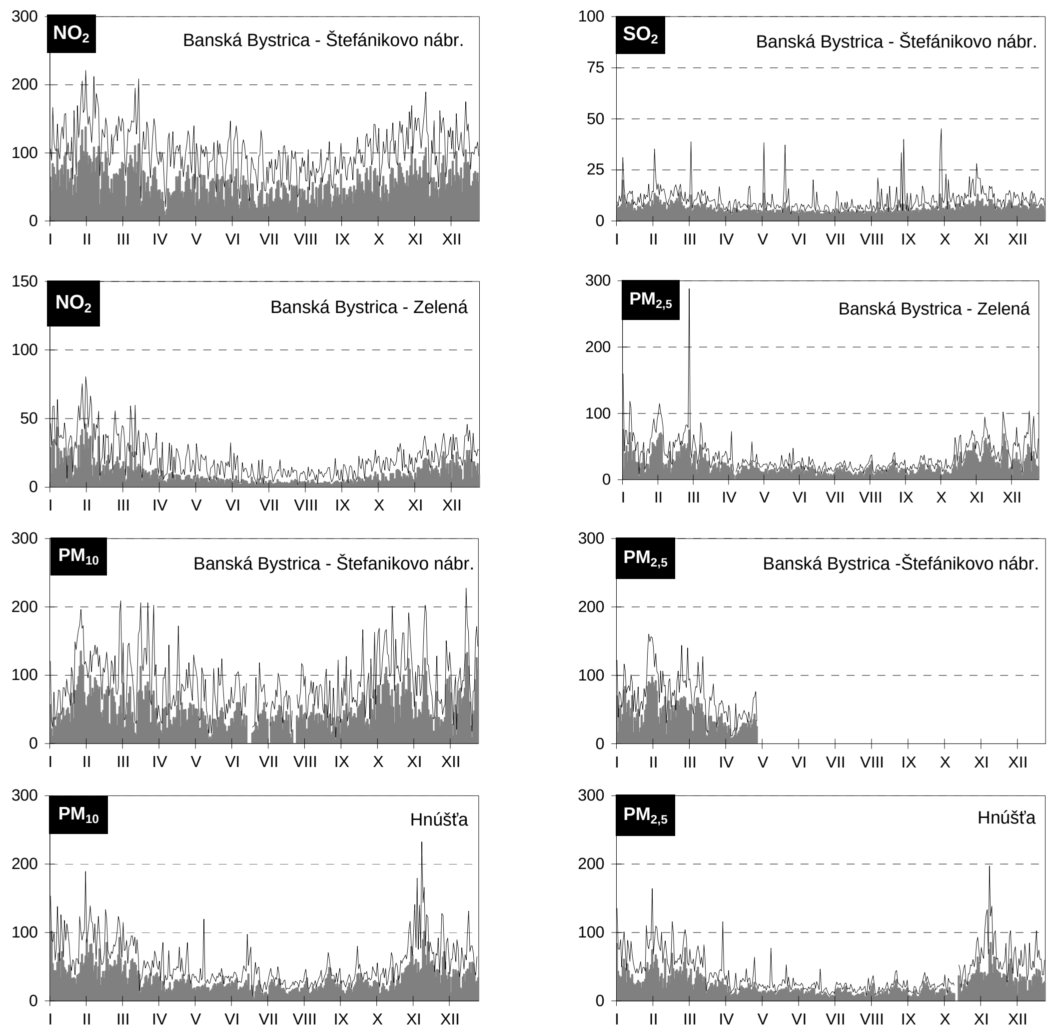
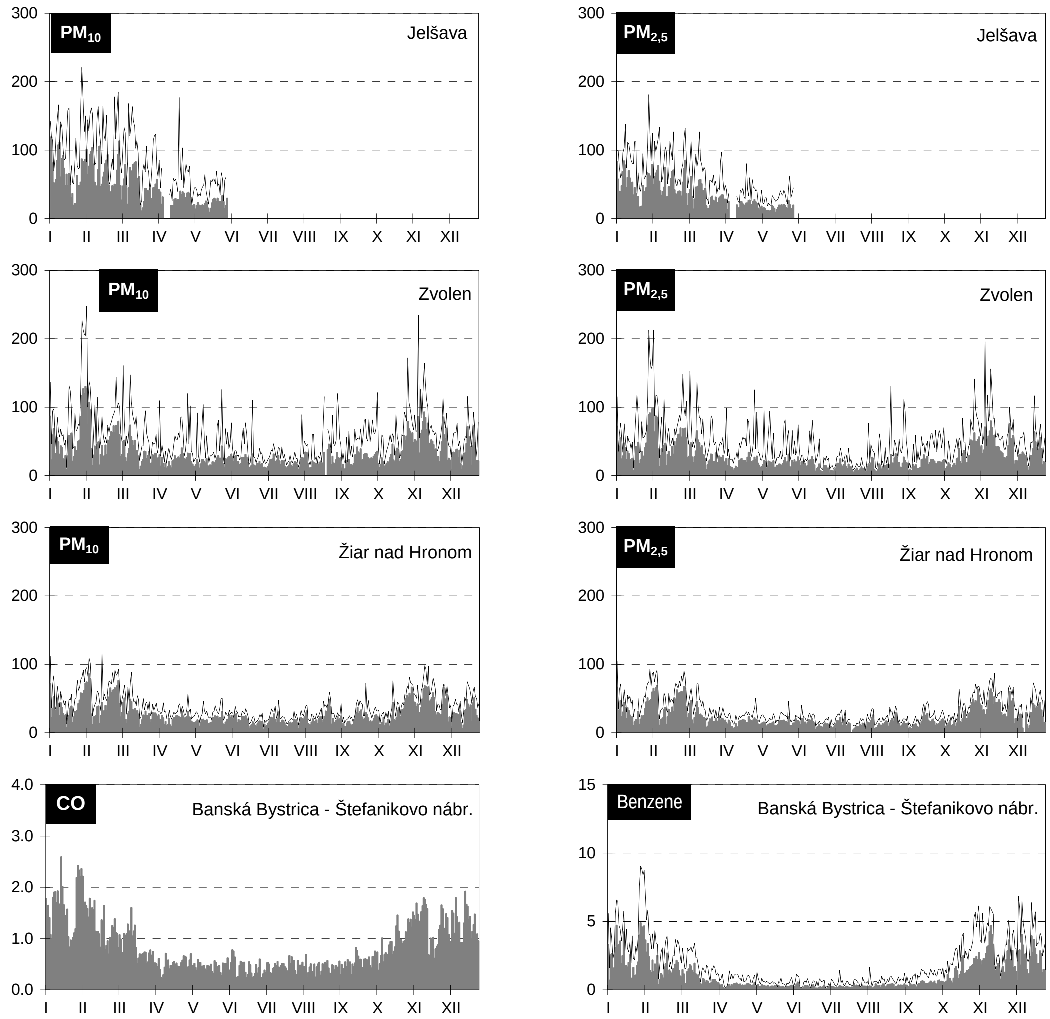


Fig. 2.3 **Concentrations of NO_2, SO_2, PM_{10}, $PM_{2,5}$, CO and benzene – zone Banská Bystrica region – 2011**

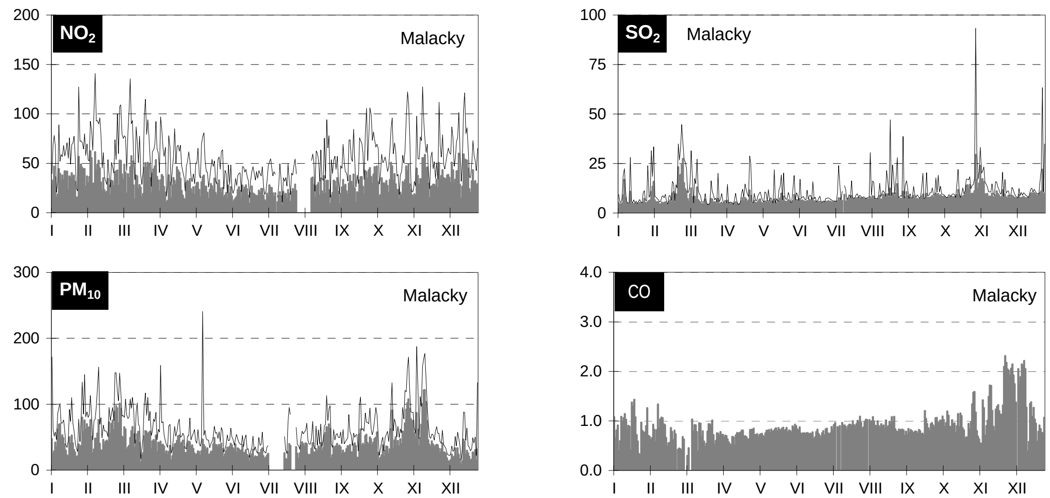




concentrations: NO_2, SO_2, PM_{10}, $PM_{2,5}$, benzene - daily average [µg.m^{-3}]
CO - daily maximum of 8 h means [mg.m^{-3}]

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

Fig. 2.4 **Concentrations of NO_2, SO_2, PM_{10}, CO and benzene – zone Bratislava region – 2011**



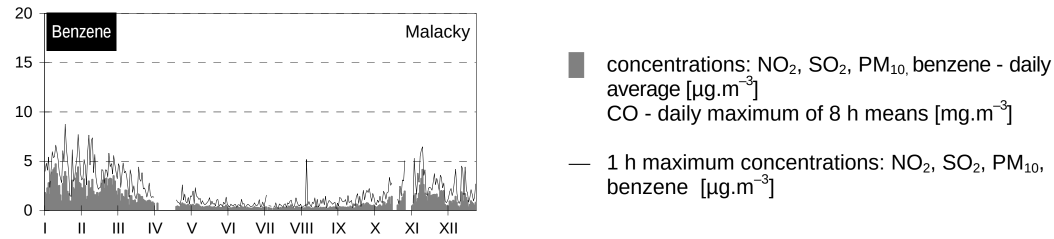
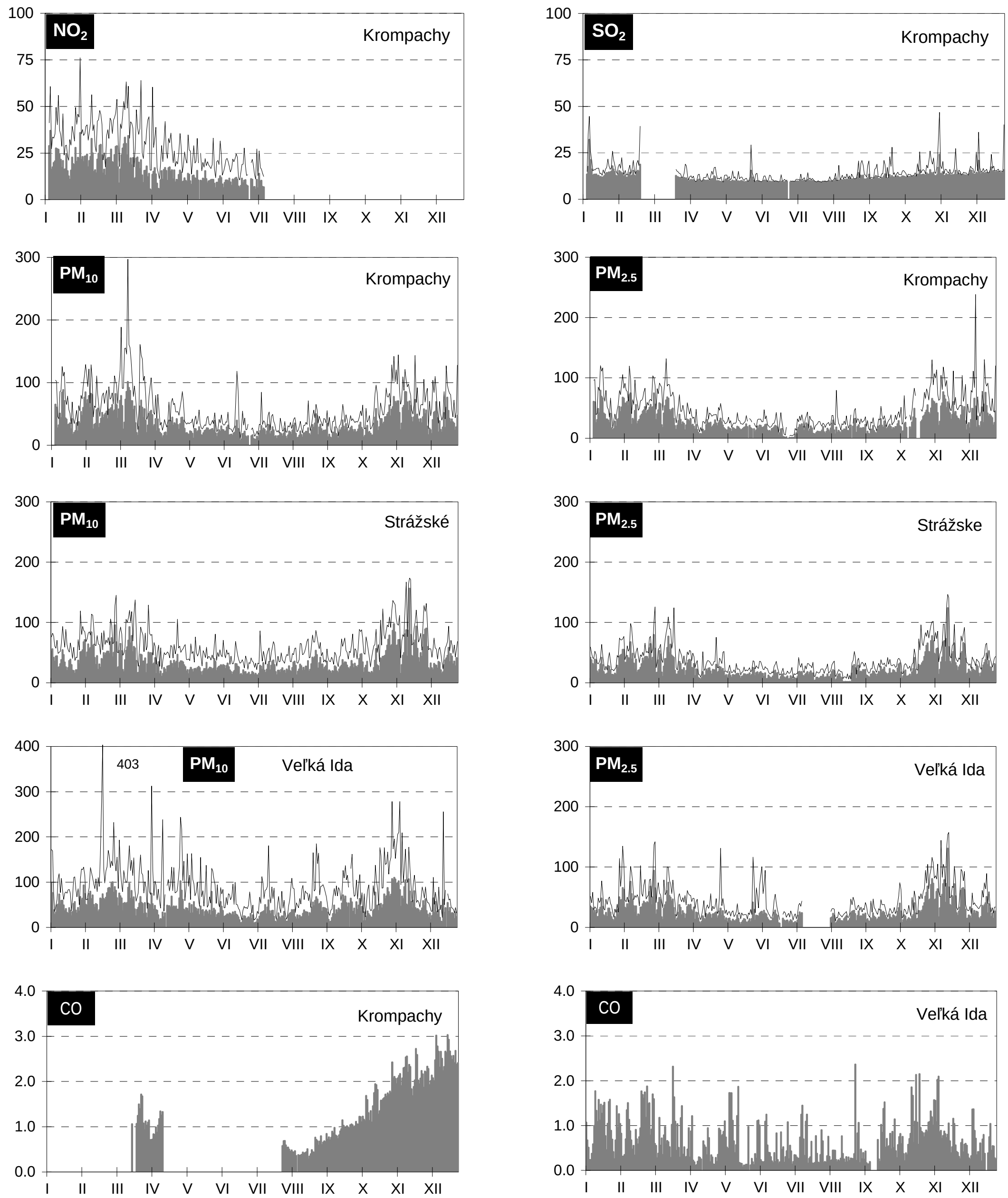


Fig. 2.5 **Concentrations of NO_2, SO_2, PM_{10}, $PM_{2.5}$, CO and benzene – zone Košice region – 2011**



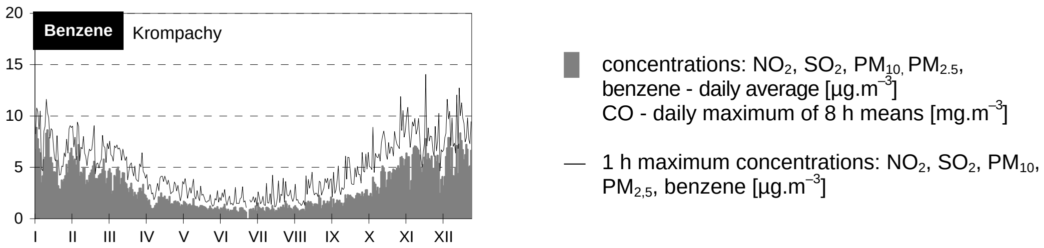


Fig. 2.6 **Concentrations of NO_2, SO_2, PM_{10}, $PM_{2.5}$, CO and benzene – zone Nitra region – 2011**

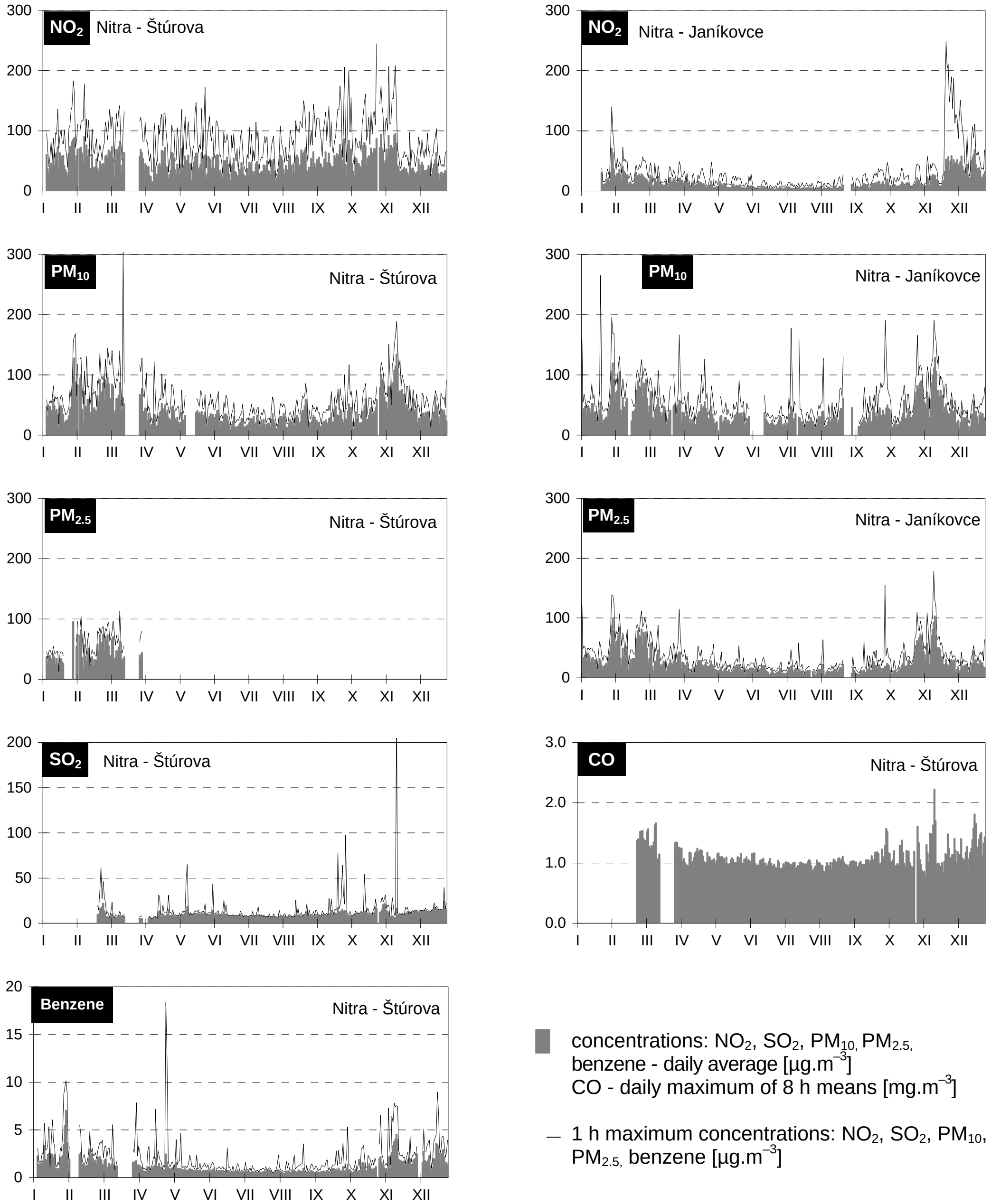
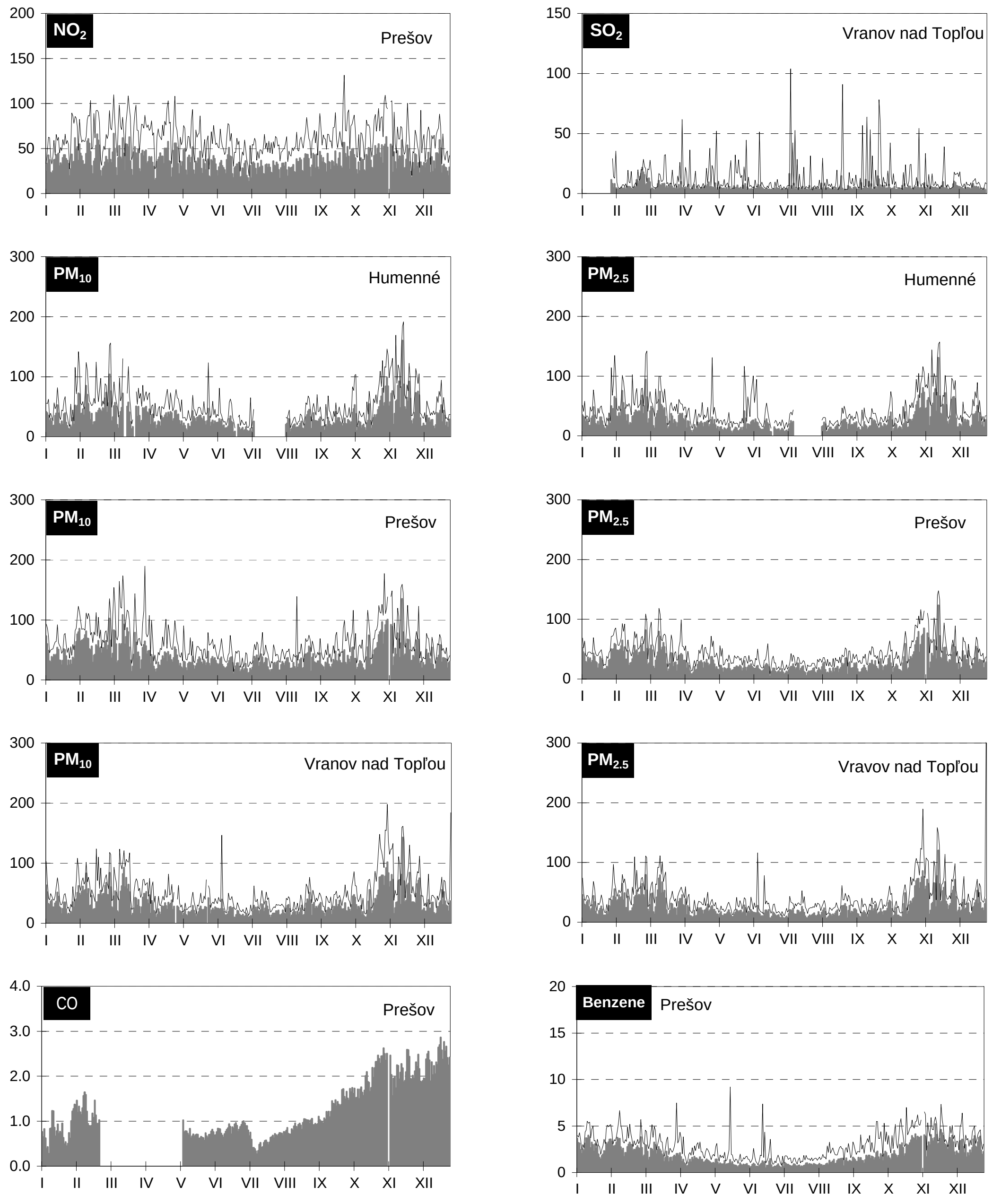


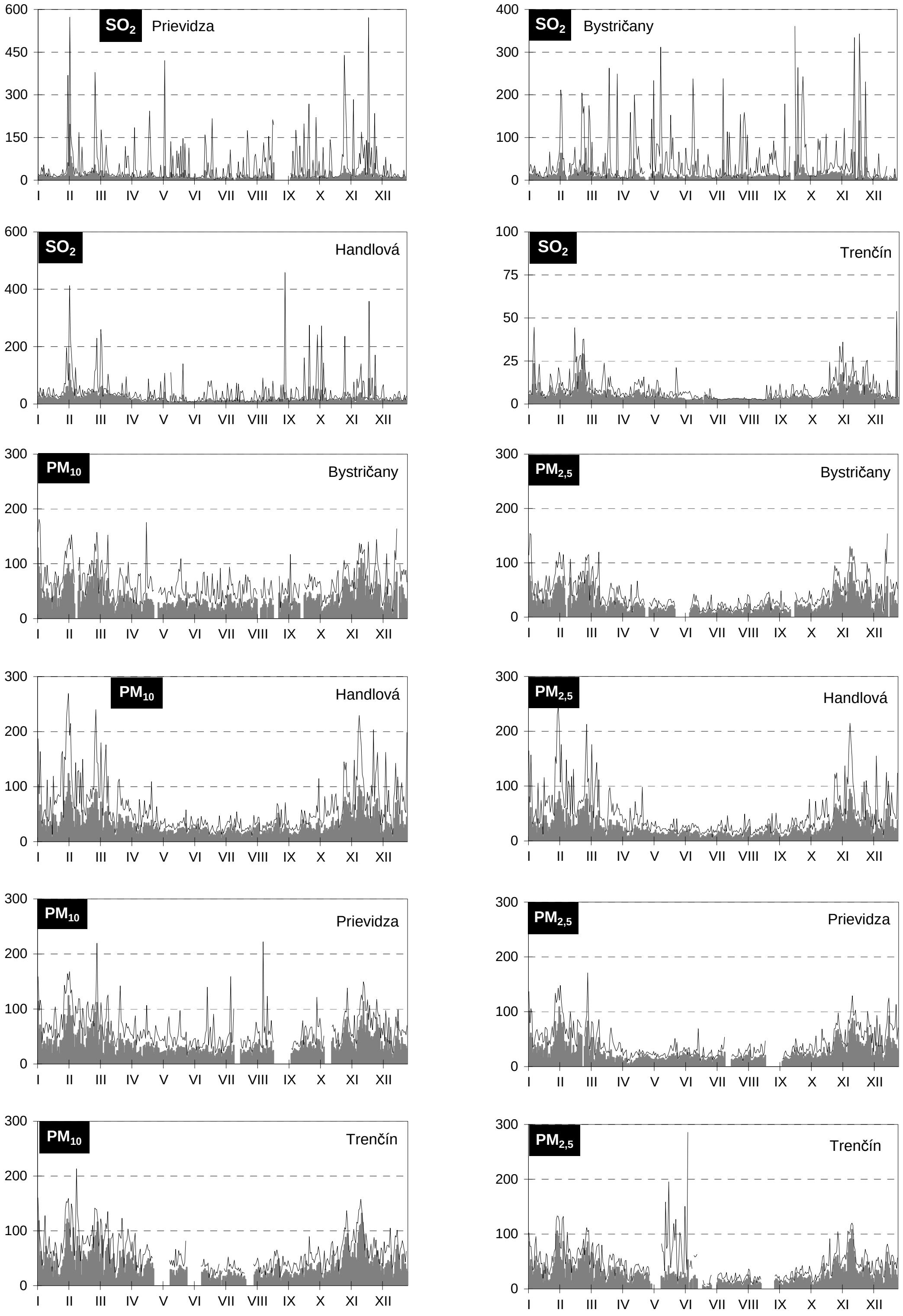
Fig. 2.7 **Concentrations of NO_2, SO_2, PM_{10}, $PM_{2.5}$, CO and benzene – zone Prešov region – 2011**

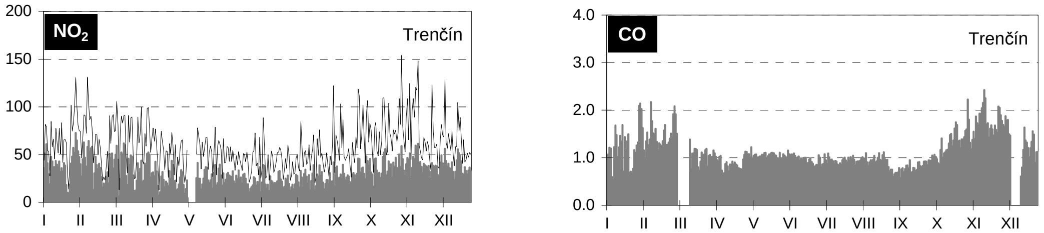


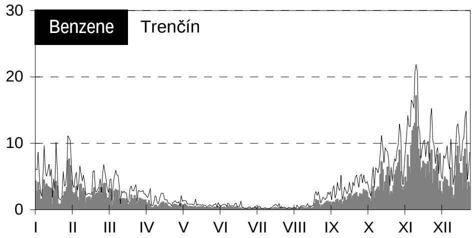
concentrations: NO_2, SO_2, PM_{10}, $PM_{2.5}$, benzene - daily average [µg.m^{-3}]
CO - daily maximum of 8 h means [mg.m^{-3}]

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

Fig. 2.8 **Concentrations of NO_2, SO_2, PM_{10}, $PM_{2.5}$, CO and benzene – zone Trenčín region – 2011**







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

— 1 h maximum concentrations: NO_2, SO_2, PM_{10}, $PM_{2.5}$, benzene [μg.m^{-3}]

Fig. 2.9 **Concentrations of NO_2, SO_2, PM_{10}, $PM_{2.5}$, CO and benzene – zone Trnava region – 2011**

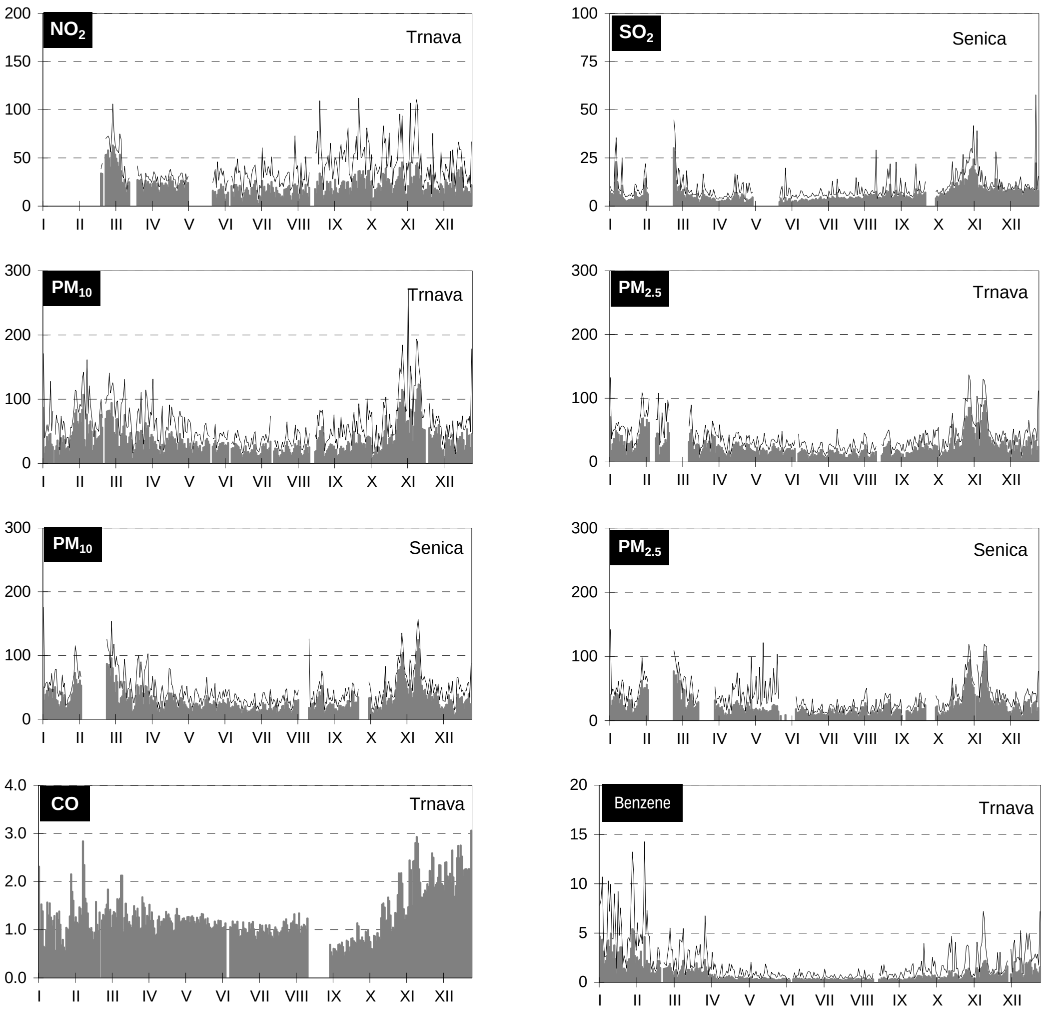


Fig. 2.10 **Concentrations of NO_2, SO_2, PM_{10}, $PM_{2.5}$, CO and benzene – zone Žilina region – 2011**

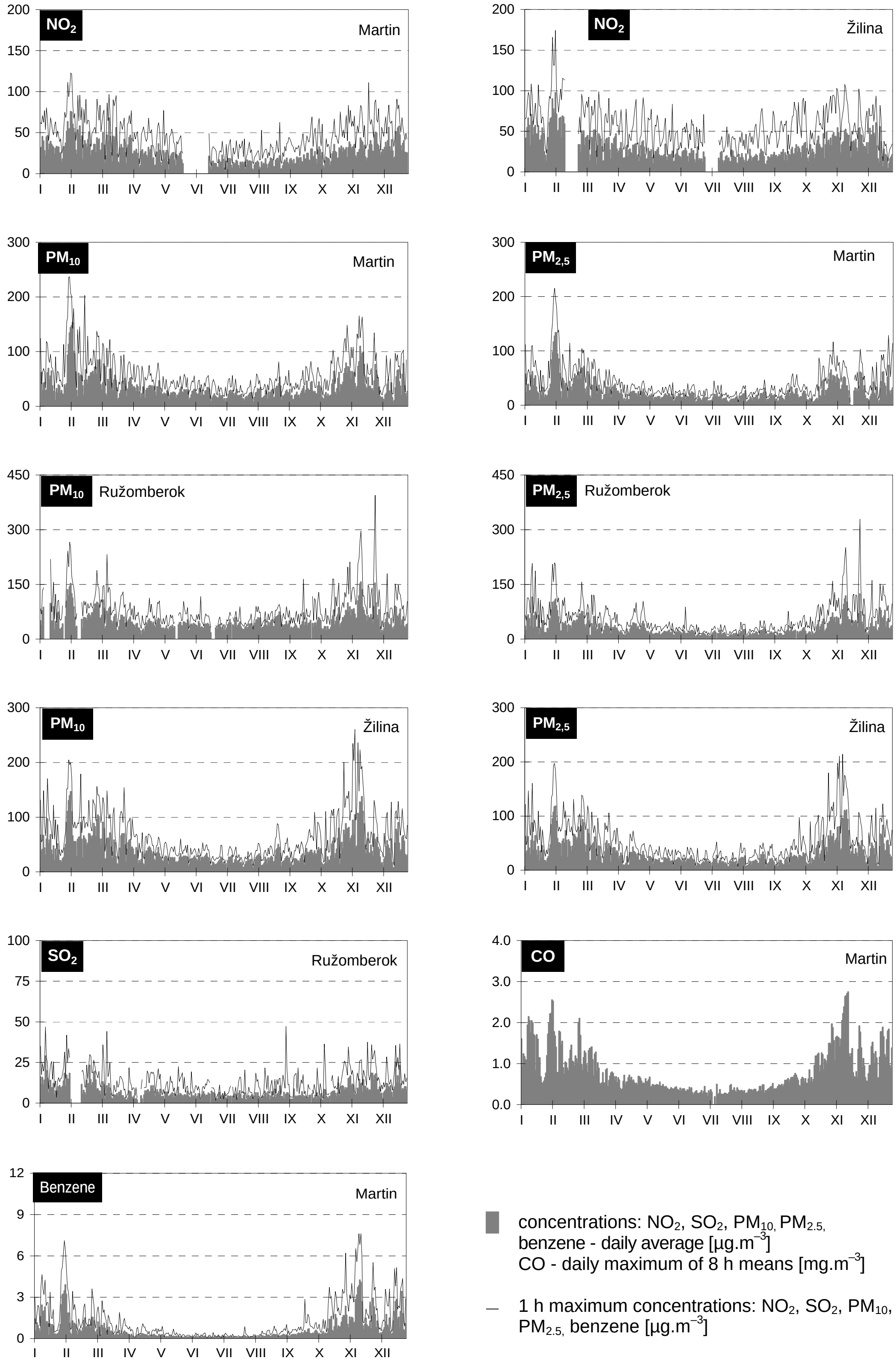
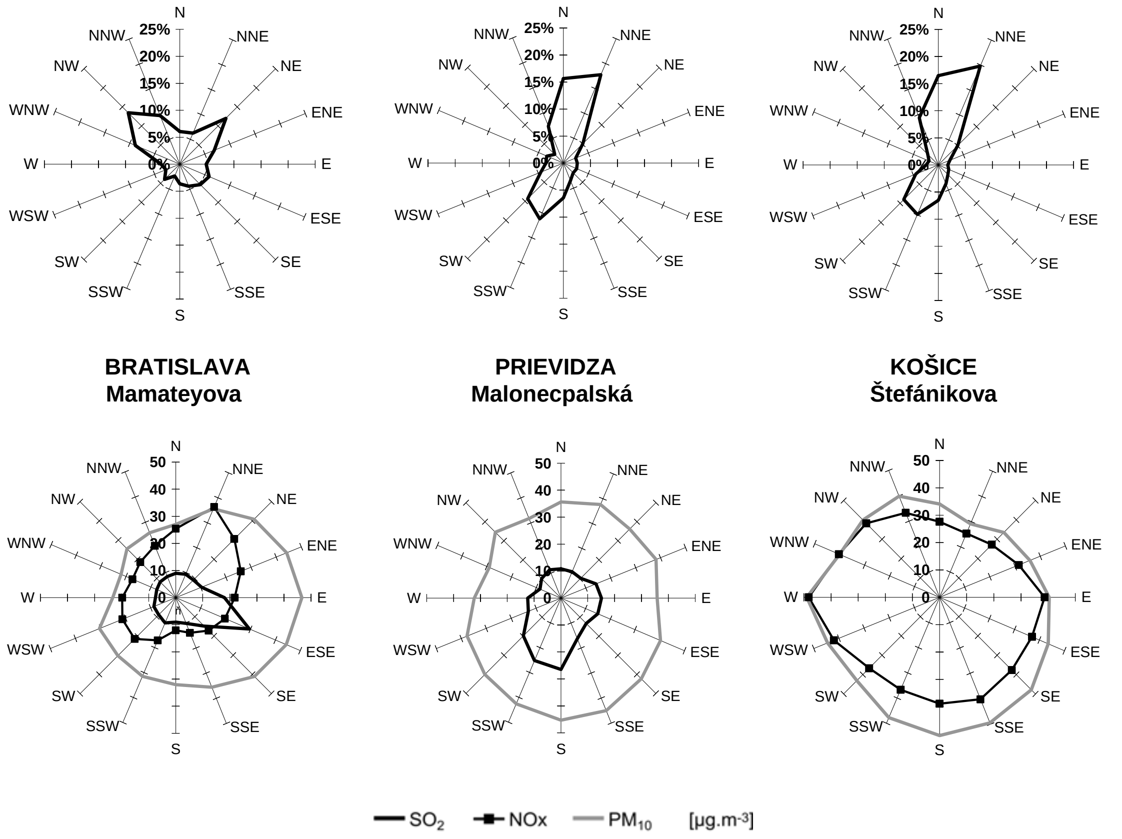


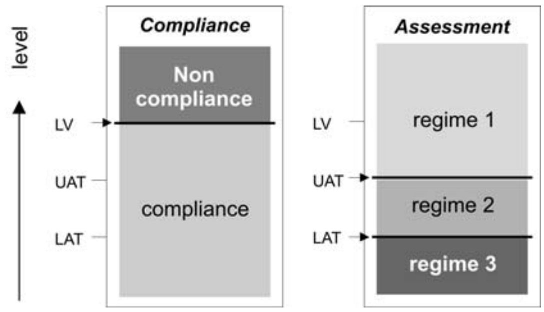
Fig. 2.11 **Wind and concentration roses – 2011**



2.3 PROCESSING OF MEASUREMENT RESULTS ACCORDING TO LIMIT VALUES

The Air Protection Act 137/2010 Coll. harmonized the principles of air quality assessment with the EU AQ legislation. Accordingly to these requirements 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 Figure 2.12 and in Table 2.2 are specified requirements for air quality assessment for specific regimes.

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



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

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

In the year 2011 margin of tolerance was given only for daily limit values of PM_{10} for particular stations, at which EC approved these extension as legitimate and annual limit for $PM_{2,5}$. Limit values, upper and lower assessment thresholds defined in Decree No. 360/2010 Coll. about Air Quality are presented in tables 2.3 and 2.4. Alert thresholds values were set up for:

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

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

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

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

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

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

Sulphur dioxide In the year 2011 in none of agglomeration or zone the hourly or daily limit values were exceeded in more cases than it is allowed. Also none alert concentration has not been exceeded as well.

Nitrogen dioxide Annual limit value plus margin of tolerance was exceeded at stations Bratislava-Trnavské mýto, Banská Bystrica-Štefánikovo nábrežie and Nitra-Štúrova. The maximal concentration 56,3 $\mu g.m^{-3}$ were observed at station Banská Bystrica-Štefánikovo. To this emissions significantly contributed emissions from reconstruction works of traffic circle which will result to improvement of local air quality.

PM_{10} The major air pollution problem in Slovakia similarly to the whole Europe is pollution by particulate matter. In the year 2011 daily limit value was exceeded at 27 stations In the year 2010 SR obtained from EC exception for daily PM_{10} daily values according to the article 22 of Directive 208/50/ES. These exception practically applicable for the zones Trenčín, Trnava and Prešov region until 11th of June 2011. In each of these zones at least at one station the daily value plus margin of tolerance was exceeded. At 6 AMS annual limit value was exceeded as well.

$PM_{2,5}$ For $PM_{2,5}$ is given only annual limit 25 $\mu g.m^{-3}$, which come in force in 1. 1. 2015. For the year 2011 is given limit value and margin of tolerance 28 $\mu g.m^{-3}$ (Commission implementing Decision 2011/850/EU, ANNEX 1, A, 5). In 2011 was this value exceeded at 8 stations and target limit at 25 $\mu g.m^{-3}$ at 18 stations..

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

Benzene The highest annual concentration 3,1 $\mu g.m^{-3}$ in Krompachy is deeply bellow the limit value 5 $\mu g.m^{-3}$.

Pb, As, Ni, Cd The results are not available due to the technical problems.

BaP The target value which has to be attained in the year 2012 was exceeded at stations Veľká Ida-Letná, Krompachy-SNP, Prievidza-Malonecpalská and Trnava-Kollárova.

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

	Interval of averaging	Limit value* [μg.m⁻³]	To be met by	Margin of tolerance	Limit value + margin of tolerance [μg.m⁻³]											
					Since 31/12/00	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
SO_2	1h	350 (24)	1.1.2005	150 μg.m-3	500	470	440	410	380	350	350	350	350	350	350	350
SO_2	24h	125 (3)	1.1.2005	-												
SO_2^v	1y, W[1]	20 (-)	1.1.2003	-												
NO_2	1h	200 (18)	1.1.2010	50%	300	290	280	270	260	250	240	230	220	210	200	200
NO_2	1y	40 (-)	1.1.2010	50%	60	58	56	54	52	50	48	46	44	42	40	40
NO_x^v	1y	30 (-)	1.1.2003	-												
PM_{10}	24h	50 (35)	1.1.2005	50%	75	70	65	60	55	50	50	50	50	50	50	50
PM_{10}	24h	50 (35)	11.6.2011	50%											75***	75***
PM_{10}	1y	40 (-)	1.1.2005	20%	48	46	45	43	42	40	40	40	40	40	40	40
Pb	1y	0.5 (-)	1.1.2005	100%	1.0	0.9	0.8	0.7	0.6	0.5	0.5	0.5	0.5	0.5	0.5	0.5
CO	max. 8 hour daily value	10000 (-)	1.1.2003 (1.1.2005)	6000 μg.m-3	16000	16000	16000	14000	12000	10000	10000	10000	10000	10000	10000	10000
Benzén	1y	5 (-)	1.1.2006 (1.1.2010)	100%	10	10	10	10	10	10	9	8	7	6	5	5
$PM_{2.5}$	1y	25	1. 1. 2015	5 μg.m-3											29	28
$PM_{2.5}$**	1y	25	1. 1. 2010												25	25

[1] winter period (October 1 - March 31) *[v] critical level for protection of vegetation*
** allowed exceedances per year are in brackets ** limit value*
**** exception is applicable for zones Trnava, Trenčín and Prešov region*

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

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

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

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

Tab. 2.5 **Assessment of air quality according to limit values for protection of human health – 2011**

AGLOMERATION / Zone		Human protection										VHP [2)]	
	Pollutant	SO_2		NO_2		PM_{10}			$PM_{2.5}$ +MT	CO	Ben-zene	SO_2	NO_2
	Time of averaging	1 hour	24 hour	1 hour	1 year	24 hour	1 year	24 hour [4)]	1 year	8 hour [1)]	1 year	3 subsequent hour	3 subsequent hour
	Limit value [µg.m^{-3}] *(number of exceedances)*	350 *(24)*	125 *(3)*	200 *(18)*	40	50 *(35)*	40	75 *(35)*	28	10000	5	500	400
BRATISLAVA	Bratislava, Kamenné nám.					43	30.4	x					
	Bratislava, Trnavské mýto			[a] 1	[a] 51.2	90	41.8	x		3574	1.8		0
	Bratislava, Jeséniova			0	14.3	34	28.9	x					0
	Bratislava, Mamateyova	0	0	0	22.2	53	33.2	x				0	0
KOŠICE	Košice, Štefánikova			0	32.7	89	39.2	x	27.7		[a] 2.1		
	Košice, Amurská					66	34.2	x	25.9				
Banská Bystrica region	Banská Bystrica, Štefánikovo nábr.	0	0	8	56.3	127	47.7	x	[c] 42.6	2592	1.0	0	0
	Banská Bystrica, Zelená			0	9.8				22.5				
	Jelšava, Jesenského					[c] 49	[c] 47.0	x	[c] 34.7				
	Hnúšťa, Hlavná					62	33.1	x	24.1				
	Zvolen, J. Alexyho					57	32.3	x	26.5				
	Žiar n. H., Jilemnického					35	26.9	x	22.3				
Bratislava region	Malacky, Sasinkova	0	0	0	30.3	76	40.5	x		2312	1.0	0	0
Košice region	Veľká Ida, Letná					118	44.6	x	30.8	2365			
	Strážske, Mierová					63	35.2	x	24.1				
	Krompachy, SNP	0	0	[b] 0	[b] 15.8	77	35.2	x	27.7	[b] 3030	3.1	0	0
Nitra region	Nitra, Janíkovce			3	14.6	63	37.7	x	24.0				
	Nitra, Štúrova	[a] 0	[a] 0	4	47.3	67	38.4	x	[c] 43.7	[a] 2223	1.2	0	0
Prešov region	Humenné, Nám. slobody					50	33.8	31	26.9				
	Prešov, Arm. gen. L. Svobodu			0	36.3	89	39.8	65	28.9	[a] 2863	1.9		
	Vranov nad Topľou, M. R. Štefánika	0	0			57	32.6	40	26.1			0	
	Stará Lesná, AÚ SAV, EMEP [3)]					7	22.3	3	14.8				
	Kolonické sedlo, Hvezdáreň [3)]					16	25.4	9	16.3				
Trenčín region	Prievidza, Malonecpalská	10	2			63	38.0	43	28.0			0	
	Bystričany, Rozvodňa SSE	1	1			68	38.1	44	26.9			0	
	Handlová, Morovianska cesta	3	1			59	32.9	40	25.4			0	
	Trenčín, Hasičská	0	0	0	32.3	86	39.7	63	29.0	2425	2.3	0	0
Trnava region	Senica, Hviezdoslavova	[a] 0	[a] 0			40	30.8	30	[a] 23.8			0	
	Trnava, Kollárova			[a] 0	[a] 22.4	59	36.7	44	24.9	3061	0.9		0
	Topoľníky, Aszód, EMEP [3)]					41	26.5	27	23.7				
Žilina region	Martin, Jesenského			0	25.5	69	35.6	x	25.7	2747	0.7		
	Ružombeyear, Riadok	0	0			131	50.6	x	31.6			0	
	Žilina, Obežná			0	30.0	95	39.1	x	31.8				0

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

[3)] *stations located in rural background areas*

[4)] *limit values plus margin of tolerance (exception is applicable till 11th June 2011); x - exception was not given*

Pollutants which exceeded limit values are in bold

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

Tab. 2.6 **Assessment of air quality according to target and limit values for As, Cd and Ni for the protection of human health in 2011**

AGLOMERATION/ zone	Pollutant	As	Cd	Ni	Pb
	Target value [ng.m^{-3}]	6.0	5	20	
	Limit value [ng.m^{-3}]				500
	Upper assessment threshold [ng.m^{-3}]	3.6	3	14	350
	Lower assessment threshold [ng.m^{-3}]	2.4	2	10	250
Slovakia	Banská Bystrica, Štefánikovo nábr.				
	Veľká Ida, Letná				
	Krompachy, SNP				
	Prievidza, Malonecpalská				
	Ružomberok, Riadok				

Results are not available due to the technical problems.

Tab. 2.7 **Assessment of air quality according to target values for BaP for the protection of human health in 2011**

AGLOMERATION / zone	Pollutant	BaP
	Target value [ng.m^{-3}]	1.0
	Upper assessment threshold [ng.m^{-3}]	0.6
	Lower assessment threshold [ng.m^{-3}]	0.4
BRATISLAVA	Bratislava, Trnavské mýto	0.7
Slovensko	Veľká Ida, Letná	4.2
	Krompachy, SNP	2.5
	Prievidza, Malonecpalská	2.1
	Trnava, Kollárova	1.1
	Nitra, Štúrova	0.9

ATMOSPHERIC OZONE 3

3.1 ATMOSPHERIC OZONE

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

The growth of ozone concentrations in the troposphere approximately 1 $\mu g.m^{-3}$ annually was observed over the industrial continents of the Northern Hemisphere by the end of 1980s. It is associated with the increasing emission of ozone precursors (NO_x, 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 2011 was lower as in 2003. The high ground level ozone concentrations, mainly during photochemical smog episodes in summer, impact unfavourably on human health (mainly on the respiratory system of human beings), vegetation (mainly on agricultural crops and forests) and various materials.

3.2 GROUND LEVEL OZONE IN THE SLOVAK REPUBLIC DURING 2006 – 2011

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 2006 – 2011

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 2011 the number of missing data did not exceed 8% almost at all stations (Tab. 3.2). Large gaps were only at the Jelšava, Nitra Janíkovce and Topoľníky.

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

Station	2006	2007	2008	2009	2010	2011
Banská Bystrica, Zelená				*42.5	0.03	0.1
Bratislava, Jeséniova	16.8	0.6	1.6	0.1	0.2	1.3
Bratislava, Mamateyova	2.3	0.8	1.1	7.2	6.2	4.9
Humenné, Nám. Slobody	10.3	9.5	0.5	0.1	3.8	7.5
Jelšava, Jesenského	8.2	5.0	0.1	3.0	2.8	61.6
Košice, Ďumbierska	44.4	1.1	0.1	2.1	0.4	0.1
Nitra, Janíkovce				*13.7	22.5	63.5
Prievidza, Malonecpalská		1.9	0.4	3.4	0.5	4.6
Žilina, Obežná	0.5	1.0	0.05	1.5	0.1	0.4
Gánovce, Meteo. st.	7.8	0.01	1.7	0.1	0.4	0.2
Chopok, EMEP	29.0	1.0	1.7	0.3	2.6	2.2
Kojšovská hoľa	6.3	0.7	1.9	0.1	14.2	2.5
Stará Lesná, AÚ SAV, EMEP	10.9	0.2	0.3	0.6	0.4	2.2
Starina, Vodná nádrž, EMEP	24.8	6.6	2.6	0.8	0.1	0.2
Topoľníky, Aszód, EMEP	1.7	1.4	0.6	0.6	2.9	-

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

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

Station	2006	2007	2008	2009	2010	2011
Banská Bystrica, Zelená				**53	56	60
Bratislava, Jeséniova	66	59	59	60	61	63
Bratislava, Mamateyova	50	49	48	48	46	51
Humenné, Nám. slobody	62	56	55	59	53	53
Jelšava, Jesenského	55	56	51	49	44	-
Košice, Ďumbierska	**49	57	56	81	63	73
Nitra, Janíkovce				*74	53	-
Prievidza, Malonecpalská		48	53	50	49	51
Žilina, Obežná	44	44	46	48	47	48
Gánovce, Meteo. st.	68	60	65	62	63	64
Chopok, EMEP	**96	91	92	90	87	96
Kojšovská hoľa	84	79	76	85	90	87
Stará Lesná, AÚ SAV, EMEP	73	68	74	61	67	65
Starina, Vodná nádrž, EMEP	**62	62	59	58	51	59
Topoľníky, Aszód, EMEP	60	58	60	59	55	-

**75 – 90%, ** 50 – 75% of valid measurements - long-term failure*

In 2011, the annual average concentrations of ground level ozone in urban and industrial locations of Slovakia ranged within the interval 48 – 73 μg.m^{-3} (Tab. 3.3). The concentrations in the rest of the territory ranged between 59 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 2011, according to vegetation period averages, belongs to the photochemically less active years. Annual averages of ground level ozone concentration in 2011 were lower than in record year 2003.

In Figure 3.1, the seasonal cycle of daily ozone concentrations in Stará Lesná during 1992 – 2011 is depicted. The seasonal course is typical for lowlands and valley (not summit) positions of industrial continents. Original spring maximums of ozone concentrations, associated with the transport of ozone from upper atmospheric layers, is extended for the whole summer period, as a consequence of photochemical ozone formation in a atmospheric boundary layer.

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

The number of exceedances of ozone threshold values in Slovakia during 2006 – 2011 is summarised in Tables 3.4 – 3.6. The alert threshold when the public must be warned (240 μg.m^{-3}) was not exceeded in 2011 (Tab. 3.4). The information threshold to the public (180 μg.m^{-3}) was in 2011 exceeded only at Bratislava Jeséniova station.

Fig. 3.1 **Seasonal variability of ground level ozone concentration in Stará Lesná during 1992 – 2011**

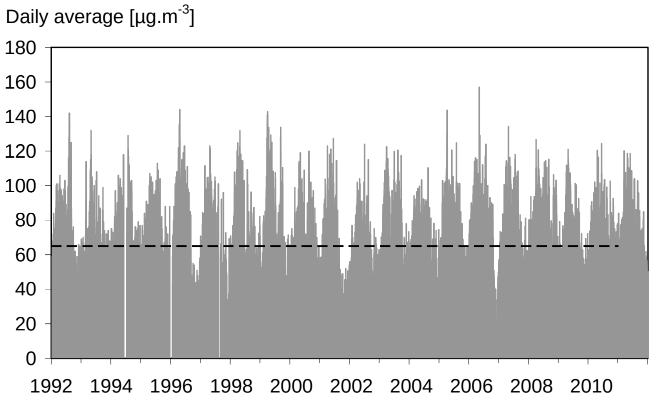
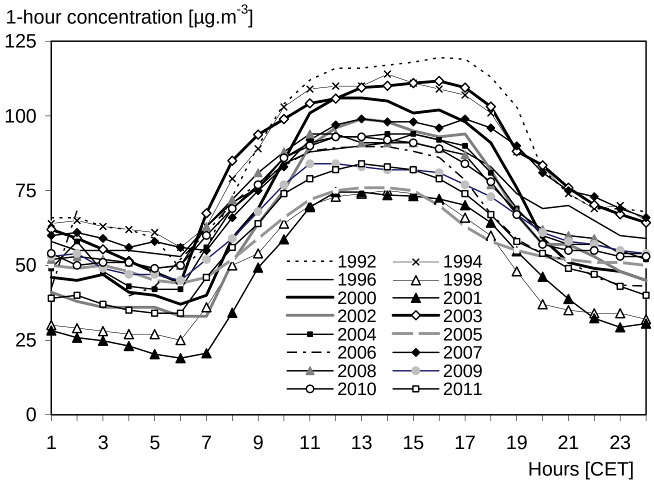


Fig. 3.2 **Average daily cycles of ground level ozone concentration in Stará Lesná, in August 1992 – 2011**



Tab. 3.4 **Number of exceedances of ozone information threshold (IT) and alert threshold (AT) to the public during 2006 – 2011**

Station	AT = 240 μg.m^{-3}						IT = 180 μg.m^{-3}					
	2006	2007	2008	2009	2010	2011	2006	2007	2008	2009	2010	2011
Banská Bystrica, Zelená				0	0	0				0	0	0
Bratislava, Jeséniova	0	0	0	0	12	0	19	10	0	0	39	3
Bratislava, Mamateyova	0	1	0	0	0	0	11	17	1	2	3	0
Humenné, Nám. Slobody	0	0	0	0	0	0	1	0	0	0	0	0
Jelšava, Jesenského	0	0	0	0	0	0	3	6	0	0	0	0
Košice, Ďumbierska	0	0	0	0	0	0	0	0	0	0	0	0
Nitra, Janíkovce				0	0	0				1	0	0
Prievidza, Malonecpalská	0	0	0	0	0	0	0	1	0	0	0	0
Žilina, Obežná	0	0	0	0	0	0	8	0	0	0	0	0
Gánovce, Meteo. st.	0	0	0	0	0	0	0	0	0	0	0	0
Chopok, EMEP	0	0	0	0	0	0	1	0	0	0	0	0
Kojšovská hoľa	0	0	0	0	0	0	1	2	2	0	0	0
Stará Lesná, AÚ SAV, EMEP	0	0	0	0	0	0	1	0	0	0	0	0
Starina, Vodná nádrž, EMEP	0	0	0	0	0	0	3	0	0	0	0	0
Topoľníky, Aszód, EMEP	0	0	0	0	0	-	0	4	0	0	0	-

In Table 3.5 is presented the number of exceedances of ozone target value for protection of human health (8 h mean 120 µg.m^{-3}) averaged over 2009 – 2011. The target value not to be exceeded on more than 25 days per calendar year averaged over three years. In 2009 – 2011 was the number of 25 days overstepped at seven monitoring stations. The highest exceedance was observed at Chopok (55 days), Kojšovská hoľa (61 days) and Košice Ďumbierska (63 days) stations.

Tab. 3.5 **Number of exceedances of ozone target value for protection of human health (8 h average 120 µg.m^{-3}) during 2009 – 2011**

Station	2009	2010	2011	Average 2009 – 2011
Banská Bystrica, Zelená	18	17	32	24
Bratislava, Jeséniova	32	24	24	**27**
Bratislava, Mamateyova	22	21	27	23
Humenné, Nám. slobody	43	8	10	20
Jelšava, Jesenského	17	4	13	10
Košice, Ďumbierska	106	14	70	**63**
Nitra, Janíkovce	85	16	11	**50**
Prievidza, Malonecpalská	19	9	14	14
Žilina, Obežná	36	20	34	**30**
Gánovce, Meteo. st.	5	7	25	12
Chopok, EMEP	62	36	68	**55**
Kojšovská hoľa	71	55	58	**61**
Stará Lesná, AÚ SAV, EMEP	15	15	17	16
Starina, Vodná nádrž, EMEP	22	2	7	10
Topoľníky, Aszód, EMEP	41	23	-	**32**

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 seven stations).

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

Station	2009	2010	2011	Average 2007 – 2011
Banská Bystrica, Zelená	17178	15110	19748	17345
Bratislava, Jeséniova	17765	21253	17584	**19580**
Bratislava, Mamateyova	13479	14712	16534	17504
Humenné, Nám. slobody	23878	9606	17635	**20161**
Jelšava, Jesenského	14469	8542	24358	16919
Košice, Ďumbierska	38806	12496	29975	**22381**
Nitra, Janíkovce	32110	12991	–	*
Prievidza, Malonecpalská	12742	11874	13961	14579
Žilina, Obežná	18767	16248	17661	**18277**
Gánovce, Meteo. st.	13990	12786	19025	16880
Chopok, EMEP	27828	20815	29298	**27332**
Kojšovská hoľa	25276	23077	25597	**24581**
Stará Lesná, AÚ SAV, EMEP	11536	12894	15314	16019
Starina, Vodná nádrž, EMEP	15215	5107	10153	12289
Topoľníky, Aszód, EMEP	20768	16764	–	**22198**

- long-term failure ** station did not measure a sufficient number of years*

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 (NO_x, 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 2011 was in average below the 2003 level.

3.3 TOTAL ATMOSPHERIC OZONE OVER THE TERRITORY OF THE SLOVAK REPUBLIC IN 2011

Since August 1993 total atmospheric ozone over the territory of Slovakia has been measured with the Brewer ozone spectrophotometer MKIV #097 in the Aerological and Radiation Centre (ARC) of the Slovak Hydrometeorological Institute (SHMÚ) at Gánovce near Poprad (49º02’N, 20º19’E, 706 m a.s.l.). As well the solar UV spectra is regularly scanned through the range 290 – 325 nm at 0.5 nm increments. Poprad-Gánovce station is a part of the Global Ozone Observing System (GOOS). The results are submitted to the World Ozone Data Centre (WOUDC) in Canada and to the WMO Ozone Mapping Centre in Greece. Poprad-Gánovce station is included to Global Atmosphere Watch (GAW) network for total ozone and solar UV spectral radiation.

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

The annual mean of the total atmospheric ozone was 317.0 Dobson Units in 2011. This is 6.3% below the long-term average (calculated upon the Hradec Kralove measurements in the period 1962 – 1990).

Since 1994 annual means measured at Poprad-Gánovce station have been available. The 1994 – 2011 long-term average is 326.9 Dobson units. In mentioned period the annual mean in the year 2011 was the second lowest with the deviation of –3.0%. In comparison with the year 2010 the annual mean was lower by 8.5%. It has been the highest inter-annual difference since the beginning of measurements at Ganovce.

Total ozone statistics for the year 2011 (daily means, relative deviations from long term average, monthly means, standard deviations and extremes) are in Table 3.7. Positive difference from the long-term average was in January only. Monthly minimums were broken in April, September and November. The April average deviation of total ozone from long-term average of –15% was the biggest negative one in the history of total ozone measurements at Poprad-Gánovce.

Total ozone weekly averages are shown in Figure 3.3. The graph illustrates the total ozone amount in the year 2011 with respect to long-term mean values and shows significant short-term variations in total column ozone in our geographical region. Besides four weeks in January only four additional positive weekly averages were recorded during the year.

Fig. 3.3 **Total atmospheric ozone over the territory of Slovakia in 2011**

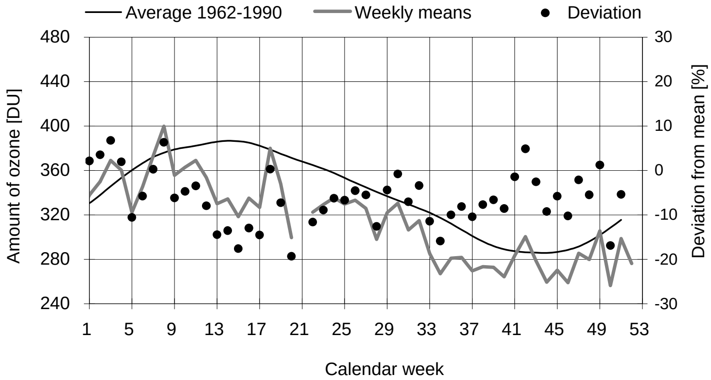
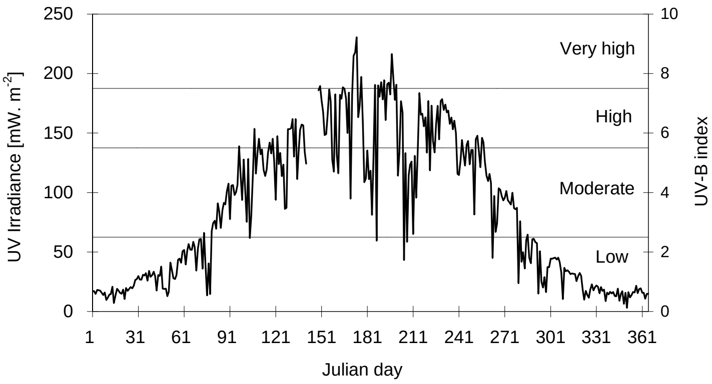


Fig. 3.4 **Annual course of CIE effective irradiance and UV index noon values – Gánovce 2011**



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

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

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

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

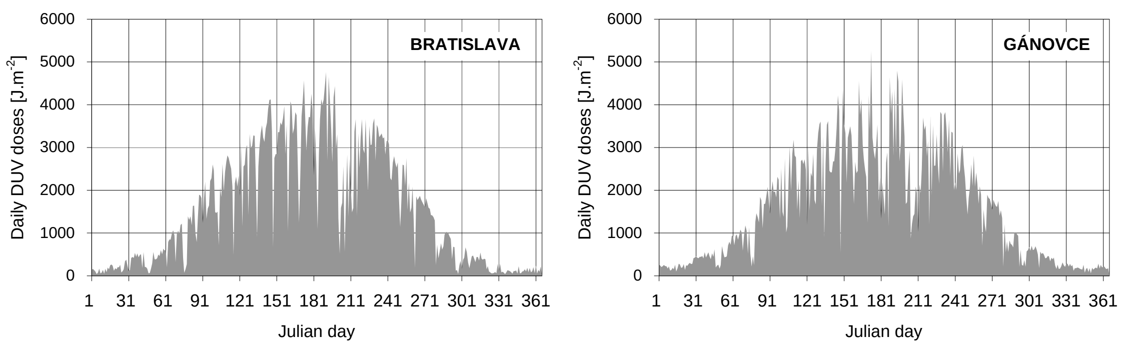
The biggest 1 min average of the CIE-erythemal UV irradiance of 223.8 mW.m^{-2} (3.84 MED.h^{-1}) was registered in Bratislava (48º10'N, 17º06'E, 304 m a.s.l.) on June 23. Deviation of the daily total column ozone from the long-term average was –14% on that day. The biggest 1 min average of the CIE-erythemal UV irradiance of 248.2 mW.m^{-2} (4.25 MED.h^{-1}) was registered at Poprad-Ganovce on June 28. Deviation of the daily total column ozone from the long-term average was –8% on that day.

The biggest hourly average of the CIE-erythemal UV irradiance of 191.2 mW.m^{-2} (3.28 MED.h^{-1}) was registered in Bratislava on July 10. Deviation of the daily total column ozone from the long-term average was –15% on that day. The biggest hourly average of the CIE-erythemal UV irradiance of 217.4 mW.m^{-2} (3.73 MED.h^{-1}) was registered at Poprad-Ganovce on June 22. Deviation of the daily total column ozone from the long-term average was –15% on that day.

Daily doses of the CIE-erythemal UV radiation are presented in Figure 3.5. Maximum daily dose of 4761 J.m^{-2} (which correspondents to 22.7 MED) was measured in Bratislava on July 10. Maximum daily dose of 5260 J.m^{-2} (25.0 MED) was measured at Poprad-Ganovce on June 22. At both stations the days with maximum daily doses and biggest hourly averages are the same.

In the period April – September 2011 total CIE-erythemal UV radiation dose in Bratislava was 493 598 J.m^{-2}. This value is 18% higher than the dose in 2010. Total CIE-erythemal dose at Poprad-Ganovce was 469 654 J.m^{-2} for the same period. This value is also 18% higher than the dose in 2010. Higher yearly totals of UV radiation in 2011 are caused by two factors. Sunshine duration in Bratislava was more than 247 hours and at Poprad-Ganovce more than 218 hours longer in comparison with previous year and the ozone layer was reduced during whole period.

Obr. 3.5 Annual Course of CIE effective UV radiation Daily Doses in 2011



Tab. 3.7 **Total atmospheric ozone in Dobson units [DU] and its deviations from long-term average [%] at Poprad-Gánovce in 2011**

Day	I		II		III		IV		V		VI		VII		VIII		IX		X		XI		XII	
	O_3	Dev	O_3	Dev	O_3	Dev	O_3	Dev	O_3	Dev	O_3	Dev	O_3	Dev	O_3	Dev	O_3	Dev	O_3	Dev	O_3	Dev	O_3	Dev
1	310	-5	336	-6	352	-7	348	-10	338	-11	328	-10	345	-1	314	-5	286	-8	276	-5	254	-11	285	-4
2	321	-2	336	-7	355	-6	333	-14	338	-11	321	-12	330	-5	316	-5	299	-4	274	-6	252	-12	288	-3
3	388	18	336	-7	358	-6	322	-17	346	-9	321	-12	323	-7	301	-9	286	-8	254	-13	259	-9	276	-7
4	325	-1	330	-9	351	-8	345	-11	382	1	321	-12	338	-2	298	-10	279	-10	258	-11	263	-8	276	-8
5	335	2	306	-16	339	-11	368	-5	425	12	317	-13	353	2	309	-6	286	-7	241	-17	272	-5	282	-6
6	341	3	295	-19	358	-6	350	-10	395	4	326	-10	352	2	304	-8	290	-6	241	-17	258	-10	312	4
7	316	-5	309	-15	393	3	312	-19	411	9	312	-14	322	-7	305	-7	279	-9	261	-10	261	-9	325	8
8	322	-3	355	-3	355	-7	321	-17	363	-4	321	-11	312	-9	311	-5	298	-3	287	-1	265	-7	368	22
9	339	2	352	-4	379	0	325	-16	348	-8	335	-7	312	-9	317	-3	275	-10	308	7	270	-6	306	1
10	346	3	321	-13	365	-4	320	-17	353	-6	345	-4	293	-15	341	5	274	-10	280	-3	288	0	285	-6
11	369	10	368	0	357	-6	346	-10	347	-8	331	-8	297	-13	310	-5	271	-11	256	-11	268	-7	262	-14
12	328	-3	375	2	346	-9	295	-24	340	-9	337	-6	309	-10	304	-7	284	-7	279	-3	271	-6	286	-6
13	357	6	339	-8	345	-9	316	-18	346	-8	344	-4	295	-14	315	-3	258	-15	287	0	269	-6	280	-9
14	293	-14	341	-8	373	-2	362	-6	346	-7	333	-7	283	-17	306	-6	257	-15	301	5	280	-2	272	-12
15	408	20	336	-9	360	-6	341	-12	355	-5	345	-4	291	-15	293	-9	276	-8	291	1	260	-10	298	-3
16	350	3	386	4	353	-8	287	-26	359	-4	328	-8	302	-11	300	-7	274	-9	289	1	245	-15	324	5
17	319	-7	380	2	346	-10	281	-27	359	-4	318	-11	310	-9	291	-10	272	-9	281	-2	251	-13		
18	321	-6	401	7	387	1	329	-15	354	-5	311	-13	298	-12	276	-14	269	-10	282	-2	251	-13	334	7
19	344	0	411	10	387	1	333	-14	336	-10	369	4	307	-9	272	-15	267	-11	272	-5	271	-6	362	16
20	416	20	358	-4	378	-1	321	-17	341	-8	349	-2	313	-7	282	-12	272	-9	300	5	256	-12	336	7
21	374	8	331	-12	369	-4	330	-14	350	-6	319	-10	343	2	282	-12	274	-8	302	5	296	2	303	-4
22	411	18	404	8	362	-6	324	-16			302	-15	321	-5	272	-15	268	-10	338	18	289	-1	303	-4
23	398	14	450	20	378	-1	347	-10			305	-14	324	-4	266	-17	289	-2	329	15	282	-3	251	-21
24	388	11	438	16	334	-13	356	-7			326	-8	349	4	268	-16	272	-8	308	8	286	-2	254	-20
25	337	-4	416	11	324	-16	361	-6			364	3	354	6	262	-17	273	-7	308	8	288	-1	283	-11
26	380	8	383	2	342	-11	346	-10			344	-2	333	0	265	-16	274	-7	266	-7	282	-4	263	-18
27	409	16	377	0	368	-4	322	-16			329	-6	328	-2	268	-15	279	-5	275	-4	276	-6	252	-21
28	347	-2	377	0	343	-11	309	-19			321	-8	317	-5	269	-15	272	-7	273	-5	276	-6	243	-25
29	328	-8			327	-15	303	-21	322	-12	335	-4	330	-1	275	-13	263	-10	263	-8	283	-4	249	-23
30	333	-7			324	-16	309	-19	325	-11	350	0	343	3	261	-17	272	-7	258	-10	276	-6	319	-1
31	317	-11			315	-18			325	-11			310	-7	282	-10			259	-10			331	2
Ø	351	3	362	-2	356	-7	329	-15	354	-5	330	-8	320	-6	291	-10	276	-8	280	-2	270	-7	294	-5
Std	34	9	39	9	19	5	22	6	25	6	16	5	20	6	20	5	10	3	23	8	13	4	32	11
Max	416	20	450	20	393	3	368	-5	425	12	369	4	354	6	341	5	299	-2	338	18	296	2	368	22
Min	293	-14	295	-19	315	-18	281	-27	322	-12	302	-15	283	-17	261	-17	257	-15	241	-17	245	-15	243	-25

O_3 - *total ozone* Dev - *relative deviation from long-term mean (Hradec Králové 1962 – 1990)*

Std - *standard deviation [DU]*

4

EMISSION AND AIR POLLUTION SOURCE INVENTORY

4.1 EMISSION AND AIR POLLUTION SOURCE INVENTORY

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

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

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

STATIONARY SOURCES

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

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

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

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

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

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

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

Positive contribution of database NEIS

- Homogeneous system of data processing about sources and their emissions at local, regional and national level.
- Provision of an actual and effective tool to all primary data processors providing uniform level of acquisition, processing, control and verification of data about the sources and their emissions.
- 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 the NEIS database exclusively in coincidence with the legislative regulations.
- Establishment of a Slovak national database that enables the top state administration bodies to fulfill 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.air.sk.
- Establishment of air pollution operators and sources documents archive.

The comparison of the EAPSI and NEIS systems

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

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

The NEIS system includes the sources of air pollution, which are assigned according to the category and input (Decree No. 356/2010):

Large sources	Stationary sources containing stationary combustion units having cumulative heating input over 50 MW and other technological units with a production capacity above the defined limit.
Middle sources	Stationary sources containing stationary combustion units having cumulative heating input 0.3 – 50 MW and other technological units with a production capacity under the defined limit for the large sources and above the defined limit.
Small sources	Stationary equipment – domestic heating equipment for combustion of solid fuels and natural gas with heating input less than 0.3 MW.

Results (1990 – 2011) – evaluation

Large sources

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

NEIS Since 2000 the gathering of the selected data on sources and their emissions has been provided in the NEIS. The system contained 863 (712 of it in operation) large point sources in 2011. As the sources of 5 MW and above were included to the evidence of large point sources in the EAPSI system, the comparison of numbers of sources in both systems is not possible.

Middle sources

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

NEIS Since 2000 the data updating in the NEIS system has been provided each year. In 2011, NEIS registered 12921 (10885 of it in operation) medium sources. System EAPSI 2 registered only sources of heating output 0.2 – 5 MW and therefore to compare the number of sources in the individual systems is not possible.

Small sources

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

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

MOBILE SOURCES

Emissions estimates from mobile sources have been calculated every year since 1990. To balance emissions from road transport sector has been used COPERT 4[2] software program since the 2008 which is approved and recommended by Executive Committee the UNECE Convention on Long-Range Transboundary Air Pollution[3]. The calculation of emissions from the road transport sector in Slovakia for the year 2011 has been provided in the newest version COPERT 4 version 9.0. Activity date were applied as input date such as numbers of vehicles for each category defined in program COPERT 4 and average annual mileage in each category of vehicles. Emissions are calculated according to fuel type and also by type of vehicle. Additional input data were levels of pollutants in fuels (gasoline, diesel, LPG, CNG) and fuel consumption including the share of biofuels. Model COPERT v.9.0 takes into account the share of biofuels in the energy consumption of different types of vehicles. Model COPERT does not count Total Suspended Particulates (TSP) from abrasion of tires and brakes and does not provide any solid particles from road abrasion. These missing emissions were calculated separately from traffic performance in fleet mileage (detected from the COPERT from numbers of vehicles and annual mileage) and emission factors Tier 1 set out in EMEP/EEA air pollutant emission inventory guidebook to complete emission balance. Fuel and energy consumption values show a slight decrease for the year 2011 compared to 2010, particularly gasoline (petrol stayed about the same), which had an impact on the production of mostly lower emissions. Decreasing trend is assigned mainly due to the global economic crisis.

In addition to road transport emissions are evaluated and the sources of pollution and of rail, air and water transport in Slovakia. Methodology balances of emissions from the operation of railway traction units is processed according to the methodology EMEP/CORINAIR[4] and non-road sources using emission factors according to the methodological manual Emission Inventory Guidebook. The balance of production of emissions from water transport in the SR is limited to waterway activity in the Slovak Danube. Methodology used assessing the annual production of pollutants from the operation of waterway traffic traction activities of vessels on the Danube is a simplified methodology EMEP/CORINAIR non-road sources based on the calculations of applying average emission factors recommended by the CORINAIR working group. An important factor in the appraisal emissions in aviation is altitude. Different impacts on air pollution have emissions from air traffic on air and road to the landing and take-off maneuvers. The methodology for objectively assessing the impact of air pollutants in larger altitude from aircraft engines is not clearly developed yet, therefore, emission inventory is prepared on the base of local pollution on major airports in Slovakia. Operationally essential input – the number of statistics are made of aircraft movements, flight (LTO) cycle, fuel consumption and an overview of fuel sold. Innovative methodology is also based on knowledge of emission factors of individual aircraft types.

[2] *http://www.emisia.com/copert/*
[3] *http://www.unece.org/env/lrtap/*
[4] *http://www.eea.europa.eu/publications/emep-eea-emission-inventory-guidebook-2009*

4.2 DEVELOPMENT OF TRENDS IN BASIC POLLUTANTS

EMISSIONS OF BASIC POLLUTANTS

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

Particulate matter and SO_2

Emissions of particulate matter and SO_2 have been decreasing continuously since 1990. Apart from the decrease in energy production and energy efficiency, this was caused by the change of the fuel base in favour of high-grade fuels, as well as the improvement of fuel quality characters used. A further spreading of separation techniques used, respectively advancing of its effectiveness shared in the particulate matter emission reduction. The downward trend of SO_2 emissions up to year 2000 was caused by the decreasing consumption of brown coal, hard coal, heavy fuel oil, use of low-sulphur fuel oil (Slovnaft Ltd., Bratislava) and installation of the desulphurisation systems for the large power sources (power plants in Zemianske Kostoľany and Vojany). The fluctuations of SO_2 emissions within 2001 and 2003 were caused either by their partial or total operation, or by the quality of combusted fuel and volume of production of energetic sources. In 2004 till 2006 the another decrease of SO_2 emissions was recorded mainly at large sources. This decrease was caused mainly by the combustion of low-sulphur-content fuel oils and coal (Slovnaft Ltd., Bratislava, TEKO Ltd., Košice) and by the reduction of production volume (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 retail price of natural gas and coal. Considerable decrease of SO_2 emission of about 77% was observed in road transport category in 2005. This decrease, contrary to the increase in consumption of fuel substances was caused by the implementation of measures referring to the content of sulphur in fuel substances (Decree No. 53/2004). The decrease of particulate matter emissions in 2006 was achieved mainly by reconstruction of separators in some sources in energy and industry (Power plants in Zemianske Kostoľany, U.S. Steel Ltd., Košice). Another decrease of the particulate matter and SO_2 emissions in 2007 and 2008 for the large stationary sources was mostly caused by the power plant in Vojany, of which some combustion units was out of operation. Since 2008, the trend of emissions of SO_2 and PM is stable. Increase of SO_2 emissions from the large sources in 2010 of 8% was caused by the increase of brown coal consumption in power plant Slovenské elektrárne in Nováky, and by the slightly increase of sulphur-content in this fuel. A slight increase in PM emissions in 2011 occurred in the sector of small sources - households, where the consumption of firewood increased at the expense of natural gas.

Oxides of nitrogen

Emissions of nitrogen oxides have showed a smooth decrease since 1990, although in the years 1994 – 1995 they increased slightly in order to the increase in consumption of natural gas. A decrease of emissions of NO_x since 1996 was caused by the change of emission factor, taking into consideration the resent condition of technique and technology in combustion processes. Since 1997, the decrease in solid fuel consumption has led to a further decrease in NO_x emissions. In the further emissions decrease in years 2002 and 2003 participated the denitrification process (power plant Vojany). In 2006 NO_x emissions decreased mainly at large and middle stationary sources. This decline is related to the reduction of production (power plants in Zemianske Kostoľany and Vojany) and consumption of solid fuel (since 2007 each year significantly reduces the consumption of anthracite, a downward trend has the consumption of Polish coal too) and natural gas (power plants in Zemianske Kostoľany, Slovak Gas Industry Ltd. Nitra). Significant decline of NO_x emissions was achieved in mobile sources, mainly in the road transport. This decrease is connected to the renovation of rolling stock in case of both passenger and good vehicles, and to the use of more accurate emission factor.

CO

The downward trend in CO emissions since 1990 has been caused mainly by the decrease in consumption and by the change of composition of fuel combusted by retail consumers. Carbon monoxide emissions from the large sources have been slightly decreasing as well. The iron and steel industry participate most significantly in the total CO emissions, therefore the emission trend is following the iron and steel production volume. The decrease in CO emissions since 1996 was due to the effects of policy and measures (determined on the results of measurements) to reduce CO emissions from the most significantly sources. The emission trend changes of CO within 1997 and 2003 is also affected by the quantity of pig iron production as well as the fuel consumption. In 2004 the CO emissions slightly increased mainly at large sources (the CO emissions specified by continuous measurement in U.S. Steel Ltd., Košice), since then the emissions have had only moderately decreasing trend. In 2005 the decrease of CO emissions was announced at large sources too, mainly as a consequence of agglomerate production cutting down in U.S. Steel Ltd., Košice and by the implementation of a new technology with effective combustion at lime production (Dolvap Ltd., Varín). Significant decrease (22%) in CO emissions of large sources in 2009 was mainly due to decrease in iron and steel production as a result of economic recession. Increase of CO emissions was achieved only in the sector of small sources (residential heating) and it is related to the increase of wood consumption caused by the increasing price of natural gas and coal. The emission decrease in the sector road transport is associated with onward renovation of rolling stock by the generationally new vehicles equipped by the three-way catalysts. Emissions in year 2010 increased (about to the level of year 2002) due to increased production of iron and steel in facility U.S. Steel s.r.o., Košice. In 2011 continues the increase of CO emissions due to an increase of agglomerate production in U.S. Steel Košice s.r.o, but is still under the emission level in 2004 and 2006, where emissions were the highest during the last decade.

EMISSIONS OF OTHER POLLUTANTS

The Slovak Republic is bound by the Convention on Long Range Transboundary Air Pollution (1979) to provide inventory of the selected pollutants. The emission inventories of non-methane volatile organic compounds (NMVOC), heavy metals (HMs), persistent organic pollutants (POPs) and particulate matter with aerodynamic diameter less than 10 or 2.5 µm (PM_{10} and $PM_{2.5}$) are processed in accordance with the international methodology using the NFR09 nomenclature and recommendations of TFEIP working groups. Emissions at national level are estimated in cooperation with the external experts and balanced on the base of activity data multiplied by the emission factors. Estimated emissions of pollutants mentioned above as well as the other basic pollutants are transformed into the international NFR system according to the requirements for reporting and annually reported to the UNECE secretariat and EEA by the Ministry of Environment of the SR.

NMVOC

Emission inventory of NMVOC is elaborated according to EMEP/EEA (Air Pollutant Emission Inventory Guidebook). In 2001 a new subsector road paving with asphalt was included in the national emission inventory and as a result of this the emissions increased adequately in individual years. In 2004 the emission factor from the mentioned sector was revalued and changed. The previous emission factor was based on the highest emission production. New emission factor respects the fact that asphalt mixture contains 5.5% of asphalt. The rest consists of aggregate. The combustion of wood was for the first time included in the residential sector in 2004. Emissions increased slightly in the mentioned sector. In the sector of fuel distribution, LPG distribution has been included since 2001.

The NMVOC emissions have decreased since 1990 according to the balance. This development was caused by the decreased consumption of solvent based paints and the gradual introduction of low solvent paint, broad introduction of measures in the crude oil processing and fuel distribution sectors as well as a change of fuels in the energy sector and alteration of the cars in favour of cars equipped with catalysts. The NMVOC emissions have increased in the sector of paints and glues by about 54% since 2000 because the paints and glues are used as part of a large spectrum of industrial activities and various technological operations. Continually the consumption and import of print's ink and solvent paints has increased, too. In years 2004 and 2005 occurred expansion in automotive industry in Slovakia, many of paint-shops was opened and so the consumption of paints has increased. Since 2007, entered into force Council Directive 1999/13/EC of 11 March 1999 with which operators had to adjust to emission limits. In 2007 was recalculated time series from sector dry cleaning and degreasing as a result of refinements counting solvent consumption in the use of paints and glues. In 2008, time series of land-filled and incinerated waste were recalculated on the basis of updated input data. Finally, emissions from road transport were recalculated in order to use an updated version of the model COPERT IV. In 2009 there was a decrease in NMVOC emissions associated with the decrease in industrial production. Emissions from road transport were recalculated until 2000, because of the use of a new version of the model COPERT IV in inventory. Due to updating of activity data, were emissions from waste sector for years 2008, 2005, 2004 and 2002 recalculated. Decreasing trend of NMVOC emissions is continuing to the year 2010. The most significant decline was in solvents consumption in sector degreasing of metal surfaces and road transport.

POPs

Emission inventory of persistent organic pollutants (POPs) is processed according to the methodology, elaborated in the frame of the project Initial Assistance to the Slovak Republic in Meeting Its Obligations Under the Stockholm Convention on Persistent Organic Pollutants, and updated according to the UNEP [5] and methodologies used in the Czech Republic and Poland. Emissions of polychlorinated dioxins and furans (PCDD/F) and polycyclic aromatic hydrocarbons (PAH) from road transport were recalculated by model COPERT IV.

Emissions of POPs from sector energy and waste incineration was recalculated in 2012. Downward trend of POPs emissions to the air proved to be most remarkable in the area of PAH emissions in the 90-ties, when it was caused mostly by the change of aluminium production technology (use of pre-baked anodes) (Tab. 4.8, Fig. 4.5). Increased emissions of polychlorinated biphenyls (PCB) were influenced by the increase of consumption in crude oil in the road transport and using wood in the residential sector. Increased consumption of wood in this sector influenced also total emission of PAHs. Emissions of PCDD/F have declined since 2000 because of reconstruction of some technologies (for example municipal and industrial waste incinerators). Total emissions PCDD/F depend on waste incineration, iron ore agglomeration and domestic heating., Variations in PCB and PAH emissions are given by variations of fuel consumption in road transport sector. HCB emissions are influenced by production of secondary copper and cement.

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

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

PM_{10}, $PM_{2,5}$ Emissions of PM_{10} and $PM_{2.5}$ have been processed annually on the base of requirements of EMEP/EEA (Air Pollutant Emission Inventory Guidebook), starting from the base year 2000. Emissions of PM_{10} and $PM_{2.5}$ are estimated based on the amount of TSP from database NEIS and they are calculated according to the IIASA methodology. Emissions from the road transport are calculated by the COPERT IV[2] model. The most important contribution to emissions of PM_{10} and $PM_{2.5}$ in the sector of road transport is from diesel engines; the contribution of abrasion to emission of PM_{10} and $PM_{2.5}$ is less important than in total PM (Tab. 4.2 a, b). The most important contribution to total emissions of PM_{10} and $PM_{2.5}$ can be found in the residential sector, increased emissions in this sector are caused by the increased consumption in wood as a consequence of increased price of natural gas and coal. (Tab. 4.9, Fig. 4.6).

Calculation of emissions PM_{10} and $PM_{2.5}$ was elaborated using default indicators. Considering the fact that on the EU level are studies to determine the emission ceilings in Member States in accordance with GAINS [6] model (IIASA), the SR has decided to establish new methodology of emission estimation for PM_{10} and $PM_{2.5}$ in accordance with the GAINS model (input data, emission factors). GAINS model uses the data aggregated from energy balance of the SR from Slovak Statistical Office; whereas country specific methodology uses the input data from NEIS database. The estimated emissions of PM_{10} and $PM_{2.5}$ by country specific methodology are fully consistent with TSP emissions. This is a basic requirement for estimation of emission projections. The whole calculation is already programmed in NEIS database.

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

Share of individual sectors in total emissions of the Slovak Republic in 2011

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

Most important sources of air pollution in the Slovak Republic in 2011

Table 4.4 introduces twenty the most important air pollution sources in the SR. The share of these sources in the total air emissions of the SR varies from 72.35% to 97.48%. Table 4.5 lists top ten sources in administrative regions according to the amount of emissions of basic pollutants.

Specific territorial emissions in 2011

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

4.3 VERIFICATION OF THE RESULTS

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

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

Note: The inventory results of the basic pollutants emitted in year N are completed to the 30th October (N+1) and the inventory results of the other pollutants emitted in year N are completed to the 15th February (N+2).

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

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

EAPSI 1–3 – stationary sources *EAPSI 4 – mobile sources (road and other transport)*

[1] *data based on expert estimate* [2] *the 1996 data*

Tab. 4.1b **Emissions of basic pollutants [thous. t] in the SR within 2000 – 2011**

			2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
PM	Stationary sources – NEIS	LS [1]	29.923	29.722	25.037	20.166	17.670	18.719	13.992	6.020	5.406	4.966	4.936	5.139
		MS [1]	4.958	4.405	3.767	3.259	2.748	2.392	2.281	1.979	1.764	1.554	1.474	1.404
		SS [2]	19.877	20.550	17.217	18.300	21.504	28.709	26.980	26.821	26.921	27.083	26.214	28.507
	Mobile sources	RT	1.834	2.036	2.212	2.225	2.375	2.849	2.610	3.074	2.791	2.470	2.745	2.682
		OT	0.399	0.404	0.366	0.329	0.343	0.359	0.336	0.353	0.325	0.295	0.384	0.195
	Total		56.991	57.117	48.599	44.279	44.640	53.028	46.199	38.247	37.207	36.368	35.753	37.927
SO_2	Stationary sources – NEIS	LS [1]	101.956	109.822	91.461	95.283	87.932	81.592	80.104	64.974	64.059	59.739	64.798	64.321
		MS [1]	8.083	6.655	3.964	3.620	2.652	2.107	1.902	1.598	1.246	0.991	0.906	0.839
		SS [2]	16.055	13.764	7.127	6.384	5.381	5.073	5.524	3.735	3.844	3.116	3.424	3.102
	Mobile sources	RT	0.670	0.675	0.730	0.150	0.159	0.189	0.177	0.204	0.210	0.194	0.211	0.204
		OT	0.189	0.194	0.064	0.059	0.063	0.047	0.044	0.047	0.045	0.041	0.054	0.017
	Total		126.953	131.110	103.346	105.496	96.187	89.008	87.751	70.558	69.404	64.081	69.393	68.483
NO_x	Stationary sources – NEIS	LS [1]	54.484	51.653	46.412	44.605	44.244	42.424	39.038	35.762	34.488	31.333	31.466	31.199
		MS [1]	8.052	7.751	6.356	6.620	4.926	4.377	4.992	3.542	3.575	3.389	3.485	3.716
		SS [2]	7.993	8.391	7.137	7.356	7.582	8.866	8.336	7.819	7.979	7.990	8.076	8.215
	Mobile sources	RT	32.027	35.072	35.495	34.914	37.794	41.473	39.561	43.838	43.249	37.638	40.510	37.773
		OT	4.860	4.899	4.808	4.305	4.506	4.723	4.427	4.654	4.568	3.854	5.058	4.108
	Total		107.416	107.766	100.208	97.800	99.052	101.863	96.354	95.615	93.859	84.204	88.595	85.011
CO	Stationary sources – NEIS	LS [1]	120.609	115.177	122.225	141.047	147.317	133.787	147.318	141.062	136.530	106.635	125.475	136.615
		MS [1]	10.779	10.280	9.150	9.394	7.531	5.853	5.350	5.330	4.518	4.104	4.446	4.680
		SS [2]	53.792	50.178	33.815	33.811	34.753	41.766	40.882	37.018	37.367	36.181	35.953	37.710
	Mobile sources	RT	113.171	127.348	123.273	106.268	101.161	89.077	77.516	59.244	65.068	59.568	53.489	46.880
		OT	1.719	1.626	1.591	1.463	1.509	1.566	1.452	1.533	1.446	1.360	1.542	1.277
	Total		300.070	304.609	290.054	291.983	292.271	272.049	272.518	244.187	244.929	207.848	220.905	227.162

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

[1] *According to the Decree of MPŽPaRR SR No. 356/2010 Coll.*

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

Emissions from road transport estimated to January 31st 2013, emissions from other sectors to November 15th 2012.

Tab. 4.2a **Emissions of PM [t] from road transport in the SR within 1990 – 2011**

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Emissions from diesel engine	2 221	1 826	1 571	1 417	1 452	1 501	1 413	1 338	1 362	1 228	955
Emissions from diesel engine	116	107	91	94	99	96	90	73	75	50	42
Emissions from LPG engine	0	0	0	0	0	0	0	0	0	0	1
Emissions from CNG engine	0	0	0	0	0	0	0	0	0	0	0
Total emissions from exhaust	2 337	1 932	1 662	1 511	1 551	1 597	1 503	1 411	1 437	1 278	998
Abrasion emissions	1 031	848	778	764	833	900	929	979	1 013	987	836
Total	3 368	2 780	2 440	2 276	2 385	2 497	2 432	2 389	2 451	2 265	1 834

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Emissions from diesel engine	1 025	1 182	1 150	1 253	1 488	1 305	1 606	1 261	1 060	1 223	1197
Emissions from diesel engine	51	48	44	40	44	37	36	36	28	24	23
Emissions from LPG engine	1	1	1	1	1	1	1	1	1	1	1
Emissions from CNG engine	0	0	0	0	0	0	0	0	0	0	0
Total emissions from exhaust	1 077	1 231	1 196	1 294	1 533	1 343	1 643	1 299	1 089	1 248	1221
Abrasion emissions	959	982	1 029	1 081	1 315	1 267	1 431	1 493	1 381	1 497	1461
Total	2 036	2 212	2 225	2 375	2 849	2 610	3 074	2 791	2 470	2 745	2682

Tab. 4.2b **Emissions of PM_{10} and $PM_{2,5}$ [t] from road transport in the SR within 2000 – 2011**

	2000		2001		2002		2003		2004		2005	
	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	955	955	1 025	1 025	1 182	1 182	1 150	1 150	1 253	1 253	1 488	1 488
Emissions from petrol engines	42	42	51	51	48	48	44	44	40	40	44	44
Total emissions from exhaust	998	998	1 076	1 076	1 229	1 229	1 194	1 194	1 292	1 292	1 532	1 532
Abrasion emissions	559	298	637	340	655	349	676	361	711	379	866	462
Total	1 556	1 296	1 713	1 416	1 884	1 578	1 870	1 555	2 003	1 672	2 398	1 994

	2006		2007		2008		2009		2010		2011	
	PM_{10}	$PM_{2,5}$	PM_{10}	$PM_{2,5}$	PM_{10}	$PM_{2,5}$	PM_{10}	$PM_{2,5}$	PM_{10}	$PM_{2,5}$	$PM_{2,5}$	PM_{10}
Emissions from diesel engines	1 305	1 305	1 606	1 606	1 261	1 261	1 060	1 060	1 223	1 223	1 197	1 197
Emissions from petrol engines	37	37	36	36	36	36	28	28	24	24	23	23
Total emissions from exhaust	1 342	1 342	1 642	1 642	1 297	1 297	1 088	1 088	1 247	1 247	1 220	1 220
Abrasion emissions	821	437	909	485	976	521	876	470	948	506	928	496
Total	2 163	1 779	2 551	2 127	2 273	1 818	1 965	1 558	2 195	1 753	2 148	1 716

Emissions estimated to January 30st, 2013

Fig. 4.1 **Development trends in basic pollutant emissions within 1990 – 2011**

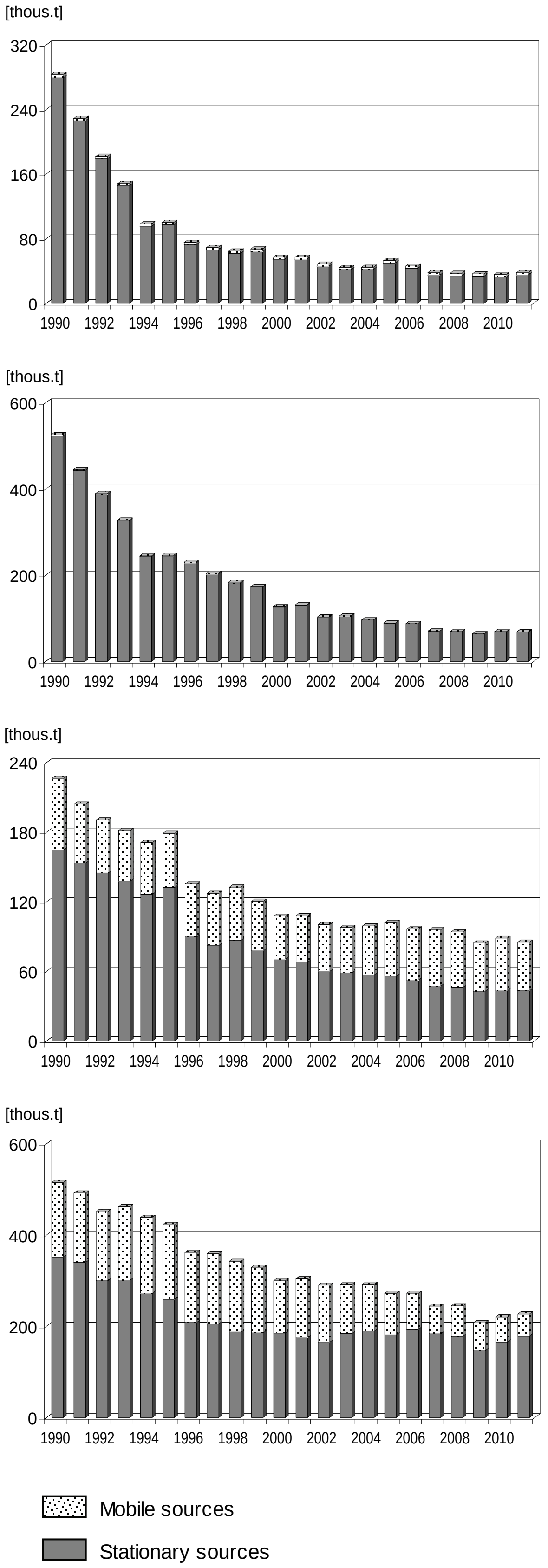
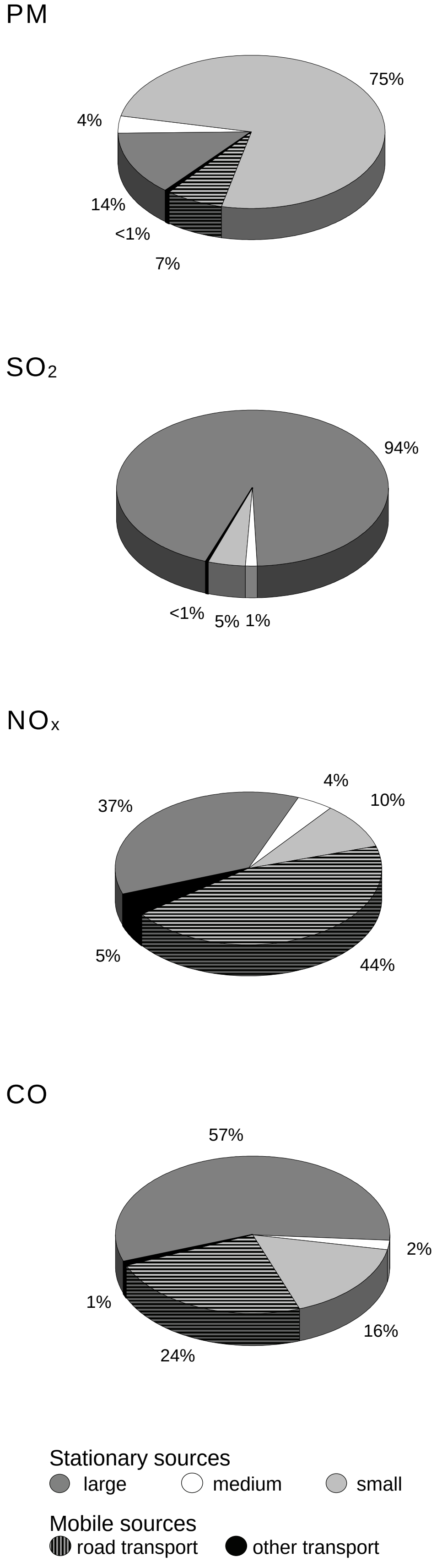


Fig. 4.2 **Emissions of basic pollutants in 2011**



Tab. 4.3 **Stationary source emissions of basic pollutants [t] in agglomerations and zones* within 2000 – 2010**

PM		2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Agglo-meration	Bratislava	942	477	444	484	470	472	430	353	339	332	327	309
	Košice	15758	17173	14601	9890	6807	4362	4107	3418	3056	3009	3245	3268
Zone	Bratislava region	501	546	493	466	457	506	452	469	477	469	447	482
	Trnava region	1518	1518	1284	1325	1522	1935	1825	1752	1770	1755	1742	1902
	Trenčín region	4607	4820	4199	4331	4804	5280	4712	4464	4312	4145	3843	4197
	Nitra region	3057	2921	2476	2474	2740	3414	3144	3074	3053	2991	2896	3194
	Žilina region	6585	6271	5298	5344	5852	7076	6540	6443	6459	6447	6238	6831
	Banská Bystrica reg.	6320	6355	5334	5346	5820	7378	6710	6579	6566	6497	6328	6772
	Prešov region	4207	4266	3491	3667	4588	5556	5158	4606	4514	4608	4345	4671
	Košice region	11262	10331	8400	8398	8862	13842	10176	3663	3545	3349	3213	3422
Total		54758	54677	46022	41725	41922	49820	43254	34820	34090	33603	32625	35050

SO_2		2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Agglo-meration	Bratislava	13240	13594	11348	12263	9869	9285	11764	8648	8302	9265	10276	7422
	Košice	18307	12607	10500	10781	13113	12526	11417	10307	9910	9087	9671	9247
Zone	Bratislava region	384	380	208	150	290	377	207	176	169	178	160	191
	Trnava region	2160	2051	1166	1077	1141	1037	1039	566	566	423	472	494
	Trenčín region	28625	45187	38305	46051	44108	40937	39659	33450	36114	33251	37232	40144
	Nitra region	4752	4749	3799	3648	2485	2336	2367	1158	1134	1066	532	382
	Žilina region	10775	10237	7140	7647	6147	5035	4444	3751	3693	3384	2949	2606
	Banská Bystrica reg.	10654	10043	8814	7983	6300	6197	6791	5022	4724	4119	4157	4978
	Prešov region	8372	8082	6320	6719	4864	4856	4204	3407	1811	1945	2474	1487
	Košice region	28825	23310	14952	8969	7649	6185	5639	3823	2727	1128	1203	1310
Total		126094	130242	102552	105287	95966	88772	87530	70307	69149	63847	69127	68262

NO_x		2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Agglo-meration	Bratislava	6393	5151	5313	5462	5318	4791	4521	4110	4112	4142	4126	3710
	Košice	12382	12172	12140	12355	11107	10929	12222	9975	8665	8167	9323	7883
Zone	Bratislava region	1792	1900	1972	1602	1670	1742	1700	1882	1874	1739	1437	1712
	Trnava region	2012	1966	1684	1675	1644	1667	1608	1470	1563	1381	1487	1774
	Trenčín region	9083	10489	9616	10167	9677	7822	7835	7219	7588	7328	6892	7639
	Nitra region	3905	3974	3843	3921	4356	3989	3653	2979	3465	3220	2603	3003
	Žilina region	5433	5170	4599	4491	4709	4674	4479	4550	4397	4256	4757	4964
	Banská Bystrica reg.	6541	6666	6316	5840	6160	6281	5522	5550	5699	4465	5399	5840
	Prešov region	3279	3443	3212	3244	3168	3459	3284	2849	2490	2781	2785	2500
	Košice region	19710	16864	11209	9825	8943	10314	7543	6538	6189	5233	4217	4105
Total		70530	67794	59905	58581	56752	55666	52366	47122	46042	42712	43027	43130

CO		2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Agglo-meration	Bratislava	1528	1319	1264	1224	1277	1120	1065	879	821	837	824	868
	Košice	84544	78619	83700	104605	107218	93197	109060	102663	94378	68477	88292	101053
Zone	Bratislava region	1951	1638	1488	2794	1775	1576	1901	2020	2661	3520	3250	3037
	Trnava region	4746	4682	3591	3399	3493	3865	3563	3459	3306	2627	2728	2967
	Trenčín region	11684	10334	7815	7789	8036	9331	10854	9430	10043	10481	11476	11151
	Nitra region	7964	7379	5470	5586	5672	6627	6459	5690	6849	6385	6185	6283
	Žilina region	19357	19287	16520	16462	17257	15924	14990	14686	14210	11573	12059	12370
	Banská Bystrica reg.	26309	26301	24299	25727	27840	29375	26835	27382	29303	27604	25728	26445
	Prešov region	12170	11838	9075	8804	8800	9282	8714	7522	7080	7042	6795	7010
	Košice region	14927	14237	11969	7862	8232	11109	10108	9680	9764	8374	8536	7820
Total		185180	175636	165191	184252	189601	181407	193550	183410	178415	146920	165874	179005

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

Tab. 4.4 **The most important air pollution sources in the SR and their share in the emissions of pollutants (NEIS – large and middle sources*) in 2011**

	PM		SO_2		NO_x		CO	
	Operator	[%]	Operator	[%]	Operator	[%]	Operator	[%]
1	U.S. Steel, s.r.o., Košice	44.67	SE, a.s., Bratislava, o.z., ENO Zem. Kostoľany	60.69	U.S. Steel, s.r.o., Košice	16.31	U.S. Steel, s.r.o., Košice	70.71
2	SE, a.s., Bratislava, o.z., ENO Zem. Kostoľany	6.31	U.S. Steel, s.r.o., Košice	11.76	SE, a.s., Bratislava, o.z., ENO Zem. Kostoľany	12.10	Slovalco, a.s., Žiar nad Hronom	9.59
3	Mondi scp, a.s., Ružomberok	3.86	CM European power Slovakia, s.r.o., Bratislava	8.64	Tepláreň Košice, a.s.	4.47	CEMMAC, a.s., Horné Srnie	1.98
4	Carmeuse Slovakia s.r.o., závod Košice	2.58	Slovalco, a.s., Žiar nad Hronom	3.42	CM European power Slovakia, s.r.o., Bratislava	3.85	KOVOHUTY, a.s., Krompachy	1.91
5	Duslo a.s., Šaľa	2.48	SLOVNAFT, a.s., Bratislava	2.43	Mondi scp, a.s., Ružomberok	3.59	Považská cementáreň, a.s., Ladce	1.55
6	Považská cementáreň, a.s., Ladce	1.64	Tepláreň Košice, a.s.	2.12	Slovenské magnezitové závody, a.s., Jelšava	3.47	Slovenské magnezitové závody, a.s., Jelšava	1.43
7	Carmeuse Slovakia, s.r.o., závod Včeláre	1.60	Zvolenská teplárenská, a.s., Zvolen	1.53	Holcim (Slovensko), a.s., Rohožník	3.41	Holcim (Slovensko), a.s., Rohožník	1.37
8	Novácke chemické závody, a.s., Nováky	1.59	Martinská teplárenská, a.s., Martin	1.01	V.S.H., a.s., Turňa nad Bodvou	2.57	CALMIT spol. s r.o. Bratislava, prev. Žirany	1.17
9	Tepláreň Košice, a.s.,	1.37	BUKÓZA ENERGO, a.s., Vranov nad Topľou	1.00	Považská cementáreň, a.s., Ladce	2.54	DOLVAP, s.r.o., Varín	1.06
10	CM European power Slovakia, s.r.o., Bratislava	1.22	SE, a.s., Bratislava, Elektráreň Vojany I a II	0.97	SLOVNAFT, a.s., Bratislava	2.22	OFZ, a.s., Istebné	0.81
11	Slovalco, a.s., Žiar nad Hronom	1.17	Žilinská teplárenská, a.s., Žilina	0.94	Duslo, a.s., Šaľa	2.10	Calmit, s.r.o., Bratislava, prev. Tisovec	0.59
12	Knauf Insulation, s.r.o., Nová Baňa	1.04	Dalkia Industry Žiar nad Hronom, a.s., Žiar n/H	0.69	OFZ, a.s., Istebné	2.00	Slovenské magnezitové závody, a.s., závod	0.42
13	DOLVAP, s.r.o., Varín	0.82	Knauf Insulation, s.r.o., Nová Baňa	0.41	eustream, a.s., prev. Veľké Kapušany	1.92	SE, a.s., Bratislava, o.z., ENO Zem. Kostoľany	0.34
14	SE, a.s., Bratislava, Elektráreň Vojany I a II	0.57	Mondi scp, a.s., Ružomberok	0.33	eustream, a.s., prev. Veľké Zlievce	1.90	Mondi scp, a.s., Ružomberok	0.32
15	BUKOCEL, a.s., Hencovce	0.57	TP 2, s.r.o., STRÁŽSKE	0.28	SE, a.s., Bratislava, Elektráreň Vojany I a II	1.80	SLOVNAFT, a.s., Bratislava	0.30
16	VOLKSWAGEN SLOVAKIA, a.s., Bratislava	0.51	Duslo, a.s., odštepný závod ISTROCHEM	0.28	CEMMAC, a.s., Horné Srnie	1.79	SE, a.s., Bratislava, Elektráreň Vojany I a II	0.25
17	SLOVNAFT, a.s., Bratislava	0.50	OFZ, a.s., Istebné	0.27	eustream, a.s., prev. Ivanka pri Nitre	1.76	BUKOCEL, a.s., Hencovce	0.25
18	Zvolenská teplárenská, a.s., Zvolen	0.48	Slovenské cukrovary, a.s., Sereď	0.27	eustream, a.s., prev. Jablonov nad Turňou	1.58	Carmeuse Slovakia, s.r.o., závod Košice	0.24
19	Amylum Slovakia, s.r.o., Boleráz	0.44	CHEMES, a.s., HUMENNÉ	0.22	Slovalco, a.s., Žiar nad Hronom	1.58	Železiarne Podbrezová, a.s.	0.21
20	Holcim (Slovensko), a.s., Rohožník	0.41	Slovenské magnezitové závody, a.s., závod	0.21	Žilinská teplárenská, a.s., Žilina	1.39	Slovmag, a.s., Lubeník	0.21
Sum		73.82		97.48		72.35		94.70

** According to the Decree of MŽP SR No. 356/2010 Coll.*

Tab. 4.5 **Sequence of the sources within the region according to the emissions in 2011 (NEIS – large and middle sources*)**

BRATISLAVA REGION

	PM		SO_2	
	Source	District	Source	District
1.	CM European power Slovakia, s.r.o., Bratislava	Bratislava II	CM European power Slovakia, s.r.o., Bratislava	Bratislava II
2.	VOLKSWAGEN SLOVAKIA, a.s., Bratislava	Bratislava IV	SLOVNAFT, a.s., Bratislava	Bratislava II
3.	SLOVNAFT, a.s., Bratislava	Bratislava II	Duslo, a.s. odštepný závod ISTROCHEM Bratislava	Bratislava III
4.	Holcim (Slovensko), a.s., Rohožník	Malacky	Holcim (Slovensko), a.s., Rohožník	Malacky
5.	Swedspan Slovakia, s.r.o., Malacky	Malacky	MO SR, PSB Bratislava, kotolne Viničné a Sl. Grob	Pezinok
6.	Slovnaft Petrochemicals, s.r.o., Bratislava	Bratislava II	Slovnaft Petrochemicals, s.r.o., Bratislava	Bratislava II
7.	PPC POWER, a.s., Bratislava	Bratislava III	Odvoz a likvidácia odpadu, a.s., Bratislava	Bratislava II
8.	Termming, a. s. Bratislava	Bratislava II	Univolt-Remat, s.r.o., Pezinok	Pezinok
9.	Obec Rohožník	Malacky	NAFTA, a.s., Gbely	Malacky
10.	MO SR, PSB Bratislava, kotolne Viničné a Sl. Grob	Pezinok	Swedspan Slovakia, s.r.o., Malacky	Malacky
	NO_x		CO	
	Source	District	Source	District
1.	CM European power Slovakia, s.r.o., Bratislava	Bratislava II	Holcim (Slovensko), a.s., Rohožník	Malacky
2.	Holcim (Slovensko), a.s., Rohožník	Malacky	SLOVNAFT, a.s., Bratislava	Bratislava II
3.	SLOVNAFT, a.s., Bratislava	Bratislava II	Swedspan Slovakia, s.r.o., Malacky	Malacky
4.	PPC POWER, a.s., Bratislava	Bratislava III	Termming, a.s., Bratislava, Malacky	Malacky
5.	Slovnaft Petrochemicals, s.r.o., Bratislava	Bratislava II	VOLKSWAGEN SLOVAKIA, a.s., Bratislava	Bratislava IV
6.	Swedspan Slovakia, s.r.o., Malacky	Malacky	NAFTA, a.s., Gbely	Malacky
7.	VOLKSWAGEN SLOVAKIA, a.s., Bratislava	Bratislava IV	Slovnaft Petrochemicals, s.r.o., Bratislava	Bratislava II
8.	Odvoz a likvidácia odpadu, a.s., Bratislava	Bratislava II	Obec Rohožník	Malacky
9.	Dalkia, a.s., Bratislava, zdroje v okrese BA 5	Bratislava V	P.F.A., s.r.o., Lozorno	Malacky
10.	Bratislavská teplárenská, a.s., Bratislava, Tepl. západ	Bratislava IV	MO SR, PSB Bratislava, kotolne Viničné a Sl. Grob	Pezinok

TRNAVA REGION

	PM		SO_2	
	Source	District	Source	District
1.	Amylum Slovakia spol. s r.o., Boleráz	Trnava	Slovenské cukrovary, a.s., Sereď	Galanta
2.	RaVOD Pata roľnícke a výrobnoobchodné družstvo	Galanta	Johns Manville Slovakia, a.s., Trnava	Trnava
3.	E.ON Elektrárne, s.r.o., Trakovice	Hlohovec	Zlieváreň Trnava, s.r.o.	Trnava
4.	Agropodnik, a.s., Trnava Lehnice	Dunajská Streda	Mach-Trade, s.r.o., Sereď	Galanta
5.	Slovenské cukrovary, a.s., Sereď	Galanta	Baňa Čáry, a.s., Čáry	Senica
6.	Johns Manville Slovakia, a.s., Trnava	Trnava	RUPOS, s.r.o., Ružindol	Trnava
7.	Zlieváreň Trnava, s.r.o.	Trnava	Optimize Roi, s.r.o., Čiližská Radvaň	Dunajská Streda
8.	PENAM, a.s., Nitra, prev. Trnava	Trnava	PD Siladice	Hlohovec
9.	AGROPODNIK, a.s., Trnava	Trnava	ITOP, s.r.o., Veľký Meder	Dunajská Streda
10.	AGROPODNIK, a.s., Trnava, prev. Senica	Senica	ENVIRAL, a.s., Leopoldov	Hlohovec
	NO_x		CO	
	Source	District	Source	District
1.	E.ON Elektrárne, s.r.o., Trakovice	Hlohovec	Službyt, s.r.o., Senica	Senica
2.	Slovenské cukrovary, a.s., Sereď	Galanta	E.ON Elektrárne, s.r.o., Trakovice	Hlohovec
3.	Johns Manville Slovakia, a.s., Trnava	Trnava	I.D.C. Holding, a.s., Pečivárne Sereď	Galanta
4.	ENVIRAL, a.s., Leopoldov	Hlohovec	Swedwood Slovakia, s.r.o., OZ Malacky prev. Trnava	Trnava
5.	Amylum Slovakia spol. s r.o., Boleráz	Trnava	Zlieváreň Trnava, s.r.o.	Trnava
6.	Službyt, s.r.o., Senica	Senica	Slovasfalt Bratislava, obaľ. Moravský Sv. Ján	Senica
7.	Swedwood Slovakia, s.r.o., OZ Malacky prev. Trnava	Trnava	ENVIRAL, a.s., Leopoldov	Hlohovec
8.	Zlieváreň Trnava, s.r.o.	Trnava	Slovenské cukrovary, a.s., Sereď	Galanta
9.	Mach-Trade, s.r.o., Sereď	Galanta	Amylum Slovakia, spol. s r.o., Boleráz	Trnava
10.	BEKAERT Hlohovec, a.s.	Hlohovec	Johns Manville Slovakia, a.s., Trnava	Trnava

NITRA REGION

	PM		SO_2	
	Source	District	Source	District
1.	Duslo, a.s., Šaľa	Šaľa	Icopal, a.s., Štúrovo	Nové Zámky
2.	BYTREAL Tlmače, s.r.o., Tlmače	Levice	BYTREAL Tlmače, s.r.o., Tlmače	Levice
3.	Prvá energetická a teplárenská spoločnosť, s.r.o.,	Zlaté Moravce	Liaharenský podnik Nitra, a.s., Veľký Ďur	Levice
4.	P.G.TRADE spol. s r.o., Komárno, zdroje v okrese	Nové Zámky	Bioplyn Cetín, s.r.o., Malý Cetín	Nitra
5.	PPC ČAB akciová spoločnosť Nové Sady	Nitra	CALMIT, spol. s r.o., Bratislava, prev. Žirany	Nitra
6.	SES, a.s., Tlmače	Levice	EMGO Slovakia, s.r.o., Nové Zámky	Nové Zámky
7.	Slovintegra Energy, s.r.o., Levice	Levice	MO SR, Stredisko prevádzky objektov Nitra	Nitra
8.	ACHP Levice, a.s., Levice	Nitra	ELEKTROKARBON, a.s., Topoľčany	Topoľčany
9.	PALMA Group, a.s., Levice	Levice	Duslo, a.s., Šaľa	Šaľa
10.	Lencos, s.r.o., Levice	Levice	Základná škola s VJM a MŠ Salka	Nové Zámky
	NO_x		CO	
	Source	District	Source	District
1.	Duslo, a.s., Šaľa	Šaľa	CALMIT spol. s r.o., Bratislava, prev. Žirany	Nitra
2.	eustream, a.s., prev. Ivanka pri Nitre	Nitra	Duslo, a.s., Šaľa	Šaľa
3.	Slovintegra Energy, s.r.o., Levice	Levice	Slovintegra Energy, s.r.o., Levice	Levice
4.	BIOENERGY TOPOĽČANY, s.r.o.,	Topoľčany	Bytkomfort, s.r.o., Nové Zámky	Nové Zámky
5.	Bytkomfort, s.r.o., Nové Zámky	Nové Zámky	Wienerberger Slov. tehelne spol. s r. o., Zl. Moravce	Zlaté Moravce
6.	SES, a.s., Tlmače	Levice	EUROVIA SK, a.s., Beladice	Zlaté Moravce
7.	Nitrianska teplárenská spoločnosť, a.s., Nitra	Nitra	eustream, a.s., prev. Ivanka pri Nitre	Nitra
8.	COM-therm, s.r.o., Komárno	Komárno	SECOP, s.r.o., Zlaté Moravce	Zlaté Moravce
9.	OPM2SR, s.r.o., Nitra	Nitra	Liaharenský podnik Nitra, a.s., Veľký Ďur	Levice
10.	DECODOM, s.r.o., Topoľčany	Topoľčany	BIOENERGY TOPOĽČANY, s.r.o.,	Topoľčany

TRENČÍN REGION

	PM		SO_2	
	Source	District	Source	District
1.	SE, a.s., Bratislava, o.z. ENO Zem. Kostoľany	Prievidza	SE, a.s., Bratislava, o.z. ENO Zem. Kostoľany	Prievidza
2.	Považská cementáreň, a.s., Ladce	Ilava	VETROPACK NEMŠOVÁ, s.r.o.	Trenčín
3.	Novácke chemické závody, a.s., Nováky	Prievidza	Hornonitrianske bane Prievidza, a.s., zdroje v okrese	Prievidza
4.	Hornonitrianske bane Prievidza, a.s., zdroje v okrese	Prievidza	TEPLÁREŇ, a.s., Považská Bystrica	Považská Bystrica
5.	Kronotimber SK, s.r.o., Lehota pod Vtáčnikom	Prievidza	Služby pre bývanie, s.r.o., Trenčín	Trenčín
6.	TERMONOVA, a.s., Nová Dubnica	Ilava	Continental Matador Rubber, s.r.o., Púchov	Púchov
7.	Považský cukor, a.s., Trenčianska Teplá	Trenčín	Považská cementáreň, a.s., Ladce	Ilava
8.	CEMMAC, a.s., Horné Srnie	Trenčín	SlovZink, a.s., Košeca	Ilava
9.	KVARTET, a.s., Partizánske	Partizánske	PREFA - STAV, s.r.o., Podlužany	Bánovce n/B
10.	TEPLÁREŇ, a.s., Považská Bystrica	Považská Bystrica	Bioplyn Horovce, s.r.o.	Púchov
	NO_x		CO	
	Source	District	Source	District
1.	SE, a.s., Bratislava, o.z. ENO Zem. Kostoľany	Prievidza	CEMMAC, a.s., Horné Srnie	Trenčín
2.	Považská cementáreň, a.s., Ladce	Ilava	Považská cementáreň, a.s., Ladce	Ilava
3.	CEMMAC, a.s., Horné Srnie	Trenčín	SE, a.s., Bratislava, o.z. ENO Zem. Kostoľany	Prievidza
4.	RONA, a.s., Lednické Rovne	Púchov	Novácke chemické závody, a.s., Nováky	Prievidza
5.	VETROPACK NEMŠOVÁ, s.r.o.	Trenčín	Považský cukor, a.s., Trenčianska Teplá	Trenčín
6.	Novácke chemické závody, a.s., Nováky	Prievidza	TSM Partizánske, s.r.o.	Partizánske
7.	Continental Matador Rubber, s.r.o., Púchov	Púchov	TEPLÁREŇ, a.s., Považská Bystrica	Považská Bystrica
8.	TEPLÁREŇ, a.s., Považská Bystrica	Považská Bystrica	KVARTET, a.s., Partizánske	Partizánske
9.	TERMONOVA, a.s., Nová Dubnica	Ilava	PSL, a.s., Považská Bystrica	Považská Bystrica
10.	TSM Partizánske, s.r.o.	Partizánske	Služby pre bývanie, s.r.o., Trenčín	Trenčín

BANSKÁ BYSTRICA REGION

	PM		SO_2	
	Source	District	Source	District
1.	Slovalco, a.s., Žiar nad Hronom	Žiar nad Hronom	Slovalco, a.s., Žiar nad Hronom	Žiar nad Hronom
2.	Knauf Insulation, s.r.o., Nová Baňa	Žarnovica	Zvolenská teplárenská, a.s., Zvolen	Zvolen
3.	Zvolenská teplárenská, a.s., Zvolen	Zvolen	Dalkia Industry Žiar nad Hronom, a.s.	Žiar nad Hronom
4.	Dalkia Industry Žiar nad Hronom, a.s.	Žiar nad Hronom	Knauf Insulation, s.r.o., Nová Baňa	Žarnovica
5.	Slovmag, a.s., Lubeník	Revúca	Slovmag, a.s., Lubeník	Revúca
6.	Harmanec - Kuvert, s.r.o., Brezno	Brezno	Slovenské magnezitové závody, a.s., Jelšava	Revúca
7.	Slovenské magnezitové závody, a.s., Jelšava	Revúca	VUM, a.s., Žiar nad Hronom	Žiar nad Hronom
8.	PPS GROUP, a.s., Detva	Detva	Železiarne Podbrezová, a.s.	Brezno
9.	MO SR, PS budov Banská Bystrica	Brezno	Družstvo Agrospol, Lučenec	Lučenec
10.	Smrečina Hofatex, a.s., Banská Bystrica	Banská Bystrica	Baňa Dolina, a.s., Veľký Krtíš	Veľký Krtíš
	NO_x		CO	
	Source	District	Source	District
1.	Slovenské magnezitové závody, a.s., Jelšava	Revúca	Slovalco, a.s., Žiar nad Hronom	Žiar nad Hronom
2.	eustream, a.s., prev. Veľké Zlievce	Veľký Krtíš	Slovenské magnezitové závody, a.s., Jelšava	Revúca
3.	Slovalco, a.s., Žiar nad Hronom	Žiar nad Hronom	Calmit, spol. s r.o., prev. Tisovec	Rimavská Sobota
4.	Zvolenská teplárenská, a.s., Zvolen	Zvolen	Železiarne Podbrezová, a.s.	Brezno
5.	Dalkia Industry Žiar nad Hronom, a.s.	Žiar nad Hronom	Slovmag, a.s., Lubeník	Revúca
6.	Smrečina Hofatex, a.s., Banská Bystrica	Banská Bystrica	VUM, a.s., Žiar nad Hronom	Žiar nad Hronom
7.	Slovmag, a.s., Lubeník	Revúca	Smrečina Hofatex, a.s., Banská Bystrica	Banská Bystrica
8.	Železiarne Podbrezová, a.s.	Brezno	Zvolenská teplárenská, a.s., Zvolen	Zvolen
9.	Bučina Zvolen, a.s.	Zvolen	Knauf Insulation, s.r.o., Nová Baňa	Žarnovica
10.	Calmit, spol. s r.o., prev. Tisovec	Rimavská Sobota	STEFE ECB, s.r.o., Rimavská Sobota	Rimavská Sobota

ŽILINA REGION

	PM		SO_2	
	Source	District	Source	District
1.	Mondi scp, a.s., Ružomberok	Ružomberok	Martinská teplárenská, a.s., Martin	Martin
2.	DOLVAP, s.r.o., Varín	Žilina	Žilinská teplárenská, a.s., Žilina	Žilina
3.	SOTE, s.r.o., Čadca	Čadca	Mondi scp, a.s., Ružomberok	Ružomberok
4.	Žilinská teplárenská, a.s., Žilina	Žilina	OFZ, a.s., Istebné	Dolný Kubín
5.	TEHOS, s.r.o., Dolný Kubín	Dolný Kubín	SOTE, s.r.o., Čadca	Čadca
6.	OFZ, a.s., Istebné	Dolný Kubín	ŽOS Vrútky, a.s.	Martin
7.	Martinská teplárenská, a.s., Martin	Martin	ZDROJ MT, s.r.o., Martin - Priekopa	Martin
8.	DOLKAM Šuja, a.s., Rajec	Žilina	RABČAN, s.r.o., Rabča	Námestovo
9.	AMICO DREVO, s.r.o., Oravský Podzámok	Dolný Kubín	DOLVAP, s.r.o., Varín	Žilina
10	KIA Motors Slovakia, s.r.o., Žilina	Žilina	AVEX electronics, s.r.o., prev. Oravská Lesná	Námestovo
	NO_x		CO	
	Source	District	Source	District
1.	Mondi scp, a.s., Ružomberok	Ružomberok	DOLVAP, s.r.o., Varín	Žilina
2.	OFZ, a.s., Istebné	Dolný Kubín	OFZ, a.s., Istebné	Dolný Kubín
3.	Žilinská teplárenská, a.s., Žilina	Žilina	Mondi scp, a.s., Ružomberok	Ružomberok
4.	Martinská teplárenská, a.s., Martin	Martin	LMT, a.s., Liptovský Mikuláš	Liptovský Mikuláš
5.	Specialty Minerals Slovakia, s.r.o., Ružomberok	Ružomberok	SOTE, s.r.o., Čadca	Čadca
6.	Rettenmeier Tatra Timber, s.r.o., Liptovský Hrádok	Liptovský Mikuláš	Swedwood Slovakia, s.r.o., prev. Závažná Poruba	Liptovský Mikuláš
7.	KIA Motors Slovakia, s.r.o., Žilina	Žilina	Rettenmeier Tatra Timber, s.r.o., Liptovský Hrádok	Liptovský Mikuláš
8.	LMT, a.s., Liptovský Mikuláš	Liptovský Mikuláš	Turzovská drevárska fabrika, s.r.o., Turzovka	Čadca
9.	TEHOS, s.r.o., Dolný Kubín	Dolný Kubín	ŽOS Vrútky, a.s.	Martin
10	SOTE, s.r.o., Čadca	Čadca	Žilinská teplárenská, a.s., Žilina	Žilina

PREŠOV REGION

	PM		SO_2	
	Source	District	Source	District
1.	BUKOCEL, a.s., Hencovce	Vranov n/Topľou	BUKÓZA ENERGO, a.s., Vranov nad Topľou	Vranov n/Topľou
2.	CHEMES, a.s., HUMENNÉ	Humenné	CHEMES, a.s., HUMENNÉ	Humenné
3.	BUKÓZA ENERGO, a.s., Vranov nad Topľou	Vranov n/Topľou	Energy Snina, a.s.	Snina
4.	BIOENERGY BARDEJOV, s.r.o., Bardejov	Bardejov	BUKOCEL, a.s., Hencovce	Vranov n/Topľou
5.	Zeocem Bystré, a.s.	Vranov n/Topľou	Zastrova, a.s., Spišská Stará Ves	Kežmarok
6.	TATRAVAGÓNKA, a.s., POPRAD	Poprad	Zeocem Bystré, a.s.	Vranov n/Topľou
7.	Kronospan SK, s.r.o., Prešov	Prešov	Roľnícke družstvo v Plavnici	Stará Ľubovňa
8.	Lesy Slovenskej republiky, o.z. Vranov n. Topľou	Vranov n/Topľou	ZŠ Malcov	Bardejov
9.	Legno Export spol., s r.o. Beňadikovce	Svidník	Základná škola s materskou školou KOŠAROVCE	Humenné
10	SCHULE SLOVAKIA, s.r.o., Poprad	Poprad	MO SR, Stredisko prevádzky objektov Prešov	Prešov
	NO_x		CO	
	Source	District	Source	District
1.	BUKÓZA ENERGO, a.s., Vranov nad Topľou	Vranov n/Topľou	BUKOCEL, a.s., Hencovce	Vranov n/Topľou
2.	CHEMES, a.s., HUMENNÉ	Humenné	Leier Baustoffe SK, s.r.o., Petrovany	Prešov
3.	BUKOCEL, a.s., Hencovce	Vranov n/Topľou	BIOENERGY BARDEJOV, s.r.o., Bardejov	Bardejov
4.	BIOENERGY BARDEJOV, s.r.o., Bardejov	Bardejov	BUKÓZA ENERGO, a.s., Vranov nad Topľou	Vranov n/Topľou
5.	Energy Snina, a.s.	Snina	CHEMES, a.s., HUMENNÉ	Humenné
6.	SPRAVBYTKOMFORT, a.s., Prešov	Prešov	SPRAVBYTKOMFORT, a.s., Prešov	Prešov
7.	DALKIA POPRAD, a.s.	Poprad	TENERGO BRNO, a.s., prev. Snina	Snina
8.	CHEMOSVIT ENERGOCHEM, a.s., SVIT	Poprad	Energy Snina, a.s.	Snina
9.	Kronospan SK, s.r.o., Prešov	Prešov	SCHULE SLOVAKIA, s.r.o., Poprad	Poprad
10	TATRAVAGÓNKA, a.s., POPRAD	Poprad	Spravbytherm, s.r.o., Kežmarok	Kežmarok

KOŠICE REGION

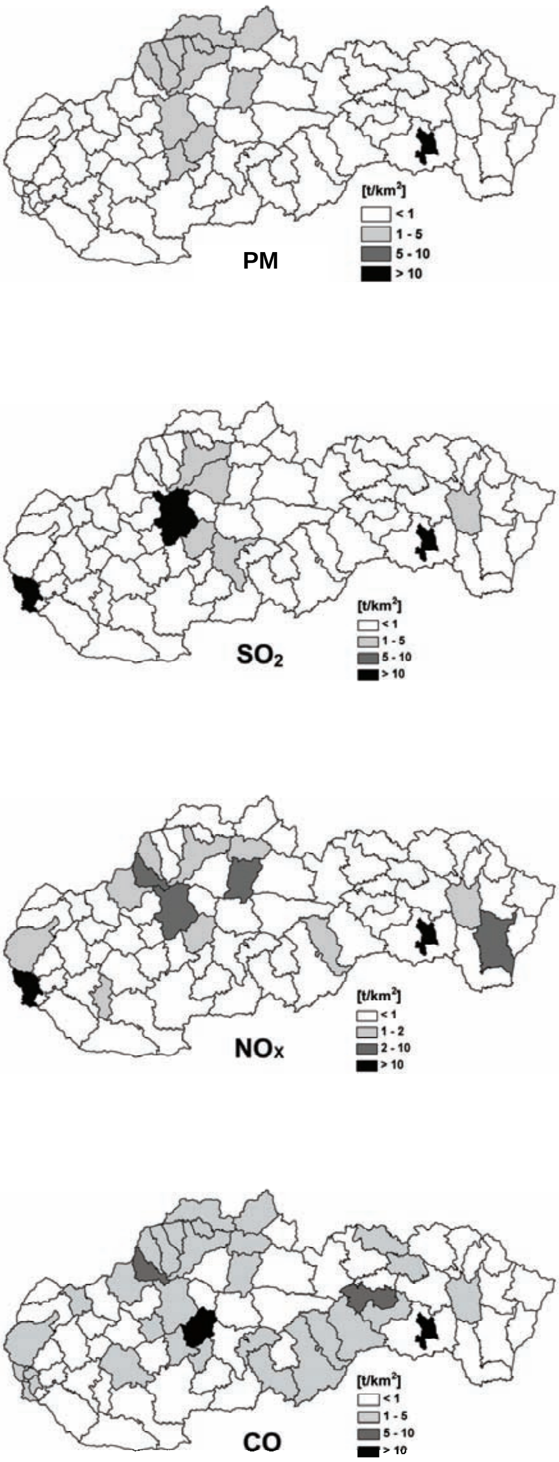
	PM		SO_2	
	Source	District	Source	District
1.	U.S. Steel, s.r.o., Košice	Košice II	U.S. Steel, s.r.o., Košice	Košice II
2.	Carmeuse Slovakia, s.r.o., závod Košice	Košice II	Tepláreň Košice, a.s.	Košice IV
3.	Carmeuse Slovakia, s.r.o., závod Včeláre	Košice - okolie	SE, a.s., Bratislava, Elektráreň Vojany I a II	Michalovce
4.	Tepláreň Košice, a.s.	Košice IV	TP 2, s.r.o., STRÁŽSKE	Michalovce
5.	SE, a.s., Bratislava, Elektráreň Vojany I a II	Michalovce	Slovenské magnezitové závody, a.s., závod Bočiar	Košice II
6.	V.S.H., a.s., Turňa nad Bodvou	Košice - okolie	KOVOHUTY, a.s., Krompachy	Spišská Nová Ves
7.	KOVOHUTY, a.s., Krompachy	Spišská Nová Ves	Refrako, s.r.o., Košice	Košice II
8.	Refrako, s.r.o., Košice	Košice II	eustream, a.s., prev. Jablonov nad Turňou	Rožňava
9.	VSK MINERAL, s.r.o., lom Spišská N. Ves	Spišská Nová Ves	Vulkmont Košice	Košice II
10	ŽSR Bratislava, zdroje v okrese Trebišov	Trebišov	V.S.H., a.s., Turňa nad Bodvou	Košice - okolie
	NO_x		CO	
	Source	District	Source	District
1.	U.S. Steel, s.r.o., Košice	Košice II	U.S. Steel, s.r.o., Košice	Košice II
2.	Tepláreň Košice, a.s.	Košice IV	KOVOHUTY, a.s., Krompachy	Spišská Nová Ves
3.	V.S.H., a.s Turňa nad Bodvou	Košice - okolie	Slovenské magnezitové závody, a.s., závod Bočiar	Košice II
4.	eustream, a.s., prev. Veľké Kapušany	Michalovce	SE, a.s., Bratislava, Elektráreň Vojany I a II	Michalovce
5.	SE, a.s., Bratislava, Elektráreň Vojany I a II	Michalovce	Carmeuse Slovakia, s.r.o., závod Košice	Košice II
6.	eustream, a.s., prev. Jablonov nad Turňou	Rožňava	HNOJIVÁ DUSLO, s.r.o., STRÁŽSKE	Michalovce
7.	Carmeuse Slovakia, s.r.o., závod Košice	Košice II	Tepláreň Košice, a.s.	Košice IV
8.	HNOJIVÁ DUSLO, s.r.o., STRÁŽSKE	Michalovce	eustream, a.s., prev. Veľké Kapušany	Michalovce
9.	TP 2, s.r.o., STRÁŽSKE	Michalovce	EMBRACO SLOVAKIA, s.r.o., Spišská Nová Ves	Spišská Nová Ves
10	KOSIT, a.s., Košice	Košice IV	TP 2, s.r.o., STRÁŽSKE	Michalovce

**According to the Decree of MPŽPaRR SR No. 356/2010 Coll.*

Tab. 4.6 **Stationary source emissions by districts in 2011**

District	Emissions [$t.year^{-1}$]				Specific territorial emis. [$t.year^{-1}.km^{-2}$]			
	PM	SO_2	NO_x	CO	PM	SO_2	NO_x	CO
1. Bratislava	309	7422	3710	868	0.84	20.17	10.08	2.36
2. Malacky	269	158	1527	2687	0.28	0.17	1.61	2.83
3. Pezinok	114	23	91	190	0.30	0.06	0.24	0.51
4. Senec	100	11	94	159	0.28	0.03	0.26	0.44
5. Dunajská Streda	402	47	215	550	0.37	0.04	0.20	0.51
6. Galanta	283	217	329	417	0.44	0.34	0.51	0.65
7. Hlohovec	141	19	432	295	0.53	0.07	1.62	1.11
8. Piešťany	228	25	118	319	0.60	0.06	0.31	0.84
9. Senica	341	44	162	676	0.50	0.07	0.24	0.99
10. Skalica	219	23	93	294	0.61	0.06	0.26	0.82
11. Trnava	287	119	424	414	0.39	0.16	0.57	0.56
12. Bánovce n/B	240	30	80	320	0.52	0.07	0.17	0.69
13. Ilava	352	36	1029	2527	0.98	0.10	2.88	7.06
14. Myjava	349	38	98	485	1.07	0.12	0.30	1.48
15. Nové Mesto n/V	326	35	135	442	0.56	0.06	0.23	0.76
16. Partizánske	165	24	105	391	0.55	0.08	0.35	1.30
17. Považská Bystrica	602	82	197	912	1.30	0.18	0.42	1.97
18. Prievidza	1257	39666	4561	1771	1.31	41.32	4.75	1.85
19. Púchov	522	74	436	696	1.39	0.20	1.16	1.86
20. Trenčín	384	160	999	3607	0.57	0.24	1.48	5.34
21. Komárno	415	44	218	583	0.38	0.04	0.20	0.53
22. Levice	1075	134	456	1522	0.69	0.09	0.29	0.98
23. Nitra	340	51	899	2185	0.39	0.06	1.03	2.51
24. Nové Zámky	608	87	293	902	0.45	0.06	0.22	0.67
25. Šaľa	298	15	819	296	0.84	0.04	2.30	0.83
26. Topoľčany	204	24	206	294	0.34	0.04	0.34	0.49
27. Zlaté Moravce	254	28	111	501	0.49	0.05	0.21	0.96
28. Bytča	408	45	110	541	1.45	0.16	0.39	1.92
29. Čadca	1221	246	329	1716	1.60	0.32	0.43	2.26
30. Dolný Kubín	354	211	817	1583	0.72	0.43	1.66	3.22
31. Kysucké Nové Mesto	261	27	98	346	1.50	0.16	0.57	1.99
32. Liptovský Mikuláš	625	72	362	1154	0.47	0.05	0.27	0.86
33. Martin	479	797	444	746	0.65	1.08	0.60	1.01
34. Námestovo	1193	156	272	1586	1.73	0.23	0.39	2.29
35. Ružomberok	944	293	1547	1378	1.46	0.45	2.39	2.13
36. Turčianske Teplice	217	26	56	286	0.55	0.07	0.14	0.73
37. Tvrdošín	186	20	72	245	0.39	0.04	0.15	0.51
38. Žilina	944	715	857	2788	1.16	0.88	1.05	3.42
39. Banská Bystrica	553	61	389	878	0.68	0.08	0.48	1.09
40. Banská Štiavnica	258	33	65	344	0.88	0.11	0.22	1.18
41. Brezno	674	100	278	1245	0.53	0.08	0.22	0.98
42. Detva	446	48	186	614	0.99	0.11	0.41	1.37
43. Krupina	371	45	97	497	0.63	0.08	0.17	0.85
44. Lučenec	646	79	201	864	0.78	0.10	0.24	1.05
45. Poltár	214	26	115	311	0.45	0.06	0.24	0.65
46. Revúca	530	273	1440	2987	0.73	0.37	1.97	4.09
47. Rimavská Sobota	1147	130	427	2378	0.78	0.09	0.29	1.62
48. Veľký Krtíš	527	79	812	752	0.62	0.09	0.96	0.89
49. Zvolen	368	1035	640	539	0.49	1.36	0.84	0.71
50. Žarnovica	522	318	193	680	1.23	0.75	0.45	1.60
51. Žiar n/H	515	2750	997	14355	0.99	5.31	1.92	27.71
52. Bardejov	431	49	224	644	0.46	0.05	0.24	0.69
53. Humenné	372	186	348	518	0.49	0.25	0.46	0.69
54. Kežmarok	438	55	137	605	0.52	0.07	0.16	0.72
55. Levoča	220	26	65	301	0.62	0.07	0.18	0.84
56. Medzilaborce	186	20	44	242	0.43	0.05	0.10	0.57
57. Poprad	299	31	202	439	0.27	0.03	0.18	0.40
58. Prešov	494	56	283	897	0.53	0.06	0.30	0.96
59. Sabinov	414	45	127	548	0.86	0.09	0.26	1.13
60. Snina	435	133	201	655	0.54	0.17	0.25	0.81
61. Stará Ľubovňa	535	65	151	713	0.86	0.10	0.24	1.14
62. Stropkov	147	16	42	197	0.38	0.04	0.11	0.51
63. Svidník	279	30	76	365	0.51	0.06	0.14	0.66
64. Vranov n/T	420	773	601	885	0.55	1.01	0.78	1.15
65. Gelnica	411	45	103	552	0.70	0.08	0.18	0.95
66. Košice	3268	9247	7883	101053	13.45	38.05	32.44	415.85
67. Košice - okolie	927	109	1155	1150	0.60	0.07	0.75	0.75
68. Michalovce	194	834	1620	794	0.19	0.82	1.59	0.78
69. Rožňava	917	118	818	1268	0.78	0.10	0.70	1.08
70. Sobrance	178	29	55	234	0.33	0.05	0.10	0.43
71. Spišská Nová Ves	397	127	183	3283	0.68	0.22	0.31	5.59
72. Trebišov	397	48	172	539	0.37	0.05	0.16	0.50
Slovakia	35050	68262	43130	179005	0.71	1.39	0.88	3.65

Fig. 4.3 **Specific territorial emission in 2011**

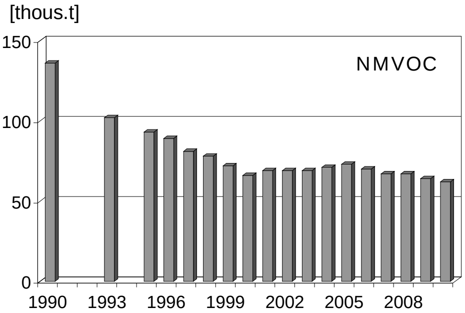


Tab. 4.7 **NMVOC emissions [t] in the SR in 1990, 1995, 2000, 2002 – 2010**

Sector / Subsector	1990	1995	2000	2002	2003	2004	2005	2006	2007	2008	2009	2010
Combustion processes I	335	258	201	214	214	203	185	174	158	172	157	159
Public power	223	187	139	147	161	156	139	131	121	130	119	121
District heating plants	112	71	62	67	53	47	46	43	37	42	38	39
Combustion processes II	12641	9618	7913	7070	7505	8931	11934	11162	11113	11173	11273	10957
Commercial and institutional plants	226	150	26	23	24	25	28	27	29	32	49	67
Agriculture	IE	IE	6	7	7	7	9	8	6	6	6	5
Residential plants	12415	9468	7881	7040	7474	8899	11897	11127	11078	11135	11218	10885
Combustion processes in industry	981	805	584	646	703	751	806	897	881	883	662	940
Comb. in boilers, gas turb. and stat. eng.	206	150	158	146	168	120	121	117	94	94	90	87
Iron production	32	29	28	32	35	34	33	37	36	32	27	33
Ore agglomeration	438	358	396	383	409	402	384	390	367	338	213	273
Copper production	305	268	2	85	91	195	268	353	384	419	332	548
Production processes	27029	11129	8717	7728	7152	7104	6434	5821	5474	4903	4338	4841
Processes in petroleum industries	17188	7474	6627	5571	4672	4617	4058	3469	3166	2804	2623	2693
Coke production	1053	834	719	765	801	800	783	787	783	720	450	900
Steel production	43	36	34	40	43	41	41	47	47	42	36	45
Rolling mills	233	297	300	304	336	329	341	361	372	347	295	318
Aluminium production	0,101	0,049	0,165	0,165	0,167	0,235	0,2	0,2	0,3	0,2	0,2	0,2
Proc. in organic chemical industries	6437	1369	651	690	941	970	870	845	793	667	609	584
Food production	2073	1118	385	357	358	346	340	311	312	322	324	301
Road paving with asphalt	2,4	1	0,5	0,5	0,6	0,5	0,7	0,5	0,7	0,8	0,8	0,7
Exploitation&distrib. of natural resour.	8822	8535	5929	6024	7431	7696	7104	6276	6170	6363	6207	5864
Exploitation&distribution of crude oil	5198	4298	3750	3801	3999	4149	4280	4472	4266	4272	4324	4037
Distribution of fuel	3624	4237	2179	2223	3432	3547	2824	1804	1904	2091	1883	1827
Solvent and other products use	52875	37065	26978	31020	32272	32760	33561	34634	33579	33964	33330	31860
Use of paints and glues	32811	20687	13214	15110	16369	18457	18918	19522	20003	20385	20365	20279
Dry cleaning and degreasing	11500	7695	5092	7332	7408	5822	6101	6600	5057	5052	4412	3005
Processing of fat and oil	332	363	299	240	156	134	189	152	147	138	144	152
Products	8232	8320	8374	8338	8339	8347	8353	8360	8372	8389	8409	8425
Road transport	27334	24129	14041	15136	13121	12465	11974	10362	8710	8834	7325	6596
Other transport	953	599	528	500	460	469	488	449	484	455	417	594
Waste incineration	4631	388	190	130	139	154	150	182	138	121	134	152
Municipal waste	71	107	147	111	115	130	130	135	128	112	126	101
Industrial waste	281	281	43	19	23	21	17	44	8	7	5	48
Hospital waste	IE	IE	0,1	0,1	2	2	3	4	3	3	3	3
Agricultural waste*	4279											
Agriculture	651	436	436	436	436	436	436	436	437	438	439	440
Total	136252	92962	65517	68904	69433	70969	73072	70394	67144	67307	64282	62405

Emissions from transport estimated to January 31th, 2013, emissions from the other sectors estimated to December 31th, 2012.
IE = included in other source category
** Agricultural waste combustion is prohibited since 1994*
Because of changeover from EAPSI to NEIS in year 2000 some changes of source appointment have to be done in the framework of subsectors combustion in boilers, gas turbines and stationary engines; commercial and institutional plants and new sector agriculture (sector non-industrial combustion plants) was established.

Fig. 4.4 **Development trends in NMVOC emissions in 1990 – 2010**

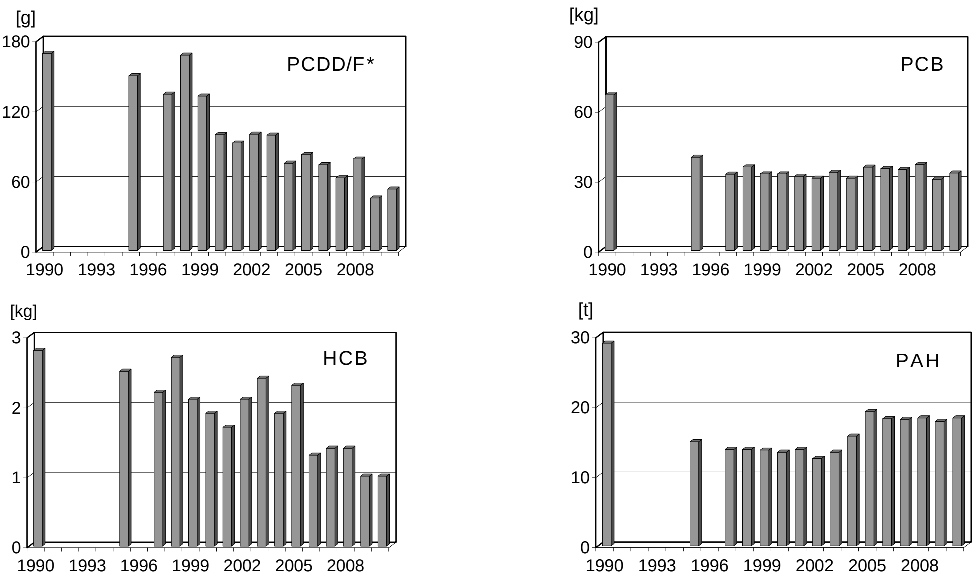


Tab. 4.8 **Emissions of persistent organic pollutants in the SR in 2010**

Sector / Subsector	PCDD/F*	PCB	HCB	PAH				
				sum PAH	B(a)P	B(k)F	B(b)F	I(1,2,3-cd)P
	[g]	[kg]	[kg]	[kg]	[kg]	[kg]	[kg]	[kg]
Combustion processes I	7.926	0.556	0.190	1 813.922	196.266	508.648	508.826	600.182
Public power	1.688	0.525	0.174	7.495	0.079	3.551	3.729	0.136
District heating plants	0.238	0.031	0.016	10.266	0.026	5.097	5.097	0.046
Coke production	6.000			1 796.161	196.161	500.000	500.000	600.000
Combustion processes II	3.200	8.607	0.163	14 717.942	4 210.027	1 836.408	5 526.891	3 144.616
Commercial and institutional plants	0.034	0.007	0.002	1.038	0.006	0.504	0.517	0.011
Residential plants	3.162	8.599	0.160	14 716.764	4 210.015	1 835.853	5 526.302	3 144.595
Agriculture	0.004	0.001	0.000	0.140	0.006	0.051	0.072	0.010
Combustion processes in industry	18.775	3.460	0.183	110.319	66.485	15.992	21.059	6.784
Comb. in boilers, gas turb. and stat. eng.	0.483	0.585	0.094	18.557	1.387	5.081	9.841	2.248
Iron production	0.365	0.023		62.030	62.030			
Ore agglomeration	17.361	2.728	0.079	28.943	2.976	10.789	10.789	4.390
Cast iron production	0.089	0.017		0.014	0.003	0.005	0.005	0.002
Others	0.477	0.106	0.010	0.775	0.089	0.117	0.425	0.144
Production processes	7.599	1.986	0.384	1 305.335	475.976	385.310	393.841	50.208
Aluminium production	0.257	0.043		598.370	195.597	189.080	189.080	24.613
Steel production	6.382	1.896		84.151	84.151			
Carbon mineral production				622.814	196.229	196.229	204.761	25.595
Wood impregnation								
Others	0.960	0.048	0.384					
Road transport	0.396	14.912	0.012	139.614	19.629	48.332	48.639	23.013
Other transport	0.009	0.869	0.001	10.355	2.589	1.553	3.624	2.589
Waste incineration	15.351	2.886	0.057	163.480	45.718	32.710	67.564	17.489
Municipal waste	0.073	0.971	0.018	7.124	0.128	3.482	3.482	0.031
Industrial waste	13.545	1.806	0.025	7.020	0.126	3.431	3.431	0.031
Hospital waste	0.900	0.018	0.000	0.070	0.001	0.034	0.034	0.000
Others	0.833	0.091	0.013	149.266	45.462	25.762	60.616	17.427
Total	53.256	33.277	0.989	18 260.967	5 016.691	2 828.952	6 570.444	3 844.880

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 from transport estimated to December 14th, 2011, emissions from other sectors estimated to February 15th, 2012.

Fig. 4.5 **Development trends in POPs emissions in 1990 – 2010**

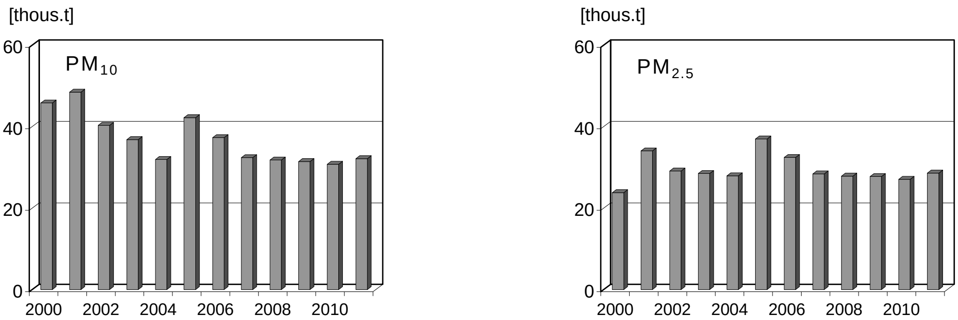


Tab. 4.9 **PM_{10} and $PM_{2.5}$ emissions [thous. t] in the SR in 2006– 2011**

Sector / Subsector	2006		2007		2008		2009		2010		2011	
	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	5.756	5.172	1.438	1.048	1.307	0.939	1.227	0.878	1.200	0.877	1.253	0.936
Public Electricity and Heat Production	5.053	4.735	0.743	0.612	0.696	0.561	0.649	0.518	0.619	0.522	0.703	0.600
Petroleum refining	0.099	0.078	0.112	0.089	0.076	0.061	0.083	0.066	0.049	0.039	0.047	0.037
Coke production	0.604	0.359	0.583	0.346	0.535	0.317	0.495	0.294	0.532	0.316	0.503	0.299
Combustion processes II	25.399	22.740	25.296	23.048	25.431	23.145	25.589	23.460	24.773	22.594	26.993	24.739
Commercial and institutional plants	0.173	0.123	0.136	0.094	0.173	0.124	0.137	0.102	0.147	0.114	0.147	0.117
Residential plants	25.016	22.485	25.044	22.903	25.137	22.967	25.353	23.311	24.508	22.431	26.722	24.573
Agriculture	0.084	0.038	0.067	0.031	0.077	0.035	0.068	0.031	0.081	0.034	0.088	0.035
Other combustion processes	0.126	0.094	0.048	0.019	0.044	0.020	0.032	0.016	0.036	0.016	0.036	0.014
Combustion processes in industry	2.693	1.931	2.041	1.485	1.762	1.295	1.603	1.158	1.506	1.092	1.383	0.946
Production of iron and steel	0.794	0.601	0.556	0.395	0.470	0.324	0.395	0.287	0.515	0.376	0.484	0.330
Production of non-ferrous metals	0.145	0.123	0.136	0.117	0.193	0.166	0.178	0.155	0.169	0.146	0.097	0.081
Chemical industry	0.385	0.281	0.225	0.179	0.226	0.187	0.243	0.193	0.218	0.183	0.194	0.164
Production of paper and cellulose	0.226	0.096	0.086	0.056	0.082	0.049	0.149	0.102	0.094	0.040	0.141	0.057
Food production	0.093	0.077	0.048	0.028	0.042	0.022	0.036	0.019	0.036	0.019	0.037	0.018
Other combustion processes in industry	1.051	0.753	0.991	0.710	0.748	0.546	0.601	0.404	0.475	0.329	0.429	0.296
Transport	2.483	2.084	2.889	2.447	2.583	2.113	2.247	1.826	2.562	2.102	2.334	1.893
Civil aviation	0.010	0.010	0.010	0.010	0.012	0.012	0.009	0.009	0.008	0.008	0.008	0.008
Road transport	1.343	1.343	1.643	1.643	1.299	1.299	1.089	1.089	1.248	1.248	1.221	1.221
Road transport - abrasion	0.821	0.437	0.909	0.485	0.976	0.521	0.876	0.470	0.948	0.506	0.928	0.496
Railways	0.146	0.139	0.141	0.133	0.128	0.122	0.111	0.105	0.113	0.107	0.109	0.104
Navigation	0.163	0.155	0.185	0.176	0.169	0.160	0.161	0.153	0.244	0.231	0.068	0.065
Industrial technologies	0.177	0.072	0.151	0.063	0.148	0.058	0.124	0.052	0.120	0.051	0.156	0.075
Mineral products	0.047	0.004	0.041	0.003	0.043	0.004	0.033	0.003	0.033	0.003	0.029	0.002
Chemical industry	0.083	0.051	0.069	0.042	0.063	0.039	0.058	0.036	0.057	0.035	0.098	0.060
Paper and pulp	0.001	0.001	0.001	0.001	0.001	0.001	0.001	<0.001	0.001	<0.001	0.001	<0.001
Other industrial processes	0.045	0.015	0.040	0.016	0.041	0.015	0.032	0.013	0.029	0.012	0.028	0.012
Total	36.508	31.999	31.814	28.091	31.230	27.551	30.790	27.374	30.160	26.715	32.118	28.589

Emissions from road and other transport estimated to January 31st, 2013, emissions from other sectors estimated to December 1st, 2012.

Fig. 4.6 **Development trends in PM_{10} and $PM_{2.5}$ emissions in 2000 – 2011**

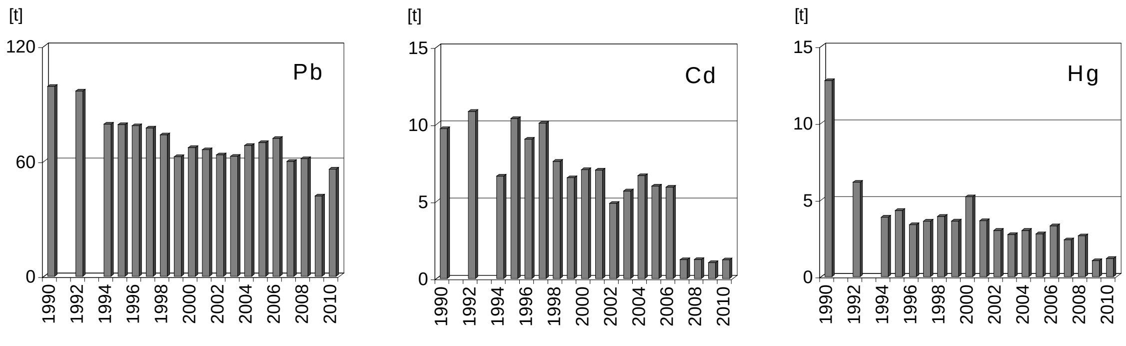


Tab. 4.10 **Emissions of heavy metals [t] in the SR in 2010**

Sector / Subsector	Pb	As	Cd	Cr	Cu	Hg	Ni	Se	Zn
Combustion processes I	1.901	0.343	0.082	0.062	0.072	0.057	0.230	0.010	2.742
Public power	0.028	0.199	0.001	0.059	0.042	0.004	0.227	0.009	0.064
District heating plants	1.873	0.144	0.080	0.003	0.030	0.054	0.003	0.0001	2.678
Combustion processes II	1.138	0.528	0.033	0.248	0.363	0.032	0.238	0.037	3.251
Commercial and institutional plants	0.191	0.047	0.008	0.011	0.013	0.006	0.009	0.001	0.280
Residential plants	0.934	0.476	0.025	0.235	0.349	0.026	0.227	0.036	2.951
Agriculture	0.013	0.006	0.001	0.001	0.001	0.0004	0.001	0.0001	0.020
Combustion processes in industry	40.616	20.824	0.528	2.128	38.421	0.497	10.001	11.344	28.123
Comb. in boilers, gas turb. and stat. engines	1.633	0.293	0.077	0.380	0.195	0.100	5.853	0.151	2.102
Iron production	0.124	0.011	0.197	0.938	0.073	0.314	3.123	0.040	7.812
Glass production	6.915	0.697	0.050	0.739	0.185	0.015	0.585	5.543	3.387
Ore agglomeration	16.828	0.025	0.010	0.055	5.531	0.040	0.424	0.781	8.804
Copper production	14.985	19.790	0.193		32.436	0.001		4.828	5.981
Cement production	0.130	0.002	0.0004	0.014		0.027	0.015	0.0002	0.033
Aluminium oxide production									
Magnesite production	0.0004	0.008	0.001	0.002	0.001	0.00003	0.0004		0.002
Production processes	1.673	0.088	0.037	0.802	2.972	0.188	7.587	0.015	15.076
Steel production	1.366	0.074	0.015	0.173	2.698	0.015	2.727	0.015	5.693
Aluminium production			0.016				1.630		1.630
Ferro alloys production	0.124	0.009	0.004	0.002	0.005		0.001		0.601
Pig iron production	0.107	0.004	0.002	0.018			0.009		0.076
Galvanizing	0.070			0.609	0.210		3.220		6.090
Alloys (Cu-Zn) production	0.006				0.059				0.986
Inorganic chemical industry						0.173			
Road transport	2.334		0.021	0.105	3.581		0.147	0.021	2.106
Other transport			0.001	0.004	0.148		0.006	0.001	0.087
Waste incineration	11.624	0.014	0.747	0.872	1.425	0.619	0.505	0.008	5.141
Municipal waste	8.248	0.009	0.458	0.825	1.136	0.330	0.495	0.002	3.116
Industrial waste	2.812	0.004	0.241	0.039	0.241	0.241	0.008	0.005	1.687
Hospital waste	0.564	0.001	0.048	0.008	0.048	0.048	0.002	0.001	0.338
Cremation						0.004			
Total	55.797	21.793	1.207	4.012	46.585	1.184	18.597	11.432	54.848

Emissions estimated to December 31th, 2012

Fig. 4.7 **Development trends in heavy metals emissions in 1990 – 2010**



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 Cooperation and Development (OECD) as well as the Slovak Republic – known collectively as Annex I countries – committed themselves to adopting policies and measures to reduced their greenhouse gas (GHG) emissions under the Convention. Regarding the specific economic situation in 1992, was the Slovak Republic together with the Russian Federation and other countries from the Eastern and Central Europe, included in the special subgroup under Annex I countries called Economies in Transition (EIT).

Kyoto protocol

The Kyoto Protocol, adopted by consensus at the third session of the Conference of the Parties (COP-3) in Kyoto, December 1997, enforced the international responsibility for the climate change. The all Annex I countries which ratified the Kyoto Protocol (KP), formally defined their reduction targets in articles of the KP. The Kyoto Protocol came into force on February 16, 2005 after compliance of requirement determined in Article 25, paragraph 1; it means after signing of more than one-half of Annex I countries, that representing of minimum 55% of total CO_2 emissions of Annex I countries in 1990 (the signature of the Russian Federation ensured the majority). Detail rules for the Kyoto Protocol implementation was adopted on COP7 in 2001 and are known as Marrakesh Accords.

Developed countries included in Annex B of the Kyoto Protocol have individual or common target to reduce emissions of six greenhouse gases during the commitment period (2008 – 2012) by 5.2% in comparison with the base year 1990. The Slovak Republic and the most countries of Central and East Europe agreed to reduce base year level of all six GHG emissions by 8% during period 2008 – 2012. 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 member state with the EU-15 approval as „burden-sharing agreement“ (Article 4, KP).[2] The priority of the Annex I countries to the KP is to achieve reduction target with the most effective economic tools calls as flexible mechanisms (joint implementation, clean development and emission trading). The share of flexible mechanisms utilization is limited, the most important is reduction achieved by domestic measures.

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

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

The new member states joined the European Community after 2004 have individual targets under the Kyoto Protocol. The Czech Republic, Estonia, Bulgaria, Latvia, Lithuania, Romania, Slovakia and Slovenia have reduction targets of 8% from the base year, while Hungary and Poland have reduction targets of 6%. Cyprus and Malta have no Kyoto target, while Croatia has a reduction target of 5%. The additional EEA member countries Norway and Iceland are allowed to increase emissions under the Kyoto Protocol, by 1% and 10% respectively, from their base year emissions. The candidate country Turkey has ratified the UNFCCC, but not the Kyoto Protocol. Lichtenstein and Switzerland have a reduction target of 8%. The final accounting of the Kyoto targets will be on April 15, 2015 based on the national inventory submissions.

Post-Kyoto period

After not fully successful talks on the Conference of the Parties (COP15) and CMP5 (5. session of the Kyoto Parties) in Copenhagen (December 2009), where the EU political targets was not fulfilled, the challenge was to negotiate further international agreement for regulation and mitigation climate change impacts after December 31, 2012. This challenge was fulfilled on the 18. Conference of the Parties in Doha, Qatar (in November 2012), where the Amendment of the Kyoto Protocol was agreed. It has been amended so that will continue as of January 1, 2013. Governments have decided that the length of the second commitment period will be 8 years and the countries that are talking on further commitments under the Kyoto Protocol have agreed to review their emission reduction commitments at the latest by 2014, with a view to increasing their respective levels of ambition.

QUELROs (quantified emission limitations and reduction obligations) are already published by the several developed countries such as Norway, Switzerland, Australia, EU or New Zeeland. Some of the countries are still waiting for further international negotiations. The international cooperation between developed and developing countries in commitment a reduction target (defined as target to hold the increase in global temperature below 2°C in 2100 against pre-industrial level).

EU together with the other Annex I countries push “step wise approach” to mitigate agreed reduction targets. In detail projection it is the definition of mitigation trajectories for developed and developing countries up to 2050 with regard to keep 2°C global target, need to keep indicator CO_2/per capita on level 2 tons/per capita and the definition for a rigorous, robust and transparent system for Monitoring, Reporting and Verification (MRV) of commitments. The EU policy is to support transparent reporting system for developing countries with the clear rules for emission reporting, financing of adaptation actions and policies and measures effect.

The EU and legislative framework

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. The Slovak Republic submit the data about GHG emissions in the relevant extend to the January 15, annually according to the Decision 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:

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

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

The harmonisation of the legislative and reporting commitments under the UNFCCC and the KP with the measures already included in the EU legislation led to the current process of the Decision 280/2004/EC revision. It is shown that there are areas in which the transparency, accuracy, consistency and efficiency of the existing monitoring and reporting system should be better streamlined.

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

The integrated Climate and Energy Package (CEP)[4] introduced officially by European Community on January 23, 2008 is principled, complex and ambitious plan for GHGs emission reduction, increasing of energy efficiency, decreasing of fossil fuels consumption and supporting of innovative, low-carbon technologies.

A comprehensive set of fundamental legal standards for the Climate and Energy Package was published in the Official Journal of the European Union of 5th June 2009, as follows:

- Regulation (EC) 443/2009 of the European Parliament and of the Council of 23rd April 2009 setting emission performance standards for new passenger cars as part of the Community's integrated approach to reduce CO2 emissions from light-duty vehicles.
- Directive 2009/28/EC of the European Parliament and of the Council of 23rd April 2009 on the promotion of the use of energy from renewable resources and amending and subsequently repealing Directives 2001/77/EC and 2003/30/EC.
- Directive 2009/29/EC of the European Parliament and of the Council of 23rd April 2009 amending Directive 2003/87/EC so as to improve and extend the greenhouse gas emission trading scheme (ETS) of the Community.
- Directive 2009/30/EC of the European Parliament and of the Council of 23rd April 2009 amending Directive 98/70/EC as regards the specification of petrol, diesel and gas-oil and introducing a mechanism to monitor and reduce greenhouse gas emissions and amending Council Directive 1999/32/EC as regards the specification of fuel used by inland navigation and repealing Directive 93/12/EEC.
- Directive 2009/31/EC of the European Parliament and of the Council of 23rd April 2009 on the geological storage of carbon dioxide and amending Council Directive 85/337/EEC, European Parliament and Council Directives 2000/60/EC, 2001/80/EC, 2004/35/EC, 2006/12/EC, 2008/1/EC and Regulation (EC) 1013/2006.
- Decision 406/2009/EC of the European Parliament and of the Council of 23rd April 2009 on the effort sharing of Member States to reduce their greenhouse gas emissions to meet the Community’s greenhouse gas emission reduction commitments up to 2020.

The decision of the European Commission for the emissions reduction of the GHG emissions not included in the ETS is very important. Slovakia according to the previous results of the GHG emissions balance has 5% increase of the 2005 emission level which will be reach in 2020. This target is not easy to reach mostly in the sectors such as transport, agriculture, residential heating or waste management. The annual trajectory is necessary to follow in every year of the 8 years cycle (2013 – 2020) and this will be reviewed annually.

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[4] *Assessment Report and Implementation of the Climate-Energy Package in the Slovak Republic, November 2009.*

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 UNFCC defines an obligation to register and inventory the emission of greenhouse gases (CO_2, CH_4, N_2O and F-gases, included HFCs, PFCs and SF_6) according to the adopted IPCC methodology.[5] The growth in concentrations of greenhouse gases in the atmosphere (caused by anthropogenic emission) leads to the strengthening of the greenhouse gas effect and thus to the additional warming of the atmosphere. The present climate models estimate that global average temperature will rise by about 1.4 – 5.8 °C by the year 2100.

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

- emissions into the atmosphere
- weakening of natural sink mechanisms

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

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

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 18% 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. Permafrost contains large reservoirs of organic carbon and methane accumulated in an ice structure. Rapid global warming and melting of permafrost in polar areas is potential high risking of methane release into atmosphere.

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 semi-conductors, 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 4 721 Mt CO_2 equivealents in 2010, this represent an increase (2.4%) compared to 2009, bringing emissions at the lowest level (–15.4%) since 1990 without emissions and removals from land use, land use change and forestry (LULUCF) and international bunkers. The projected decrease in EU-27, compared to 1990, can reaches 19% in 2020 if additional domestic policies and measures are taken into account. Based on these data can be assumed, that the share of EU-27 GHG emissions on world emission is 11.2%.

Between 1990 and 2010, EU-27 per capita emissions declined to 9.3 tonnes of CO_2 equivalents. The main decrease occurred particularly in the early 1990s. Comparable with other world are higher (7 t CO_2 equivalents per capita). Emissions per capita differ among EU countries and correspond with energy intensity (primary energy consumption per capita) and energy mix (emission per produced energy unit). All new member states, except Cyprus, Malta and Slovenia have decreased their per capita emissions substantially since 1990.

Total aggregated GHG emissions decreased in new member states by 36.9% in 2010 comparable to the base year 1990, mainly due to introduction of market economies and the consequent restructuring or closure of heavily polluting and energy-intensive industries. Introducing more efficient low-carbon technologies and increasing share of services on total Gross Domestic Product (GDP) growth. The transport sector, especially road transport is most growing sector in all EU member states, where additional policies and measures are required. The aggregated GHG emissions in the Slovak Republic assumed 0.4% of the world emissions.

The emissions of greenhouse gases in the Slovak Republic are estimated in accordance with the requirements of the UN FCCC[1] and the Kyoto Protocol. The values listed in Tables are updated annually if information provided in the Statistical Yearbook of the Slovak Republic is revised and/or if methodology is changed. Emissions were estimated in compliance with the methods provided in the IPCC Guidelines,[6] Good Practice Guidance (GPG)[7] and in the SHMÚ's reports. The Fifth National Communication of the SR on the Climate Change was submitted on December 31, 2009 to the secretariat of the UNFCCC. The Communication is accessible on the web page www.enviro.gov.sk and was revised by expert review team. In October 2012, the National Inventory System of the Slovak Republic[8] was revised under the in-country review for the inventory submission 2012 of the SR by expert review team under responsibility of the UNFCCC secretariat. The list of potential problems was published into the outcome report from the review for the information for the Ministry of Environment of the SR and SHMÚ. The in-country review was a tool for the analysis of current status in the parties of the KP and to get eligibility for participation of the Kyoto flexible mechanisms. Further information about the National Inventory System is available on the website http://ghg-inventory.shmu.sk.

Total GHG emissions of the Slovak Republic were 46 114 Gg of CO_2 equivalents in 2010 (without sinks from land use, land use change and forestry (LULUCF)). This represents a reduction by more than 36% in comparison with the base year 1990. In comparison with 2009, the emissions increased by 4%. The emissions signified in the literature as net emissions with the sinks from LULUCF in 2010 were 40 026 Gg of CO_2 equivalents and decreased against base year by 35% caused by higher sinks in LULUCF and removing the consequences from the storm calamity in the High Tatra mountains. According to the decision of the Convention body the strictly recommended reporting software is CRFReporter, which generate automatically the required CRF Tables. The new reporting program was used also for recalculation the time series in the consistency way. The base year was agreed by national authority (the 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). The first results of preliminary GHG inventory for 2011 show the increase of emissions and decrease of sinks caused by increasing economic activity (Tab. 5.1).

Tab. 5.1 **Aggregate[9] anthropogenic emissions of GHG [Tg] in Slovakia in 1990 – 2010**

	1990	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
CO_2	60.75	44.88	44.70	44.81	44.32	43.43	41.37	44.17	42.89	43.61	43.03	42.66	42.10	40.08	41.23	36.03	38.02
CH_4	4.44	4.10	4.09	4.15	4.40	4.62	4.32	4.38	4.99	4.82	4.72	4.52	4.59	4.51	4.65	4.31	4.21
N_2O	6.35	4.16	4.30	4.22	3.80	3.31	3.58	3.76	3.74	3.79	3.81	3.77	4.04	3.97	3.85	3.54	3.42
HFCs		0.012	0.024	0.033	0.040	0.058	0.077	0.102	0.130	0.154	0.182	0.206	0.248	0.285	0.336	0.381	0.420
PFCs		0.114	0.035	0.035	0.025	0.014	0.012	0.016	0.014	0.022	0.020	0.020	0.036	0.025	0.036	0.018	0.021
SF_6	0.000	0.010	0.011	0.011	0.012	0.013	0.013	0.013	0.014	0.015	0.016	0.016	0.017	0.017	0.019	0.019	0.020
Total without LULUCF*	71.81	53.27	53.17	53.26	52.61	51.45	49.38	52.44	51.77	52.41	51.78	51.20	51.03	48.88	50.12	44.30	46.11
Total with LULUCF	61.52	42.30	42.33	42.16	39.44	41.04	39.09	42.52	41.49	42.76	42.83	45.91	43.12	41.10	43.02	37.07	40.03

Emissions, as submitted in December 07, 2012
** GHG emissions without sinks from LULUCF, national total under the Kyoto Protocol*

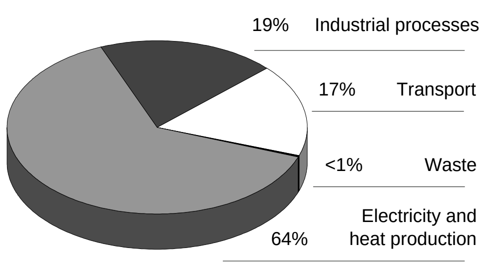
6 *Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventory, Volume 1-3*
7 *Good Practice Guidance and Uncertainty Management in National GHGs Inventories, IPCC 2000*
8 *Vestnik MZP SR, 2007, 3, pages 19 – 45*
9 *According to the currently valid convention the emission reduction expressed in CO_2 equivalent should be reported, Climate Change 1995, The Science of Climate Change GWP100: CO_2=1, CH_4=21, N_2O=310, F-gases =140 – 23 900*

CO_2 – carbon dioxide

Emissions

A most important anthropogenic source of CO_2 emissions in the atmosphere is combustion and transformation of fossil fuels, which account for about 90% of the total CO_2 emissions in the SR. In addition, carbon dioxide arises during technological processes of cement, lime, magnesite and using of limestone production. 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 (Fig. 5.1).

Fig. 5.1 **CO_2 emissions in 2010**



Total net CO_2 emissions increased in 2010 compared with the previous year (6%), totally decreased by more than 37% 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. In the last year important changes of energy sources and economic recession led to the decrease of energy consumption in the Slovak Republic were occurred.

It is expected the long-time increasing of the CO_2 emissions, approved by national projections.[10] 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.

Tab. 5.2 **Total emissions and sinks of CO_2 [Gg] in 1990, 1995 and 2000 – 2010**

	1990	1995	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
CO_2 with LULUCF	50 424	33 892	31 036	34 228	32 586	33 934	34 058	37 350	34 158	32 273	34 104	28 775	31 909
CO_2 without LULUCF	60 745	44 879	41 367	44 169	42 887	43 610	43 029	42 660	42 097	40 080	41 226	36 031	38 025
Fossil Fuel Combustion	52 469	37 477	34 107	36 609	34 860	35 861	34 363	34 675	33 594	31 722	32 936	29 074	30 649
Electricity&Heat Production	47 582	33 233	29 957	31 909	30 026	30 913	29 153	28 512	27 833	25 299	26 322	22 993	24 092
Transport	4 888	4243	4 150	4700	4 834	4 948	5 209	6 162	5 762	6 423	6 614	6 081	6 557
Fugitive Emissions	0,15	0,15	0,18	0,19	0,18	0,19	0,18	0,17	0,17	0,15	0,15	0,24	0,19
Industrial Processes	8 083	7 249	7 132	7 437	7 927	7 644	8 555	7 878	8 366	8 264	8 196	6 864	7 255
Mineral Products	2 966	2 305	2 524	2 586	2 599	2 297	2 979	2 970	3 019	3 049	3 145	2 456	2 303
Chemical Industry	617	809	847	879	861	784	917	928	819	835	784	832	704
Production of Metals	4 499	4 135	3 762	3 972	4 467	4 563	4 659	3 980	4 528	4 380	4 267	3 576	4 248
Solvent Use	130	91	65	70	75	78	83	85	88	86	88	87	84
LULUCF	-10 322	-10 987	-10 332	-9 941	-10 300	-9 676	-8 971	-5 309	-7 939	-7 807	-7 122	-7 256	-6 116
Forest Land	-10 335	-10 389	-9 230	-9 047	-9 189	-8 750	-8 028	-4 678	-7 060	-7 074	-6 355	-6 607	-5 333
Cropland	-180	-338	-520	-349	-577	-660	-624	-653	-737	-658	-723	-702	-715
Settlements	-328	-534	-829	-825	-744	-491	-482	-319	-381	-356	-363	-410	-326
Grassland	121	98	88	102	73	97	76	84	79	88	99	212	119
Other Land	401	176	159	178	136	128	88	257	159	192	221	251	138
Waste	63	63	63	52	25	26	28	22	48	8	6	5	37
Waste Incineration	63	63	63	52	25	26	28	22	48	8	6	5	37
*Biomass Burning**	*794*	*1 183*	*1 426*	*1 632*	*1 622*	*1 734*	*2 183*	*3 045*	*2 843*	*2 983*	*5 267*	*2 641*	*2 820*
*International Bunkers**	*128*	*103*	*45*	*69*	*72*	*79*	*86*	*91*	*132*	*150*	*167*	*144*	*137*

Emissions, as submitted in December 07, 2012 * *CO_2 emissions are not being accounted into the total emissions*

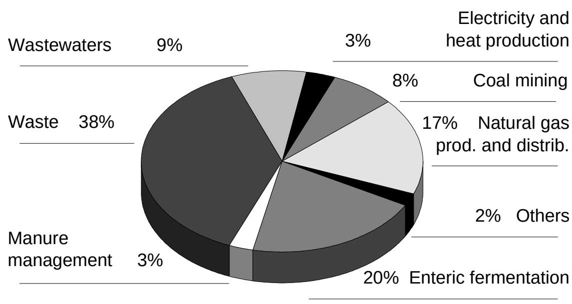
[10] *The Biennial Report 2013 according Decision 280/2004/EC*

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 from 1950, 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 (Tab. 5.2). The new IPPC methodology[11] was implemented in the last inventory year for the estimation the sinks in the LULUCF sector according the good practice. 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 categories are biomass burning controlled and wild forest fires. All GHGs are estimated in these categories.

CH_4 – methane

Fig. 5.2 **CH_4 emissions in 2010**



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 (Fig. 5.2).

Total methane emissions reached in 2010 200.5 Gg, what is slight decrease comparable to the previous year. Emissions decreased by 4% 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 – 2010 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 important methodology change in agricultural sector was performed based on Tier 2 methodology and regional input activity data in enteric fermentation of the key animal categories (cattle, sheep, swine), as well as. The methane emissions decreased in all sub-sectors except LULUCF and waste, caused by implementation of new methodologies. (Tab. 5.3).

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

Tab. 5.3 Total emissions of CH_4 [Gg] in 1990, 1995 and 2000 – 2010

	1990	1995	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
CH_4 with LULUCF	212.28	195.58	206.47	209.22	238.16	230.35	225.63	216.36	219.70	215.42	222.34	206.03	201.58
CH_4 without LULUCF	211.61	195.13	205.91	208.54	237.49	229.63	224.81	215.29	218.80	214.53	221.34	205.04	200.49
Fossil Fuel Combustion	4.30	5.61	6.19	6.93	6.68	7.06	8.29	10.74	9.94	9.31	16.14	7.60	7.32
Electricity&Heat Production	3.10	4.37	5.23	5.87	5.67	6.07	7.34	9.80	9.07	8.46	15.30	6.87	6.60
Transport	1.20	1.25	0.97	1.07	1.01	0.99	0.96	0.94	0.87	0.84	0.83	0.74	0.72
Fugitive Emissions	51.65	58.83	62.88	61.19	59.44	57.04	54.09	48.13	46.80	48.96	50.86	54.69	49.91
Coal Mining	27.20	29.70	28.82	26.33	25.69	21.11	19.77	16.17	14.67	13.52	15.95	16.92	15.23
Oil and NG Produc.&Distrib.	24.45	29.13	34.06	34.86	33.74	35.93	34.32	31.96	32.13	35.45	34.91	37.77	34.68
Industrial Processes	0.05	0.06	0.07	0.07	0.09	0.10	0.10	0.08	0.07	0.06	0.06	0.06	0.07
Chemical Industry	0.05	0.06	0.06	0.06	0.06	0.05	0.06	0.07	0.05	0.06	0.05	0.06	0.04
Production of Metals			0.01	0.01	0.03	0.04	0.03	0.02	0.02	0.01	0.01	0.00	0.03
Agriculture	113.46	80.96	60.34	61.67	60.12	57.52	52.87	53.19	52.28	51.36	48.98	47.15	46.48
Enteric Fermentation	95.90	67.71	50.82	52.04	50.38	48.26	45.02	45.53	44.79	44.51	43.13	41.20	40.81
Manure Management	17.56	13.25	9.52	9.63	9.74	9.26	7.84	7.66	7.49	6.84	5.85	5.94	5.67
LULUCF	0.67	0.46	0.56	0.68	0.67	0.72	0.82	1.07	0.90	0.89	1.00	0.99	1.09
Forest Fires	0.67	0.46	0.56	0.68	0.67	0.72	0.82	1.07	0.90	0.89	1.00	0.99	1.09
Waste	42.16	49.66	76.42	78.68	111.16	107.90	109.46	103.15	109.71	104.83	105.30	95.54	96.71
Solid Waste Disposal Sites	22.37	30.85	57.51	59.94	87.90	84.59	89.32	82.67	88.26	84.45	84.80	75.45	76.92
Wastewaters	19.71	18.67	18.77	18.56	18.57	18.52	18.33	18.08	18.04	17.97	17.84	17.36	17.12
Composting	0.08	0.14	0.15	0.17	4.69	4.79	1.81	2.40	3.41	2.42	2.65	2.73	2.68
*International Bunkers **	*0.0062*	*0.0044*	*0.0007*	*0.0024*	*0.0024*	*0.0023*	*0.0018*	*0.0015*	*0.0035*	*0.0038*	*0.0042*	*0.0037*	*0.0037*

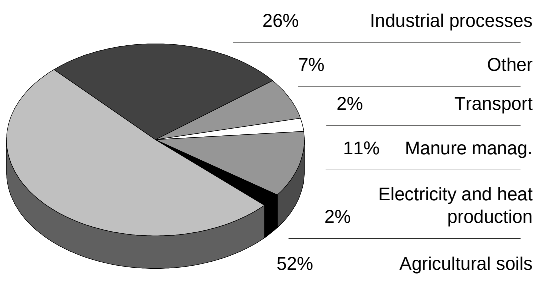
Emissions, as submitted in December 07, 2012
** CH_4 emissions are not being accounted into the total emissions*

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.[6,7] The N_2O emission arising by manipulation of sewage and sludge has been estimated also for municipal and industrial wastewater treatment plants (Fig. 5.3).

In 2010, the total N_2O emissions slightly decreased compared with the year 2009 and reached 11.03 Gg. However, the drop compared to the reference year 1990 is more than 46%. The N_2O emissions trend is stable since 1993. The most substantial increase is expected in energy (use of biomass) and industrial processes (regards to increase in nitric acid production) sectors. The higher increase of N_2O emissions is observed in waste sector, the emissions raised about 4% from base year. This relates to the amount of industrial wastewater treatment and detailed methodology and changes in the consideration of the waste categories. Emissions of N_2O are show the higher level of uncertainty and the time series is slightly inconsistent comparable with other gases (Tab. 5.4).

Fig. 5.3 **N_2O emissions in 2010**



Tab. 5.4 **Total emissions of N_2O [Gg] in 1990, 1995 and 2000 – 2010**

	1990	1995	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
N_2O with LULUCF	20.526	13.430	11.675	12.150	12.067	12.240	12.318	12.186	13.045	12.837	12.436	11.449	11.040
N_2O without LULUCF	20.487	13.418	11.555	12.140	12.063	12.219	12.304	12.169	13.035	12.811	12.430	11.426	11.025
Fossil Fuel Combustion	0.842	0.574	0.533	0.581	0.554	0.581	0.553	0.609	0.571	0.539	0.664	0.509	0.505
Electricity&Heat Production	0.490	0.318	0.280	0.301	0.293	0.330	0.311	0.343	0.320	0.292	0.403	0.264	0.246
Transport	0.352	0.256	0.253	0.281	0.261	0.251	0.242	0.266	0.251	0.247	0.261	0.245	0.259
Fugitive Emissions	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Industrial Processes	3.832	3.762	3.415	3.871	3.437	3.821	4.380	4.145	5.109	4.574	4.241	3.522	2.916
Chemical Industry	3.832	3.762	3.415	3.871	3.437	3.821	4.380	4.145	5.109	4.574	4.241	3.522	2.916
Solvent Use	0.055	0.100	0.065	0.097	0.185	0.191	0.259	0.279	0.266	0.258	0.255	0.250	0.261
Agriculture	15.296	8.572	7.190	7.247	7.160	6.951	6.659	6.626	6.508	6.944	6.777	6.653	6.846
Manure Management	3.466	2.307	1.601	1.548	1.532	1.488	1.386	1.340	1.309	1.284	1.239	1.216	1.208
Agricultural Soils	11.830	6.266	5.589	5.698	5.629	5.463	5.273	5.286	5.198	5.660	5.538	5.436	5.638
LULUCF	0.039	0.011	0.120	0.010	0.004	0.020	0.014	0.017	0.010	0.026	0.006	0.023	0.015
Forest Fires	0.039	0.011	0.120	0.010	0.004	0.020	0.014	0.017	0.010	0.026	0.006	0.023	0.015
Waste	0.462	0.410	0.353	0.343	0.727	0.676	0.453	0.510	0.581	0.495	0.494	0.493	0.497
Wastewaters	0.448	0.391	0.333	0.323	0.359	0.303	0.300	0.313	0.309	0.301	0.282	0.280	0.281
Waste Incineration	0.009	0.009	0.009	0.007	0.016	0.013	0.017	0.018	0.016	0.013	0.012	0.009	0.015
Composting	0.006	0.011	0.011	0.013	0.352	0.359	0.136	0.180	0.256	0.181	0.199	0.204	0.201
*International bunkers **	*0.004*	*0.026*	*0.001*	*0.013*	*0.014*	*0.011*	*0.006*	*0.003*	*0.016*	*0.018*	*0.019*	*0.017*	*0.018*

Emissions, as submitted in December 7, 2012 ** N_2O emissions are not being accounted into the total emission*

HFCs, PFCs, SF_6

Sources and emissions of the so-called F-gases have been assessed on the territory of the Slovak Republic. The procedure was carried out in coincidence with the methodology IPCC[6,7] and the actual and potential emissions were estimated from 1990 (Tab. 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 and SF_6 has risen since 1995 and this trend is expected in the future, as well. The PFCs emissions increase is not expected because the utilization of these gases is not occurred and emissions are only from elimination process in the present.

Tab. 5.5 **Total emissions of HFCs, PFCs and SF_6 in 1990, 1995 and 2000 – 2010**

	GWP		1990	1995	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Total emissions CO_2 eq.		[Gg]	271.40	135.88	101.77	131.37	158.35	191.02	216.95	242.72	301.05	327.07	390.21	417.76	461.55
HFCs emissions CO_2 eq.		[Gg]		11.65	77.01	102.30	130.18	154.34	181.52	206.19	248.42	284.75	335.54	380.61	420.49
HFC-23	11 700	[Mg]		0.00	0.03	0.03	0.03	0.05	0.05	0.05	0.05	0.10	0.10	0.10	0.06
HFC-32	650	[Mg]			0.55	1.00	2.07	3.22	4.63	6.42	9.33	12.34	16.07	20.51	22.40
HFC-41	150														.
HFC-43-10mee	1 300														.
HFC-125	2 800	[Mg]		0.01	2.28	3.95	6.66	9.04	11.85	14.47	18.51	21.65	28.21	34.07	37.52
HFC-134	1 000														.
HFC-134a	1 300	[Mg]		7.50	41.69	50.82	58.22	65.25	71.21	76.70	88.48	100.92	110.72	117.26	133.55
HFC-152a	140	[Mg]			0.67	0.78	0.89	0.96	1.02	0.92	0.83	0.75	0.89	1.10	6.67
HFC-143	300														.
HFC-143a	3 800	[Mg]			2.29	4.10	6.33	8.12	10.79	13.13	16.64	18.79	22.97	27.26	29.20
HFC-227ea	2 900	[Mg]		0.65	2.30	2.59	2.64	2.67	2.58	2.45	2.39	2.32	2.26	2.37	2.50
HFC-236fa	6 300				0.03	0.15	0.35	0.43	0.53	0.62	0.69	0.82	1.06	1.15	1.11
HFC-245ca	560														
PFCs emissions CO_2 eq.		[Gg]	271.37	114.32	11.65	15.59	13.75	21.65	19.91	20.25	35.82	24.88	36.16	17.76	21.15
CF_4	6 500	[Mg]	36.60	15.42	1.57	2.18	1.90	2.93	2.69	2.73	4.83	3.35	4.87	2.39	2.85
C_2F_6	9 200	[Mg]	3.64	1.53	0.15	0.15	0.15	0.28	0.26	0.27	0.48	0.34	0.49	0.24	0.29
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	13.11	13.48	14.42	15.03	15.53	16.27	16.81	17.44	18.51	19.39	19.90
SF_6	23 900	[Mg]	0.00	0.41	0.55	0.56	0.60	0.63	0.65	0.68	0.70	0.73	0.77	0.81	0.83

Emissions, as submitted in December 7, 2012

In 2010, 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 2009, the emissions increased by 5% and reached level of the reference year 1990.

5.3 ASSESSMENT

The aggregated emission of GHGs in year 2009 were on the lowest historical level since 1990 (without LULUCF) and in 2010 again increased on the level before economic crises. There is the decreasing of aggregated emission against the base year (1990) about approximately 20 000 Gg it means the decreasing about almost 35% without sinks from LULUCF. A major share of aggregated emission covers the energy sector by about 69%, the industrial processes sector covers about 19%, the agriculture sector about 7% and the waste sector more than 5%. The solvent use sector covers less than 1% of the total emissions. These shares are determined as emissions in CO_2 of aggregated equivalents (Tab. 5.6).[11]

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 emission 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[7] estimated that the GHG emission inventory of 2010 is 7.8% (according level assessment) and 4.8% (according trend assessment). The calculation uncertainty by using the more sophisticated Tier 2 - Monte Carlo method is evaluated for the solid waste disposal site category, energy sector and industrial processes. The essential result from the Monte Carlo estimation of landfill emissions is fact that total uncertainty was reduced comparable to IPCC default recommended value by Tier 1 (50%). This value is in the interval (–75,65%; +72,03%) for total methane emissions from SWDS according the time series from 1960. The uncertainty assessment of the sector energy, category combustion of fossil fuels was performed by Monte Carlo method and set unsymmetrical interval of uncertainty (–2,84%; 3,89%). The Monte Carlo uncertainty assessment of the industrial processes sector set unsymmetrical interval of uncertainty (–2,49%; 2,52%).

In order to reduce uncertainty of emission inventory, it is necessary to determine and classify key sources and categories. The key sources were selected according to a cumulative contribution to the total emissions. They represent more than 95% of total GHG emissions. Key sources and categories were determined according to the IPCC[7] method with and without LULUCF sector. In 2010, the Slovak Republic determined 29 key sources without LULUCF and 26 key sources with LULUCF to be assessed according to the level. According to anticipated trends was assessed 28 key sources without LULUCF and 31 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. In the next submission the more detailed key source analyses will be prepared.

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. The economic recessions as the impact of the global crisis started in 2008 and other local influences (gas crises in 2009) caused the further decrease of GHG emissions in 2009 (Fig. 5.4).

A comparison of the GDP trend with the trend of aggregate emissions of greenhouse gasses shows that the SR is one of few countries where the trend of emissions is decoupled from the GDP increase. However, by international comparison, the generation of greenhouse gasses per capita still remains high. This is a result of the energy-intensive economy with the higher share of metallurgy, chemical and mineral industry). Without introduction of effective measures the Slovak Republic will contribute to further increase of GHG emissions due to anticipated growth of the GDP and recovery of economic activities. Therefore, the investment strategy to tackle GHG emissions is one of the most important objectives.

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

Tab. 5.6 **Aggregated emissions of GHGs according the sectors in CO_2 *eq*. [Gg] in 1990, 1995 and 2000 – 2010**

	1990	1995	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Energy*	53 906	39 008	35 723	38 220	36 421	37 388	35 844	36 100	34 963	33 113	34 549	30 541	32 008
Industrial Processes**	9 543	8 552	8 294	8 770	9 152	9 021	10 131	9 407	10 252	10 010	9 902	8 375	8 622
Solvent Use	147	122	85	100	132	137	163	172	171	166	167	164	164
Agriculture	7 124	4 358	3 496	3 542	3 482	3 363	3 175	3 171	3 115	3 231	3 129	3 052	3 098
LULUCF	-10 295	-10 974	-10 283	-9 923	-10 285	-9 654	-8 949	-5 282	-7 916	-7 780	-7 099	-7 229	-6 088
Waste	1 091	1 233	1 777	1 811	2 584	2 502	2 467	2 346	2 533	2 363	2 370	2 164	2 222
Total with LULUCF	61 516	42 298	39 092	42 519	41 487	42 757	42 832	45 914	43 117	41 103	43 018	37 068	40 026

Emissions, as submitted in December 7, 2012
** including transport   ** including F-gases*

Fig. 5.4 **Aggregated emissions of GHGs in 2010**