

AIR QUALITY REPORT OF THE SLOVAK REPUBLIC

2025

ANNEX

AIR QUALITY ASSESSMENT IN AGGLOMERATION KOŠICE AND KOŠICE REGION

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1 DESCRIPTION OF TERRITORY OF AGGLOMERATION KOŠICE AND KOŠICE REGION IN TERMS OF AIR QUALITY

For the purposes of air quality assessment, the territory of Slovakia is divided into zones and agglomerations¹.

- **The Košice Agglomeration** comprises the City of Košice and the municipalities of Bočiar, Haniska, Sokolany and Veľká Ida,
- **The Košice Region** covers the entire Košice Self-Governing Region, excluding the territory of the Košice Agglomeration.

According to data from the Statistical Office of the Slovak Republic, the **average population density** in the Košice Self-Governing Region is **115 inhabitants per km²**.

The highest population density is recorded in **Košice III District**, with **1,630 inhabitants per km²**, while **Sobrance District** has the lowest population density, at **41 inhabitants per km²**. For comparison, the **average population density in the Slovak Republic** was **111 inhabitants per km²** on the same reference date.

1.1 Košice Agglomeration

Košice is located in the Hornád valley in the Košice basin, and according to the orographic classification belongs to the Inner Carpathians. From the southwest, it extends into the Slovak Karst region, to the north lies the Slovak Ore Mountains, and to the east of the city are the Slanské vrchy Mountains. Wind conditions in Košice are characterised by a prevailing flow from the north, the area is relatively well-ventilated.

Air pollution sources in agglomeration Košice

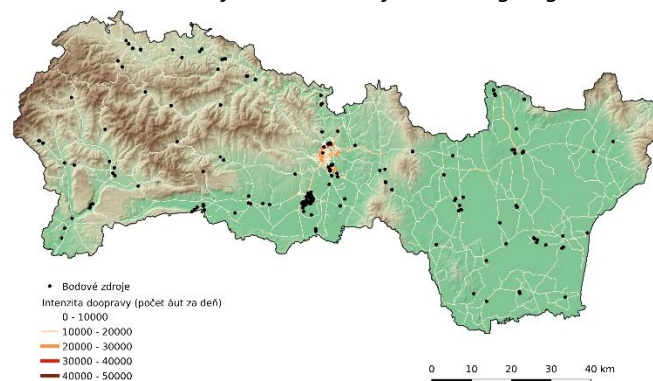
In the Košice agglomeration, the Košice-Šaca district, there is an industrial complex focused on iron and steel metallurgy and coke production, which is the dominant industrial source of air pollution. Other industrial sources include cement plants. The air quality in the municipalities of Veľká Ida, Haniska, Sokolany and Bočiar and to a lesser extent also in Košice is influenced by pollution sources from the nearby industrial complex. A relatively favourable circumstance here is the prevailing wind flow from the north. Air quality here is also affected by heating households with solid fuel

Tab. 1.1. contains the traffic intensity on major roads in agglomeration according to the national transport census in 2022 and 2023)³. **Fig. 1.1** shows road sections with higher traffic intensity, which were processed by the Transport Research Centre (*Centrum dopravného výzkumu*, CDV) for the year 2025. The map also shows the locations of point sources.

Tab. 1.1 Number of vehicles on the busiest roads in the agglomeration (vehicle/day)

Motorway / road	Number of vehicles	Heavy goods vehicles	Passenger cars
n. 20 – KE III	38 939	6 178	32 684
n. 16 KE IV	52 733	9 400	43 159
n. 19 KE III	18 151	2 137	15 960
n. 552 KE IV	18 273	2 706	15 512
n. 17	21 993	4 264	17 608

Fig.1.1 Road Network of the Košice Self-Governing Region.



¹ https://www.shmu.sk/sk/?page=1&id=oko_info_az

1.2 Košice Region

The relief of the eastern part of the Košice Region is mainly flat thanks to the Eastern Slovak Plain, which is separated from the Košice Basin by the Slanské Hills. On the border with the Prešov region stretch Vihorlat Mountains, from west to east stretches the Hornád Basin. In the western, more mountainous part region, the Volovské vrchy Mountains are separated from the Slovak Karst by the Rožňava Basin. Hornád Basin in the northern part of the territory extends into the southern part of the Prešov region. The highest point of the Košice Region is Stolica Hill (1 476 m a. s. l.) in the Stolice Hills, the lowest point is 94 m a. s. l.

Sources of air pollution in the Košice Region

Tab. 1.2 contains the traffic intensity on major roads in the region according to the national transport census in 2022 and 2023).

Tab. 1.2 Number of vehicles on the most frequented roads of the Košice Region.(vehicle/day)

District	Motorway / road	Number of vehicles	Heavy goods vehicles	Passenger cars
Spišská Nová Ves	n. 533	15 077	1 562	13 398
Trebišov	n. 19	13 653	2 467	11 154
	n. 79	9 988	1 604	8 335
Michalovce	n. 19	20 536	2 444	18 007
Strážske	n. 18	9 269	1 566	7 661
Sobrance	n. 19	7 976	1 045	6 903
Rožňava	n. 16	10 980	1 890	9 045
	n. 526	11 910	866	10 973
Košice-okolie	16	13 192	1 773	11 352
	n. 526 Moldava	10 239	839	9 362

Fig. 1.2 Distribution of Heating Fuels in Detached Houses in the Košice Region ².

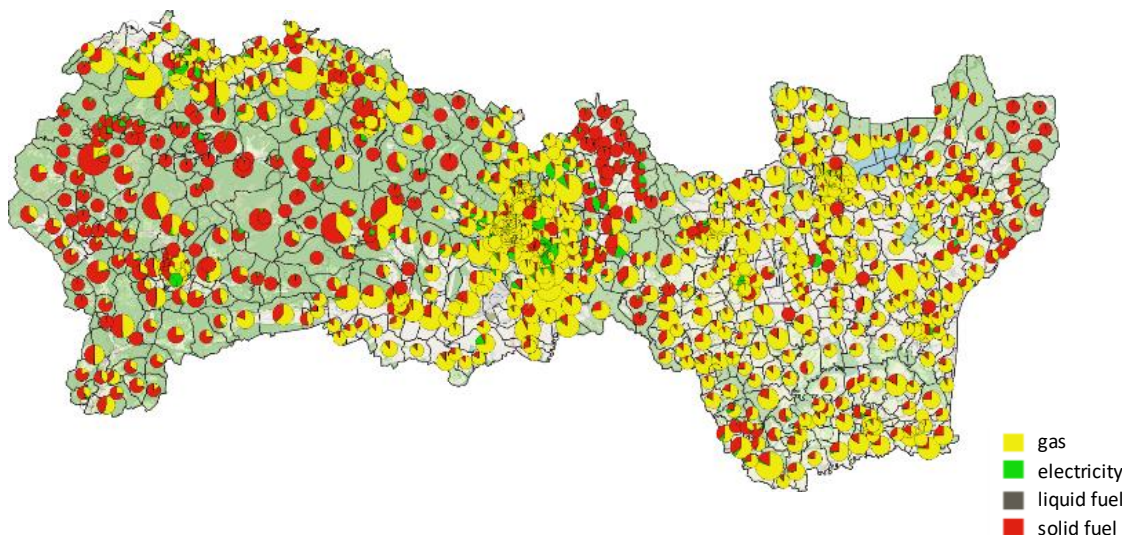


Fig. 1.2 shows the shares of fuel Types in the heating of houses and block of flats in each municipality (or basic settlement units) of the Košice Region, showing that the spatial distribution of Types of fuels is not geographically homogeneous. In the western part, in the north of the Košice basin and in the extreme north-east, solid fuels predominate, in Košice and its surroundings and in the eastern part gas is largely used for heating.

² <https://www.scitanie.sk>

2 AIR QUALITY MONITORING STATIONS IN KOŠICE AGGLOMERATION AND KOŠICE REGION

Tab. 2.1 and Tab. 2.2 contain information on air quality monitoring stations in the agglomeration Košice and the Košice Region:

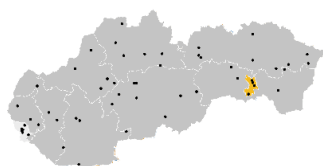
- international Eol code, station characteristics according to the dominant sources of air pollution (traffic, background, industrial), Type of monitored area (urban, suburban, rural/regional) and geographical coordinates;
- monitoring programme. Continuous monitoring automatic instruments provide hourly average concentrations of PM₁₀, PM_{2.5}, nitrogen oxides, sulphur dioxide, ozone, carbon monoxide, benzene and mercury. The SHMÚ test laboratory analyses heavy metals and polycyclic aromatic hydrocarbons as part of manual monitoring, resulting in 24-hour average concentrations.

2.1 Košice Agglomeration

Air quality monitoring in Košice began in 1971. Currently, air quality is being monitored at four stations in the area. The Košice, Štefánikova station reflects the influence of road traffic, while the monitoring stations Košice, Amurská, and Košice, Ďumbierska characterise urban and suburban background pollution. The monitoring station in Veľká Ida* is located near the railway station in an open grassy area on the south-eastern edge of the municipality. To the northeast of the station, there is a metallurgical complex producing iron, steel, and coke (U. S. Steel site), and to the southeast of the station is mostly grassed waste dump.

Tab. 2.1 Air quality monitoring programme in Košice agglomeration.

Košice Agglomeration							Monitoring programme									
District	Eol code	Station name	Type		Geographical		Altitude [m]	Continuous								Manual
			areas	stations	length	width		PM ₁₀	PM _{2.5}	NO, NO ₂	SO ₂	O ₃	CO	Benzene	Hg	As, Cd, Ni, Pb
Košice I	SK0264A	Košice, Amurská	U	B	21°17'08"	48°41'25"	201									
Košice I	SK0267A	Košice, Štefánikova	U	T	21°15'32"	48°43'35"	209									
Košice I	SK0016A	Košice, Ďumbierska	S	B	21°14'42"	48°45'12"	240									
Košice surroundings	SK0018A	Veľká Ida, Letná	S	I	21°10'31"	48°35'32"	209									
Total								3	3	1	1	1	2	1	0	1



Area Type:
 U – urban
 S – semi-urban
 R – rural (regional)

Station Type:
 B – background
 T – traffic
 I – industrial

2.2 Košice Region

Air quality monitoring in the Košice Region is complicated due to the diversity of terrain and the size of the area. There are four monitoring stations in the region, two of the sites have relatively long-term history of measurements. The beginnings of air quality monitoring in Krompachy and Strážske date back to the 1980s. The goal was to capture the impact of industrial activities. Over the years, the impact of industrial sources has declined, and the station in Krompachy is categorised as urban traffic, and in Strážske as urban background. In 2020, a suburban monitoring station was added in Trebišov.

The station at Kojšovská hora is located at a radar site at an altitude of 1 232 m a. s. l., in the eastern part of the Snina district. It characterises the air quality in a less polluted area. Air quality monitoring started here in 2009.

Tab. 2.2 Air quality monitoring programme in Košice Region.

Košice Region (without agglomeration Košice)							Monitoring programme										
							Continuous								Manual		
District	Eol code	Station name	Type		Geographical		Altitude [m]	PM ₁₀	PM _{2,5}	NO, NO ₂	SO ₂	O ₃	CO	Benzene	Hg	As, Cd, Ni, Pb	B(a)P
			areas	stations	length	width											
Gelnica	SK0042A	Kojšovská hoľa	R	B	20°59'14"	48°46'58"	1232										
Michalovce	SK0030A	Strážske, Mierová	U	B	21°50'15"	48°52'27"	133										
Spišská Nová Ves	SK0265A	Krompachy, SNP	U	T	20°52'26"	48°54'56"	372										
Trebišov	SK0073A	Trebišov, T. G. Masaryka	S	B	21°42'45"	48°37'42"	107										
							Total	3	3	3	1	2	1	1	0	0	1



3 ASSESSMENT OF THE AIR QUALITY IN KOŠICE AGGLOMERATION AND KOŠICE REGION

This chapter provides a more detailed analysis of air quality based on the results of monitoring carried out in the Košice Agglomeration and the Košice Region in 2025.

The Košice Agglomeration consists of the City of Košice together with the municipalities of Veľká Ida, Haniska, Sokoľany and Bočiar. The reason for defining this specific area for air quality assessment is that the metallurgical complex focused on the production of iron, steel and coke, located south of Košice near the above-mentioned municipalities, has a significant impact on air quality throughout the agglomeration.

The Košice Region comprises the territory of the region outside the Košice Agglomeration.

Tab. 3.1 Assessment of air pollution against limit values for the protection of human health and the PM₁₀ smog warning system in the Košice Agglomeration and the Košice Region.

AGGLOMERATION Zone	Pollutant Averaging period	Type	Protection of human health								IT ²⁾	AT ²⁾	
			SO ₂		NO ₂		PM ₁₀		PM _{2,5}	CO	O ₃	PM ₁₀	PM ₁₀
	Parameter	Areas / stations	1 h	24 h	1 h	1 year	24 h	1 year	1 year	8 h ¹⁾	8 h ³⁾	12 h	12 h
			number of exceedances	number of exceedances	number of exceedances	average	number of exceedances	average	average	average	average	duration of exceedance [h]	duration of exceedance [h]
			350	125	200	40	50	40	20	10 000	120	100	150
			24	3	18		35				25		
Limit value [µg·m ⁻³] Maximum number of exceedances													
KOŠICE	Košice, Štefánikova	UT	0	0	0	20	24	24	15	1453		9	0
	Košice, Amurská	UB					13	21	15				0
	Košice, Ďumbierska	UB									7		
	Veľká Ida, Letná	SI					42	31	20	2011		73	0
Košice Region	Kojšovská hoľa	RB			0	2					17		0
	Trebišov, T. G. Masaryka	SB			0	10	10	20	15		3		0
	Strážske, Mierová	UB					4	19	14				0
	Krompachy, SNP	UT	0	0	0	12	14	22	16	1565			0

 $\geq 90\%$ valid measures

Exceedances of the limit value are marked in red.

¹⁾ maximum 8 hour concentration

²⁾ IT, AT – duration of exceedances (in hours) of the information threshold (IT) and alert threshold (AT) for PM₁₀

In accordance with Decree of the Ministry of Environment of the Slovak Republic No. 250/2023 Coll. on Air Quality, as amended, the required proportion of valid values was met at the monitoring stations.

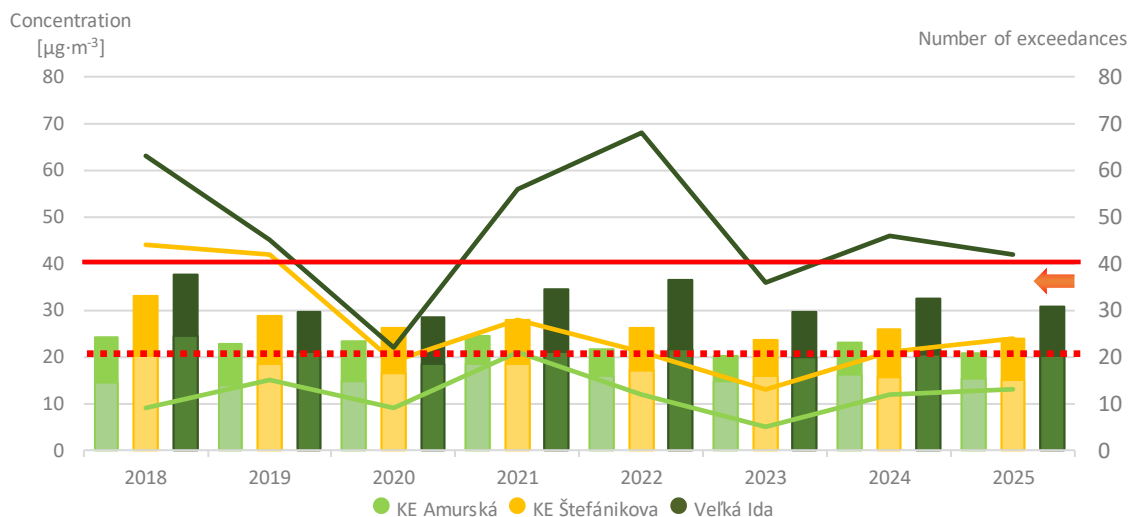
³⁾ Number of days with of the maximum daily eight-hour concentration $> 120 \mu\text{g}\cdot\text{m}^{-3}$, average over 3 calendar years.

3.1 KOŠICE AGGLOMERATION

3.1.1 PM₁₀ and PM_{2,5}

Fig. 3.1 shows the average annual concentrations of PM₁₀, PM_{2,5} and the number of days with average daily PM₁₀ concentrations above 50 $\mu\text{g}\cdot\text{m}^{-3}$ according to the results of measurements at monitoring stations in the agglomeration Košice in 2018–2025.

Fig. 3.1 Average annual concentrations of PM₁₀, PM_{2,5} and the number of exceedances of the daily limit value for PM₁₀.



PM₁₀ dark column colour, **PM_{2,5}** – light column colour; **number of exceedances** – solid lines. Horizontal lines show limit values (LH), red solid PM₁₀ (average annual concentration: 40 $\mu\text{g}\cdot\text{m}^{-3}$); red striped PM_{2,5} (average annual concentration: 20 $\mu\text{g}\cdot\text{m}^{-3}$); red solid arrow – LH number of exceedances (average daily PM₁₀ concentration 50 $\mu\text{g}\cdot\text{m}^{-3}$ max. number of exceedances 35/calendar year).

The annual average concentrations of PM₁₀ (40 $\mu\text{g}\cdot\text{m}^{-3}$) and PM_{2,5} (20 $\mu\text{g}\cdot\text{m}^{-3}$) in the Košice agglomeration did not exceed the respective limit values in 2025. At the Veľká Ida monitoring station, the annual average PM_{2,5} concentration reached the limit value of 20 $\mu\text{g}\cdot\text{m}^{-3}$.

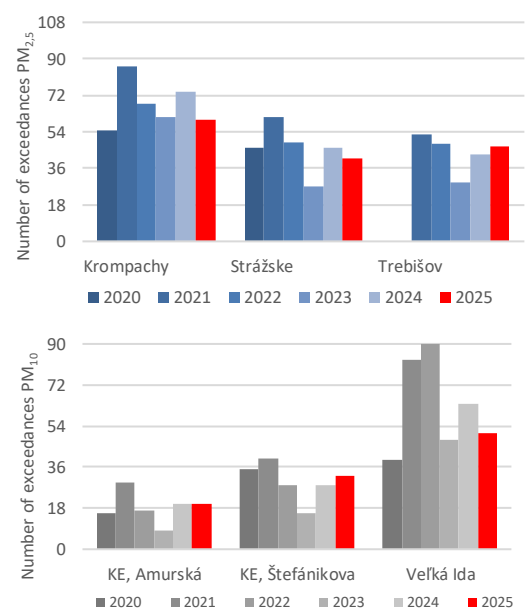
The daily limit value for PM₁₀ was exceeded at the Veľká Ida monitoring station, where 42 exceedances of the daily limit were recorded.

On **Fig. 3.1** it can be observed that, unlike in other zones, the concentration values do not exhibit a clear downward trend. Instead, they show a variable pattern, with concentrations being strongly influenced by the atmospheric dispersion conditions prevailing in each particular year.

■ Assessment of Compliance with the Requirements of the New Directive

As part of the European Green Deal, the European Union has developed a Zero Pollution Action Plan, which sets out a vision for 2050. Its objective is to reduce air pollution by that year to levels that are no longer considered harmful to human health and natural ecosystems. The Action Plan

Fig. 3.2 Number of exceedances of the PM_{2,5} and PM₁₀ daily limit values applicable from 2030*.



* The average daily concentration of PM_{2,5} > 25 $\mu\text{g}\cdot\text{m}^{-3}$ and PM₁₀ > 45 $\mu\text{g}\cdot\text{m}^{-3}$ may be exceeded a maximum of 18 times per year. The limit value applies from 1 January 2030.

includes new EU limit values and target values for many pollutants. The greatest challenge for Slovakia will be achieving compliance with the limit values for PM_{2,5}. For PM_{2,5}, the Plan introduces a daily limit value of 25 µg·m⁻³, which must not be exceeded more than 18 times per year (to be achieved by 1 January 2030).

The daily PM₁₀ limit value under the new EU Air Quality Directive (45 µg·m⁻³, with a maximum of 18 exceedances per year) would have been exceeded at all air quality monitoring stations (AQMSs) in the Košice agglomeration.

The new annual PM₁₀ limit value (20 µg·m⁻³) would also have been exceeded at all air quality monitoring stations (AQMSs) in the Košice agglomeration..

The new annual PM_{2,5} limit value (10 µg·m⁻³) would have been exceeded at all AMSs. The daily PM₁₀ limit value (25 µg·m⁻³, with a maximum of 18 exceedances) would likewise have been exceeded at all AMS in the Košice agglomeration.

Fig. 3.2 (top) shows the number of days exceeding the new EU daily limit value for PM_{2,5}. The highest number of exceedances was recorded at the Veľká Ida AMS (72 exceedances). A high number of exceedances would also have been recorded at the Košice, Amurská AMS, with more than 50 exceedances, and at the Košice, Štefánikova AMS, with more than 45 exceedances.

Fig. 3.2 (bottom) illustrates the number of exceedances of the daily PM₁₀ limit value (45 µg·m⁻³, with a maximum of 18 exceedances). None of the AMSs in the Košice agglomeration would have complied with the limit value.

The highest number of exceedances was recorded at the Veľká Ida AMS, with 51 exceedances. At the Košice, Štefánikova AMS, 32 exceedances were recorded, while the Košice, Amurská AMS would have exceeded the limit only slightly, with 20 exceedances.

The failure to meet the stricter limit values for particulate matter at all AMSs in the agglomeration indicates a high emission burden across the entire area. Košice is the only zone in Slovakia where, based on the 2025 data, none of the monitoring stations would comply with the new PM limit values. The fact that the Košice agglomeration does not meet the new limit values at any monitoring station despite relatively favourable dispersion conditions highlights the dominant influence of emissions from industrial sources of pollution. This is also supported by the annual patterns of particulate matter and benzo(a)pyrene concentrations, which, unlike in most other zones, do not show a pronounced decrease outside the heating season.

To achieve compliance with the stricter limit values, further reductions in this type of emissions will therefore be crucial. In this context, the planned modernization of the production plant under its new owner, Nippon Steel, represents a significant opportunity, as the company has announced investments in the modernization of production technologies. Successful implementation of these measures should make a substantial contribution to improving air quality in the Košice agglomeration.

3.1.2 Nitrogen dioxide

The main source of NO₂ emissions is road traffic. NO₂ monitoring in the zone is carried out at the traffic AMS Košice, Štefánikova. The annual average concentration (20 µg·m⁻³) did not exceed the current limit value of 40 µg·m⁻³. Compared with the reference period, a significant decrease was observed (**Fig. 3.4**).

Fig. 3.4 shows the NO₂ concentration values. The highest concentrations were recorded in February, which is associated with poorer dispersion conditions. During the summer months, concentrations were significantly lower, due to both reduced traffic intensity (holidays, vacations) and more favourable dispersion conditions during this period.

Fig. 3.3 Average NO_2 concentrations ($\mu\text{g}\cdot\text{m}^{-3}$); comparison of 2025 with the period 2017–2024.

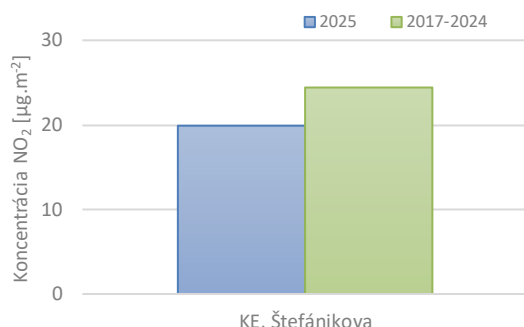
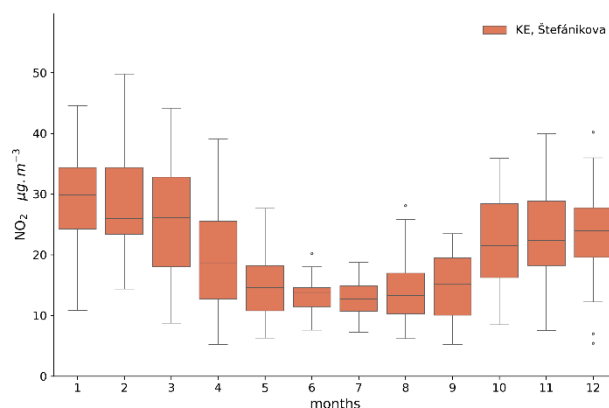


Fig. 3.4 Boxplots of NO_2 concentration by months.



■ Assessment of Compliance with the Requirements of the New Directive

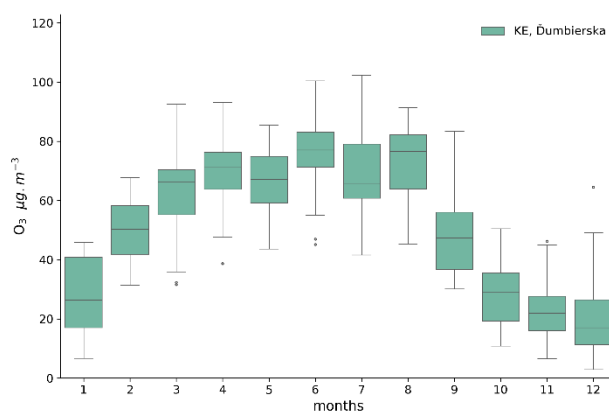
The new EU annual limit value for NO_2 ($20 \mu\text{g}\cdot\text{m}^{-3}$), which will enter into force in 2030, would not be exceeded at the Košice, Štefánikova AMS. The concentration was at the level of the future limit value, representing a favourable starting point for meeting the requirements of the Directive by 2030.

3.1.3 Ozone

Ozone monitoring is carried out at the background AMS Košice, Ďumbierska. The target value for O_3 for the protection of human health was not exceeded.

The highest ground-level ozone concentrations generally occur during the warm months (Fig. 3.5); in 2025, the highest values were recorded in July. The graph shows a typical seasonal pattern of O_3 concentrations, with pronounced differences between concentrations in the warm and cold seasons.

Fig. 3.5 Box plots of O_3 concentration by months.



Tab. 3.2 Number of days with exceedances of the target value for ground-level ozone for the protection of human health.

Station	2023	2024	2025	Average 2023 – 2025
Košice, Ďumbierska	4	15	2	7

■ $\geq 90\%$ of the required valid data

Note: According to Decree of the Ministry of the Environment of the Slovak Republic No. 250/2023 Coll. on air quality, the target value for the protection of human health for ground-level ozone is defined as follows: the maximum daily 8-hour mean concentration must not exceed $120 \mu\text{g}\cdot\text{m}^{-3}$ on more than 25 days per calendar year, averaged over three years.

■ Assessment of Compliance with the Requirements of the New Directive

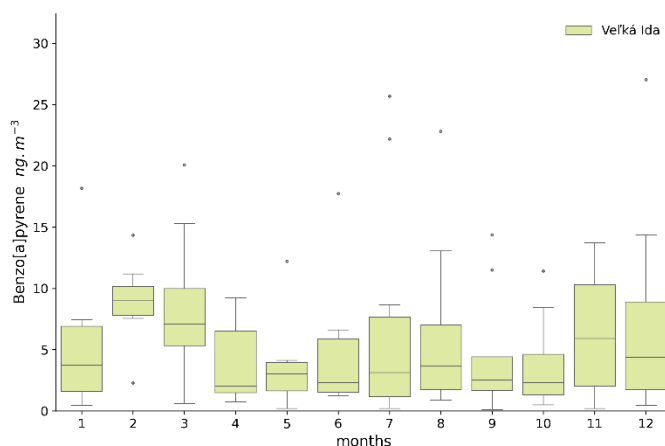
The stricter EU limit value for O₃ (18 days with exceedances of the maximum daily 8-hour average concentration) would not have been exceeded.

3.1.4 Benzo(a)pyrene

Benzo(a)pyrene [B(a)P] is monitored in the Košice agglomeration at the suburban industrial station in **Veľká Ida**. The concentrations of this pollutant are presented in **Tab. 3.3**. The target value for B(a)P was exceeded almost sixfold (5.8 µg·m⁻³). The site is significantly affected by emissions from the metallurgical complex, as confirmed by the relatively uniform monthly pattern of concentrations throughout the year (**Fig. 3.6**). The maximum measured concentrations exceeded 25 µg·m⁻³.

Unlike at other monitoring stations, domestic heating is not the main source of pollution. B(a)P concentrations were very high even during the summer months; the second-highest concentration was recorded in July, and the fourth-highest concentrations were measured in August.

Fig. 3.6 Boxplots of B(a)P concentration by months.



Tab. 3.3 Annual mean concentrations of benzo(a)pyrene in years 2020 – 2025.

	2020	2021	2022	2023	2024	2025
Target value [ng·m ⁻³]	1,0	1,0	1,0	1,0	1,0	1,0
Veľká Ida, Letná	4,6	6,1	5,4	4,9	6,2	5,8

≥ 90% of valid measurements

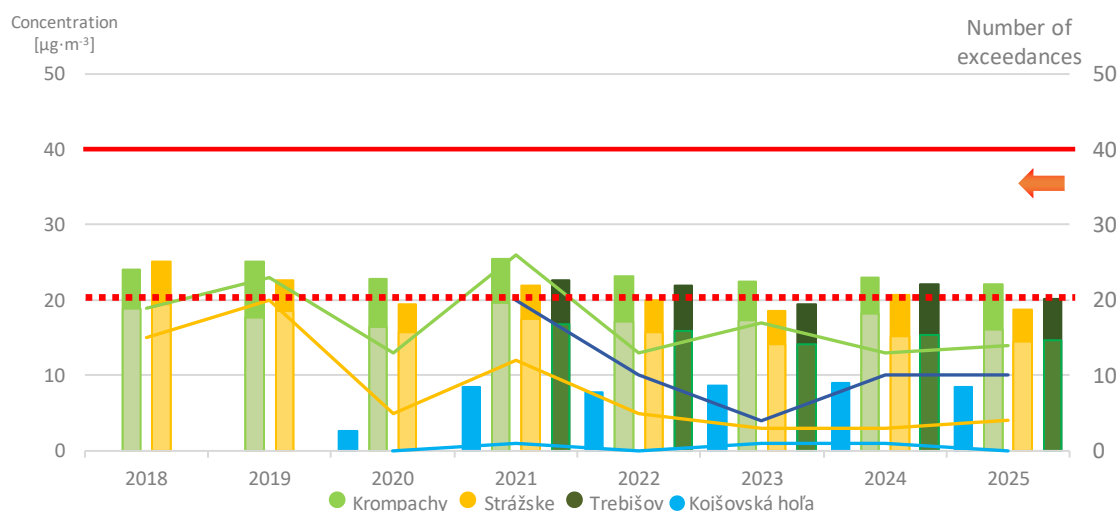
Exceedances of the target value are marked in red.

3.2 KOŠICE REGION

3.2.1 PM₁₀ and PM_{2,5}

Fig. 3.7 shows the annual average concentrations of PM₁₀ and PM_{2,5}, as well as the number of days with an average daily PM₁₀ concentration above 50 µg·m⁻³, based on measurement results from monitoring stations in the Košice Region during the years 2018–2025.

Fig. 3.7 Annual mean concentrations of PM₁₀ and PM_{2,5} and the number of exceedances of the daily PM₁₀ limit value.



Columns: PM₁₀ – dark-coloured columns; PM_{2,5} – light-coloured columns; horizontal lines – number of exceedances.

Red lines represent the limit values (LV): solid line – PM₁₀ (annual average concentration: 40 µg·m⁻³); dashed line – PM_{2,5} (annual average concentration: 20 µg·m⁻³); arrow – LV for the number of exceedances (daily average PM₁₀ concentration of 50 µg·m⁻³, maximum number of exceedances: 35 per calendar year).

The annual limit values for PM₁₀ (40 µg·m⁻³) and PM_{2,5} (20 µg·m⁻³) **were not exceeded** in the Košice Region in 2025.

The daily PM₁₀ limit value (50 µg·m⁻³), which may be exceeded a maximum of 35 times per year, was not exceeded at any monitoring station.

■ Assessment of Compliance with the Requirements of the New Directive

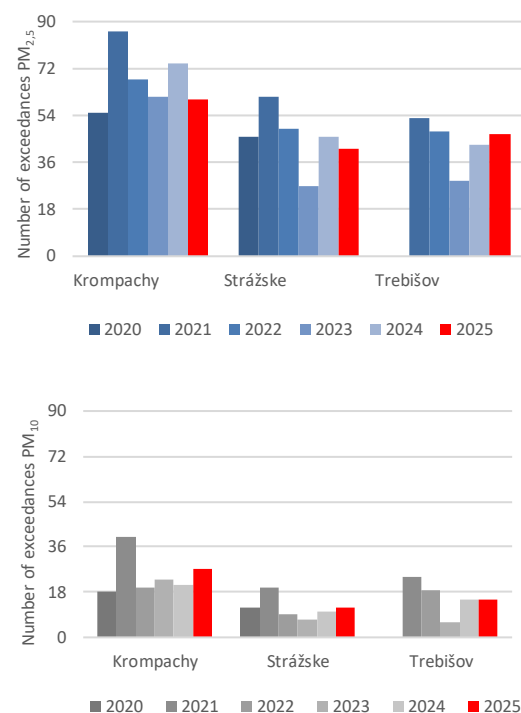
The daily PM₁₀ limit value under the new EU Directive (45 µg·m⁻³), with a maximum of 18 exceedances, would have been exceeded in the Košice Region at the Krompachy AMS. The annual PM₁₀ limit value (20 µg·m⁻³) would likewise have been exceeded at the Krompachy AMS (22 µg·m⁻³), while the Trebišov AMS would have reached the upper limit value threshold.

The daily PM_{2,5} limit value under the new EU Directive (25 µg·m⁻³), with a maximum of 18 exceedances, would have been exceeded at all AMS in the Košice Region. The annual PM_{2,5} limit value (10 µg·m⁻³) would also have been exceeded at all AMS.

Fig. 3.8 (top) shows the development of the number of exceedances of the new daily limit value for $PM_{2,5}$. In 2025, the daily limit value would have been exceeded by more than twofold at all AMS in the zone. The highest number of exceedances would have been recorded at the Kropachy AMS (54), Trebišov AMS (47), and Strážske AMS (41). Compared with previous years, no significant decrease can be observed.

Fig. 3.8 (bottom) shows the number of exceedances of the new EU daily PM_{10} limit value. The limit value would have been exceeded at the Kropachy AMS (27 exceedances). At the other AMS, Trebišov (15) and Strážske (12), the number of exceedances would have remained below the limit value with a sufficient margin. Compared with previous years, no significant decrease can be observed.

Fig. 3.8 Number of exceedances of the daily limit values for $PM_{2,5}$ and PM_{10} applicable from 2030*.



* The daily average concentrations of $PM_{2,5} > 25 \mu g \cdot m^{-3}$ and $PM_{10} > 45 \mu g \cdot m^{-3}$ may be exceeded a maximum of 18 times per year; the limit applies from 1 January 2030.

3.2.2 Nitrogen dioxide

Monitoring of nitrogen dioxide (NO_2) concentrations is carried out at three AMS: Kojšovská hoľa, Trebišov, and the traffic AMS Kropachy. The main source of NO_2 emissions is road traffic.

The annual limit value was not exceeded at any AMS. The largest decrease in concentrations compared with the reference period can be observed at the traffic AMS Kropachy (**Fig. 3.9**). With an annual average concentration of $12 \mu g \cdot m^{-3}$, the traffic AMS Kropachy recorded the lowest annual average NO_2 concentration among traffic stations, indicating that the influence of traffic at this location is gradually decreasing. Concentrations at the other AMS remained at levels comparable to the reference period.

The average monthly NO_2 values are shown in **Fig. 3.10**. The highest concentrations were recorded in February.

Fig. 3.9 Average NO_2 concentrations ($\mu g \cdot m^{-3}$); comparison of 2025 with the period 2017–2024.

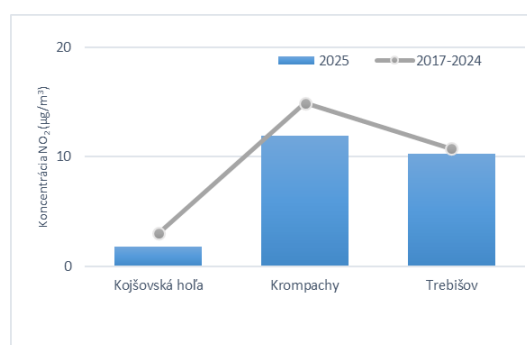
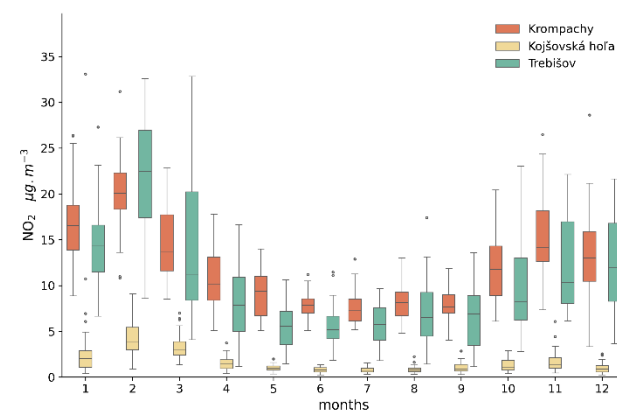


Fig. 3.10 Box plots of NO_2 concentrations by months.



■ Assessment of Compliance with the Requirements of the New Directive

The new EU annual limit value for NO₂ (20 µg·m⁻³) would be met by all AMS in the Košice Region.

The annual average NO₂ concentrations in 2025 were in line with the WHO guideline value (10 µg·m⁻³) at the Kojšovská hoľa AMS (2 µg·m⁻³) and at the Trebišov AMS (10 µg·m⁻³).

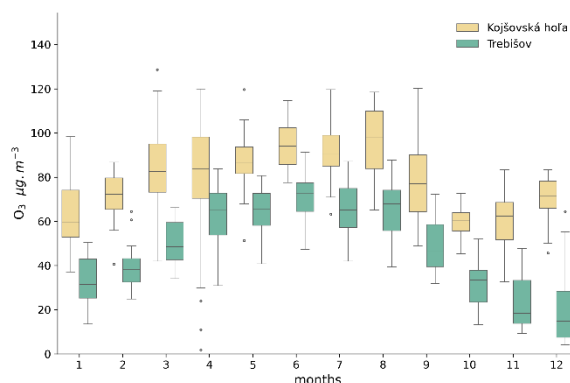
3.2.3 Ozone

Monitoring of ground-level ozone (O₃) in the zone is carried out at two AMS: Trebišov and Kojšovská hoľa.

The target value for O₃ for the protection of human health was not exceeded at any AMS (Tab. 3.4).

The Kojšovská hoľa station is located at an altitude of more than 1000 m above sea level, which results in high ozone concentrations throughout the year. This phenomenon is typical for high-altitude stations, which are influenced by stratospheric O₃ transport and stronger solar radiation, promoting photochemical processes.

Fig. 3.11 Box plots of O₃ concentrations by months.



At both AMS, a typical seasonal pattern can be observed, with the highest ozone concentrations occurring during the summer months (Fig. 3.11). This is related to the higher intensity of solar radiation required for the formation of ground-level ozone. The lowest values are observed in winter (November–February), when solar radiation is weaker and atmospheric conditions are less favourable for ozone formation.

Tab. 3.5 Number of days with exceedances of the target value for ground-level ozone for the protection of human health.

Station	2023	2024	2025	Average 2023 – 2025
Kojšovská hoľa	*17	11	23	17
Trebišov, T. G. Masaryka	3	1	5	3

■ ≥ 90% of the required valid data

Note: According to Decree of the Ministry of the Environment of the Slovak Republic No. 250/2023 Coll. on air quality, the target value for the protection of human health for ground-level ozone is defined as follows: the maximum daily 8-hour mean concentration must not exceed 120 µg·m⁻³ on more than 25 days per calendar year, averaged over three years.

■ Assessment of Compliance with the Requirements of the New Directive

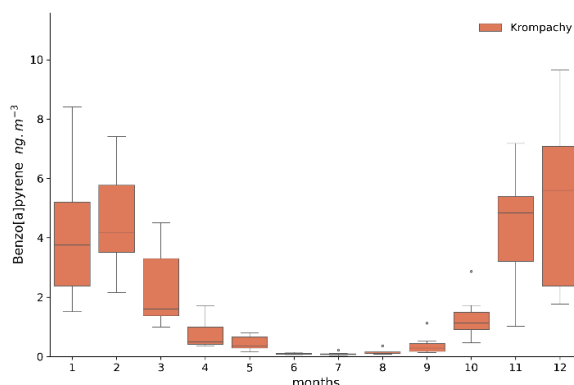
The stricter EU limit value for O₃ (18 days with exceedances of the maximum daily 8-hour average concentration, average over 3 calendar years.) would not have been exceeded at any monitoring station.

3.2.4 Benzo(a)pyrene

Benzo(a)pyrene [B(a)P] is monitored in the Košice Region at the Krompachy AMS. The target value of $1 \text{ ng}\cdot\text{m}^{-3}$ was exceeded twofold in 2025 (Tab. 3.5), and the development of concentrations does not show a decreasing trend, unlike in other zones.

As shown in Fig. 3.12, B(a)P concentrations in Krompachy exhibit a pronounced seasonal pattern, with maximum values occurring during the winter months. Outside the heating season, concentrations are very low or negligible. This represents a significant contrast compared with the Veľká Ida site (Fig. 3.6), indicating the strong influence of domestic heating during the winter period. The use of solid fuels for heating is the main source of B(a)P emissions, a carcinogenic pollutant, and has a negative impact on air quality during the winter season.

Fig. 3.11 Box plot of benzo[a]pyrene by months



Tab. 3.6 Annual mean concentrations of benzo(a)pyrene in 2020–2025.

	2020	2021	2022	2023	2024	2025
Target value [$\text{ng}\cdot\text{m}^{-3}$]	1,0	1,0	1,0	1,0	1,0	1,0
Krompachy, SNP	2,1	2,2	2,2	2,1	1,8	2,0

■ $\geq 90\%$ valid measurements

Exceedances of the target value are marked in red.

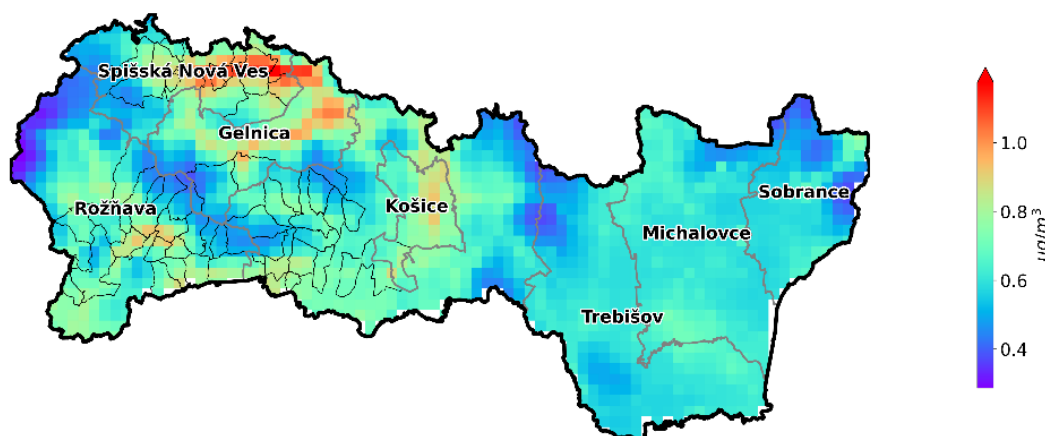
3.2.5 Benzene

The modelling outputs (Fig. 3.14) show spatial differences in benzene concentrations within the zone. Relatively higher values occur in the northwestern part of the region, in the districts of Spišská Nová Ves and Gelnica, as well as in the vicinity of Košice, reflecting the influence of local emission sources and traffic.

However, even in these areas, the modelled concentrations remain well below the benzene limit value, indicating a favourable level of air pollution by this pollutant.

The modelled concentrations at the AMS locations Košice, Štefánikova and Krompachy were calculated at levels of $0.9 \text{ }\mu\text{g}\cdot\text{m}^{-3}$ and $1.0 \text{ }\mu\text{g}\cdot\text{m}^{-3}$, respectively.

Fig. 3.12 Annual mean benzene concentration according to the CMAQ model output.



4 AIR QUALITY MODELLING

Fig. 4.1 presents the PM_{10} modelling results calculated using the RIO model in combination with IDW-R (a more detailed description of the method is provided in Chapter 4).

Based on the results of mathematical modelling using the RIO and IDW-R interpolation model, the highest PM_{10} concentrations are expected to occur in the southern part of the Košice agglomeration (in the municipalities of Veľká Ida, Sokolany, Haniska, and Boniar), influenced by emissions from the metallurgical complex.

In the Košice Region, the highest PM_{10} concentrations are likely to occur mainly in the Abov area and in the districts of Rožňava, Spišská Nová Ves, and Gelnica (**Fig. 4.1**). The same locations would also show the highest number of exceedances of the daily PM_{10} limit value based on the modelling results (**Fig. 4.2**).

Fig. 4.1 Annual mean concentrations of PM_{10} according to the results of the RIO and IDW-R models.

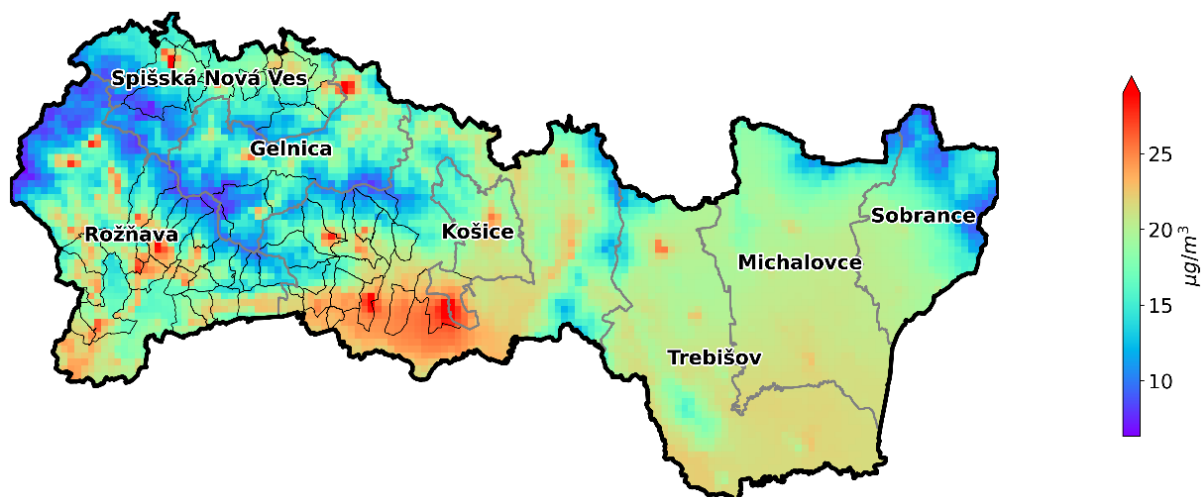
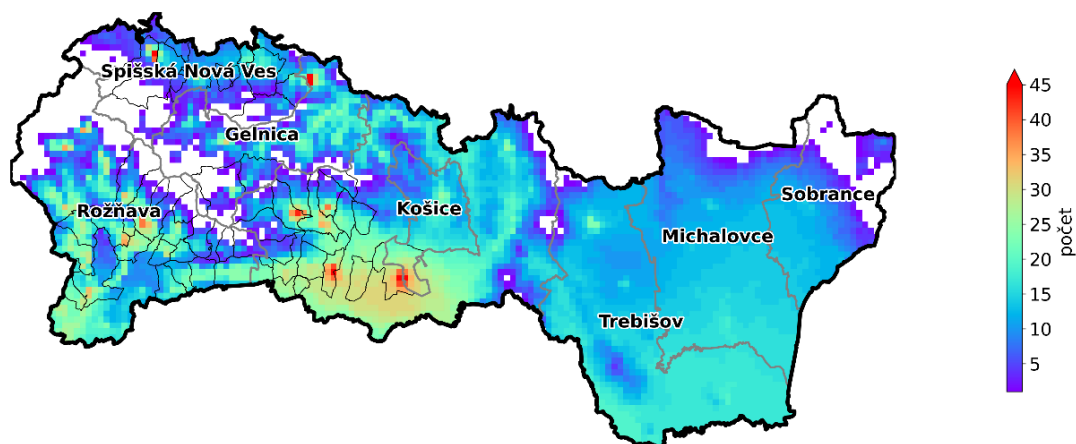


Fig. 4.2 Number of exceedances of the PM_{10} daily limit value. Only areas with a non-zero number of exceedances are shown.



The map in **Fig. 4.3** shows the spatial distribution of annual average $PM_{2,5}$ concentrations based on the output of the RIO model combined with the IDW-R model. According to the model results, the annual average $PM_{2,5}$ concentration exceeded the WHO guideline value across the entire zone, except for uninhabited mountainous areas (WHO guideline values are stricter than EU limit values).

The spatial distribution of annual average $PM_{2,5}$ concentrations according to the RIO and IDW-R models shows a similar pattern to PM_{10} . The highest values, besides the Košice agglomeration, occur in the Abov area and in the districts of Rožňava and Spišská Nová Ves.

Fig. 4.3 Annual mean concentrations of $PM_{2,5}$ according to the results of RIO, IDW-R.

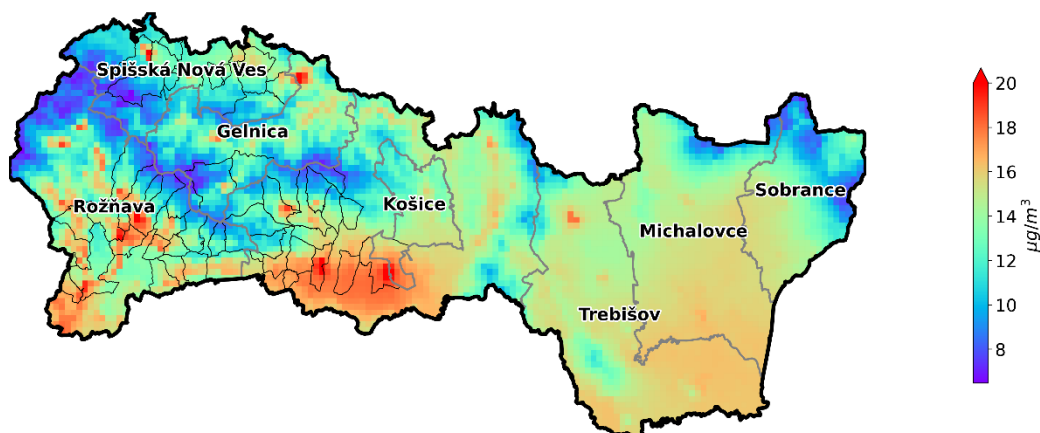
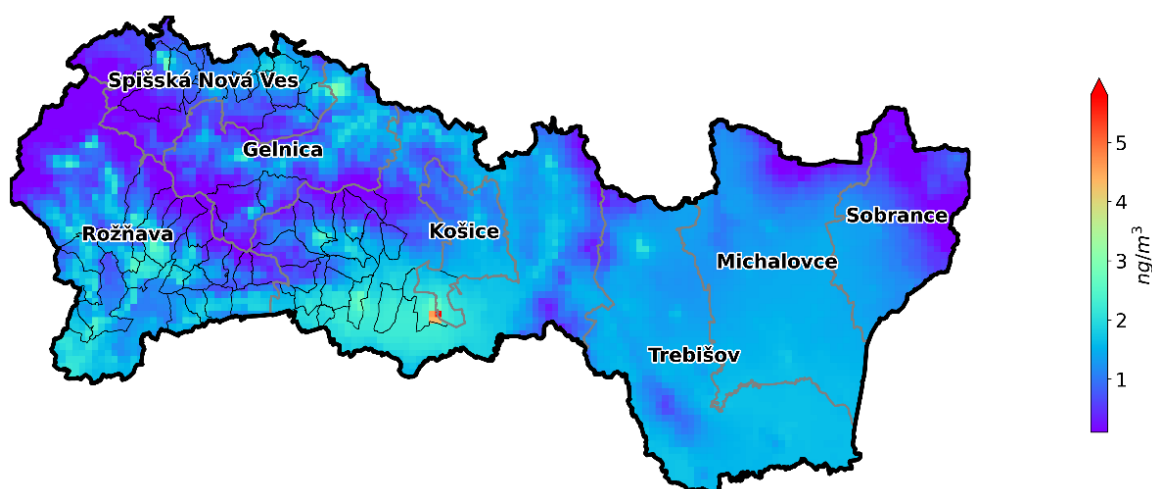


Fig. 4.4 shows the spatial distribution of the annual average B(a)P concentration based on the output of the RIO and IDW-R models. Since the model is based on measured data (and auxiliary fields), the outputs over the large area of the Košice Region are subject to considerable uncertainty.

The model may overestimate B(a)P concentrations, particularly in the vicinity of Košice and the East Slovak Lowland. This is mainly due to the strong influence of the high annual average concentration measured at Veľká Ida. Together with Krompachy, Veľká Ida is one of the two stations in the Košice Region where B(a)P is monitored.

To obtain a more detailed understanding of the spatial distribution, high-resolution modelling using detailed emission data is required (i.e., information on the amount and type of fuels used, the types of heating appliances used in households, etc.). The most significant source of B(a)P emissions in the Košice agglomeration is coke production, with domestic heating contributing to a lesser extent. The situation is different in the Košice Region, where the dominant source is domestic heating with solid fuels, particularly insufficiently dried wood or unsuitable fuels (various types of waste).

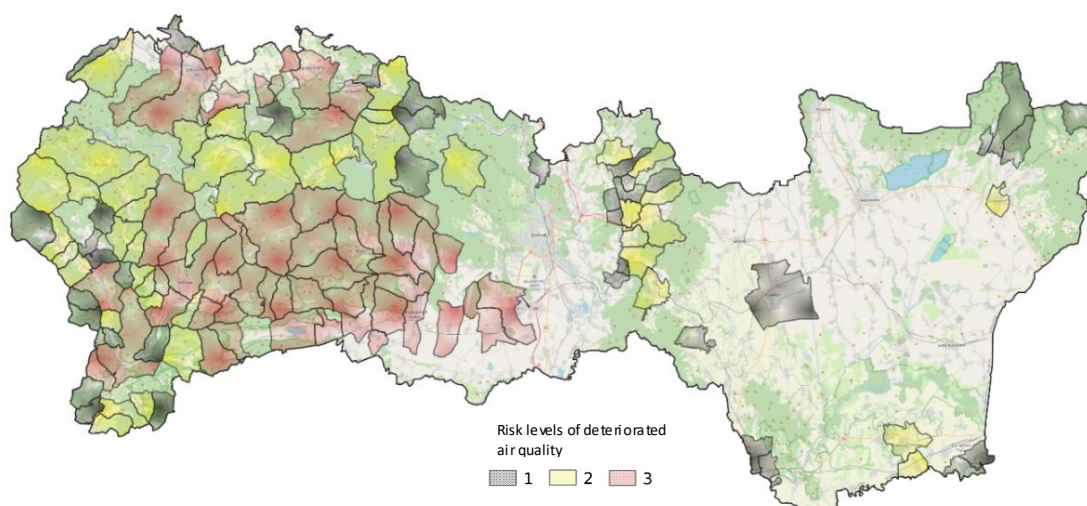
Fig. 4.4 Annual mean concentrations of benzo(a)pyrene according to the results of RIO, IDW-R.



4.1 Risk areas

Fig. 4.5 shows municipalities at risk of deteriorated air quality, identified using the Integrated Assessment Method for municipalities. Degree 3 corresponds to the highest probability of being affected by air pollution. The methodology includes the extent of household solid fuel heating, the influence of unfavourable dispersion conditions from both short-term and long-term perspectives, results of the CMAQ chemical transport model, the RIO interpolation model, and high-resolution CALPUFF modelling results for selected domains with a potential risk of deteriorated air quality.

Fig. 4.5 Map of risk areas (municipalities and districts) in the Košice Region and the Košice agglomeration



Municipalities where high-resolution modelling identified exceedances of PM limit values, the NO₂ limit value, or the B(a)P target value were automatically assigned risk level 3, similarly to municipalities where exceedances of limit or target values were detected by measurements. The list of municipalities and their assigned risk levels is available on the *SHMÚ website*.

Zones and agglomerations containing at least one municipality with risk level 3 are required to prepare an Air Quality Improvement Programme. In this context, municipalities with risk level 3 correspond to air quality management areas. However, emission reduction measures must be implemented throughout the designated area in all municipalities with risk levels 2 or 3, and ideally also in municipalities with risk level 1.

The assessment using the Integrated Assessment Method aims to identify areas where air quality improvement measures need to be focused. Considering the distribution of emission sources and the microclimatic characteristics of the area, it is likely that pollution levels vary between individual locations within the risk area. The spatial distribution of air pollution is represented by the results of high-resolution modelling, which are gradually being supplemented on the *SHMÚ website*.

5 Summary

In the Košice Agglomeration, the limit value for the **average daily concentration of PM₁₀** was exceeded at the **Veľká Ida – Letná monitoring station**. Several exceedances were also recorded during the warm months of the year. Targeted measures aimed at reducing dust emissions from industrial sources could significantly contribute to decreasing the number of these exceedances.

The **target value for B(a)P** was exceeded at the monitoring stations in **Krompachy** and **Veľká Ida – Letná**. At the latter monitoring station, the target value was exceeded by almost **six times**.

No monitoring station recorded an exceedance of the limit value for the **average annual concentrations of PM₁₀, PM_{2,5}, SO₂, NO₂, CO, benzene**, or the target value for **ozone**.

In the **Košice Region**, no exceedance of the limit values for **SO₂, NO₂, CO and O₃** was recorded in 2025, nor were there any exceedances of the limit values for the **average annual concentrations of PM₁₀ and PM_{2,5}**.

The long-term trend in **NO₂ concentrations** at traffic monitoring stations in the zone and agglomeration shows a decreasing pattern. In contrast, for **PM₁₀**, stagnation without positive development has been observed at most monitoring stations.

Based on the outputs of the **RIO and IDW-R models**, it can be concluded that, in the **Košice Region**, there is an increased risk of higher concentrations of **PM_{2,5} and B(a)P** in municipalities in the south-western part of the region, particularly in the districts of **Rožňava, Spišská Nová Ves and Gelnica**, as well as in the southern part of the **Košice Agglomeration**.

When assessing compliance with the requirements arising from the new **Air Quality Directive 2024/2881**, which introduces stricter limit values, the main challenge in the **Košice Region** and the **Košice Agglomeration** would be meeting the new limit values for **PM_{2,5} and B(a)P**. All monitoring stations in the region currently fail to meet several of the stricter air quality requirements set by the new directive.

If air quality were assessed according to **WHO recommendations**, none of the monitoring stations in the zone or agglomeration would meet the recommended concentration levels for air pollutants. The ambition of the **Zero Pollution Action Plan** is to achieve air quality in line with these recommendations by **2050**.

From the perspective of air quality, a major issue in the **Košice Self-Governing Region** is the high level of **B(a)P pollution** in the southern part of the **Košice Agglomeration**, particularly in the municipality of **Veľká Ida**, which is significantly affected by emissions from the metallurgical complex. This area is among the most severely affected areas in Slovakia in terms of adverse air quality.