AIR POLLUTION IN THE SLOVAK REPUBLIC 2023

ANNEX

AIR QUALITY ASSESSMENT IN ZONE NITRA REGION

Emissions and Air Quality Division
SLOVAK HYDROMETEOROLOGICAL INSTITUTE

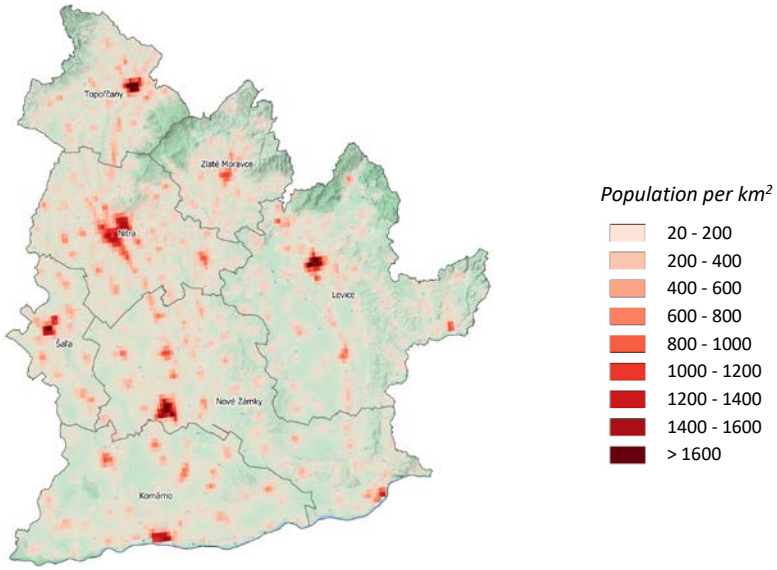
Bratislava, September 2024
Version 1

1 DESCRIPTION OF NITRA REGION TERRITORY IN TERMS OF AIR QUALITY

The Nitra region is mostly situated on the Danubian Lowland, partly the Považský Inovec, Tríbeč, Pohronský Inovec and Štiavnické vrchy mountain ranges extend here. The highest point is Panská Javorina (943 m a. s. l.) in the northern part of the zone, the lowest altitude in the Nitra region is around 100 m a. s. l. The area of the region is for the most part well ventilated. **Fig. 1.1** shows the spatial distribution of population density in the zone.

The whole Nitra region is one zone in terms of air quality assessment for SO_2, NO_2, NO_X, PM_{10}, $PM_{2.5}$, benzene, polycyclic aromatic hydrocarbons and CO in the air.

Fig. 1.1 *Population density in the zone Nitra region (Source: EUROSTAT, 2018).*



Air pollution sources in zone Nitra region

The dominant source of air pollution in the Nitra region is road transport. Natural gas is mainly used for household heating, the share of solid fuels is lower compared to other zones, except for the more mountainous area in the north of the region (according to census data).

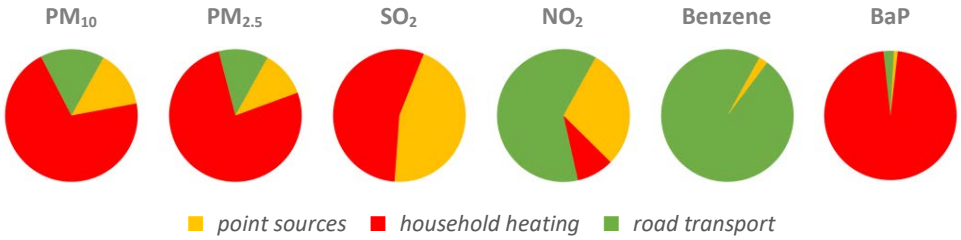
Road traffic characteristics - the most frequented parts of roads in the Nitra region with the average number of vehicles per 24 hours according to the National Traffic Census 2022 and 2023[1]:

- the highest intensity is reached by the **R1 motorway** on the part of the road from Trnava to Nitra: 35 479 vehicles (7 491 trucks/buses (hereinafter referred to as T/B) and 27 941 cars (hereinafter referred to as C)) and the R1A connection from Nitra to R1: 33 116 vehicles (5 767 T/B, 27 221 C);
- **road No. 51** from Nitra to Levice: 24 279 vehicles on the the part of the road in the Nitra district (3 309 T/B, 20 845 PC), 17 229 vehicles in the Levice district (1 739 T/B, 15 405 C);
- **road No. 64** from the north of the region to the south connecting Chynorany - Topoľčany - Nitra - Nové Zámky - Komárno: in the Topoľčany district 12 357 vehicles (1 584 T/B, 10 703 C), in the Nitra district 29 816 vehicles (3 484 T/B, 26 236 C), in the Nové Zámky district a maximum of 16 958 vehicles (2 683 T/B, 14 195 C) and in the Komárno district 9 634 vehicles (1 832 T/B, 7 753 C);
- **road No. 75** Šaľa - Nové Zámky: 20 306 vehicles in Šaľa district (2 976 T/B, 17 187 C);
- in the south of the region, **road No. 63** connecting Veľký Meder - Komárno: 19 412 vehicles (2 746 T/B, 16 530 C).

Some other roads with high traffic intensity: **road No. 564** in Levice leading to Tlmače: 14 590 vehicles (1 567 T/B, 12 934 C); **road No. 580** leading through Šurany from west to east: 8 650 vehicles (1 063 T/B, 7 520 C); and **road No. 509** Nové Zámky - Štúrovo: 3 966 vehicles (597 T/B, 3 342 C).

[1] *https://www.ssc.sk/sk/cinnosti/rozvoj-cestnej-siete/dopravne-inzinierstvo/celostatne-scitanie-dopravy-v-roku-2022-a-2023.ssc*

Fig. 1.2 *Share of different types of air pollution sources in total emissions in the Nitra region.*

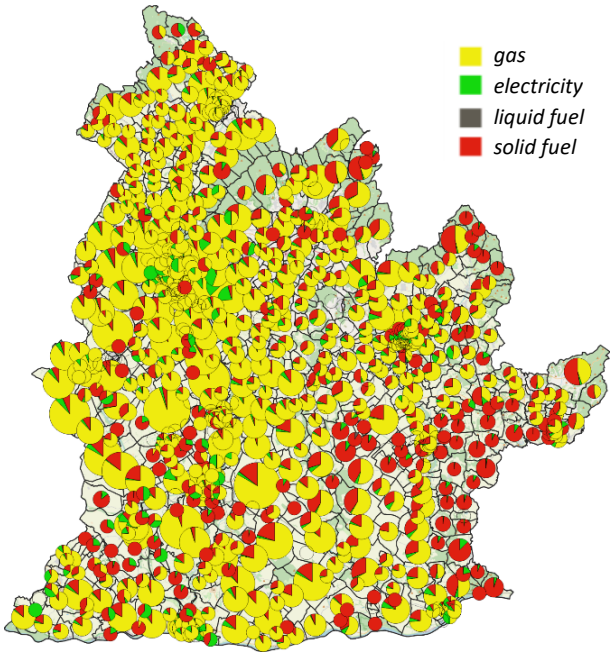


Note: Medium and large air pollution sources registered in the NEIS database are identified for this purpose as "point sources".

Industrial sources of air pollution are less important here in terms of their contribution to local air pollution from basic pollutants. Depending on meteorological conditions, the influence of the chemical industry can be seen in the Nitra region.

Fig. 1.3 shows the shares of fuel types in the heating of family and residential houses in individual municipalities (or basic settlement units) of the Nitra region, while it can be seen that the spatial distribution of fuel types is not geographically homogeneous. In the total for the whole zone in 2021, gas heating prevailed in the south-eastern part of the region, while in the area of southern Hont, southern part of Tekov and Dolná Nitra regions it is almost exclusively solid fuel heating.

Fig. 1.3 *Share of different types of fuel used for heating in the municipalities of the region [2].*



2 AIR QUALITY MONITORING STATIONS IN ZONE NITRA REGION

In the Nitra region, air quality is monitored at 4 stations. The monitoring station Nitra, Štúrova reflects the impact of road traffic about 100 metres from the roundabout. The suburban background station is located on the south-eastern outskirts in the Nitra, Janíkovce in the school grounds and represents an area of rural character. An airport with irregular traffic is located to the south-east approximately 500 m from this monitoring station.

In 2021, a monitoring station in Komárno and Plášťovce became operational in the Nitra region. The new station in Komárno complemented the air quality measurements in the southern part of the Danubian Lowland. The AMS is located in the housing estate on Vnútorná Okružná street, in a location characterised by urban background air pollution. Plášťovce is a medium-sized municipality with a predominantly detached houses. The municipality lies in the eastern part of the Nitra region in the Levice district. The air flow is influenced by the rolling terrain, which slopes and opens towards the south affecting the spread and dispersion of air pollutants. The station monitors background levels of pollution in a suburban area.

[2] *https://www.scitanie.sk*

Tab. 2.1 contains information on air quality monitoring stations in the zone Nitra region:

- international EoI 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 devices provide hourly average concentrations of PM_{10}, $PM_{2.5}$, nitrogen oxides, sulphur dioxide, ozone, carbon monoxide and benzene. The SHMÚ test laboratory analyses heavy metals and polycyclic aromatic hydrocarbons as part of manual monitoring, resulting in 24-hour average concentrations.

Tab. 2.1 *Air quality monitoring programme in the zone Nitra region.*

Zone Nitra region								Monitoring programme									
								Continuously								Manually	
District	EoI code	Station	Type of		Geographical		Altitude [m]	PM_{10}	$PM_{2.5}$	NO, NO_2	SO_2	O_3	CO	Benzene	Hg	As, Cd, Ni, Pb	BaP
			area	station	longitude	latitude											
Nitra	SK0269A	Nitra, Štúrova	U	T	18°04'37"	48°18'34"	143										
Nitra	SK0134A	Nitra, Janíkovce	S	B	18°08'27"	48°16'59"	149										
Komárno	SK0064A	Komárno, Vnútorná Okružná	U	B	18°08'19"	47°45'51"	110										
Levice	SK0070A	Plášťovce	S	B	18°58'42"	48°09'35"	149										
							Total	4	4	4	1	3	1	1	0	0	2

Type of area:
U – urban
S – suburban
R – regional

Type of station:
T – traffic
B – background
I – industrial

3 ASSESSMENT OF AIR QUALITY IN ZONE NITRA REGION

This chapter contains an assessment of air quality in the zone Nitra region based on monitoring, supplemented by mathematical modelling results for PM_{10}, $PM_{2.5}$ and benzo(a)pyrene for the year 2023.

Tab. 3.1 *Assessment of air pollution according to limit values for protection of human health and smog warning system for PM_{10} in the zone Nitra region – 2023.*

	Protection of human health									IT[2)]	AT[2)]
Pollutant	SO_2		NO_2		PM_{10}		$PM_{2.5}$	CO	Benzene	PM_{10}	PM_{10}
Averaging period	1 h	24 h	1 h	1 year	24 h	1 year	1 year	8 h[1)]	1 year	12 h	12 h
Parameter	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]
Limit value [µg·m^{-3}]	350	125	200	40	50	40	20	10 000	5	100	150
Maximum number of exceedances	24	3	18		35						
Nitra, Janíkovce			0	10	1	16	12			0	0
Nitra, Štúrova	0	0	0	22	3	21	12	895	0.20	0	0
Komárno, Vnútorná Okružná			0	13	1	18	12			10	0
Plášťovce			0	7	34	22	20			24	6

≥ 90% of valid measurements

[1)] eight-hour maximum concentration

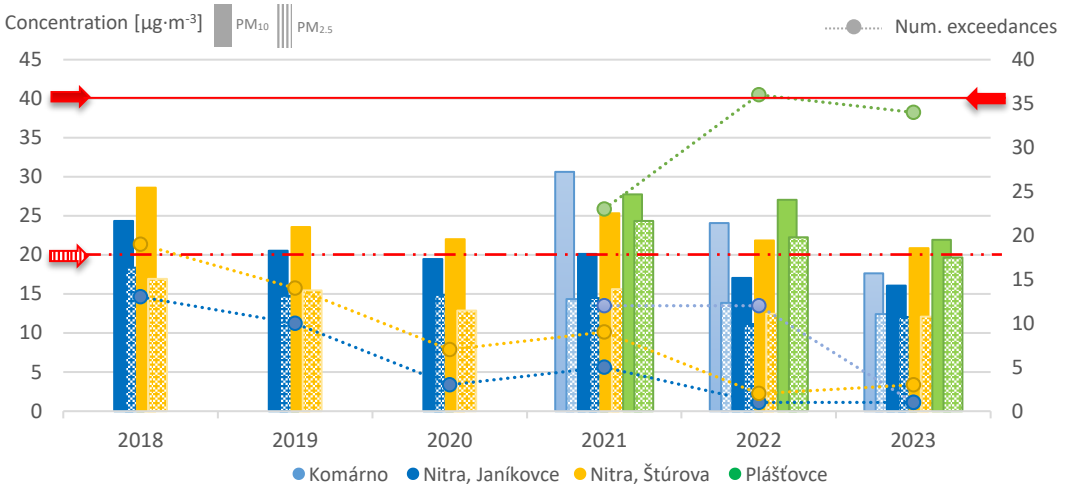
[2)] IT, AT – duration of exceedance (in hours) of the information threshold (IT) and alert threshold (AT) for PM_{10}

In accordance with the Decree of the Ministry of Environment of the Slovak Republic No. 250/2023 Coll. on air quality, the required proportion of valid values was observed at the monitoring stations.

3.1 PM_{10} and $PM_{2.5}$

Fig. 3.1 shows the average annual concentrations of PM_{10}, $PM_{2.5}$ and the number of days with average daily PM_{10} concentrations above 50 $\mu g \cdot m^{-3}$ according to the results of measurements at monitoring stations in the zone Nitra region in 2018 – 2023.

Fig. 3.1 *Average annual concentrations of PM_{10}, $PM_{2.5}$ and the number of exceedances of the daily limit value for PM_{10}.*



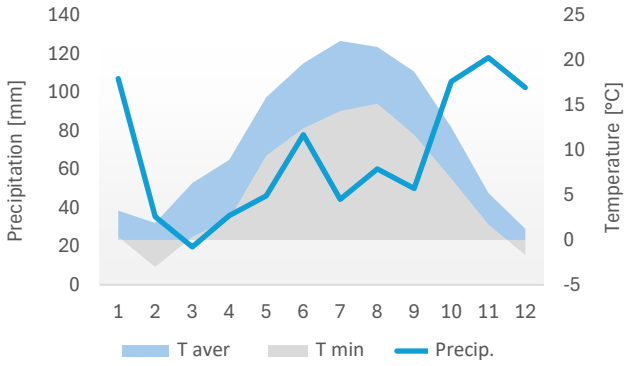
*The arrows show the limit values, **red striped** $PM_{2.5}$ (average annual concentration: 20 $\mu g \cdot m^{-3}$); **red on the left** PM_{10} (average annual concentration: 40 $\mu g \cdot m^{-3}$) and **red on the right** the number of exceedances (average daily PM_{10} concentration of 50 $\mu g \cdot m^{-3}$ must not be exceeded more than 35 times in a calendar year).*

The limit value of 40 $\mu g \cdot m^{-3}$ for the annual average concentration of PM_{10} in the zone has not been exceeded. The limit value for the number of exceedances (35) of the average daily limit concentration of PM_{10} (50 $\mu g \cdot m^{-3}$) was not exceeded by any station (**Fig. 3.1**). The suburban background station Plášťovce recorded higher PM_{10} values also in 2023 (annual mean concentration of 22 $\mu g \cdot m^{-3}$ – representing a year-on-year decrease of 5 $\mu g \cdot m^{-3}$ – and 34 exceedances of the daily mean limit concentration) than the traffic station Nitra, Štúrova (21 $\mu g \cdot m^{-3}$ and 3 exceedances).

At the Komárno urban background station, there was a significant year-on-year improvement in 2023: an annual mean concentration of 18 $\mu g \cdot m^{-3}$ (year-on-year decrease of 6 $\mu g \cdot m^{-3}$) and 1 exceedance (year-on-year decrease of 11) of the daily mean limit concentration. Similarly, low concentrations of PM_{10} were measured at the suburban background station Nitra, Janíkovce: 16 $\mu g \cdot m^{-3}$ and 1 exceedance.

Fig. 3.2 captures the meteorological conditions in each month at Dudince, near Plášťovce. The values of higher PM concentrations in Plášťovce in winter months correlate with the period of low temperatures and the necessity of heating households. The occurrence of low temperatures continued for only a few days in February, but the situation was complicated by the long-term influence of pressure highs with unfavourable dispersion conditions.

Fig. 3.2 *Monthly precipitation totals, average and minimum temperatures (data from climatological station Dudince near Plášťovce).*



In April 2024, a Directive of the European Parliament and of the Council on ambient air quality and cleaner air in Europe[3] was approved, containing a forward-looking target and new EU limits for air pollutants to be achieved (i.e. not exceeded) by EU Member States by 1 January 2030. Comparing the PM_{10} values in 2023 against this forward-looking target (**Fig. 3.1**), we see that the new EU limit of 20 $\mu g \cdot m^{-3}$ for the annual average concentration of PM_{10} was already met by Nitra, Janíkovce and Komárno last year, with the remaining two stations narrowly exceeding it.

Fig. 3.3 and **Fig. 3.5** show the modelling results for PM_{10} and $PM_{2.5}$ calculated for the year 2023 using the RIO model subsequently adjusted using the regression IDW-R method (see Chapter 4 of *Air pollution in the Slovak Republic 2023 Report* for more details).

Fig. 3.3 *Average annual PM_{10} concentration (left) and number of exceedances of the PM_{10} daily limit value (right) in 2023.*

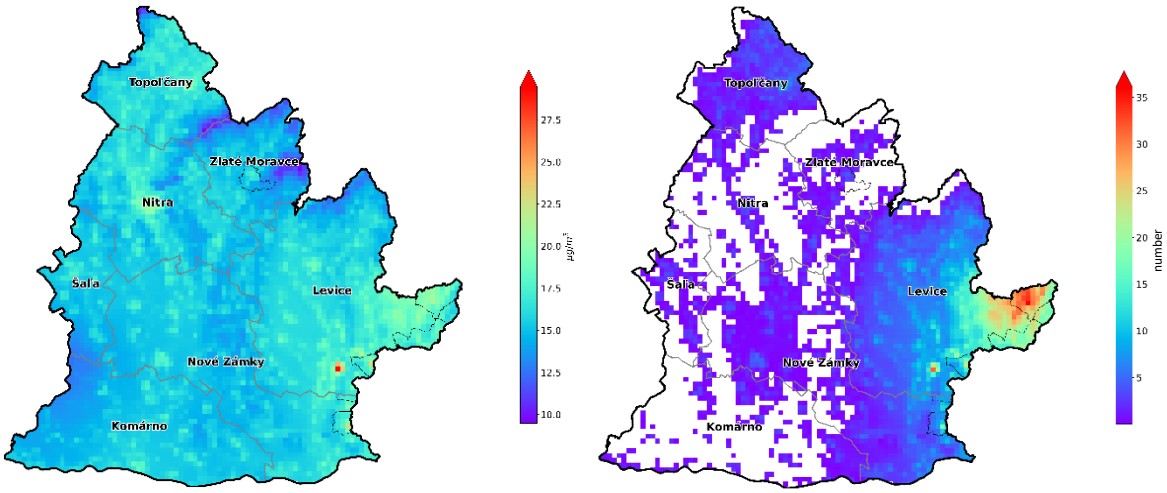
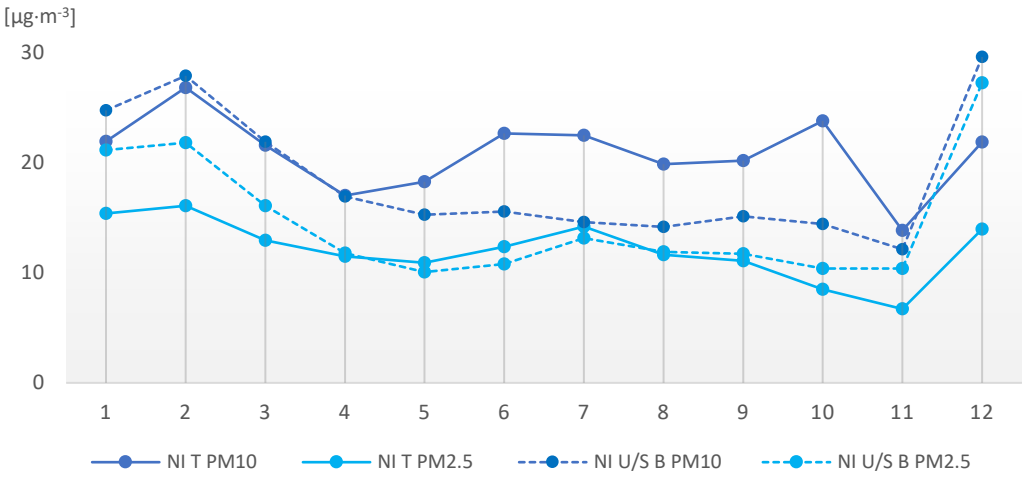


Fig. 3.4 *Average monthly concentrations of PM_{10} and $PM_{2.5}$ in the Nitra region by station type.*



U/S B PM10 *and* ***U/S B PM2.5*** *– average monthly concentrations of PM_{10} and $PM_{2.5}$ at the urban/suburban background stations Nitra, Janíkovce; Komárno and Plášťovce;* ***T PM10*** *and* ***T PM2.5*** *– average monthly concentrations of PM_{10} and $PM_{2.5}$ at the traffic station Nitra, Štúrova.*

[3] *https://www.europarl.europa.eu/news/sk/press-room/20240419IPR20587/znecistenie-ovzdusia-parlament-prijal-zakon-pre-vyssiu-kvalitu-ovzdusia*

In the plot of monthly average PM_{10} and $PM_{2.5}$ concentrations (**Fig. 3.4**), we see a similar pattern for all stations. The traffic station in Nitra had higher monthly concentrations than the average of background stations (urban and suburban) only in the summer months and in October. The effect of household heating with solid fuel, which is reflected in an increase in concentrations in the cold part of the year, was most pronounced at the station Plášťovce.

Higher concentrations of fine particles ($PM_{2.5}$) in the air are risky, mainly because of their adverse effects on human health. The average annual concentration of $PM_{2.5}$ in Plášťovce in 2023 was at the limit value (20 $\mu g \cdot m^{-3}$), which represents an annual improvement of 2 $\mu g \cdot m^{-3}$. At both stations in Nitra (Štúrova and Janíkovce) and Komárno, this indicator reached 12 $\mu g \cdot m^{-3}$ (**Tab. 3.1**), a similar level to the previous year. Plášťovce recorded high concentrations of $PM_{2.5}$ in the cold months of the year (January, February and December), ranging from 33 $\mu g \cdot m^{-3}$ to 47 $\mu g \cdot m^{-3}$. This is probably due to heating of households with solid fuel. At all four stations in the zone, the mean annual concentration was higher than the WHO recommendation (up to 5 $\mu g \cdot m^{-3}$) [4], and this is also true for all monthly concentrations. Even in summer, when $PM_{2.5}$ values tend to be lower, the monthly average at all AMS was more than twice the WHO recommendation.

The map in **Fig. 3.5** shows the spatial distribution of annual mean $PM_{2.5}$ concentrations according to the output of the RIO model combined with IDW-R.

Fig. 3.5 *Average annual $PM_{2.5}$ concentrations in 2023.*

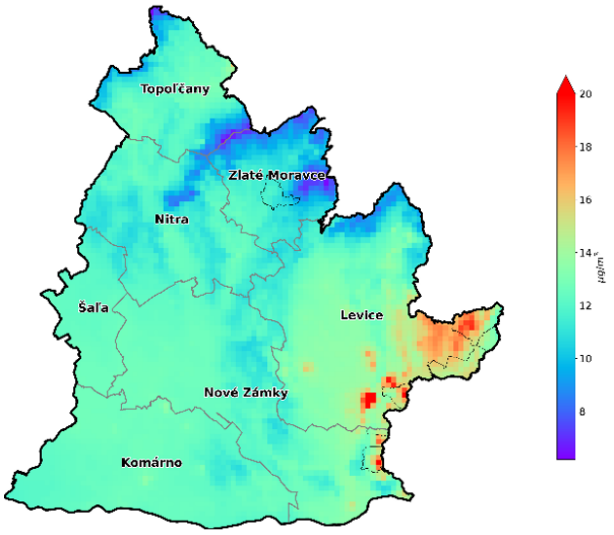
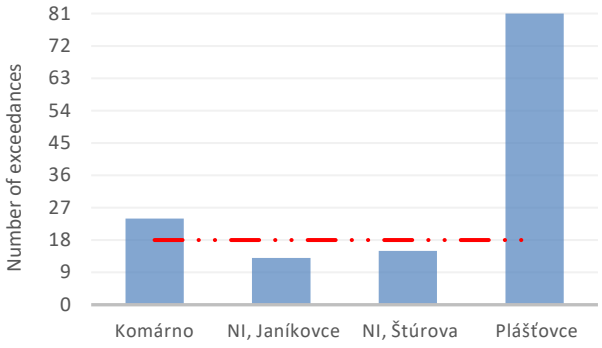


Fig. 3.6 captures $PM_{2.5}$ concentrations relative to the forward-looking objective and the new EU limit to be achieved by EU Member States by 1 January 2030 (approved along with the other forward-looking EU limits in April 2024). In this case, the newly introduced EU limit specifies that the daily average concentration of $PM_{2.5}$ (25 $\mu g \cdot m^{-3}$) is not to be exceeded more than 18 times per calendar year. Applying this commitment on 1 January 2030 to the results in 2023, we see that in Plášťovce (81 exceedances) the number of exceedances exceeded 4.5 times the new EU limit and in Komárno (24 exceedances) 1.3 times. The two stations in Nitra (13 and 15 exceedances), on the other hand, already met the new EU limit in 2023.

Fig. 3.6 *Number of days with average daily $PM_{2.5}$ concentration > 25 $\mu g \cdot m^{-3}$) in 2023 – evaluation in view of the newly introduced EU limit*.*



** Under to the new EU limit, which will enter into force on 1 January 2030, the average daily concentration of $PM_{2.5}$ must not exceed 25 $\mu g \cdot m^{-3}$ more than 18 times per year.*

The new EU limit value of 10 $\mu g \cdot m^{-3}$ – to be achieved by 1 January 2030 – for the annual average concentration of $PM_{2.5}$ was not met in 2023 by a single station in the zone.

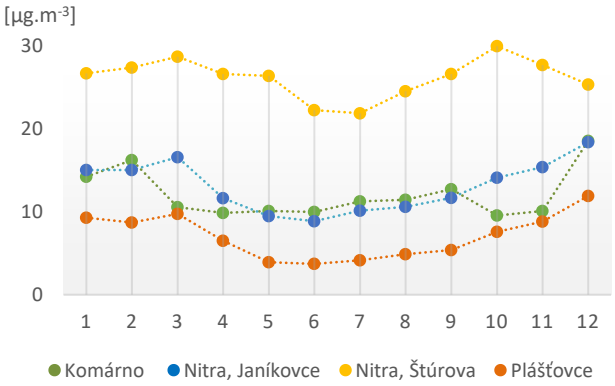
[4] *WHO GLOBAL AIR QUALITY GUIDELINES, 2021. Recommendations on classical air pollutants. (str. 4) https://apps.who.int/iris/bitstream/handle/10665/345334/9789240034433-eng.pdf*

3.2 Nitrogen dioxide

Nitrogen dioxide monitoring is carried out at four stations in the zone, the average monthly values for individual stations are shown in **Fig. 3.7**. NO_2 concentrations maintain a relatively constant level throughout the year with no seasonal fluctuations, except for the Nitra, Štúrova station. Overall, they are at a relatively low level.

The main source of NO_2 emissions is road transport. The highest concentrations for this reason are recorded at the traffic station Nitra, Štúrova, but even here the annual average value (22 $\mu g \cdot m^{-3}$) was well below the limit value (40 $\mu g \cdot m^{-3}$). This confirmed the improvement recorded at this traffic station in 2022 (22 $\mu g \cdot m^{-3}$) – in 2021 it was 27 $\mu g \cdot m^{-3}$ and in 2018 up to 34 $\mu g \cdot m^{-3}$, for example. The average annual concentrations measured at the stations Plášťovce (7 $\mu g \cdot m^{-3}$) and Nitra, Janíkovce (10 $\mu g \cdot m^{-3}$) even meet the WHO recommendations (10 $\mu g \cdot m^{-3}$), which are considerably stricter than the EU limits (new EU limit as of 1 January 2030 for NO_2: 20 $\mu g \cdot m^{-3}$).

Fig. 3.7 Average monthly NO_2 concentrations in 2023.

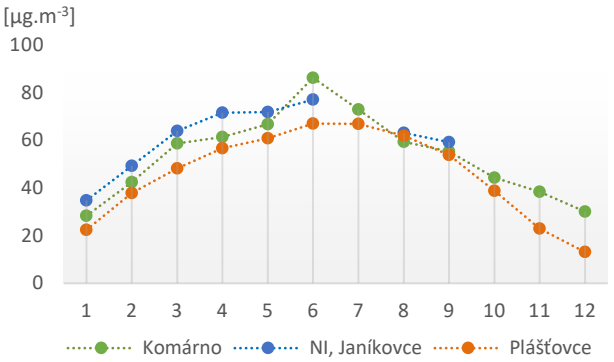


3.3 Ozone

Ozone monitoring is carried out in this zone at three monitoring stations: Komárno, Plášťovce and Nitra, Janíkovce.

The highest concentrations of ground-level ozone are usually found in warm months with high sunshine intensity. (**Fig. 3.8**). Their values increase with sunrise, peak around midday and gradually decrease in the evening to a minimum that occurs in the morning. Large differences in ground-level ozone concentrations are also observed in the warm and cold seasons.

Fig. 3.8 Average monthly concentrations O_3 in 2023.



In the zone, we recorded 3 exceedances of the 1-hour information threshold for ground-level ozone in Komárno in 2023. The ground-level ozone alert threshold was not exceeded at any station in the zone.

3.4 Benzo(a)pyrene

Benzo(a)pyrene is monitored at two monitoring stations in the Nitra region – in Nitra on Štúrova Street and in Plášťovce. The target value of 1 $ng \cdot m^{-3}$ was exceeded in Plášťovce more than 2.5 times (2.7 $ng \cdot m^{-3}$) (**Tab. 3.2**). The annual pattern of concentrations has an even more pronounced maximum in the cold half of the year compared to PM particles (**Fig. 3.9**).

The most significant source of benzo(a)pyrene is household heating with solid fuels, especially underdried wood or unsuitable fuels (various types of waste). **Fig. 3.10** shows the spatial distribution of the annual average benzo(a)pyrene concentration according to the RIO model outputs combined with IDW-R. To obtain more detailed outputs, mathematical modelling with high spatial resolution and detailed temporal and spatial distribution of emissions is required. In areas with a high share of solid fuels in household heating and unfavourable dispersion conditions in winter months, benzo(a)pyrene air pollution is a potential problem.

Tab. 3.2 *Average annual concentration of benzo(a)pyrene in 2018 – 2023.*

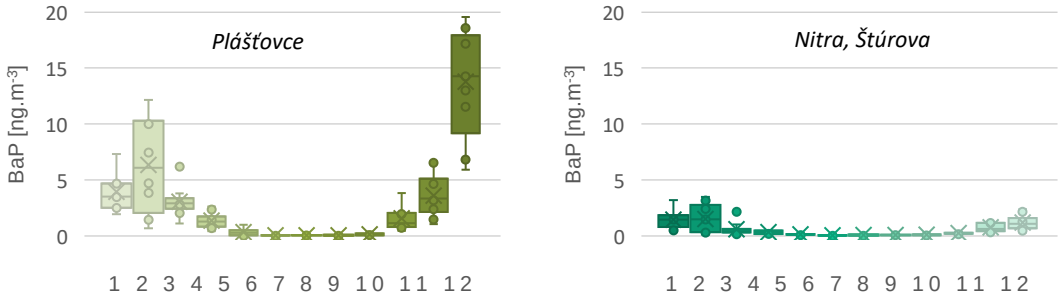
	2018	2019	2020	2021	2022	2023
Target value [ng·m^{-3}]	1.0	1.0	1.0	1.0	1.0	1.0
Nitra, Štúrova	0.9	0.8	0.6	0.8	0.6	0.5
Plášťovce				2.2	*2.4	2.7

≥ 90% of valid measurements

The red colour indicates that the target value has been exceeded in case of sufficient data coverage (≥ 90%) in a given year.

** malfunction of the device from 11 March to the end of March and from 6 June to 5 July 2022*

Fig. 3.9 *Average monthly concentrations of benzo(a)pyrene in 2023.*



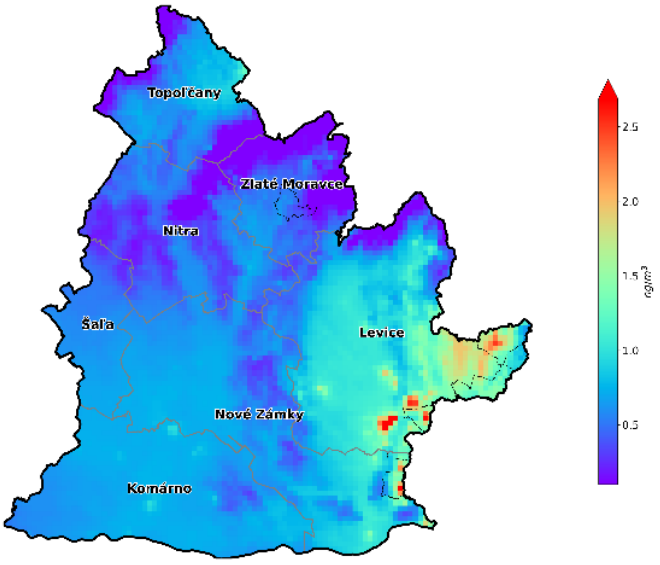


Fig. 3.10
Average annual concentration of benzo(a)pyrene according to RIO model output, IDW-R (2023).

3.5 Risk municipalities

Fig. 3.11 displays municipalities at risk due to deteriorated air quality as determined by the integrated municipal assessment method[5]. Level 3 corresponds to the highest probability of air pollution risk. The methodology includes the level of household heating with solid fuels, the impact of worsened dispersion conditions from both short-term and long-term perspectives, results from the chemical transport model CMAQ, the interpolation model RIO, and high-resolution modelling results using the CALPUFF model in selected domains with an assumed deteriorated air quality.

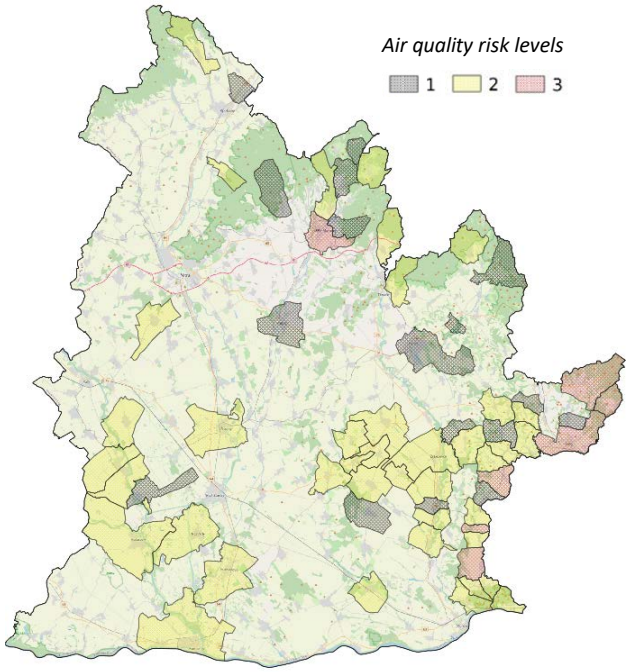
[5] *Štefánik, D., Krajčovičová, J.: Metóda integrovaného posúdenia obcí vzhľadom na riziko nepriaznivej kvality ovzdušia, SHMÚ, 2023, available at https://www.shmu.sk/sk/?page=996*

Municipalities in which the limit value for PM, NO_2, or the target value for BaP was exceeded based on high spatial resolution modelling were automatically assigned a risk level 3, similar to municipalities where the limit or target value exceedance was detected through measurement. The list of municipalities and their risk levels can be found on the SHMÚ website[6].

Zones and agglomerations that include at least one municipality with a risk level 3 will develop an Air Quality Plan. In this regard, municipalities with a risk level 3 correspond to *air quality management areas*. However, measures to reduce emissions must be implemented in all municipalities within this designated zone with a risk level 2 or 3, ideally also in municipalities with a risk level 1.

The assessment using the integrated assessment method aims to identify areas where action to improve air quality needs to be targeted. Given the distribution of air pollution sources and considering the microclimatic characteristics of the region, it is likely that pollution levels vary at different locations within the risk area. Spatial distribution of air pollution is provided by high-resolution modelling results, which are updated on the SHMÚ website[7].

Fig. 3.11 *Risk municipalities in zone Nitra region (2023).*



3.6 Summary

At both stations in Nitra (Štúrova and Janíkovce), we observed a slight year-on-year improvement in 2023 – a decrease in PM_{10} concentrations. Significant improvement of this indicator occurred in Plášťovce and Komárno. The long-term trend of PM pollution has a slightly decreasing character in the zone, however, Plášťovce has measured an increase in the number of PM_{10} exceedances since 2021. NO_2 concentrations have been decreasing in the long term (since 2016) at AMS Nitra, Štefánikova, the remaining stations maintain low pollution levels.

In 2023, no exceedances of the limit values for SO_2, NO_2, CO and benzene were measured in the zone Nitra region. The limit value for the annual and daily average concentration of PM_{10} was not exceeded at any monitoring station. The limit value for the number of exceedances of the average daily value of PM_{10} in 2023 was not exceeded at any station, with the highest number of exceedances measured in Plášťovce. The annual average concentration of $PM_{2.5}$ reached the limit value at this station, but at the same time there was a slight year-on-year improvement in air quality for this pollutant.

The target value for benzo(a)pyrene was exceeded more than 2.5 times at the station in Plášťovce, according to measurements in 2023. Although it can be assumed that higher concentrations of PM and benzo(a)pyrene will occur in the Nitra region, especially in the winter months, and in other areas, the nature of the region is predominantly flat and characterised mostly by good ventilation. Areas with unfavourable dispersion conditions and a high proportion of solid fuels in household heating may be problematic.

[6] *https://www.shmu.sk/sk/?page=2873*
[7] *https://www.shmu.sk/sk/?page=2699*

If we were to assess compliance with the requirements of the new Air Quality Directive adopted by the European Parliament in April 2024 (setting stricter limit values applicable from 1 January 2030), the biggest problem in the Nitra region would be meeting the new limit values for $PM_{2.5}$ and BaP. The annual average PM_{10} targets for 2030 would be met by two stations already in 2023, and slightly exceeded by two stations. No AMSs would meet the annual $PM_{2.5}$ averages. Although PM pollution levels in the county are showing a slight downward trend, additional measures will be required to meet the requirements of the new Directive to help reduce pollution to the required levels.

If we were to assess air quality according to WHO recommendations[8], only AMS Plášťovce and Nitra, Janíkovce would meet the recommended concentrations for some pollutants. The ambition of the Zero Pollution Action Plan[9] is to achieve air quality according to these recommendations by 2050.

[8] *WHO GLOBAL AIR QUALITY GUIDELINES, 2021. Recommendations on classical air pollutants, p. 4. https://apps.who.int/iris/bitstream/handle/10665/345334/9789240034433-eng.pdf*

[9] *https://www.consilium.europa.eu/en/press/press-releases/2024/02/20/air-quality-council-and-parliament-strike-deal-to-strengthen-standards-in-the-eu/*