# AIR POLLUTION IN THE SLOVAK REPUBLIC 2022

# ANNEX

## AIR QUALITY ASSESSMENT IN ZONE NITRA REGION




Air quality monitoring department
SLOVAK HYDROMETEOROLOGICAL INSTITUTE



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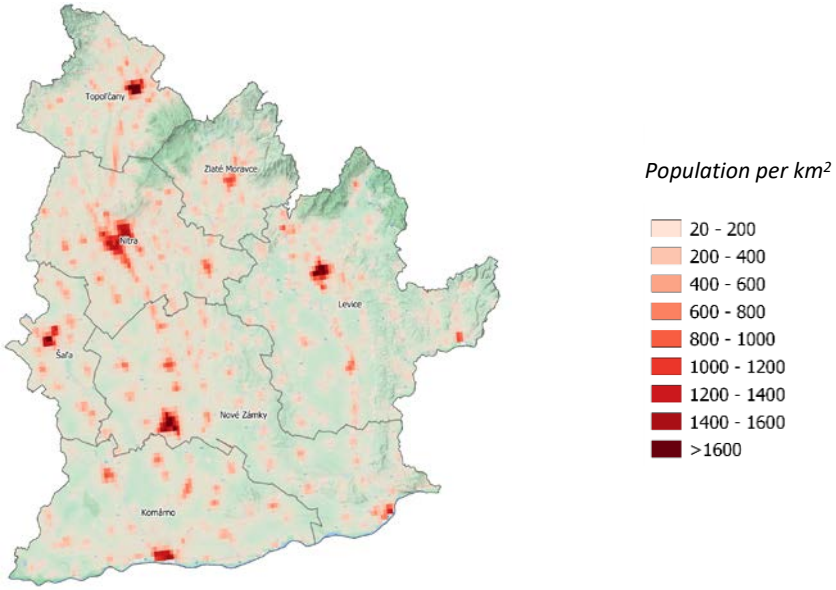
Version 1

# 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).*



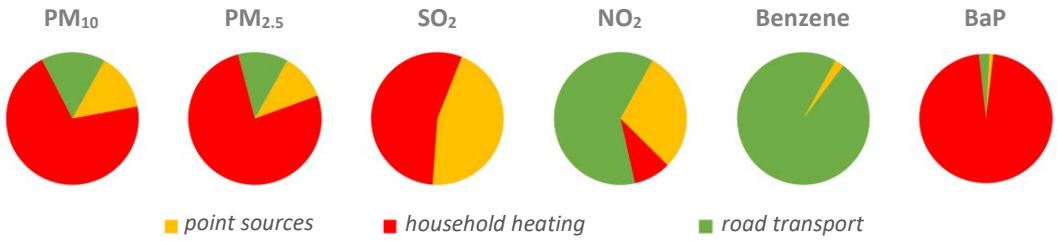

***Air pollution sources in zone Nitra region***

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).

Characteristics of road transport: the most frequent is the R1 high speed road on the part in front of Nitra from Trnava with an average daily number of 28 785 vehicles (5 582 trucks and 23 154 cars), the part of the road No. 64 in Nitra (23 436 vehicles, 3 503 trucks and 19 798 cars), the part of the road No. 63 connecting Veľký Meder and Komárno (21 847 vehicles, including 2 171 trucks and 19 573 cars), the part of road No. 75 from Šaľa to Nové Zámky (20 019 vehicles, 2 848 trucks and 17 045 cars), road No. 51 through Levice (17 367 vehicles, 2 162 trucks and 15 146 cars) and the R1 high speed road near Zlaté Moravce (17 998 vehicles, including 4 119 trucks and 13 802 cars)[1].

[1] *https://www.ssc.sk/sk/cinnosti/rozvoj-cestnej-siete/dopravne-inzinierstvo/celostatne-scitanie-dopravy-v-roku-2015/nitriansky-kraj.ssc*

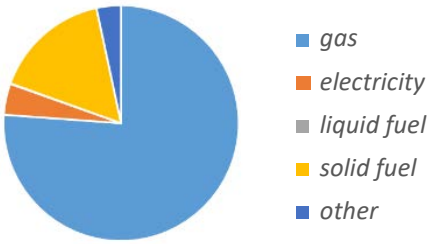
*Fig. 1.2* *Share of different types of air pollution sources in total emissions in the Nitra region.*




*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* *Share of different types of fuel used for heating in family houses [2].*




According to the Population and Housing Census (PHC) 2021 data, natural gas is mainly used for heating in family houses in the zone. The share of solid fuels is slightly higher than in the Bratislava and Trnava regions. Solid fuels are more likely to be used in rural settlements with good availability of firewood.

## 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 Veľká 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.

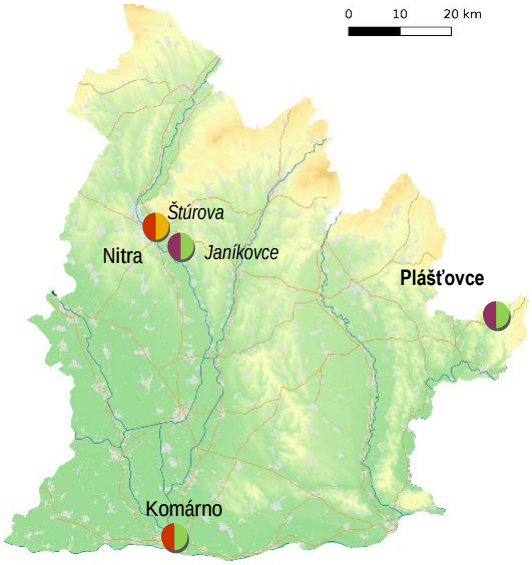
[2] *https://www.scitanie.sk*

**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** | | | | | | | | Measurement programme | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | Continuously | | | | | | | | Manually | |
| District | EoI code | Station name | 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:*
*B – background*
*T – traffic*
*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 2022.

***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 – 2022.*

| | 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 | 9 | 1 | 17 | 11 | | | 0 | 0 |
| Nitra, Štúrova | 0 | 0 | 0 | 22 | 2 | 22 | 13 | 1 621 | 0.46 | 0 | 0 |
| Komárno, Vnútorná Okružná | | | 0 | 13 | 12 | 24 | 14 | | | 9 | 0 |
| Plášťovce | | | 0 | 7 | 36 | 27 | 22 | | | 17 | 0 |

*≥ 90% of valid measurements* *Exceedance of the limit value is marked in red.*

[1)] *eight-hour maximum concentration*

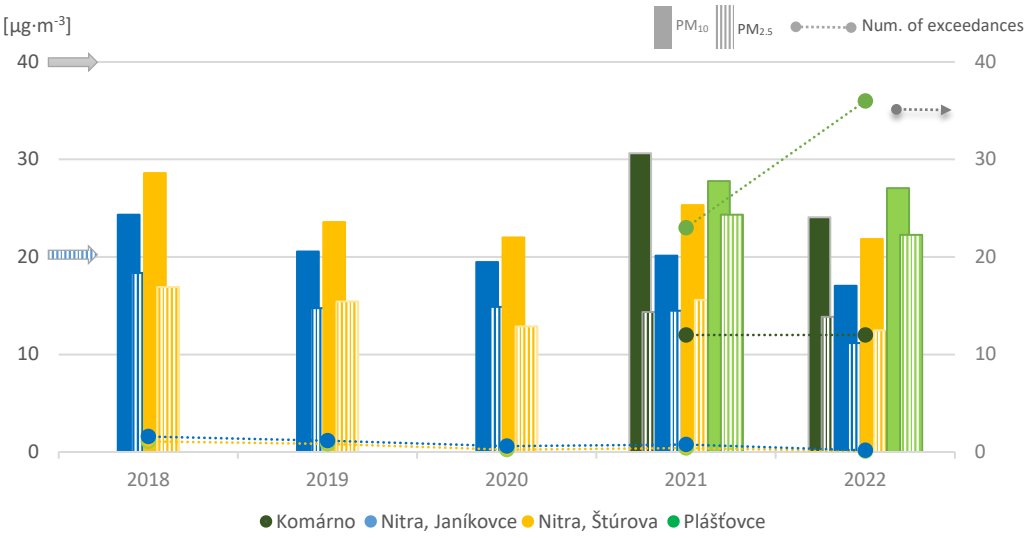
[2)] *IT, AT – duration of exceedance (in hours) of the information threshold (IT) and alert threshold (AT) for $PM_{10}$*

*In accordance with the Decree of the Ministry of Environment of the Slovak Republic No. 244/2016 Coll. on air quality as amended, 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 Nitra region in 2022.

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

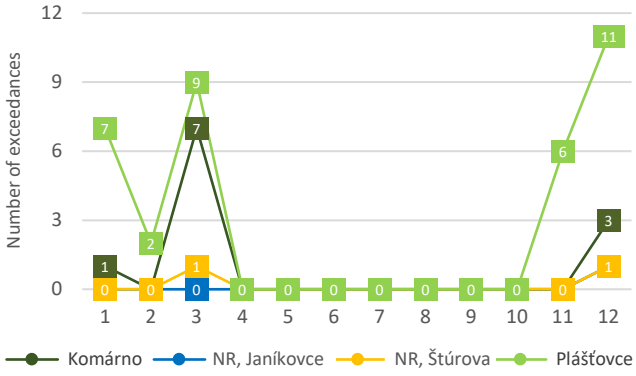



*Number of exceedances – daily average concentrations greater than 50 $\mu g \cdot m^{-3}$.*

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

### $PM_{10}$

***Fig. 3.2*** *Number of $PM_{10}$ daily limit value exceedances per month in 2022.*




The limit value for the annual average concentration of $PM_{10}$ (40 $\mu g \cdot m^{-3}$) in the zone Nitra region was not 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 exceeded at AMS Plášťovce only (36 exceedances) (**Fig. 3.1**). The two sub/urban background stations Plášťovce (annual average concentration 27 $\mu g \cdot m^{-3}$ and 36 exceedances) and Komárno (24 $\mu g \cdot m^{-3}$ and 12 exceedances) recorded higher values of these two $PM_{10}$ indicators than the traffic station Nitra, Štúrova (22 $\mu g \cdot m^{-3}$ and 2 exceedances). The suburban background station Nitra, Janíkovce measured significantly lower concentrations of $PM_{10}$ (17 $\mu g \cdot m^{-3}$ and 1 exceedance). **Fig. 3.2** shows the number of exceedances of the average daily limit concentration of $PM_{10}$ for each month of the year. All exceedances are concentrated in the cold months with the need for heating.

**Fig. 3.3** and **Fig. 3.5** show the modelling results for $PM_{10}$ and $PM_{2.5}$ calculated for the year 2022 using the RIO model subsequently adjusted using the regression IDW-R method (see Chapter 4 of *Air pollution in the Slovak Republic 2022 Report* for more details).

***Fig. 3.3*** *Annual average $PM_{10}$ concentration (left) and number of exceedances of the $PM_{10}$ daily limit value (right) in 2022.*

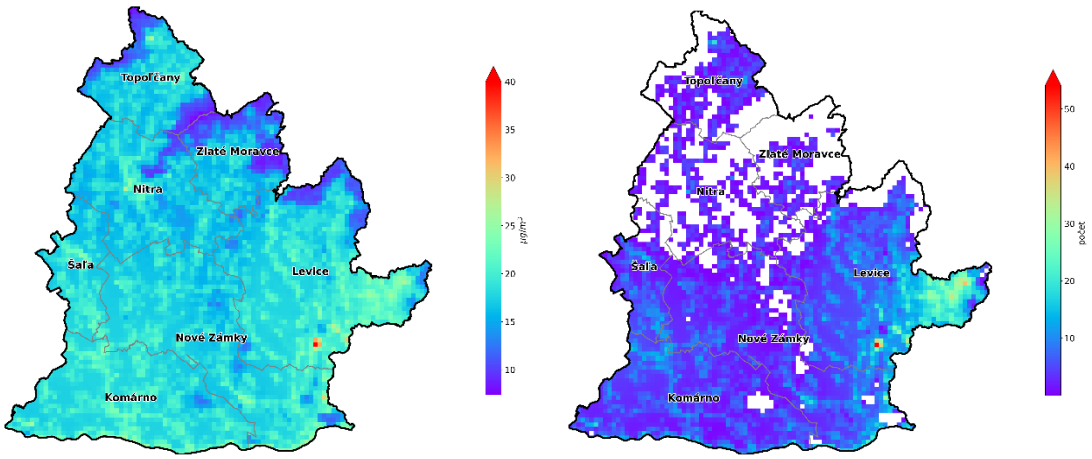
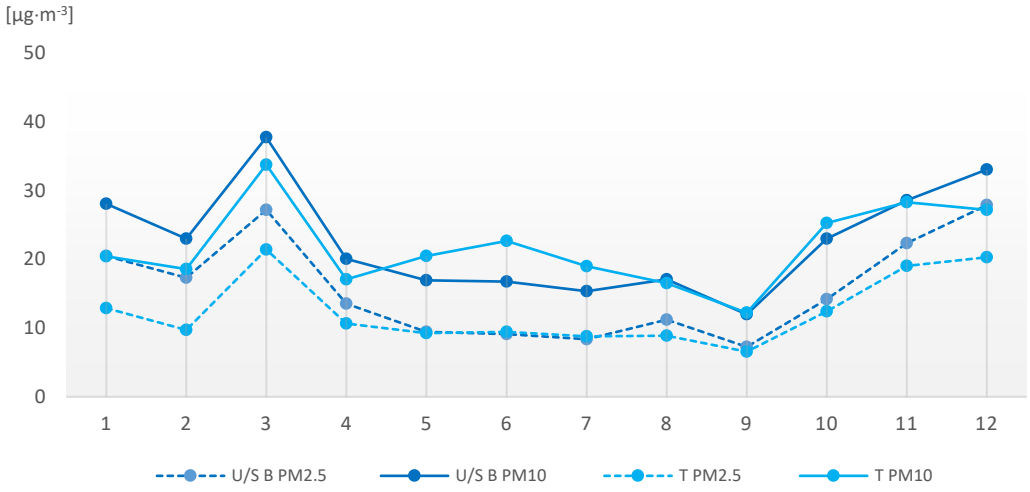



***Fig. 3.4*** *Average monthly concentrations of $PM_{10}$ and $PM_{2.5}$ in the Nitra region by station type.*




***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 transport station Nitra, Štúrova.*

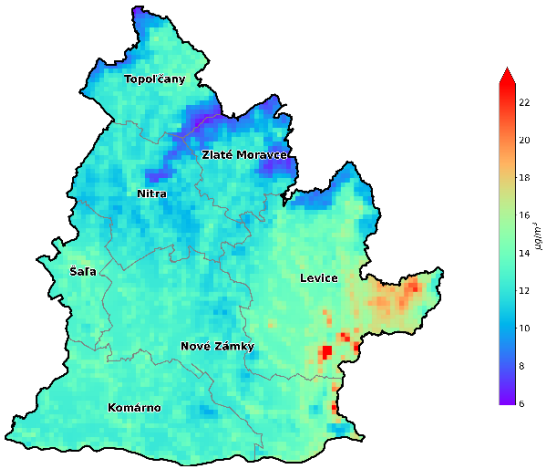
In the plot of monthly mean $PM_{10}$ and $PM_{2.5}$ concentrations (**Fig. 3.4**) we see a similar pattern for all stations. The traffic station in Nitra had higher monthly concentrations than the average of background stations (urban and suburban) only in the summer months and in October. The impact 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, which started measuring in 2021.

### $PM_{2.5}$

Increased concentrations of $PM_{2.5}$ fine particles in the air are dangerous, mainly because of their unfavourable effects on human health. Plášťovce recorded an exceedance of the limit value (20 µg·m$^{-3}$) for the annual mean concentration of $PM_{2.5}$ (22 µg·m$^{-3}$). At both stations in Nitra (Štúrova and Janíkovce), this indicator reached similar values (13 µg·m$^{-3}$ and 11 µg·m$^{-3}$) (**Tab. 3.1**), indicating a significant year-on-year decrease in the annual mean $PM_{2.5}$ 16 µg·m$^{-3}$ and 14 µg·m$^{-3}$ in 2021). High concentrations of these particles were observed in the cold months of the year (**Fig. 3.4**) at the station Plášťovce, which started measuring in 2021. This is probably due to the heating of households with solid fuel, as mentioned above. At all stations, the annual average concentration was higher than the WHO recommendation (up to 5 µg·m$^{-3}$), and this recommendation was not met in any month of the year, including summer months, when $PM_{2.5}$ concentrations tend to be the lowest.

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 2022.*




## 3.2 Nitrogen dioxide

Nitrogen dioxide monitoring is carried out at four stations in the zone, the average monthly values for each station are shown in **Fig. 3.6**.

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 µg·m$^{-3}$, which represents a significant year-on-year reduction from 27 µg·m$^{-3}$ in 2021) did not exceed the limit value (40 µg·m$^{-3}$). $NO_2$ concentrations in the zone, except for the station Nitra, Štúrova, maintain a relatively constant level throughout the year without seasonal fluctuations, as illustrated in **Fig. 3.6**. Overall, they are at a relatively low level. The concentration measured at the Nitra, Janíkovce station meets the WHO recommendations (10 µg·m$^{-3}$), which are generally considerably stricter than the EU limits.

***Fig. 3.6*** *Average monthly $NO_2$ concentrations in 2022.*

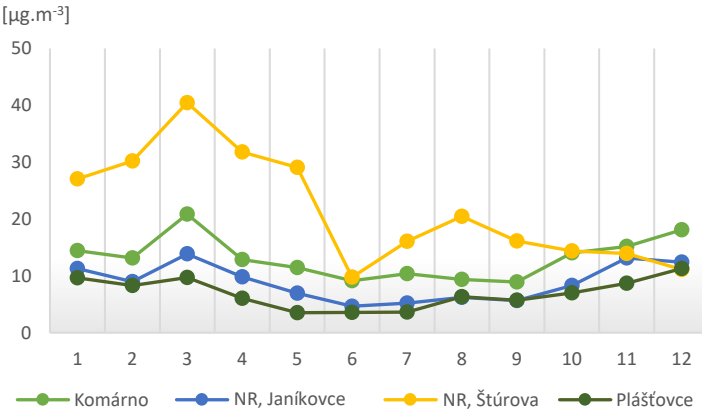
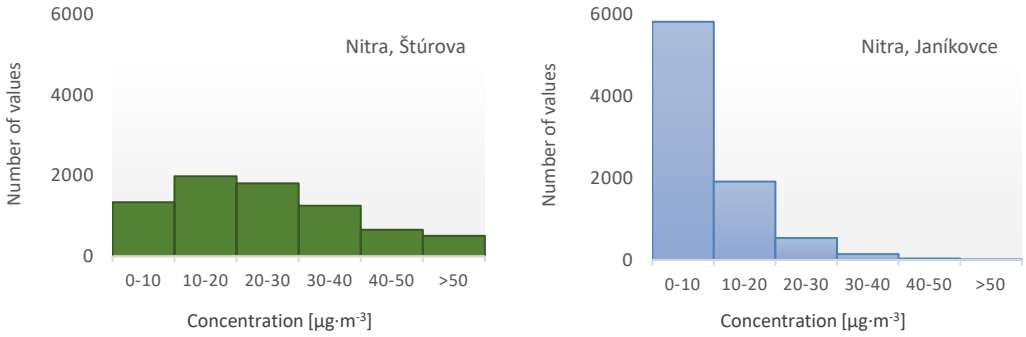


**Fig. 3.7** shows the different frequency distribution of hourly $NO_2$ concentrations at two types of stations in Nitra – the traffic station at Štúrova St. and the suburban background station in Janíkovce. While at the traffic station we measured 153 values higher than 50 $\mu g \cdot m^{-3}$, at the background station in Janíkovce only one.

***Fig. 3.7*** *Histogram of hourly $NO_2$ concentrations at Nitra, Štúrova and Janíkovce stations.*




## 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 generally occur in warm months with high sunshine (**Fig. 3.8**). **Fig. 3.9** and **Fig. 3.10** show the so-called daily course of $O_3$ concentration. It shows that concentrations increase with sunrise, peak around midday and gradually decrease in the evening to a minimum that occurs early 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 2022.*

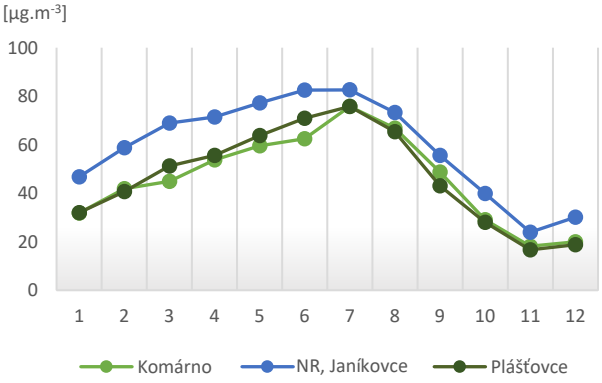



***Fig. 3.9*** *Daily $O_3$ concentration in January 2022.*

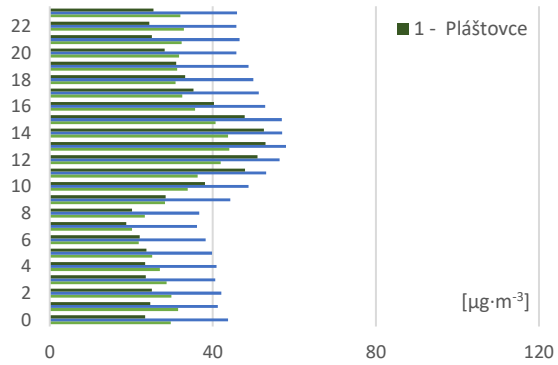
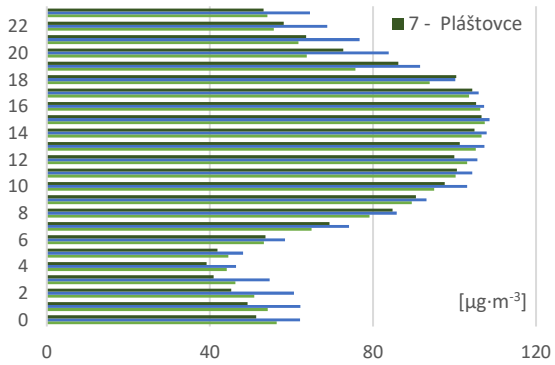



***Fig. 3.10*** *Daily $O_3$ concentration in July 2022.*




We did not observe any exceedances of the ground-level ozone information or alert thresholds at any stations in the zone in 2022.

## 3.4 Benzo(a)pyrene

Benzo(a)pyrene is monitored at two monitoring stations in the Nitra region - at Nitra, Štúrova and Plášťovce. The annual pattern of concentrations has an even more noticeable maximum in the cold half of the year compared to PM particles (**Fig. 3.11**).

Although the measurements of benzo(a)pyrene in Plášťovce achieved 88% of valid data due to instrument malfunction (90% is required), their distribution during the year allows us to assume with high probability that the target value was exceeded in Plášťovce (**Tab. 3.2**). The distribution of data over the seasons was approximately even.

The most significant source of benzo(a)pyrene is household heating with solid fuels, especially insufficiently dried wood or unsuitable fuels (various types of waste). **Fig. 3.12** shows the spatial distribution of the annual average benzo(a)pyrene concentration according to the outputs of the RIO model 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 domestic heating and unfavourable dispersion conditions in winter months, benzo(a)pyrene air pollution is a potential problem.

***Tab. 3.2*** *Assessment of air pollution by benzo(a)pyrene – annual mean concentrations.*

| | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 |
|---|---|---|---|---|---|---|
| Target value [ng·m⁻³] | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 |
| Nitra, Štúrova | 1.3 | 0.9 | 0.8 | 0.6 | 0.8 | 0.6 |
| Plášťovce | | | | | 2.2 | *2.4 |

*≥ 90% of valid measurements*

** malfunction from 11. 3. to the end of March and from 6. 6. to 5. 7. 2022*

***Fig. 3.11*** *Results of benzo(a)pyrene measurements in 2022.*

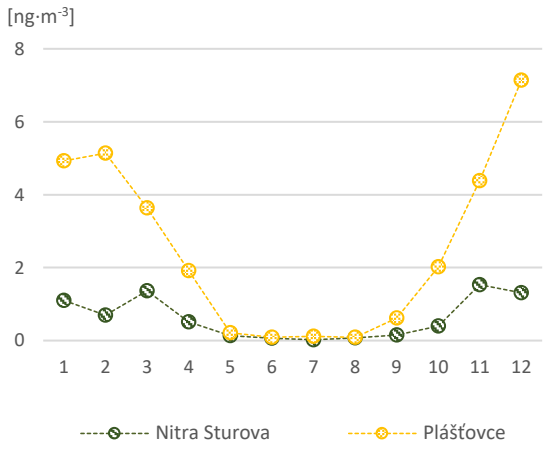
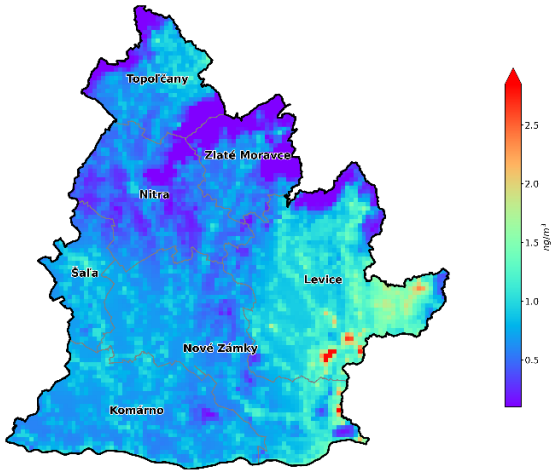


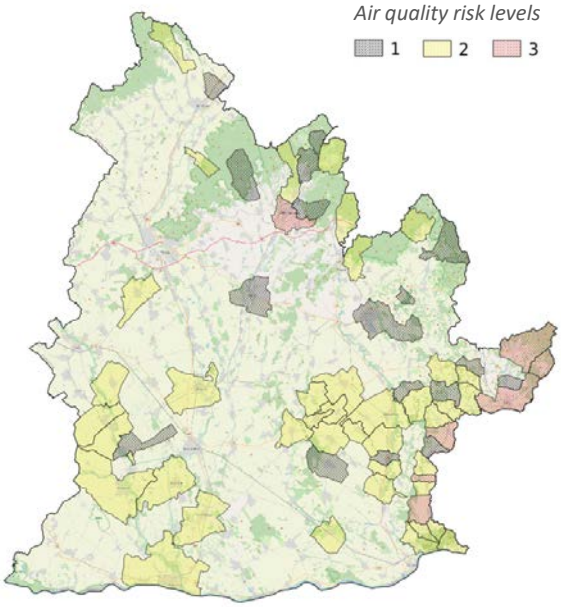

***Fig. 3.12*** *Average annual concentration of benzo(a)pyrene according to RIO model output, IDW-R (2022).*



## 3.5 Risk municipalities

**Fig. 3.13** displays municipalities at risk due to deteriorated air quality as determined by the integrated municipal assessment method[3]. *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.

***Fig. 3.13*** *Risk municipalities in zone Nitra region (2022).*




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[4].

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[5].

## 3.6 Summary

In 2022, in the zone Nitra region, no exceedance of the limit value for $SO_2$, $NO_2$, CO and benzene was measured, nor exceedance of the limit value for the annual average concentration of $PM_{10}$. The limit value for the number of $PM_{10}$ exceedances per year (maximum 35 exceedances) was surpassed at the station Plášťovce (36 exceedances). This station as well measured the annual average concentration of $PM_{2.5}$ (22 $\mu g \cdot m^{-3}$), which also surpassed the limit value (20 $\mu g \cdot m^{-3}$).

The target value for benzo(a)pyrene as measured in 2022 was exceeded with a high probability at the station in Plášťovce.

Although it can be assumed that higher concentrations of PM and benzo(a)pyrene will occur in the zone Nitra region, especially in the winter months, also in other areas, the character of the region is predominantly flat and characterised mostly by good ventilation. Areas with unfavourable dispersion conditions and a high share of solid fuels in domestic heating may be problematic.

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[3] *Štefánik, D., Krajčovičová, J.: Metóda integrovaného posúdenia obcí vzhľadom na riziko nepriaznivej kvality ovzdušia, Slovenský hydrometeorologický ústav, 2023, https://www.shmu.sk/sk/?page=996*

[4] *https://www.shmu.sk/sk/?page=2768*

[5] *https://www.shmu.sk/sk/?page=2699*