IV.3 Nitrogen oxides

IV.3.1 Air pollution by nitrogen oxides in 2019

In monitoring and evaluating the quality of ambient air, the term nitrogen oxides (NO_x) is understood to refer to a mixture of nitrogen oxide (NO) and nitrogen dioxide (NO_2). The pollution limit level for protection of human health is set for NO_2, the limit level for protection of ecosystems and vegetation is set for NO_x.

Air pollution by nitrogen dioxide in 2019 in relation to the pollution limit level for protection of human health

The annual pollution limit level for NO_2 is exceeded only at a limited number of stations (from 2% to 4% of stations in the last five years) in locations with high traffic intensity in agglomerations and large cities. Of the total number of 99 monitoring stations with a sufficient amount of data for evaluation, the annual pollution limit level of 40 μg.m^{-3} was exceeded at 1% of stations (1 station – Prague 2-Legerova (hot spot)) in 2019 (Tab. XI.8; Fig. IV.3.1). The Prague 2-Legerova (hot spot) station is classified as urban traffic. High values of NO_2 concentrations at the Prague 2-Legerova station (hot spot) are related to high intensity of traffic in the immediate vicinity of the station and its location in a street canyon where the possibility of ventilation is significantly reduced. In view of its low range of representativeness, exceeding the limit value at this station was not reflected in the map of the annual average concentration (Fig. IV.3.2) which has a resolution of 1x1 km. In most areas of the Czech Republic (99.9%), however, the average annual concentration has long been lower than 26 μg.m^{-3}, i.e. below the value of the lower assessment limit (Fig. IV.3.3).

In 2019, the limit value for hourly NO_2 concentration of 200 μg.m^{-3} was not exceeded at any location (Table XI.7).

The highest concentrations of NO_2 are attained at traffic stations in Prague, Brno and Ostrava (Fig. IV.3.1). Greater pollution of cities by NO_2 compared to rural localities is caused by traffic. Higher NO_2 concentrations can also be expected in the vicinity of local roads in municipalities with intensive traffic, higher urban development and a dense local transport network where traffic flow often drops. NO_2 concentrations decrease with increasing distance from roads.

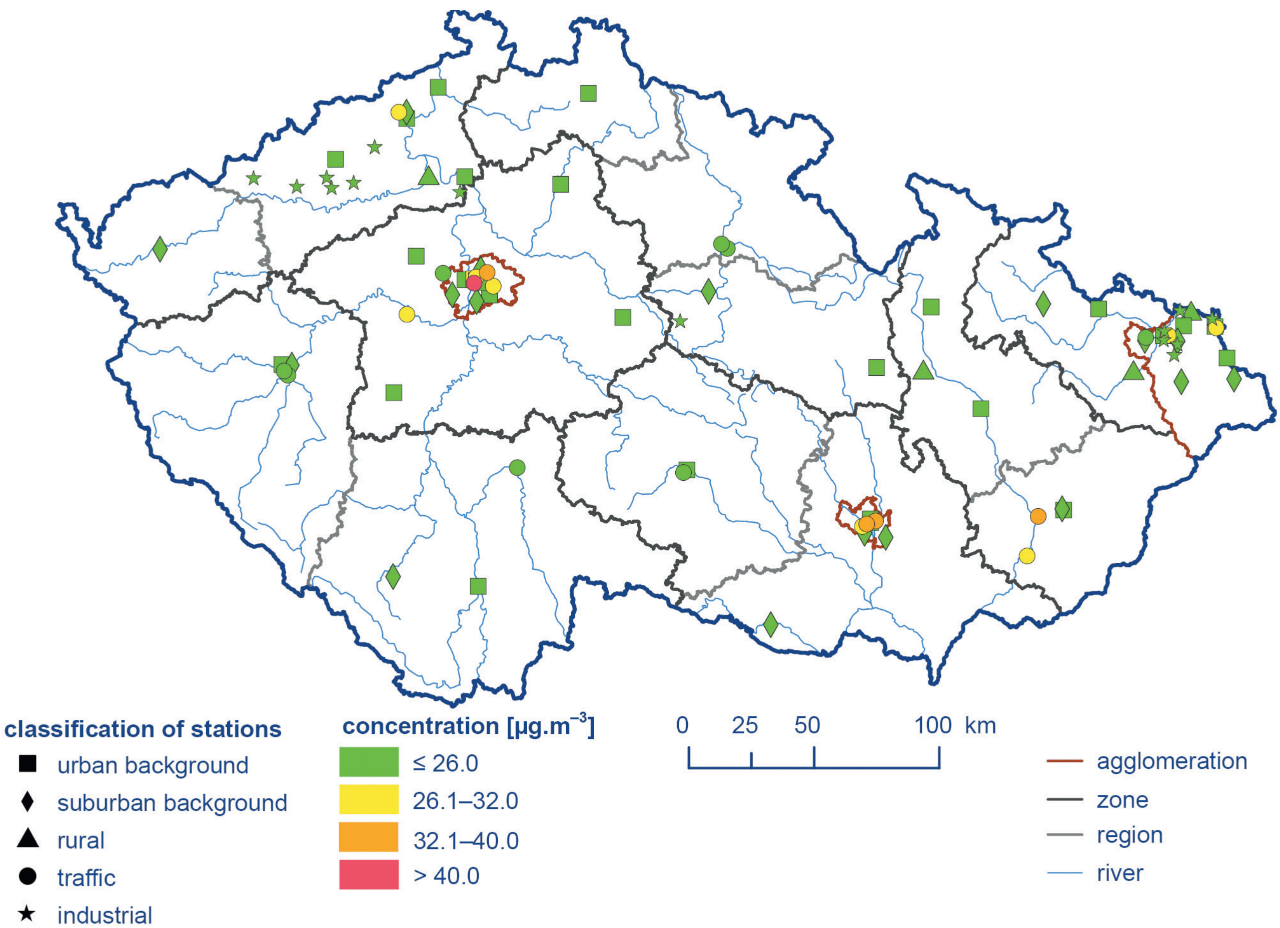
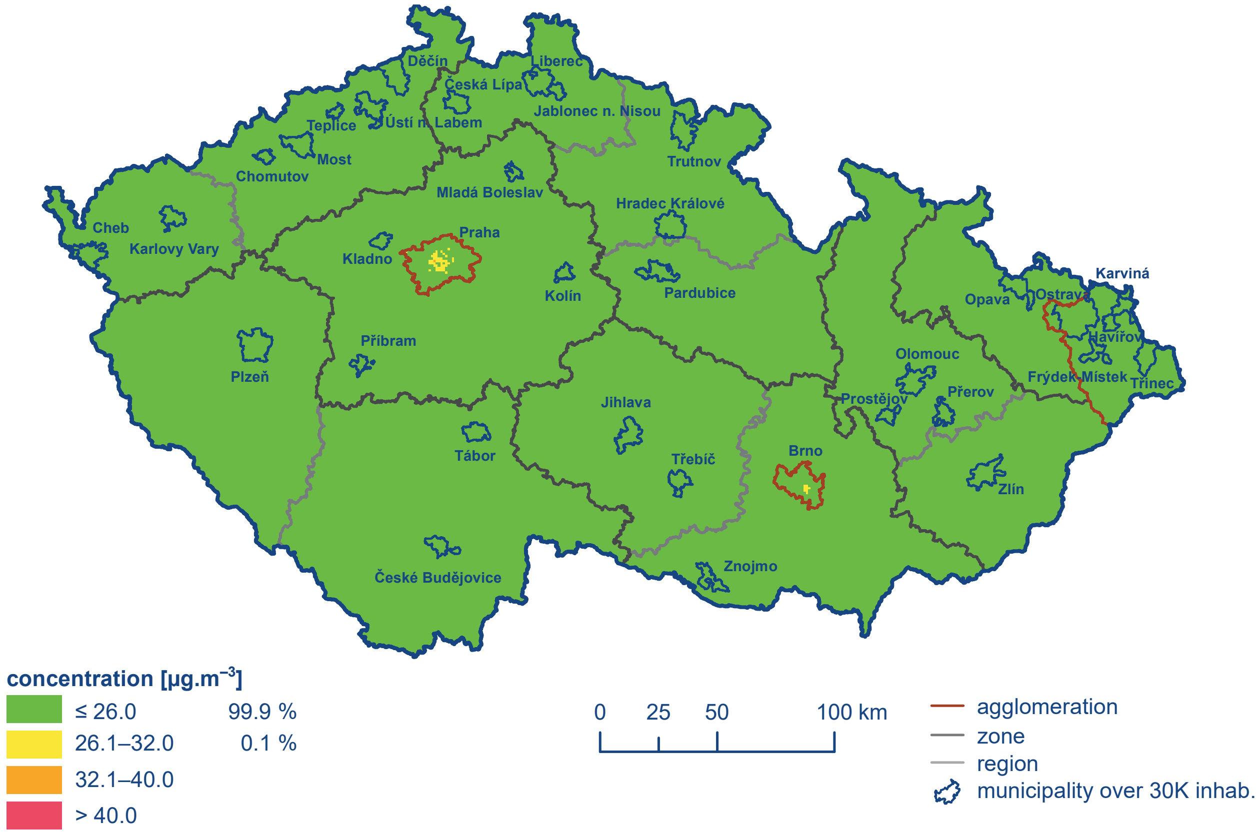


Fig. IV.3.1 Annual average NO_2 concentrations at air quality monitoring stations, 2019



Obr. IV.3.2 Field of annual average NO_2 concentration, 2019

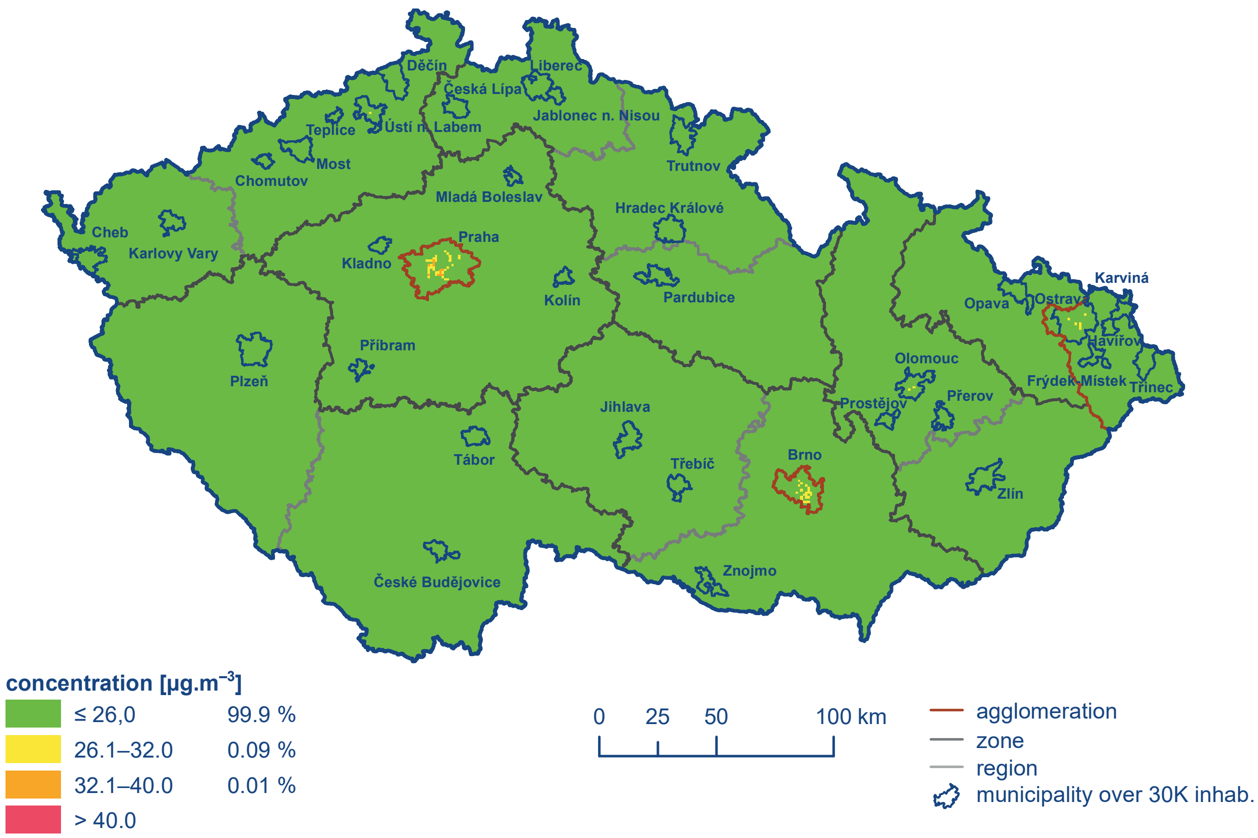


Fig. IV.3.3 Five-year average of annual average NO_2 concentrations, 2015–2019

Monthly average NO_2 concentrations were lower than ten-year average 2009–2018 throughout 2019 at all types of stations (Fig. IV.3.4). Average monthly NO_2 concentrations show an annual course with peaks in winter associated with meteorological conditions (lower intensity of solar radiation and deteriorated dispersion conditions). On the contrary, in the period April-September, there is generally a decrease in NO_2 concentrations. The reason for this decrease is the higher intensity of solar radiation (in particular at wavelengths < 400 nm) in this time of year which results in photodissociation of NO_2 to NO and O (Warneck 2000). Ground-level ozone is formed from photodissociation products under appropriate conditions and therefore ground-level ozone concentrations are higher in the April-September period (Fig. IV.4.8). In 2019, there was no significant increase in NO_2 concentrations in the winter at the end of the year at traffic stations, where the highest NO_2 concentrations are measured, due to favourable meteorological and dispersion conditions in this period, especially in November. At regional rural localities remote from direct exposure to emission sources, the average monthly NO_2 concentration is the lowest and is well below the lower assessment threshold (LAT), showing thus less distinct annual course. In the winter months, background concentrations of NO_2 increase mainly due to worse dispersion conditions, lower intensity of solar radiation, eventually the effect of seasonal emission sources.

Air pollution by nitrogen oxides in 2019 in relation to the pollution limit level for protection of ecosystems and vegetation

The pollution limit level for protection of ecosystems and vegetation for the average annual concentration of NO_x ($30\ \mu g.m^{-3}$) was not exceeded in 2019 at any of 19 rural stations with a sufficient amount of data for the evaluation (Tab. XI.9). The concentration map of annual average NO_x concentrations was prepared using combined data from all stations measuring NO_x and a dispersion model. Higher NO_x concentrations are measured in the vicinity of busy roads in municipalities. On the map, point symbols designate only rural stations because only at these locations the average annual NO_x concentrations are evaluated following the Czech legislation in force in relation to the pollution limit level for protection of ecosystems and vegetation (Fig. IV.3.5).

IV.3.2 Trends in nitrogen oxide concentrations

During the 1990s there was a marked decrease in the average annual concentrations of both NO_2 and NO_x and also in the 19^{th} highest hourly NO_2 concentration. This was a result of the sharp decrease in emissions in this period as a result of coming into force of Act No. 309/1991 Coll., and the related introduction of new technological measures to reduce emissions. This was also affected by a change in the composition of industrial production and the vehicle fleet and also in the composition of automotive fuels. Meteorological and dispersion conditions have a great impact on inter-annual variations in NO_2 and NO_x concentrations and also on the concentrations of other pollutants. Between 2000 and 2008, there have been alternating increases and decreases in both the average annual concentrations and also in the 19^{th} highest hourly concentration. In the period under consideration between 2009 and 2019 (Figures IV.3.7 and IV 3.8), higher concentrations were recorded in 2010, probably due to poor meteorological and dispersion conditions. Since 2011, it has been possible to observe a moderate decreasing trend in all the monitored characteristics of nitrogen oxides. In inter-annual comparison 2018/2019, decrease occurred in the annual NO_2 and NO_x average concentration at all types of stations. The average 19^{th} highest hourly NO_2 concentrations (Fig. IV 3.9) show a clear decrease in all types of localities except for regional stations, where a slight increase in concentrations is caused by an increase in concentrations at the Sněžník station. The Sněžník station is affected by long-range transport, and increases in short-term concentrations indicate the influence of large sources in the wider vicinity of the station. In 2019, the lowest concentrations of NO_2 and NO_x were recorded for the entire evaluated period. Good dispersion conditions and the overall warm character of the winter period in 2019 (Chap. III) contributed to the improvement of the situation, as well as the decrease in NO_x emissions related mainly to the gradual renewal of the vehicle fleet and the introduction of emission ceilings and stricter emission limits for NO_x emissions from sources in the sector 1A1a – Public electricity and heat production.

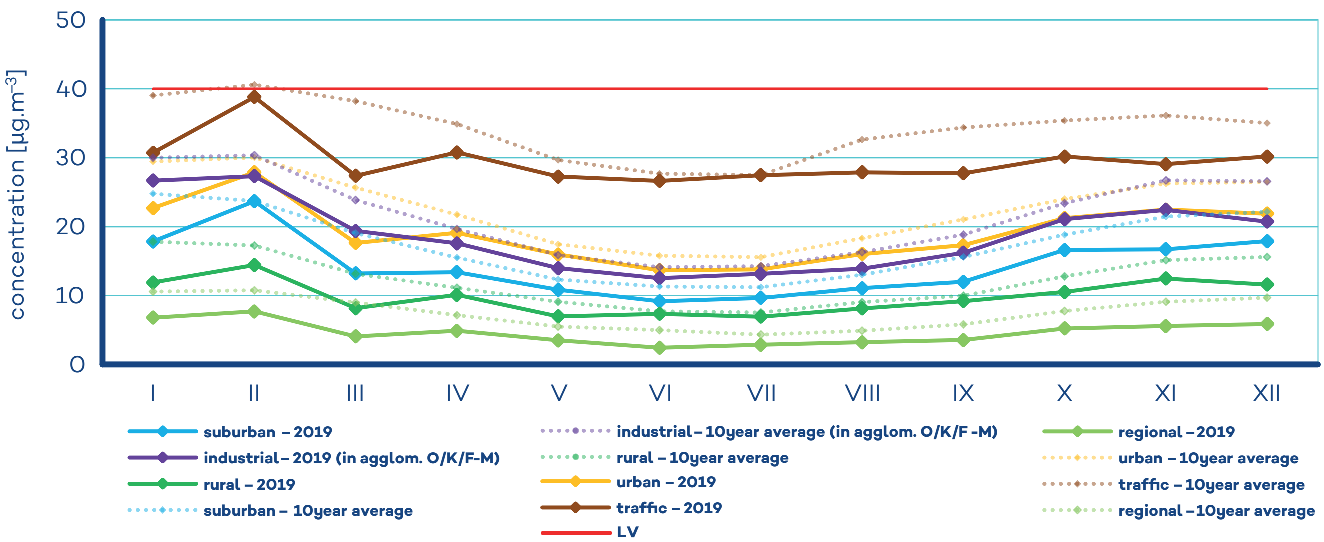
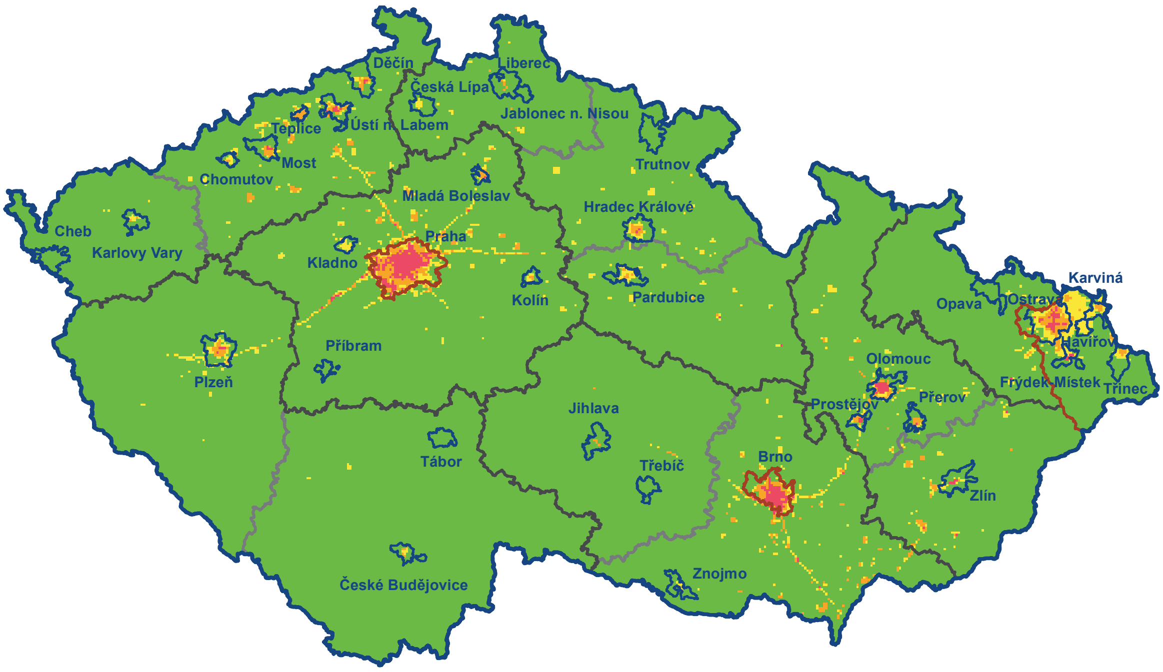


Fig. IV.3.4 Annual course of average monthly concentrations of NO_2, 2019

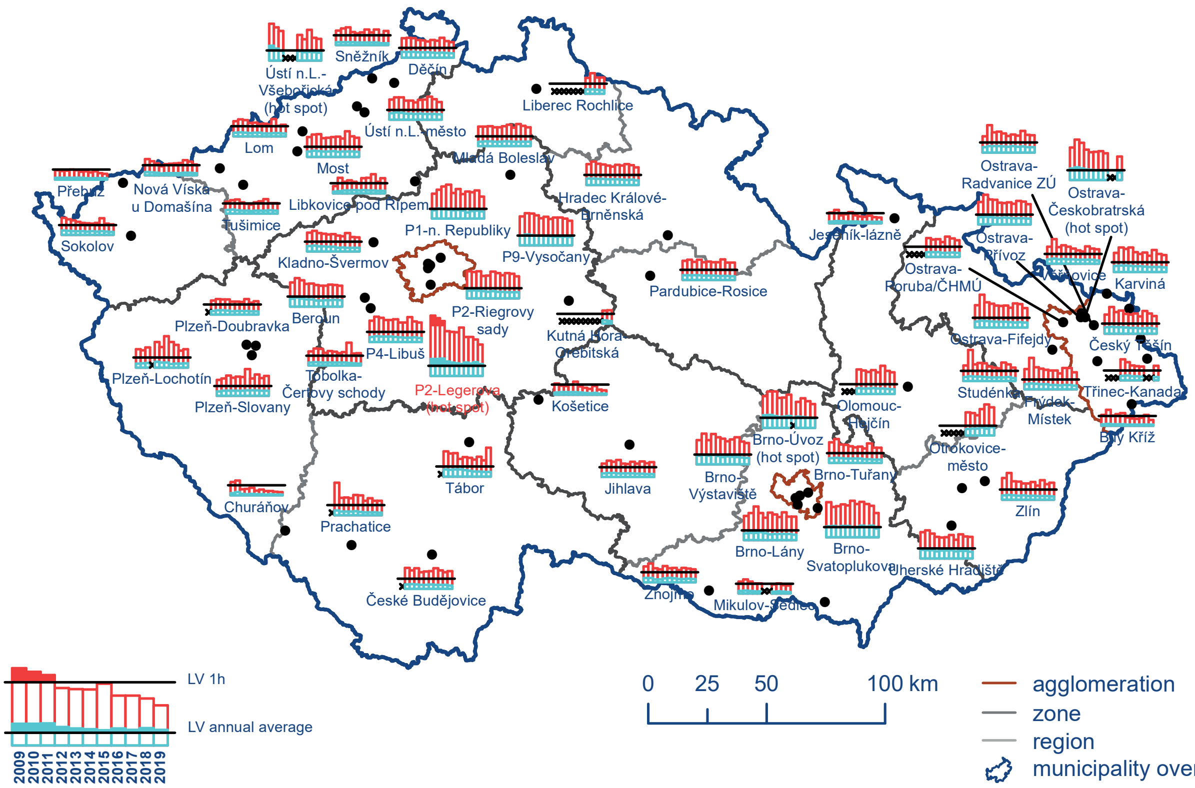


concentration [μg.m^{-3}]
- ≤ 19.5
- 19.6–24.0
- 24.1–30.0
- > 30.0
- ▲ rural station

0 25 50 100 km

- agglomeration
- zone
- region
- municipality over 30K inhab.

Fig. IV.3.5 Field of annual average NO_x concentration, 2019



0 25 50 100 km

- agglomeration
- zone
- region
- municipality over 30K inhab.

× insufficient data
> LV

Fig. IV.3.6 19th highest hourly and annual average NO_2 concentrations at selected stations, 2008–2019

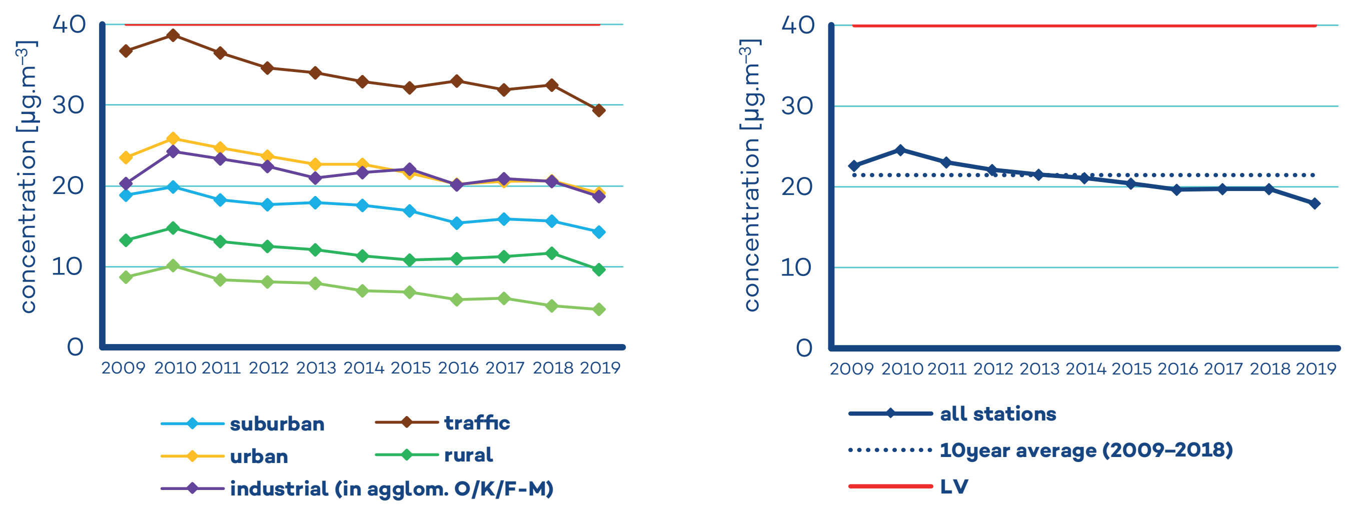


Fig. IV.3.7 Annual characteristics of NO_2 at particular types of stations in the Czech Republic, 2009–2019

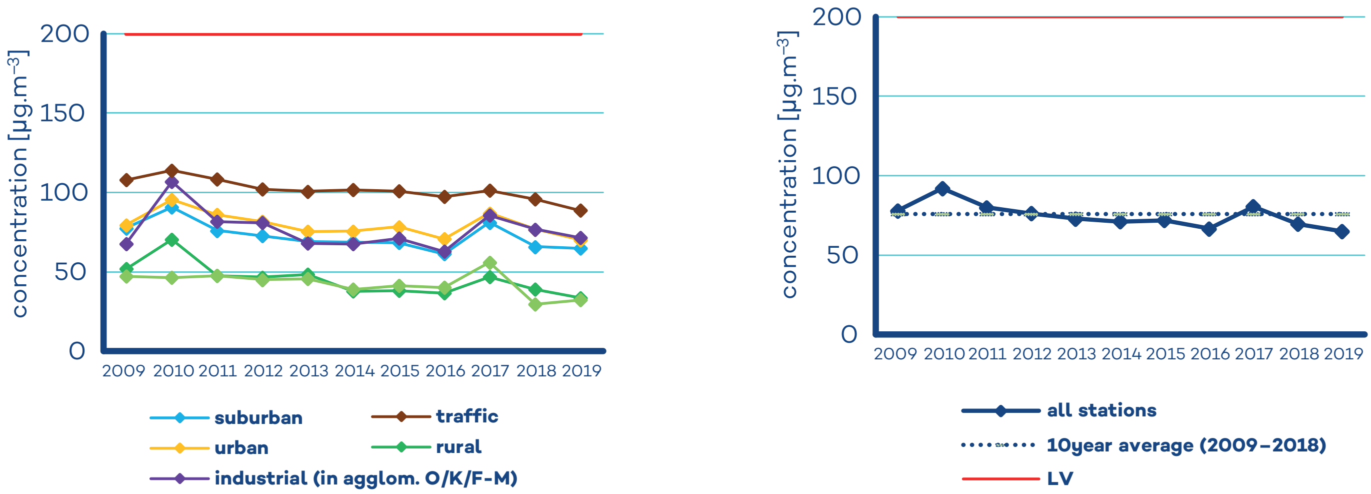


Fig. IV.3.8 Annual characteristics of 19th highest hourly NO_2 concentrations at particular types of stations in the Czech Republic, 2009–2019

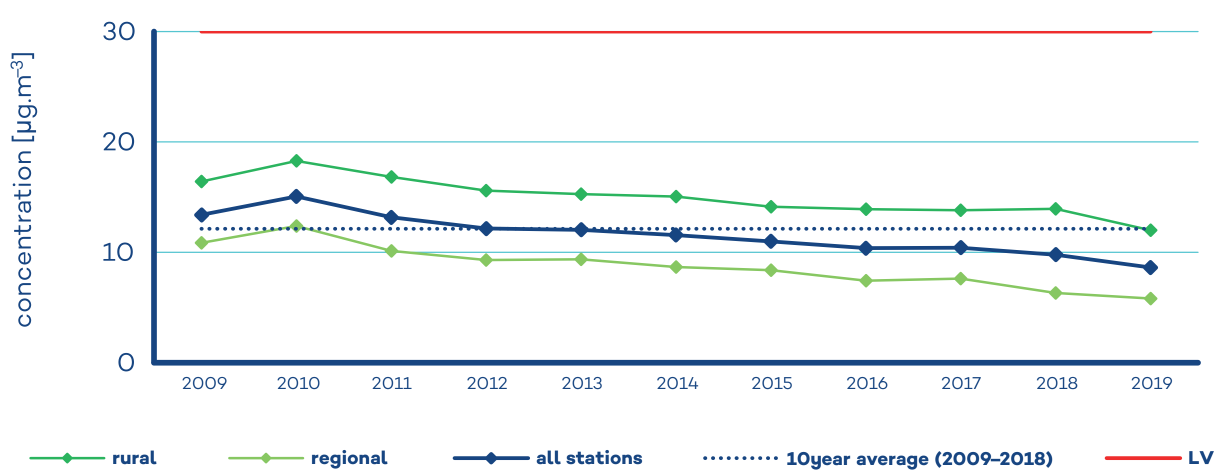


Fig. IV.3.9 Annual characteristics of NO_x at particular types of stations in the Czech Republic, 2009–2019

IV.3.3 Nitrogen oxide emissions

Nitrogen oxides (NO_x) are formed in combustion of fuels in dependence on the temperature of combustion, nitrogen content of the fuel and excess of combustion air, and are also formed in some chemical-technological processes (production of nitric acid, ammonia, fertilisers, etc.). While in combustion of fuels in boilers the fraction of NO_2 in NO_x emissions is usually up to 5%, the fraction of NO_2 in some chemical-technological processes can reach up to 100% of total NO_x emissions (Neužil 2012). NO_x emissions with higher fraction of NO_2 (10–55%) are produced by diesel engines (Carslaw at al. 2011).

The largest amount of NO_x emissions comes from transport. Sectors 1A3bi – Road transport: Passenger cars, 1A4cii – Agriculture/Forestry/Fishing: Off-road vehicles and other machinery, 1A3biii – Road transport: Heavy duty vehicles over 3.5 tons, and 1A3bii – Road transport: Light duty vehicles contributed 41.3% to national NO_x emissions in 2018. An amount of 24.4% of NO_x emissions was emitted into the air in the sector 1A1a – Public electricity and heat production (Fig. IV.3.10). The decrease in NO_x emissions in the 2009–2018 period is related primarily to natural renewal of the vehicle fleet and the introduction of emission ceilings and stricter emission limits for NO_x emissions from sources in the sector 1A1a – Public electricity and heat production (Fig. IV.3.11).

The contribution of particular emission sources differ depending on the composition of sources in a given area. The production of NO_x emissions is concentrated primarily along motorways, roadways with heavy traffic, in large cities, and in the regions where more significant energy production facilities are located (Ústí nad Labem, Central Bohemian and Moravian-Silesian regions) (Fig. IV.3.12).

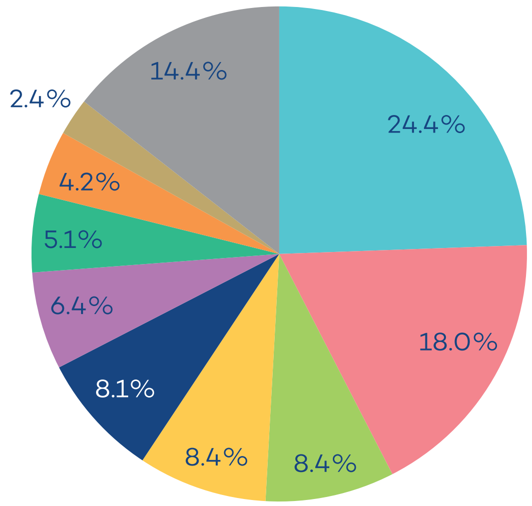


Fig. IV.3.10 Share of NFR sectors in total NO_x emissions, 2018

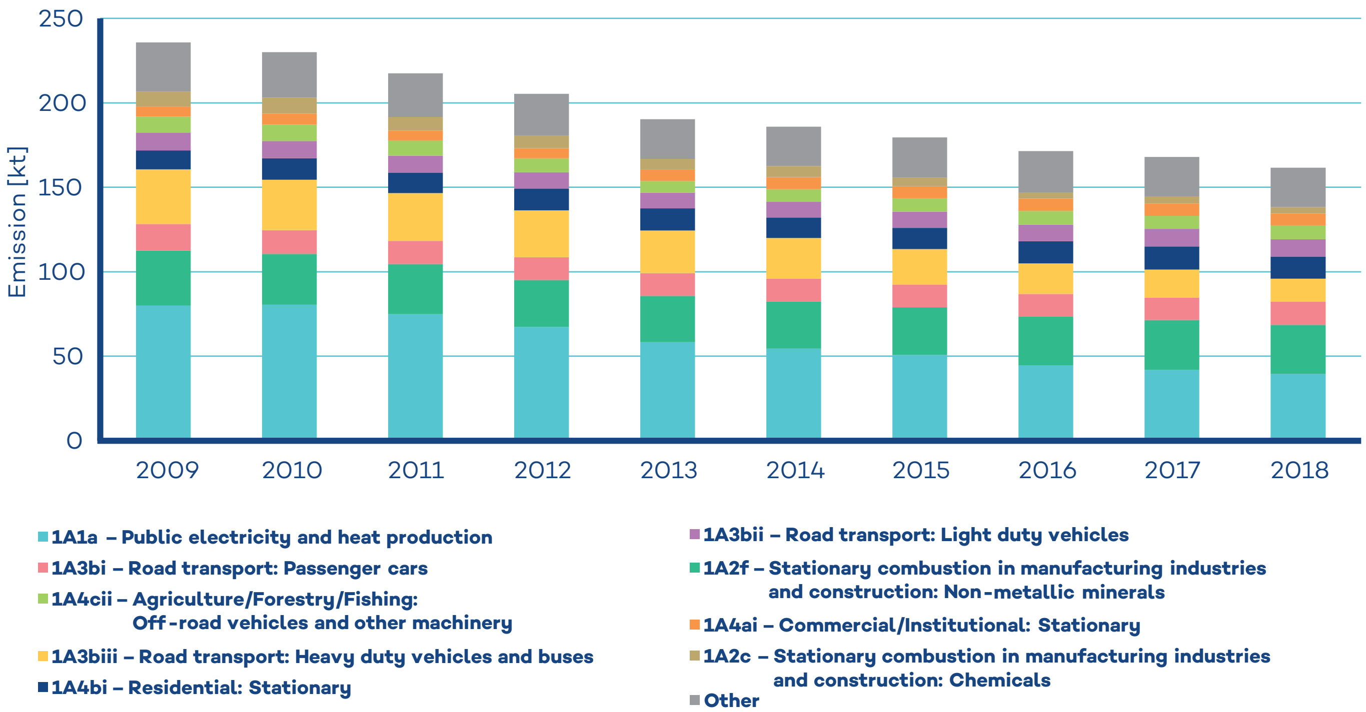


Fig. IV.3.11 Total NO_x emissions, 2009–2018

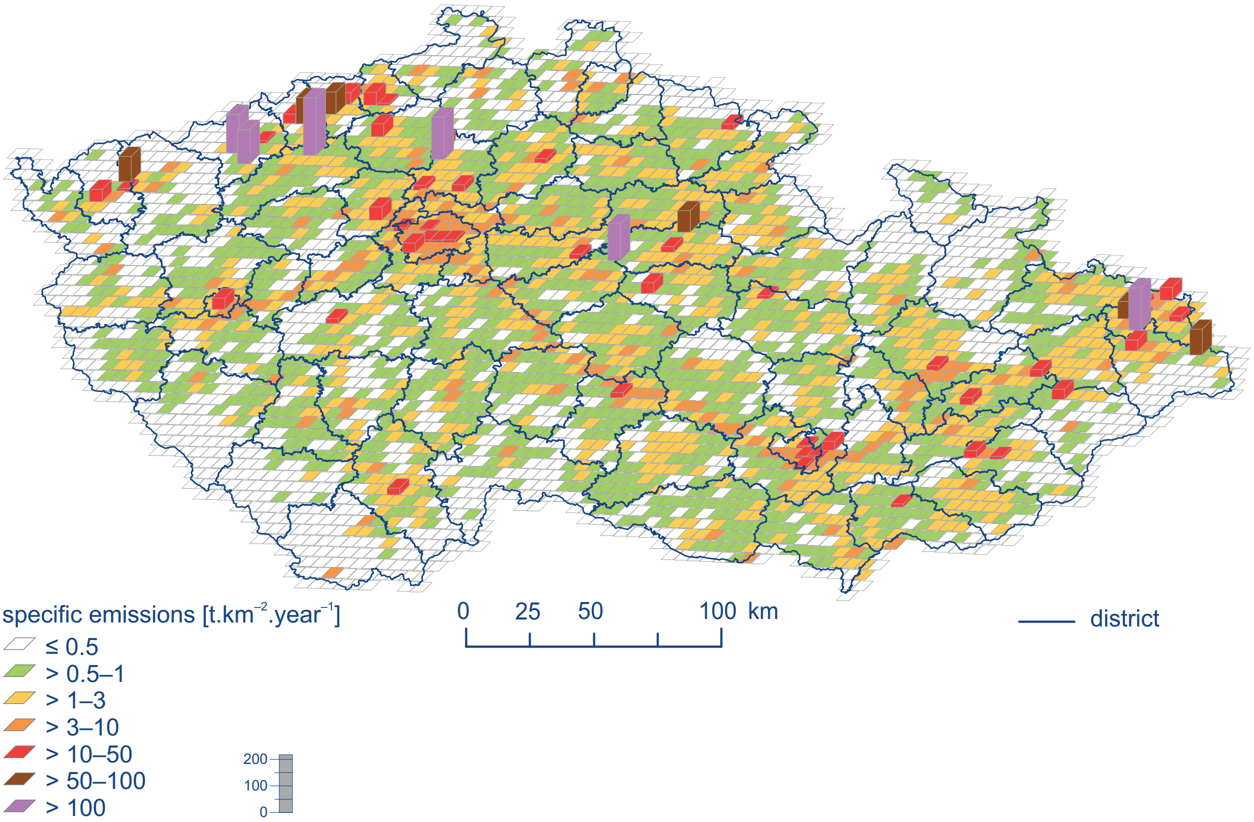


Fig. IV.3.12 NO_x emission densities in 5 x 5 km spatial resolution squares, 2018