IV.3 Nitrogen oxides

IV.3.1 Air pollution by nitrogen oxides in 2020

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). A pollution limit level for the protection of human health has been set for NO_2, while a limit level for the protection of ecosystems and vegetation has been set for NO_x.

Air pollution by nitrogen dioxide in 2020 in relation to pollution limit levels for the protection of human health

The annual pollution limit level for NO_2 has been exceeded only at a limited number of stations (from 2% to 4% of stations in the last five years), at locations with high traffic intensity in agglomerations and large cities. The limit value for the annual average nitrogen dioxide (NO_2) concentration (40 μg.m^{-3}) was not exceeded at any station for the first time during the entire observation period, i.e. since the 1990s (Fig. IV.3.1). The annual average NO_2 concentrations at most stations have outdone or have been at least very close to historical minima. High values of NO_2 concentrations have long been recorded at the Prague 2-Legerova station (hot spot) in relation to high traffic intensities in the immediate vicinity of the station and its location in a street canyon where the possibility of ventilation is significantly reduced. In 2020, the annual average concentration of 38.9 μg.m^{-3} was measured at the Praha 2-Legerova station. Higher NO_2 concentrations can also be expected in the vicinity of local roads in municipalities and cities with intensive traffic, higher urban development and a dense local transport network where traffic flow often drops. The lowest NO_2 concentrations are measured at regional stations (Churáňov, Košetice, Polom), i.e. in areas far from the influence of emission sources.

The limit value for an hourly NO_2 concentration (200 μg.m^{-3} with a maximum permitted number of 18 cases exceeding the limit per year) was not exceeded at any station in 2020. Neither the hourly NO_2 limit value was exceeded at any station.

The annual average concentration of NO_2 derived for the territory of the CR did not exceed 26 μg.m^{-3}, i.e. the value of the lower assessment threshold (Fig. IV.3.2). From a long-term perspective (Fig. IV.3.3), higher concentrations are expected in centres of large cities with high traffic intensities (Prague and Brno). However, it is important to note that NO_2 concentration maps are prepared in a resolution of 1×1 km, and therefore the effect of higher concentrations measured at transport stations with a low radius of representativeness (up to 100 m) are not reflected in the final image. The low radius of representativeness of transport stations is related to a sharp decrease in NO_2 concentrations with increasing distance from roads.

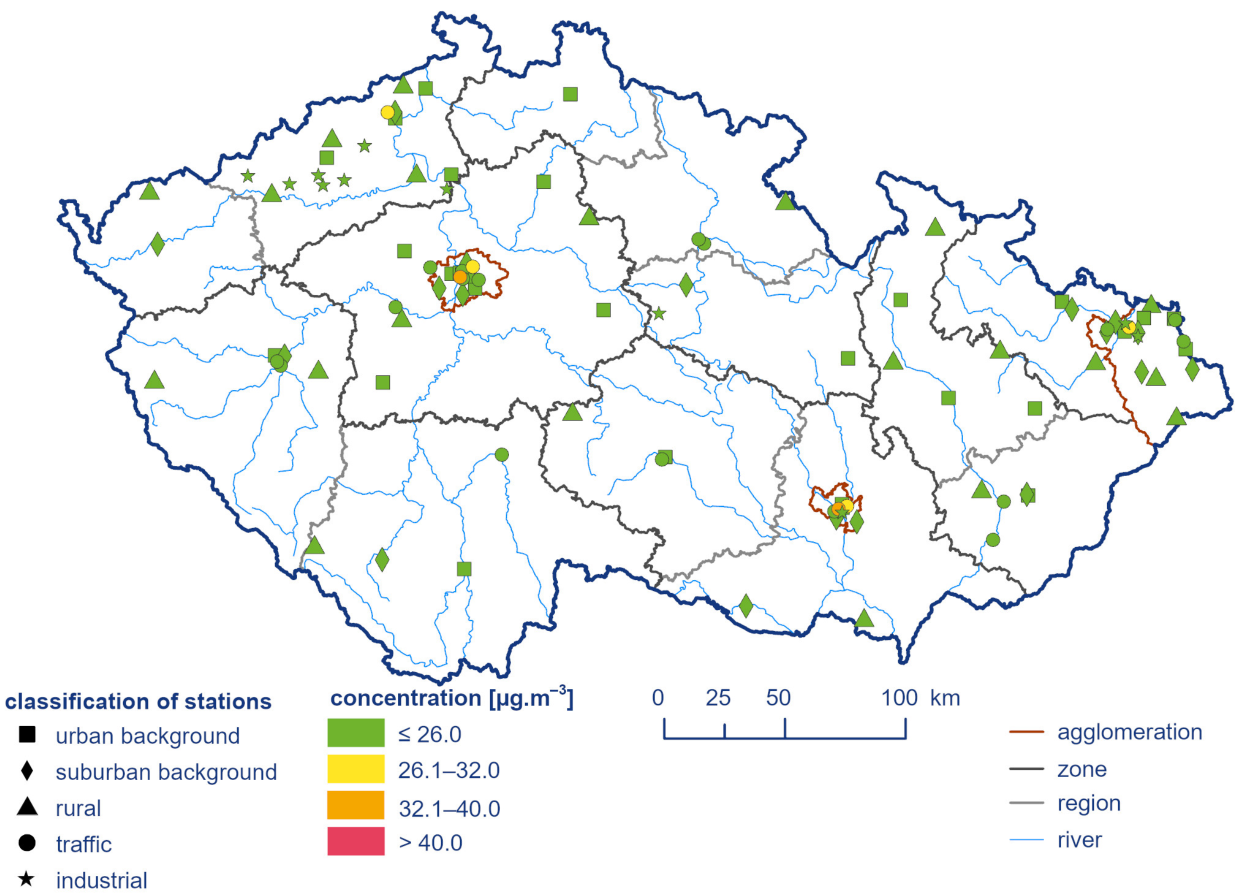

Fig. IV.3.1 Annual average NO_2 concentrations at air quality monitoring stations, 2020

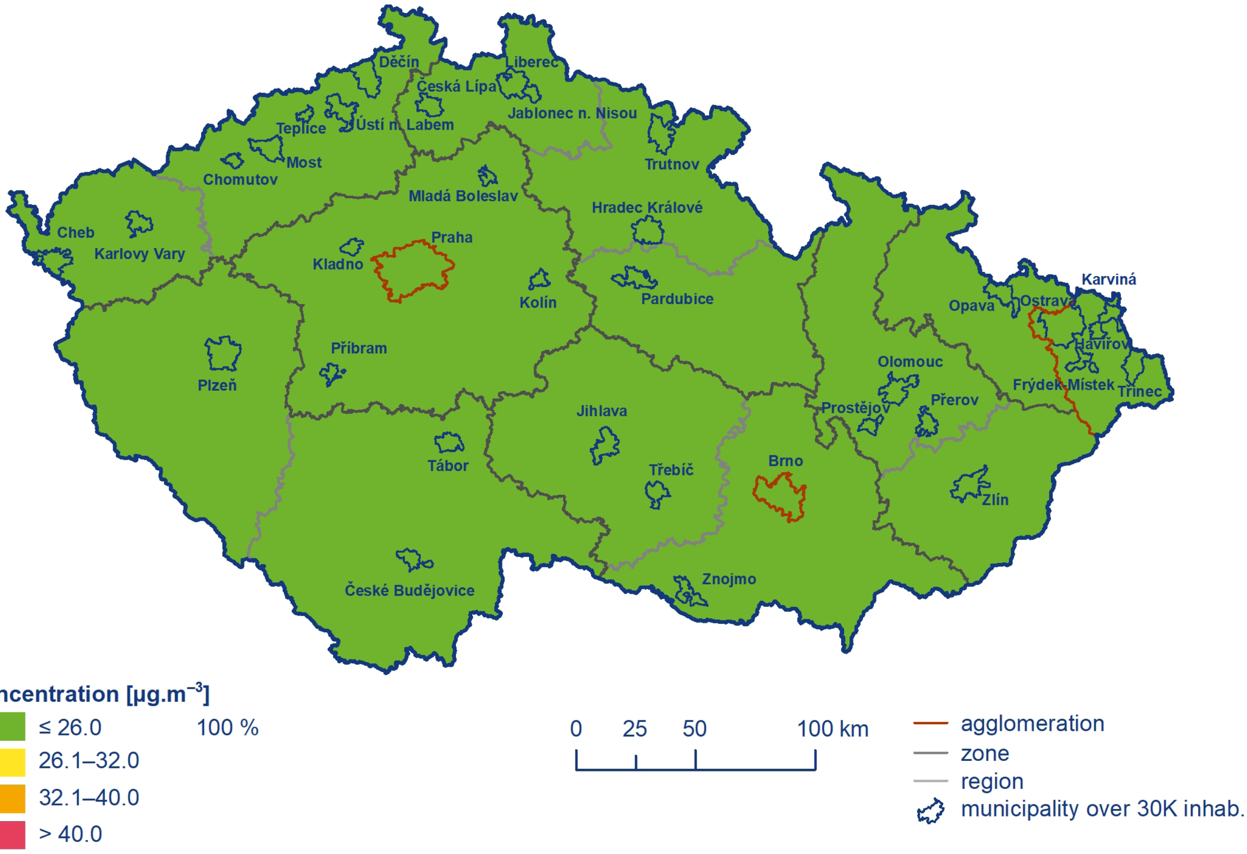

Fig. IV.3.2 Field of annual average NO_2 concentrations, 2020

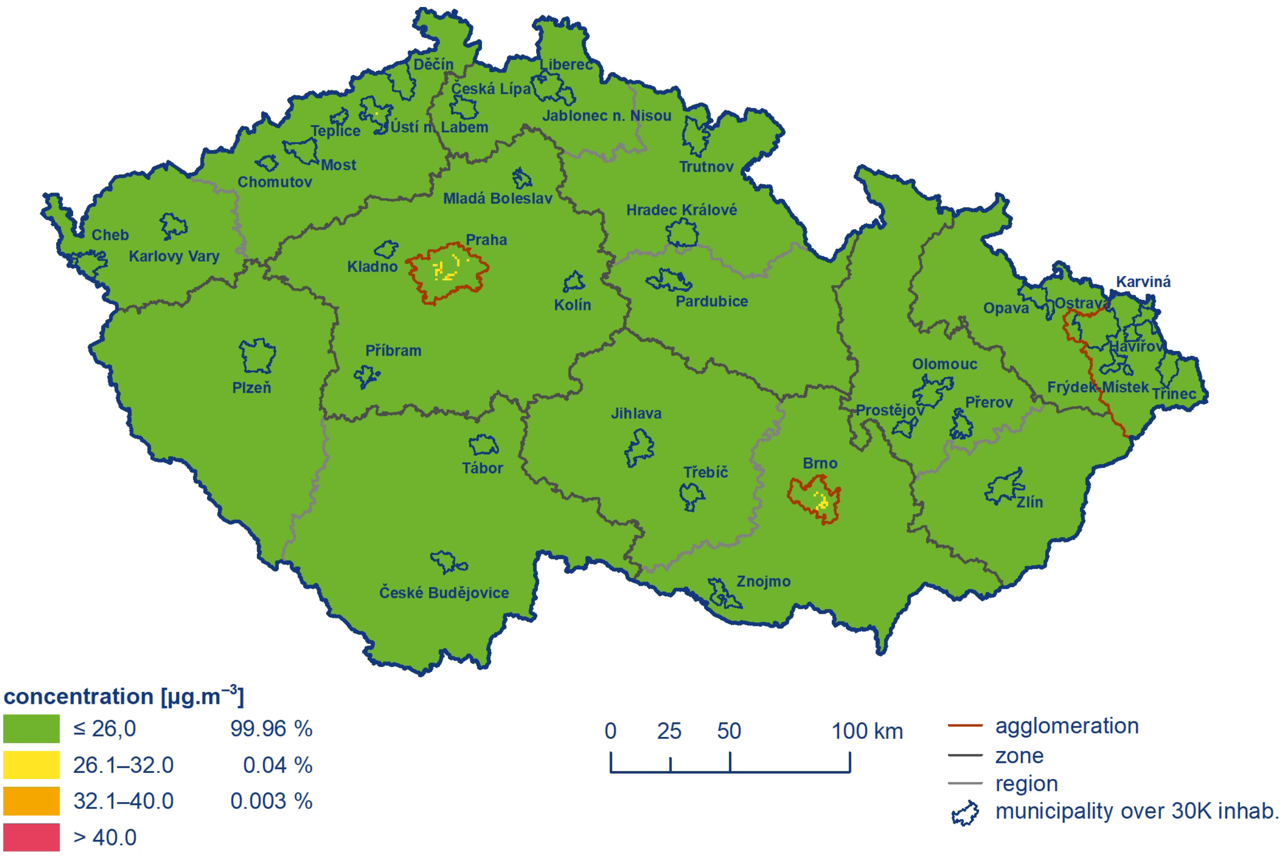

Fig. IV.3.3 Five-year average of annual average NO_2 concentrations, 2016–2020

The annual variation of monthly average concentrations is similar for all types of stations, except transport stations where the highest values of concentrations are also observed, so a strong effect from the involved emission source — transport can be seen (Fig. IV.3.4.). As transport is the main source of NO_2, which operates throughout the year, the variation of concentrations during the year is affected by meteorological and dispersion conditions. In addition, peaks in the colder period of the year occur due to increased emissions from domestic heating and car cold ignition. On the contrary, in the period April-September, there is generally a decrease in NO_2 concentrations. The reason for this decrease is higher intensity of solar radiation in this season, which results in decomposition of NO_2 and its participation in photochemical reactions forming ground-level ozone. During the summer holiday months, there is also a reduction in traffic intensity in large cities, which improves the flow of traffic and thus reduces NO_2 concentrations. The average monthly NO_2 concentrations are the lowest and well below the lower assessment threshold at regional rural localities remote from direct exposure to emission sources, showing thus less distinct annual variation. In 2020, all monthly average NO_2 concentrations were lower compared to the ten-year average 2010–2019. The most significant decrease (40–60%) compared to the ten-year average occurred in February in connection with atypical meteorological and dispersion conditions (above-average temperature and total precipitation, high wind speeds). In addition, the reduction in NO_2 concentrations in certain months was due to a reduction in traffic intensity during the emergency state (Annex II).

Air pollution by nitrogen oxides in 2020 in relation to pollution limit levels for the protection of ecosystems and vegetation

The pollution limit level for the protection of ecosystems and vegetation for the average annual NO_x concentration (30 μg.m^{-3}) was not exceeded in 2020 at any of 21 rural stations with a sufficient amount of data for evaluation. 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 average annual NO_x concentrations are evaluated only at these locations, following the Czech legislation in force in relation to the pollution limit level for the protection of ecosystems and vegetation (Fig. IV.3.5).

IV.3.2 Trends in nitrogen oxide concentrations

The trends in NO_2 concentrations at stations are evaluated over the last 11 years, i.e. 2010–2020 (Fig. IV.3.6, Fig. IV.3.7, Fig. IV.3.8, and Fig. IV.3.9). During this period, the highest NO_2 and NO_x concentrations were recorded in 2010, in association with the recurrence of poor meteorological and dispersion conditions in the cold period of the year. Since 2010, it is possible to observe a gradual decrease in all monitored nitrogen oxide characteristics. The slight increase in NO_2 and NO_x concentrations in 2017 was associated with poor dispersion conditions in the cold part of the year. In the year-on-year comparison 2019/2020, there was a further decrease in the average annual NO_2 and NO_x concentration at all types of stations. The most significant decrease occurred at transport stations, by almost 15% for the annual average NO_2 concentration, which clearly indicates a decrease in NO_2 emissions from transport due to limited traffic during emergency states. In 2020, the lowest concentrations of NO_2 and NO_x were recorded at most stations for the entire evaluated period, as well as for the entire period of their observation. Compared to the ten-year average (2010–2019) of concentrations from all stations, the annual average concentration and the 19th highest hourly NO_2 concentration decreased by 26% or by 27%, respectively.

A number of factors contributed to further improvement, in particular very good meteorological (normal to above-normal temperatures and precipitation totals) and dispersion conditions in February, and the continuing decrease in emissions due to gradual modernization of emission sources (large sources, vehicle

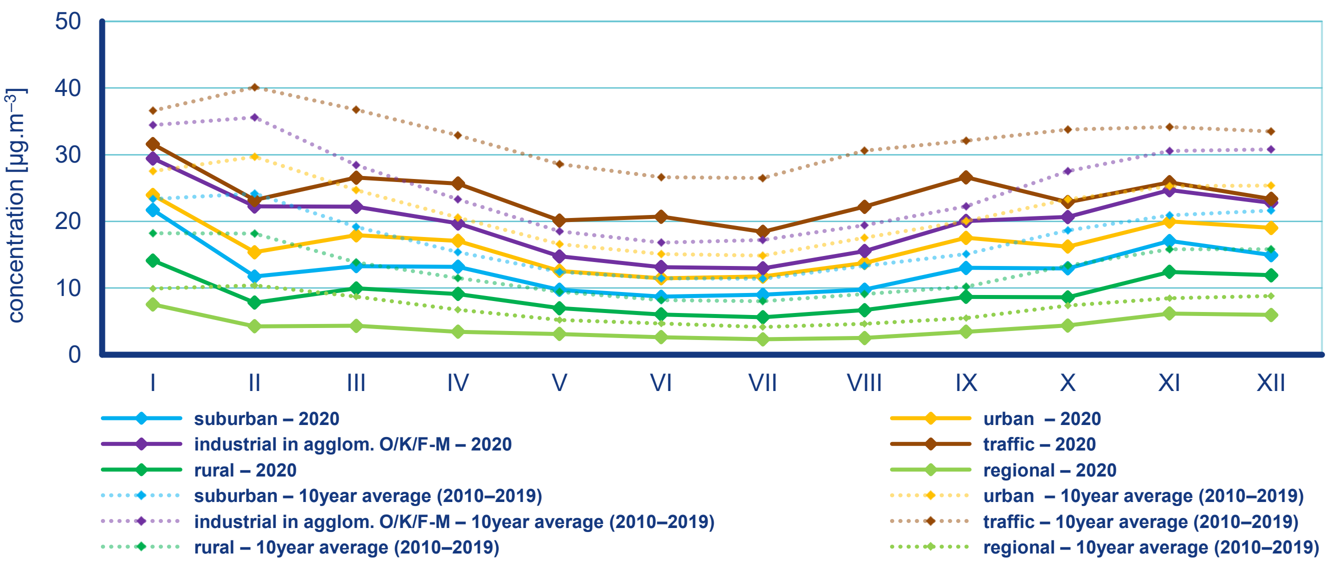

Fig. IV.3.4 Annual course of average monthly concentrations of NO_2, 2020

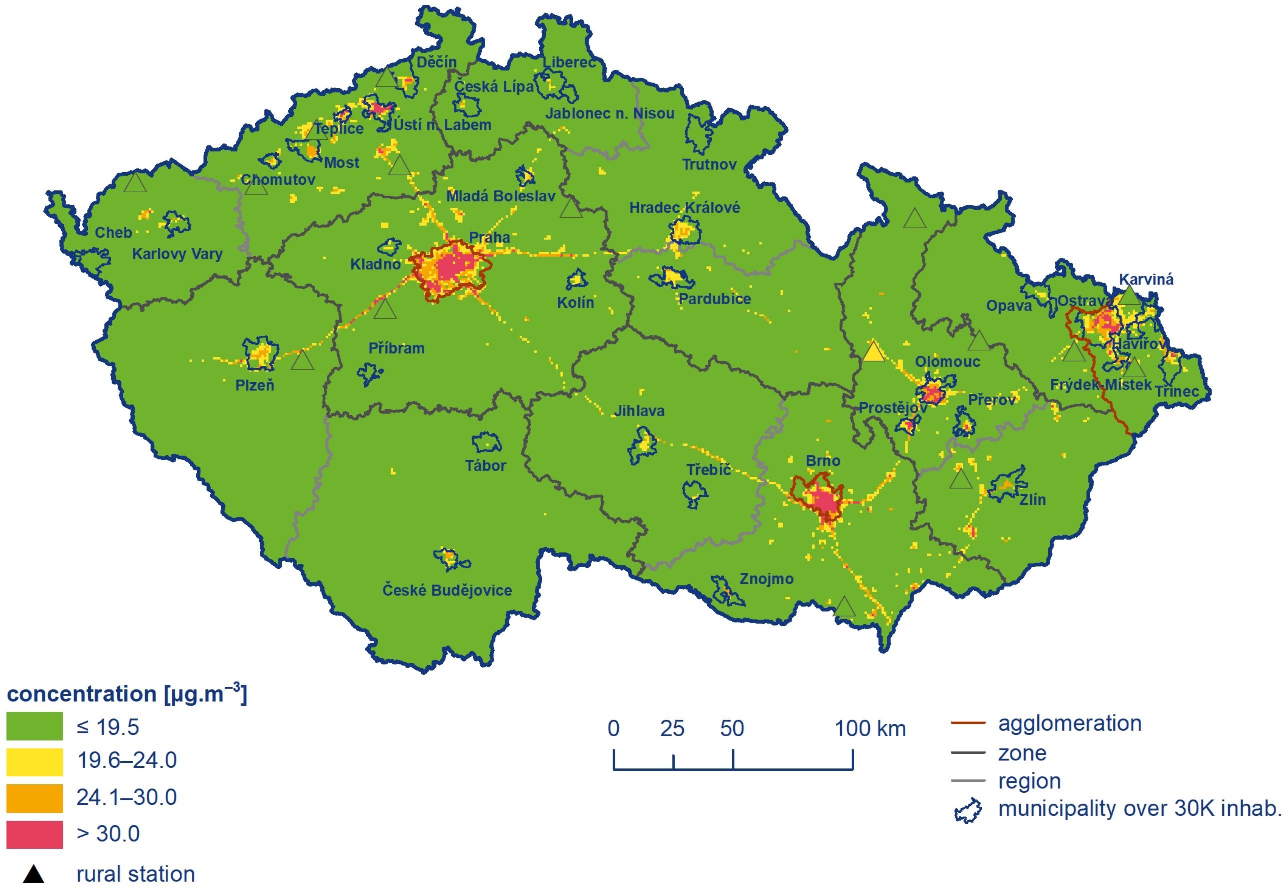

Fig. IV.3.5 Field of annual average NO_x concentration, 2020

Fig. IV.3.6 The 19th highest hourly and annual average NO_2 concentrations at selected stations, 2010–2020

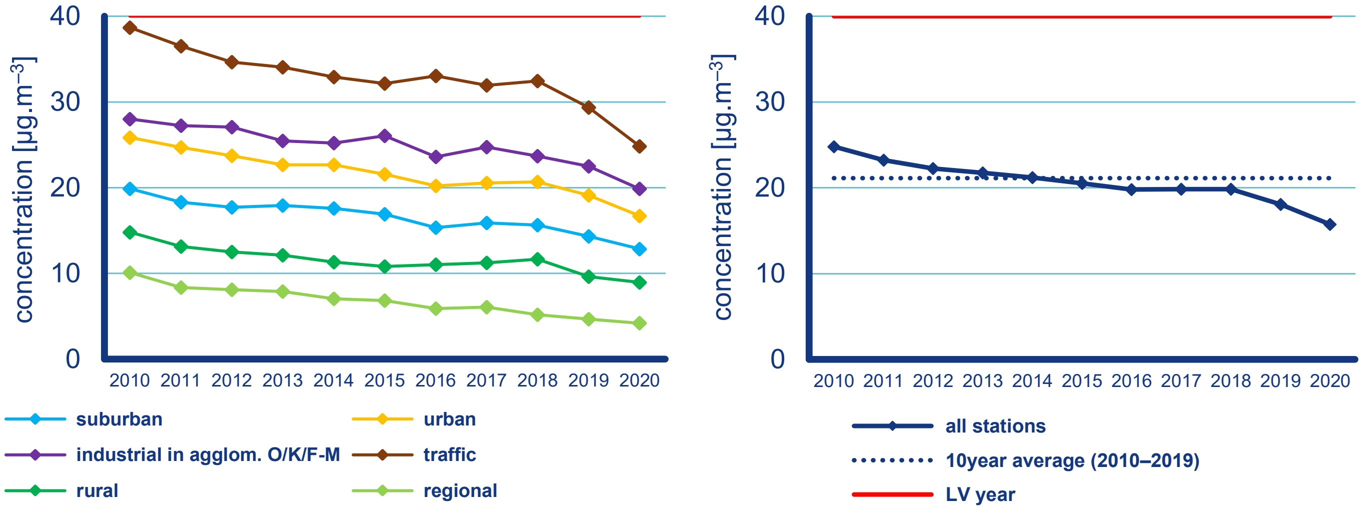

Fig. IV.3.7 Annual average NO_2 concentrations at particular types of stations, 2010–2020

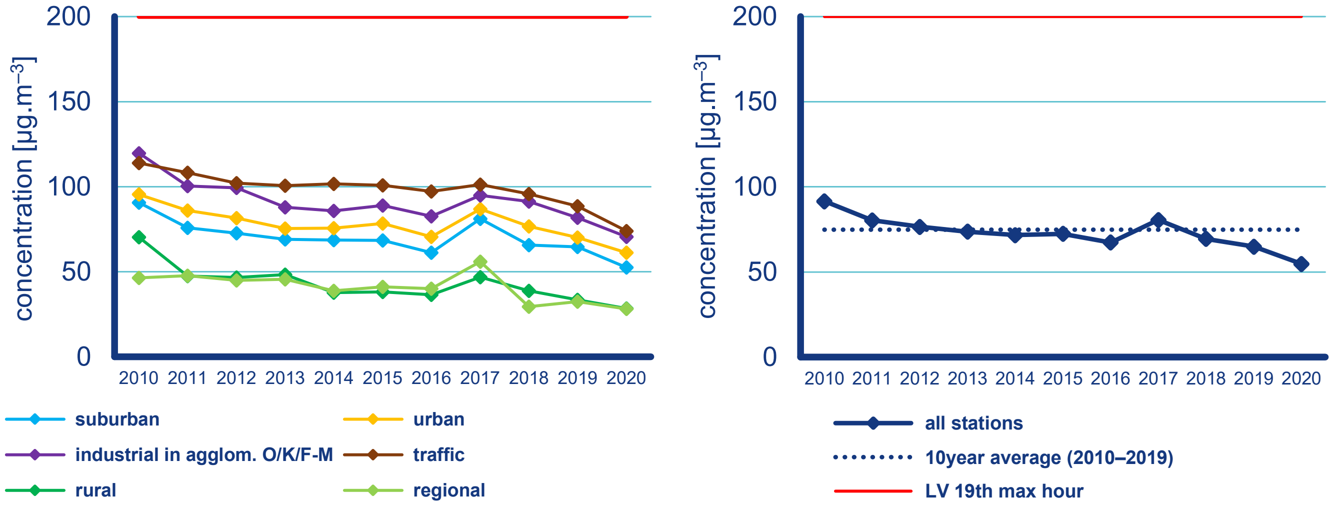

Fig. IV.3.8 The 19th highest hourly NO_2 concentrations at particular types of stations, 2010–2020

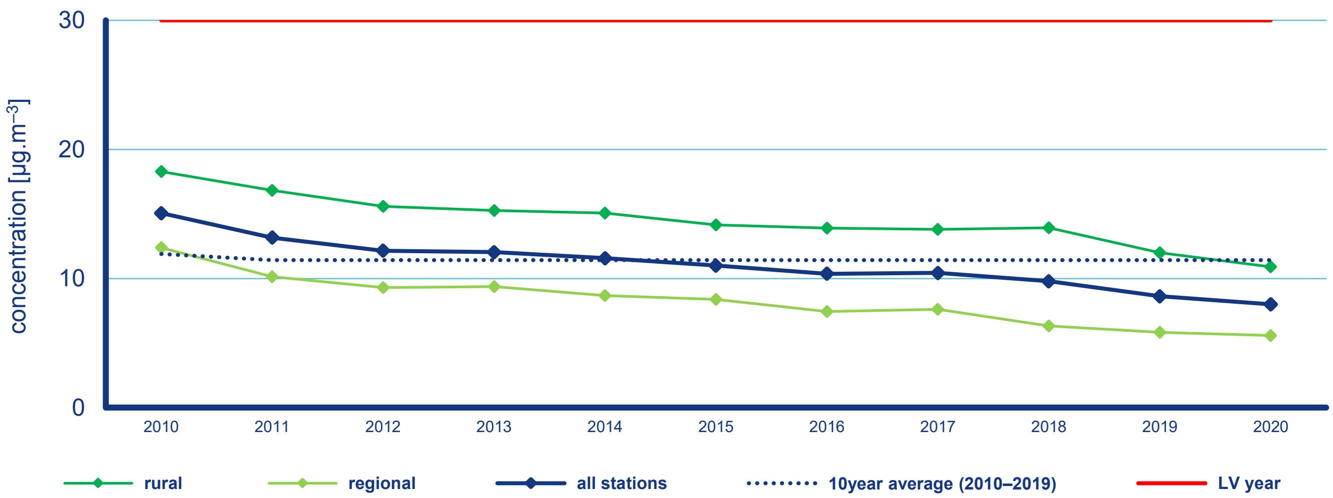

Fig. IV.3.9 Annual average NO_x concentrations at particular types of stations, 2010–2020

fleet renewal, and freight transport modernization). The decrease in concentrations was also due to measures associated with the declaration of emergency situations owing to the spread of a new type of coronavirus SARS-CoV-2, which reduced the mobility of the population and thus traffic intensity (Annex II).

IV.3.3 Nitrogen oxide emissions

Nitrogen oxides (NO_x) are formed during the combustion of fuels, depending on the temperature of combustion, nitrogen content of the fuel and excess of combustion air, and are also formed in some chemical-technological processes (the production of nitric acid, ammonia, fertilisers, etc.). While during the 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 a higher fraction of NO_2 (10–55%) are also produced by diesel engines (Carslaw at al. 2011).

The largest amount of NO_x emissions comes from mobile sources (CHMI 2021d). In 2019, 38.1% of national NO_x emissions came from the 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. 20.5% of NO_x emissions were emitted into the air from sector 1A1a – Public electricity and heat production (Fig. IV.3.10). Emissions from the sector Inorganic N-fertilizers were newly derived for the entire period, accounting for 7.9% of total emissions in 2019.

The decreasing trend in NO_x emissions in the 2010–2019 period is related primarily to natural renewal of the vehicle fleet and the introduction of emission ceilings including stricter emission limits for NO_x emissions from sources in sector 1A1a – Public electricity and heat production (Fig. IV.3.11).

The contributions 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 Bohemia and Moravian-Silesia regions).

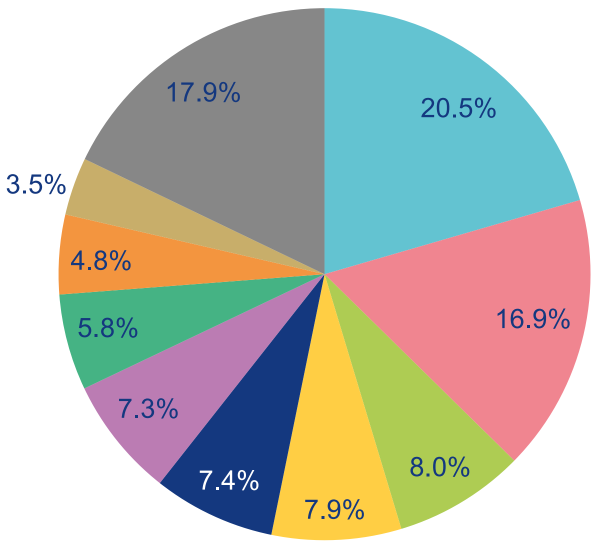

Fig. IV.3.10 Share of NFR sectors in total NO_x emissions, 2019

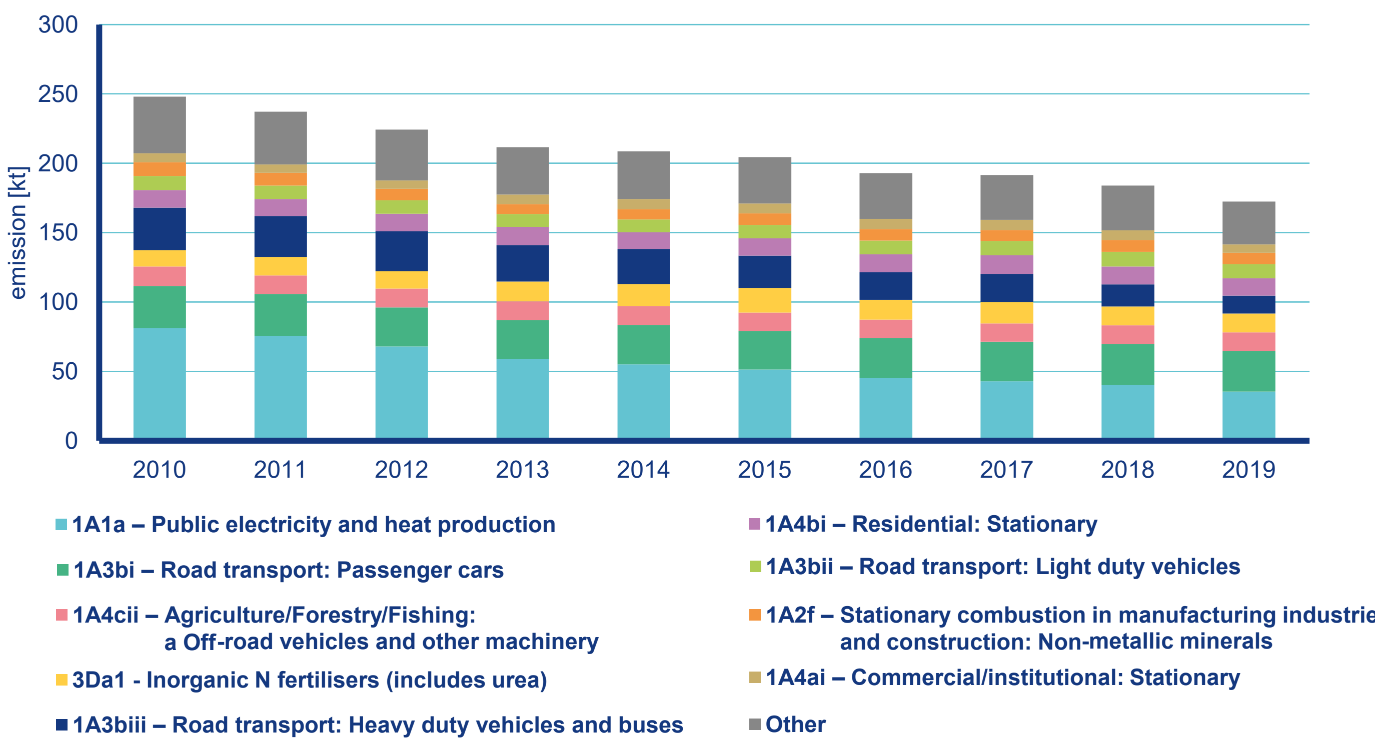

Fig. IV.3.11 Total NO_x emissions, 2010–2019