# IV.6 Heavy metals

## IV.6.1 Air pollution by heavy metals in 2021

### Arsenic

The annual pollution limit level for arsenic (6 ng·m⁻³) was not exceeded at any of 55 stations with valid annual average values in 2021 (Fig. IV.6.1). The highest annual average (3.3 ng·m⁻³) was observed at the Praha 5-Řeporyje urban background station. Compared to 2020 (2.3 ng·m⁻³), this is an increase by 43 %.

In 2021, the annual average arsenic concentrations in the Czech Republic were low and below the lower assessment threshold (2.4 ng·m⁻³). Concentrations above the lower assessment threshold occurred only at three observing stations (Lom, Rýmařov-Janovice, Praha 5-Řeporyje), but even there the upper assessment threshold (3.6 ng·m⁻³) was not reached (Fig. IV.6.2).

Arsenic concentrations have long been below the limit value over most of the Czech Republic, except for the Kladno, Prague and Most areas (Fig. IV.6.3). In non-polluted areas, concentrations are below the lower assessment threshold, though polluted areas have concentration above the limit value. Of the total 46 stations that measured arsenic concentrations both in 2020 and 2021, the annual average concentration increased at 30 stations (65 %), and decreased at 9 stations (20 %). Concentrations remained unchanged at 7 stations (15 %).

### Cadmium

The annual pollution limit level for cadmium (5 ng·m⁻³) was not exceeded at any of 55 stations with valid annual average value in 2021 (Fig. IV.6.4). The highest annual average was observed at the Tanvald-školka urban background station (1.9 ng·m⁻³). Compared to 2020 with 2.9 ng·m⁻³, this is a decrease by 34 %.

In 2021, the annual average cadmium concentrations in the Czech Republic were low and below the lower assessment limit (2 ng·m⁻³; Fig. IV.6.5).

In the long term, cadmium concentrations are below the lower assessment threshold throughout the territory of the Czech Republic, except for the Tanvald vicinity (Fig. IV.6.6). Of the total 46 stations measuring cadmium concentrations both in 2020 and 2021, the annual average concentration increased at only 2 stations (4 %), and decreased at 15 stations (33 %). Concentrations remained unchanged at 29 stations (63 %).

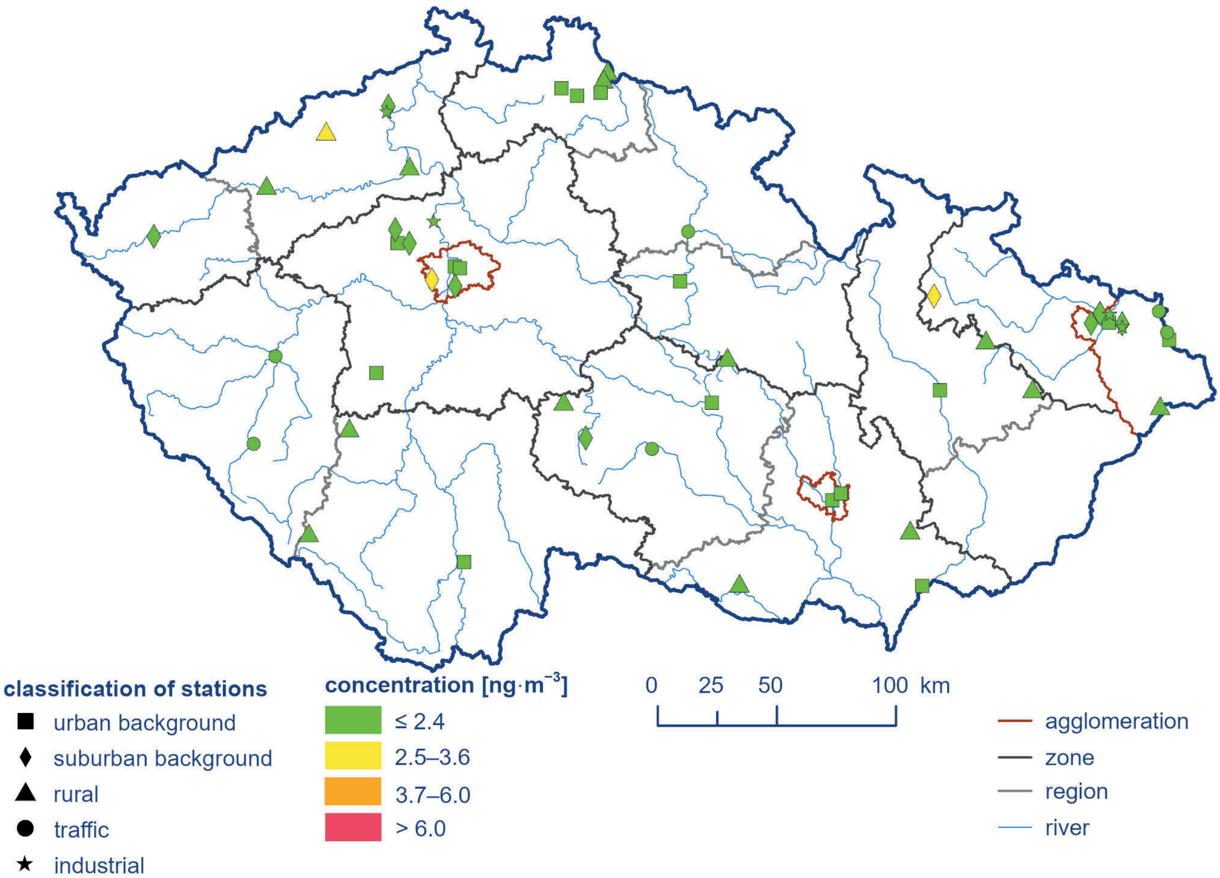


**Fig. IV.6.1 Annual average concentrations of arsenic at air quality monitoring stations, 2021**

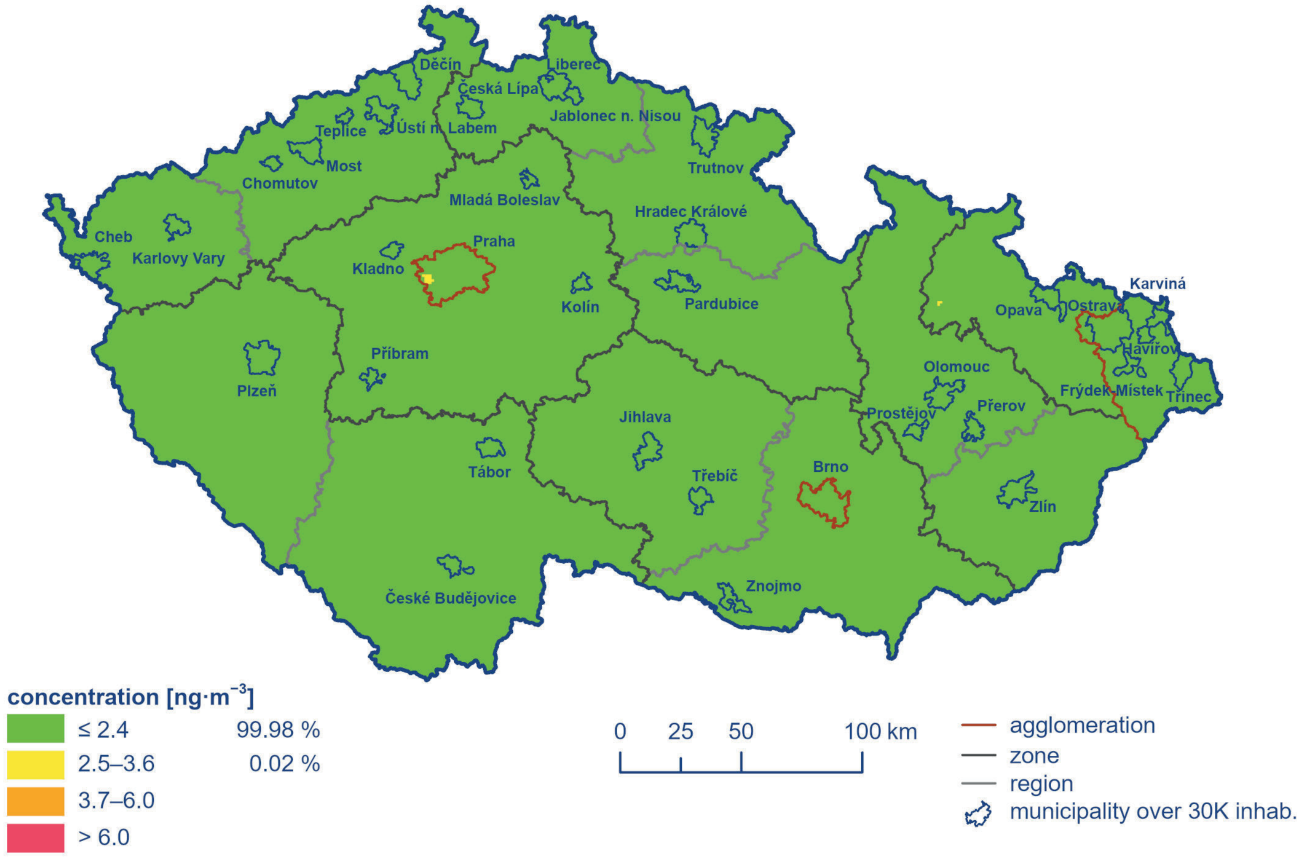


**Fig. IV.6.2 Field of annual average concentration of arsenic, 2021**

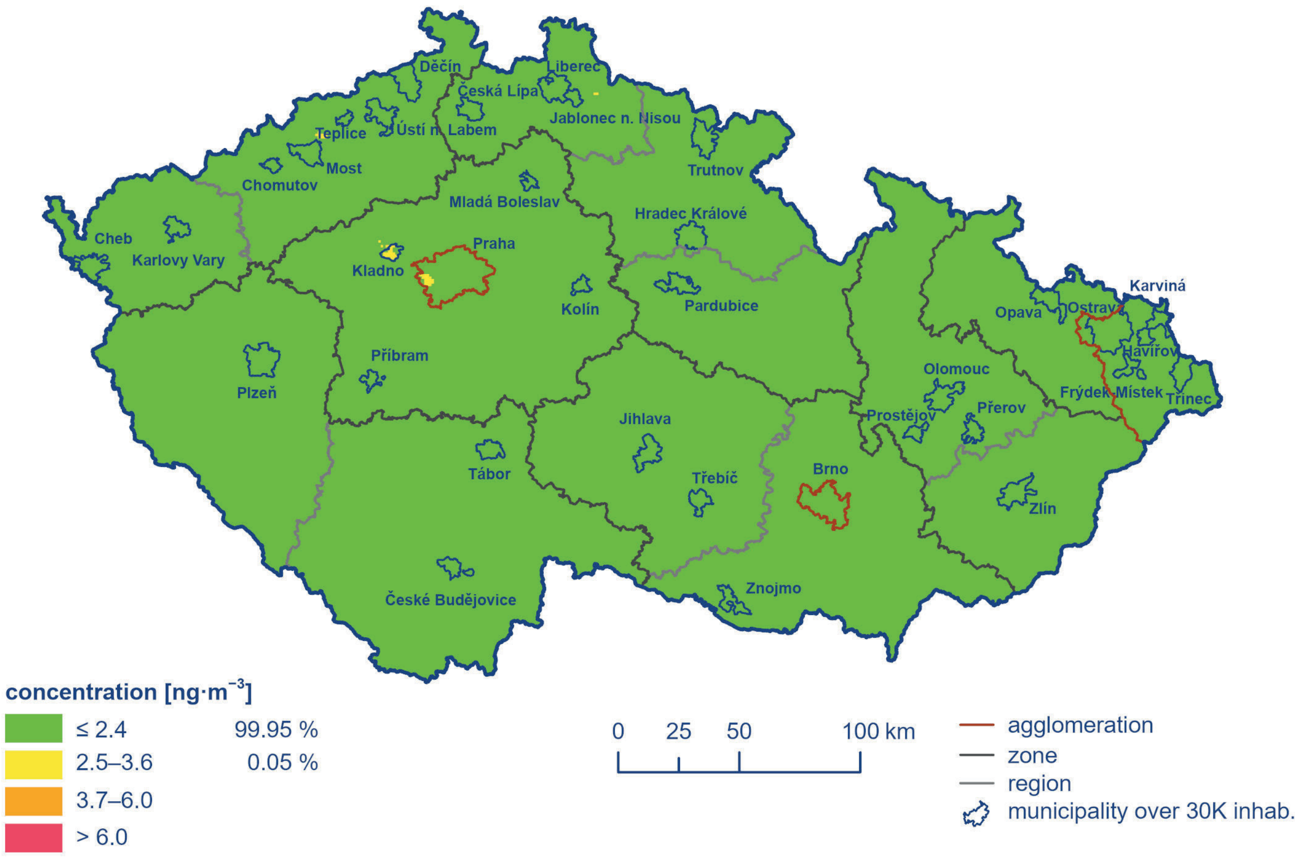


**Fig. IV.6.3 Five-year average of annual average concentrations of arsenic, 2017–2021**

## Nickel

The annual pollution limit level for nickel (20 ng·m$^{-3}$) was not exceeded at any of 54 stations with valid annual average value in 2021. The highest annual average value (4.5 ng·m$^{-3}$) was observed at the Ostrava-Mariánské Hory urban background station (3.2 ng·m$^{-3}$). Compared to 2.8 ng·m$^{-3}$ in 2020, this is an increase by 14 %.

Nickel concentrations have long been very low throughout the territory of the Czech Republic. The highest concentrations are repeatedly measured in the O/K/F-M agglomeration, but even there values do not reach the lower assessment threshold (10 ng·m$^{-3}$). Of the total 46 stations measuring nickel concentrations both in 2020 and 2021, the annual average concentration increased at 13 stations (28 %), and decreased at 16 stations (35 %). Concentrations remained unchanged at 28 stations (37 %).

## Lead

The annual pollution limit level for lead (500 ng·m$^{-3}$) was not exceeded at any of 55 stations with valid annual average values in 2021. The highest annual average (50 ng·m$^{-3}$) was observed, likewise in the previous year, at the Ostrava-Radvanice ZÚ station. Compared to 52 ng·m$^{-3}$ in 2020, this is a decrease by 2 %.

In the long term, lead concentrations are very low throughout the territory of the Czech Republic. The highest concentrations are repeatedly measured in the O/K/F-M agglomeration, but even there values do not reach the lower assessment threshold (250 ng·m$^{-3}$). Of the total 46 stations measuring lead concentrations both in 2020 and 2021, the annual average concentration increased at 26 stations (57 %), and decreased at 18 stations (39 %). Concentrations remained unchanged at 2 stations (4 %).

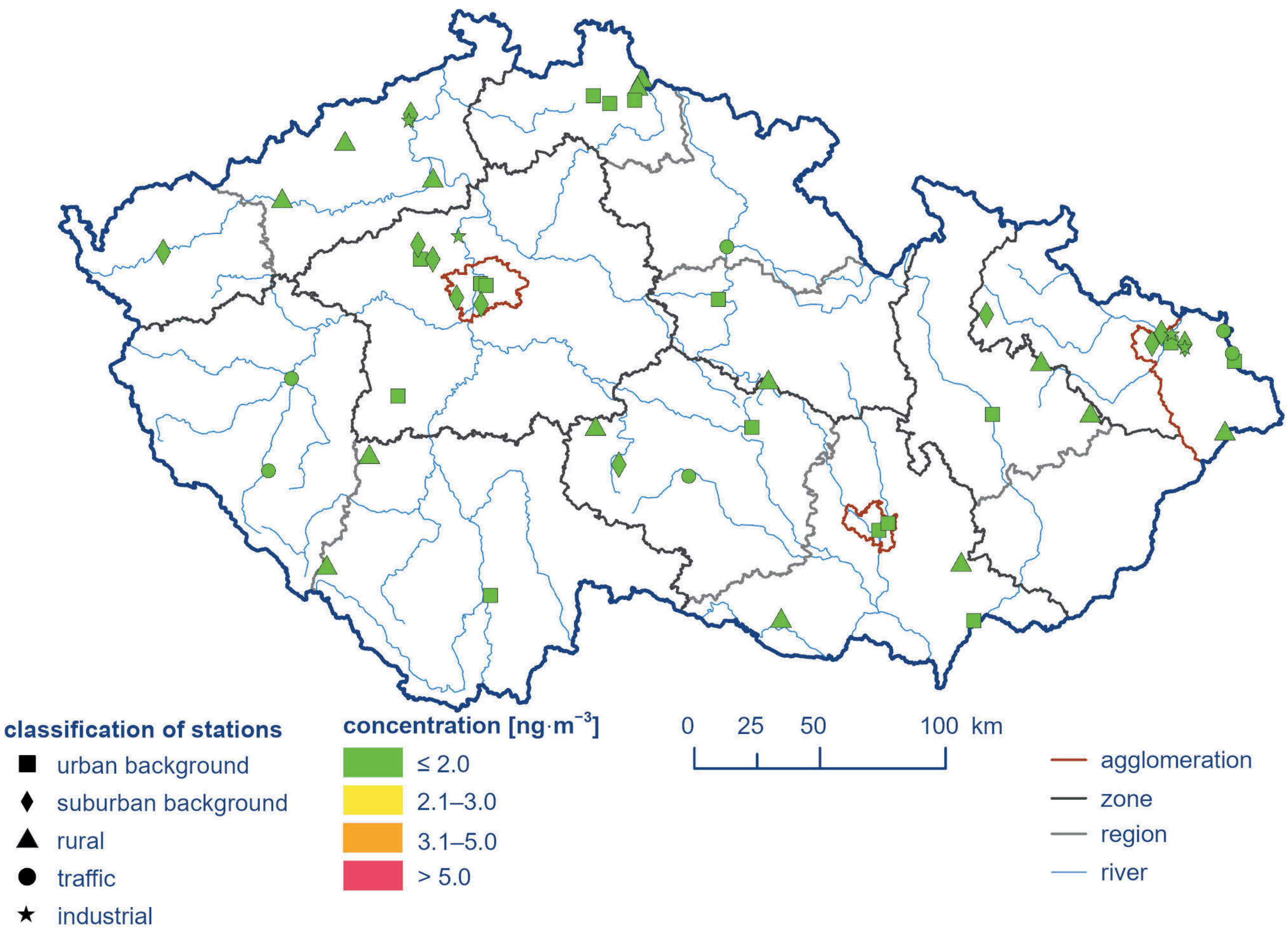


**Fig. IV.6.4 Annual average concentrations of cadmium at air quality monitoring stations, 2021**

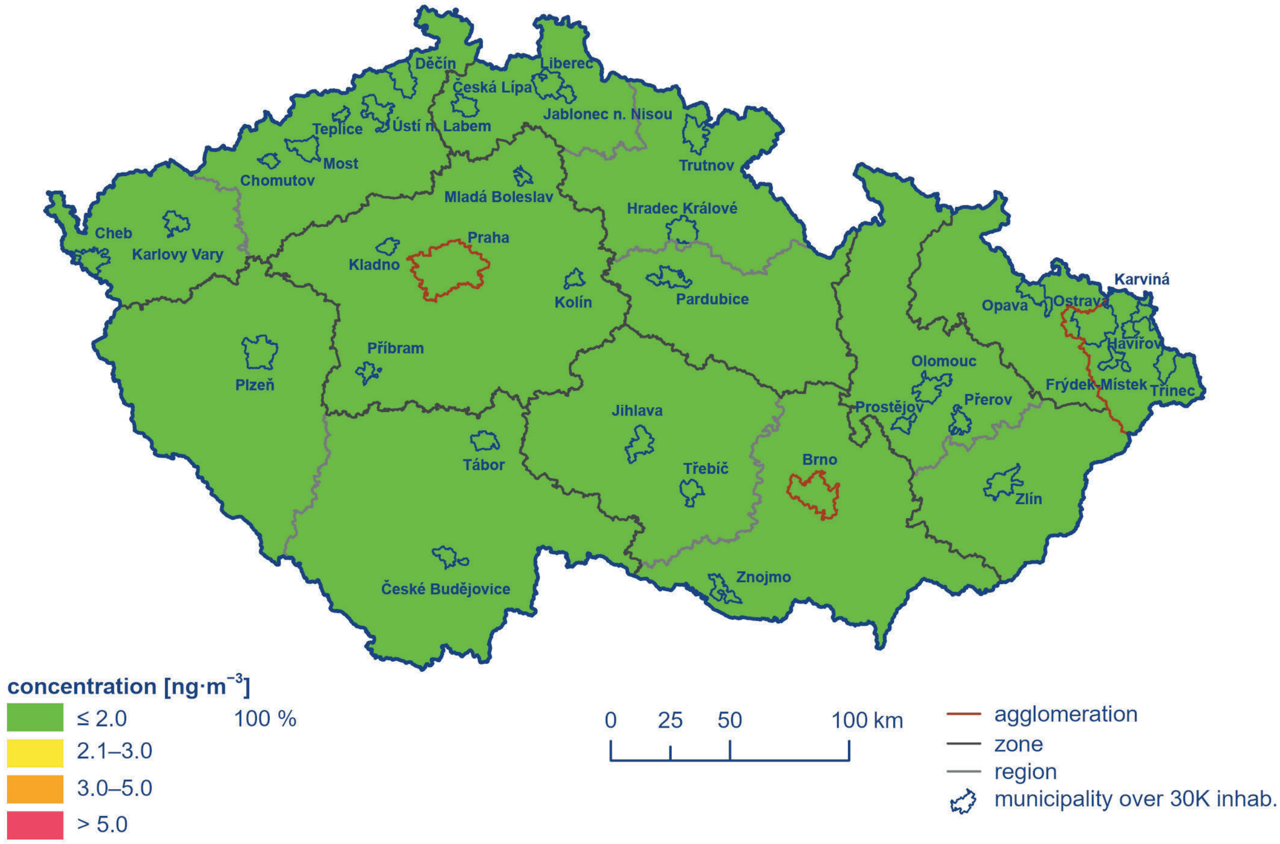


**Fig. IV.6.5 Field of annual average concentration of cadmium, 2021**

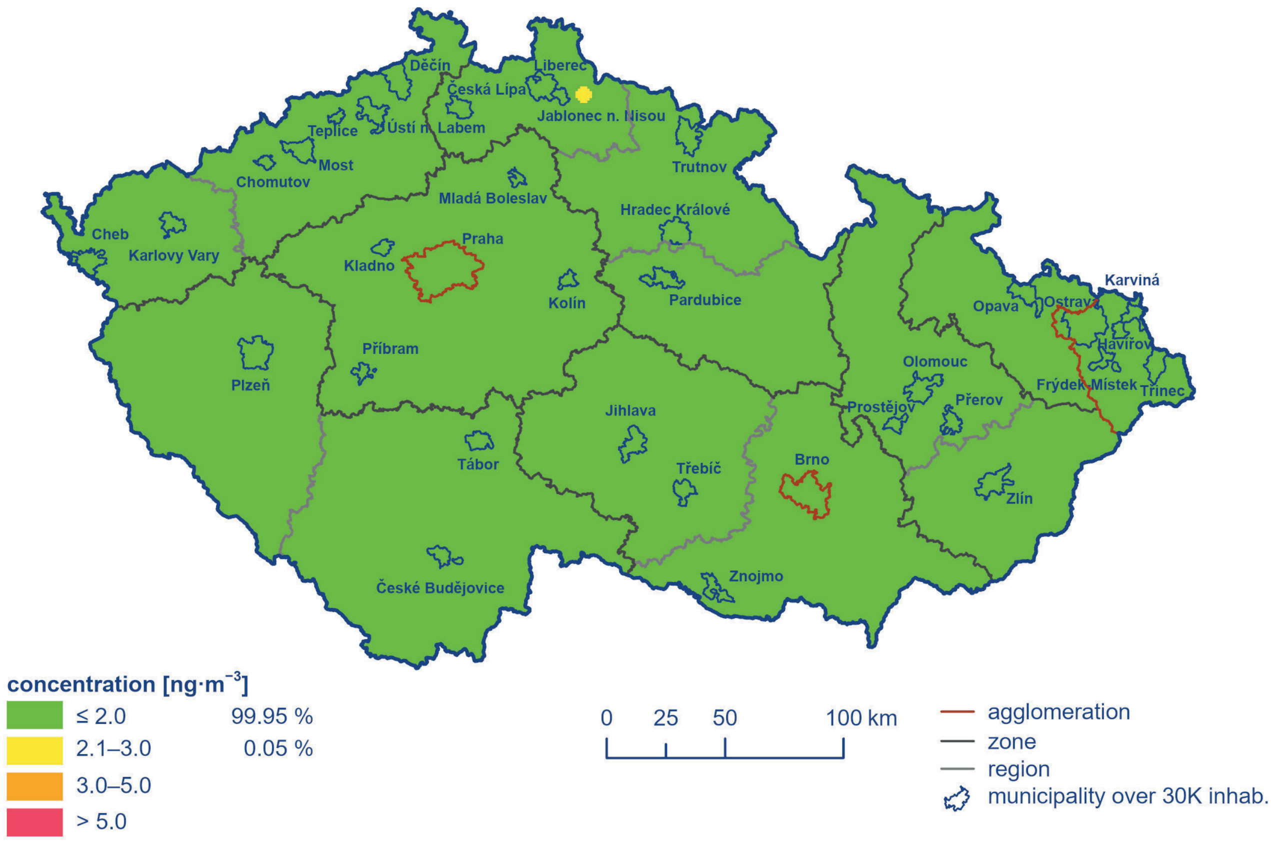


**Fig. IV.6.6 Five-year average of annual average concentrations of cadmium, 2017–2021**

## IV.6.2 Trends in heavy metal concentrations

In 2021, the countrywide average of arsenic concentrations reached the second lowest value for the evaluated period 2011–2021. Lower values were reached only in 2020. (Fig. IV.6.7). The decreasing trend of concentrations is very gradual, in the last three years the countrywide concentration values are comparable. The exception is the Kladno area, which has long been the most exposed region. Until 2014, annual concentrations have been there high, close to the pollution limit value. Since 2014, annual concentrations have been above the upper assessment threshold, however, in the last three years, this value has not been exceeded and a decreasing tendency is evident

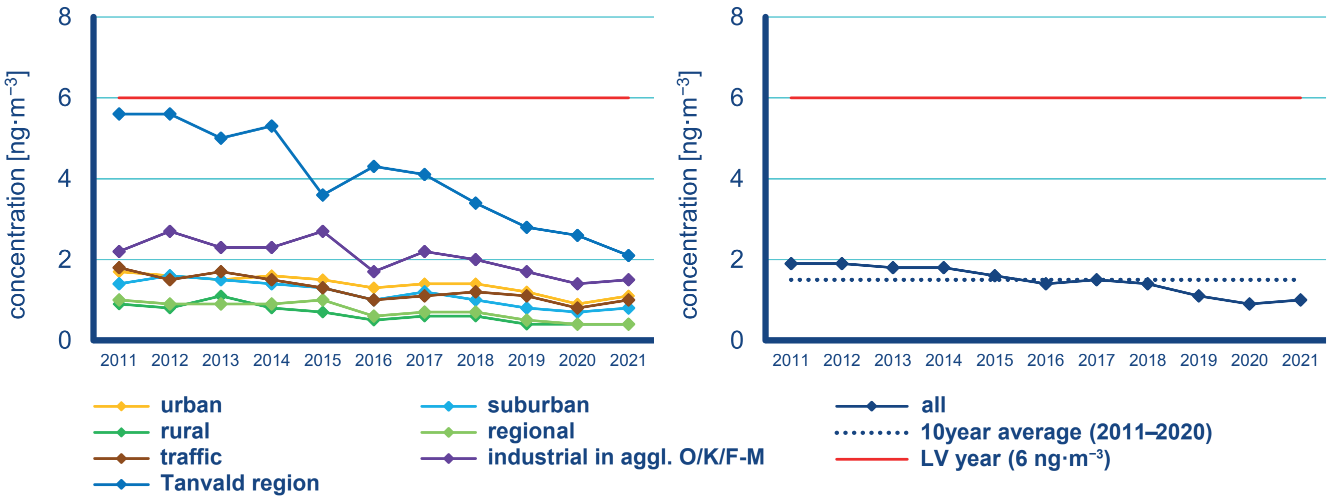


Fig. IV.6.7 Annual average concentrations of arsenic, 2011–2021

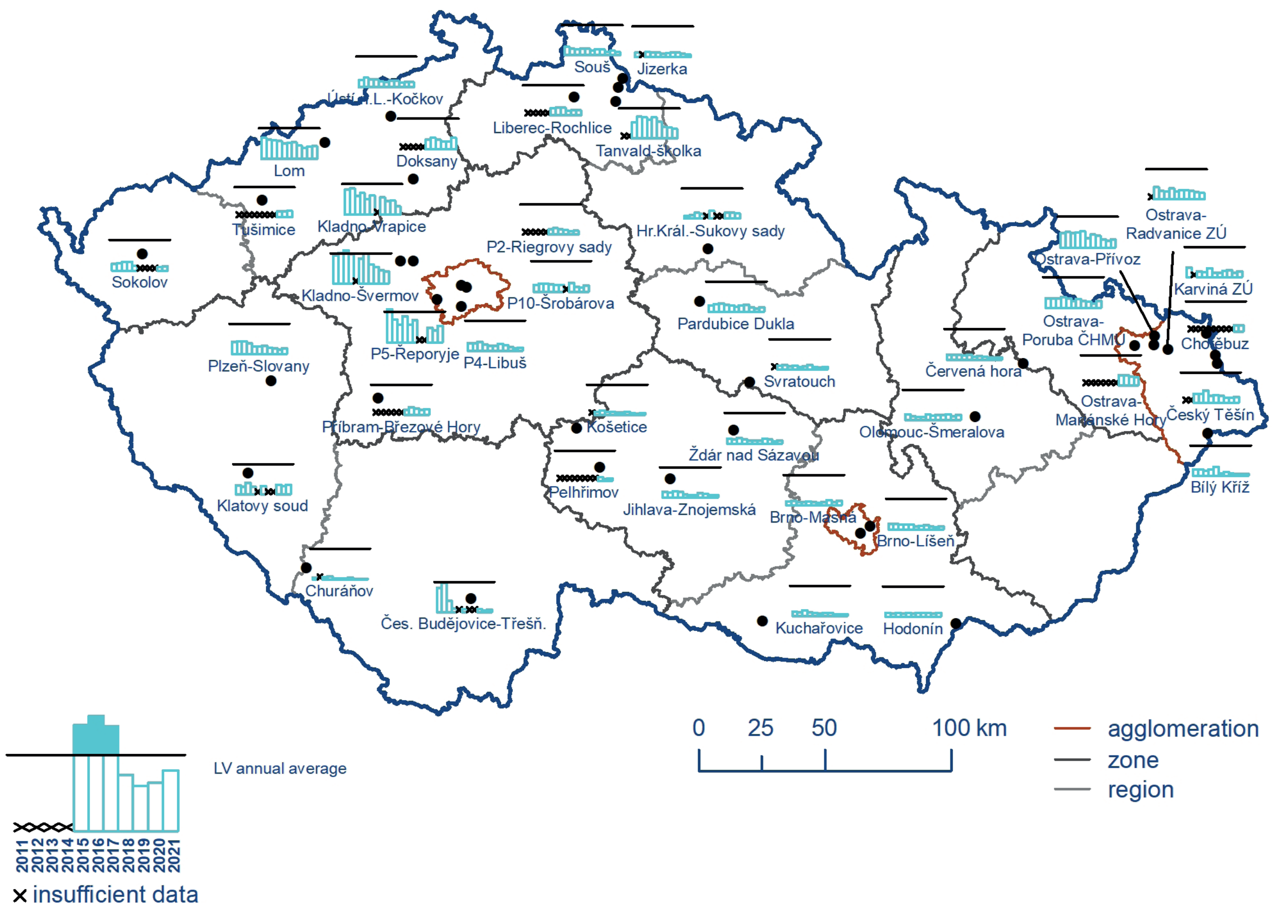


Fig. IV.6.8 Annual average concentrations of arsenic at selected stations, 2011–2021

(Fig. IV.6.8). The Kladno district is one of the areas included in a campaign to measure heavy metal concentrations under the Technology Agency of the CR project (No. TITSMZP704). Results show that increased arsenic concentrations in this region are due to the use of specific type of coal for individual household heating. The issue is subject to further investigation.

In 2021, as well as in 2017 and 2018, the national average of cadmium concentrations reached the lowest value for the evaluated period 2011–2021 (Fig. IV.6.9). A slight decrease has been observed since 2011, and a steady trend since 2016. The exception is represented by annual concentrations at industrial stations in the O/K/F-M agglomeration, which reached their lowest values in 2016 and 2017, and started to rise again in the following years.

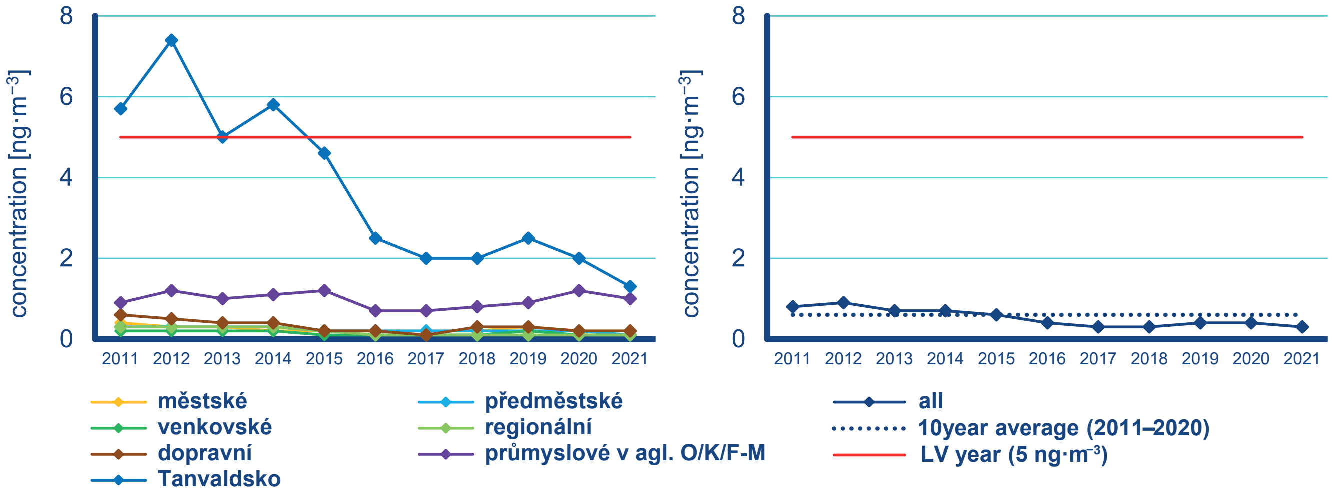


Fig. IV.6.9 Annual average concentrations of cadmium, 2011–2021


Fig. IV.6.10 Annual average concentrations of cadmium at selected stations, 2011–2021

A significant decrease in annual concentrations is observed in the Tanvald region, which has long been the most exposed area (Fig. IV.6.10). High to above-limit concentrations were observed there between 2012 and 2015. The Tanvald area is characterized by a high concentration of glass industry (ASKPCR 2014) which is a significant source of cadmium emissions from the application of paints and fluxing agents (Beranová 2013). In 2015 and 2016, the production operation was adapted to be more ecologically favourable, leading to a decrease in annual average cadmium concentrations below the limit level. However, annual evaluations of measurements at the Tanvald-školka station and monitoring of results are still needed to assess the effectiveness of specific measures.

The national average nickel concentrations have been slightly decreasing over the last 11 years with steady trend since 2015 (Fig. IV.6.11). In 2013, there was a significant increase in nickel concentrations at traffic stations. The highest concentrations since 2009 were recorded at industrial stations in 2018 and 2019. The cause of these fluctuations has not yet been sufficiently clarified.

Lead concentrations show a declining trend over the last 11 years, except for 2018, when there was a slight increase in concentrations at all types of stations (Fig. IV.6.12).

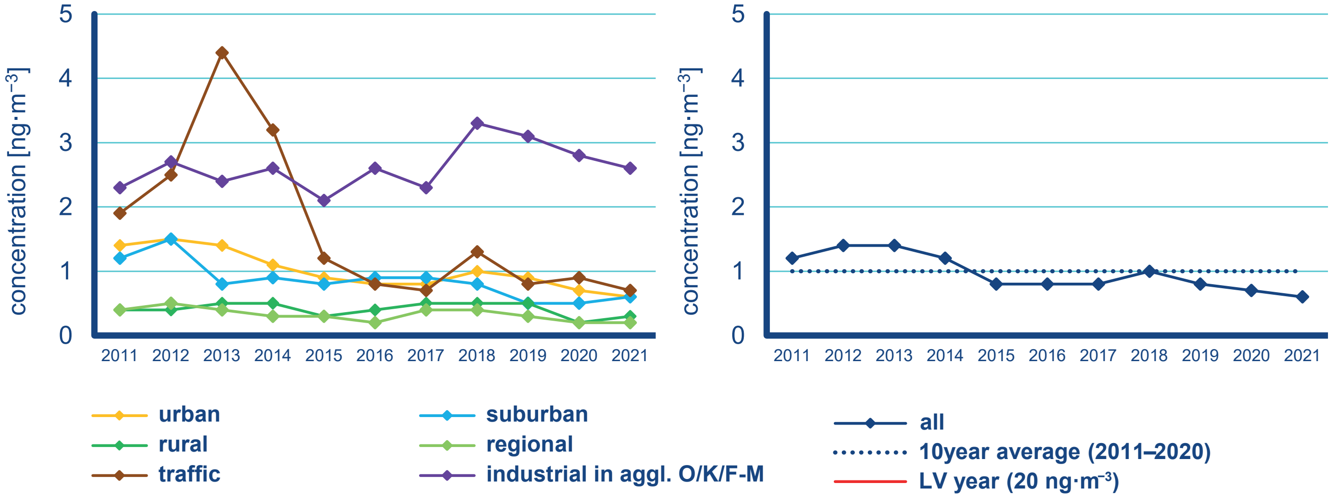


**Fig. IV.6.11 Annual average concentrations of nickel, 2011–2021**

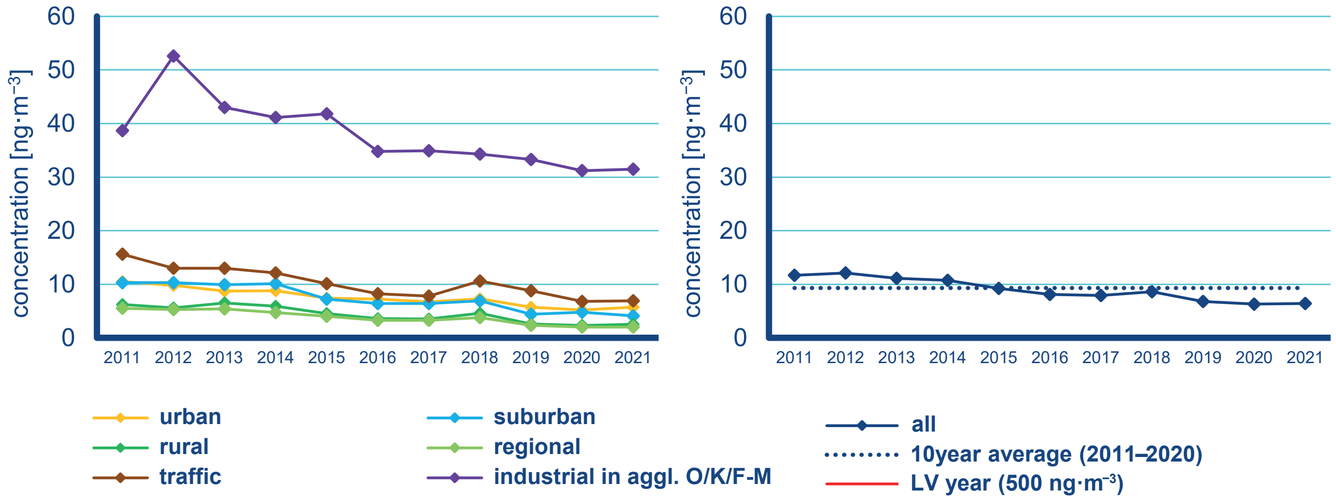


**Fig. IV.6.12 Annual average concentrations of lead, 2011–2021**

## IV.6.3 Emissions of heavy metals

Heavy metals include metals with a specific density greater than 4.5 g·cm$^{-3}$ and their compounds. Heavy metals are a natural component of solid fuels, while their contents in fuels vary depending on the mining site. The amounts of heavy metal emissions from the combustion of solid fuels depends primarily on the kind of fuel, type of combustion equipment, and combustion temperature which affects the volatility of heavy metals. Heavy metal emissions are also formed in some technological processes because they are contained in the input raw materials (e.g., iron ore, scrap metal, glass batches, paints, glass shards). In addition to these processes, there are also a number of sources of fugitive emissions containing heavy metals (for example, particles from the abrasion of brakes and tyres, or emissions related to old environmental burdens left by mining and metallurgical activities).

Combustion processes are of predominant importance primarily for the emissions of arsenic and nickel. The most significant sectors at a national scale include 1A1a — Public electricity and heat production which contributed 21.7 % to arsenic emissions and 32.9 % to nickel emissions in 2020 (Fig. IV.6.13 and Fig. IV.6.17). In 2020, there were significant contributions from the sectors of iron and steel production (2C1) related primarily to lead emissions (22.6 %; Fig. IV.6.19). The impact of sector 1A4bi — Residential: Stationary predominated in cadmium emissions, with a share of 52.1 % (Fig. IV.6.15), and also significantly contributed to arsenic emissions (33.1 %; Fig. IV.6.13). A significant proportion of total lead emissions is formed by emissions from the triggering of fireworks and pyrotechnics (29.5 %; Fig. IV.6.19), which belong to sector 2G – Other sources. The cadmium emissions from the 2G sector accounted for 9.2 %, with the main source of emissions being tobacco smoke (Fig. IV.6.15). The decreasing trend in emissions of heavy metals in the 2010–2020 period is associated with the rate of emissions of suspended particles (Chap. IV.1.3) to which these substances are bound (Figs. IV.6.14, IV.6.16, IV.6.18, and IV.6.20). Measures in the sector of iron and steel production made a substantial contribution to the decrease in heavy metal emissions, especially improvements in the dust-removal system for iron ore agglomeration sintering strands. Technical measures have also succeeded in reducing heavy metal emissions from glass production. In recent years, there has been an increase in the volume of the secondary production of non-ferrous metals, especially aluminium and lead, although this increase has possibly ceased in 2020 due to the COVID-19 pandemic. Emissions of heavy metals from these sources are very variable, and depend on the quality of the processed scrap metal.

In view of the predominant contribution of the sector of public electricity and heat production and the sector of iron and steel production, the territorial distribution of heavy metal emissions (excluding emissions from the sector 2G – Other sources) is determined mainly by the location of production facilities in these sectors. Emissions of arsenic and nickel are concentrated in areas in which thermal power plants and heating plants burning coal are located. These are primarily enterprises in the Ústí nad Labem, Central Bohemian and Pardubice regions. Emissions of cadmium and lead are predominantly produced in the O/K/F-M agglomeration due to concentration of enterprises producing iron and steel. A significant amount of lead emissions in the Central Bohemian region originates from secondary lead production at Kovohutě Příbram (Figs. IV.6.21, IV.6. 22, IV.6.23, and IV.6.24).

- **1A4bi – Residential: Stationary**
- **1A1a – Public electricity and heat production**
- **1A2c – Stationary combustion in manufacturing industries and construction: Chemical industry**
- **1A2f – Stationary combustion in manufacturing industries and construction: Non-metallic minerals**
- **1A3bvi – Road transport: Automobile tyre and brake wear**
- **1A4ai – Commercial/institutional: Stationary**
- **2A3 – Glass production**
- **2C1 – Iron and steel production**
- **2C5 – Lead production**
- **2C6 – Zinc production**
- **2G – Other product use**
- **5C2 – Open burning of waste**
- **Other**

**Legend to Figs IV.6.13 and IV.6.20**

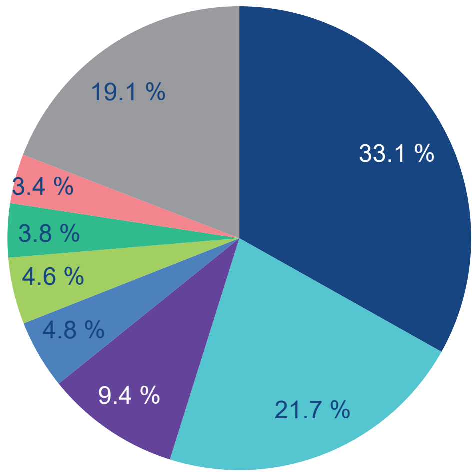


**Fig. IV.6.13 Proportion of NFR sectors to total emissions of arsenic, 2020**

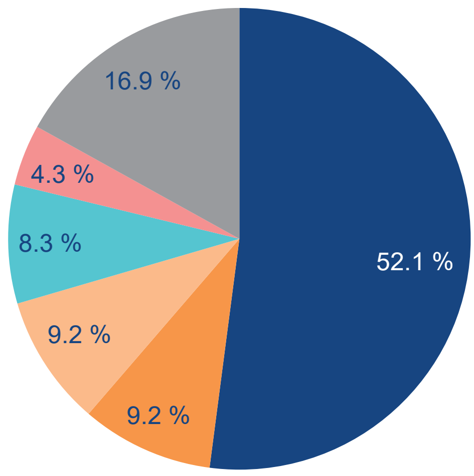


**Fig. IV.6.15 Proportion of NFR sectors to total emissions of nickel, 2020**

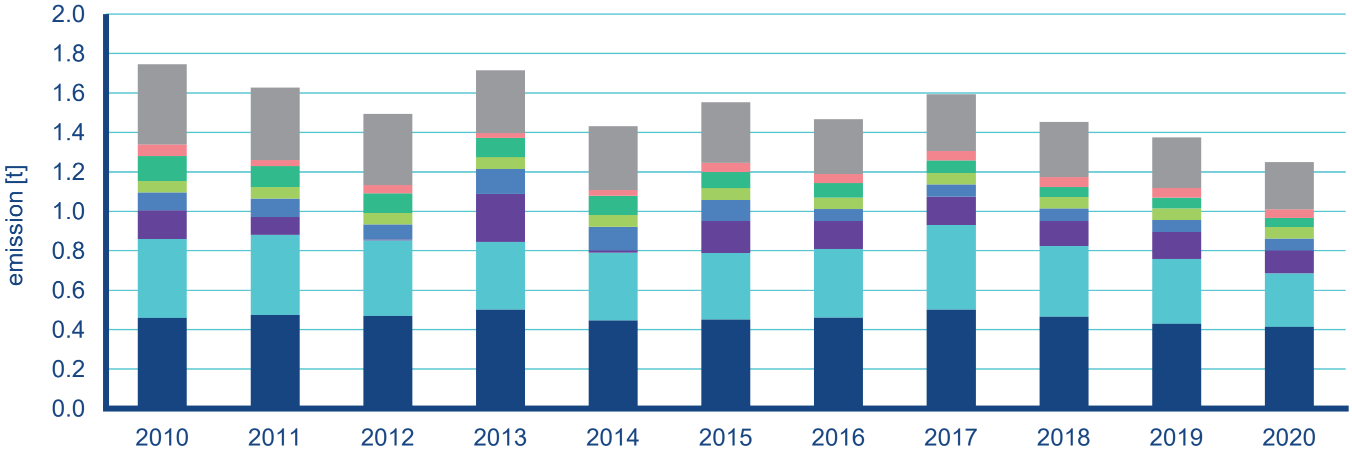


**Fig. IV.6.14 Total arsenic emissions of arsenic, 2010–2020**

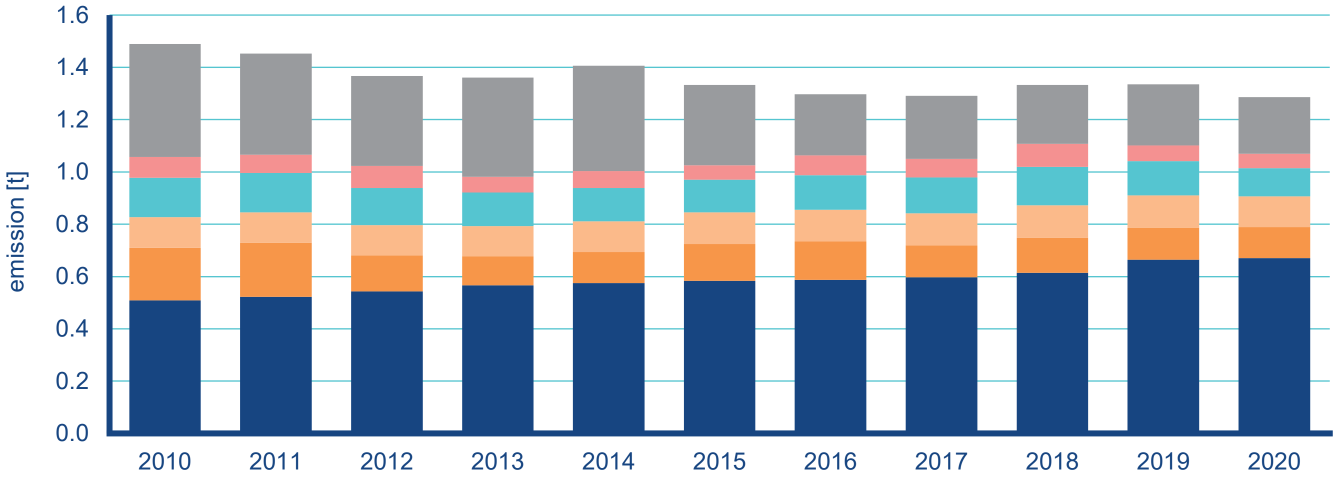


**Fig. IV.6.16 Total emissions of nickel, 2010–2020**

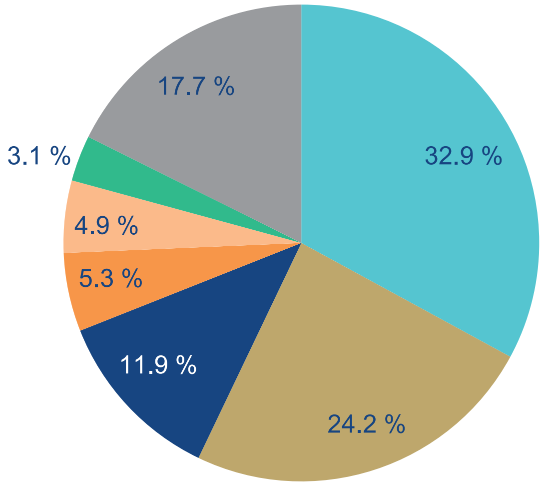


**Fig. IV.6.17 Proportion of NFR sectors to total emissions of cadmium, 2020**

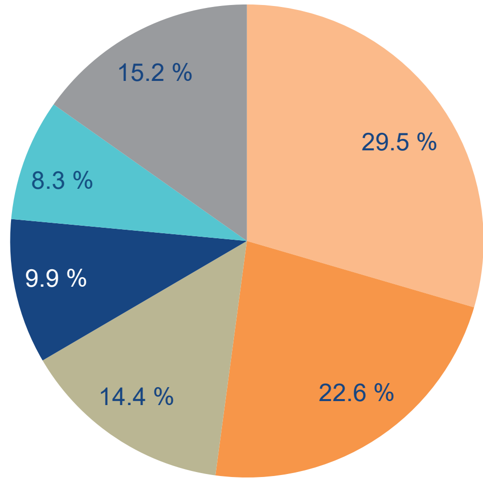


**Fig. IV.6.19 Proportion of NFR sectors to total emissions of lead, 2020**

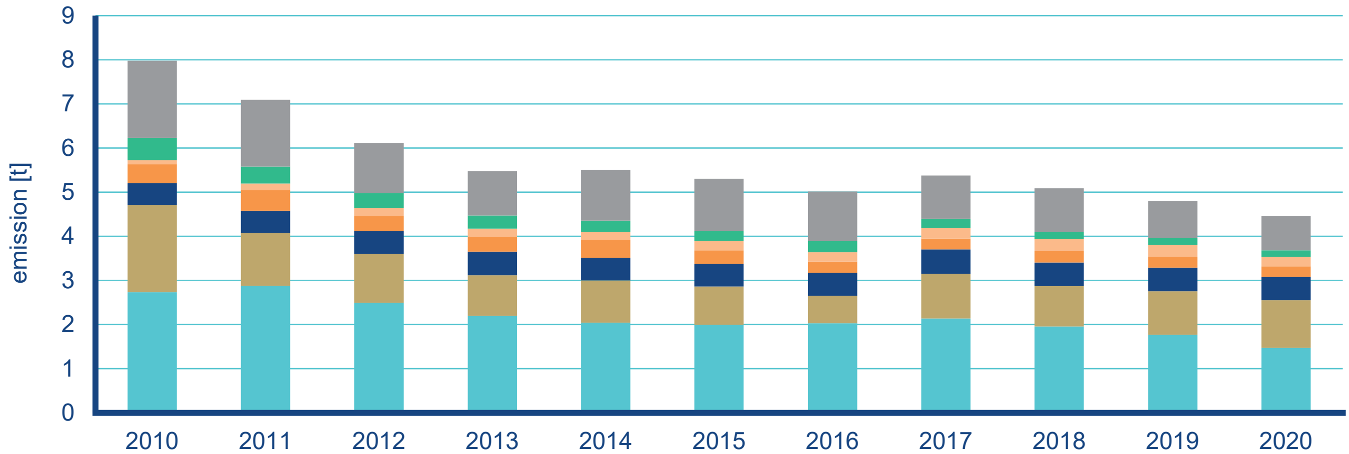


**Fig. IV.6.18 Total emissions of cadmium, 2010–2020**

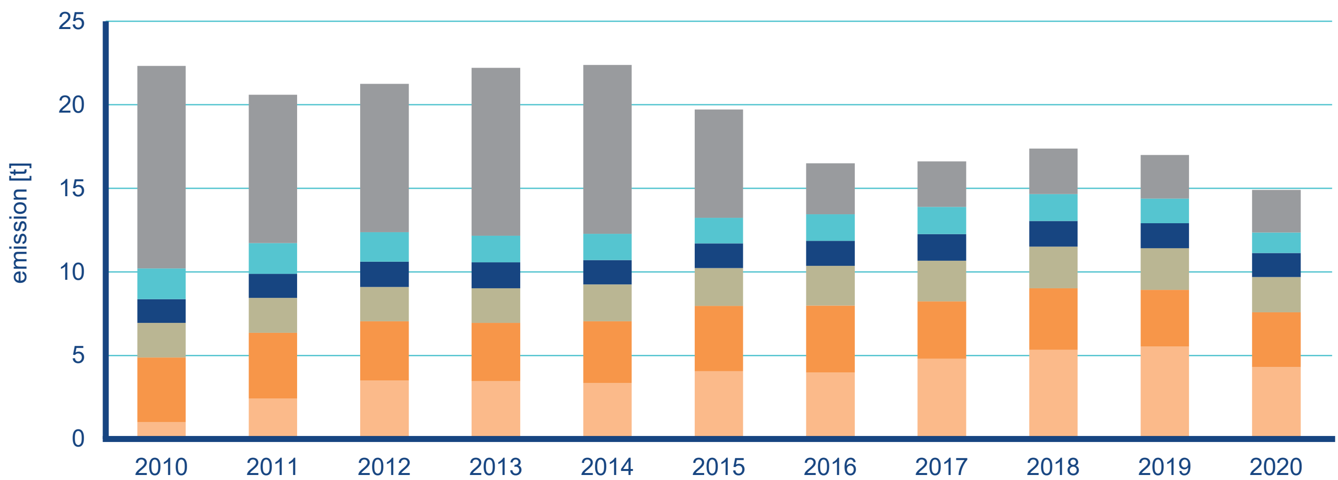


**Fig. IV.6.20 Total emissions of lead, 2010–2020**

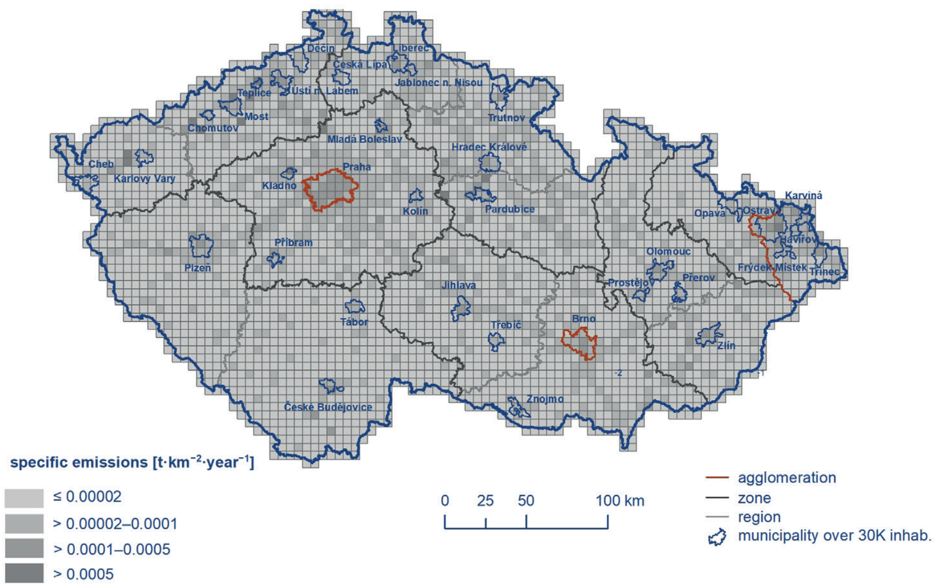


**Fig. IV.6.21 Total arsenic emissions in 5×5 km spatial resolution squares, 2020**

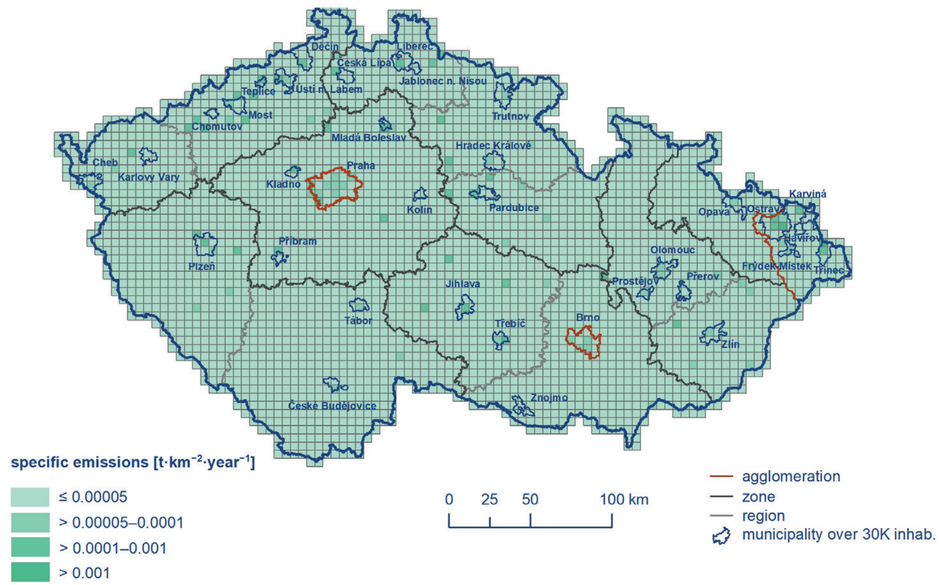


**Fig. IV.6.22 Total nickel emissions in 5×5 km spatial resolution squares, 2020**

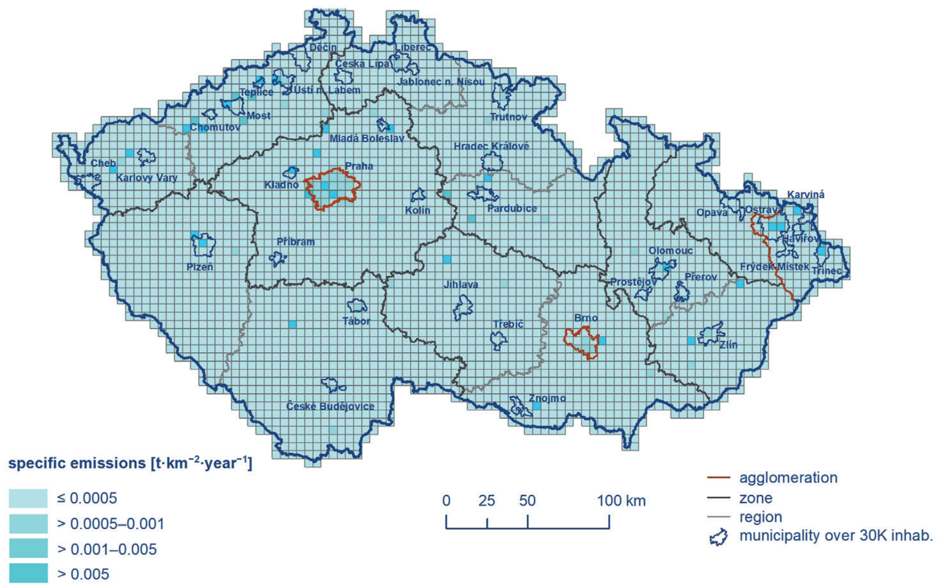


**Fig. IV.6.23 Total cadmium emissions in 5×5 km spatial resolution squares, 2020**

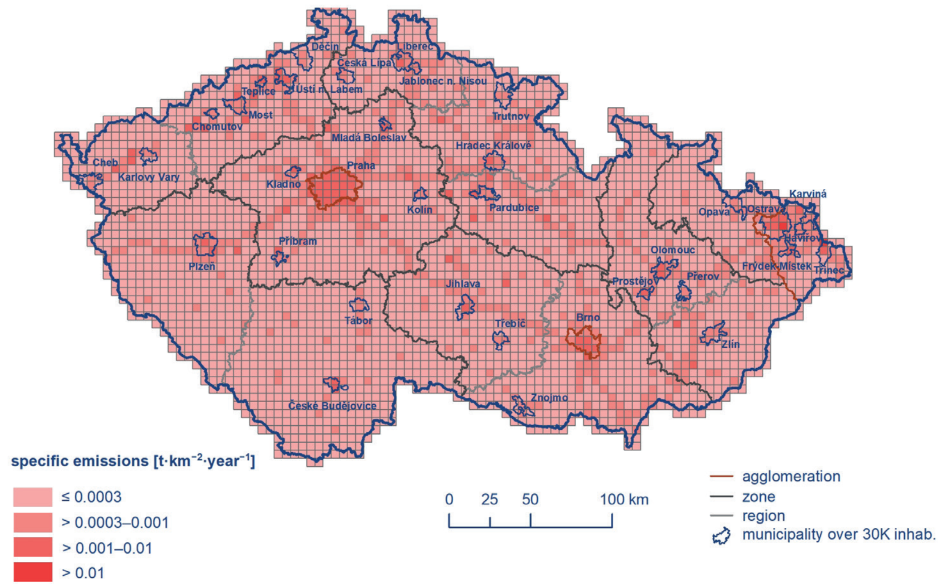


**Fig. IV.6.24 Total lead emissions in 5×5 km spatial resolution squares, 2020**