1 Environment and health

1.2 | Air quality

1.2 | Air quality

Air quality has a major impact on human health and quality of life, as well as on ecosystems and vegetation, so it is necessary to ensure compliance with limit value for pollutants and the long-term reduction of air pollution load. Air pollution is one of the many factors affecting the health of the population, the effects of which are already evident at very low concentrations with no obvious treshold safe concentration limit. Currently the most important air pollutants in Czechia are particulate matter (PM), distinguished as suspended particles with various size fractions PM_{10}, $PM_{2.5}$ and PM_1, sulphur dioxide (SO_2), oxides of nitrogen (NO_X), carbon monoxide (CO), volatile organic compounds (VOCs), polycyclic aromatic hydrocarbons (PAHs) with benzo(a)pyrene (B(a)P) typical representative, ammonia (NH_3) and ground-level ozone (O_3). Air pollution is mainly concentrated in industrial and transport congested areas, but also in small settlements where households burn solid fuels. Emissions of the main air pollutants (NO_X, SO_2, NH_3, VOC, $PM_{2.5}$) as well as emissions of PM_{10}, CO and B(a)P from anthropogenic activities are closely related to the structure of the national economy, in particular the structure of industrial and agricultural production, the intensity of transport, the types of household heating, and the success of the implementation of measures to reduce air pollution. Air pollutants pass through atmospheric deposition to other environmental components, in particular water and soil.

Overview of selected related strategic and legislative documents

Directive (EU) 2016/2284 of the European Parliament and of the Council on the reduction of national emissions of certain air pollutants, amending Directive 2003/35/EC and repealing Directive 2001/81/EC
- setting out the commitments of Member States to reduce anthropogenic emissions of SO_2, NO_X, VOC, NH_3 and $PM_{2.5}$, and the requirement to develop, adopt and implement national air pollution control programmes, as well as to monitor emissions of these substances and other pollutants

Directive 2008/50/EC of the European Parliament and of the Council on ambient air quality and cleaner air for Europe
- establishing zones and agglomerations for the purpose of ambient air quality assessment for sulphur dioxide, nitrogen dioxide and oxides of nitrogen, PM_{10} a $PM_{2.5}$, lead, benzene and carbon monoxide
- taking measures to reduce exposure to $PM_{2.5}$

Directive 2004/107/EC of the European Parliament and of the Council relating to the levels of arsenic, cadmium, mercury, nickel and polycyclic aromatic hydrocarbons in ambient air
- introducing target values for concentrations of arsenic, cadmium, nickel and benzo(a)pyrene in ambient air to eliminate, avoid or reduce their harmful effects on human health and the environment in general

CLRTAP Protocol to Abate Acidification, Eutrophication and Ground-level Ozone (the Gothenburg Protocol)
- halving the number of days with high ozone concentrations
- setting new emission ceilings as a percentage reduction of emissions relative to 2005

Act No. 201/2012 Coll., on air protection
- full transposition of the pollution limit values set by Directive 2008/50/EC of the European Parliament and of the Council and Directive 2004/107/EC of the European Parliament and of the Council

1.2.1 | Emissions of air pollutants

Key question

Is the reduction in pollutant emissions sufficient for the Czech Republic to meet the national emissions ceilings in the coming years? What are the main sources and the contribution of each source category to total emissions of air pollutant? How are pollutant and greenhouse gas emissions from different modes of transport evolving? How does home heating affect emissions of air pollutant?

Key messages

✓ Emissions of all main air pollutants are steadily decreasing. For all emissions, the required 2020 emission ceilings were achieved in 2019[9].

NO_X, VOC and CO emissions from transport have been decreasing over the long term. In 2020, emissions of all monitored pollutants and greenhouse gases from transport decreased significantly year-on-year.

~ The decrease in PM emissions from transport is insignificant; in addition to emissions from combustion processes (mainly diesel engines), transport also produces emissions from tyre and brake wear.

Emissions from household heating have been on a slightly decreasing trend over the last 10 years, nevertheless households accounted for the largest share of total emissions of PM_{10} (55.1%) and B(a)P (96.4%) in 2019.

✗ CO_2 and PAHs emissions from transport rose in the 2000–2020 period in line with the increase in fuel and energy consumption in transport. Transport in the Czech Republic is a significant source of greenhouse gas emissions.

Assessment of the trend and state of indicators

Indicator	Long-term trend (15 years and more)	Medium-term trend (10 years)	Short-term trend (5 years)	State
Emissions of selected air pollutants	↘	↘	↘	✓
Emissions from transport*				
NO_X, VOC and CO emissions from transport	↘	↘	↘	✓
PM and N_2O emissions from transport	~↗	~↗	~↗	~
CO_2 and PAH emissions from transport	↗	↗	~↗	✗
Emissions from household heating	~↗	↘	↘	✗

** Due to the different time series trends underlying the construction of the indicator, an assessment of the sub (elementary) indicators is presented.*

[9] *Final data for the year 2020 are not available at the time of publication. They will be published in February 2022 at the earliest.*

Emissions of selected air pollutants

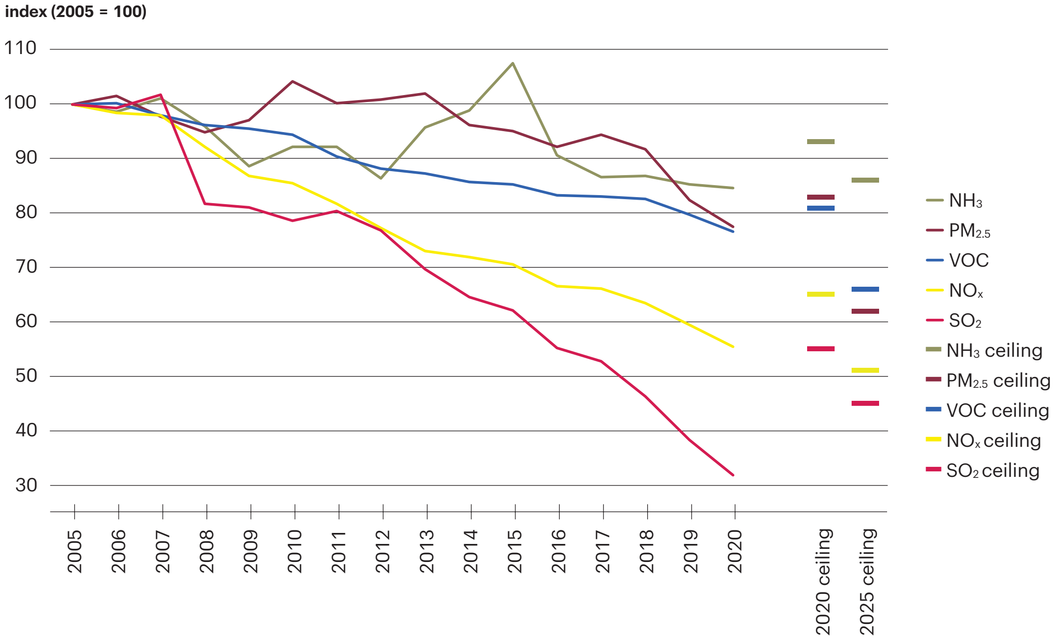
The decline in pollutant emissions reflects both the development of the national economy and the impact of the introduction of more efficient technological and production processes, the reduction of material and energy consumption, and the obligation to comply with legislative requirements for emissions from air pollution sources.

Emissions of all main pollutants (NO_X, VOC, SO_2, NH_3 and $PM_{2.5}$) into the air are decreasing in the long term. The year-on-year fluctuations are mainly due to meteorological conditions and developments in economic sectors that are sources of air pollution, in particular transport and industrial production. The largest decline in pollutants was recorded between 1990 and 2000, especially in the early part of the period, as a result of structural changes in the national economy.

Meeting the obligations of Directive 2016/2284 of the European Parliament and of the Council on the reduction of national emissions of selected air pollutants, the so-called **emission ceilings**, assumes a reduction in emissions compared to 2005 values. It is clear from the latest submission of the emission balance that for all emissions, the required reduction for 2020 (Chart 27) was achieved in 2019[10], although only just for $PM_{2.5}$. The latest inventory includes recalculations of emissions for the entire 1990–2019 period, which therefore led to the newly calculated emission ceilings. Methodological adjustments were mainly reflected in NH_3 and VOC emissions in the range of 10 to 30 thous. t per year, mainly due to changes in the technologies used to reduce emissions from livestock farming and fluctuations in the consumption of mineral fertilisers. Assessment of preliminary emissions data for the year 2020 (Figure 27) shows further reductions for all major pollutants.

Chart 27

Trends in total emissions of selected pollutants in the Czech Republic and national emission ceilings for 2020 and 2025 [index, 2005 = 100], 2005–2020



Data for the year 2020 are preliminary.

Data source: Czech Hydrometeorological Institute

[10] *Final data for the year 2020 are not available at the time of publication. They will be published in February 2022 at the earliest.*

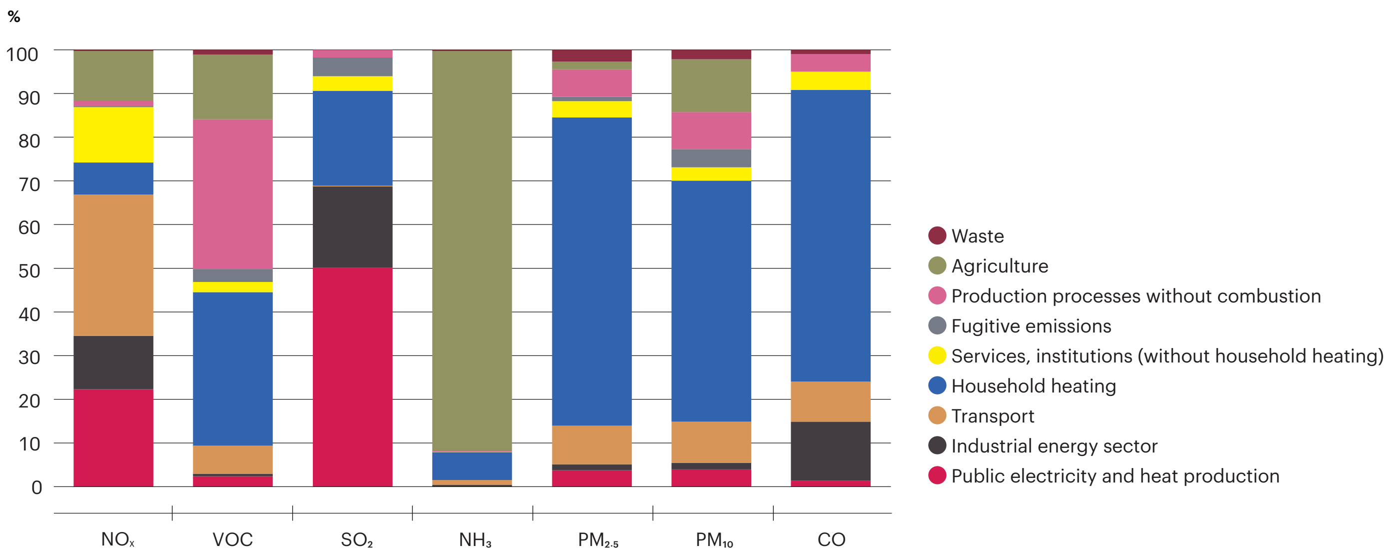
SO_2 and NO_x emissions are decreasing over the long term (SO_2 by 96.2% and NO_x by 78.5% in the 1990–2020 period) as a result of the introduction of technologies and production processes in line with requirements to apply best available techniques, change the fuels used, and reduce the energy intensity of the economy. The diversification of electricity generation, i.e. the decline of electricity generation in solid-fuel steam power plants and its increase in nuclear power plants, as well as electricity generation from renewable energy sources, plays an important role. In the short term, the dynamics of the downward trend are even more pronounced. The long-term reduction in NO_x emissions is also related to the decrease in these emissions from transport, mainly due to the gradual modernisation and renewal of the vehicle fleet. Although **NH_3 emissions** are decreasing, the dynamics are not as pronounced as for other pollutants. The long-term development of NH_3 emissions (a 50.7% decrease in the 1990–2020 period) is mainly related to the Czech Republic's agricultural policy, and the decline in livestock numbers also contributes to the long-term reduction of NH_3 emissions.

In the long term, the decrease in **PM_{10}, $PM_{2.5}$ and VOC emissions** (by 89.1%, 88.8% and 63.5% respectively in the 1990–2020 period) reflects the development of meteorological conditions in the heating season of a given year and is also significantly influenced by the type of fuel used in household heating systems. In the short term, the dynamics of the decline are even more pronounced for PM_{10} and $PM_{2.5}$. The long-term decline in **CO emissions** (61.3% in the 1990–2020 period) is linked to trends in industrial production, especially from the iron and steel works in Ostrava and Třinec, the development of which corresponds to the production volume of these facilities.

Emission sources differ by pollutant (Chart 28). For NO_x emissions, transport was the main source in 2019[11] (32.3%), followed by the public electricity and heat production (22.3%). VOC emissions came from both household heating (35.1%) and production processes without combustion (34.3%). In the case of SO_2 emissions, the majority emitter was the public energy and heat production (50.2%), followed by household heating (21.7%). NH_3 emissions were mainly from the agricultural sector (91.4%). For suspended particulate matter in the PM_{10} and $PM_{2.5}$ size fractions, the dominant source in 2019 was household heating, accounting for 70.5% of total $PM_{2.5}$ emissions and 55.1% of total PM_{10} emissions. In addition to emissions of primary suspended particulate matter by these sources, secondary suspended particulate matter is also produced by chemical reactions from precursors (NO_x, SO_2, NH_3 and VOCs). In the case of CO emissions, the main source is also local household heating (66.8%).

Chart 28

Sources of emissions of selected pollutants in the Czech Republic [%], 2019



Data for the year 2020 are not available at the time of publication.

Data source: Czech Hydrometeorological Institute

[11] *Data for the year 2020 are not available at the time of publication. They will be published in February 2022 at the earliest.*

Emissions from transport

Transport is a significant source of **air pollutants** with an impact on air quality, particularly around major roads with high traffic volumes and in large cities. In urban agglomerations without significant air pollution from stationary sources (e.g. Prague), transport is a decisive factor influencing air quality. Transport is also an important source of greenhouse gases (in 2019[12] it was the third largest source after public electricity and heat production and manufacturing industry), making development in transport essential to reducing anthropogenic pressures on the climate system and moving towards climate neutrality.

Emissions of NO_X, VOC, CO and suspended particulate matter (PM) from transport have declined over the 2000–2020 period (Chart 29). A statistically significant downward trend was registered for VOC and CO emissions in the medium term (since 2011) and short term (since 2016). Over the whole 2000–2020 period, NO_X emissions decreased by 36.9%, VOC emissions by 76.4%, CO by 81.7% and PM by 16.5%. The favourable development of emissions of these substances was influenced by the modernisation of the vehicle fleet and the growth of the share of less emissions-intensive vehicles (meeting higher EURO emissions standards) in the passenger car and truck fleets. The less pronounced decline in PM emissions, which also only occurred after 2010, was due to the increasing share of more emissions-intensive diesel cars in the passenger car fleet during this period, together with an increase in individual car transport. In addition, suspended particulate matter emissions include non-combustion emissions from brake and tyre wear, which are little affected by technology upgrades.

Emissions of **polycyclic aromatic hydrocarbons** (PAHs) from transport, which pose significant risks to public health, rose in the 2000–2020 period as fossil fuel consumption increased. Overall, emissions of PAHs more than doubled over this period (up 102.8%). However, in the short term (2016–2020), a 3.2% decrease in PAH emissions has already been observed due to the year-on-year drop in emissions in 2020.

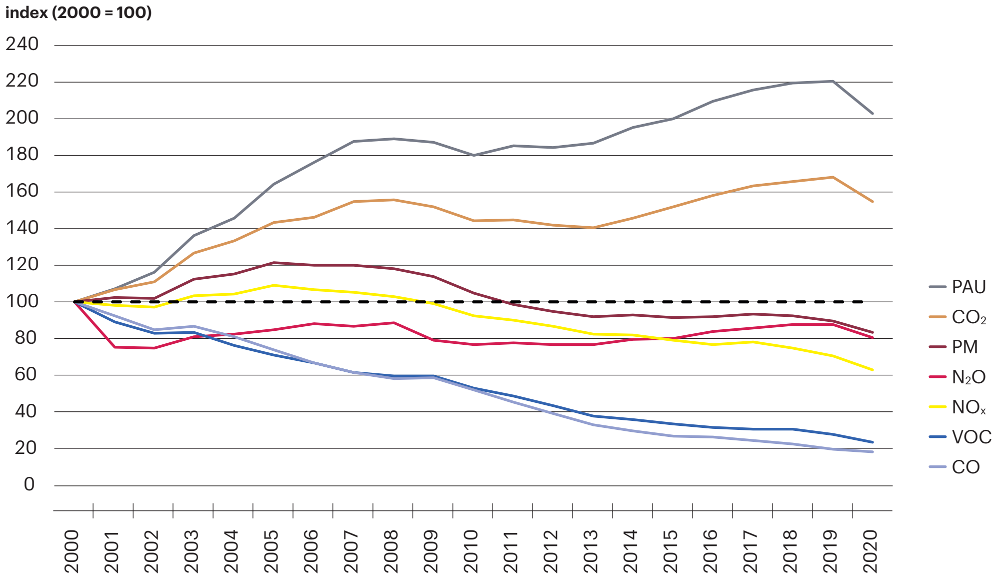
Emissions of the greenhouse gas CO_2 increased by 54.5% over the 2000–2020 period, driven by the growth in fuel and energy consumption in transport. Emissions of CO_2 from transport have risen particularly during the periods of economic growth at the beginning of the 21st century and then in the 2014–2019 period. N_2O emissions stagnated in the 2000–2020 period and accounted for only about 1% of total greenhouse gas emissions in CO_2 eq. in 2020, recalculated according to global heating coefficients.

In a year-on-year comparison between 2019 and 2020, emissions of all monitored pollutants and greenhouse gases decreased significantly due to the economic recession caused by the COVID-19 pandemic, which had an impact on passenger and freight transport performance. The largest year-on-year drops were registered for VOC (15.3%) and NO_X (10.6%) emissions, while CO_2 emissions, which had continuously risen up to then, also fell by 8.1% year-on-year in 2020.

[12] *Data for the year 2020 are not available at the time of publication.*

Chart 29

Emissions of air pollutants and greenhouse gases from transport in the Czech Republic [index, 2000 = 100], 2000–2020

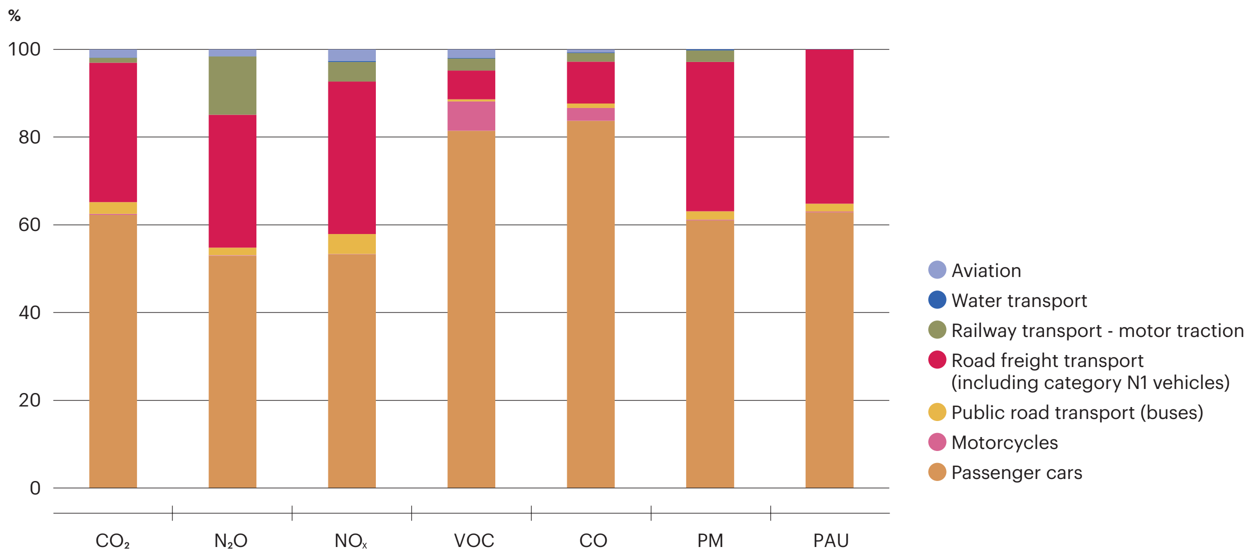


Data source: Transport Research Centre

The largest **air polluter in transport** and source of greenhouse gas emissions is **individual passenger car transport** (Chart 30), which accounted for the largest share of total transport emissions in terms of CO (83.1%) and VOC (81.5%). The share of road freight transport in the total transport emissions of individual substances was about one third, except for VOC and CO emissions. With the exception of N_2O, road transport as a whole accounts for more than 90% of the total emissions of transport pollutants. Of the non-road modes of transport, rail motor traction transport accounted for 13.3% of total N_2O emissions, air transport accounted for about 2% of total transport emissions of CO_2, N_2O, NO_X and VOC (however, this balance does not include overflights over the Czech Republic, only emissions from planes landing and taking off at airports in the Czech Republic).

Chart 30

Emissions of air pollutants and greenhouse gases by mode of transport in the Czech Republic [%], 2020



Data source: Transport Research Centre

Emissions from household heating

Household heating has a significant impact on air quality. The choice of fuel type and the way in which domestic boilers are operated in local heating systems have a significant impact on emissions and consequently on the air quality in areas where people live. Due to the imperfect combustion of solid fuels, local boilers produce significant amounts of particulate matter, polycyclic aromatic hydrocarbons and other substances that have a negative impact on the health of the population. These emissions tend to be emitted from lower chimneys than industrial emissions, and therefore do not have the opportunity to disperse in the ambient air, and so often endanger the population in high concentrations.

Another important factor affecting emissions from household heating is the duration and pattern of the **heating season**[13]. When the heating season is colder, heating emissions increase proportionally, and vice versa. The 2019 heating season was 3,832 degree days, down from the 1986–2015 long-term average, indicating a warmer season with lower heating demand. This was also reflected in the 2019 emissions from household heating[14], which were lower compared to previous years (Chart 31). In a year-on-year comparison, even with the increase in the number of degree days, there was a decrease in emissions from households for both monitored substances PM_{10} and B(a)P. In 2019, PM_{10} emissions from household heating amounted to 25.7 thous. t, the lowest value in the entire period since 2000, accounting for 55.1% of total PM_{10} emissions. This was a significant year-on-year decline of 12.5%. In the long term, and especially in the last 10 years, PM_{10} emissions from households have been on a slightly decreasing trend. B(a)P emissions from heating amounted to 14.2 t, 96.4% of total emissions. Over the long term, these emissions from household heating have also been on a slightly downward trend, but the year-on-year decline was a significant 8.1%.

The high emissions of both pollutants and greenhouse gases from households are the reason why a lot of attention is being paid to household heating, including subsidy programmes, as there is potential for further reductions in these emissions.

The Air Protection Act[15] establishes obligations for operators of local furnaces and also the possibility of controlling the fulfilment of these obligations. On 1/ 9/ 2022, solid fuel boilers classified as lower than Class 3 (according to Czech Technical Standard EN 303-5) will no longer meet the requirements of the Air Protection Act and must be replaced by that date at the latest. It is currently possible to draw support for their replacement from the so-called boiler subsidies.

However, even if a boiler complies with regulations, it is important to follow good heating practice principles, which can provide significant reductions in emissions from household heating. However, it is difficult to enforce this interest, as it is up to individuals as to how responsibly they operate their boilers.

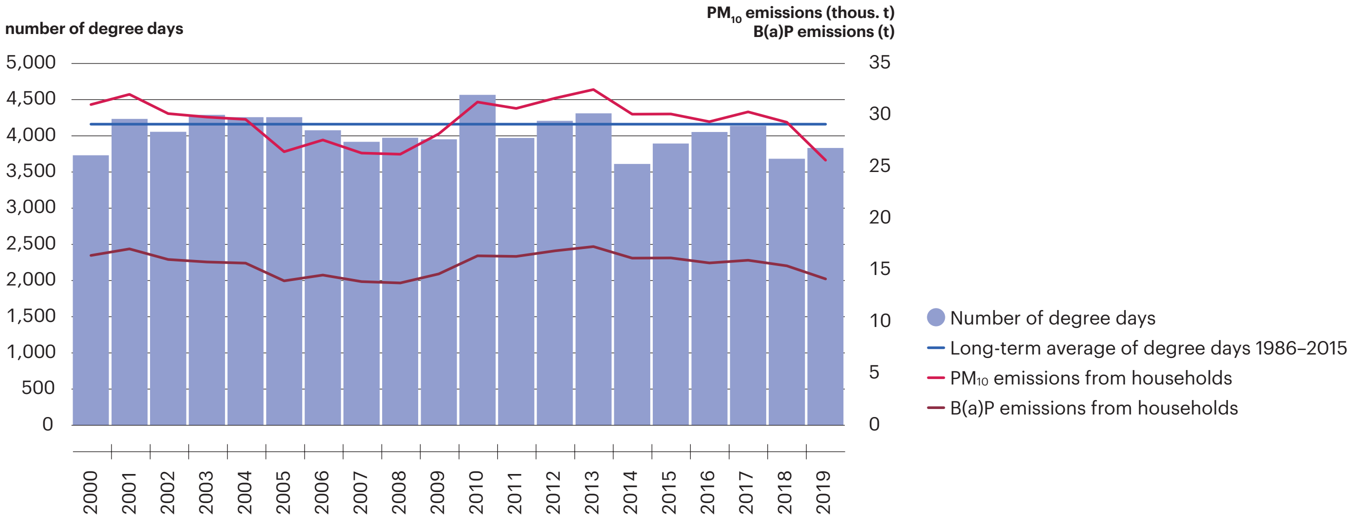
[13] *The heating season is characterised by the degree day unit, which is the product of the number of heating days and the difference between the average indoor and outdoor temperatures. Degree days thus show how cold or warm it has been for a certain period of time and how much energy was needed to heat buildings.*

[14] *Data for the year 2020 are not available at the time of publication.*

[15] *Act No. 201/2012 Coll., on air protection*

Chart 31

Comparison of heating season characteristics with PM_{10} and B(a)P emissions from household heating in the Czech Republic [number of degree days, thous. t, t], 2000–2019



Data for the year 2020 are not available at the time of publication.

Data source: Czech Hydrometeorological Institute

Heating methods and fuel consumption in households are described in more detail in chapter 2.1.1.

Air quality in an international context

Key messages

Emissions of air pollutants in Europe are decreasing, with SO_2 emissions decreasing most (by 92.2%) in the 1990–2019[21] period.

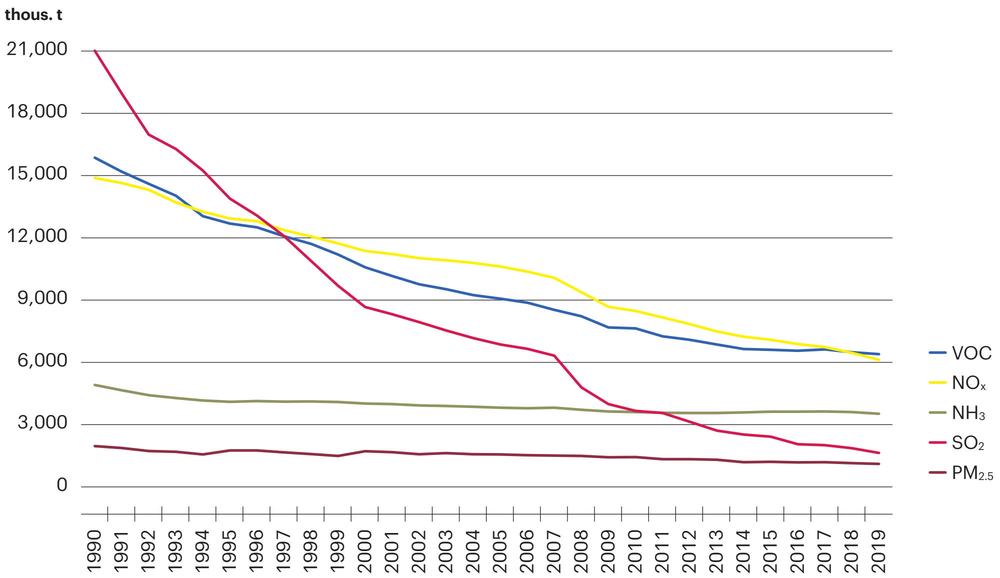
Air quality in Europe is gradually improving slightly, partly thanks to the decrease in pollutant emissions.

Air pollution is the leading cause of premature death and disease, and is the biggest health risk of all environmental factors in Europe.

Emissions of air pollutants are falling in Europe, with significant reductions (92.2%) in SO_2 emissions in the EU27 in the 1990–2019 period[22] (Chart 35), while NO_X and VOC emissions more than halved (NO_X decreased by 58.9% and VOC by 59.6%). Ammonia emissions decreased by 28.2% overall, but have been steadily increasing since 2010. $PM_{2.5}$ emissions decreased by 43.5%.

Chart 35

Emissions of the main pollutants SO_2, VOC, NO_X, NH_3 a $PM_{2.5}$ in the EU27 [thous. t], 1990–2019



Data for the year 2020 are not available at the time of publication.

Data source: EEA

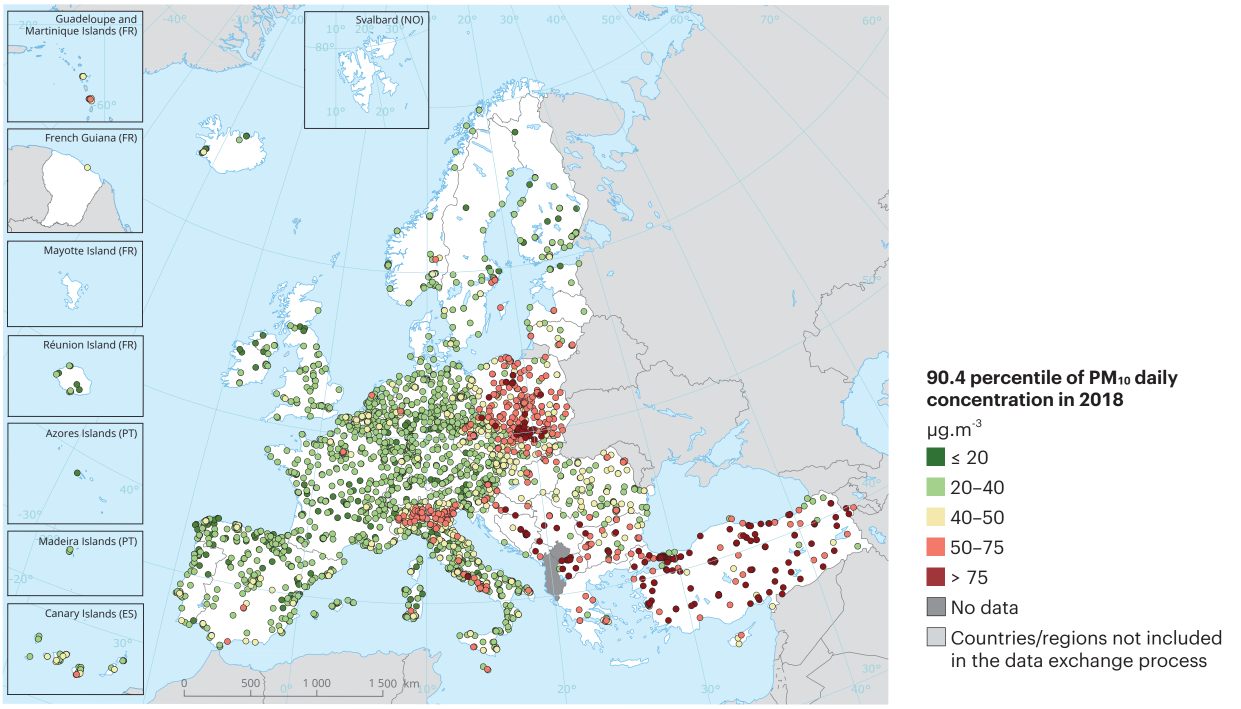
Air quality in Europe is gradually improving, partly thanks to pollutant emissions falling. The most risky substances include suspended PM_{10} (Figure 14) and $PM_{2.5}$ fractions, ground-level ozone O_3 (Figure 15) and PAHs expressed as B(a)P. The extent to which limit values are exceeded varies from year to year and is influenced by both the meteorological conditions and the current economic activity in each country, mainly industrial activities and transport.

[21, 22] *Data for the year 2020 are not available at the time of publication.*

The exceeding of limit values for PM_{10} concentrations continued in 2018[23], with around 15% of the EU28 urban population exposed to daily PM_{10} above-limit concentrations, and around 4% of the EU28 population exposed to $PM_{2.5}$ above-limit concentrations (25 µg per m^3). A significant factor influencing the exceeding of the limit values was the worsened dispersion conditions that can cause smog situations, and also the temperature conditions during heating seasons. Approximately 34% of the urban population was exposed to above-limit concentrations of ground-level ozone (O_3) in 2018. In the case of O_3 concentrations, the most important role is played by the development of meteorological conditions during the warm part of the year, while suitable meteorological conditions for ground-level ozone formation are occurring more frequently due to climate change. Around 15% of the EU28 urban population was exposed to annual B(a)P above-limit concentrations in 2018.

Figure 14

Average daily PM_{10} concentration in Europe [$\mu g.m^{-3}$], 2018



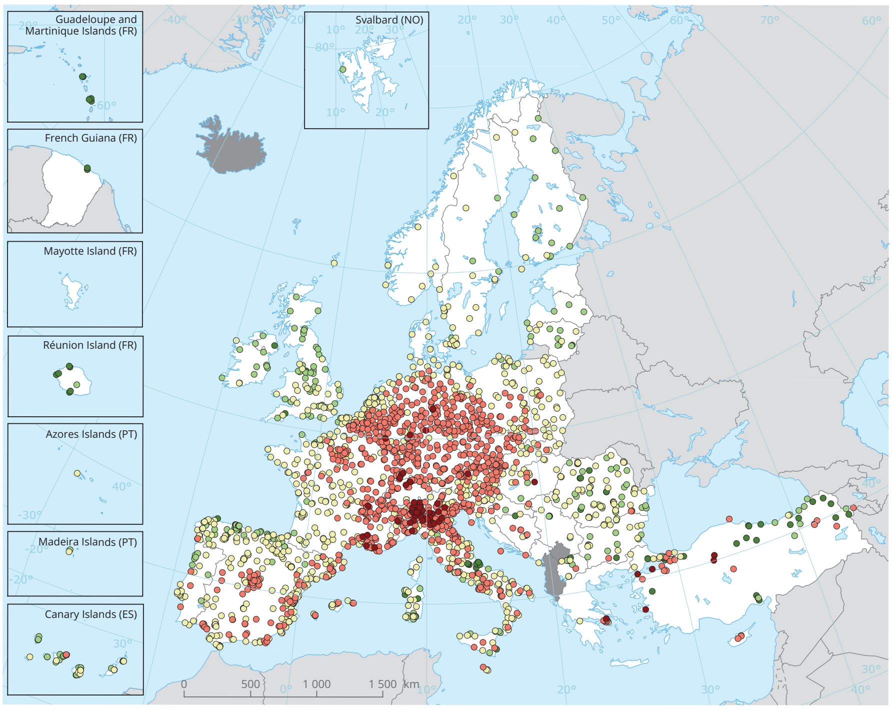
The 90.4 percentile of the daily average PM_{10} concentrations is reported, representing the 36th highest exceedance value, i.e. the established limit value. Data for the years 2019 and 2020 are not available at the time of publication.

Data source: EEA

[23] *Data for the years 2019 and 2020 are not available at the time of publication.*

Figure 15

Average daily maximum 8-hour O_3 concentration in Europe [µg.m^{-3}], 2018



93.2 percentile of O_3 maximum daily 8-hour mean in 2018

µg.m^{-3}

- ≤ 80
- 80–100
- 100–120
- 120–140
- > 140
- No data
- Countries/regions not included in the data exchange process

The 93.2 percentile of the daily maximum 8-hour average O_3 concentrations is reported, representing the 26th highest exceedance value, i.e. the established limit value. Data for 2019 and 2020 are not available at the time of publication.

Data source: EEA

According to the EEA 2020 Report[24], air pollution is the leading cause of **premature death** and disease and is the biggest health risk of all environmental factors in Europe. The latest estimates of the health impacts of air pollution for the EU28 region for 2018 show that fine $PM_{2.5}$ particulate continues to have the largest impact on health, with around 379,000 premature deaths caused by $PM_{2.5}$ exposure in 2018, although the number of premature deaths caused by $PM_{2.5}$ exposure has more than halved since 1990. The EEA 2020 Report also estimated that NO_X exposure was associated with 54,000 premature deaths and ground-level ozone was associated with 19,000 premature deaths (a 24% increase compared to 2009). Residents of central and eastern Europe, including the Balkan Peninsula, are most affected by above-limit concentrations of suspended particulate matter and B(a)P, while the Po Plain in northern Italy is also one of the most polluted areas across the board.

[24] *EEA 2020. Available from: https://www.eea.europa.eu/themes/themes/air/health-impacts-of-air-pollution*

3

Nature and landscape

3.1 | Ecological stability of the landscape and sustainable land management

3.1.2 | Soil degradation

Key question

What is the state of the land in terms of its quality and its vulnerability to degradation and land use?

Key messages

The consumption of mineral fertilisers decreased by 13.0% year-on-year to 101.7 kg of net nutrients per ha in 2020.

The consumption of plant protection products is gradually decreasing. In 2020, this amounted to 3,784.2 thous. kg of active substances, 9.7% less than in 2019.

Mineral extraction in Czechia is fluctuating with an overall downward trend, and is mainly influenced by industrial production and construction. The area affected by extraction is decreasing, while the area of reclaimed land is increasing.

Soil acidification and the depletion of alkaline nutrients may become a limiting factor for forestry. The base saturation (BS) of the soil sorption complex in the top part of mineral soil (up to 20 cm) is 4–18%.

There is extensive annual soil loss through erosion. Potentially 51.7% of agricultural land is endangered by water erosion, of which 15.6% by extreme erosion. 22.9% of agricultural land is endangered by wind erosion.
A total of 399 erosion events were recorded in 2020.

There was a further increase in the consumption of rodenticides (172.7% year-on-year).

In 2019[2], a total of 254.7 ha of agricultural and forest land was taken by road infrastructure.

[2] *Data for the year 2020 are not available at the time of publication.*

Assessment of the trend and state of indicators

Indicator	Long-term trend (15 years and more)	Medium-term trend (10 years)	Short-term trend (5 years)	State
Quality of agricultural and forest soil*				
Quality of agricultural soil	N/A	N/A	N/A	~
Quality of forest soil	↘	↘	↘	✕
Erosion and compaction of agricultural soil	N/A	↗	↗	✕
Consumption of fertilisers and plant protection products	↗	→	↘	~
Land take	↝	↗	↗	✕
Mineral extraction and reclamation*				
Mineral extraction	↘	↘	↘	N/A
Reclamation after mineral extraction	↗	↗	↗	N/A

** Due to the different time series trends underlying the construction of the indicator, an assessment of the sub (elementary) indicators is presented.*

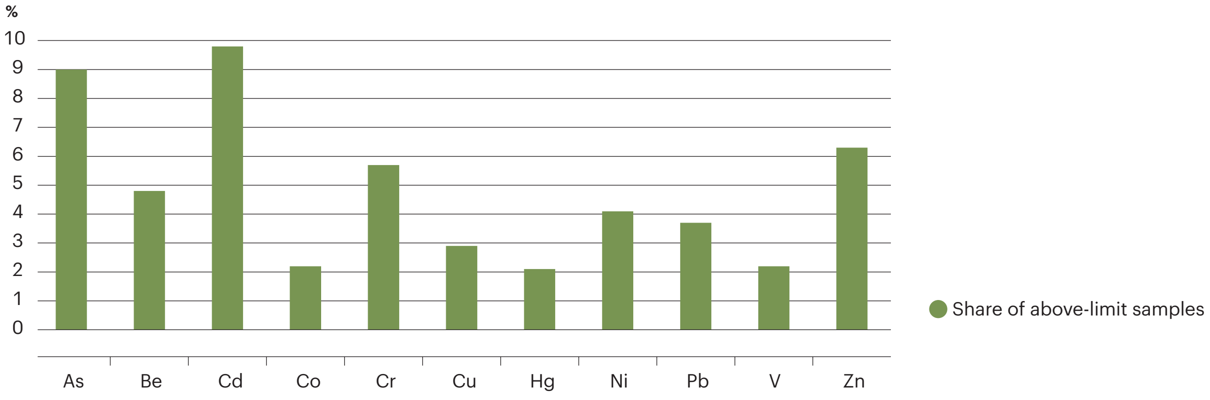
Quality of agricultural and forest soil

The **quality of agricultural soil** is determined by a number of properties (e.g. soil structure, soil reaction (pH), sorption capacity, humus content). The quality of agricultural soil is negatively affected by the content of hazardous substances in the soil, which enter the soil and sediments through anthropogenic activities. As part of **monitoring the content of hazardous elements and substances in soil** (basal soil monitoring – BMP), both inorganic pollutants and hazardous elements (e.g. As, Cd, Ni, Pb, Zn, etc.) and persistent organic pollutants (POPs) are monitored. These include in particular 12 polycyclic aromatic hydrocarbons (12 PAHs), polychlorinated biphenyls (PCBs) and organochlorine pesticides (HCH, HCB, DDT group substances). The core network of BMP points was established in 1992. The system currently contains 214 monitoring areas. The presence of hazardous elements and substances in soil is not necessarily related to agricultural activities and, if it is, it is mainly due to the application of plant protection products, sewage sludge or sediment from water reservoirs and streams.

Based on the results of the determination of the content of hazardous elements in the soil during extraction with aqua regia (Chart 97), cadmium content was the most problematic in the 1998–2020 period with 9.8% of above-limit samples for all soils (i.e. for light and other soil types that include sandy-loamy, loamy, clay-loamy and clay soils), followed by arsenic (9.0%), chromium (5.7%), zinc (6.3%) and beryllium (4.8%).

Chart 97

Share of soil samples exceeding the preventive values for element content in leachate of qua regia in the Czech Republic [%], 1998–2020



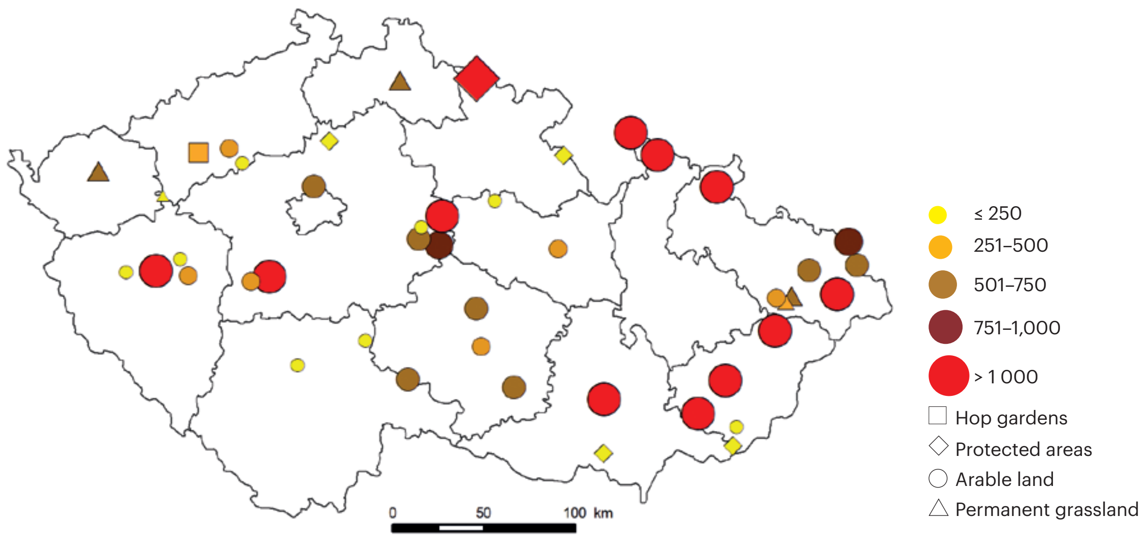
Results of the Contaminated Sites Register, 17,058 to 55,723 samples were assessed. The preventive values for the above-mentioned hazardous substances are set by Decree No. 153/2016 Coll.

Data source: Central Institute for Supervising and Testing in Agriculture

Organic pollutants are determined annually at the same 40 selected BMP monitoring sites and five sites in protected areas (Krkonoše Mountains National Park, Kokořínsko, Pálava, White Carpathians, Eagle Mountains) from the topsoil perspective. In 2020, the preventive value was exceeded for PCBs, PAHs, HCB and DDT. The HCH preventive value was not exceeded in any of the samples assessed at the monitored sites. The highest share of samples exceeding the preventive values was measured for the sum of 12 PAHs. PAHs are also produced by natural processes, but are currently present in the environment at higher levels, partly as a result of human activity, particularly the imperfect combustion of carbon-based fuels. They have a high bioaccumulation capacity and, depending on their structure, some have carcinogenic effects. Limits were exceeded at a total of eleven selected arable land observation sites and one sample from a site in a protected area (Figure 23). DDT levels were exceeded at five sites. The limit for PCBs in arable land was exceeded at two monitoring sites in 2020 and for HCB at one site.

Figure 23

Sum of 12 PAHs in topsoil of agricultural soils (at BMPs) in the Czech Republic [μg .kg^{-1} dry weight], 2020



Based on samples from 40 selected monitoring sites and five sites in protected areas. The preventive value for the sum of 12 PAHs according to Decree No. 153/2016 Coll. is 1,000 μg per kg dry matter.

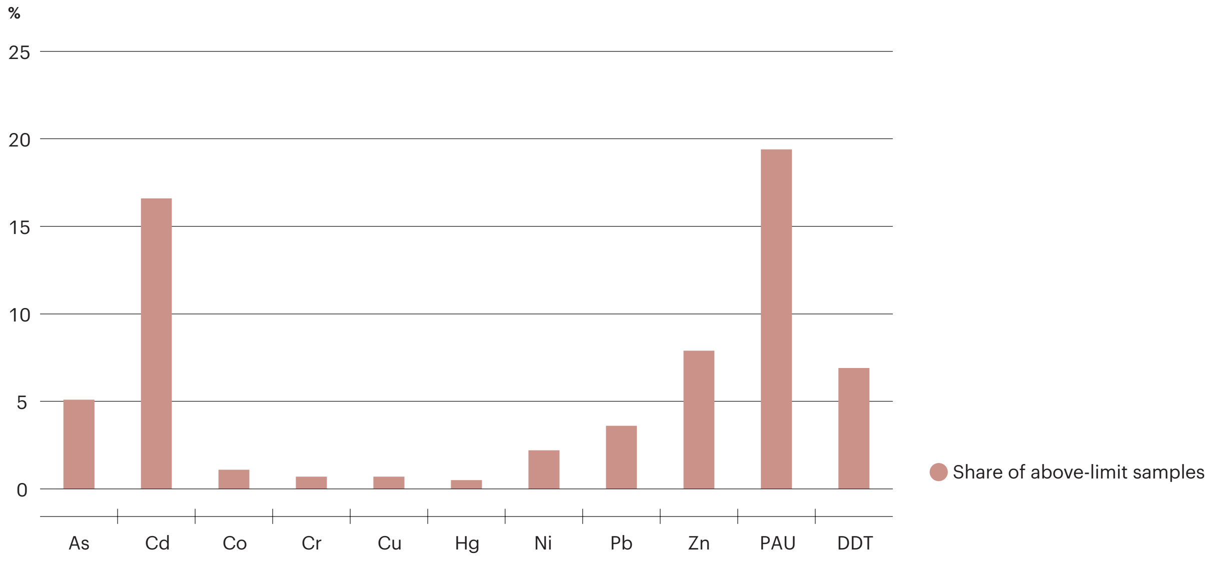
Data source: Central Institute for Supervising and Testing in Agriculture

Pond and river sediments can be deposited on agricultural land to improve its production characteristics. Sediments must first undergo analysis and, they can only be used on agricultural land if they meet the relevant limits according to Decree No. 257/2009 Coll. The content of hazardous elements and organic pollutants is monitored, as well as the grain composition, organic matter content, pH and nutrient content. The Central Institute for Supervising and Testing in Agriculture has been **monitoring the quality of pond and river sediments** since 1995 (Chart 98). A total of 602 sediment samples were assessed in the 1995–2020 period. The highest percentage of samples exceeding the limit values was recorded for PAHs (19.4% overall) and cadmium (16.6% of samples). 5% to 8% of the samples were found to be above the limit for arsenic, zinc and DDT.

As part of the soil quality assessment, the pH value is also determined, and the average soil reaction value for agricultural soil in Czechia in the 2015–2020 period was 6.0 pH (slightly acidic). The organic matter content of soils is also monitored, with 46.1% of agricultural land having organic matter content in the low to lower medium category in 2020. The low humus content in the soil is influenced by intensive agricultural management with a predominance of mineral fertiliser application and low use of manure and compost. Erosion also contributes significantly to dehumification.

Chart 98

Percentage of pond and river sediment samples exceeding limit values in the Czech Republic [%], 1995–2020



Results of long-term monitoring of soil inputs (sediments). Hazardous elements 1995–2020, approximately 500 samples; PAHs: polycyclic aromatic hydrocarbons (sum of 12 PAHs), monitored 2009–2020, 57 samples; DDT: sum of DDT including metabolites, monitored 2007–2020, 57 samples.

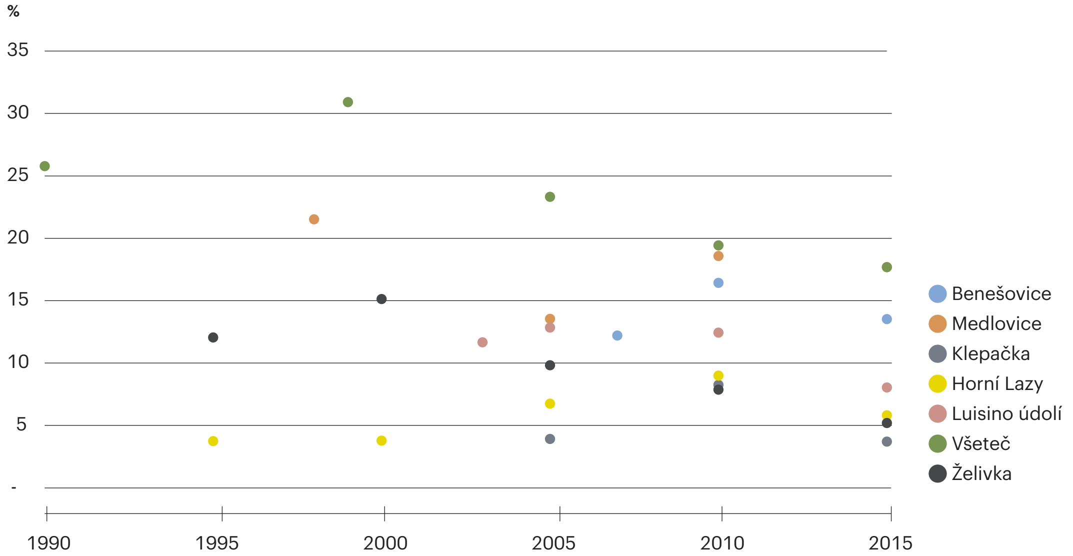
Data source: Central Institute for Supervising and Testing in Agriculture

The limiting factor of **forestry** is the availability of nutrients (especially the alkaline cations Ca, Mg, Na, K) in the soil sorption complex. The unavailability of these nutrients has a negative effect on the formation of the assimilative organs of trees, manifested by defoliation. In the past, forest soils were negatively affected by acidification caused by acid deposition from anthropogenic air pollution. Acidification of forest soils is also influenced by management, which determines the species composition and intensity of logging. For the long-term sustainability of forest management, it is a prerequisite that nutrient losses from biomass extraction (logging) do not exceed nutrient replacement by natural processes (weathering, atmospheric deposition).

The available data show acidification and reduction in **the content of alkaline nutrients** in forest soils, mainly in the upper mineral horizons, in different parts of Czechia[3]. The most pronounced deficiency is in available calcium, the content of which in the top part of the soil (up to 40 cm) in most areas is well below 140 $mg.kg^{-1}$, which is the limit for very low content. The low exchangeable alkaline nutrients content is also related to the base saturation (BS) of the soil sorption complex, which is 4–18% in the top part of the mineral soil (up to 20 cm) (Chart 99). The unfavourable state from the perspective of forest soils is illustrated by the poor health of forests, particularly evident in coniferous stands even in regions without a significant pollution history. Here, nutritional problems are often combined with other stress factors, most often drought and biotic damaging agents, yet they play a significant role.

Chart 99

Average base saturation (BS) of the sorption complex in the top part of the soil (0–20 cm) at ICP Forests Level II monitoring sites in the Czech Republic [%], 1990–2015



Data for the year 2020 are not available at the time of publication.

Data source: Forestry and Game Management Research Institute

[3] *Šrámek V., Jurkovská L., Fadrhonsová V., Hellebrandová-Neudertová K., 2013: Chemistry of forest soils of Czechia by typological category – results of monitoring of forest soils as part of the "BIOSOIL" project. Forest Research Reports, 58: 314. Available from: https://www.vulhm.cz/files/uploads/2019/01/324.pdf.*

Forest health condition

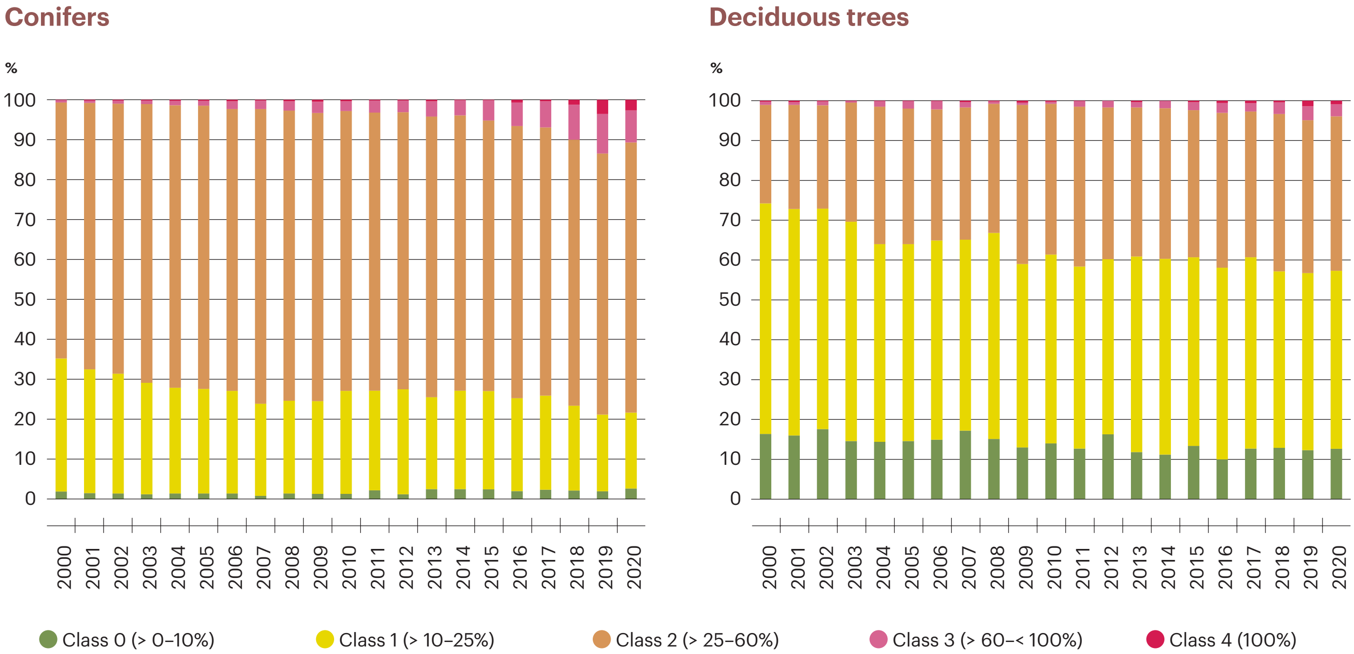
Forest land covers roughly one third of Czechia's territory and is expanding slightly, accounting for 33.9% of all land in 2020. Forest ecosystems are thus an important element for the landscape, and forestry is an important economic sector. As a renewable resource, wood has significant potential in the transition to sustainable production and consumption systems. In addition, stable forest ecosystems support biodiversity, regulate the water regime of the landscape, protect soil from erosion, improve air quality, and provide recreational and aesthetic functions. The current state of forests is very far from natural, making them vulnerable to the current threats posed by manifestations of climate change. As a result, the non-productive functions of forests are endangered and the utility and value of their main product – timber – is reduced.

The ability of forests to perform some of their functions can be assessed through the state of health expressed as the degree of defoliation, defined as the relative loss of the assimilative apparatus in the crown of a tree compared to a healthy tree growing in the same stand and habitat conditions. The assessment of the health of coniferous and deciduous stands by defoliation level is divided by age into two categories – older (60 years and older) and younger (up to 59 years). The defoliation values are divided into five basic classes (0 to 4), of which classes 2 to 4 indicate significant tree damage.

In 2020, 78.3% of conifers and 42.7% of deciduous trees were classified in **defoliation** classes 2 to 4 for older stands (60 years and older; Chart 118) and 28.7% of conifers and 23.3% of deciduous trees for younger stands (up to 59 years; Chart 119). In older stands, defoliation in the sum of classes 2 to 4 for conifers is highest for pine (94.4% in 2020), followed by larch (83.8%) and spruce (66.5%; Chart 120). Among deciduous trees, oak showed a significant defoliation rate in classes 2 to 4, with a total of 69.9% of the assessed trees, while beech showed a defoliation rate of 18.0%. For conifer stands aged up to 59 years, the situation is again least favourable for pine, which accounted for 75.6% of trees in the sum of classes 2 to 4 in 2020. A more favourable situation compared to older stands is observed in the case of spruce (only 9.7% in classes 2 to 4). In deciduous stands, even in the younger age category, oak (56.6% in classes 2 to 4) has a higher defoliation rate than beech (7.6%).

Chart 118

Defoliation of older conifer and deciduous stands (60 years and older) in the Czech Republic by class [%], 2000–2020

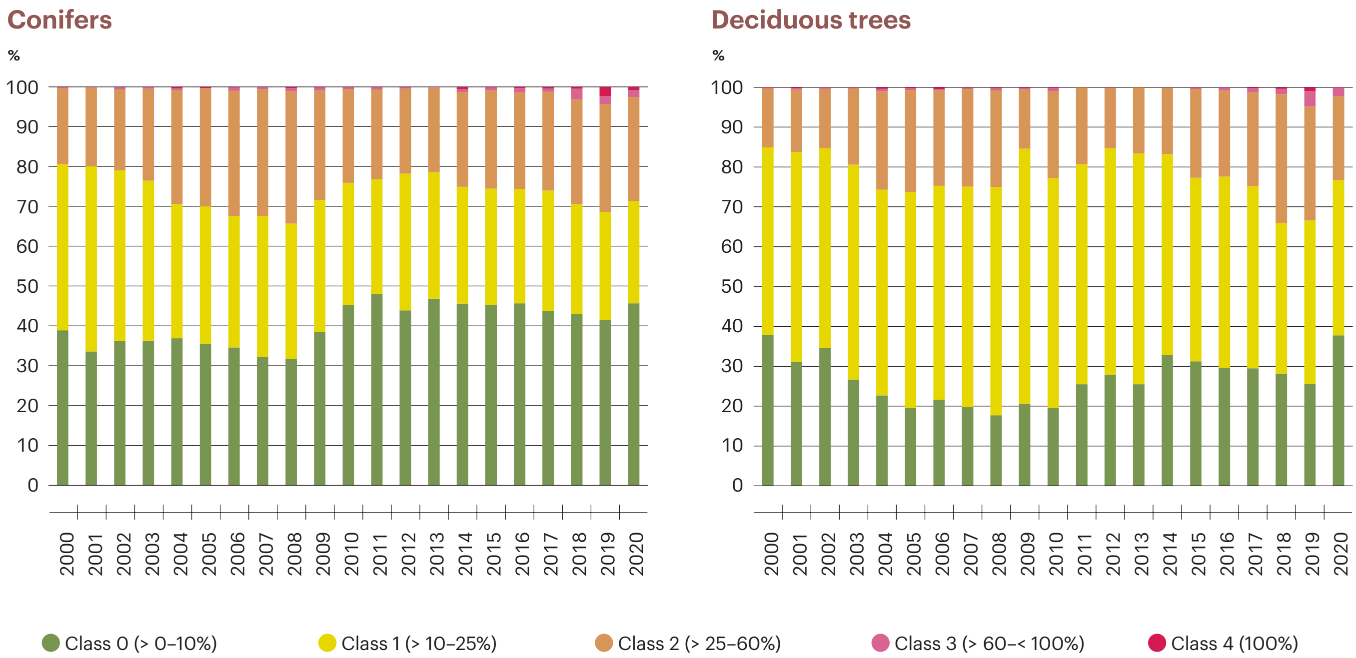


Data source: Forestry and Game Management Research Institute

Chart 119

Defoliation of younger conifer and deciduous stands (up to 59 years) in the Czech Republic by class [%], 2000–2020

Conifers / Deciduous trees

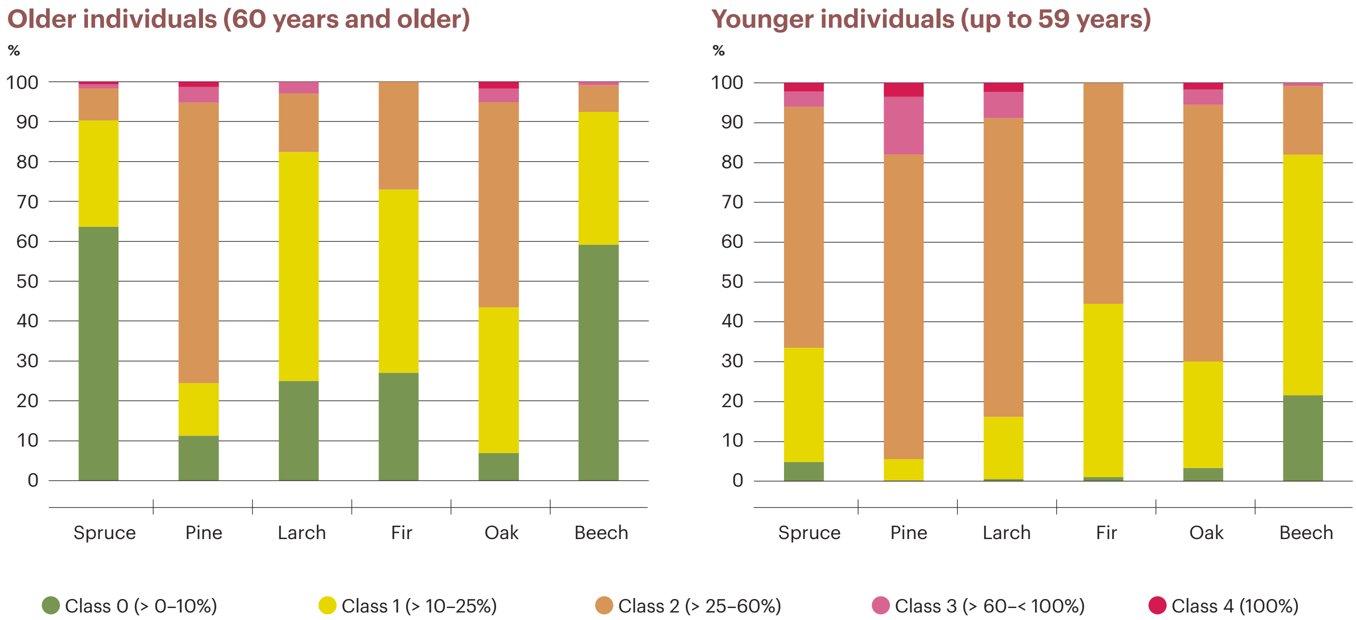


Data source: Forestry and Game Management Research Institute

Chart 120

Defoliation of basic tree species in the Czech Republic by class [%], 2020

Older individuals (60 years and older) / Younger individuals (up to 59 years)



Data source: Forestry and Game Management Research Institute

In younger stands (up to 59 years) the defoliation level is lower as younger stands have greater vitality and ability to withstand adverse environmental conditions. In addition, older stands were burdened by sulphur (SO_2) and nitrogen (NO_x) pollution during the 1970s and 1980s. The effects of anthropogenic air pollution are divided into primary, caused by direct damage to the surface of assimilating organs, and secondary, caused by leaching of alkaline nutrients due to soil acidification. Since 1989, the air pollution situation has significantly improved thanks to the installation of new industrial equipment, changes in the fuel mix, and the application of emission limits at air pollution sources. However, forest stands respond to changes with a considerable delay and, moreover, even though the pollution load intensity is demonstrably lower, it still exists. In addition to the habitat conditions and the amount of acid deposition, management practices, including tree species composition and logging intensity, also influence the acidification and overall nutrient balance of forest ecosystems. Coniferous stands are more vulnerable to acidification due to the slow decomposition of their litter, associated with the production of low molecular weight organic acids, and due to the higher concentrations of pollution in sub-crown precipitation due to dry deposition on needles.

Currently, the health of forest stands is negatively affected by the bark beetle calamity and manifestations of climate change such as drought, strong winds and the lengthening of the growing season. In addition, many forest stands are characterised by an inappropriate species composition with a predominance of pastoral farming. Trends in the representation of defoliation classes are negative in the long term, and the health of forest stands therefore remains unsatisfactory.

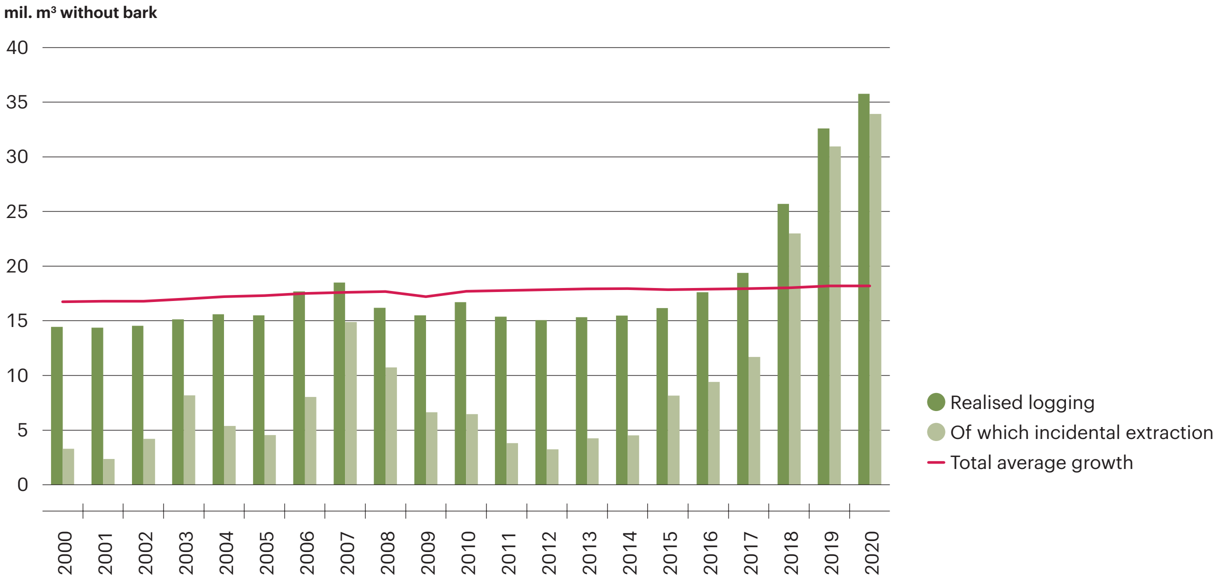
In 2020, forest ecosystems were again affected by large-scale logging after the bark beetle calamity. The **volume of recorded logging** increased again, to 35.8 mil. m^3 of wood without bark, surpassing the previous record set in 2019 (Chart 121). The share of incidental (calamity-related) logging in total logging in 2020 decreased slightly to 94.8% from 95.0% in 2019, still well above average compared to the previous period from 2000 to 2015, when the current bark beetle calamity started. 2007 was the exception when, after Hurricane Kyrill, incidental logging accounted for 80.4% of total logging. The **volume of incidental logging** in 2020 was 33.9 mil. m^3 of wood without bark, the highest recorded in history (Chart 122). Most of the incidental logging was insect-related logging (26.2 mil. m^3 of wood without bark). Thus, the volume of insect-related logging in 2020 was almost the same as the total volume of insect-related logging in the 1990–2012 period (26.0 mil. m^3 of wood without bark). insect-related logging has been on the rise since 2015, when the largest ever bark beetle calamity in our territory began in North Moravia in the Jeseníky region, and gradually spread to other areas. The bark beetle calamity is caused simultaneously by climatic conditions and the low ecological stability of forest stands, largely composed of spruce monocultures. Drought and the lengthening growing season improve conditions for the spread of the bark beetle and at the same time reduce the ability of spruce stands to resist this pest. At the same time, stands damaged by abiotic factors, such as wind, are much more susceptible to insect infestation and fungal diseases. Natural logging in 2020 was 4.6 mil. m^3 of wood without bark, which can be considered an average value in the context of previous years.

The total logging volume in 2020 significantly exceeded the **total average growth rate**, which has been slowly increasing since 2000, and in 2020 was 18.2 mil. m^3 of wood without bark (Chart 121). The overall average increment is an expression of the productive capacity of forest habitats and is a crucial indicator in assessing the principle of balance and sustainability of logging options. The record logging was reflected in the **total timber stock**, which decreased year-on-year for the first time in 2020 and amounted to 701.1 mil. m^3 of wood without bark[13]. Massive tree felling also affects the overall carbon balance of forests. While in the previous period Czech forests were carbon sinks, in the last three years they have become carbon sources. Leaving part of the wood mass in forests to decay would have a positive effect on the carbon balance, and on the quality of forest soils and biodiversity.

[13] *The total stock of timber also decreased in 2019 according to estimates based on data from the project Monitoring the State and Development of Forest Ecosystems, which since 2016 has followed on from the second cycle of the National Forest Inventory in Czechia 2011–2015. Read more: https://nil.uhul.cz/downloads/vysledky_projektu_ssvle/2020_05_18_zasoby_drivi_ssvle_2019.pdf.*

Chart 121

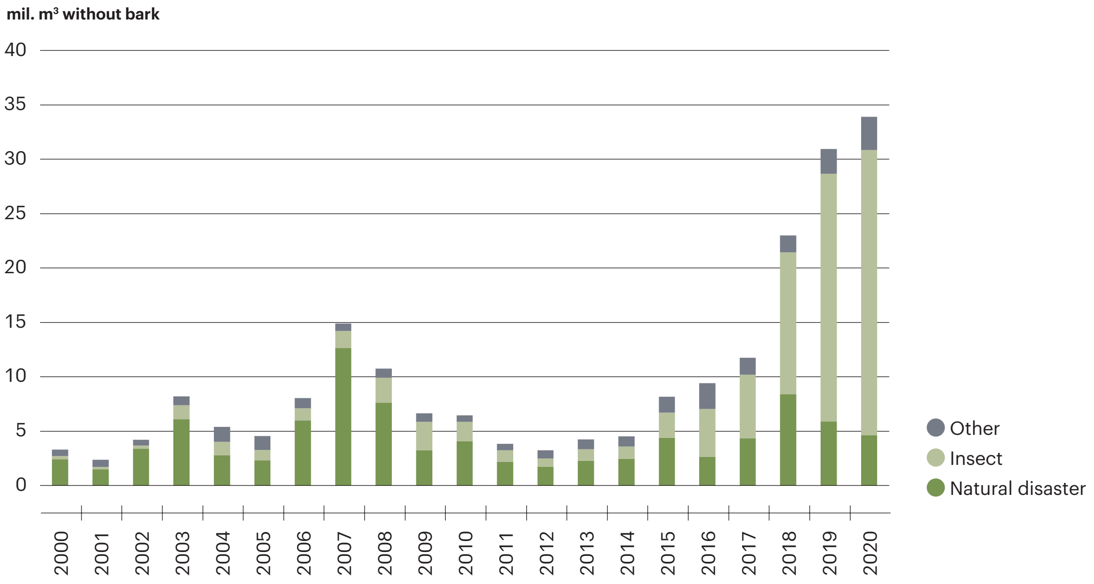
Comparison of realised timber logging with total average growth rate in the Czech Republic [mil. m^3 without bark], 2000–2020



Data source: Czech Statistical Office, Forest Management Institute

Chart 122

Incidental extraction by cause in the Czech Republic [mil. m^3 without bark], 2000–2020



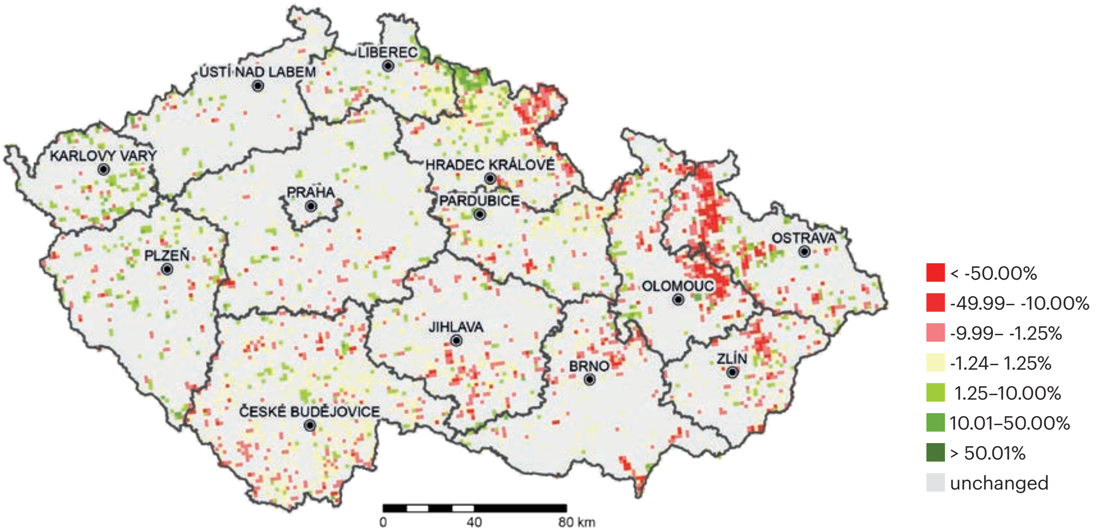
Data source: Czech Statistical Office

Many so-called calamity clearings have recently been created in areas with high logging volumes. The total area of clearings increased by 30% year-on-year to 70.9 thous. ha. Large-scale logging of wood impacted by bark beetles has also affected the land cover of Czechia, which may have downstream consequences for the entire landscape (e.g., affecting the hydrological regime). According to the CORINE Land Cover dataset[14], a total of 37.4 thous. ha of forest was lost between 2012 and 2018 (Figure 28).

[14] *Data for the years 2019 and 2020 are not available at the time of publication.*

Figure 28

Percentage change in forest cover between 2012 and 2018 in the Czech Republic according to the CORINE Land Cover dataset [%], 2018



Data for the years 2019 and 2020 are not available at the time of publication.

Data source: Czech Environmental Information Agency, European Environmental Agency

Landscape management in an international context

Key messages

The total area of forest cover and the volume of wood and carbon stock in biomass is increasing. Forests cover more than a third of Europe and almost 90% of them are used for logging. From the perspective of production, most forests are managed according to sustainable development principles.

Organic farmland accounted for 7.9% of total cultivated land in the EU28 in 2019. With a share of 15.2% in 2019[19], Czechia has an above-average share of organically managed land.

Europe's forests are facing increasing pressure from the intensifying manifestations of climate change. Damage caused by intense winds, drought, fires, and biotic agents is increasing. The health of Europe's forests is deteriorating. In total, 28.4% of the assessed stands exceeded the 25% rate in 2019[20]. 4% of forests are classified in the highest damage category (above 60%).

Forests in an international context

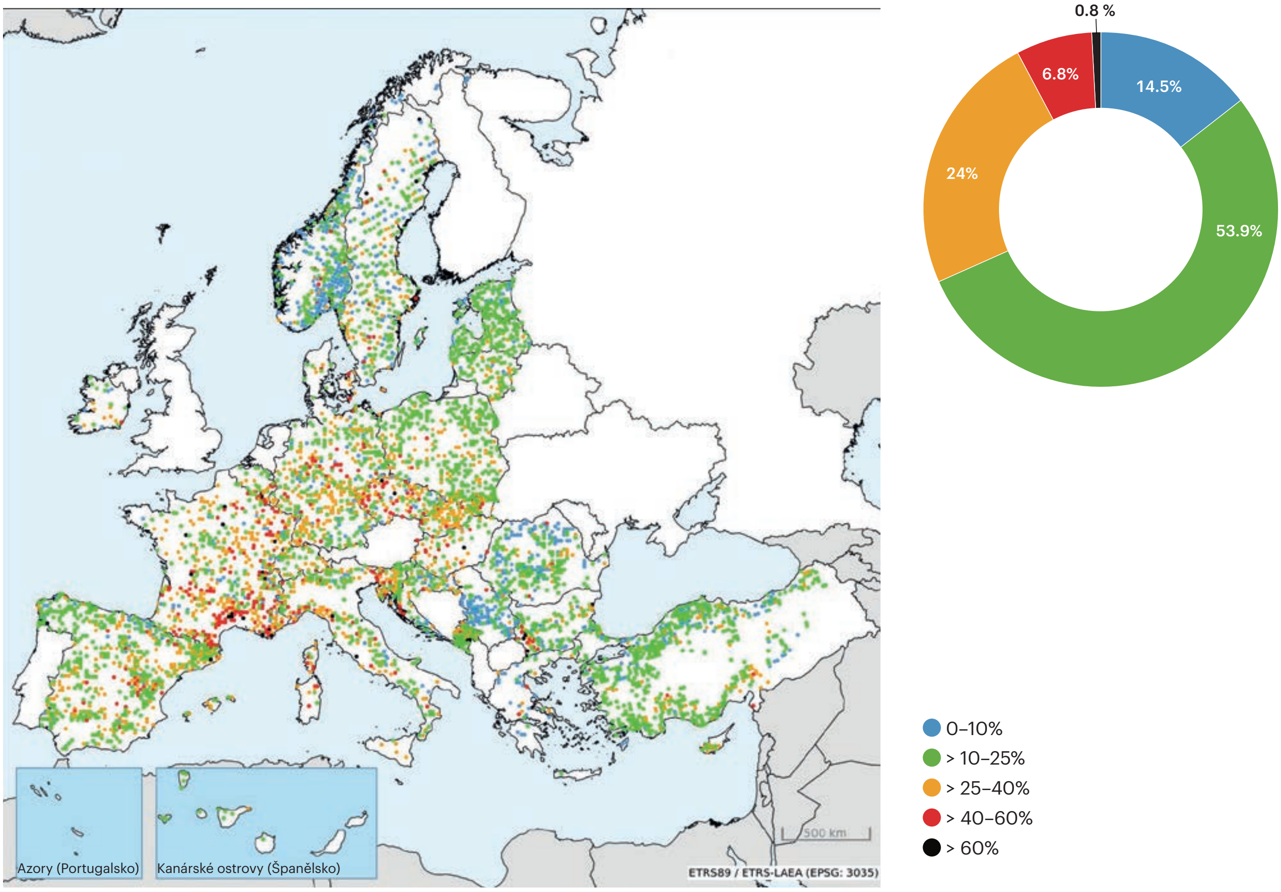
Europe's forests are human-disturbed ecosystems facing increasing impacts of climate change and atmospheric pollution, posing a risk to the vitality of forest soils and forest health. Defoliation is the result of a complex of influences and short-term factors (pest overpopulation, diseases, frost, drought, wind, and other weather damage) together with long-term factors (inappropriate age and species composition of stands, soil acidification, long-term exposure to atmospheric pollution, etc.). High defoliation rates generally indicate a reduction in the resilience of forest stands to various environmental influences. An important factor for the stability and resilience of forest ecosystems to acidification and climate change is an appropriate forest stand species composition that reflects natural conditions.

The above factors causing defoliation are the reason why Czechia is among the countries with the highest **defoliation** rates in Europe (Figure 29). In 2019[21], 71.6% of the forests in Europe were in the low defoliation damage category (0–25%) while 28.4% of the assessed stands exceeded 25% defoliation and were classified as damaged or dead. 4% of forests are classified in the highest damage category (above 60%). Forests with significant damage are mainly located in central and southern Europe, namely in southern and south-eastern France, northern Italy, Czechia, Slovenia, and Croatia. Defoliation rates in Europe are not improving. This is a worrying finding, particularly in the context of ongoing climate change and the failure to reduce nitrogen deposition.

[19, 20, 21] Data for the year 2020 are not available at the time of publication.

Figure 29

Defoliation in the main monitoring plots of all tree species in Europe [%], 2019



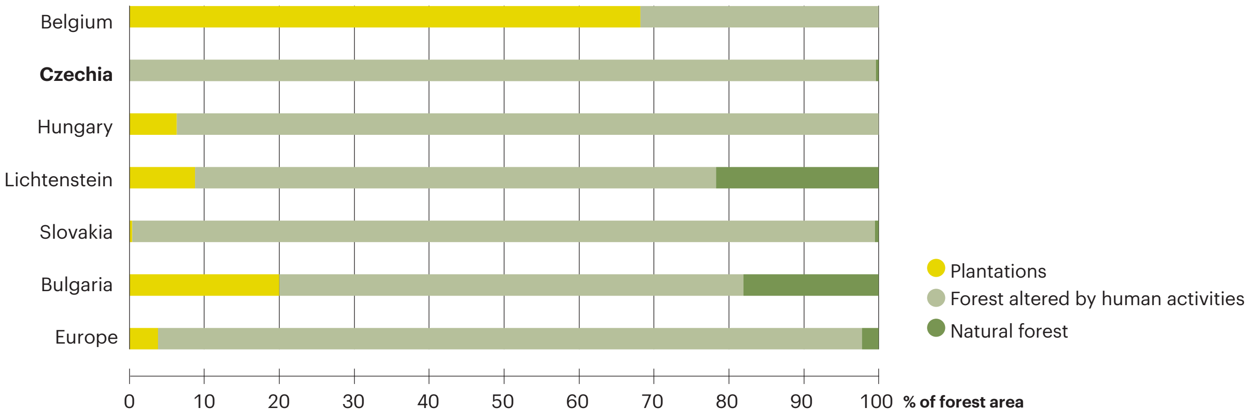
Data for the year 2020 are not available at the time of publication.

Data source: ICP Forests

In Europe, only 2.2% of the total forest area are not affected by human activity (**natural forests**). In Czechia, this share is 0.4% (Chart 128). This low level is due to the use of Europe's forests and land for commercial purposes. The highest share of native forests is found in Liechtenstein, Bulgaria and Georgia. By contrast, the highest share of plantations is found in the United Kingdom, Ireland and Belgium.

Chart 128

Share of forests affected by human activities in selected countries [% of forest area], 2020



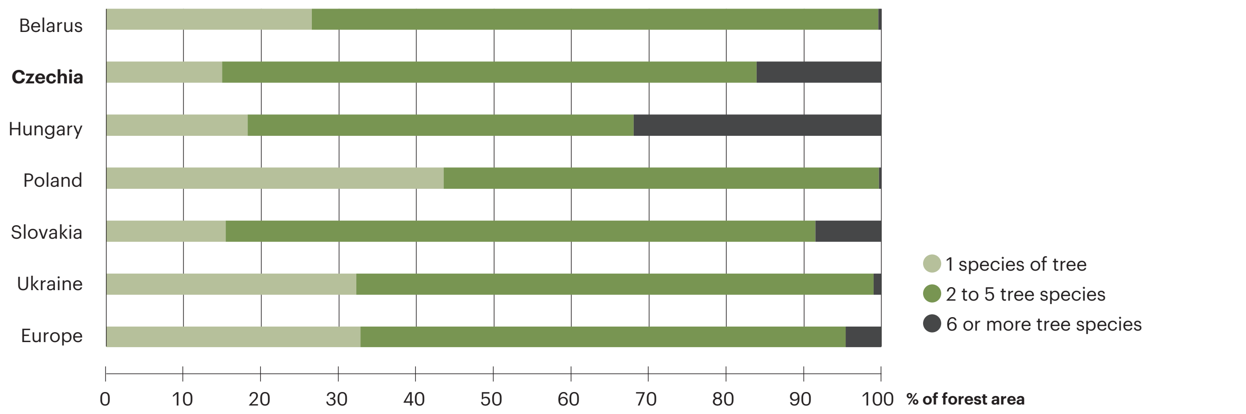
A forest altered by human activities usually differs from a natural forest in its species composition, which is influenced by human activities such as artificial regeneration. Plantations are forest stands established with the intention of obtaining as much timber as possible in a short period of time (10 to 60 years). The wood from forest plantations is mostly used to produce paper, pulp, particleboard, or firewood.

Data source: Forest Europe

Monocultures account for an average of 15.4% of forests in Czechia and 32.8% across Europe (Chart 129). At the same time, the area of stands composed of more than 6 tree species in Czechia is significantly higher than the European average (16.6% in Czechia, 4.6% in Europe). However, the species composition of forest stands in Czechia in comparison with the European average is not relevant, as specific forest ecosystems naturally composed of only one or two species (e.g. northern pine forests, subalpine spruce forests) were also included in the European average.

Chart 129

Species composition of forest stands in selected countries [% of forest area], 2015



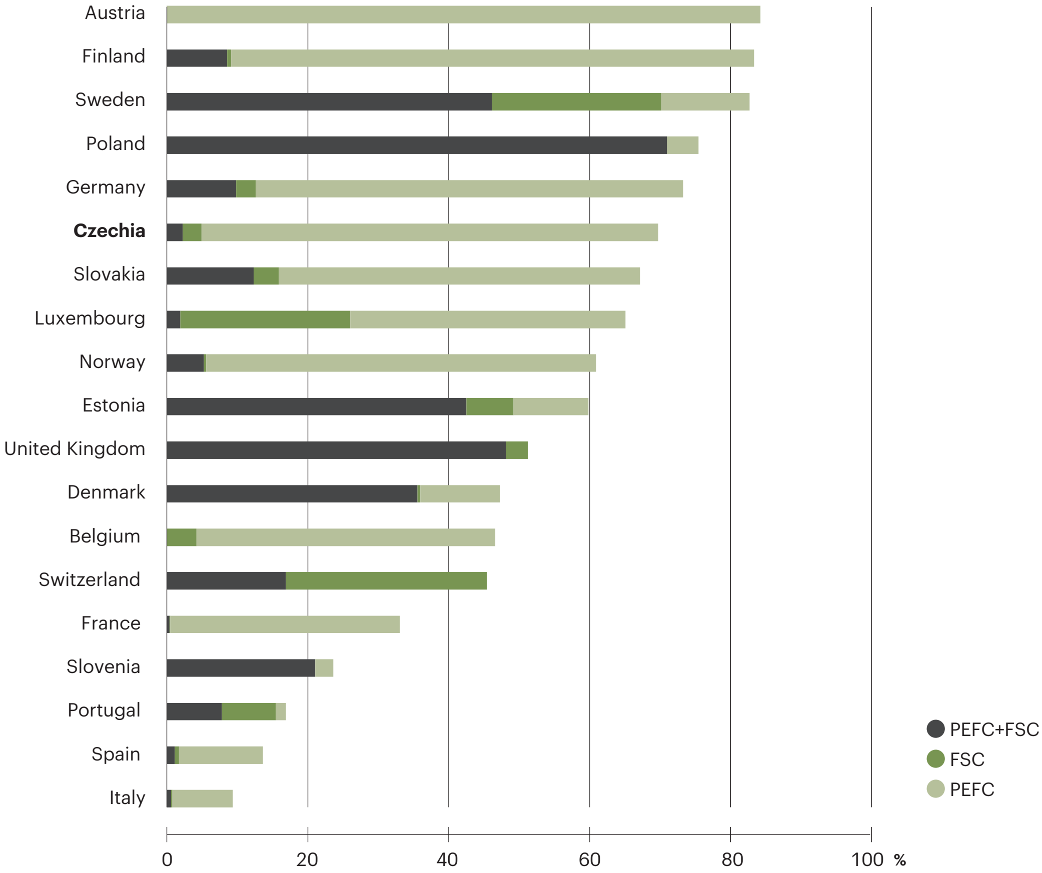
Data for the years 2016–2020 are not available at the time of publication.

Data source: Forest Europe

On average, about half of forest land in European countries is certified. The **share of PEFC and FSC certified forests** in the total forest area in the selected EU countries is highest in Austria (84.2%) and Finland (83.3%). On the other hand, the lowest share is in Italy (9.3%) and Spain (13.6%). Czechia is above average in Europe with 69.7%, mainly thanks to its high share of PEFC certified forests (Chart 130).

Chart 130

Share of PEFC and FSC certified forests in total forest area in selected countries [%], 2020



Since 2017, PEFC and FSC have been jointly surveying forest areas with both certifications (PEFC + FSC).

Data source: Programme for the Endorsement of Forest Certification Schemes, Forest Stewardship Council, Eurostat