VIII. EUROPEAN CONTEXT

Air pollution in large industrial areas has been one of the serious environmental problems in Europe since roughly the middle of the last century. The well-known episodes of the so-called smog of London forced not only the UK, but also other Western European countries to gradually adopt national laws to reduce air pollution.

In the 1960s, it became apparent that the problem could only be solved through international cooperation. Studies within a program for investigating the long-range transmission of air pollution, carried out under the auspices of the Organisation for Economic Cooperation and Development (OECD) in 1971–1977, showed that the acidification of rivers and lakes in Scandinavia was a result of so-called acid rain, caused by pollutants released into the atmosphere over continental Europe. Consequently, the first internationally binding document was adopted to resolve problems connected with air pollution at a broad regional level, namely the Convention on Long-Range Transboundary Air Pollution (CLRTAP), which was adopted by the UN Economic Commission for Europe in 1979.

Due to measures introduced both under CLRTAP and especially later within European Union (EU) legislation, air quality in Europe has improved substantially over the past decades. Emissions of many pollutants have been reduced, but pollution from suspended particulate matter and ozone still poses serious risks. Considerable parts of the European population and ecosystems continue to be exposed to higher concentrations of pollutants than legislatively stipulated limit levels and values recommended by the World Health Organisation (WHO).

Despite the improvements mentioned above, air pollution in Europe is one of the highest-risk environmental factors, causing premature deaths, increasing the incidence of a wide range of diseases, damaging vegetation and ecosystems, and leading to a loss of biodiversity. All these factors also lead to significant economic losses. A further improvement will require measures and cooperation on global, continental, national and local levels in most branches of the economy with public participation. The measures must include technological development, structural changes including optimisation of the infrastructure and territorial planning, as well as a change in behaviour. The protection of natural capital, the promotion of economic prosperity, human well-being and social development are parts of the European Union 2050 vision, set out in the 7th EU Environmental Action Programme (EU 2013).

Emissions of pollutants and greenhouse gases within Europe

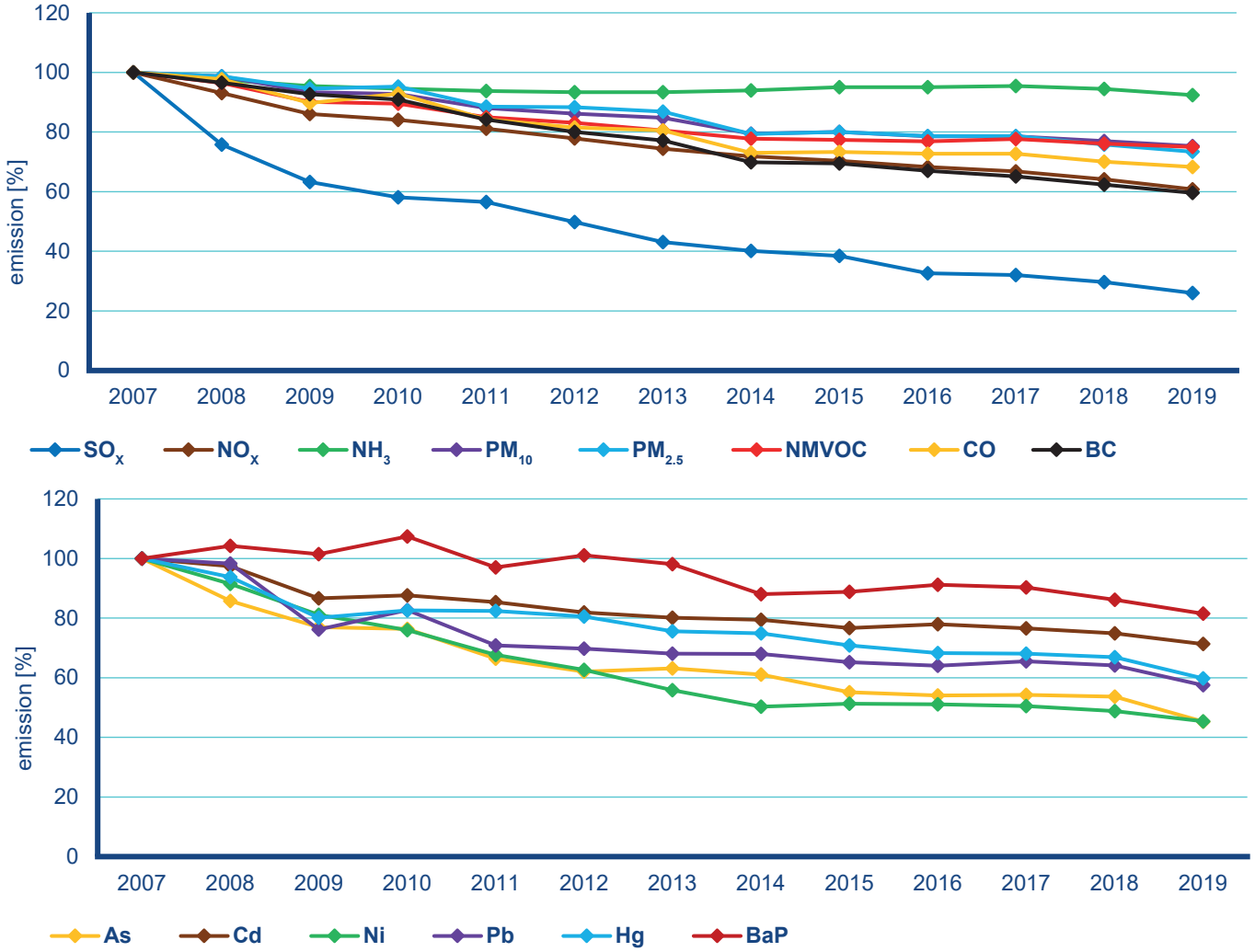
Emissions of the main pollutants released into the ambient air in Europe have decreased since 1990. Nonetheless, this reduction has not been sufficient in all the sectors and the emissions of some pollutants have even increased. For example, there has not been a sufficient reduction in NO_x emissions from mobile sources and therefore air pollution limits are not met in many cities. In the past decade, $PM_{2.5}$ and benzo[*a*]pyrene emissions have also increased in the EU as a result of the incomplete combustion of coal and biomass in households and in private and public buildings. These sources now make the greatest contribution to emissions of particulates and benzo[*a*]pyrene in the EU (Fig. VIII.1).

Greenhouse gas emissions are declining, particularly CO_2, CH_4 and N_2O emissions (Fig. VIII.2). On the contrary, there was an apparent increase in fluorinated hydrocarbon emissions until 2014. In recent years, however, the effects of EU regulations restricting the use of F-gases have begun to manifest and their emissions are gradually declining. In 2020, their amount decreased below the level of the reference year 2007 for the first time.

Overall, there are international obligations for European countries to reduce greenhouse gas emissions based on the requirements of both the UN Framework Convention on Climate Change and related regulations of the European Union. Reducing emissions of fluorinated gases and limiting their use is also required by the Montreal Protocol.

Air quality monitoring in Europe

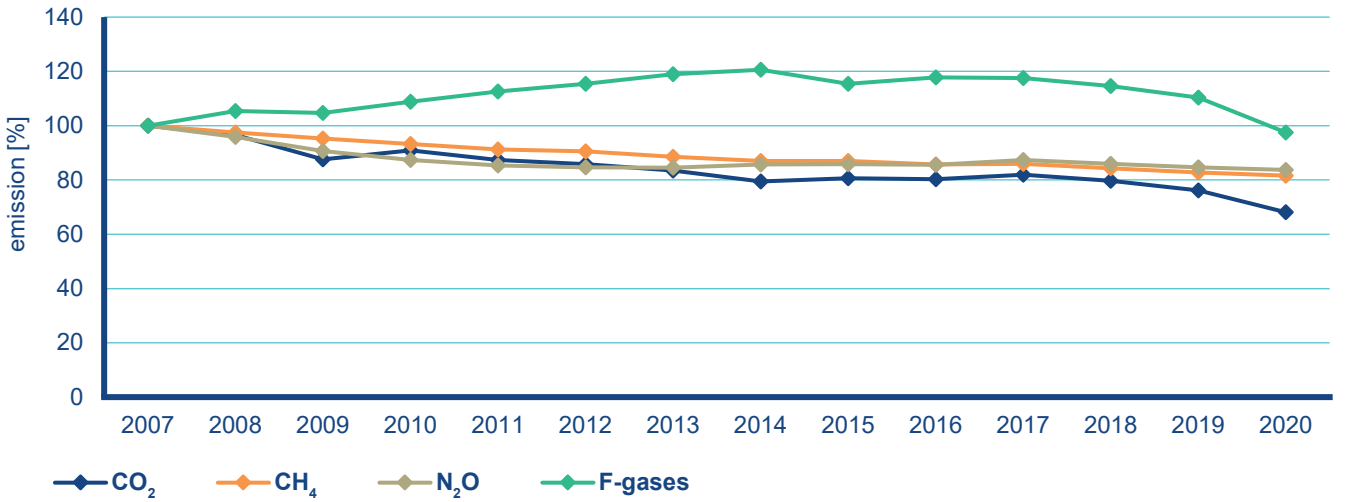
Long-term monitoring of air quality is at a high level in Europe, which together with North America are continents with the highest density of measuring stations. The national air quality monitoring networks are operated by individual countries in accordance with EU legislation, but practical provisions for these networks differ in the countries. In some, they are managed centrally by environmental agencies or meteorological institutes, in others by regional authorities. The central European database of pollutant concentrations measured at air quality monitoring stations (the AQ e-reporting database) is operated by the European Environment Agency (EEA). Each year, individual countries transmit data measured within their monitoring networks to the EEA according to EU legislation.



Note: The emission are expressed as a percentage of the emissions in 2007. Land use, lande-use change and forestry data are only available until 2012. Reporting on BC emissions has been made on a voluntary basis and has not been made for every country.

Source of data: EEA

Fig. VIII.1 Total emissions in 27 Member States of the European Union and United Kingdom, 2007–2019



„Note: The emission are expressed as a percentage of the emissions in 2007. Emissions are represented including emissions from Land use, lande-use change and forestry. Data viz National inventory of greenhouse gas emissions 2022 (UNFCCC) https://unfccc.int/ghg-inventories-annex-i-parties/2022

Source of data: UNFCCC

Fig. VIII.2 Total greenhouse gas emissions in 27 Member States of the European Union and United Kingdom, 2007–2020

In addition to the national networks, long-term pan-European projects are being implemented, whose main goals include detecting long-term trends in air quality in a European-wide context. These programmes are implemented under CLRTAP (EMEP and the group for evaluating the impacts of long-range transboundary air pollution), within the World Meteorological Organization (WMO) GAW programme, and in the framework of European research infrastructures (ACTRIS, ICOS). The long-range transport of pollutants across the continent and beyond is addressed by the CLRTAP convention under the EMEP program. The program was established in 1977 and one of its main goals is to monitor long-term trends in air quality on a regional scale, based on measurements at selected background locations.

Current state of air quality in Europe

From the viewpoint of damage to human health in Europe, the greatest problems are caused by concentration levels of suspended particulate matter (PM), ground-level ozone (O_3), nitrogen dioxide (NO_2) and carcinogenic benzo[*a*]pyrene. Polluted air causes serious health problems, especially for the inhabitants of cities and municipalities. Damage to ecosystems is caused most extensively by O_3, in addition, increased concentrations of nitrogen oxides (NO_x) contribute to excessive atmospheric deposition of nitrogen leading to a number of negative impacts to ecosystems (mainly eutrophication, acidification and reduction of biodiversity).

It has been estimated that in the three-year 2018–2020 period, 8–13 % of the population in Europe[1] was exposed to above-limit 24-hour PM_{10} concentrations, 1–2 % to above-limit annual $PM_{2.5}$ concentrations, 7–37 % to O_3 concentrations greater than the target value and 0.2–2 % to above-limit annual NO_2 concentrations (ETC/ATNI 2022). Approximately 15–22 % of the EU urban population was exposed to annual benzo[*a*]pyrene concentrations higher than the target value in the five-year period 2015–2019 (EEA 2021).

In the three-year 2018–2020 period, estimates of the percentage of the European population exposed to concentrations higher than values recommended by WHO 2021 (Tab. I.3) were even greater, namely 62–83 % concerning annual concentrations of PM_{10}, 97–98 % concerning annual concentrations of $PM_{2.5}$, and 72–83 % concerning annual concentrations of NO_2 (ETC/HE 2022). In 2019 (the latest year evaluated so far in the EEA reports), 99 % of the EU urban population was exposed to daily O_3 concentrations higher than the WHO 2021 recommended value; for the annual benzo[*a*]pyrene concentration it was 75 % and for the 24-hour SO_2 concentration 7 % of the EU urban population (EEA 2021).

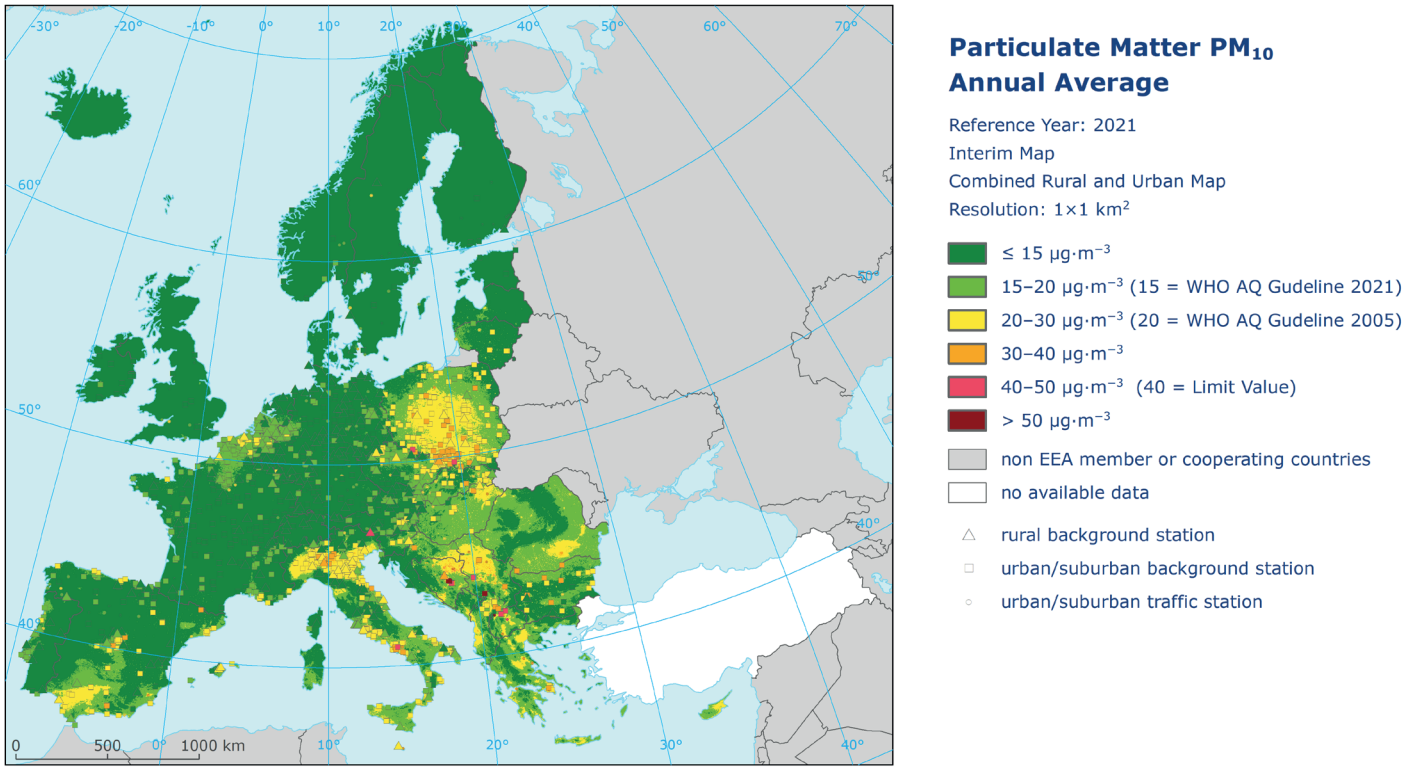
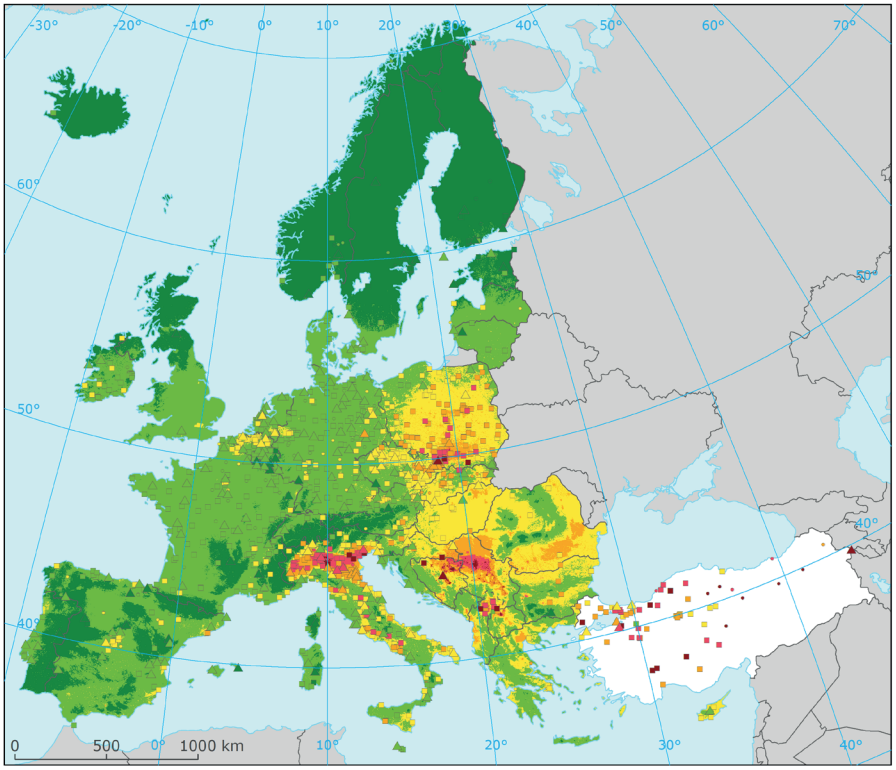


Fig. VIII.3 Field of annual average concentration of PM_{10} in Europe, 2021, preliminary map

1 Including the territory of Cyprus, without the territory of Belarus, Moldova, Ukraine and the European parts of Kazakhstan, Russia and Turkey.

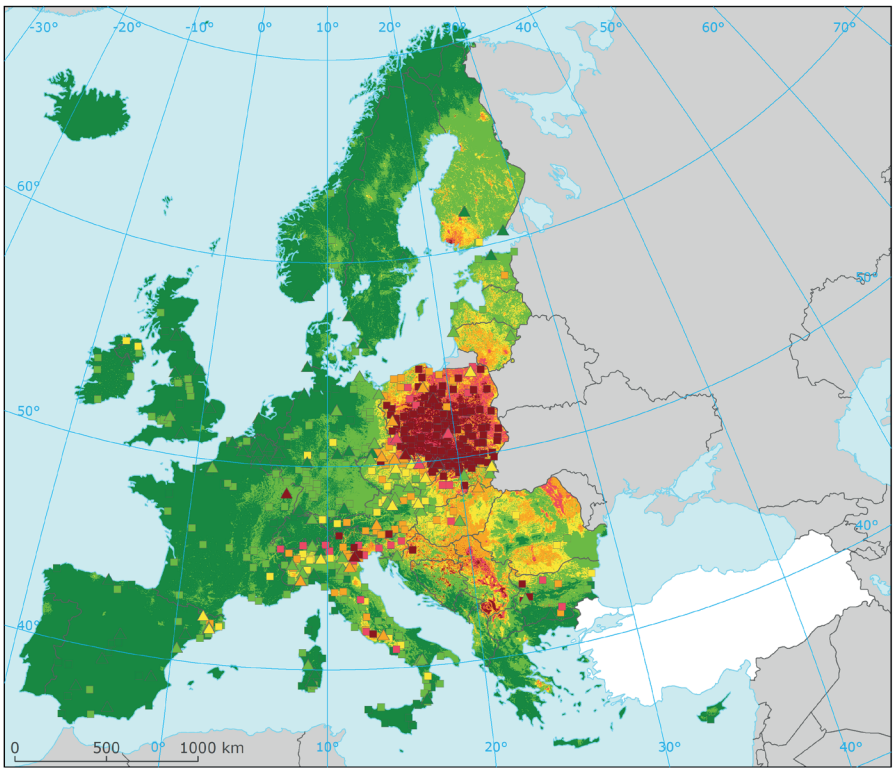


Fine Particulate Matter $PM_{2.5}$ Annual Average

Reference Year: 2020
Combined Rural and Urban Map
Resolution: 1×1 km²

- ≤ 5 µg·m⁻³
- 5–10 µg·m⁻³ (5 = WHO AQ Guideline 2021)
- 10–15 µg·m⁻³ (10 = WHO AQ Guideline 2005)
- 15–20 µg·m⁻³
- 20–25 µg·m⁻³ (20 = Indicative Limit Value)
- > 25 µg·m⁻³ (25 = Limit Value)
- non EEA member or cooperating countries
- no available data
- △ rural background station
- □ urban/suburban background station
- ○ urban/suburban traffic station

Fig. VIII.4 Field of annual average concentration of $PM_{2.5}$ in Europe, 2020

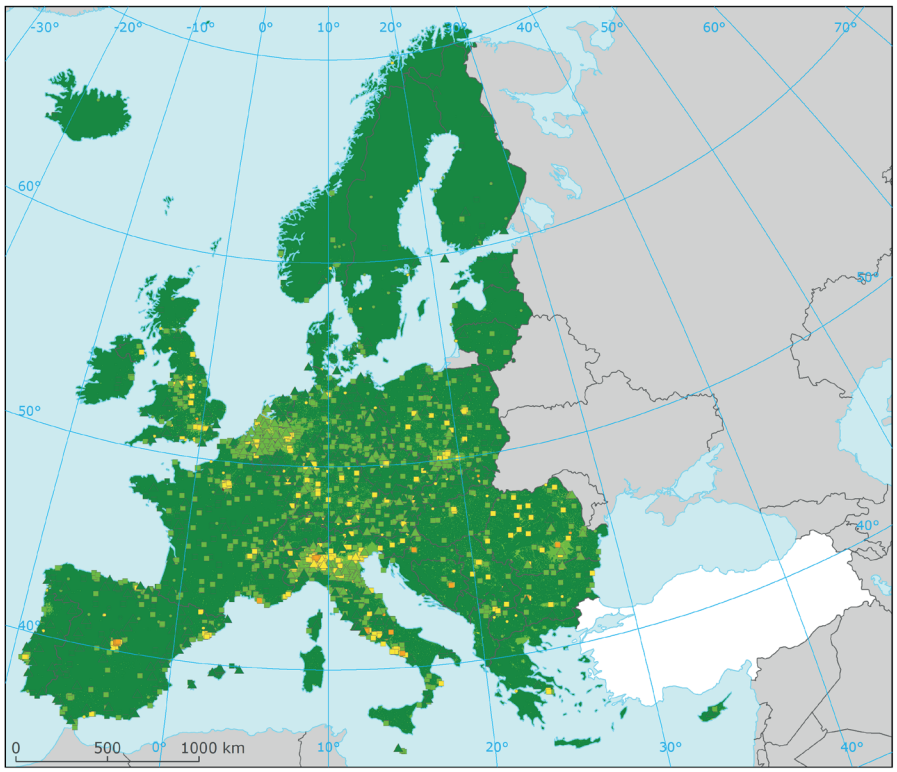


Benzo[*a*]pyrene Annual Average

Reference Year: 2020
Experimental Map
Combined Rural and Urban Map
Resolution: 1×1 km²

- ≤ 0.12 ng·m⁻³
- 0.12–0.4 ng·m⁻³
- 0.4–0.6 ng·m⁻³
- 0.6–1 ng·m⁻³
- 1–1.5 ng·m⁻³ (1 = Target Value)
- > 1.5 ng·m⁻³
- non EEA member or cooperating countries
- no available data
- △ rural background station
- □ urban/suburban background station

Fig. VIII.5 Field of annual average concentration of benzo[*a*]pyrene in Europe, 2020

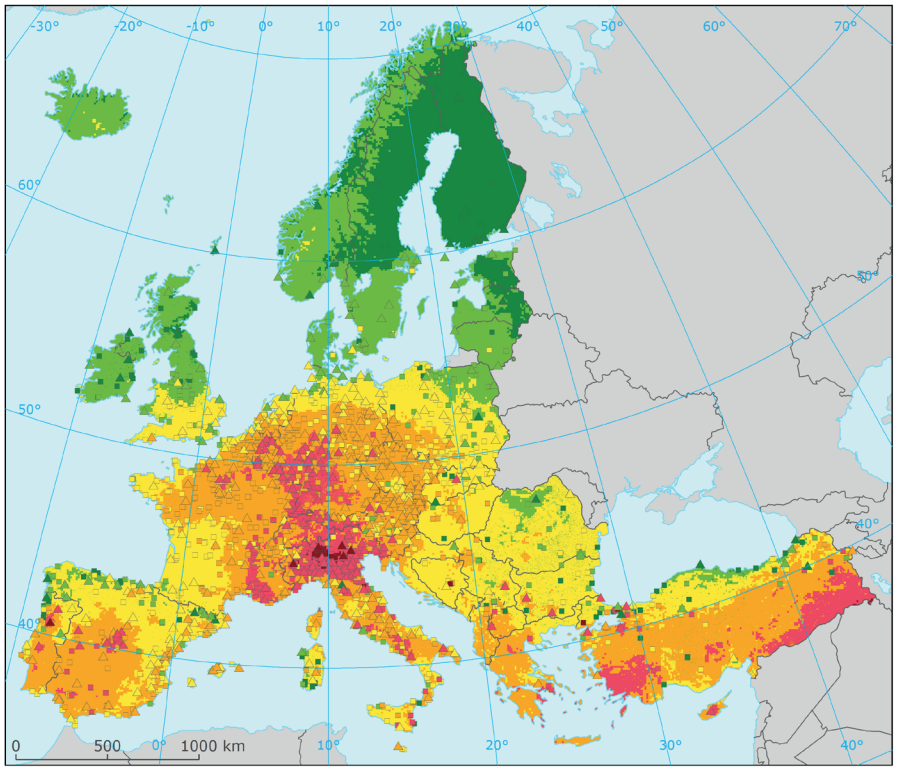


Nitrogen Dioxide (NO_2) Annual Average

Reference Year: 2021
Interim Map
Combined Rural and Urban Map
Resolution: 1×1 km²

- ≤ 10 µg·m⁻³
- 10–20 µg·m⁻³ (10 = WHO AQ Guideline 2021)
- 20–30 µg·m⁻³
- 30–40 µg·m⁻³
- 40–45 µg·m⁻³ (40 = Limit Value)
- > 45 µg·m⁻³
- non EEA member or cooperating countries
- no available data
- △ rural background station
- □ urban/suburban background station
- ○ urban/suburban traffic station

Fig. VIII.6 Field of annual average concentration of NO_2 in Europe, 2021, preliminary map



Ozone – 93.2 Percentile of Maximum Daily 8-hour Means

Reference Year: 2020
Combined Rural and Urban Background Map
Resolution: 1×1 km²

- ≤ 90 µg·m⁻³
- 90–100 µg·m⁻³
- 100–110 µg·m⁻³
- 110–120 µg·m⁻³
- 120–140 µg·m⁻³ (120 = Target Value)
- > 140 µg·m⁻³
- non EEA member or cooperating countries
- no available data
- △ rural background station
- □ urban/suburban background station

Fig. VIII.7 Field of 93.2 percentile of daily maximum 8-hour O_3 concentrations in Europe, 2020

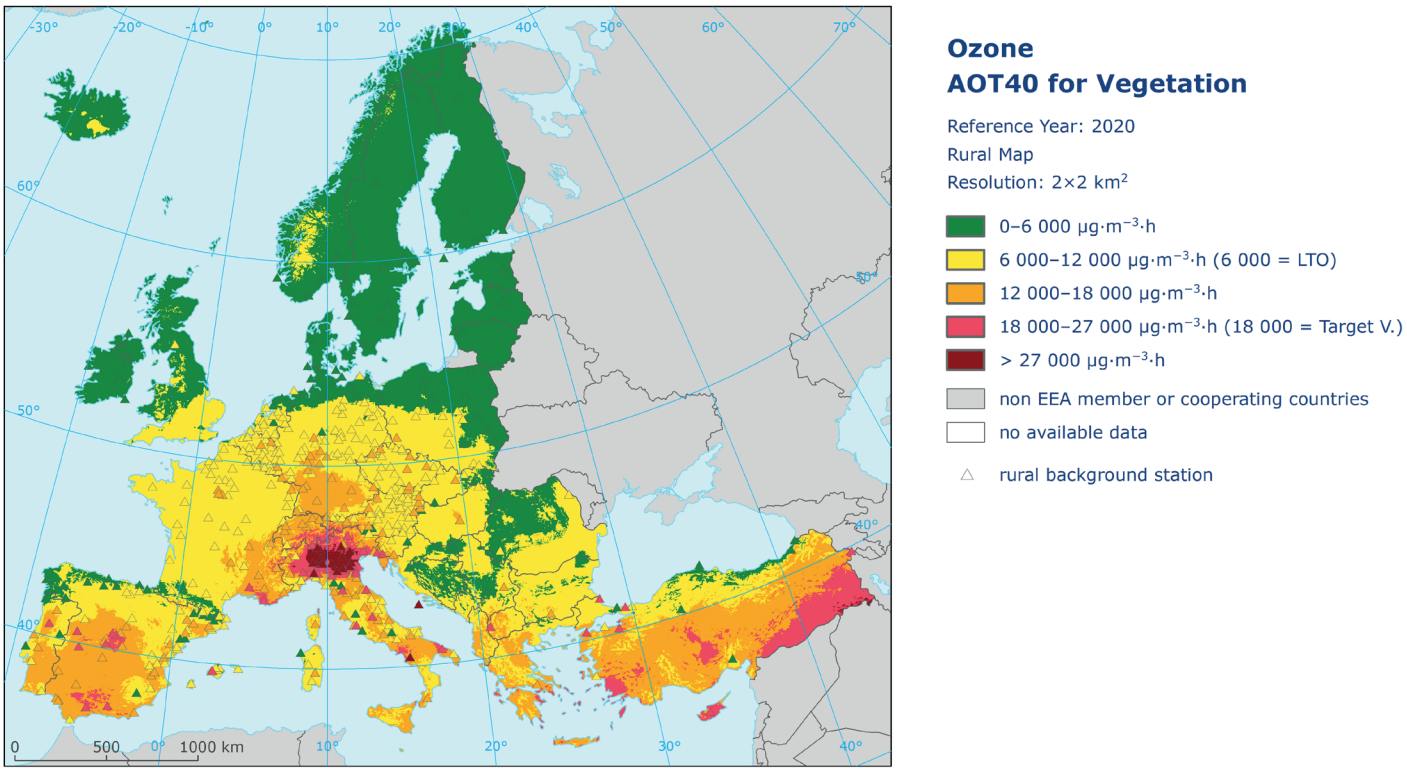


Fig. VIII.8 Field of AOT40 exposure index values for the protection of vegetation in Europe, 2020

Estimates of health impacts from the effects of polluted air indicate that in 2019, long-term exposure to fine $PM_{2.5}$ particulates in Europe contributed to approx. 373 thousand premature deaths, long-term exposure to high NO_2 concentrations to 48 thousand premature deaths, and short-term exposure to O_3 concentrations to approx. 19 thousand premature deaths (EEA 2021).

The inhabitants of Central and Eastern Europe, including the Balkan Peninsula, suffer from the greatest exposure to above-limit concentrations of suspended particulates and benzo[*a*]pyrene, while areas with the most widespread pollution also include the Po Valley in northern Italy (Fig. VIII.3, Fig. VIII.4, and Fig. VIII.5).

Limit NO_2 concentrations are exceeded particularly in areas affected by transportation (Fig. VIII.6). The occurrence of above-limit concentrations can also be anticipated in countries where these pollutants are monitored only at a limited number of sites or are not monitored at all, or this data is not provided to the EEA.

Primary pollutants coming from local and regional emission sources are also accompanied by air pollution from secondary aerosols (Chap. IV.1.3, Chap. IV.9.2) and O_3. In relation to the mechanisms of ozone formation (Chap. IV.4.3), O_3 concentrations increase from low values in northern Europe to the highest values especially in countries around the Mediterranean Sea (Fig. VIII.7, Fig. VIII.8).

Air quality of the Czech Republic in the European context

Pollution levels in various parts of the CR differ substantially. On the one hand, there are areas with very low pollution levels, in which the air quality is similar to that in the clean continuously populated regions of Europe and the pollutant concentrations are well below the air quality limit levels. The data from the Czech EMEP background stations are comparable with concentrations measured at similarly located Central European stations. On the other hand, the O/K/F-M agglomeration, together with adjacent areas in the Republic of Poland, is among the most highly polluted regions of Europe in the long run, both from the standpoint of the extent and the level of concentrations. Transmission of pollutants across the border between the CR and neighbouring countries is the most intense in the Silesia area (for more details see Chap. V.3 and Blažek et al. 2013). Obviously, polluted air flows across the state borders in other areas, but the mutual transboundary effect is much lower and quantification or even estimates of probable impacts are mostly not available. In addition to the Silesia area, the proportion of various sources to air pollution levels have only been described in detail in the Czech-Slovak boundary area of the Moravian-Silesia and Žilina regions (VŠB-TU Ostrava 2014).

Regarding the level of average concentrations per capita, the CR is among above-average polluted countries in terms of suspended particulate matter $PM_{2.5}$ and benzo[*a*]pyrene, among average to above-average polluted countries in terms of PM_{10} and O_3, and among average to below-average polluted countries in terms of NO_2 (ETC/HE 2022, EEA 2021).