
Czech
Hydrometeorological
Institute

# Improving air quality in the times of climate change: The Czech Republic experience

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# Outlines

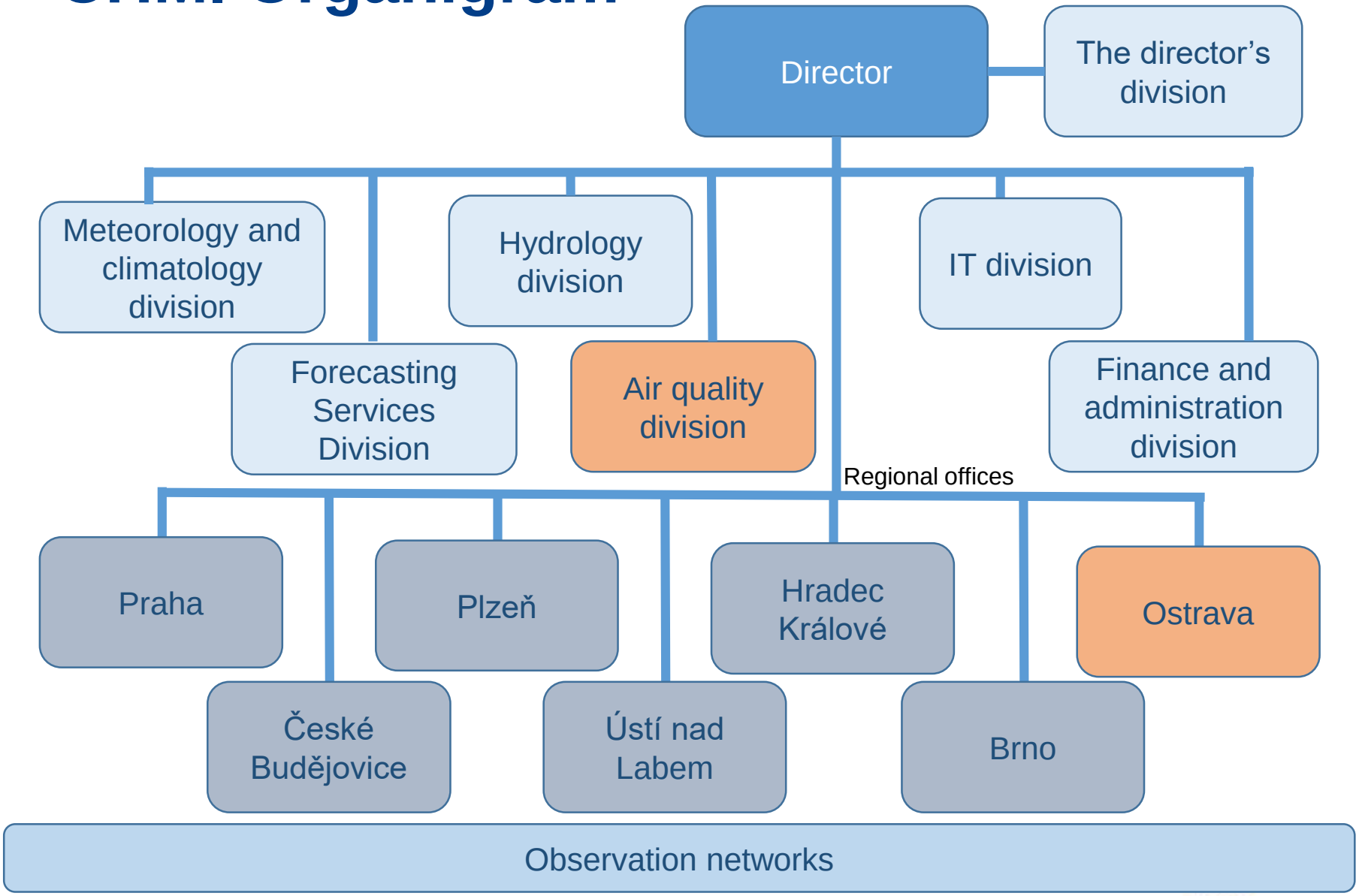
- CHMI's role in air quality monitoring and management in the Czech Republic
- Impact of climate change on air quality in the European Region
- How the Czech Republic monitors and manages air quality
- Government and science co-operate and open data
- Open data on air quality: Tools and best practices
- Opportunities for Central Asia

# CHMI's role in air quality monitoring and management in the Czech Republic



Czech Hydrometeorological Institute

# CHMI Organigram



# Czech Hydrometeorological Institute

**CHMI, authorized by the Ministry of the Environment** of the Czech Republic, ensures ambient air quality monitoring and assessment in the territory of the whole Czech Republic

**Air Quality Division** of the CHMI is entrusted by the Ministry of the Environment to collect, process and archive ambient air quality data

Data is collected, processed and archived in the **Air Quality Information System** (AQIS) database:

- is continuously developed and operated using current information technologies as an integrated system for countrywide comprehensive assessments of the state and development of air pollution
- air quality data, data on emissions and sources of air pollution and atmospheric deposition, National Inventory System for Greenhouse Gases
- also includes information from the border areas of Germany, Poland, Austria, and Slovakia, which is obtained through reciprocal data exchange

# Ambient Air Quality – Historical View

The modern-day Czech Republic, one of the two succession countries of the former Czechoslovakia post 1993, is a country with an infamous environmental pollution history, including heavy ambient air pollution with serious impacts in the past

Major reasons: emissions from  burning poor-quality lignite of local provenience with high sulphur content used for both coal-powered thermal power plants and local, domestic heating systems

Impacts both on human health and environment, including the decline of spruce forests

Prunéřov coal power plant in the 1980s

# Moravia-Silesia (Ostrava) Region

The third most populous in the CR, the second largest in terms of population density after Prague

The population is still exposed to the highest levels of air pollution in the CR

- high concentration of industrial production,
- the high density of built–up areas with local solid–fuel
- heating, and the dense transport infrastructure on both sides of

the Czech–Polish border

Spoil landfill Ema, Ostrava1962

Source: https://www.irozhlas.cz/ostrava/zpravy/hornicky-serial-rozhovor-s-profesorem-k-vyznamu-hald.A161007_2277808_ostrava-zpravy_woj

Coke plant in Ostrava, 2021

Ostrava city from the Ema spoil landfill, 2021

# Legislation and conventions for air protection

United Nations Framework Convention on Climate Change

**Convention on Long-range Transboundary Transmission of Pollutants**

Vienna Convention

Stockholm Convention

Montreal COnvention

Air Quality Standards Regulations 1001 (UK)

Kyoto Protocol

**WHO Global Guidelines for Air Quality**

Clean Air Act (United States)

Minamata Convention

**Directive 2008/50/EC**

Palestinian outdoor air standards

Act No. 201/2012 Coll. - Air Protection Act

Paris Convention

National Ambient Air Standards (Nepal)

Meaning of colours: **overarching conventions, principles and guidelines their contents** are implemented by national laws, standards and regulations (only examples of existing laws are given)International protocols and constitutionsmluvy: protection of the ozone layer , greenhouse gases, persistent organic pollutants, mercury

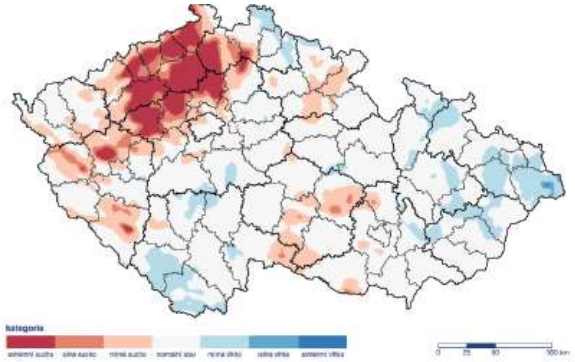
# Impact of climate change on air quality in the European Region

# Increased frequency and intensity of heatwaves
# Increased emissions from transportation

- Higher temperatures lead to increased ground-level ozone (O3) , which negatively affects human health and ecosystems
- Higher temperatures may result in increased fuel consumption, leading to more emissions from transportation, including NOx and VOCs, which promote ozone formation

# Prolonged drought periods
# Increase in wildfires

- Drought contributes to higher concentrations of particulate matter (PM10 and PM2.5) in the air due to reduced humidity and increased dustiness in the environment
- Fires release large amounts of fine particulate matter, carbon monoxide (CO), and other toxic substances into the air, significantly worsening air quality both near the fires and over longer distances



Obr. 1 Stav sucha v ČR dle API30, 24. 7. 2022

# Changes in atmospheric circulation
# Changes in precipitation patterns

- Changes in air flow patterns can cause pollutants to remain in the atmosphere over certain areas for longer periods, worsening air quality
- Irregular and intense rainfall can bring more runoff and chemicals into the atmosphere, while longer dry periods lead to increased dustiness

# How the Czech Republic monitors and manages air quality

# CHMI – Air Quality Division

Air pollutants concentrations measured at monitoring stations form the basis for air quality assessments

- The backbone network of monitoring stations is the **National Air Quality Monitoring Network** (NAQMN) operated by the CHMI, is supplemented by monitoring stations of other co-operating organizations, and these measurements are also used in air quality assessments
- The NAQMN includes both **automated** and **manual air pollution stations**, from which the samples are analysed in CHMI laboratories
- In 2021, measured data from a total of **198 locations** were supplied to the AQIS database

In addition to air pollutants for which a **limit value is set** ($SO_2$, $NO_2$, CO, benzene, $PM_{10}$, $PM_{2.5}$, benzo[*a*]pyrene, Pb, As, Cd, Ni, $O_3$, $NO_X$), many other substances that are important for environmental protection are also measured within the NAQMN (some ions, elemental and organic carbon, a group of aromatic hydrocarbons, volatile organic compounds, persistent organic compounds, etc.)

# Goal Setting

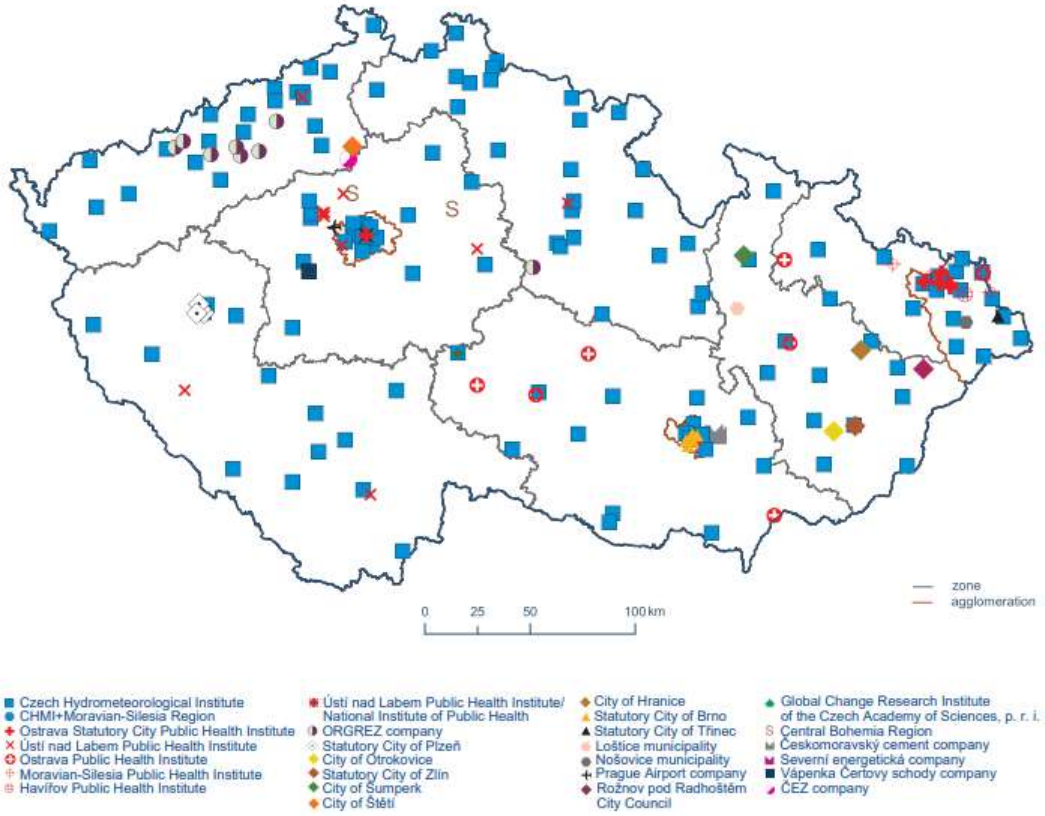
Define the information about air pollution you want to gather and the purpose of your monitoring network

- The national legislation on air quality evaluation in the Czech Republic is based on the European legislation. The basic legislative norm in the CR is Act No. 201/2012 Coll., the "Air Protection Act", defining among others, the zones and agglomerations for which ambientair quality is being evaluated
- Limit values (LV) have been set for pollutants, which are monitored and assessed in relation to their proven harmful effects on human health and ecosystems

# Station networks of ambient air quality monitoring in the Czech Republic, 2021

In 2021, **198 air quality monitoring stations** were in operation in the CR, of which **135 were in the NAQMN** ***(blue colour)***

85 are automated in the AIM network and 50 stations with manual operation with sample evaluation in the laboratories




https://www.chmi.cz/files/portal/docs/uoco/isko/grafroc/21groc/gr21en/21_01_uvod_EN_v2.pdf

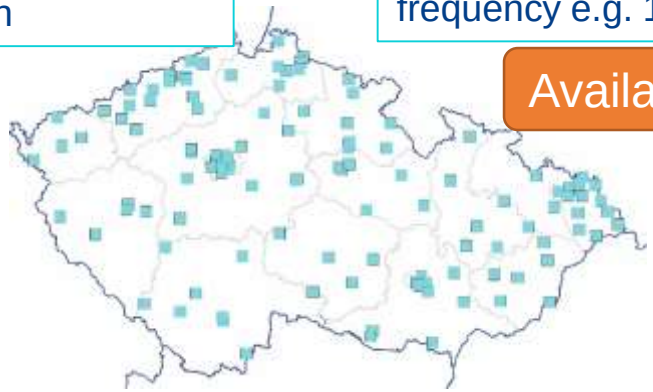
# Acquiring input data - basic measurements

Network of automatic immission monitoring (AIM) stations - 103 stations
Mobile vans
Facilities:
Automatic analyzers - hourly resolution

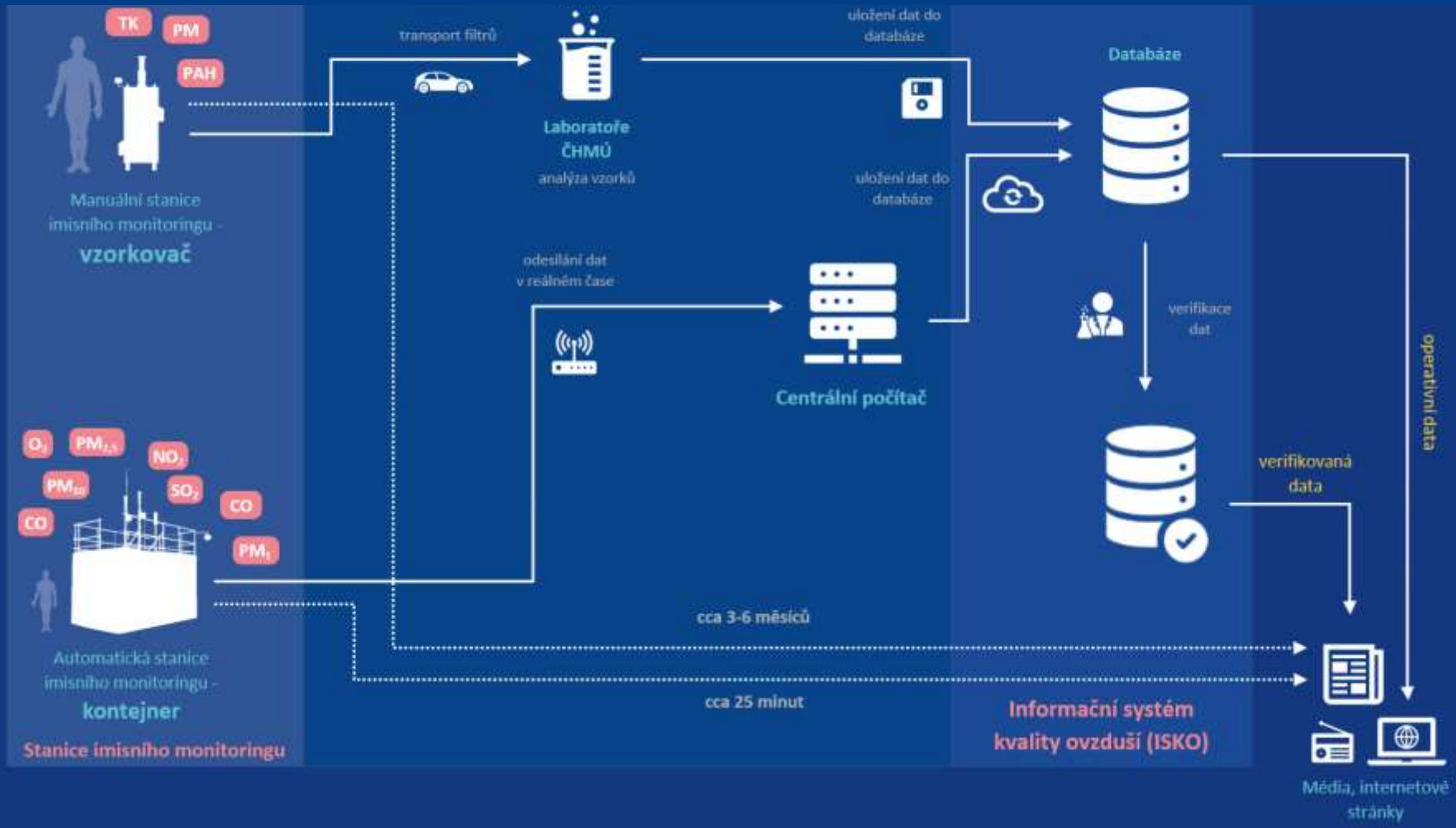
Available online

Network of manual immission monitoring stations - 33 stations
Facilities:
Samplers with different sampling frequency e.g. 1 day, 7 days

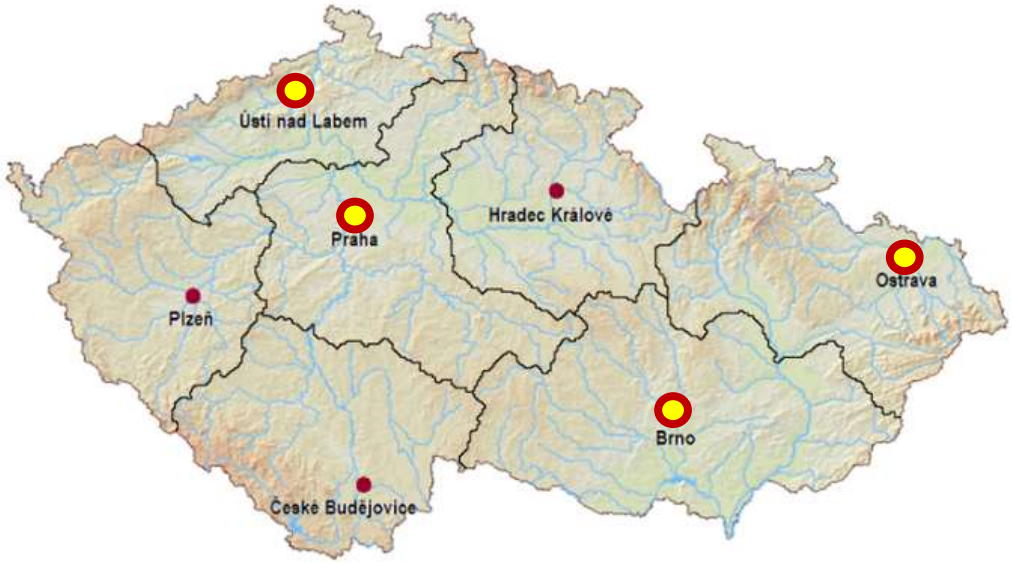
Available retrospectively

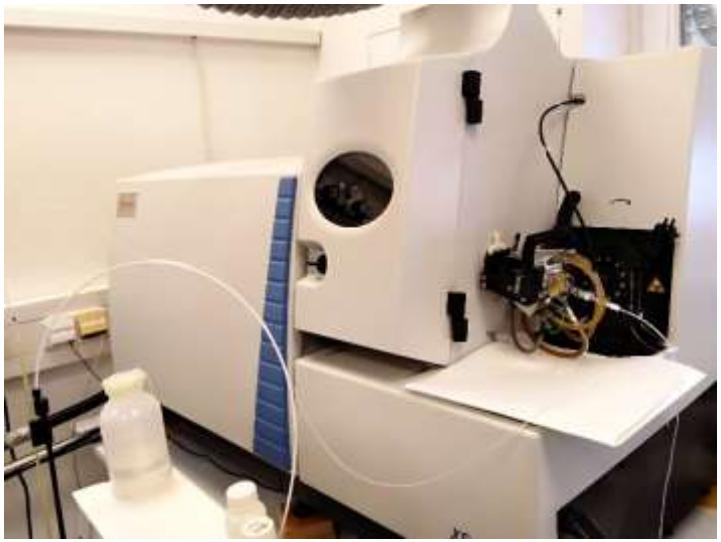


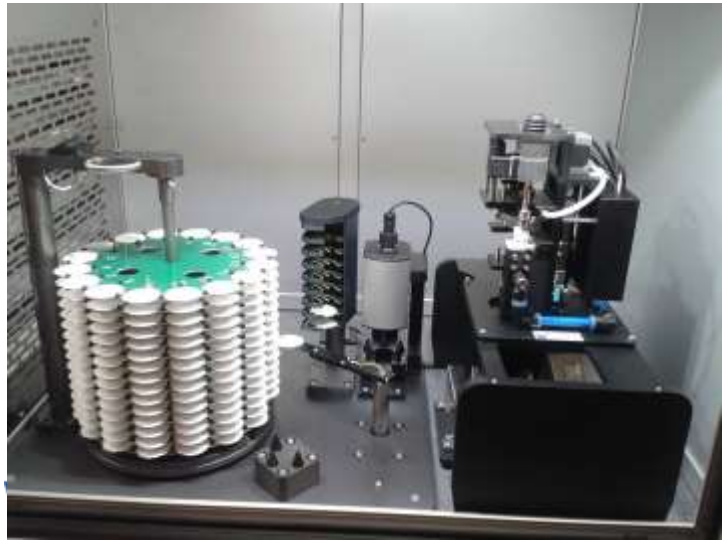
# Air Quality Monitoring Scheme



# CHMI laboratories





# Distant measurements

Limiting the influence of surface turbulence, study of long-range transport of pollution, vertical gradient of chemical and meteorological parameters

- mast measurements (e.g. light absorption on atmospheric aerosols - aethalometer, light scattering coefficient of atmospheric aerosols - nephelometer)
- lidar (laser mapping of pollutant concentrations in the atmosphere)
- sodar (assessment of the thermodynamic structure of the lower atmosphere using sound wave scattering by atmospheric turbulence); ceilometer
- monitoring from space, satellite data

# Data storage and control

Multi-step data checking

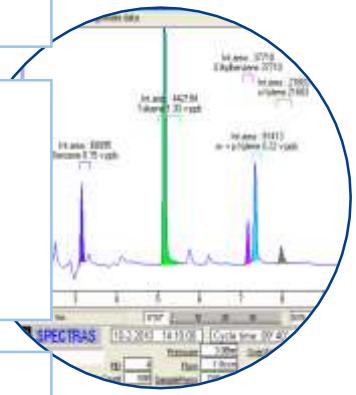
Air quality information system

every work day

Technical validation of measured values

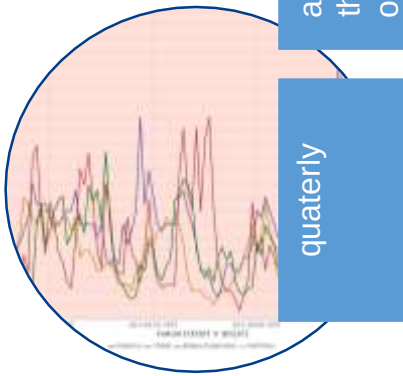
at the end of the following of the month

Verification of the data by the responsible employee and sending it to the database



quaterly

Final data verification by the database administrator

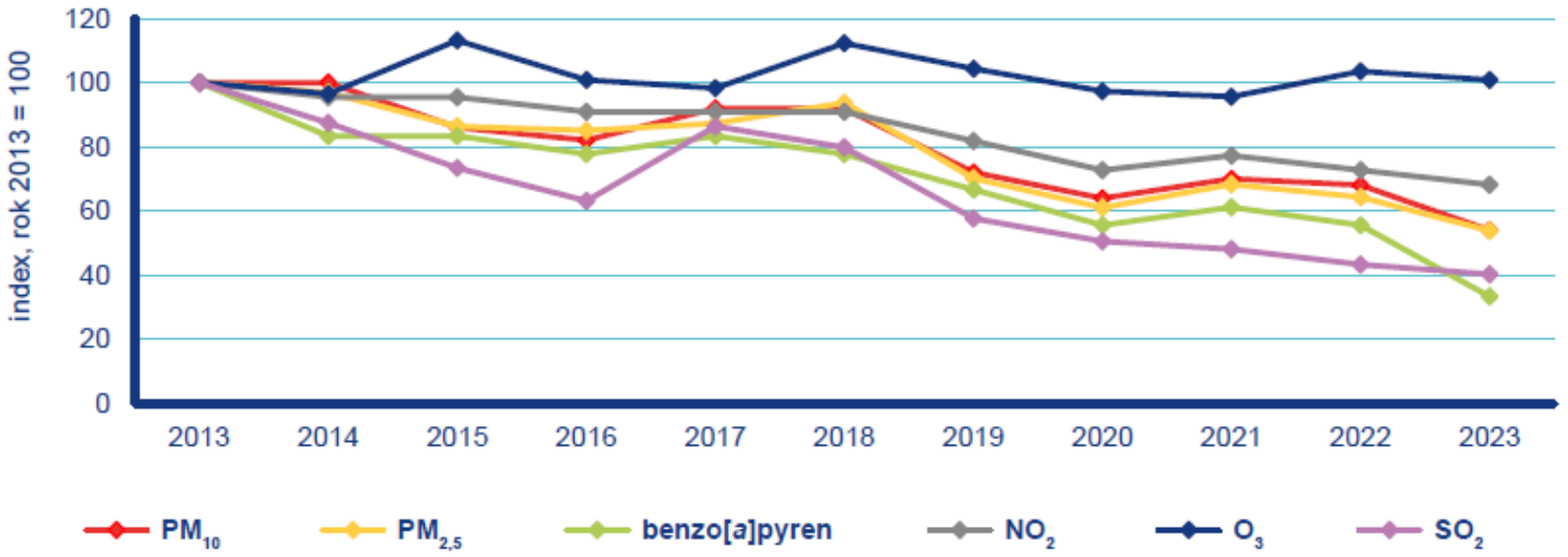


Data storage and aggregation

Calculations of special characteristics e.g. AOT40*, LDSA**, number of exceedances of the 8-hour limit***

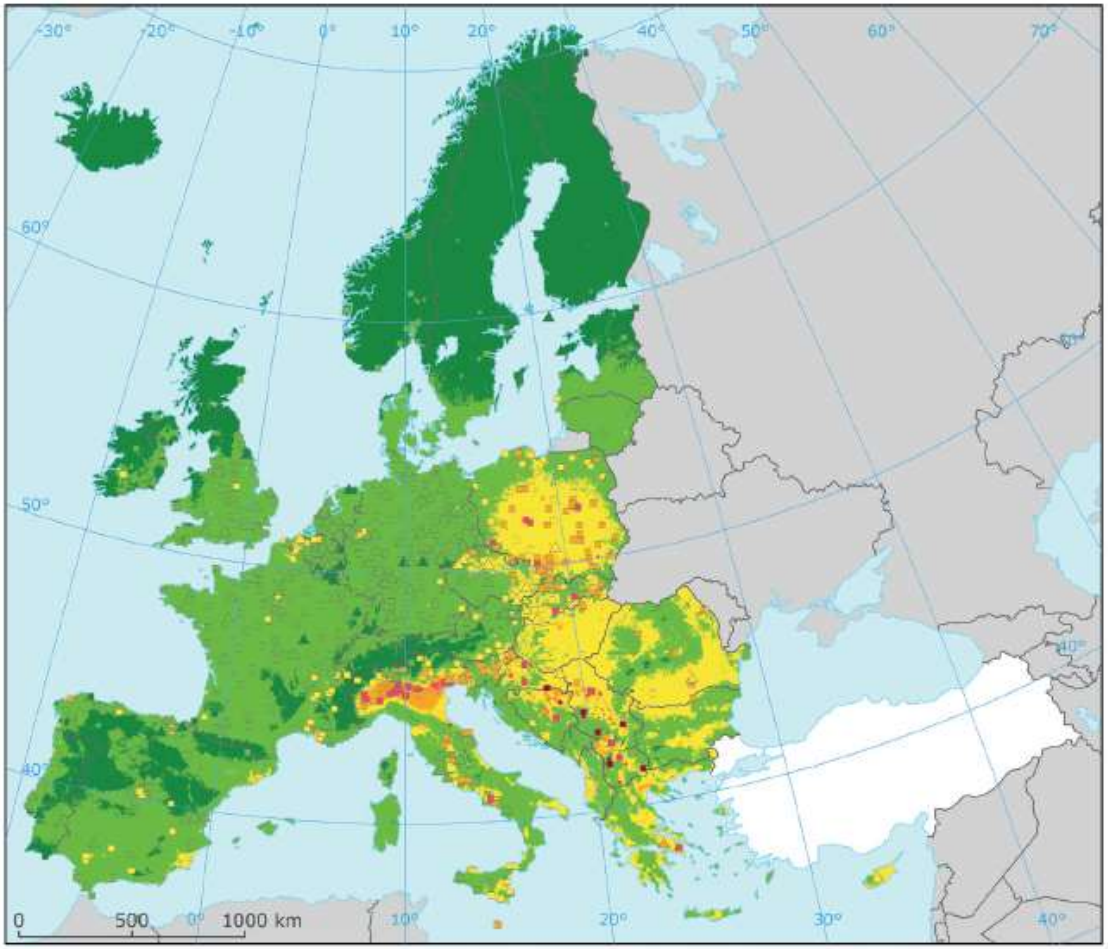
* Sum of differences between concentrations greater than 80 $\mu g \cdot m^{-3}$ (= 40 ppb) and value 80 $\mu g \cdot m^{-3}$ calculated from 1h values in the period May - July between 8:00 a 20:00 SEČ, ** Surface concentration of particles deposited in the alveolar region of the human lung *** Calculation 1. 8-hour moving average 2. maximum moving average for each day in a calendar year 3. number of times the limit is exceeded for $O_3$ and CO.

# Changes in the AQ characteristics of selected pollutants in the CR, 2013–2023




Note: The graphs show the course of the following pollution characteristics:
annual average concentration for PM2.5, NO2, benzo[a]pyrene, 36th highest 24-hour average concentration for PM10; 26th highest maximum daily 8-hour concentration for O3; 4th highest 24-hour average concentration for SO2

# PM2.5, Europe 2023 (preliminery map)




**Suspendované částice $PM_{2,5}$**
**Roční průměr**

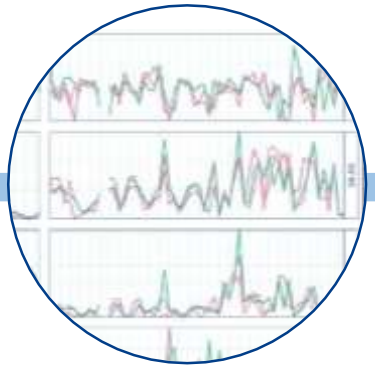
Rok: 2023
Předběžná mapa
Kombinovaná venkovská a městská mapa
Rozlišení: 1 km

- ≤ 5 µg·m$^{-3}$
- 5–10 µg·m$^{-3}$ (5 = doporučená hodnota WHO)
- 10–15 µg·m$^{-3}$
- 15–20 µg·m$^{-3}$
- 20–25 µg·m$^{-3}$ (20 = orientační limit)
- > 25 µg·m$^{-3}$ (25 = imisní limit)
- území mimo mapovanou oblast
- nejsou dostupná data

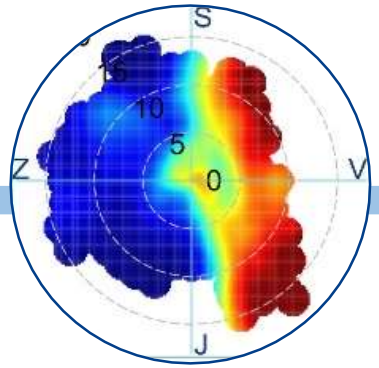
- △ venkovská pozaďová stanice
- □ městská či předměstská pozaďová stanice
- ○ městská či předměstská dopravní stanice

# Data analysis - pollution sources

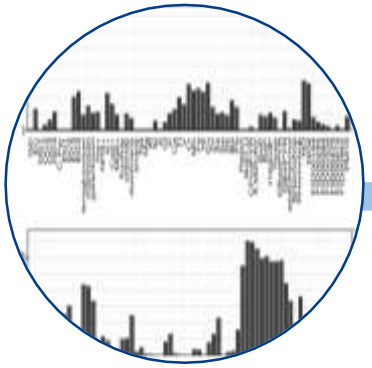
What pollution sources affect the resulting air quality in a given location?

Evolution of pollutant concentrations over time

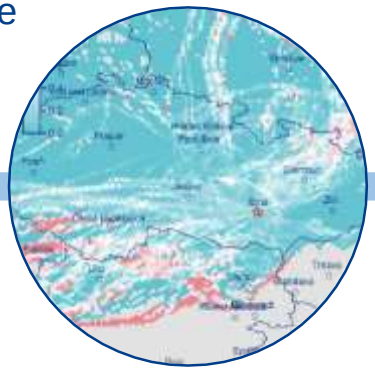



Combination of wind direction and wind speed pollution data over time - concentration roses



"Chemical footprint" of sources - local heating, transport, industry...

Proportions of individual sources of pollution



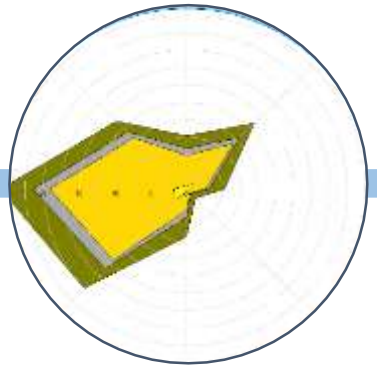
Contribution to pollution by long-haul transport

It affects the target (receptor) site:

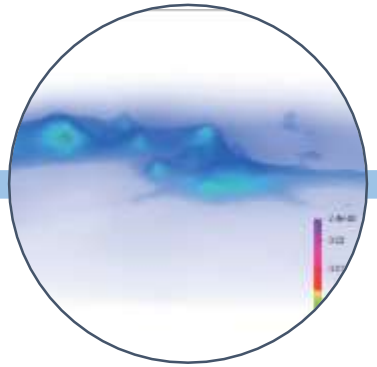
- 60 % domestic heating
- 20 % transport
- 17 % resuspension
- 7 % industry

# Data analysis - dispersion studies

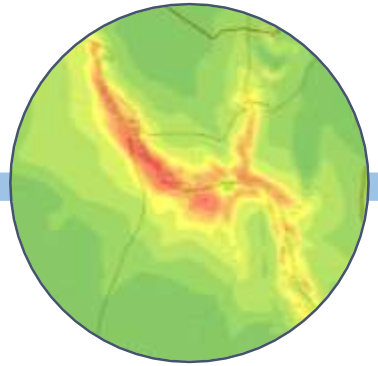
How will pollution from the new source spread in the area?



Data on pollutant concentrations and meteorological parameters



Advanced mathematical models



Targeted pollution analysis on an hourly time interval

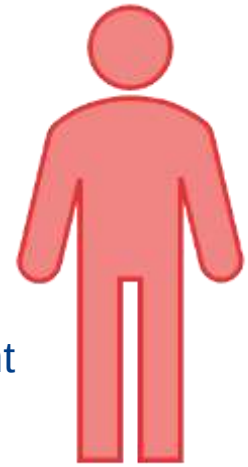
In the case of building new sources (factory, apartment building, incinerator, parking lot), dispersion studies are prepared on order, on the basis of which the construction is permitted or certain parameters of the construction are modified

# Government and science co-operate and open data

# Why is air quality so important ?

**1,5 l**

Daily water requirement in the form of fluids



**2,2 kg**

Average daily food consumption per person[1]


Average amount of air inhaled per day*

**16 inhales per minute, 1 inhale = 500 ml, 1 l air (20°C, 500 m n.m., 60 % RH) = 1.1 g*
*=16×0.5×60×24=11 520 l per day = 11520*1.1/1000 = 12.6 kg*

**The purpose of measurement is not the collection of data per se, but the provision of data as a basis for environmental management decisions**

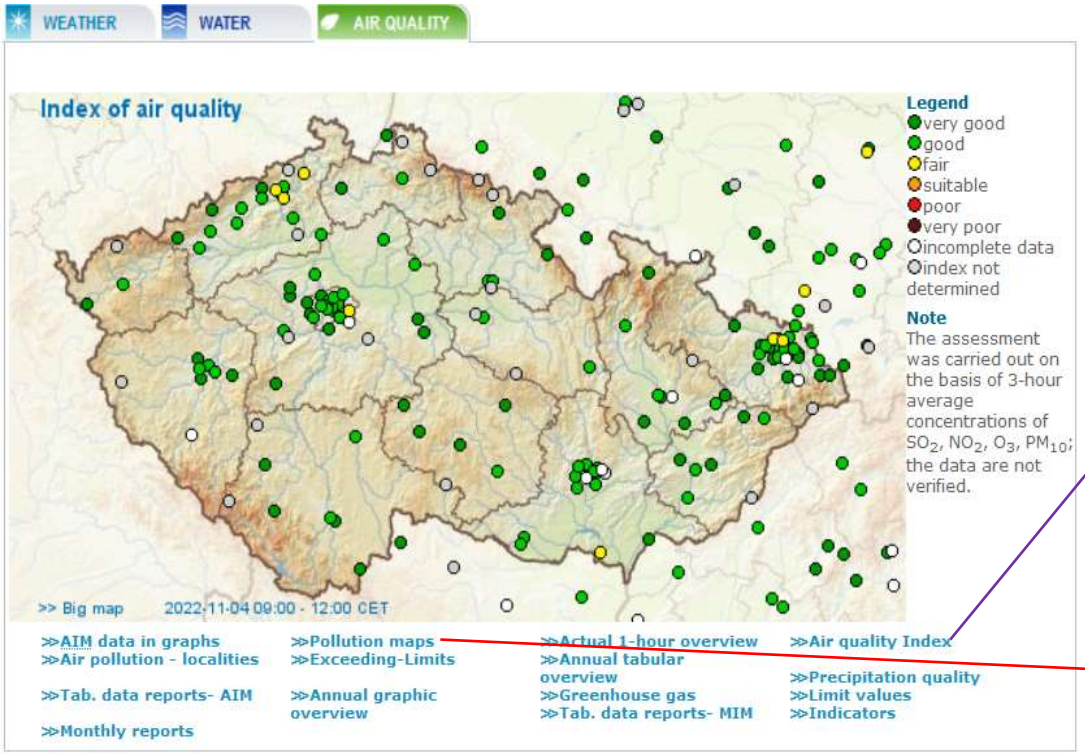
# Data Dissemination, Collaboration and Communication

- Sharing data with target audience efficiently. Making data accessible and available to those who need it in a timely and efficient manner.
- Working together towards a common goal - explain to staff the purpose and meaning of monitoring. Collaboration of multiple stakeholders or team members actively participating, information sharing, and working collectively to analyze and interpret data, develop insights, and make informed decisions.
- Communication plays a crucial role in sharing findings, insights, and recommendations derived from data analysis. Conveying information clearly, accurately, and in a way that is understandable to the intended audience.

# Current state of the air in the CR

https://www.chmi.cz/?l=en#!

mobile app






www.facebook.com/chmi.cz

The current state of the air is presented on the CHMI website via the air quality index at the stations. Other accompanying data are e.g. measured concentrations of pollutants on the basis of which current pollution maps are produced. The public is also informed about the current air quality situation via the CHMI mobile app.

# Smog warning and regulation system

According to the Czech Act No. 201/2012 Coll., on Air Protection, a **smog situation** is a state of **extremely polluted air** when the level of pollution by sulphur dioxide, nitrogen dioxide, $PM_{10}$ or tropospheric ozone exceeds one of the threshold values. The CHMI operates the system on the basis of a mandate from the Ministry of the Environment.

Information is used to:

- informing about the occurrence of a situation with elevated concentrations of air pollutants,
- to regulate (reduce) the release of pollutants from sources that significantly affect the air quality of a given area

*The measures taken practically concern only smog situations and regulations due to high concentrations of $PM_{10}$. The declaration of a smog situation, let alone regulation due to high concentrations of $NO_2$ and $SO_2$, is extremely unlikely. Ground-level ozone, as a secondary pollutant produced by chemical reactions in the air, cannot simply be regulated in the short term.*

# Air Quality Index

Different indices in regions, countries:

- different assessments of the same air quality
- but adapted to the local context


# Communication to the public

We issue regular Air Quality Assessments

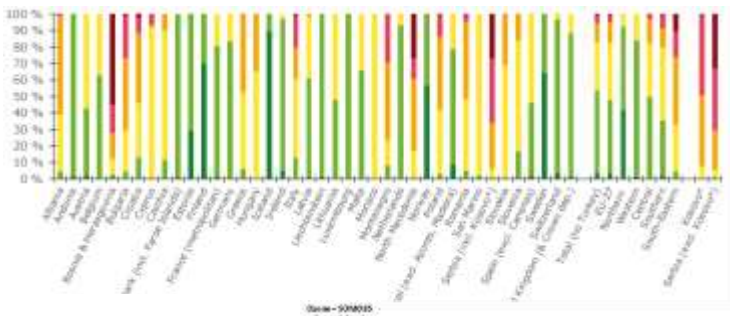


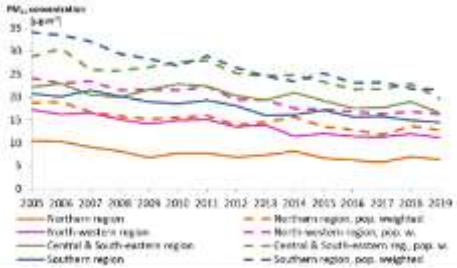

Czech Hydrometeorological Institute

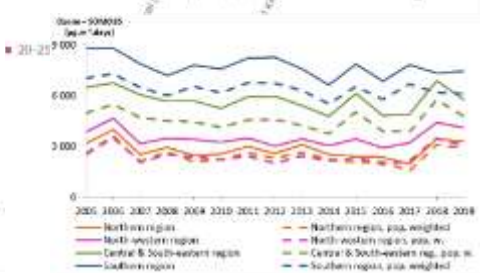
# European-wide annual air quality assessment

Within the consortium European Topic Centre Human Health and Environment (ETC HE), CHMI provides a support to the European Environmental Agency (EEA) in terms of annual air quality mapping and exposure assessment. Annual reports European air quality maps are prepared within ETC HE, which provides background materials for the EEA´s Air Quality in Europe online reports.









Based on the maps, long-term evolution and trends are also analysed. Within ETC HE, development on the air quality mapping and assessment (including Phytotoxic Ozone Doze and BaP mapping, Air Quality Index) is performed, together with the European partners.

# Communication to the public

We organize excursions to workplaces, open days, expert lectures

# Research activities

We participate in scientific conferences and publish scientific articles

# Open data on air quality: Tools and best practices

# Cooperation between the public and NGO sectors

- policy development
- public education
- air quality monitoring

Tools such as Czech Integrated Pollution Register, CHMI open data, smog warning systems and map visualizations provide widely accessible real-time data on air quality

NGOs also provide:

- Expert analyses and often initiate legislative changes, while the government provides technological and data support
- Expert opinions, comments
- Citizen participation in monitoring and inform the public through media
- Information campaigns, public debates, and educational programs on air quality and its health impacts

# Pollutant Release and Transfer Registers (PRTRs)

**Importance of civil society role in using PRTR data to advocate and raise awareness of environmental health**

**Air leaks** are one of the most common and most frequently searched for and reported leaks

A relatively wide range of substances is covered - e.g. greenhouse gases or heavy metals

In total, 60 substances or groups of substances are monitored under the E-PRTR

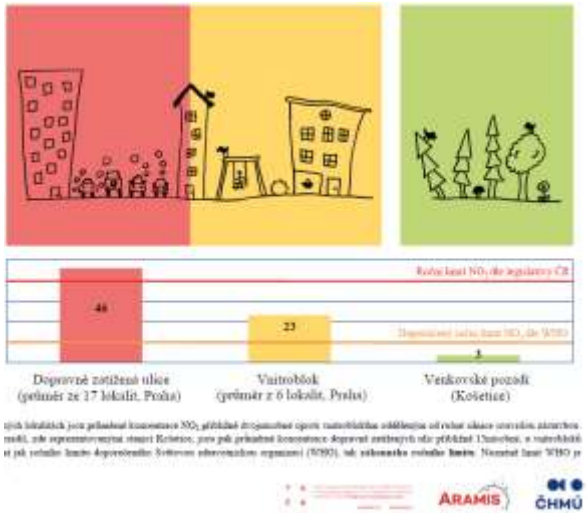
- Czech Integrated Pollution Register is managed by the Ministry of the Environment, providing **publicly accessible data on emissions**
- NGOs actively use this data for watchdog activities and **informing the public** about the biggest polluters in various regions

# Best practices

- transparent access to data

- educational campaigns

- public engagement through air quality monitoring - citizen science




- CHMI is the main national provider of air quality data and a key partner in addressing air pollution issues
- Awareness campaigns and monitoring the fulfillment of Czech climate commitments, visualizations to communicate air quality issues, especially in high-pollution areas, inform the public about the health impacts of smog and encourage activities to mitigate its effects
- Many citizen initiatives deploy their own air quality sensors and actively monitor pollution; data is often published on community platforms or social media

# Opportunities for Central Asia

# Thank you for your attention

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