
Czech
Hydrometeorological
Institute

Air Quality Management System of the Czech Republic: Monitoring, Assessment and Data Transparency

Blanka Krejčí & CHMI colleagues

Czech hydrometeorological institute, Ostrava branch
K Myslivně 3/2182, 708 00 Ostrava – Poruba, Czech Republic
Tel.: +420 596 900 218, +420 603 511 908
blanka.krejci@chmi.cz

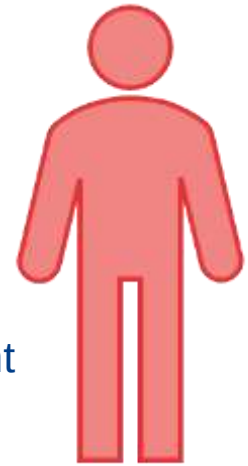
Outlines

- The role of the Czech Hydrometeorological Institute (CHMI) in the air quality monitoring in the Czech Republic
- Development of air quality
- Measured pollutants, stations and instrumentation
- Data quality assurance - key steps for a sustainable system
- Legislative limit values and thresholds for smog situations
- Using air pollution data for better decision-making in air quality management, transparent access to data, future challenges

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]

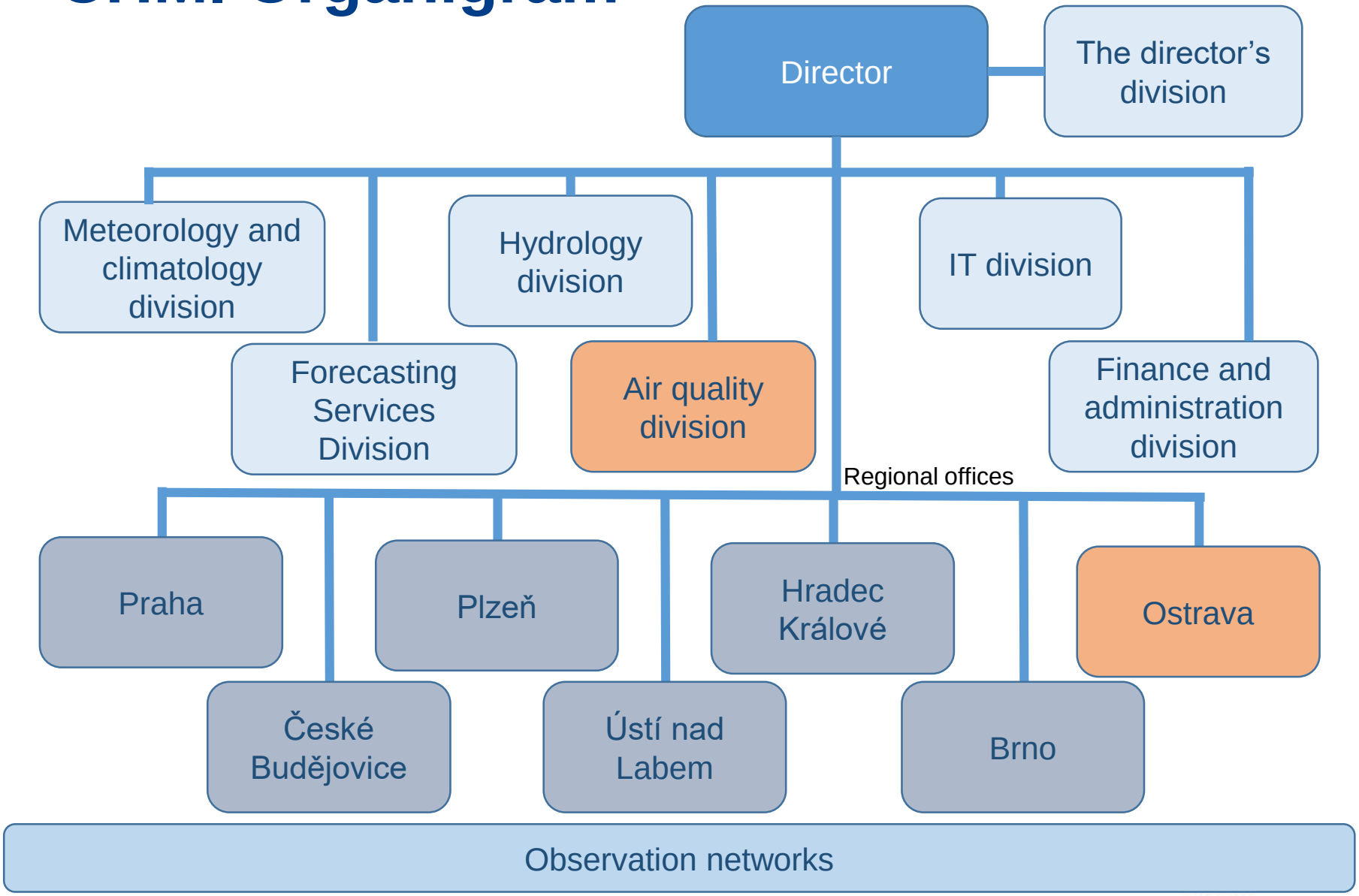
Average amount of air inhaled per day*

**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*

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

National Reference Laboratory

CHMI - a state-funded organization established by the Ministry of the Environment, among others, for the purpose of operating the National Reference Laboratory for Ambient Air Quality (NRL)

Responsibilities:

- coordinating measurement quality assurance programs organized by the Joint Research Center of the European Commission (JRC),
- coordinating the appropriate use of reference methods,
- demonstrating the equivalence of non-reference methods (using equivalence tests performed according to a special regulation),
- actively participates in measurement quality assurance programs at the EU level

Assessment and Monitoring –

Development of air quality

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

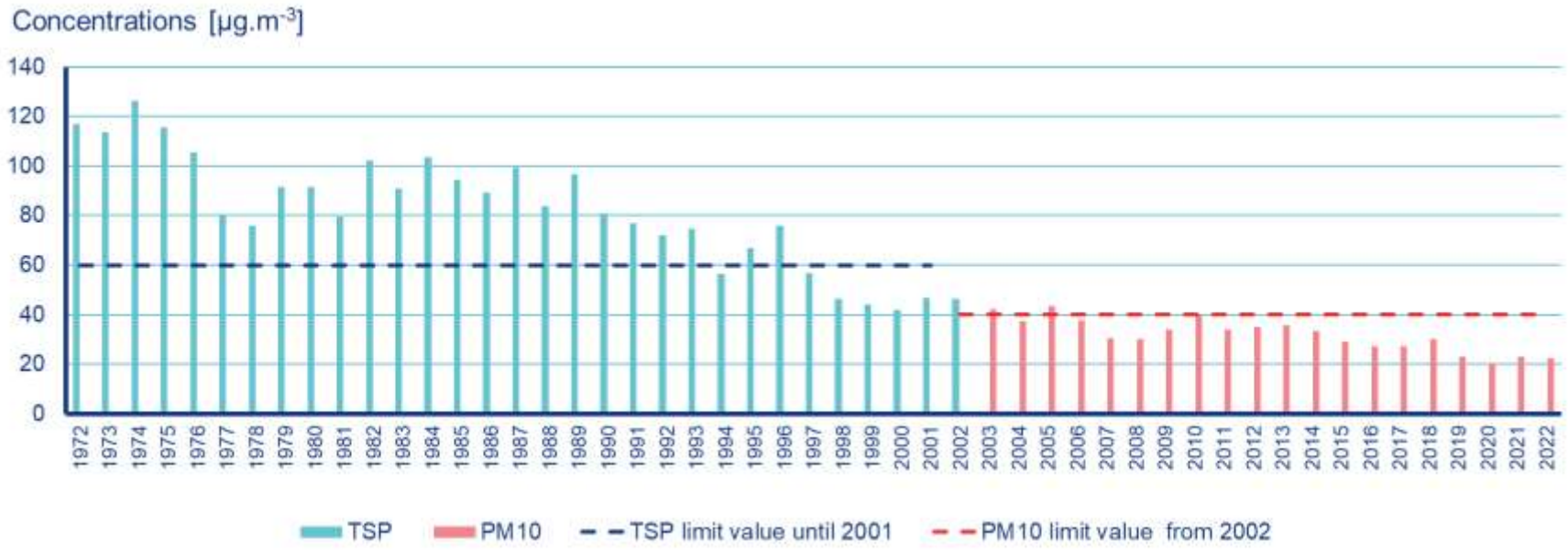
Coke plant in Ostrava, 2021

Ostrava city from the Ema spoil landfill, 2021

Ambient Air Quality Monitoring – Historical View

- The first measurements of ambient air pollution addressed sulphur dioxide (SO_2), total suspended particles (TSP) – the then measured total sample of aerosol without particle fraction distinction, and nitrogen oxides (NO_x)
- Regular ambient air quality monitoring has been in operation since the 1960s, individual networks were aimed at the most polluted areas (the **Podkrušnohoří region** in 1968, **Ostrava region** in1969, **Brno region** 1970)
- The **CHMI responsible for nationwide ambient air quality monitoring since 1964**
- Gradually, a fairly dense network has been set up for monitoring SO_2 in particular, **smog and warning systems** were built – the first in North Bohemia in 1973

Air pollution long term trend of solid particles in the Ostrava region



Annual average suspended particulate matter concentrations, Ostrava-Poruba CHMI station

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 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

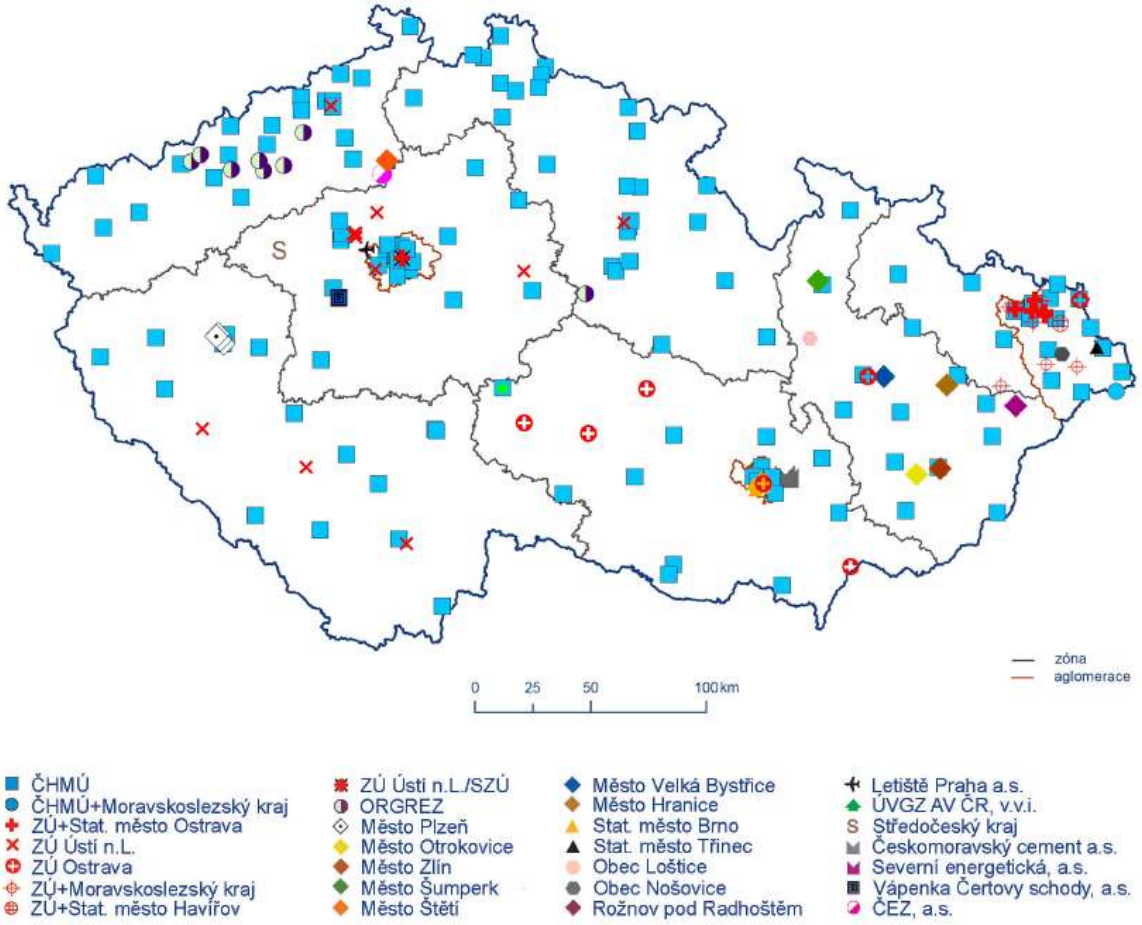
Define the information about air pollution you want to gather and the purpose of your monitoring network

- 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, 2023

About **200 air quality monitoring stations** were in operation in the CR

(NAQMN - blue colour)



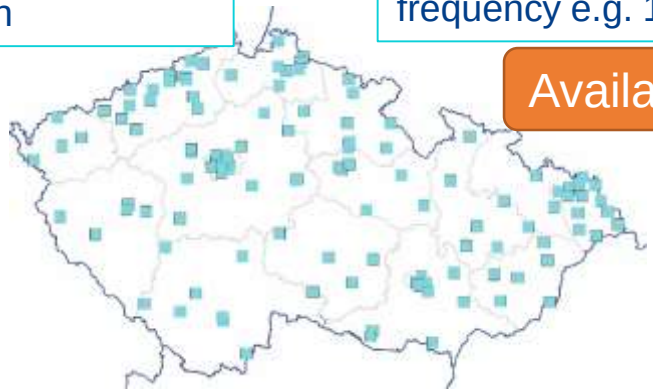
Acquiring input data - basic measurements

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

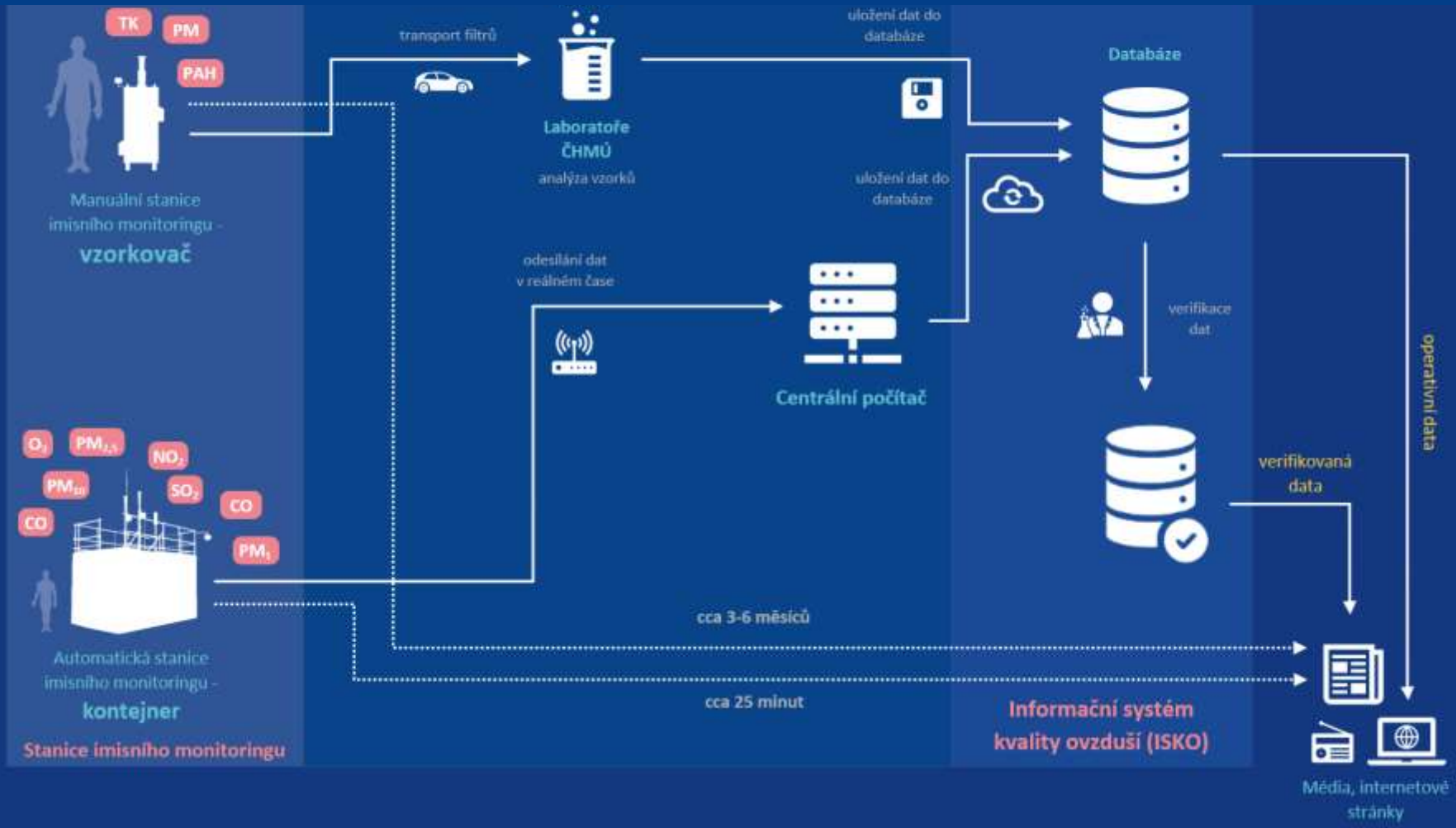
Available online

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

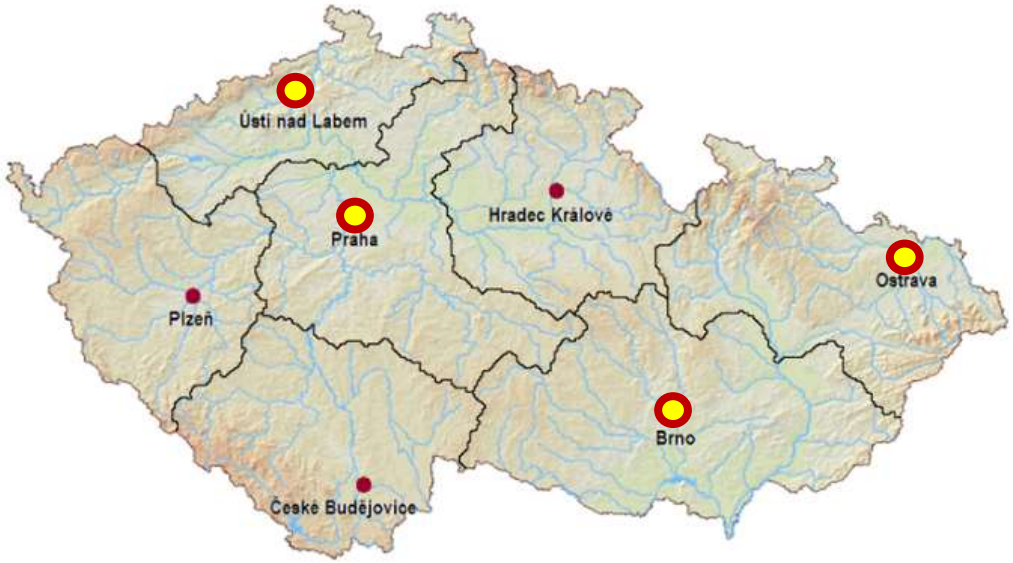
Available retrospectively

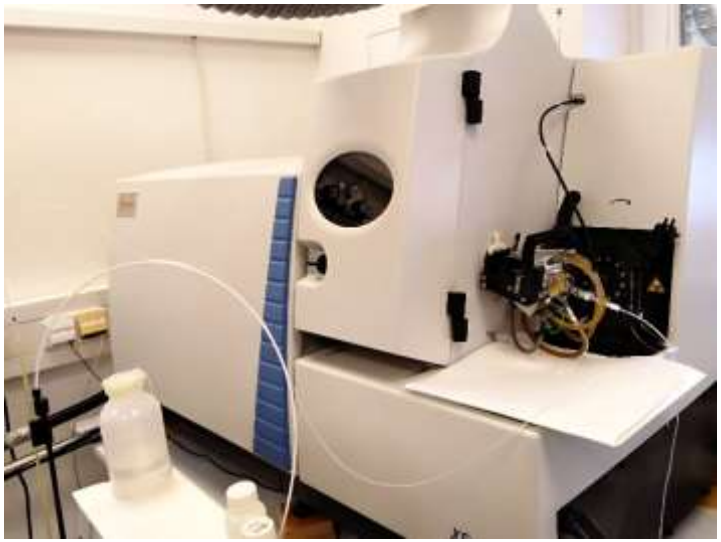


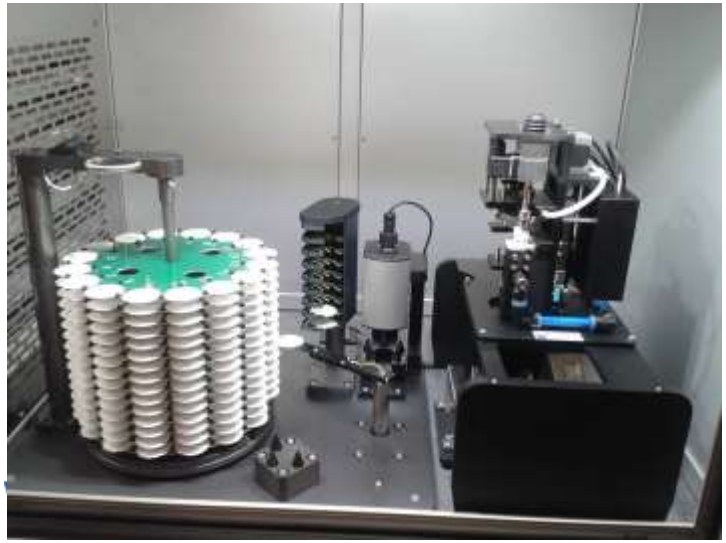
Air Quality Monitoring Scheme



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

Input data acquisition - additional measurements

Specialized measurement methods are available for specific tasks.
They allow measurements over different spatial ranges and provide an extended form of output

Mobile towers

Low cost sensors

Drones

Measurement quality

QA/QC – a documented quality assurance and control programme

A proper quality assurance and control (QA/QC) is a key component of any monitoring programme. Measurements must be accurate and reliable to be useful (and so meaningful for decision making).

The system for acquisition, processing, evaluation and reporting AQ data has to be **in accordance with the EU legislation** on AQ as well as with EU standards, regulations and existing guidelines

QA/QC programme should cower all aspects of network operation - system design, site selection, equipment selection, operation, calibration, maintenance of data management and validation, documentation of all procedures.

It has to explicitly define the unambiguous responsibility and authority for each of the activities contributing to the data quality and co-ordination between them.

Quality assurance of measurements in the CHMI

- Defined requirements for sampling techniques
- Calibration of measuring instruments in the **Calibration Laboratory** Prague-Libuš Provides metrological continuity of measurements of low (ambient air) concentrations of gaseous chemical substances in the air at national level; accreditation since 2000
- The accredited **Air Pollution Monitoring** includes standard operating procedures for sampling and laboratory determination of monitored substances in 4 laboratories

The air pollution monitoring documentation are compiled in compliance with the standard CSN/EN/ISO 17025 according to which the CHMI air pollution monitoring has been accredited and meets the requirements of the European Commission for a National Reference Laboratory.

Air Pollution Laboratories participate regularly in international interlaboratory tests (WMO/GAW) and the European monitoring network EMEP. The central CHMI air pollution laboratories also perform regular interlaboratory tests.


OSVĚDČENÍ O AKREDITACI

Data storage and control

Multi-step data checking

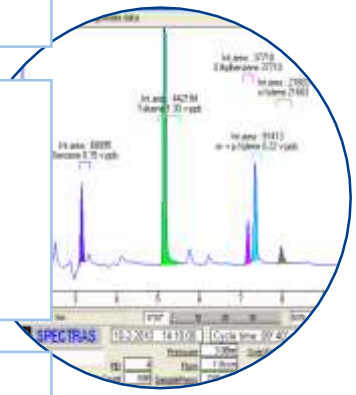
Air quality information system

every work day

Technical validation of measured values

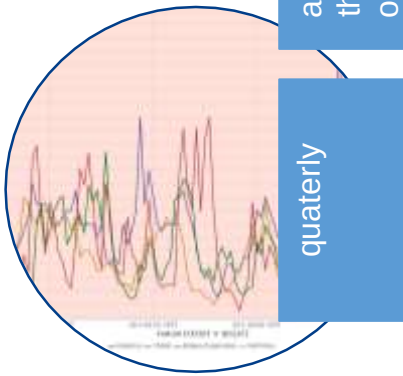
at the end of the following of the month

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.

Legislative limit values

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 constitutions: protection of the ozone layer , greenhouse gases, persistent organic pollutants, mercury

Location of stations across the CR corresponding to the legislation

- The **National Air Quality Monitoring Network** (NAQMN) was established on the basis Act No. 201/2012 Coll., on Air Protection, as amended. The purpose of the NAQMN is to monitor air pollution levels using stationary measurements
- CHMI was entrusted with the operation of the NAQMN by the Ministry of the Environment on the basis of Section 35(1) of the Air Protection Act
- The NAQMN monitoring stations must be located in such a way as to meet the requirements defined by Decree No 330/2012 Coll. This concerns in particular the requirements for the minimum number of stations and the classification of stations that NAQMN stations must meet
- The **Air Protection Act** considers only the part of monitoring stations owned and operated by the CHMI to be NAQMN, only these stations are subject to the minimum legislative requirements for assessing air pollution levels

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.

Using air pollution data for better decision-making in air quality management, transparent access to data

Objectives of the section

Comply with statutory provisions and provide air quality input data of the highest possible quality and scale

Analyse and interpret measurement results - identify causes of pollution and determine their contribution to total pollution, model pollutant dispersion, measure pollutant concentrations during exceptional and routine events

Provide and consult input to legislators, contributing to measures to improve air quality

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

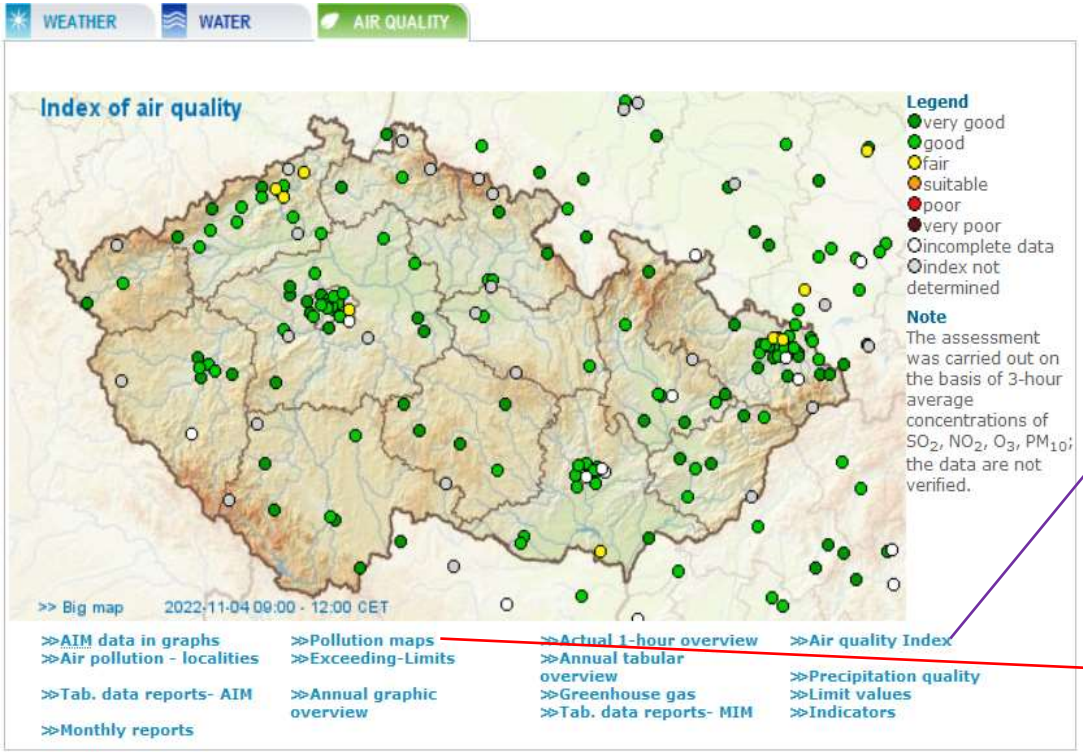
Data Dissemination, Collaboration and Communication

- 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



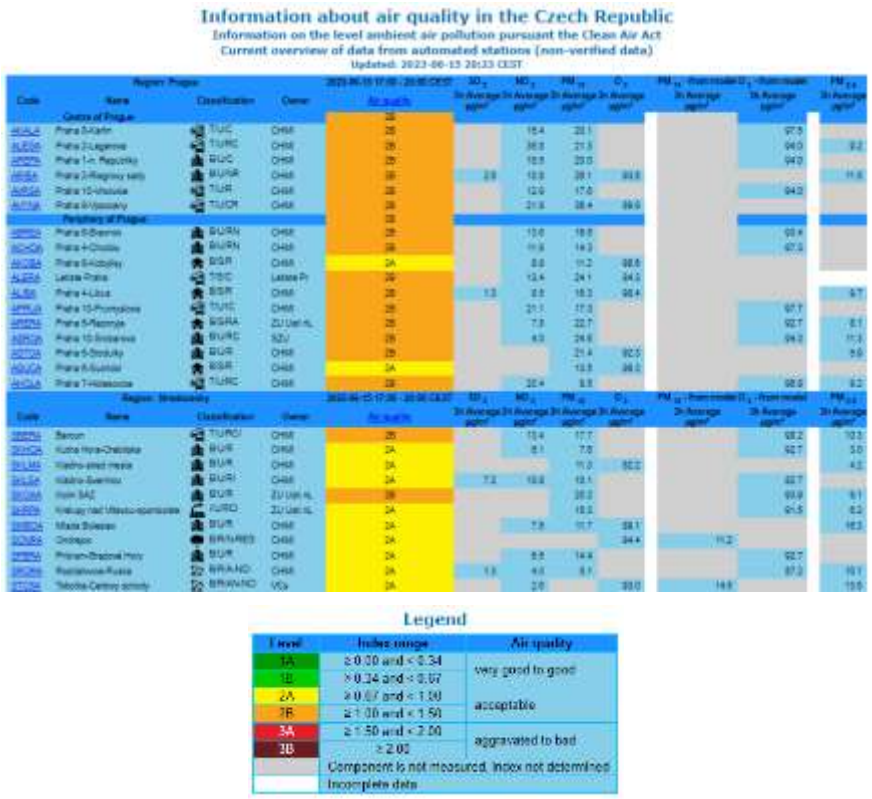
www.facebook.com/chmi.cz

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.

Air Quality Index

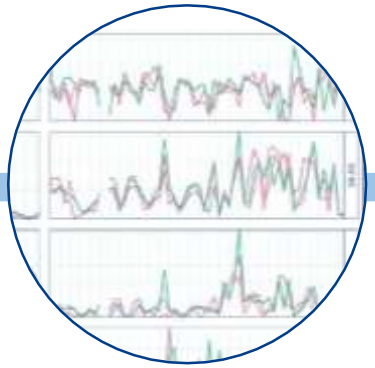
Different indices in regions, countries:

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

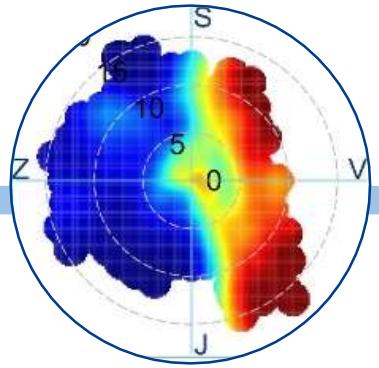


Data analysis - pollution sources

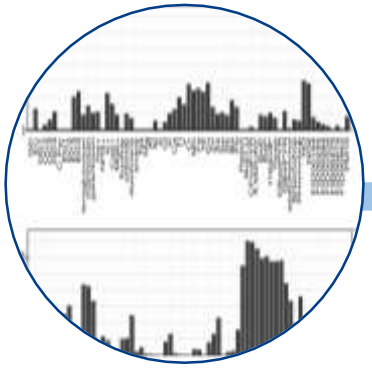
What pollution sources affect the resulting air quality in a given location?



Evolution of pollutant concentrations over time

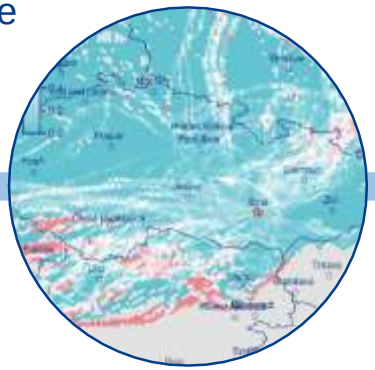


Combination of wind direction and wind speed pollution data over time - concentration roses



"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:

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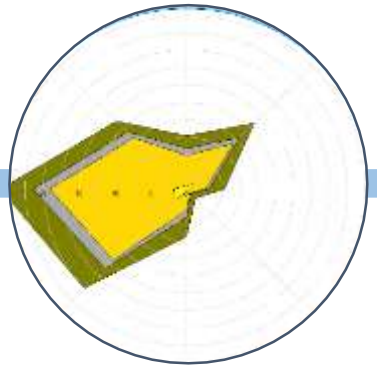
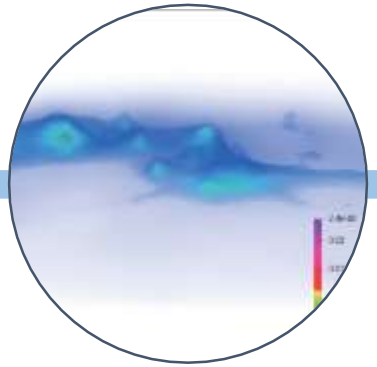
Data analysis - dispersion studies

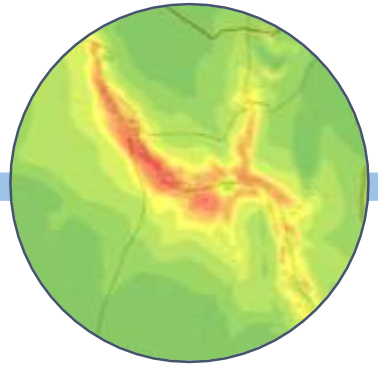
How will pollution from the new source spread in the area?



Data on pollutant concentrations and meteorological parameters



Advanced mathematical models



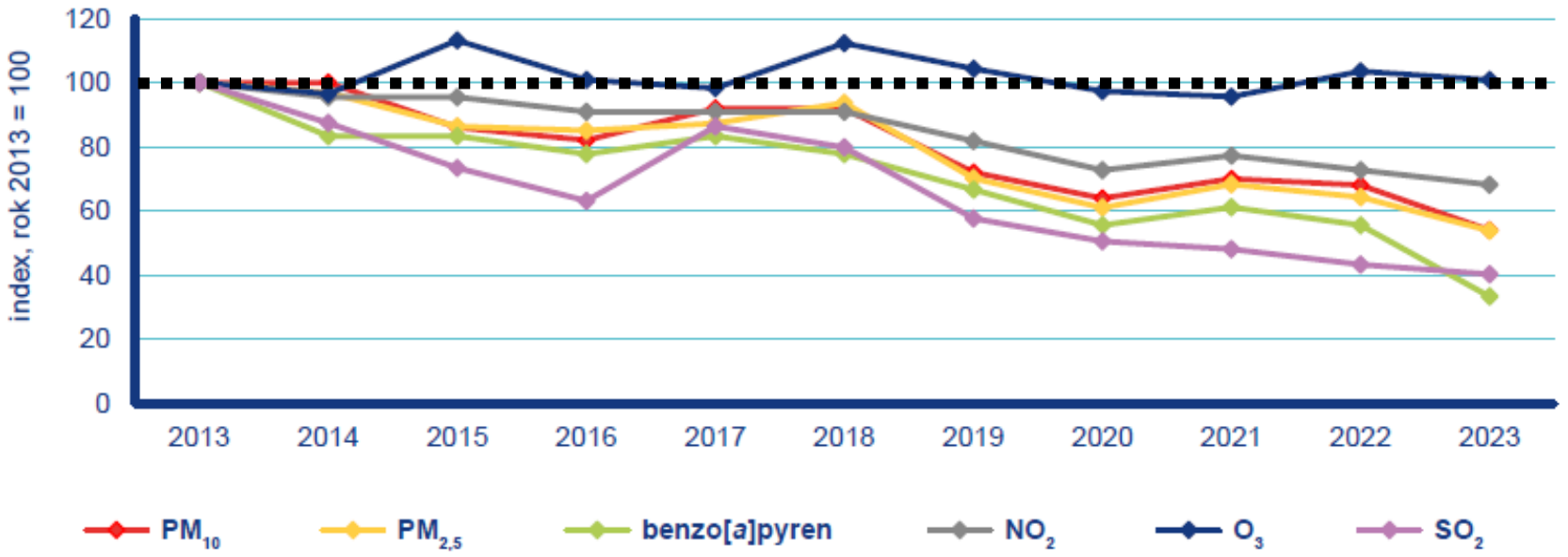
Targeted pollution analysis on an hourly time interval

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

Communication to the public

We issue regular Air Quality Assessments

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



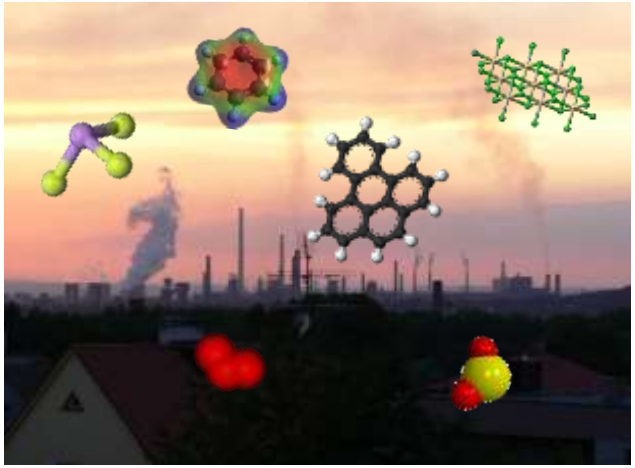
Note: The graphs show the course of the following pollution characteristics:
annual average concentration for $PM_{2.5}$, NO_2, benzo[a]pyrene, 36th highest 24-hour average concentration for PM_{10}; 26th highest maximum daily 8-hour concentration for O_3; 4th highest 24-hour average concentration for SO_2

Continuing problems and challenges

Despite of the implementation of legislation and the limit values to EU standards it was found that these steps and the decrease of pollutant concentrations in the air are not enough

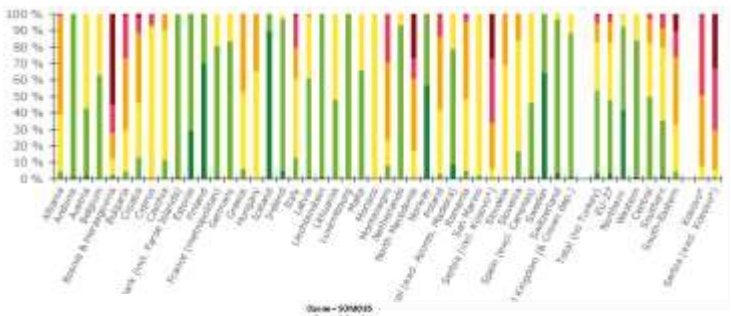
Pollutants with exceedances of limit values:

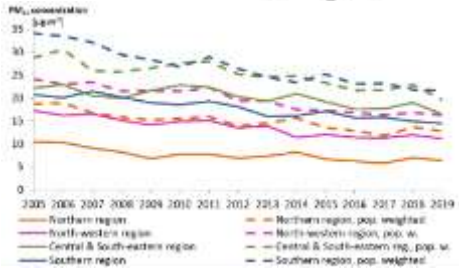
- Suspended particles $PM_{2.5}$ and PM_{10}
- Benzo[*a*]pyrene
- Ozone

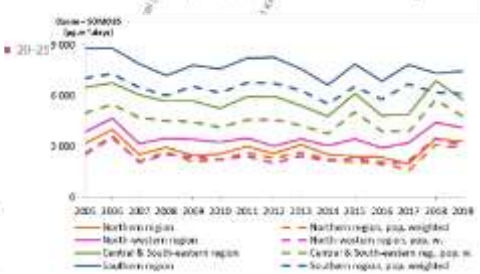


European-wide annual air quality assessment

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.

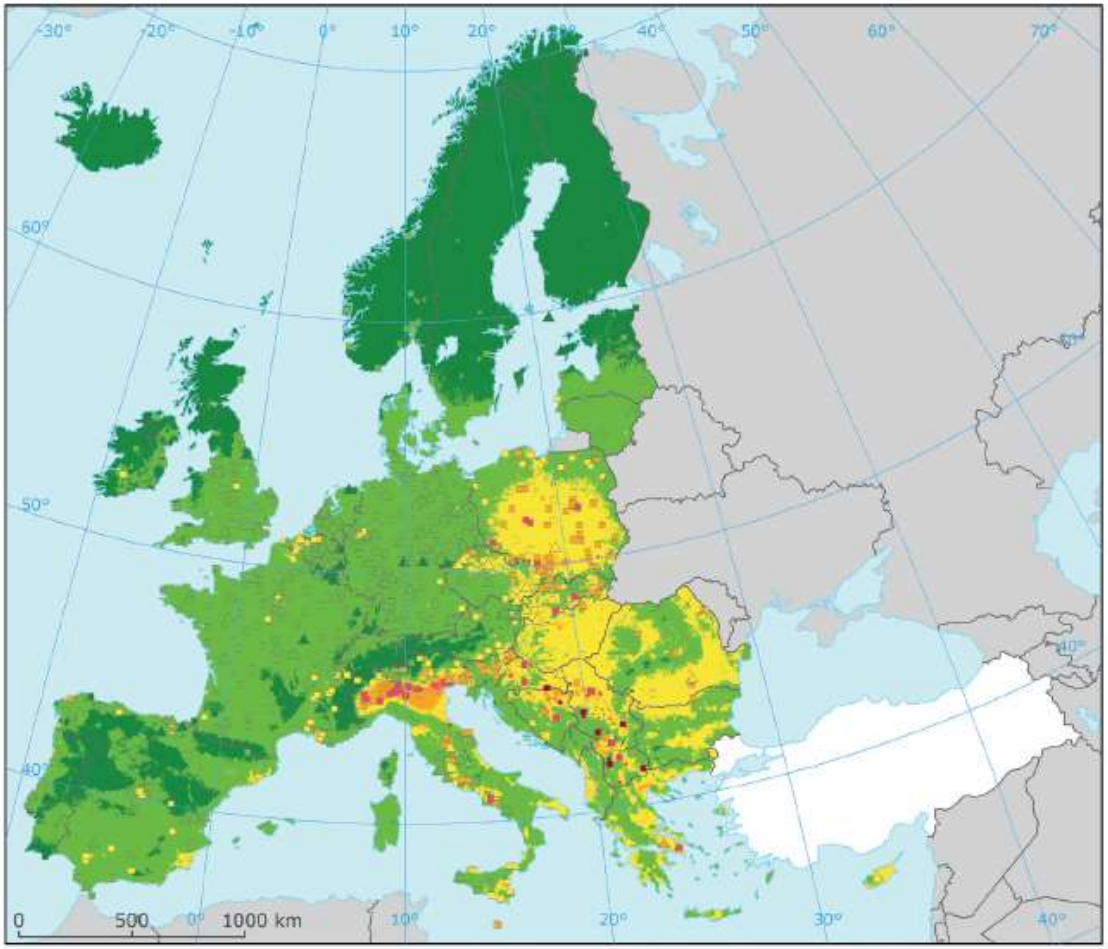






Based on the maps, long-term evolution and trends are also analysed. Within ETC HE, development on the air quality mapping and assessment (including Phytotoxic Ozone Doze and BaP mapping, Air Quality Index) is performed, together with the European partners.

$PM_{2.5}$, 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

Open data on air quality: Tools and best practices

Communication to the public

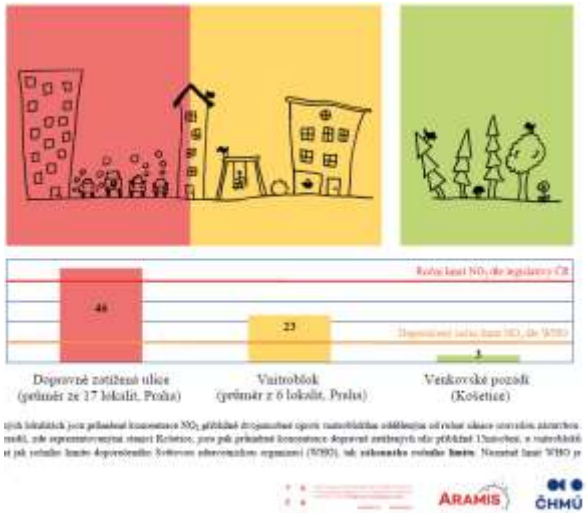
We organize excursions to workplaces, open days, expert lectures

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

Research activities

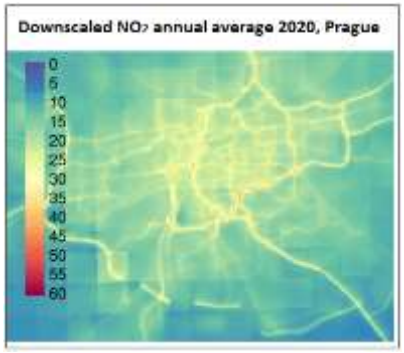
We participate in scientific conferences and publish scientific articles

The Air Quality Research Assessment and Monitoring Integrated Systém (ARAMIS) project

https://www.projekt-aramis.cz/indexENG.html

A unique research center administered by the Technology Agency of the Czech Republic as part of the Applied research, experimental development and innovation in the field of environment program.

The project primarily concentrates on development, update and creation of tools, methodologies and processes for the assessment of air quality. It also deals with emissions of standard pollutants, as well as greenhouse gases including their projections and quantification of impacts on health of the public and ecosystems, energy consumption, economy and other aspects of living. The aim of the project is to contribute towards improvement of the environment, especially air quality in the Czech Republic, by implementation of the project results.



Research within other projects

https://www.chmi.cz/informace-a-sluzby/projekty

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

Thank you for your attention

Mgr. Blanka Krejčí, PhD.
✉blanka.krejci@chmi.cz

Czech Hydrometeorological Institute