
Czech
Hydrometeorological
Institute

30 years of experience in the air quality monitoring in the Czech Republic

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Introduction

Czech Hydrometeorological Institute

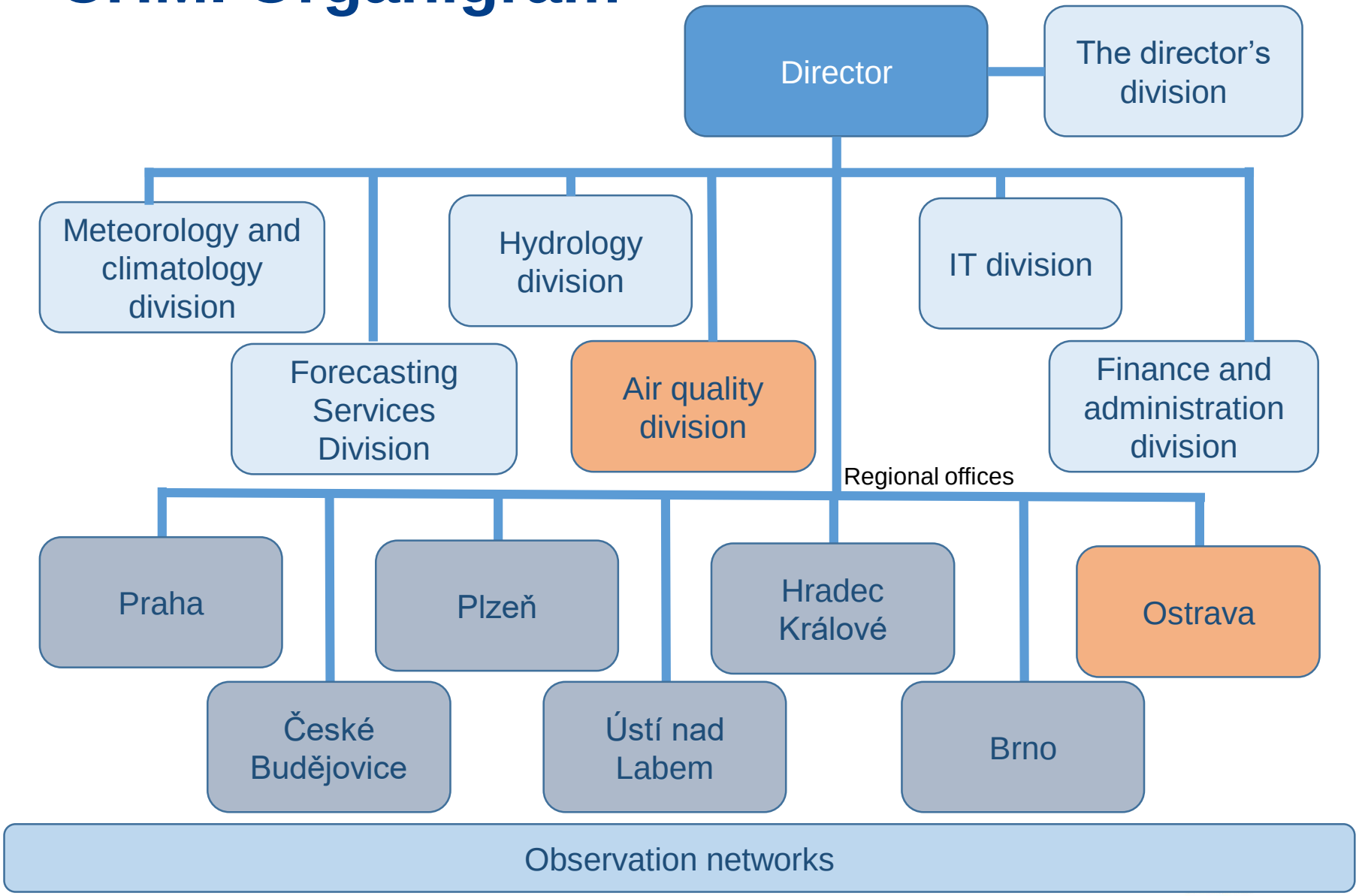
CHMI, authorized by the Ministry of the Environment of the Czech Republic, ensures ambient air quality monitoring and assessment in the territory of the whole Czech Republic

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

CHMI Organigram



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.)

Assessment and Monitoring –

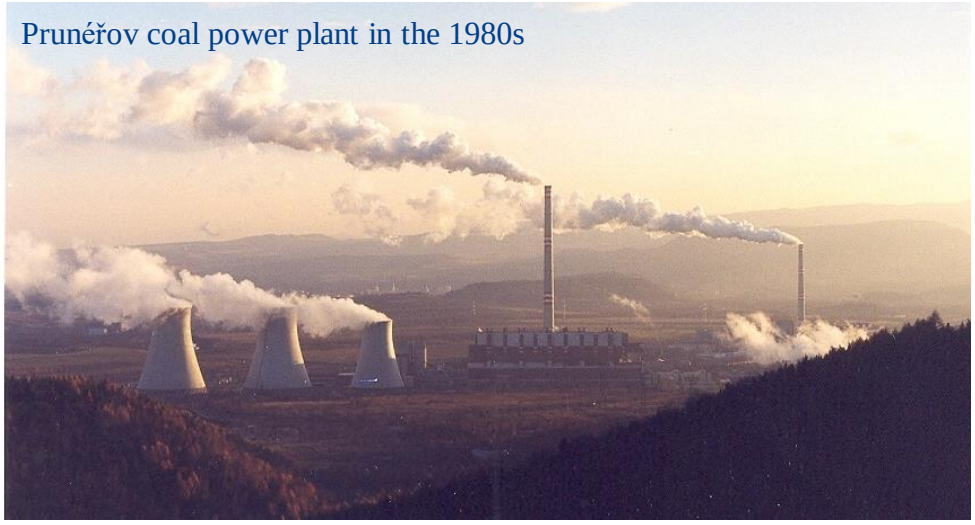
Historical View

Ambient Air Quality – Historical View

The modern-day Czech Republic (CR), 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

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

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

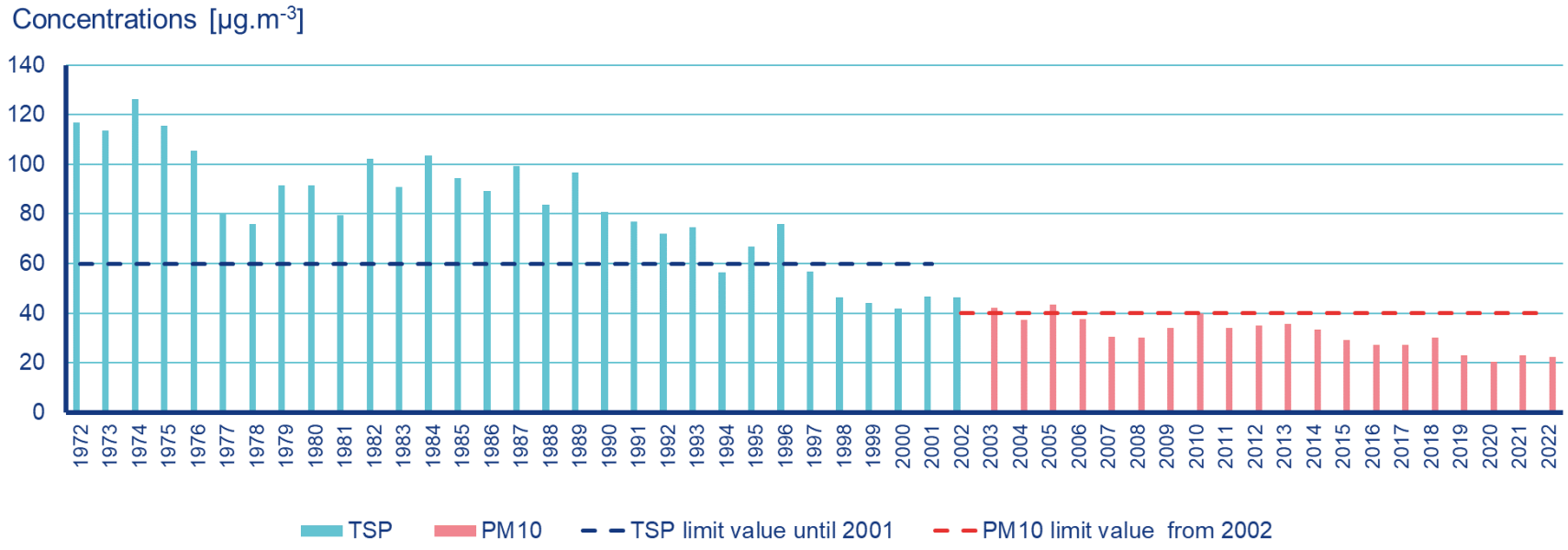
Spoil landfill Ema, Ostrava1962

Source: https://www.idnes.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

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



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

Ambient Air Quality Monitoring – Historical View

After covering the most heavily impacted regions, measurement also began in relatively unpolluted areas, far from the emission sources in order to gain information on **regional background air pollution**:

- **Svratouch** in the Czech-Moravian Highlands (BAPMON – since1972, EMEP – since 1977),
- **Košetice** in 1980 for environmental monitoring on a regional scale

Current National Air Quality Monitoring Network (NAQMN)

Czech Hydrometeorological Institute

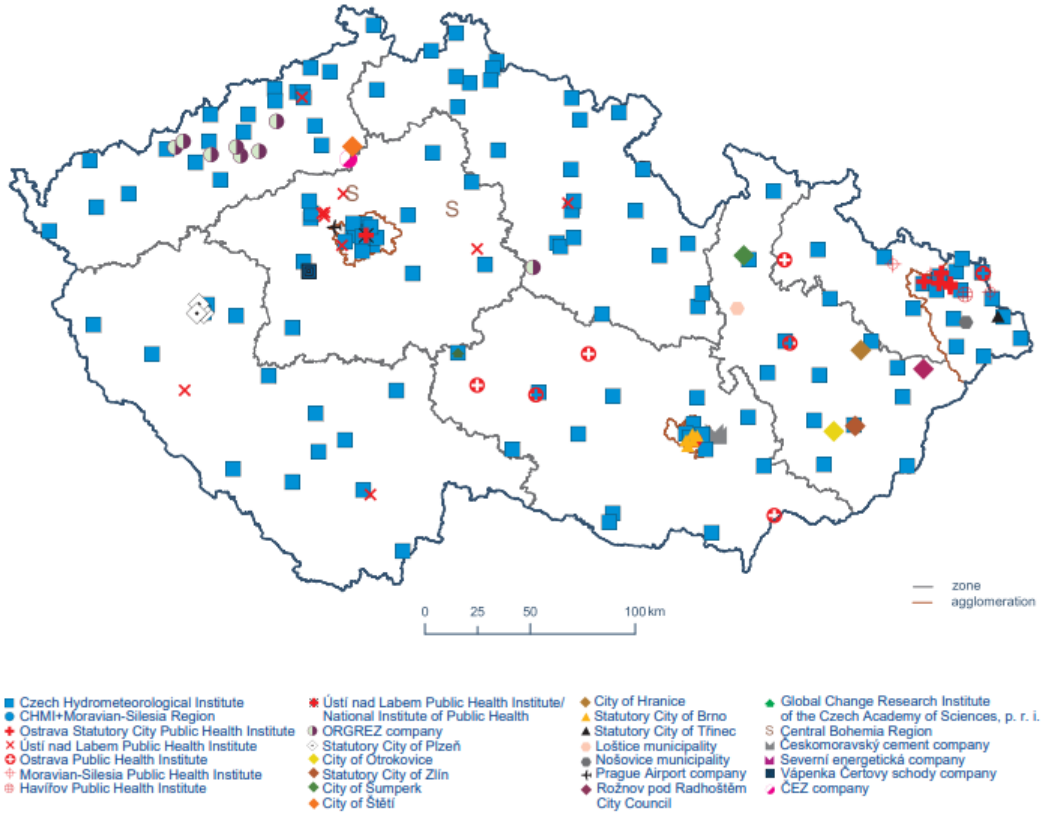
Location of stations across the CR corresponding to the legislation

- 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

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

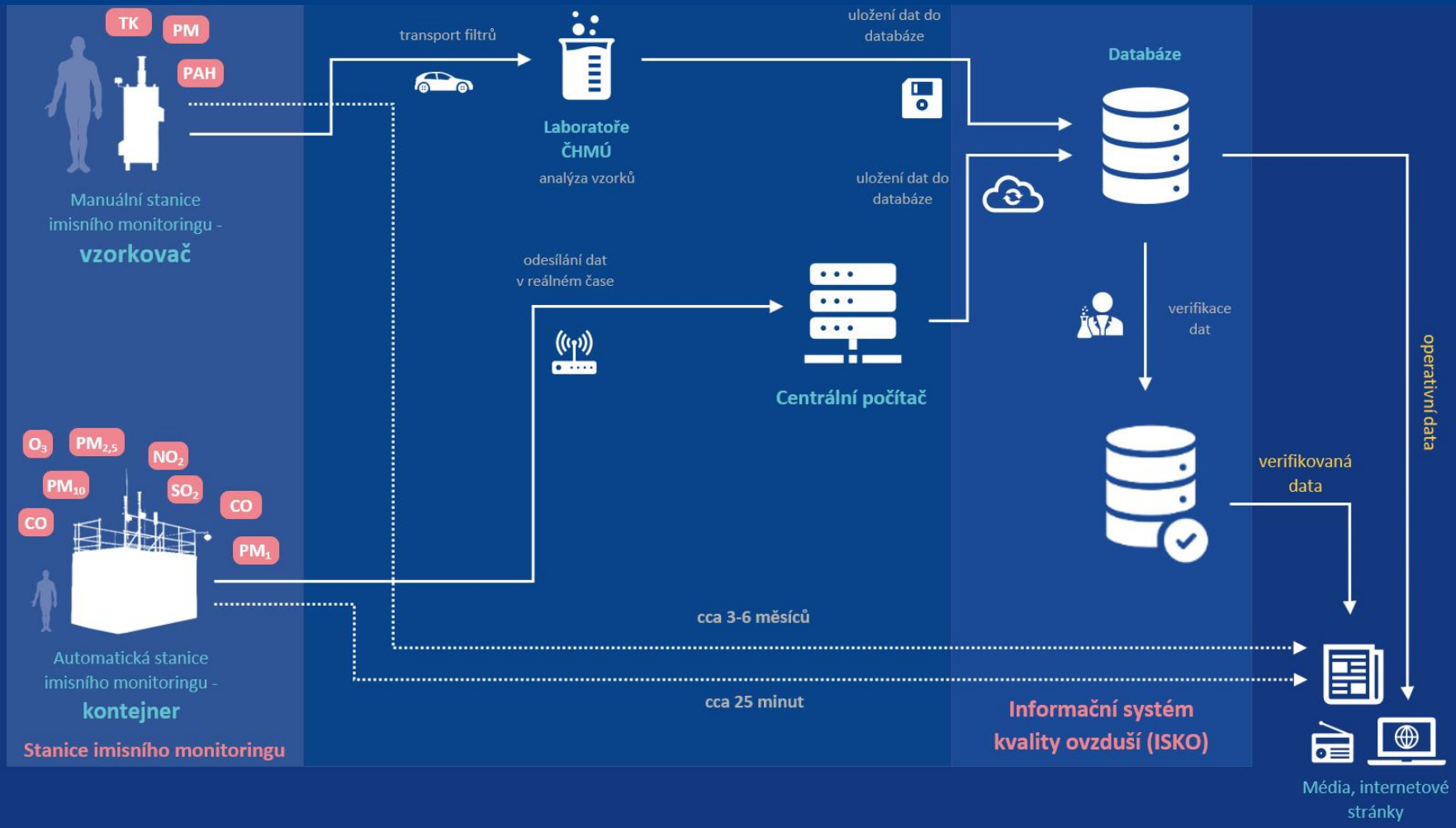


https://www.chmi.cz/files/portal/docs/uoco/isko/grafroc/21groc/gr21en/21_01_uvod_EN_v2.pdf

Useful links:

- Sampling procedures and description of used methods in Czech Republic, as well as types of measuring programmes are published in the latest annual Air Quality Reports: https://www.chmi.cz/files/portal/docs/uoco/isko/tab_roc/2021_enh/index_GB.html
- https://www.chmi.cz/files/portal/docs/reditel/SIS/nakladatelstvi/assets/154.pdf
- The classification of stations is designed with respect to the reporting requirements set in the Commission Implementing Decision 2011/850/EU, laying down rules for Directives 2004/107/EC and 2008/50/EC of the European Parliament and of the Council as regards the reciprocal exchange of information and reporting on ambient air quality, the so called e-reporting (http://dd.eionet.europa.eu/vocabularies).
- https://www.eea.europa.eu/en/topics/in-depth/air-pollution

Air Quality Monitoring Scheme



Automated monitoring stations

- Concentrations of suspended particulate matter PM1, PM10 and PM2.5
- Particle number distribution
- Sulphur dioxide
- Nitrogen oxides
- Carbon monoxide
- Ozone
- Volatile organic compouds

Operational (provisional, preliminary) data

The aim of automatic ambient air quality measurement is to provide data for the protection of human health **in near real time**. This requires **fast, automatic data checking**.

Full QA/QC procedures cannot be used → lower data accuracy and reliability than for final reporting

Data at this stage cannot be used for purposes other than to inform the current situation

Particulate matter measurement

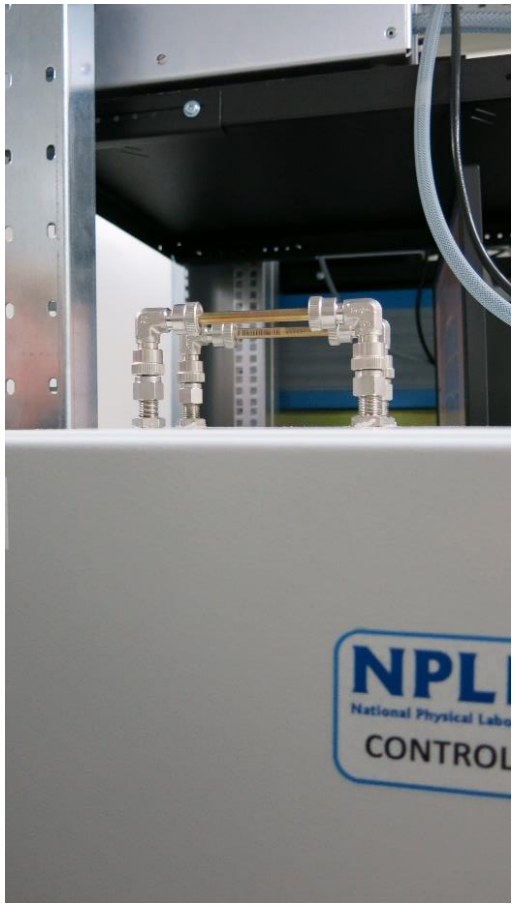
Reference method = gravimetry (manual method)

Automated monitoring = non-referential

Determination of aerosol particle concentration in outdoor air by automatic beta (MP101M Environnement S.A.) and optical dust meters (FIDAS 200 Palas GmbH) used in the CHMI

Guidance to the Demonstration of Equivalence of Ambient Air Monitoring Methods
http://ec.europa.eu/environment/air/quality/legislation/assessment.htm

Manual monitoring stations

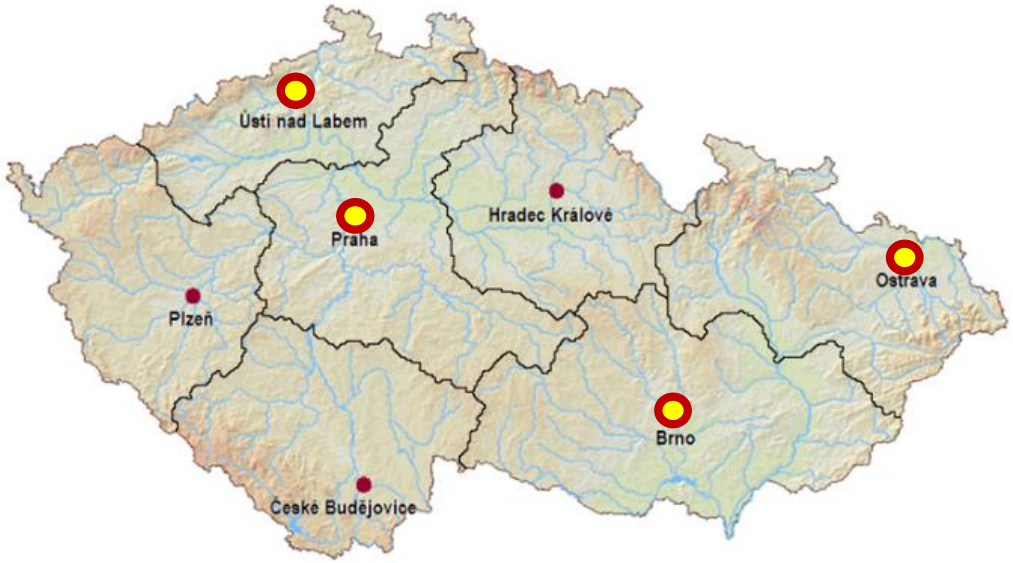


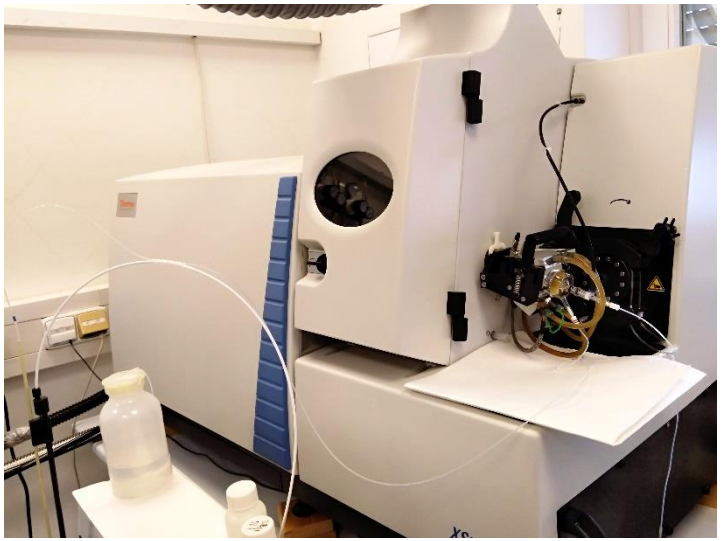
Manually monitored pollutants

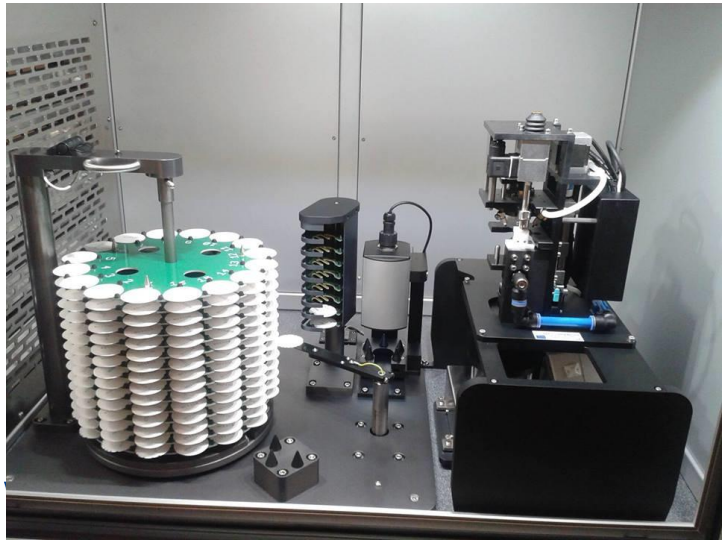
- Concentrations of suspended particulate matter PM10 and PM2.5
- Heavy metals in PM
- PAHs in PM10
- EC/OC
- Particle morphology and elemental composition
- Volatile organic compouds

Total qualitative analysis of atmospheric precipitation with determination of heavy metals, cations and anions at selected stations

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

Use of sensor systems

- sensor quality
- calibration and accuracy evaluation
- communication, data transmission
- visualisation, interpretation and management of large data sets
- public involvement, meeting expectations

Additional monitoring, screening, trend detection, "community monitoring", support for citizen science, local activities, networking

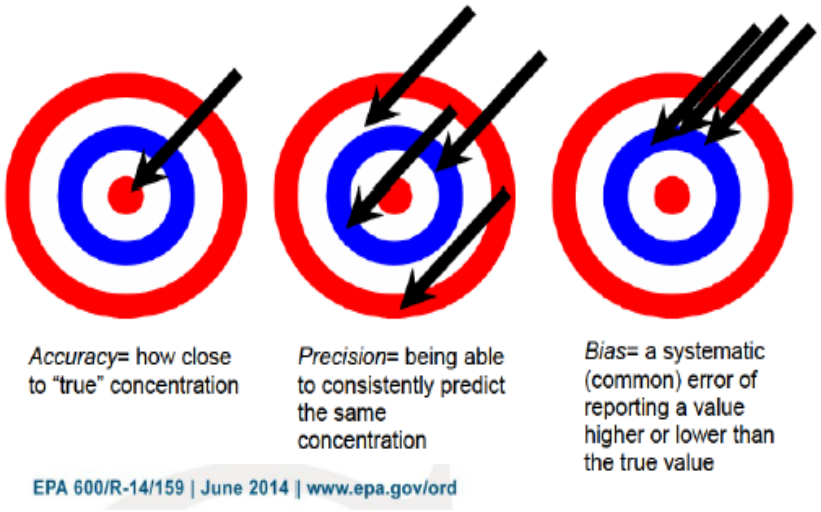
Limitations for sensor measurements

Cross-sensitivity with other pollutants

Sensitivity to temperature and humidity

Long-term stability

Sensitivity at low concentrations



Source: https://www.epa.gov

Sensor unit is not a miniature reference station (low public literacy in metrology)

Representativeness of location

Measurement quality

Measurement, error, result

The inseparable property of any **measurement** (= numerical investigation of a physical property of a phenomenon) …

… is the **error** (= difference/deviation) of the value determined by the measurement from the true/real value

The **result** of a measurement (= comparison with a generally accepted unit) is a **number** (= approximation to the true/real value)

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.

Collecting and reporting data

Theory: all of the QA activities are performed correctly, in compliance with the relevant CEN standards and standard operational procedures ⇒ the measurements will meet the requirements of the EU Directives without further checking

Practice: there is a need to QC the data by careful data management and checking, analyser/sampler faults must be identified and addressed quickly in order to fulfil the data quality objectives for data capture

1. Any suspect data must be identified and investigated prior to submission of data to the data user
2. there is the need to ensure that the data are reported correctly

Quality assurance

Quality assurance covers practices that are undertaken **prior to data collection** in order to ensure that the sampling arrangements and analyzers are **capable of providing reliable measurements**:

- Training, procedures - all routine activities undertaken in the operation of the facility are clearly and unambiguously laid out in a documented set of procedures, analyzer selection, siting
- An infrastructure for ensuring that methods and techniques are used properly in routine work, internal analytical QA procedures, also participation in third party audits and assessment are need

Quality assurance *refers to the overall management of the process involved in obtaining the data, i.e. relates to the measurement process*

Quality control

Control covers practices applied **after data collection** in order to ensure that the measurements obtained are **repeatable** and traceable:

Routine calibration, routine and periodic maintenance, instrument history, data review, data handling, data comparison, data rectification, independent assessment.

Quality control *refers to the activities undertaken to check and optimise data accuracy and precision after collection, i.e. concerned primarily with outputs*

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.

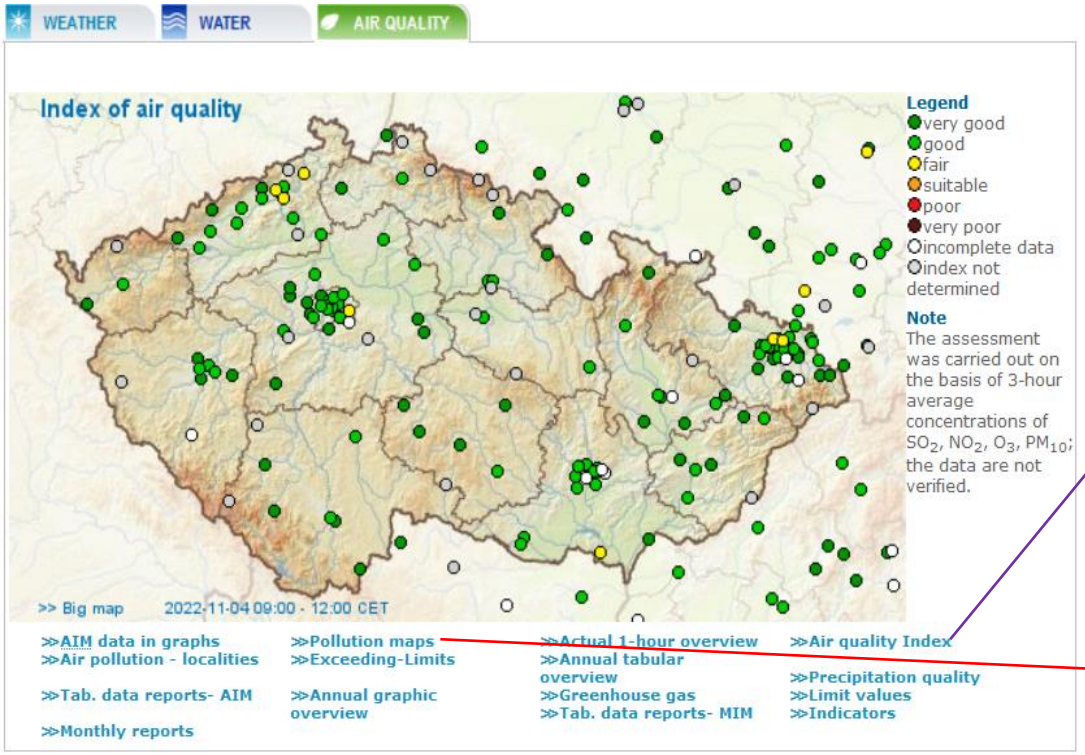

OSVĚDČENÍ O AKREDITACI

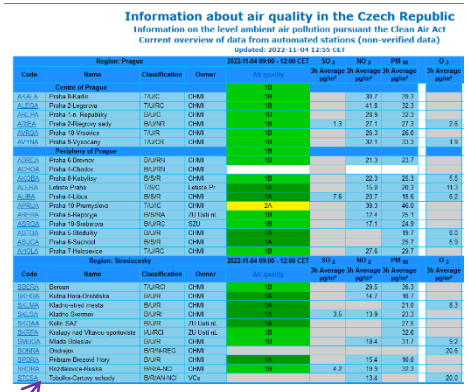
The purpose of measurement is not the collection of data per se, but the provision of data as a basis for environmental management decisions

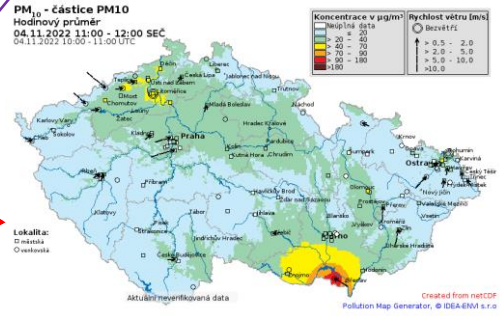
Current state of the air in the CR

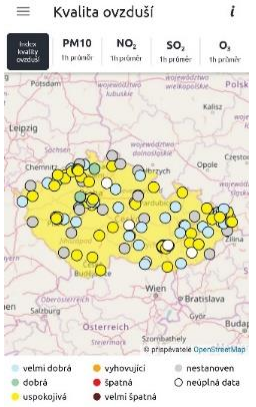
https://www.chmi.cz/?l=en#!

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

Information about air quality in the Czech Republic

Information on the level ambient air pollution pursuant the Clean Air Act

Current overview of data from automated stations (non-verified data)

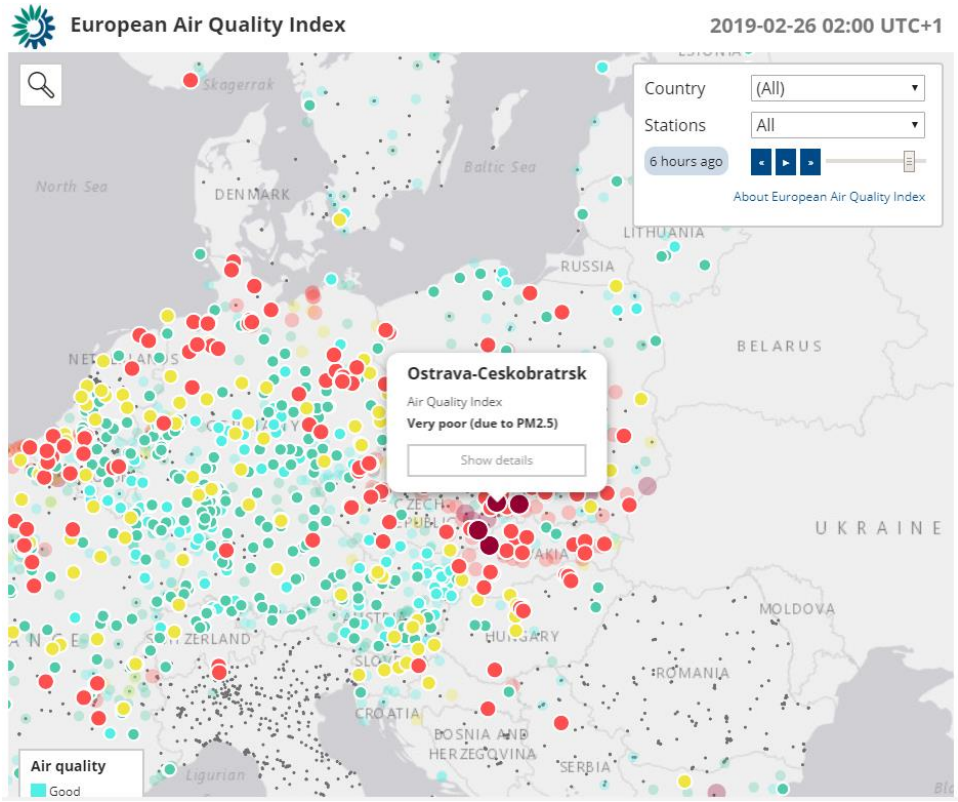
Updated: 2023-06-15 20:33 CEST

Region: Prague				2023-06-15 17:00 - 20:00 CEST	SO_2	NO_2	PM_{10}	O_3	PM_{10} - from model	O_3 - from model	$PM_{2.5}$
Code	Name	Classification	Owner	Air quality	3h Average µg/m³	3h Average µg/m³	3h Average µg/m³	3h Average µg/m³	3h Average µg/m³	3h Average µg/m³	3h Average µg/m³
Centre of Prague				2B							
AKALA	Praha 8-Karlin	T/UC	CHMI	2B		15.4	20.1			97.6	
ALEGA	Praha 2-Legerova	T/UC	CHMI	2B		35.8	21.3			94.0	9.2
AREPA	Praha 1-n. Republiky	B/UC	CHMI	2B		18.5	20.0			94.0	
ARIEA	Praha 2-Riegrovy sady	B/UNR	CHMI	2B	2.8	10.8	26.1	93.8			11.5
AVRSA	Praha 10-Vrsovice	T/UR	CHMI	2B		12.9	17.6			94.0	
AVYNA	Praha 9-Vysocany	T/UCR	CHMI	2B		21.9	36.4	89.9			
Periphery of Prague				2B							
ABREA	Praha 6-Brevnov	B/URN	CHMI	2B		13.6	16.5			93.4	
ACHOA	Praha 4-Chodov	B/URN	CHMI	2B		11.9	14.3			97.3	
AKOBA	Praha 8-Kobylisy	B/SR	CHMI	2A		8.9	11.2	98.6			
ALERA	Letiste Praha	T/SIC	Letiste Pr	2B		13.4	24.1	84.3			
ALIBA	Praha 4-Libus	B/SR	CHMI	2B	1.3	8.5	16.3	98.4			9.7
APRUA	Praha 10-Prumyslova	T/UIC	CHMI	2B		21.1	17.3			97.7	
ARERA	Praha 5-Reporyje	B/SRA	ZU Usti nL	2B		7.8	22.7			92.7	8.1
ASROA	Praha 10-Srobarova	B/URC	SZU	2B		4.0	24.8			94.3	11.3
ASTOA	Praha 5-Stodulky	B/UR	CHMI	2B			21.4	92.3			5.9
ASUCA	Praha 6-Suchdol	B/SR	CHMI	2A			13.5	99.3			
AHOLA	Praha 7-Holesovice	T/UIC	CHMI	2B		20.4	8.5			96.8	9.2

Region: Stredocesky				2023-06-15 17:00 - 20:00 CEST	SO_2	NO_2	PM_{10}	O_3	PM_{10} - from model	O_3 - from model	$PM_{2.5}$
Code	Name	Classification	Owner	Air quality	3h Average µg/m³	3h Average µg/m³	3h Average µg/m³	3h Average µg/m³	3h Average µg/m³	3h Average µg/m³	3h Average µg/m³
SBERA	Beroun	T/UIRCI	CHMI	2B		13.4	17.7			90.2	10.3
SKHOA	Kutna Hora-Orebitska	B/UR	CHMI	2A		6.1	7.6			92.7	3.0
SKLMA	Kladno-stred mesta	B/UR	CHMI	2A			11.3	82.2			4.2
SKLSA	Kladno-Svermov	B/URI	CHMI	2A	7.2	10.8	10.1			82.7	
SKOAA	Kolin SAZ	B/UR	ZU Usti nL	2B			20.2			93.9	9.1
SKRPA	Kralupy nad Vltavou-sportoviste	I/UIRCI	ZU Usti nL	2A			15.3			91.5	6.3
SMBOA	Mlada Boleslav	B/UR	CHMI	2A		7.5	11.7	89.1			16.3
SONRA	Ondrejov	B/RN-REG	CHMI	2A				94.4	11.2		
SPBRA	Pribram-Brezové Hory	B/UR	CHMI	2A		6.5	14.4			92.7	
SRORA	Rozdalovice-Ruska	B/RA-NCI	CHMI	2A	1.3	4.0	5.1			87.2	10.1
STCSA	Tobolka-Certovy schody	B/RAN-NCI	VCs	2A		2.6		93.0	14.5		13.5

Legend

Level	Index range	Air quality
1A	≥ 0.00 and < 0.34	very good to good
1B	≥ 0.34 and < 0.67	
2A	≥ 0.67 and < 1.00	acceptable
2B	≥ 1.00 and < 1.50	
3A	≥ 1.50 and < 2.00	aggravated to bad
3B	≥ 2.00	
	Component is not measured, index not determined	
	Incomplete data	



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, PM10 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 PM10. The declaration of a smog situation, let alone regulation due to high concentrations of NO2 and SO2, 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.

Monitoring – Future

Expected development of the measuring network

In **2015** The National Air Quality Monitoring Network (NAQMN) was extensively renewed

In **2025** similar network renewal expected under The Operational Programme Environment

We will build on the results of projects that are designing our network optimising



Expected development: encrease/reduce?

Better air quality monitoring and modelling is needed to improve air quality management and enforcement of rules

- Air quality has improved over the last two years – expectation of **reduced** measurements
- Energy crisis – assumption of worsening air quality – **increased** need to measure
- Newly proposed limit values and changes in legislation: stricter – **increased** need to measure
- Savings in the economy – expectation of **reduced** measurements

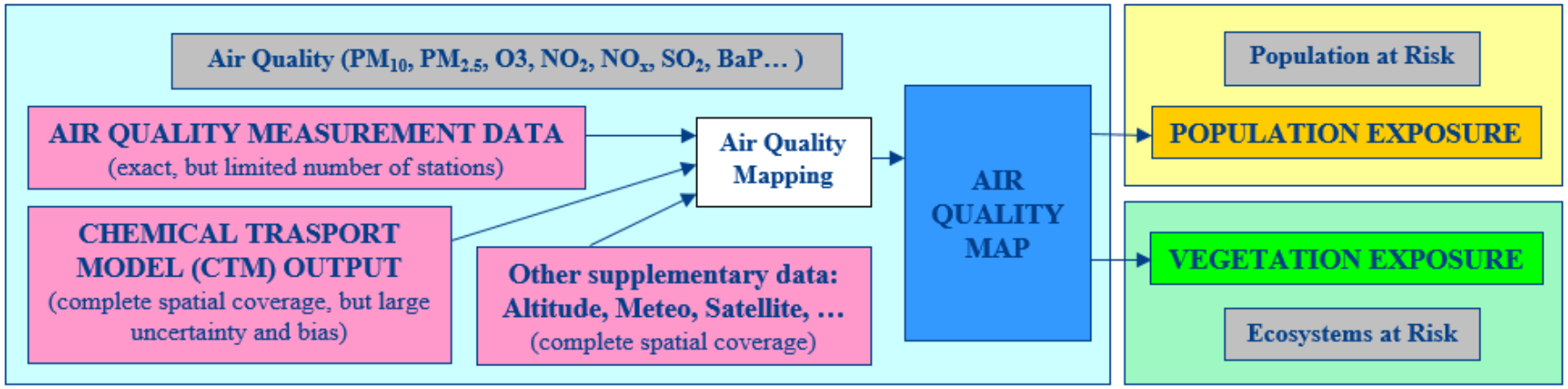
Assessment – Current state

Regular annual air quality assessment

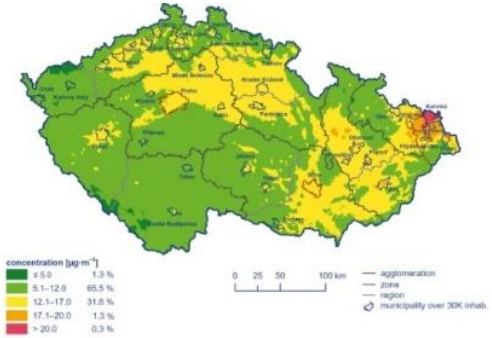
Ambient air quality concentrations measured at monitoring stations are the basis for assessing air quality.

However, in order to address air pollution problems and to assess its impacts, it is necessary to know the spatial distribution of pollutant concentrations. Air quality maps make it possible to identify areas with exceedances of limit values, for which legislation requires the preparation of air quality improvement programmes.

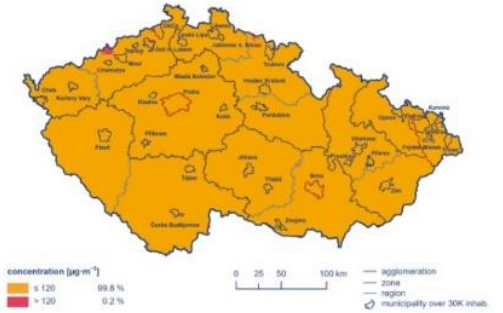
The maps are prepared using of a combination of measured concentrations at stations and dispersion models (CTMs) or other additional data (altitude, meteo, satellite, etc.) The resulting maps for the assessment are at 1 x 1 km^2 resolution.

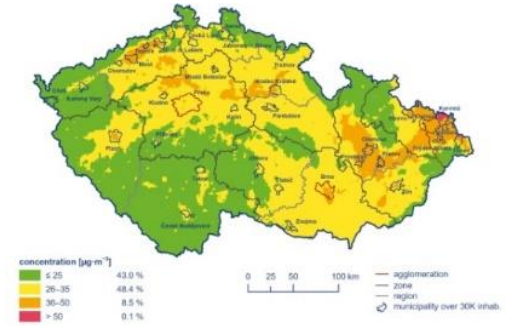


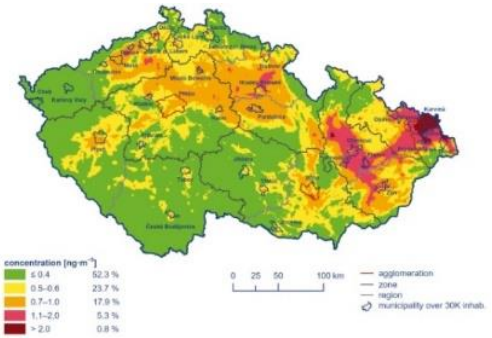
Regular annual air quality assessment

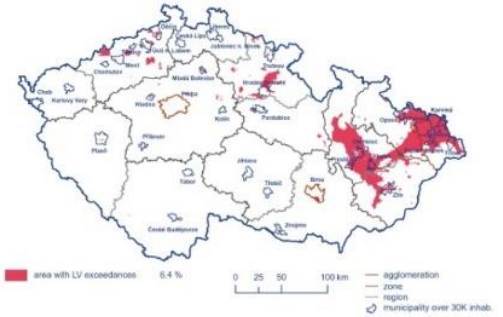


The area mapping provides key information on areas with above-limit value concentrations and the number of people exposed to these concentrations.









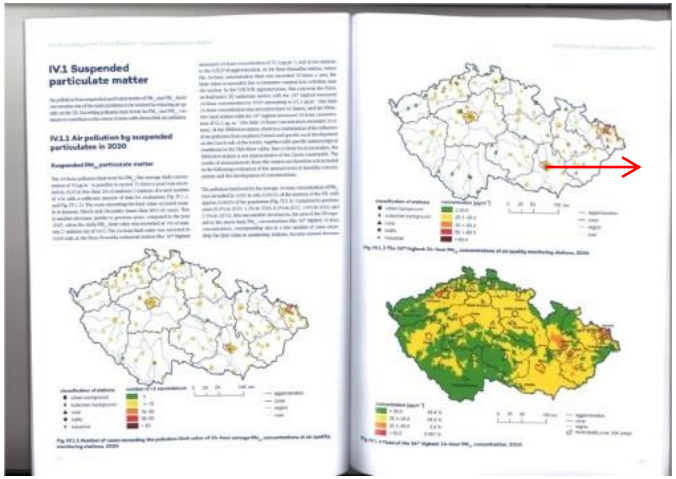
Tab. Percentage of the area exceeding the pollution limit (%) and percentage of population resident in areas exposed to above-limit values (%) in the Czech Republic, 2021

Czech Republic	Pollutants specified in Annex 1 to Act No. 201/2012 Coll., as amended						
	Item 1 of the Annex			Item 3 of the Annex		Item 4 of the Annex	
	PM_{10}	$PM_{2.5}$		BaP		O_3	
	36th max. 24-h average > 50 µg·m^{-3}	annual average > 20 µg·m^{-3}	Total LV exceedances	annual average > 1 ng·m^{-3}	Total exceedances, ozone excluded	26. highest values max. daily 8-h runing average (in the three–year average) > 120 µg·m^{-3}	Total exceedances, including ozone
Inhabitants	0.4	1.5	1.5	19.7	19.7	0.02	19.7
Area	0.1	0.3	0.3	6.1	6.1	0.2	6.4

Regular annual air quality assessment

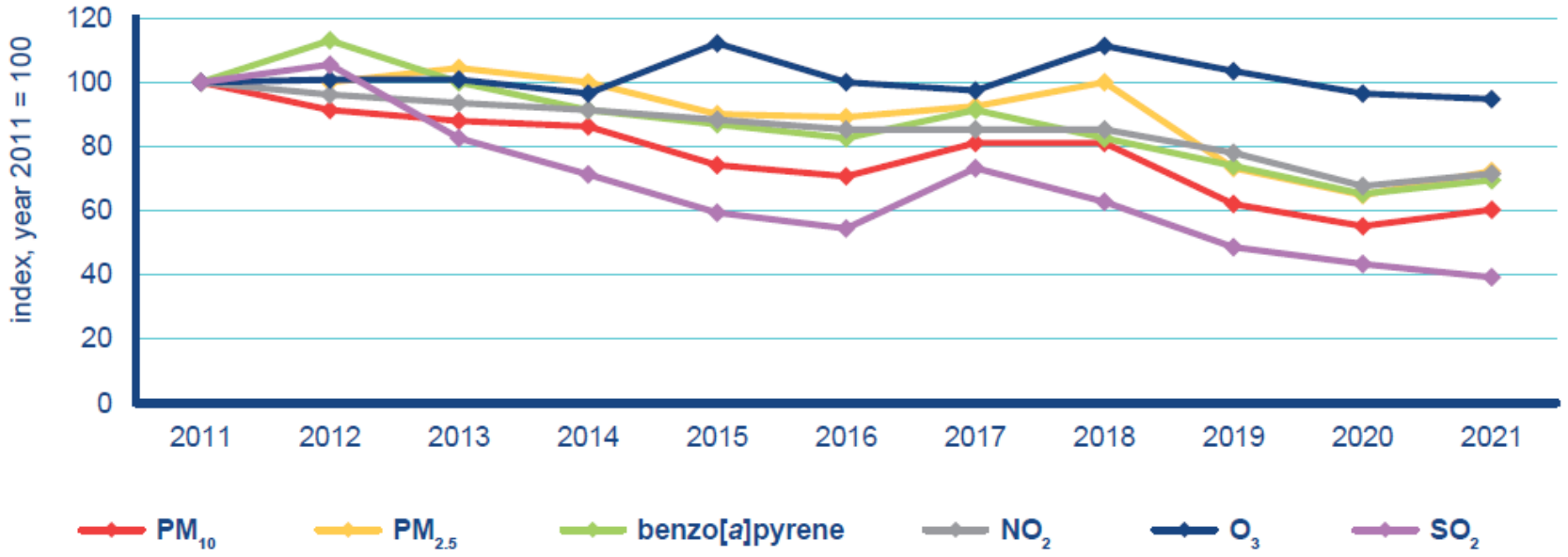
The information obtained on exceedances of limit values in zones and agglomerations is reported to the EU in accordance with the requirements of European legislation in the framework of E-reporting

The results of the annual assessment are published in a tabular and graphical yearbooks of the ČHMÚ



The yearbooks are also published in interactive form with the possibility of downloading images and data: https://info.chmi.cz/rocenka/ko2020/

Changes in the AQ characteristics of selected pollutants in the CR, 2011–2021



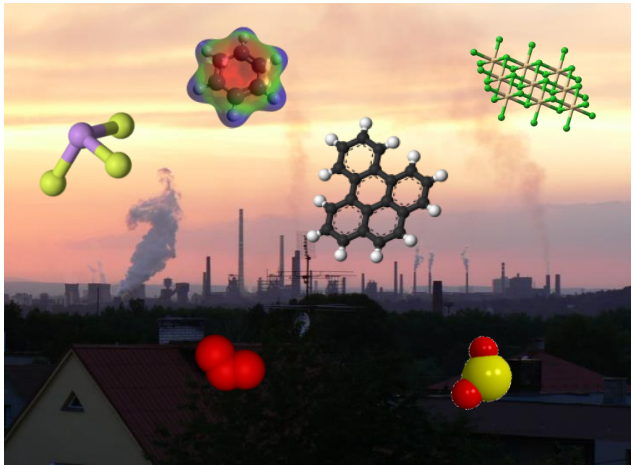
Note: The graphs show the course of the following pollution characteristics:
annual average concentration for PM2.5, NO2, benzo[a]pyrene, 36th highest 24-hour average concentration for PM10; 26th highest maximum daily 8-hour concentration for O3; 4th highest 24-hour average concentration for SO2

Continuing problems and challenges

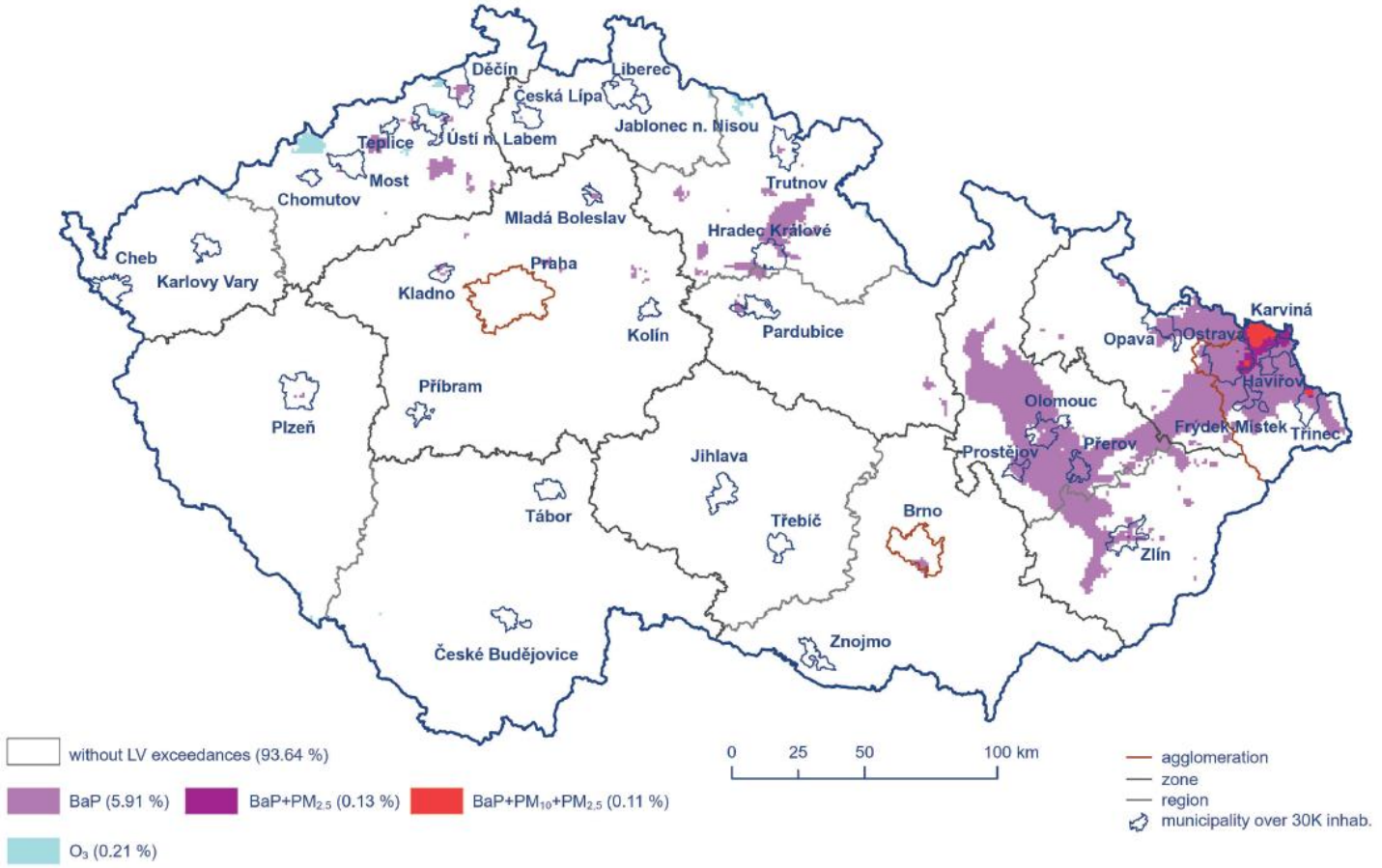
Despite of the implementation of legislation and the limit values to EU standards it was found that these steps and the decrease of pollutant concentrations in the air are not enough

Pollutants with exceedances of limit values:

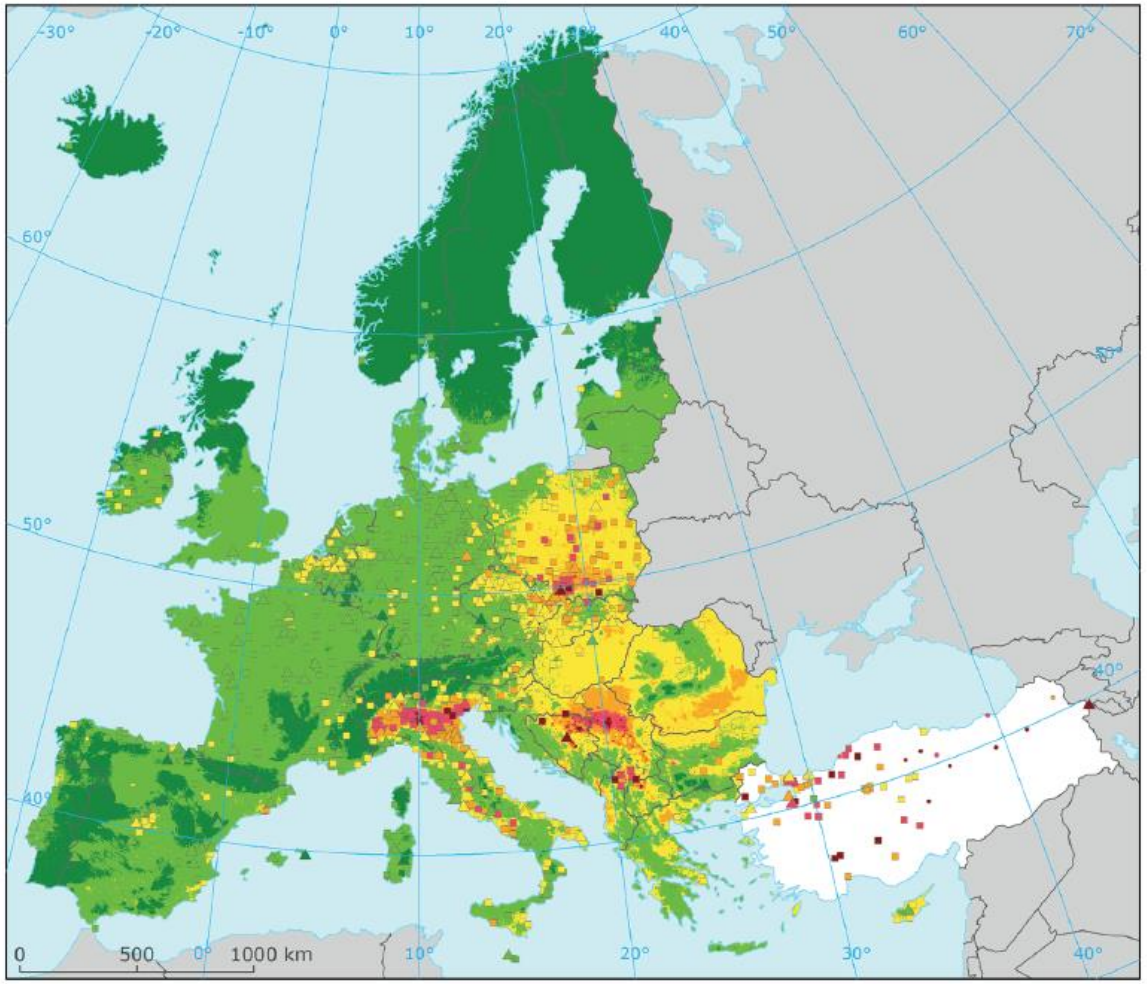
- Suspended particles $PM_{2.5}$ and PM_{10}
- Benzo[*a*]pyrene
- Ozone



CR areas with exceeding of the health protection limit values for selected groups of pollutants, 2021



PM2.5, Europe



Fine Particulate Matter $PM_{2.5}$ Annual Average

Reference Year: 2020
Combined Rural and Urban Map
Resolution: 1×1 km^2

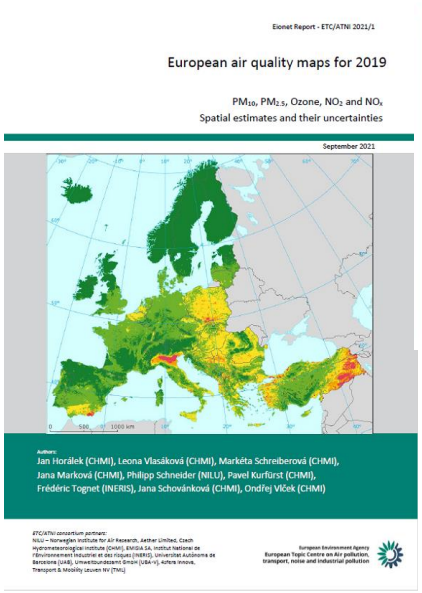
- ≤ 5 $\mu g \cdot m^{-3}$
- 5–10 $\mu g \cdot m^{-3}$ (5 = WHO AQ Guideline 2021)
- 10–15 $\mu g \cdot m^{-3}$ (10 = WHO AQ Guideline 2005)
- 15–20 $\mu g \cdot m^{-3}$
- 20–25 $\mu g \cdot m^{-3}$ (20 = Indicative Limit Value)
- > 25 $\mu g \cdot m^{-3}$ (25 = Limit Value)
- non EEA member or cooperating countries
- no available data

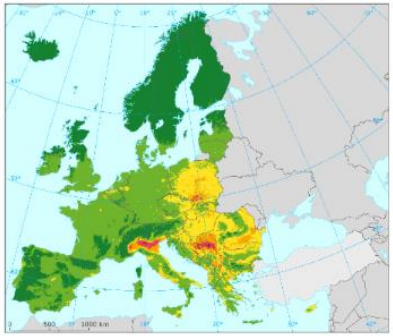
- △ rural background station
- □ urban/suburban background station
- ○ urban/suburban traffic station

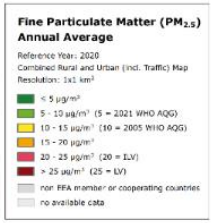
Assessment – Future

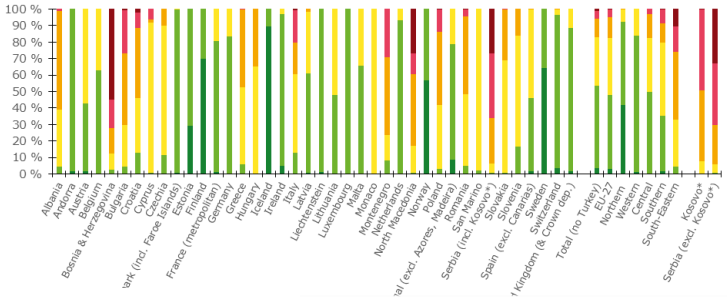
European-wide annual air quality assessment

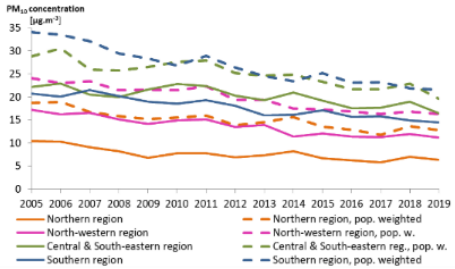
Within the consortium European Topic Centre Human Health and Environment (ETC HE), CHMI provides a support to the European Environmental Agency (EEA) in terms of annual air quality mapping and exposure assessment. Annual reports European air quality maps are prepared within ETC HE, which provides background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

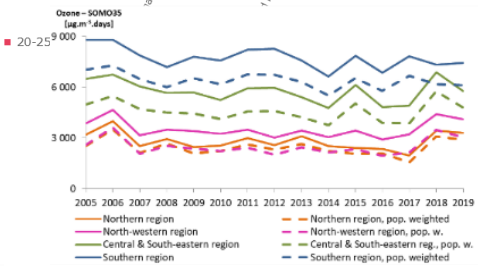












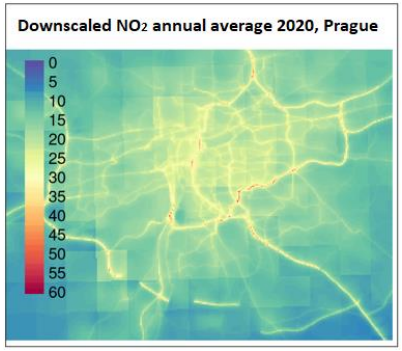
Based on the maps, long-term evolution and trends are also analysed. Within ETC HE, development on the air quality mapping and assessment (including Phytotoxic Ozone Doze and BaP mapping, Air Quality Index) is performed, together with the European partners.

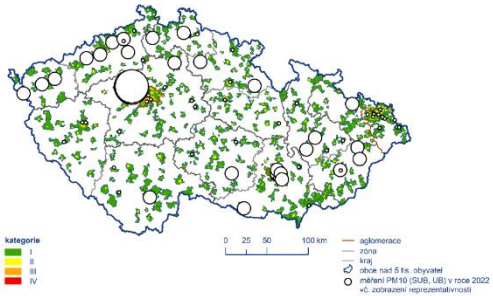
The Air Quality Research Assessment and Monitoring Integrated Systém (ARAMIS) project

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

Key steps for the establishment of a long-term sustainable and stable ambient air monitoring system

Czech Hydrometeorological Institute

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

Placement of Monitoring Stations

Identify key locations where monitoring stations will be placed. These stations should be strategically distributed to cover relevant areas and provide accurate data on air pollution

Crucial are:

- network design,
- station siting
- instrument selection

Selection of Suitable Measuring Instruments

- technical equipment of monitoring stations and data transmission and also management system (control of stations with remote access)
- complete system of instrumentation calibration

Measured data QA/QC has to be guaranteed by methods of measurements

– standard operating procedures

– hardware and software tools

– maintenance, calibration and emergency plans

– appropriate staff in terms of quality and quantity

– personnel training and education

Crucial are:

- correct sampling,
- storage and transport of samples

Correct Data Collection and Data Analysis

Including approval process, data verification

- **Verification** = confirmation obtained by objective evidence that specified requirements are met. Verification, authentication, check, proof of authenticity, review.

- Validation of data ("stamp"), release of data - i.e. „I will not go back to it unless someone questions it“
- **Validation** = proving validity, fitness for purpose. In data terms: comparing the product (numbers, methods) with the expected reality
- In the verification process, provisional (operational) data is compared with all relevant information
- The goal is to have the best possible final dataset with known uncertainty for meaningful comparison with other data

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.

Qualified staff consisting of:

- technical team for the operation and routine maintenance of the stations
- dedicated team for the calibration of automatic instruments, linked to national and international calibration centres
- troubleshooting (external) services
- analytical laboratories for the processing of manually analysed samples
- specialists for data control and verification, interpretation of results and communication with the public and decision makers

Thank you for your attention

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✉*blanka.krejci@chmi.cz*

Czech Hydrometeorological Institute