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HEALTH IMPACTS AND MAIN SOURCES OF PARTICULATE MATTER

Christian Nagl

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CONTENT

- What is particulate matter (PM₁₀, PM_{2.5},...)?
- What are the health impacts of PM?
- WHO guideline levels for PM
- What are the main sources for PM and how can they be identified?

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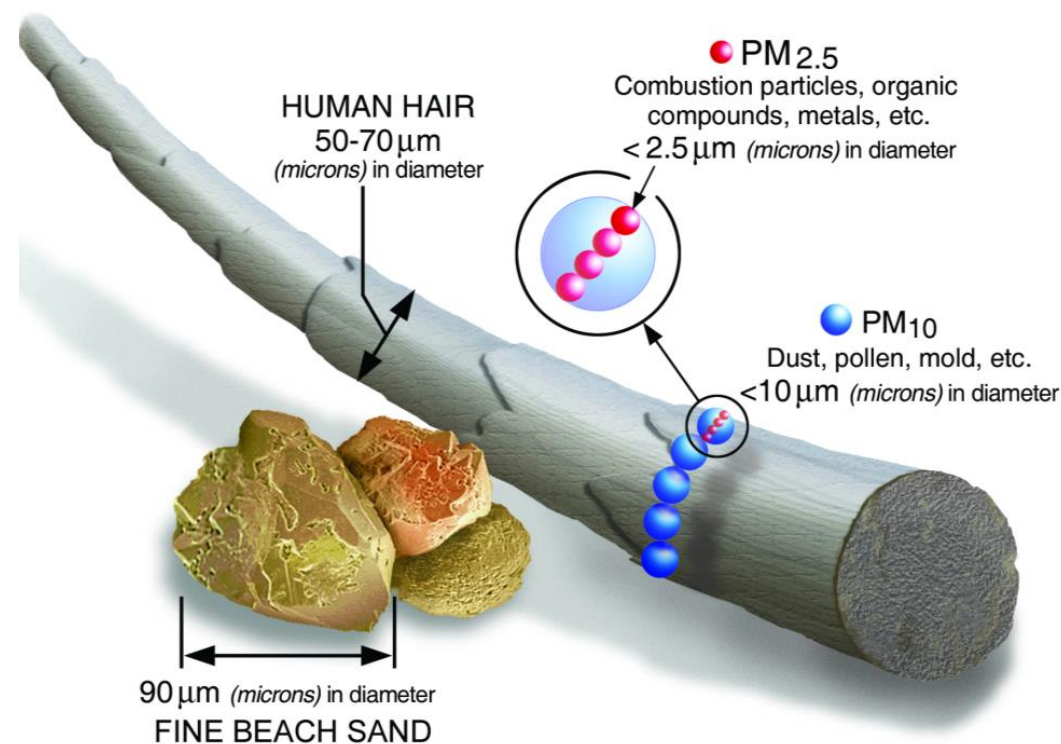




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WHAT IS PARTICULATE MATTER (PM)?

- PM_{10} = particulate matter $< 10 \mu\text{m}$ aerodynamic diameter, corresponds to particles with a diameter of $10 \mu\text{m}$ and density of 1g/cm^3 (usually provided in $\mu\text{g/m}^3$)
- $PM_{2.5}$ = particulate matter $< 2.5 \mu\text{m}$
- PM_1 = $PM < 1 \mu\text{m}$
- ultrafine particles (UFP) = particle number concentration ($\#/ \text{cm}^3$)
- PM_{10} particles are of the same size as cells \rightarrow hence not directly visible
- But: reduced visibility



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© US EPA (<https://www.epa.gov/pm-pollution/particulate-matter-pm-basics#PM>)

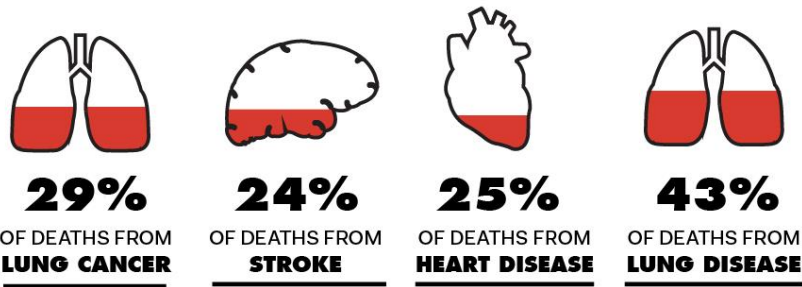


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HEALTH IMPACTS

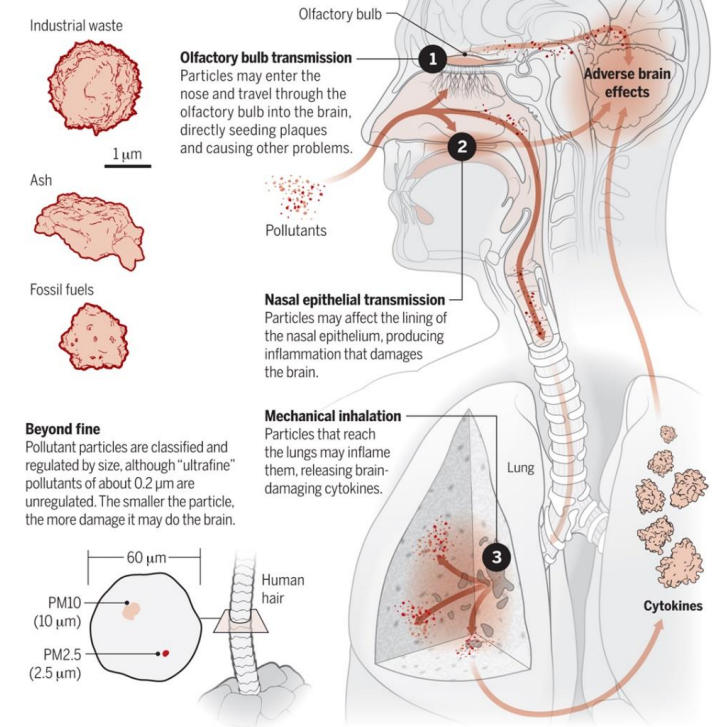
THE INVISIBLE KILLER

Air pollution may not always be visible, but it can be deadly.



Modes of attack

Pollutant particles might make their way to the brain and damage it directly, or they might attack it from a distance, by triggering the release of inflammatory molecules.



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Source: Underwood 2017



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AIR POLLUTION AND HEALTH

- Air pollution is the main environmental threat to human health
- Both ambient and household air pollution contribute to this threat
- 7 million premature deaths due to exposure to AP
 - 21% due to pneumonia
 - 20% from stroke
 - 34% from ischemic heart disease
 - 19% from COPD (chronic obstructive pulmonary disease)
 - 7% from lung cancer
- Fine particulate matter is the most relevant air pollutant



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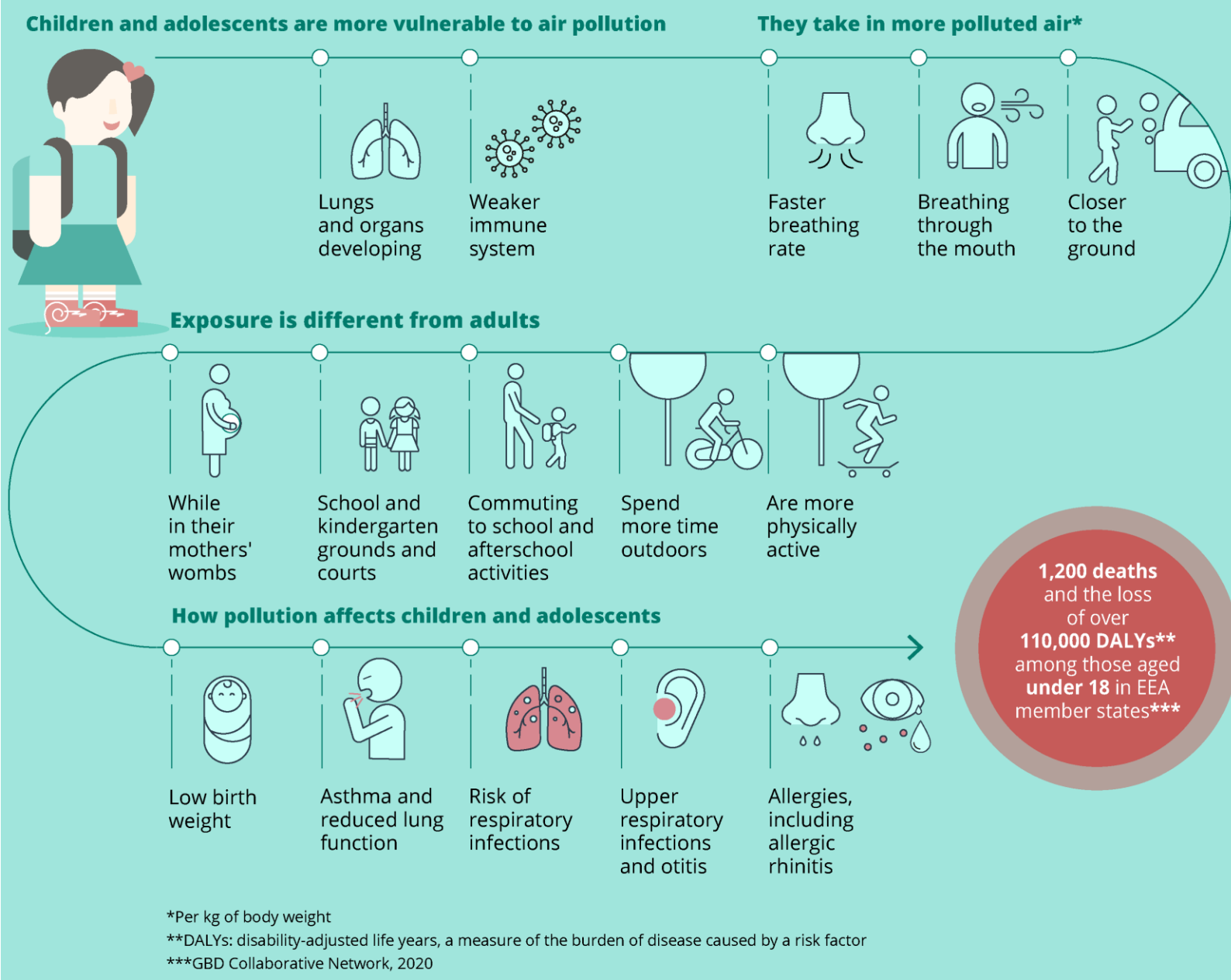




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CHILDREN MORE VULNERABLE

- Impacts of air pollution can have lifelong effects (not only health, but also social and economic)
- Pneumonia major health risk for children → 50% of deaths by pneumonia due to air pollution



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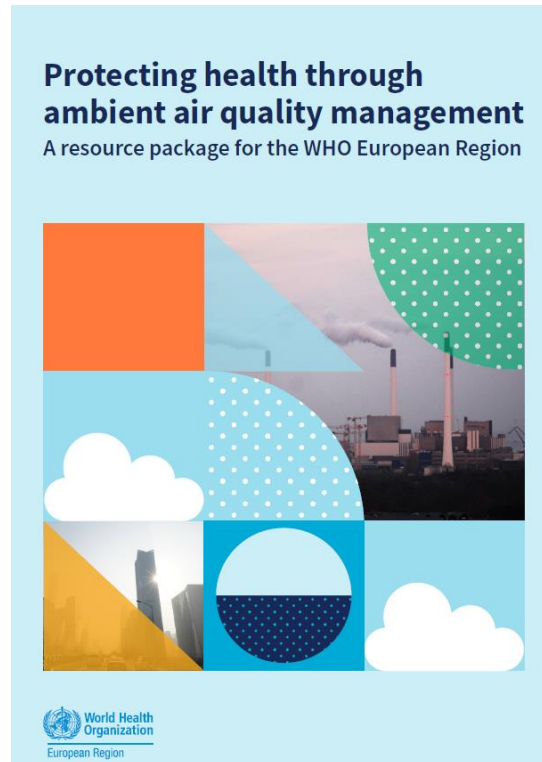
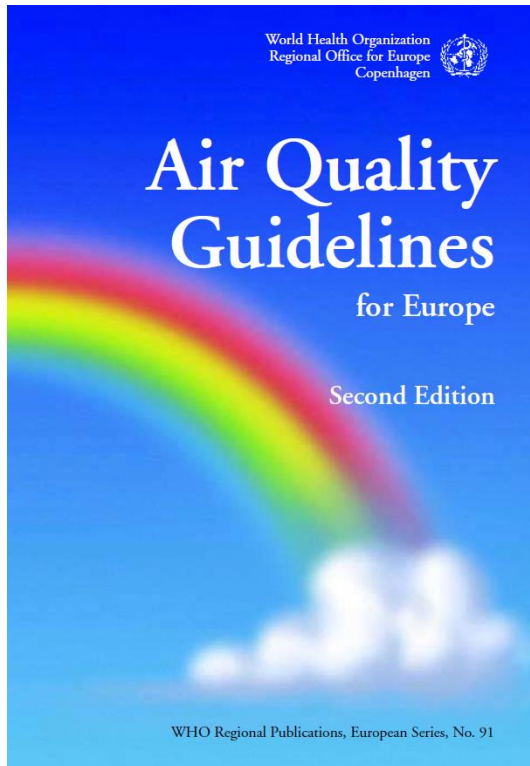


Source: [EEA](#)



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WHO AIR QUALITY GUIDELINES



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WHO AIR QUALITY GUIDELINES (AQG)

- Based on extensive evidence of health impacts of air pollutants
- Identify levels of air quality necessary to protect public health worldwide
- Provide recommendations on air quality guideline levels for PM_{2.5}, PM₁₀, O₃, NO₂, SO₂ and CO
- Not legally binding, but serve as an evidence-informed reference for setting standards, policies, instrument to design measures
- Do not apply to occupational settings
- Do not address specific recommendations on policies and interventions
- Update published in 2021

Pollutant	Time coverage	AGQ level 2021
PM _{2.5} [µg/m ³]	Year	5
	24 h ^a	15
PM ₁₀ [µg/m ³]	Year	15
	24 h ^a	45

^a 99 percentile (i.e. 3-4 exceedance days per year)

Source: [WHO 2021](#)

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RESOURCE PACKAGE TO IMPLEMENT WHO AIR QUALITY GUIDELINES

- Introduction to air quality and its health impacts
- Collection of commented resources and tools for:
 - Air quality policies
 - Air quality standards
 - Air quality plans
 - Air quality modelling
 - Source apportionment
 - Health impacts of air pollution
 - Emission reduction policies and measures
 - Communication, capacity building
 - Training courses



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PM SOURCES AND THEIR IDENTIFICATION

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MAIN SOURCES OF PARTICULATE MATTER

Primary sources

- Residential heating with biomass or coal in old stoves and boilers
- Diesel vehicles
- Open burning of waste and agricultural waste
- Construction works, quarries, agriculture
- Industry, power plants
- Natural sources (desert dust)

Secondary sources

- Ammonium sulphate ($\text{NH}_3 + \text{SO}_2$)
- Ammonium nitrate ($\text{NH}_3 + \text{NO}_x$)
- Secondary organic aerosol (volatile organic compounds): anthropogenic & natural sources



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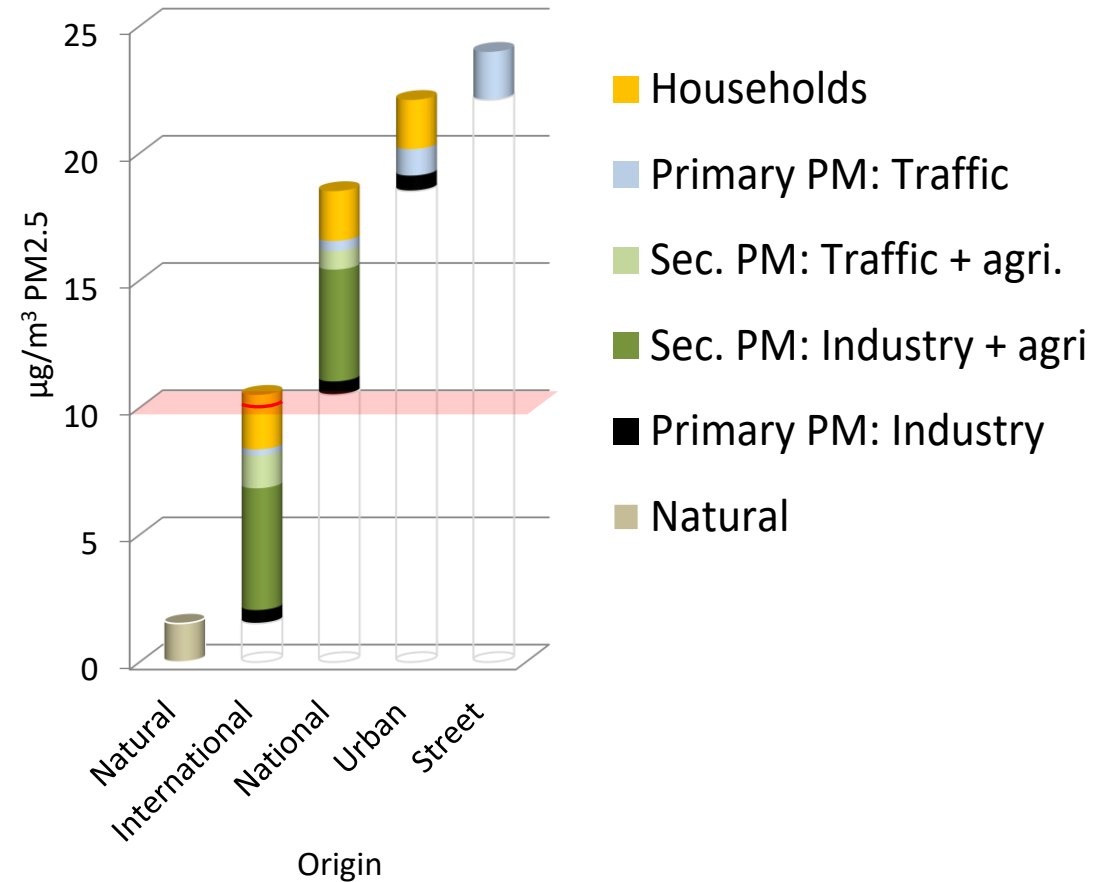


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SOURCES DEPEND ON TIME, LOCATION

- PM contributions
 - international
 - national
 - urban, local
- ➔ Engagement on all levels needed!
- ➔ Most often no single, dominant source ➔ various sources should be addressed
- ➔ Secondary PM often has a large share

Example PM_{2.5} in CZ 2009



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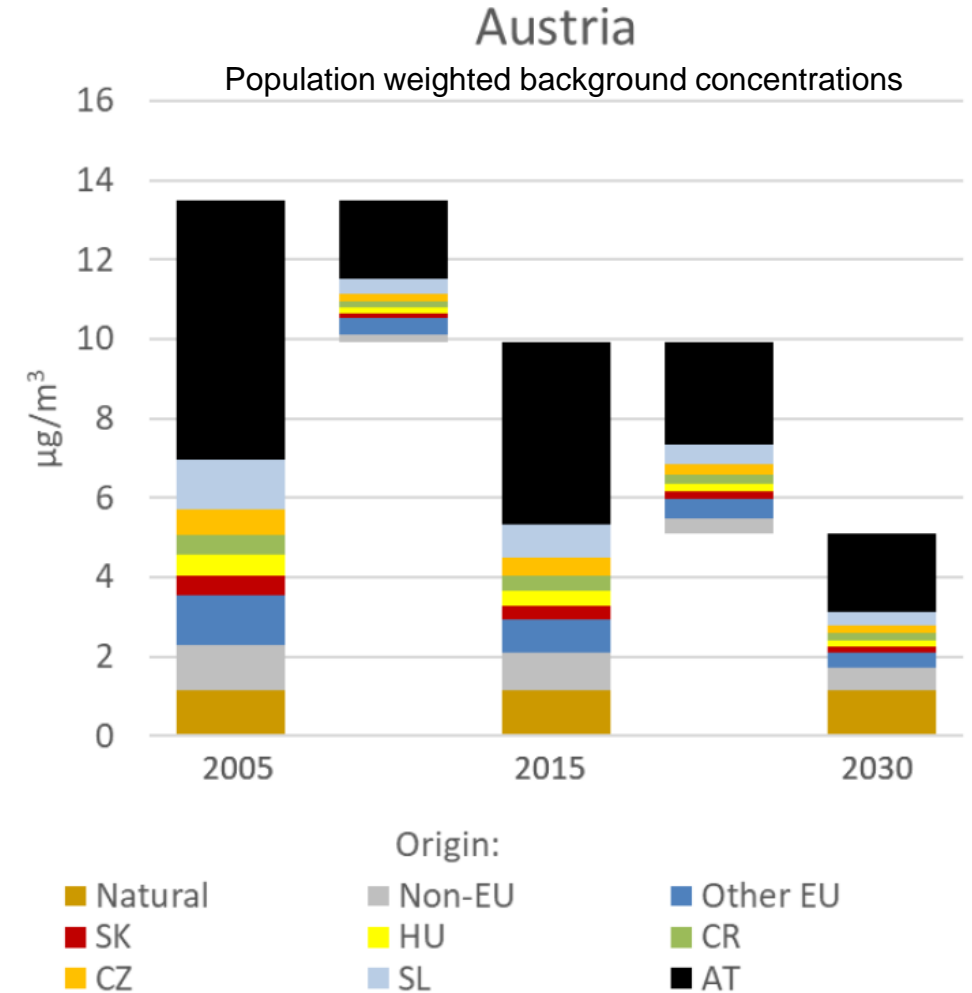
(c) IIASA, Kieseewetter et al. 2014



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TRANSBOUNDARY CONTRIBUTIONS

- Long atmospheric lifetime of particles (up to 1 week)
→ particles are transported over large distances
 - Especially relevant:
 - Secondary particles formed in the atmosphere by precursor substances
 - Desert dust
 - Wildfires
- Cooperation between countries important



Source: [IIASA 2022, 3rd Clean Air Outlook](#)

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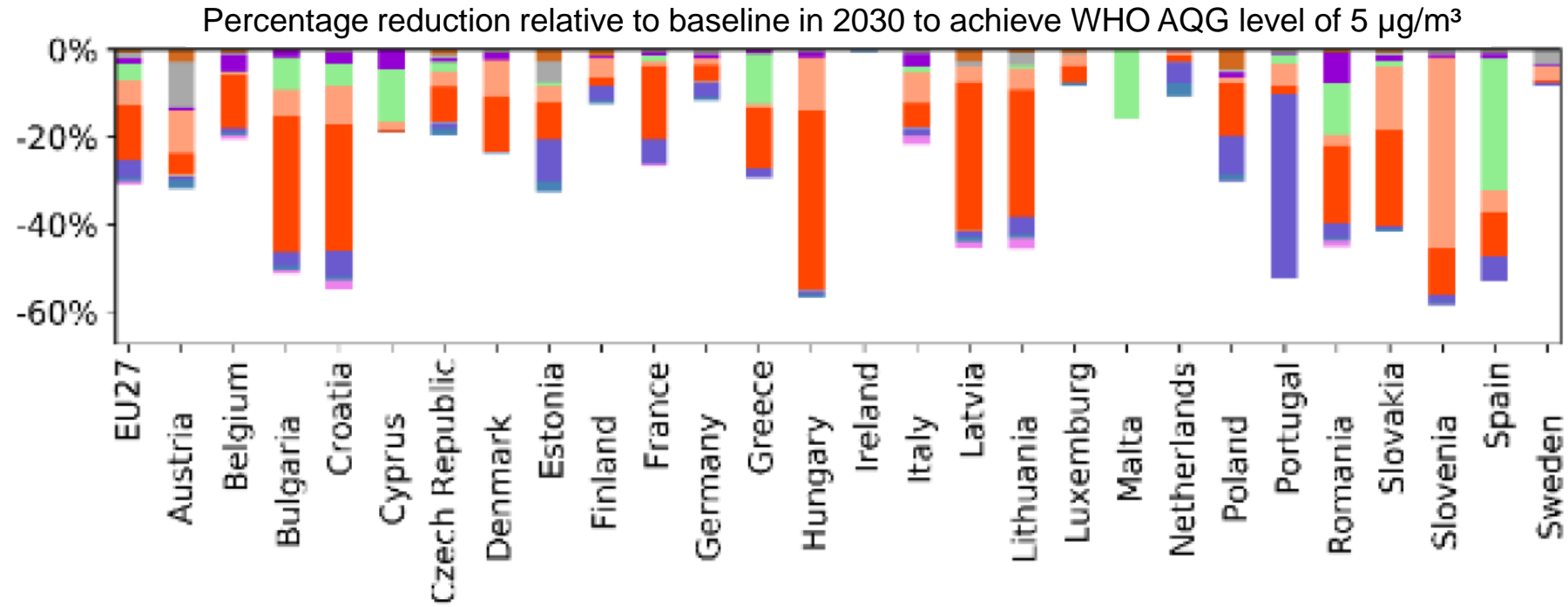
Source: [IIASA 2022, 3rd Clean Air Outlook](#)



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EFFECTIVENESS OF MEASURE DEPENDENT ON LOCATION

- Cleaner residential stoves
- Cleaner residential boilers
- Other industrial processes
- Ban of agri. waste burning
- Power plants PM control



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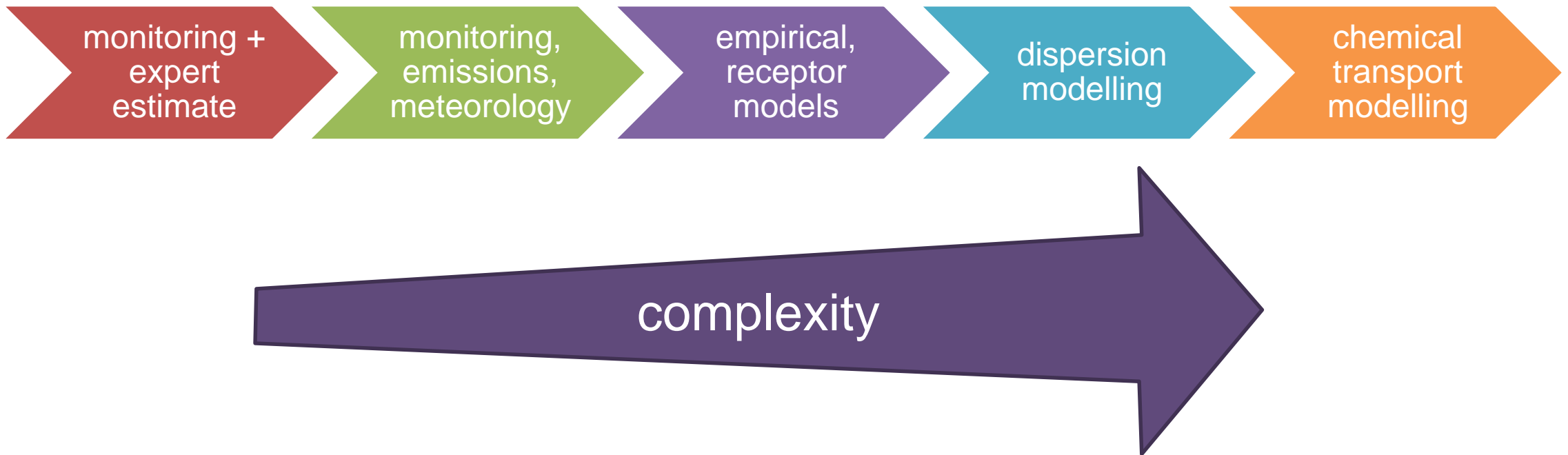


Source: Impact Assessment to Revision of AAQDs



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IDENTIFICATION OF MAIN SOURCES



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DIFFICULTIES TO IDENTIFY PM SOURCES

- Large number of sources
 - Formation of secondary particles
 - Transboundary contributions
 - High uncertainty of emissions from relevant sources
 - Residential heating
 - Construction works
 - Resuspension of road dust
 - Desert dust
 - High uncertainty of PM modelling
- ➔ Pragmatic approach often sufficient and more suitable (monitoring data, information about emissions, expert estimate)
 - ➔ Many no-regret measures
 - ➔ Any reduction of PM levels results in less impact on health

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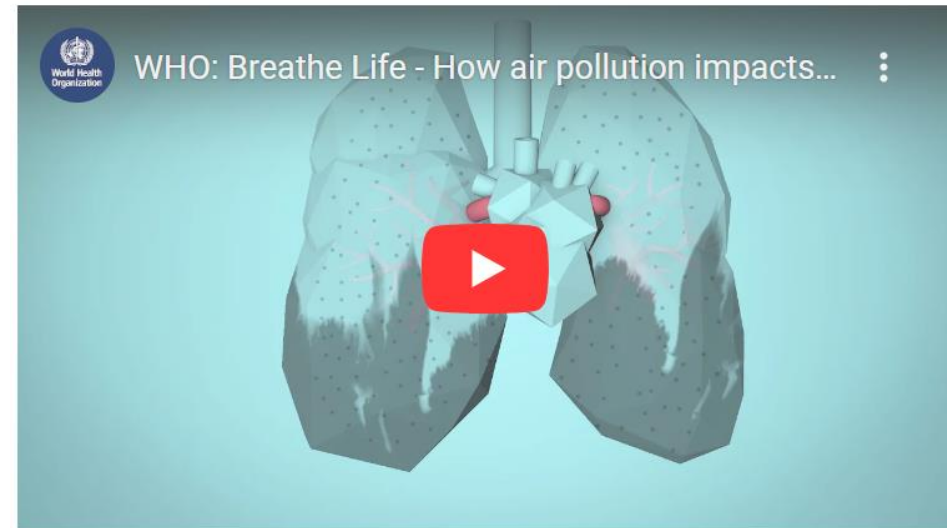


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FURTHER INFORMATION

- WHO, CCAC, UNEP BreatheLife initiative:
<https://breathelife2030.org/>
- [WHO air quality](#), [WHO Europe air quality](#)
- [WHO air quality guidelines](#)
- [WHO resource package](#) to implement guidelines

- [JRC source apportionment guidance](#)



<https://youtu.be/GVBeY1jSG9Y> (in 8 different languages)

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