

Swiss TPH

Air pollution and health: Problems – solutions – and roadblocks

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25 September 2025

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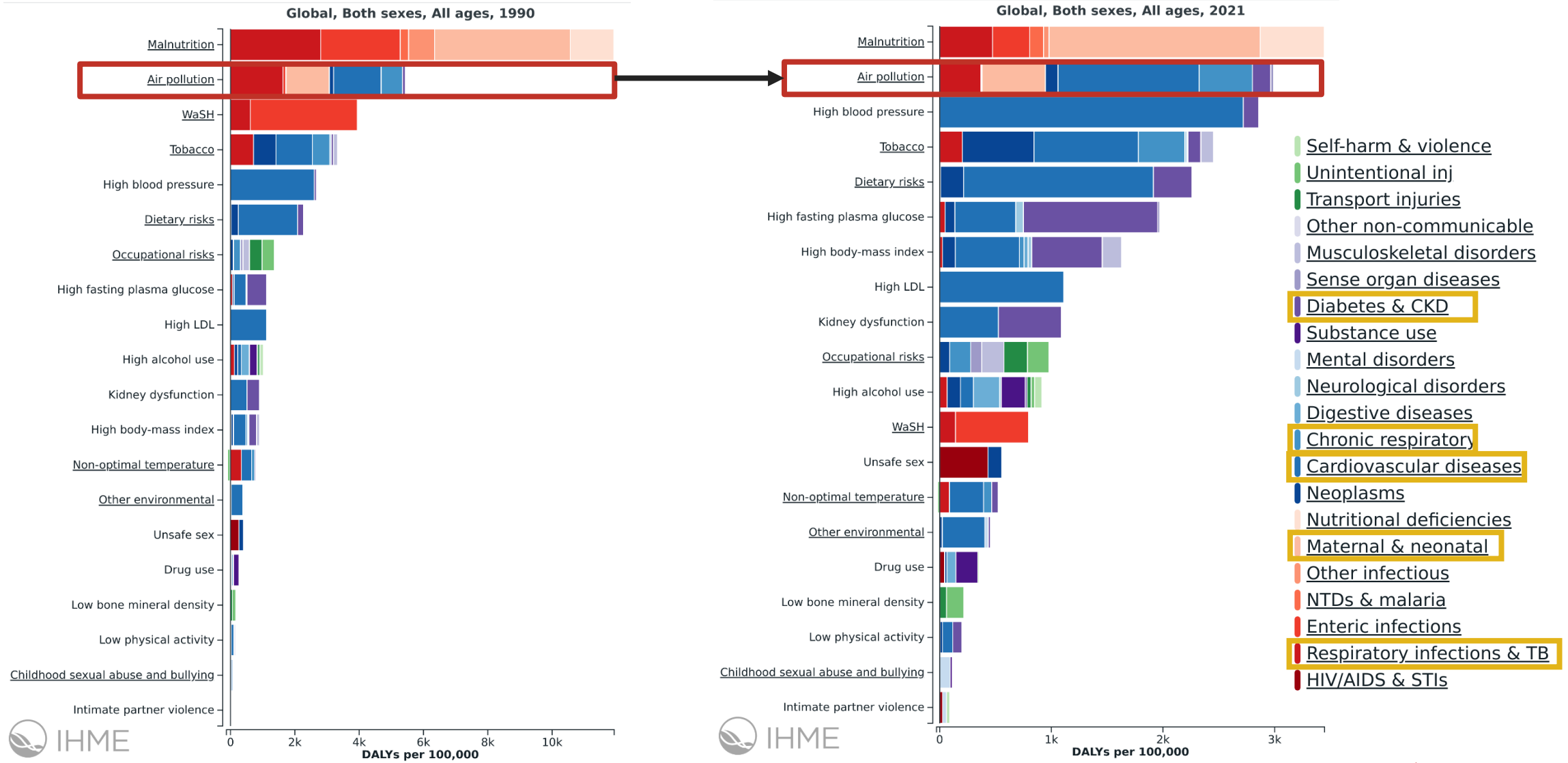
What is the problem?

Global Burden of Disease



From: https://vizhub.healthdata.org/gbd-compare/#

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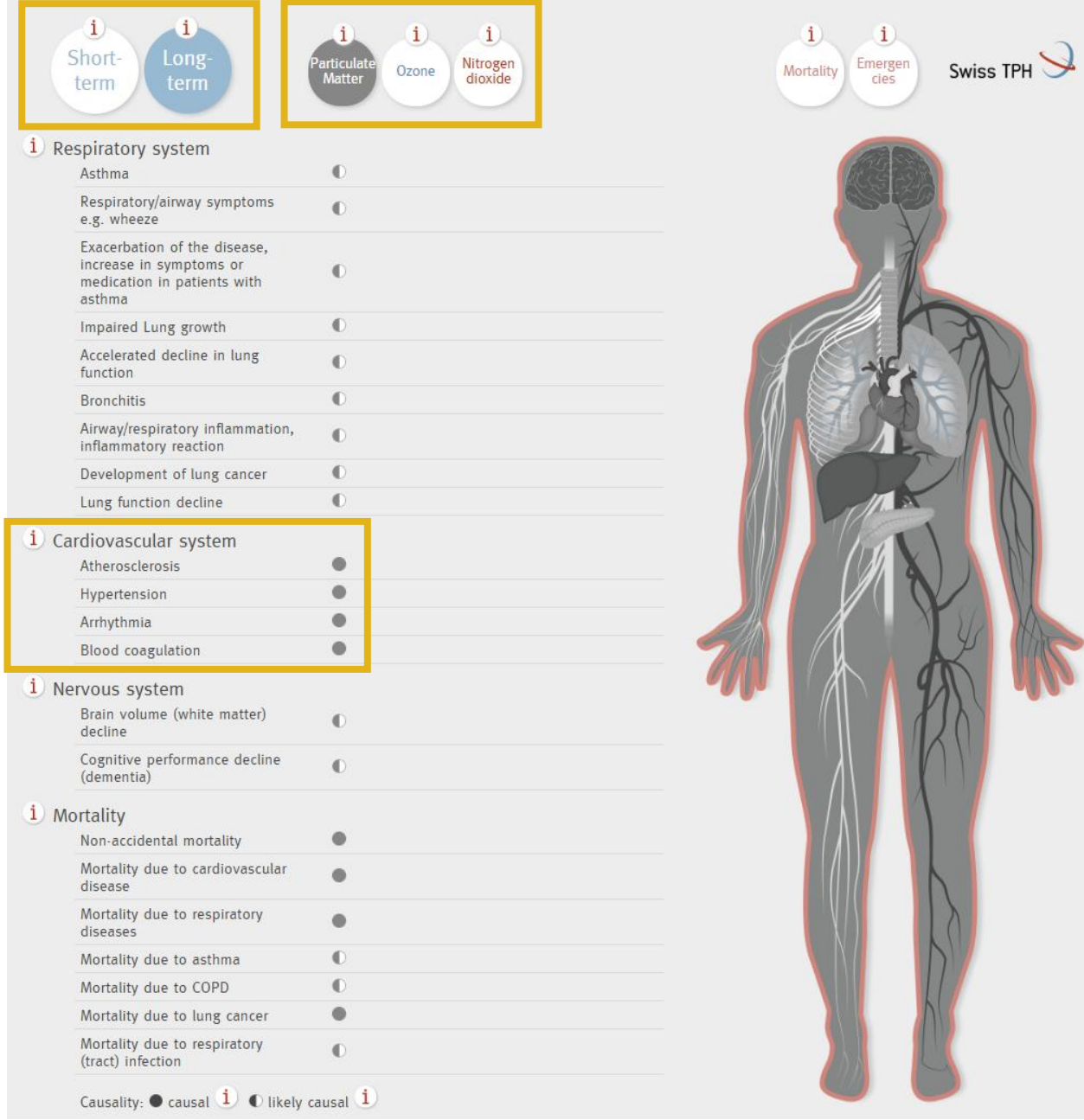
Air pollution affects many organs

- Long or short-term effects
- Different pollutants
- State of the evidence



From:
https://www.swisstph.ch/en/projects/ludok/healtheffects

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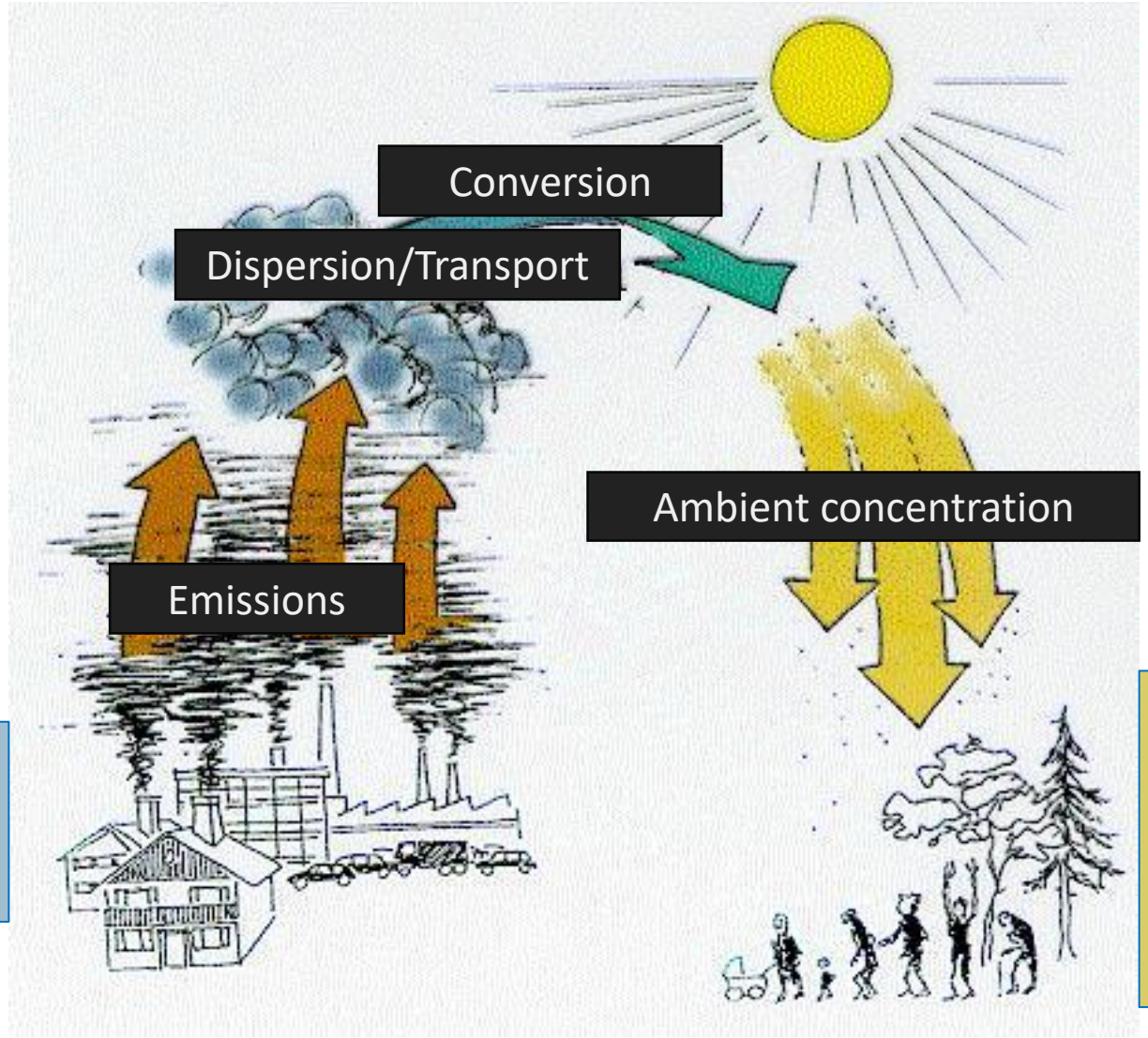
What is the solution?

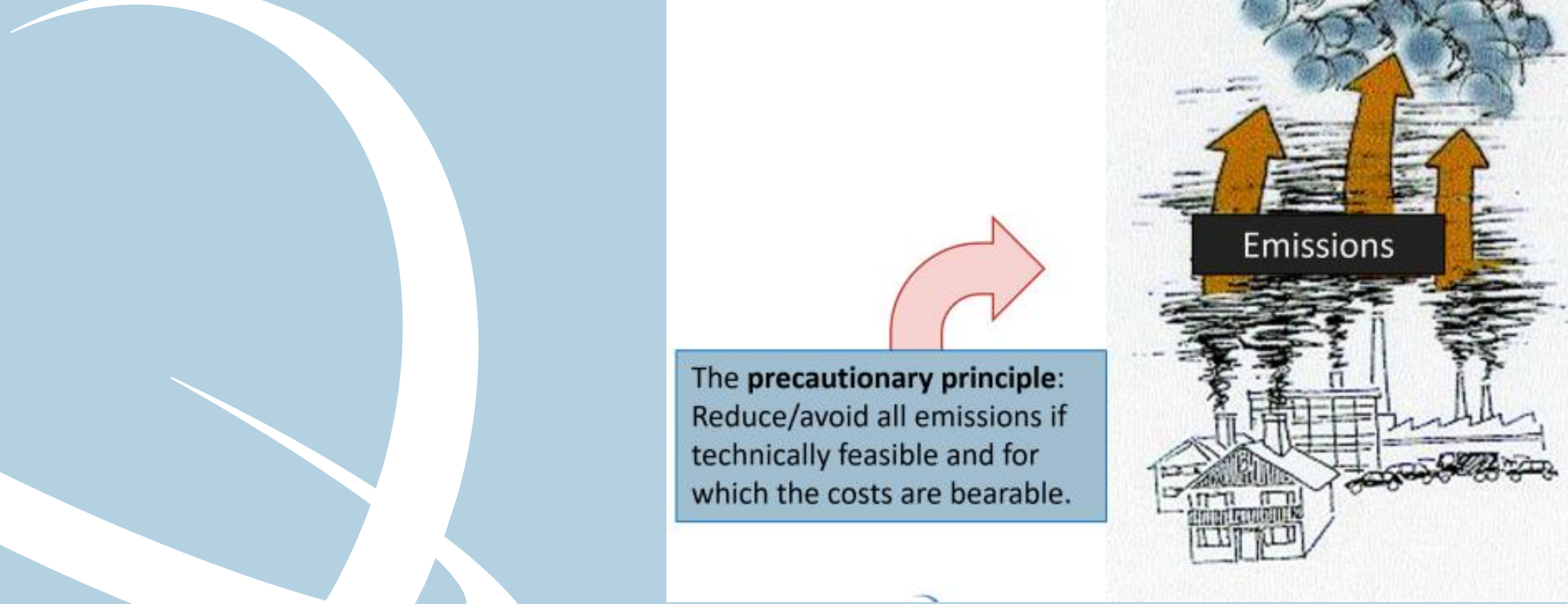
Air pollution regulation – two places to act



The **precautionary principle**: Reduce/avoid all emissions if technically feasible and for which the costs are bearable.

Make sure that:

1) The **health of people** and **animals** does not suffer.
2) **Buildings** are not damaged.
3) The fertility of the **soil**, the quality of the **water**, and **ecosystems** are not negatively affected.



What is the solution?

Reduction of emissions

Air pollution has natural and anthropogenic sources…

Examples of **anthropogenic** sources:

- Traffic (cars, motorcycles, mopeds, trucks, buses, trains)
- Airplanes, propellor planes, helicopters, drones
- Recreation (barbecue, campfires, fireworks, motorsports)
- Industry
- Agricultural burning, intensive cattle farming
- Residential combustion (cooking, heating)
- Smoking (Environmental Tobacco Smoke)
- Power generation
- Construction
- War (bombs, missiles)

Relatively easy to control and regulate

Examples of **natural** sources:

- Volcanic eruptions
- Wildfires
- Desert dust
- Pollen?

Relatively hard to control and regulate

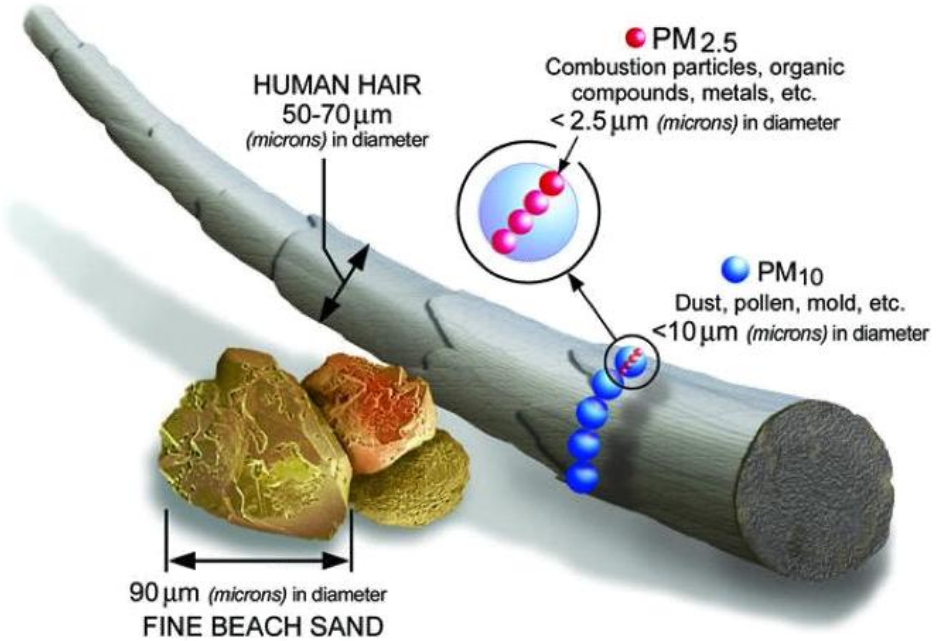



Air pollution is a heterogeneous mixture of gases and particles

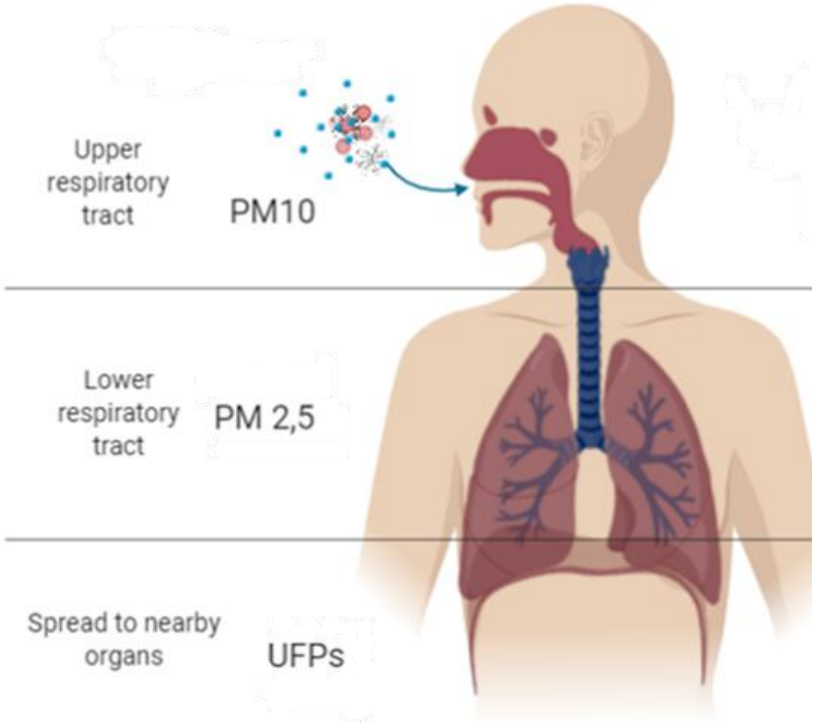
- **Nitrogen Dioxide: NO_2**
  - Brownish gas, irritates the respiratory system
  - Originates from combustion (N_2 in air is oxidized)
- **Ozone: O_3**
  - Stratospheric ozone protects us from UV radiation, but ground-level ozone is an airway irritant
  - Secondary air pollutant: formed by a reaction
    - NO_2+UV-light→NO+O
    - $O + O_2 \rightarrow O_3$
- **Particulate Matter (PM)**

Particulate matter (PM) – Size matters!

- Different size fractions: PM_{10}, $PM_{2.5}$, ultrafine particles (<0.1 µm)
- The smaller the particles, the deeper they penetrate into the lungs
- Ultrafine particles can transcend between the lung-blood and blood-brain barriers
- We don't have enough epidemiological evidence on ultrafine particles (yet)



From: US Environmental Protection Agency

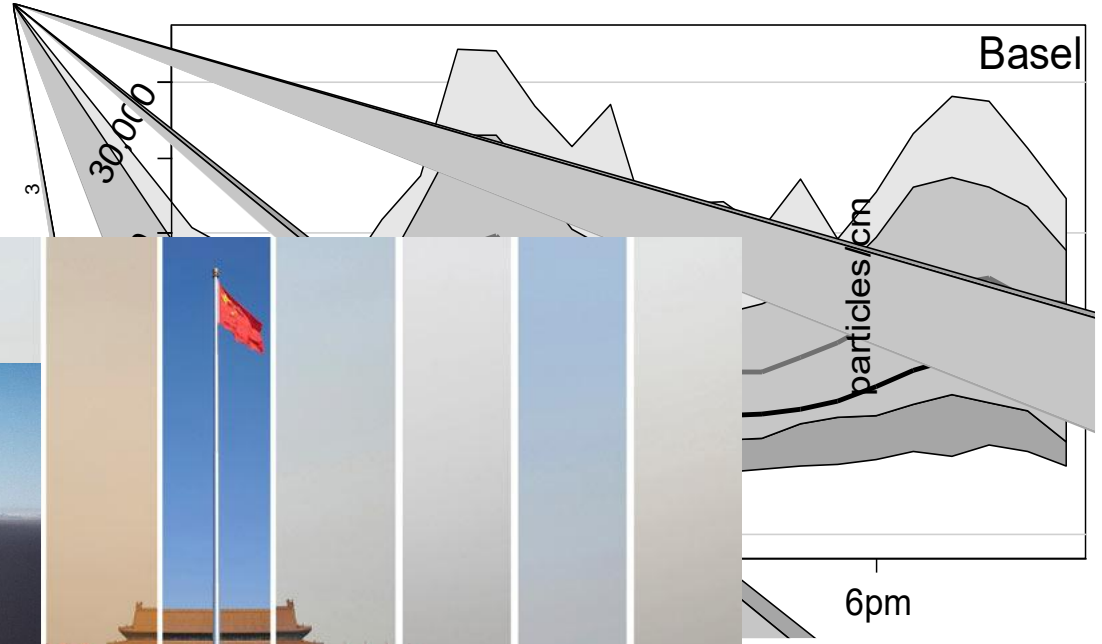


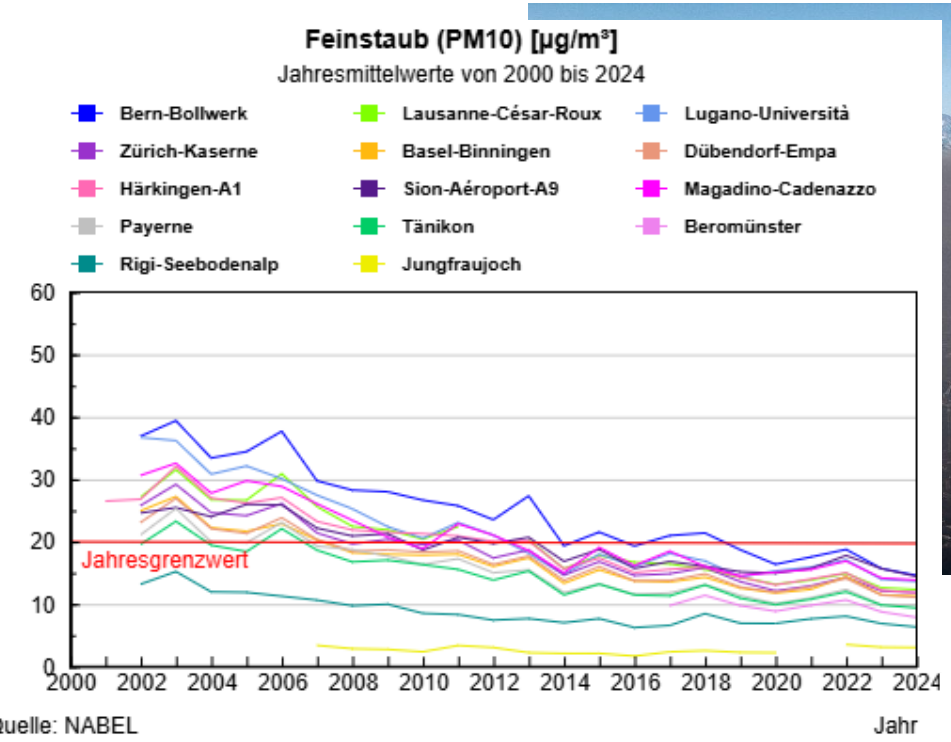
From: Loaiza-Ceballos, 2021

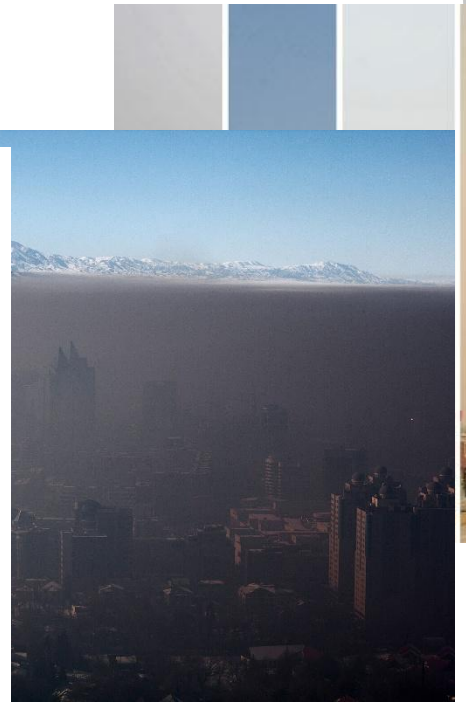
Air pollution concentrations vary in time…

- Diurnal - rush hour
- Daily basis - weather & activity dependent
- Seasonal basis - inversions, heating season
- Long-term trends

From: Meier et al., 2015

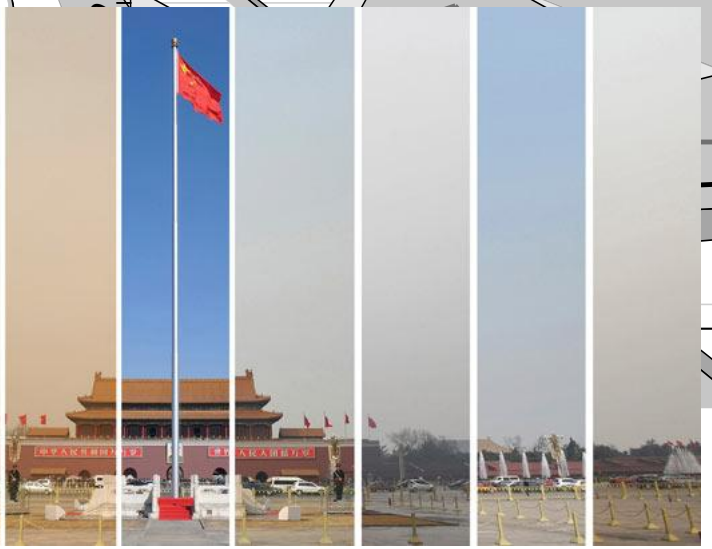






Almaty, Kazakhstan during an inversion

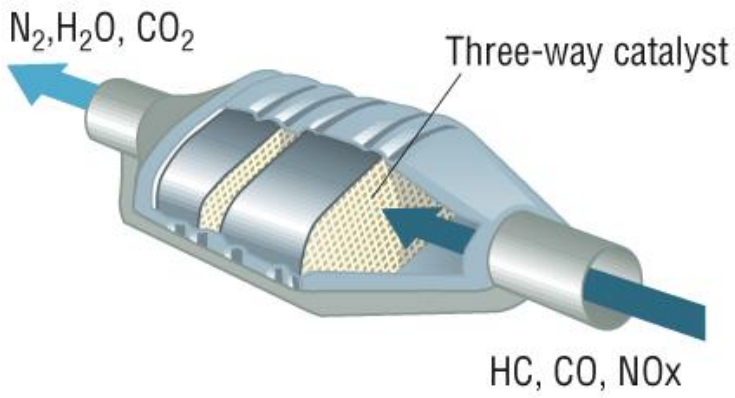
From: NABEL Switzerland

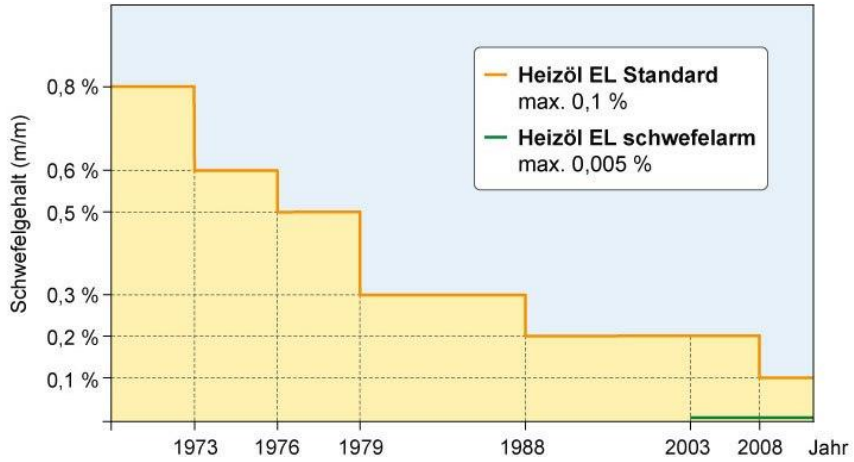


Air Pollution over Tiananmen Square, China
From: The Guardian

Examples of interventions on the emissions side

- Since 1970: Phase-out of tetra-ethyl lead as anti-knock agent in petrol for cars
- 1970-2010: Use of increasingly low-sulfur fuels
- Since 1987: Catalytic converters on cars: reduction of NO_x, oxidation of CO and unburned hydrocarbons
- 1990: Irish coal ban
- From 2000 onwards: Diesel particulate filters
- From 2035 onwards: Electric driving - no more combustion engine sold in Europe after 2035!



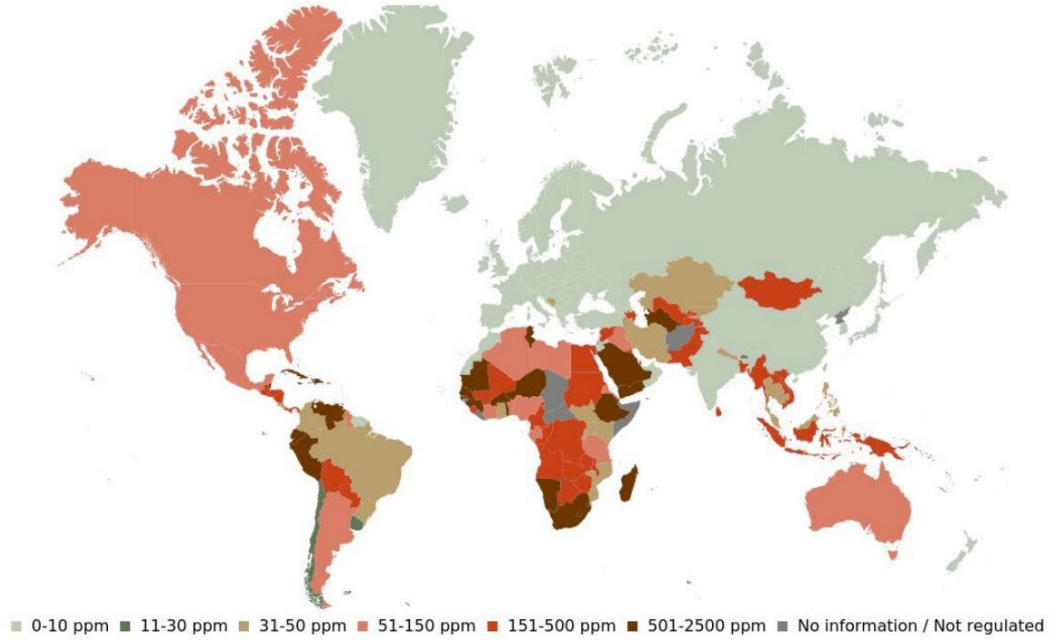


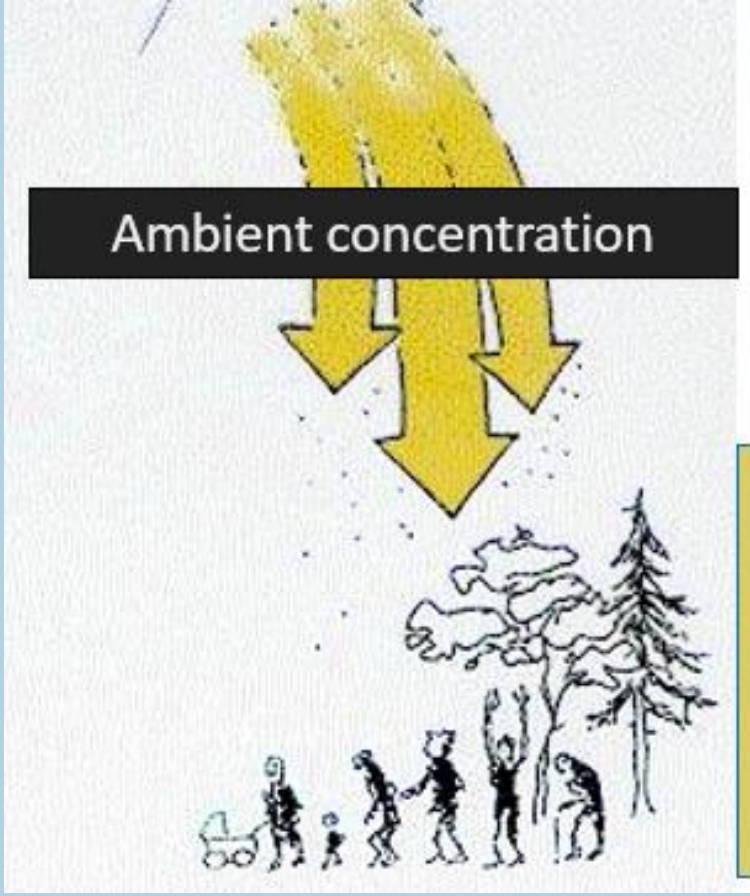
Roadblocks

- Still a lot of unnecessary anthropogenic pollution
- Environmental inequality: polluting activities / fuels are moved to low & middle income countries

Stubble burning in Pakistan
From: https://imaggeo.egu.eu/view/4190/

Maximum sulfur limits in gasoline, 2023
From: Stratas Advisors





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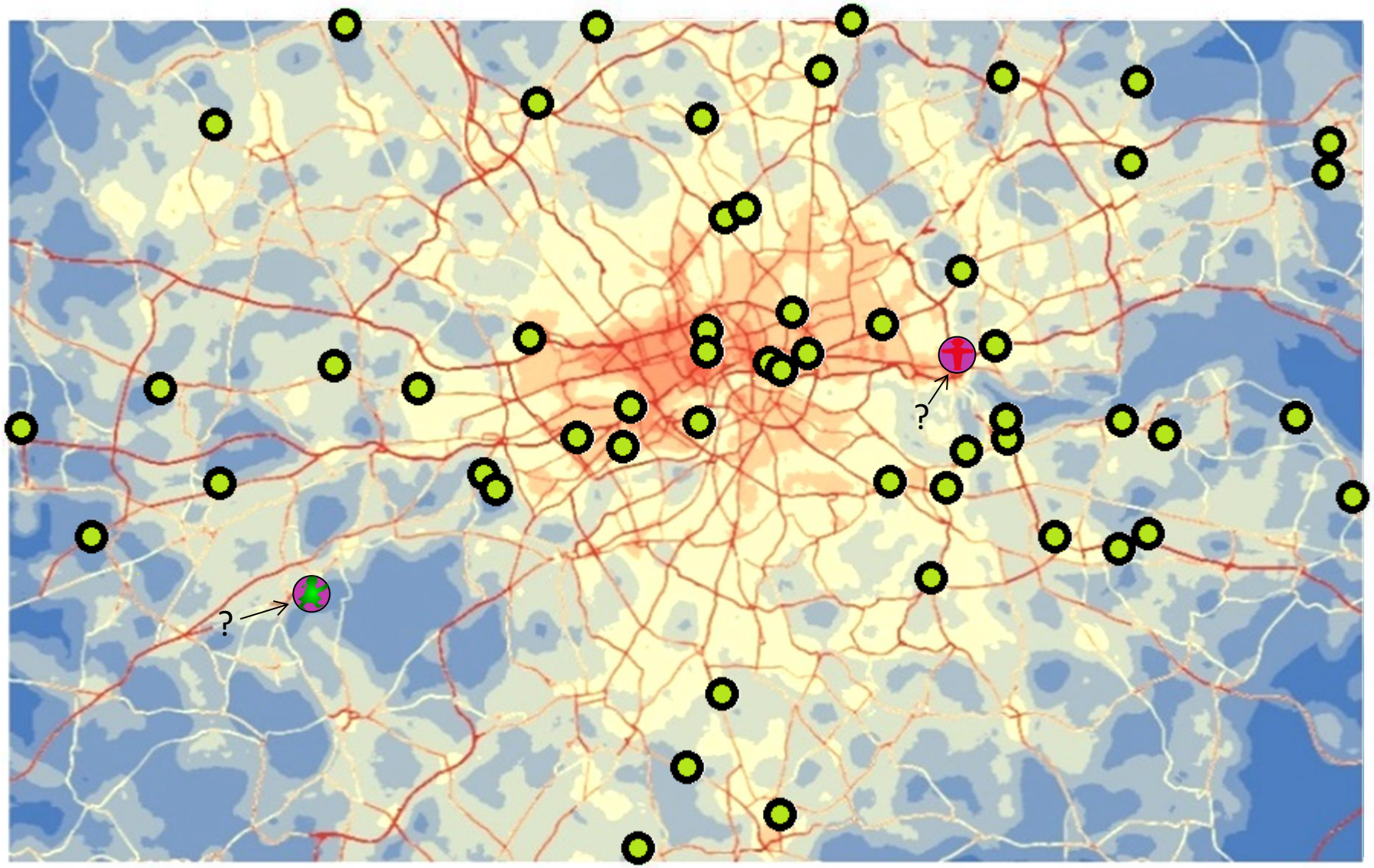
What is the solution?

Regulation of ambient concentration

Ambient concentrations: Epidemiological studies in a nutshell



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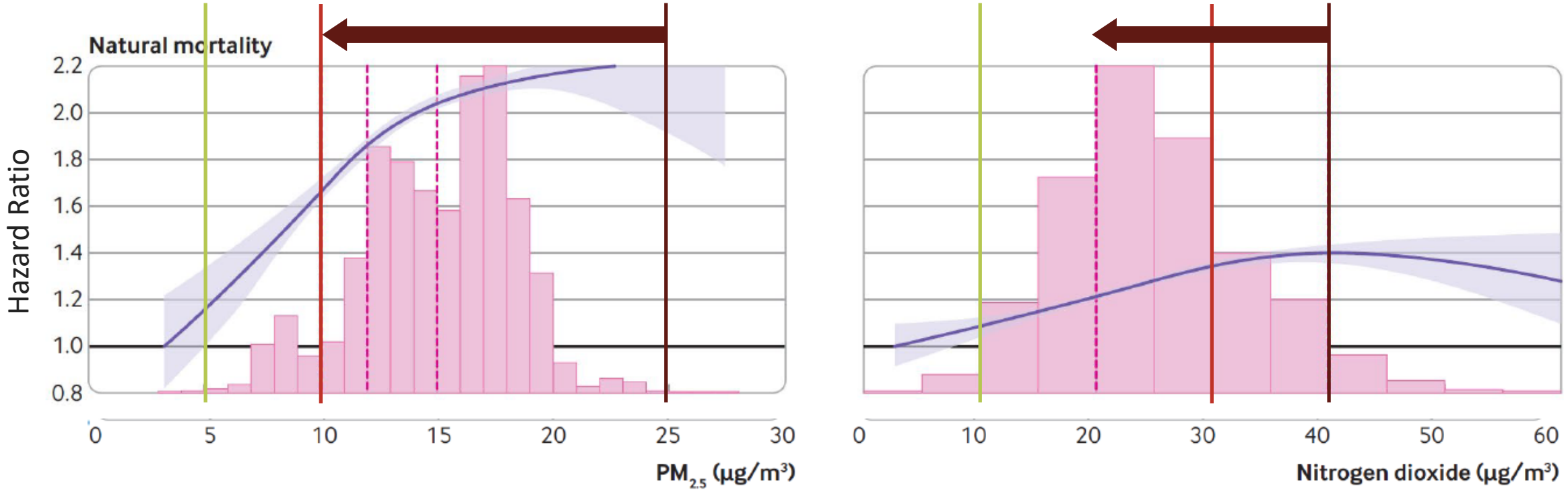
What does a concentration-response curve have to do with health protection?

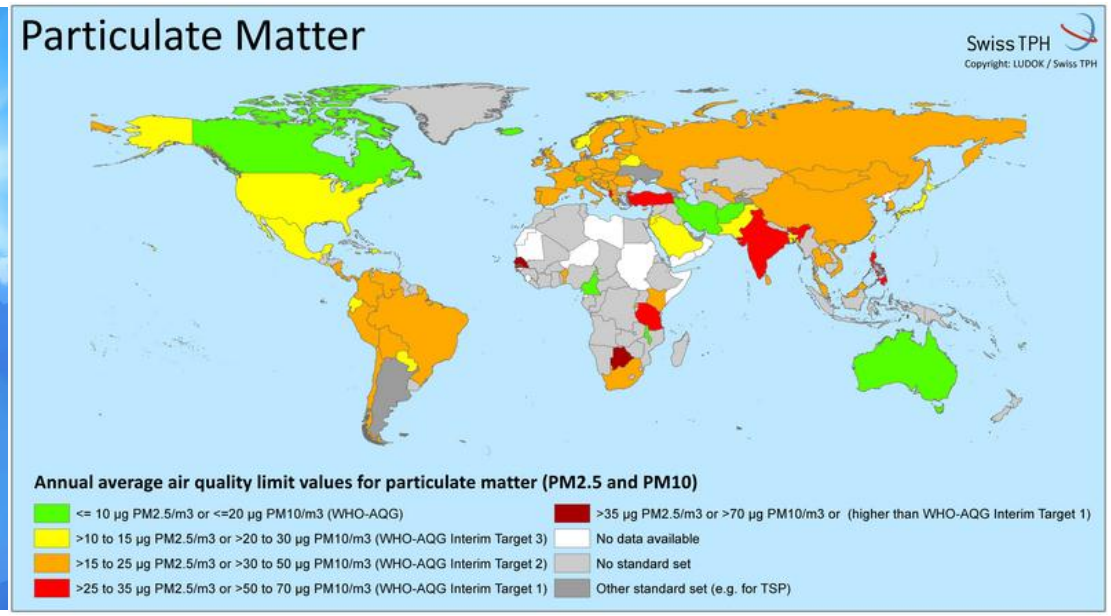
- **Pink**: The exposure distribution on the European population
- **Blau**: Concentration-response curve: the risk increases with higher exposure
- The **brown** line shows the current air quality standards in der EU and changes planned for 2030
- The **red** line shows the current air quality standards in Switzerland
- The **green** line shows what World Health Organization (WHO) recommended in 2021
- Every additional reduction in air pollution benefits public health

Strak, Weinmayr, Rodopoulou et al., 2021. Results from the ELAPSE study: Effects of Low-Level Air Pollution: A Study in Europe

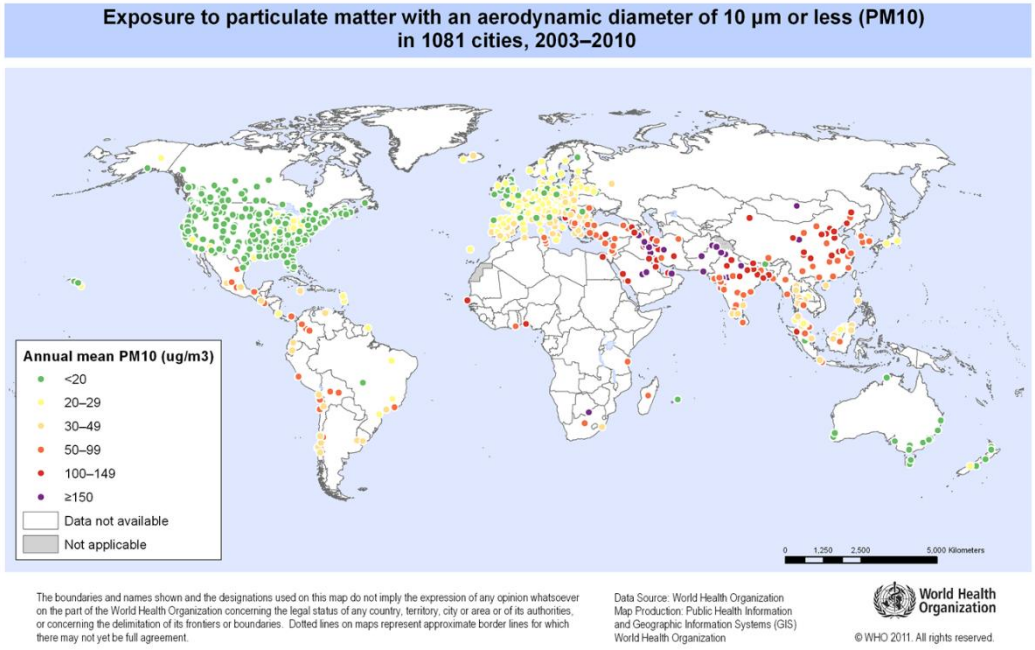


Roadblock: are the current laws sufficient to protect our health?

- Most countries have "acceptable" limit values that are (far) above the WHO's recommendations
- For particulate matter, only PM_{10} und $PM_{2.5}$ are regulated, ultrafine particles not (yet)
- Regulations do not ensure clean air when they are not enforced



Kutlar Joss, Eeftens, …, Künzli, *IJPH*, 2017



From: World health Organization, 2011

Environmental Epidemiology

1) Air pollution remains a major problem around the world
2) Reduction of emissions and regulation of ambient air and enforcement are solutions
3) Roadblocks:
   - Unnecessary anthropogenic emissions and inequal distribution of polluting activities
   - Current legislation accepts exposure levels at which health effects still occur, and do not yet regulate all pollutants

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