



# EPCAC – Expert Panel on Clean Air in Cities

Position paper: Clean Air in Cities

Co-chairs:

- **Martine Ouwersloot**, Ministry of Infrastructure and Water management, Netherlands
- **Guus Velders**, RIVM, Netherlands

# Summary of Paper



Goal: Provide cities with options to improve their air quality

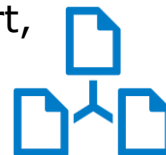
- Sources of air pollution differ per city and pollutant → Tools: GAINS, Sherpa, ...



- Many sources outside the city → Collaboration at regional, national and international level necessary



- Synergies between policies are needed: Climate, Transport, Air quality



**Remember!!!**



## Summary

1. Introduction: Air quality is still a problem, especially in cities
2. The air quality situation in cities
3. Sources of air pollution impacting cities
4. Measures
5. The way forward

Annex 1: List of potential interventions

Annex 2: How to develop a successful multi-level air quality plan

References

**Writing team:** Andreas Eisold, Philippe Thunis, Gregor Kieseweter, Martin Lutz, Rob Maas, Maaike Lammerts-Huitema, Martine Ouwersloot, Guus Velders



# Air quality in cities



Measured annual mean PM<sub>2.5</sub>  
(population weighted,  $\mu\text{g}/\text{m}^3$ ) in 2019

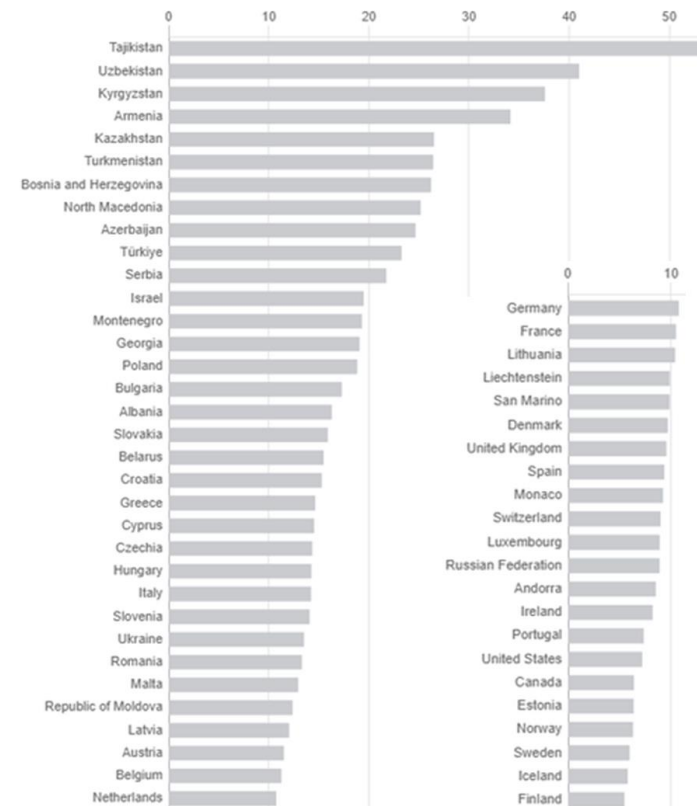
Already significant reductions in urban air pollution

Still largest environmental threat to public health globally



Large differences between cities:

- Closely connected cities
- Cities in industrial areas
- ... in rural areas
- ... in mountains



# Air quality in cities: key elements

- Cities contribution to **their own pollution**: NO<sub>2</sub> (dominant), PM (often significant)
- Significant pollution from **outside the city**
- Pollutants from cities transported over long distances → **background air pollution**
- Local measures essential when local contribution is high; achieving WHO guidelines require **actions are various levels**
- Largest benefits for public health by **reductions in population exposure**
- Many measures that offer **win-win solutions** to objectives in other policy areas (energy, health, urban planning)

# Tools for sources of air pollution in cities

Main emission sector contributing to ambient  $\text{PM}_{2.5}$  in cities are estimated with the GAINS model (IIASA) and SHERPA (JRC)



# Tools: Sources of air pollution: GAINS

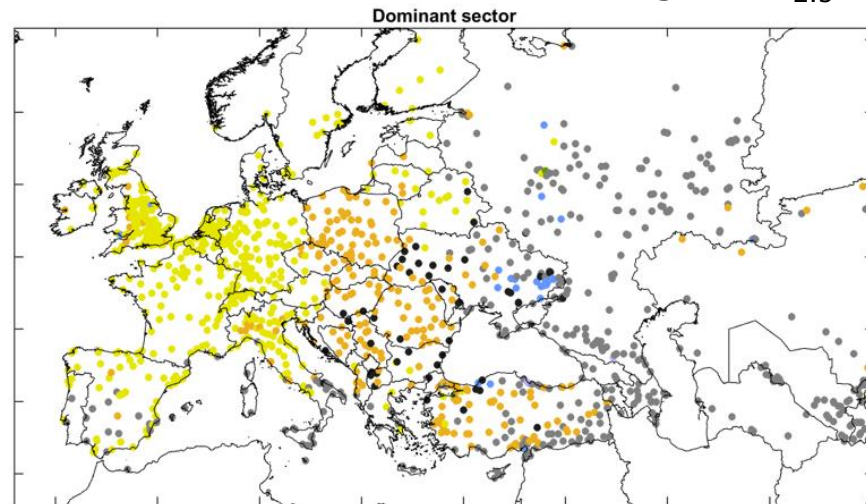
- Central and Eastern European countries: residential combustion dominant



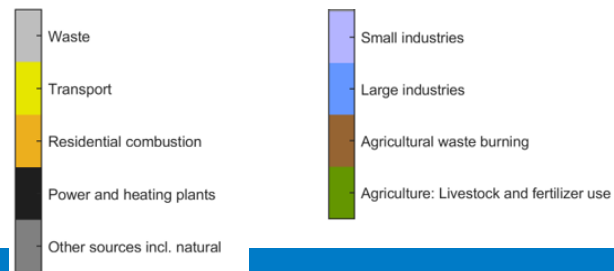
- Western Europe: transport



## Main emission sector contributing to PM<sub>2.5</sub>



GAINS (IIASA)



# Tools: Sources of air pollution: JRC atlas (SHERPA)

- Central and Eastern European countries: residential combustion dominant



- Western Europe: residential

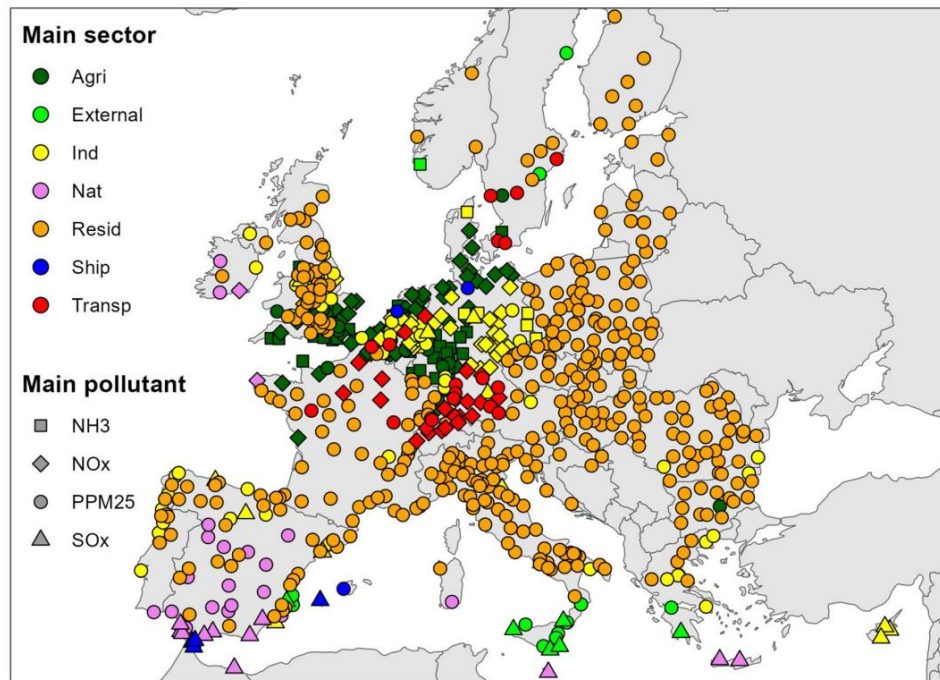


- Benelux, western Germany: agriculture



- Differences SHERPA and GAINS:
  - Model setup
  - Inventory emissions
  - Year of calculation
  - Only most important sectors shown

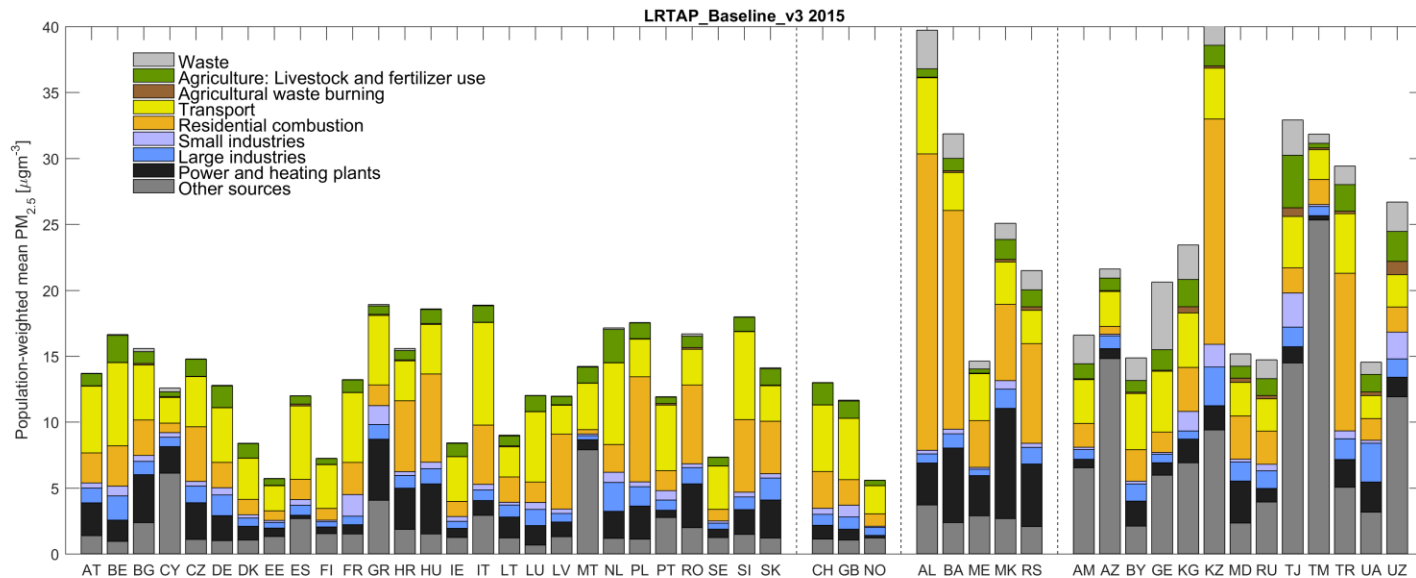
## Main emission sector contributing to PM<sub>2.5</sub>



JRC atlas, Zauli-Sajani et al. (2024)

# GAINS: Source sector contributions in cities

- Population weighted average of all cities > 50,000 inhabitants within each country)



Source: CIAM/IIASA, GAINS model calculations for the Gothenburg Protocol Revision, described in TFIAM Policy Brief.

# Sources of PM<sub>2.5</sub>



## Local:

- Residential combustion with solid fuels
- Road transport: combustion and non-exhaust emissions
- Construction activities (urban exposure)
- Municipal waste burning
- Some cities: large industrial facilities and shipping in city → urban background



## National/regional:

- Large industrial plants, highways, airports, national shipping, agriculture
- Contribute to urban background
- Secondary inorganic aerosols: formation from ammonia and nitrogen/sulfur oxides



## Transboundary

- Depends on location of city
- Mainly secondary aerosols, but primary may also contribute (wood burning, forest fires)



# Sources of NO<sub>2</sub> and ozone

NO<sub>2</sub>:

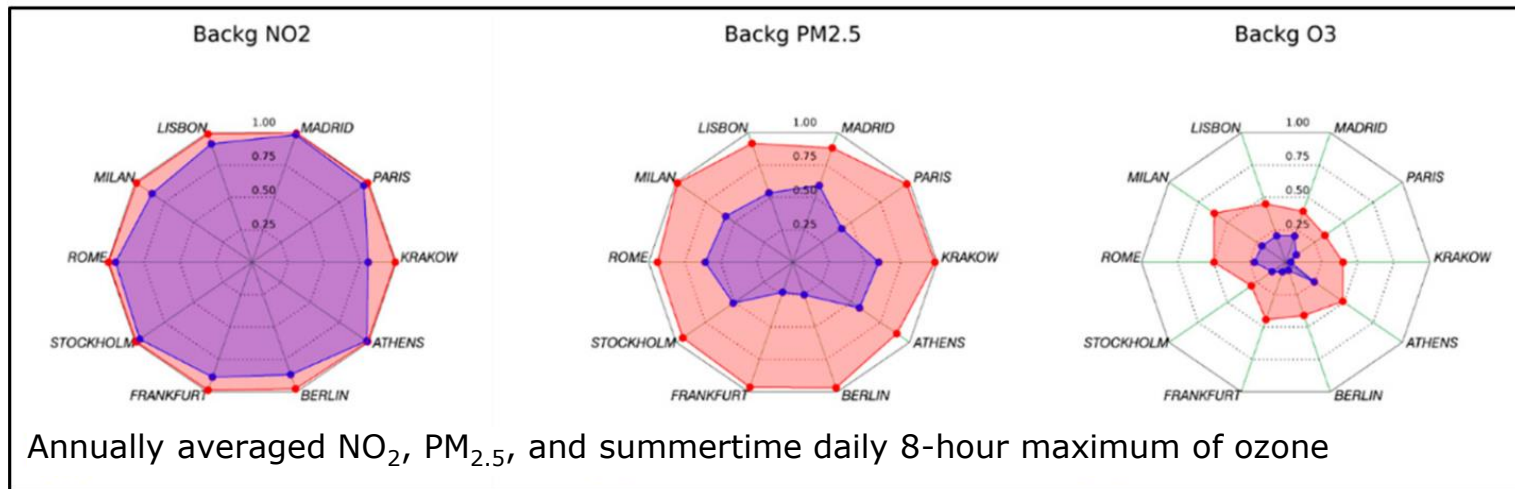
- Local sources: transport, residential (industry and shipping also in some cities)



Ozone:

- Formed in atmosphere from anthropogenic/biogenic NO<sub>x</sub>, NMVOC, and methane, with sunlight
- Precursor emission transported over long distances to produce ozone

# City (blue) versus EU reductions (red)



Pisoni et al., (2022)

**PM<sub>2.5</sub>:** Measures needed on all spatial scales

**NO<sub>2</sub>:** Exposure reduction almost entirely by local measures

**Ozone:** Strong focus on large-scale measures (also outside of Europe)

**But,** to what extent do urban measures require regulatory/financial support from national governments (or EU)

# Long list of potential measures

- Mainly from “Review of interventions to improve outdoor air quality and public health” from Public Health England (2019)
- Also, “Indicative list of air pollution abatement measures” in Section B of Annex VIII of the revised EU Air Quality Directive (2024)

No.	Measure/intervention	Policy type(s)	Spatial scale of implementation	Targeted emissions (AQ or GHG)	Main governance level in charge of implementation and enforcement	Requisite support from other governance level
<b>Reduce demand for more polluting forms of transport</b> by reducing overall travel or restricting certain types of vehicles or encouraging the uptake of sustainable transport						
T1	Promote freight modal shift from road to rail through pull measures	Funding Infrastructure	national	NO <sub>x</sub> , PM	National, by funding schemes and investments in rail infrastructure	EU/international through coordination of rail infrastructure investments to facilitate
T2	Emission dependent lorry road user charging	Taxation	national	NO <sub>x</sub> , PM CO <sub>2</sub>	National, by operating road pricing schemes on national motorways and main roads	EU/international by providing or harmonizing regulatory framework for road user charging, as relevant
T3	national road pricing for all vehicles and/or vehicle taxes, preferably emission-dependent	Taxation	National	NO <sub>x</sub> , PM CO <sub>2</sub>	National, by operating road pricing schemes on national motorways and main roads	EU/international by providing or harmonizing regulatory framework for road user charging, as relevant

# Measures to improve air quality in urban areas

- 63 on Road and non-road mobile machinery
- 16 on Industrial and residential heating
- 7 on Urban planning and on behavioral change

Also important are measures in agriculture:

- Controlling ammonia from livestock, manure management/storage and fertilizer
  - essential to reduce  $PM_{2.5}$  exposure in cities
- Regional/national/larger level → (inter)national collaboration



# Wide range of measures exists

- Most effective combination depends on local conditions and distribution of sources
- Local authorities are main actor, but collaboration across all level of governments is essential for effective implementation
- Coherence between policy areas is essential: air quality, climate/energy action
- To maximise health benefits, measures with a city-wide effect should receive more focus than hot-spot measures

# The way forward to improve air quality

Increase knowledge on:

- Rating of synergies between climate change adaptation and air quality management
- Health impact of various PM species
- Health benefits of combined PM, NO<sub>2</sub> and ozone mitigation
- Distribution and effects of particle number concentration (UFP fraction)
- Emission factors for combustion of modern fuels (hydrogen, ammonia, etc.)
- Emission factors for non-exhaust emissions from road transport
- Non-technical measures where regulation reaches its limits



# Next steps EPCAC

Policy: Maintain, strengthen network of experts and policy makers

- **Focus on cities**: Eurocities, Governance of Mayors

Science: Continue work on model comparisons

- Differences in source attribution and emission reductions: EMEP/GAINS, JRC/Sherpa, Chimere, local/national modelling experiences
- Connections with TFMM, TFH, HTAP

Meeting: Annual EPCAC meeting, next in fall 2025

Report: Annually to TFIAM on progress

# Thank you



Position paper available:

[https://iiasa.ac.at/sites/default/files/2024-12/EPCAC\\_Position\\_Paper\\_27nov2024.pdf](https://iiasa.ac.at/sites/default/files/2024-12/EPCAC_Position_Paper_27nov2024.pdf)



## Clean Air in Cities

Position paper from the Expert Panel on Clean Air in Cities (EPCAC) under the UNECE's Air Convention (CLRTAP) Task Force on Integrated Assessment Modelling (TFIAM)

November 27, 2024

### Summary

Air pollution is the most harmful environmental risk factor to human health as cities are densely populated – the air pollution in cities is breathed by thousands or even millions of people. Cities are a unique opportunity to significantly improve public health. The major sources of air pollution in cities differ from city to city and from pollutant to pollutant. In most cities combustion from either

# Backup slides

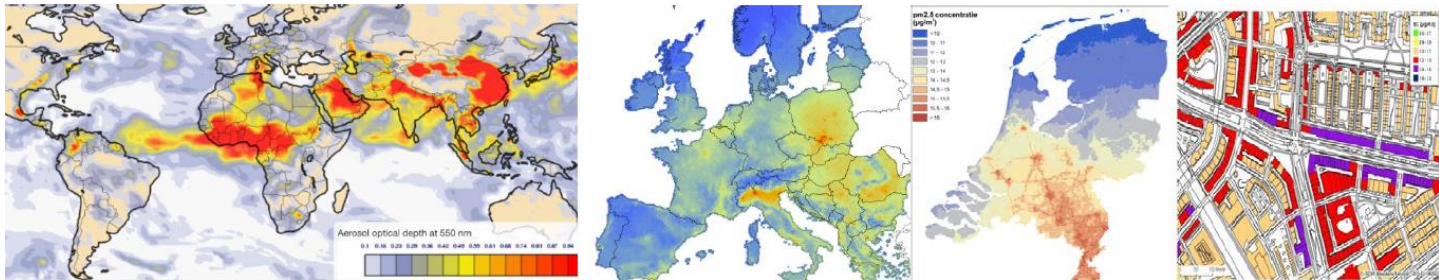


# Expert Panel on Clean Air in Cities

- Adopted by the Executive Body of the UNECE Air Convention, Dec 14, 2018

- Revised TFIAM mandate:

“Multi-scale multi-objective assessment modelling aimed at cost-effective policy strategies that combine international, national and local actions as well as the links between air quality policy and other policy processes (e.g. on SDGs, climate, biodiversity).”



# Key questions

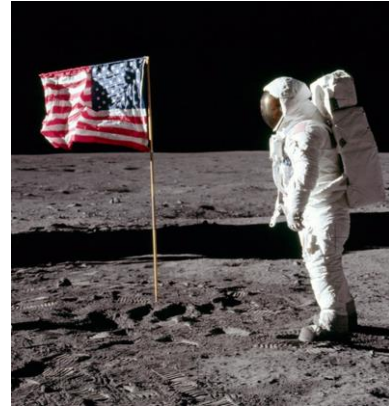
- **Which actions** at **which government level** are most effective to reduce health effects?
- Can we say more about the **cost-effectiveness** of measures at different government levels?
- What **knowledge** should be improved for robust policy advice?



# Mission and Task

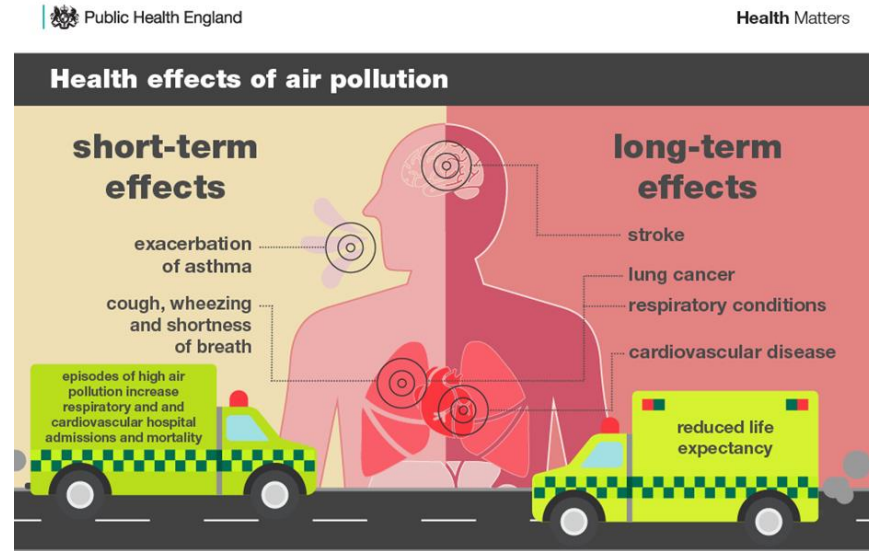
- EPCAC will **provide a science-policy arena** for analysis of cost-effective multi-scale air quality strategies
- EPCAC will **highlight the interactions between geographical scales**, acknowledging that air quality on a local scale is affected by international policies whilst the impact of local policies is propagated to other cities, regions and countries

→ **Involvement of cities is important**



# Effects of air pollution on human health







- Air pollution remain largest environmental threat to public health globally
- Most common metrics:
  - PM<sub>2.5</sub>
  - NO<sub>2</sub>
  - Ozone
- WHO air quality guidelines
- Legally binding limit values in countries



<https://www.gov.uk/government/publications/health-matters-air-pollution/health-matters-air-pollution>

# Annex: Develop a multi-level air quality plan

Political elements for success are:

1. Political support 
2. Input from scientists: monitoring, emission, modelling, health 
3. Involvement stakeholders: problem framing, targets, measures 
4. Citizens' awareness/participation in problem framing 
5. Funding 
6. Agreement on enforcement, monitoring, review 

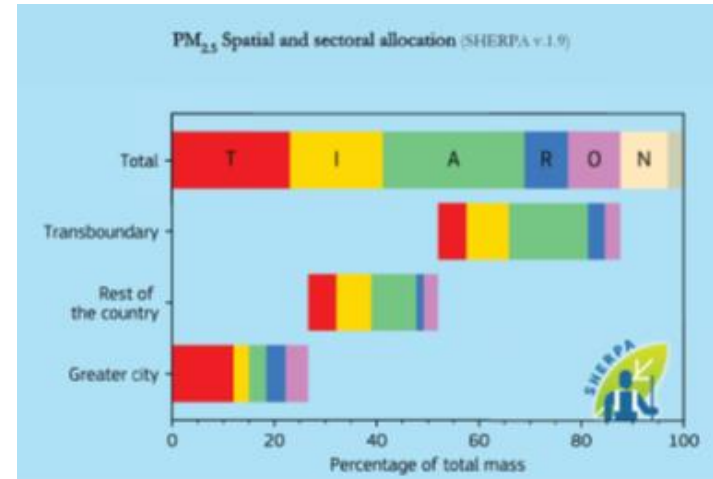
# Annex: Develop a multi-level air quality plan

Knowledge needed for an air quality plan:

1. What are the main sources of air pollution?
2. What future changes in emissions/concentrations are expected with existing policy?
3. Which options are available to further reduce concentrations?

Needed:

- Emission inventories and projections
- Assessment of concentrations and impacts
- Projections and responses



Sources of air pollution in Brussels (source: SHERPA modelling, Thunis et al., 2018)