ERASMUS-EDU-2023-CBHE
Project number: 101129032

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(01/01/2024 – 31/12/2026)

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# MICRO-CREDENTIAL

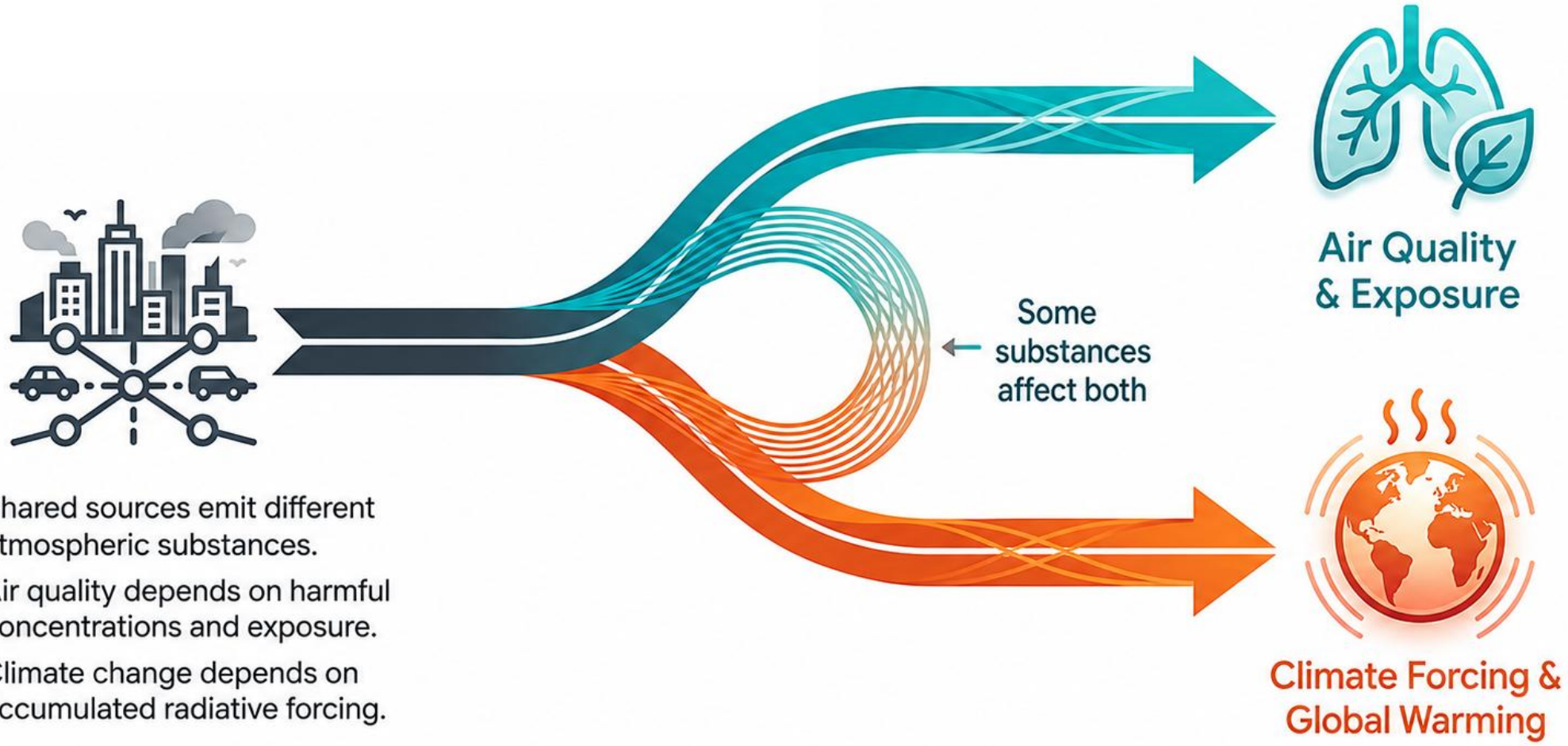
# CLIMATE CHANGE FOR SUSTAINABLE LAND MANAGEMENT IN CENTRAL ASIA

## 7.- Cities, Air Quality and Human Health

## *Air Pollutants vs Greenhouse Gases: Similarities and Differences*

*CC-W07-V26*

# Air Pollutants and Greenhouse Gases: Why the Distinction Matters




- Shared sources emit different atmospheric substances.
- Air quality depends on harmful concentrations and exposure.
- Climate change depends on accumulated radiative forcing.

**Shared sources do not make air pollutants and greenhouse gases equivalent.**

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# Same Human Activities, Different Atmospheric Problems

- Major sources emit mixtures, not single substances.
- Combustion links air pollution and climate change.
- Impacts depend on what is emitted and where it travels.




**The same source can create different air-quality and climate effects.**

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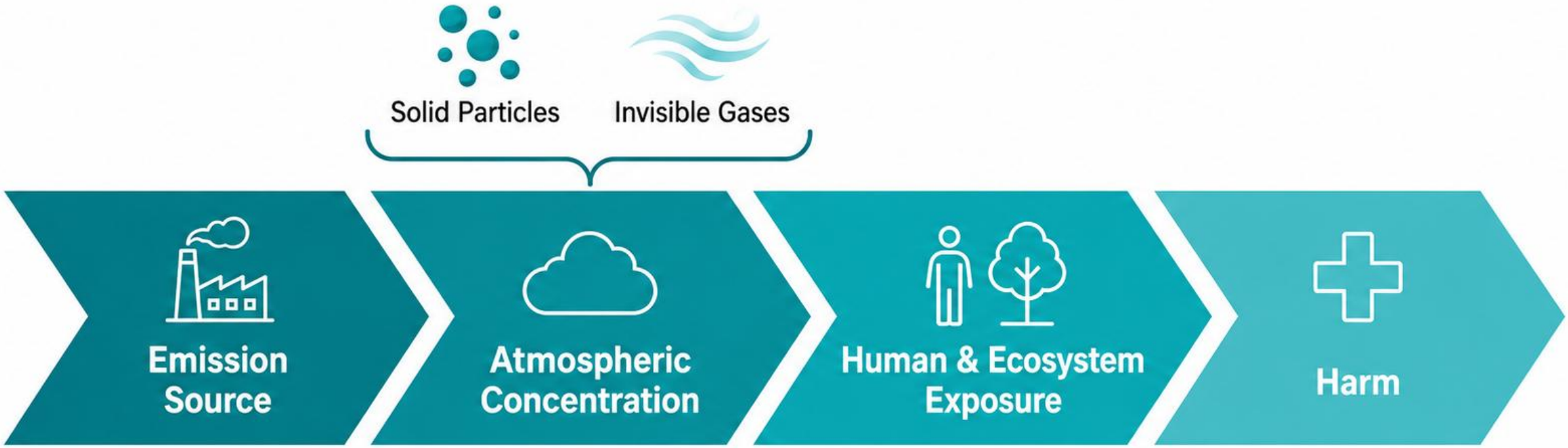
# What Defines an Air Pollutant?




- Air pollutants include particles and gases.
- Harm depends on concentration, exposure, and toxicity.
- Local conditions shape final exposure levels.

**Air-quality management focuses on the air people breathe.**

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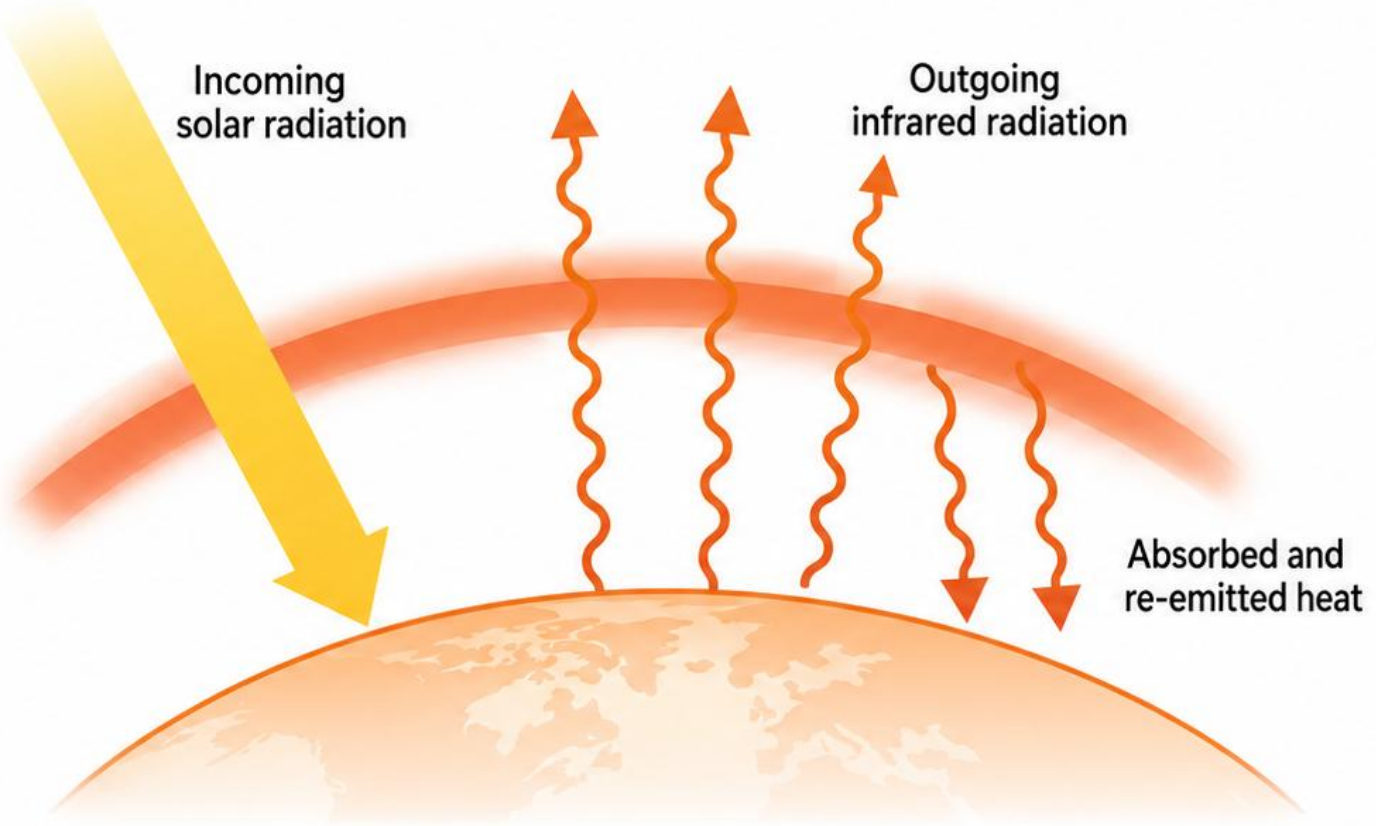
# What Defines a Greenhouse Gas?

- GHGs absorb and re-emit outgoing infrared radiation.
- Many persist and accumulate in the atmosphere.
- Long-lived GHGs influence climate far from their sources.




**Greenhouse gases are defined by their effect on Earth's energy balance, no local exposure.**

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# The Core Differences: Effects, Lifetimes and Spatial Scales

| | Air Pollutants | Greenhouse Gases |
|---|---|---|
| Main Effect | Health & ecosystem harm | Climate forcing |
| Typical Lifetime | Mostly days to weeks | Often decades to centuries |
| Dominant Scale | Local / regional | Global / widely distributed |
| Response to Reductions | Often relatively rapid | Requires sustained long-term action |

Important exceptions: methane, tropospheric ozone and black carbon connect both systems.

Air quality may improve relatively quickly, while climate stabilization requires sustained action.

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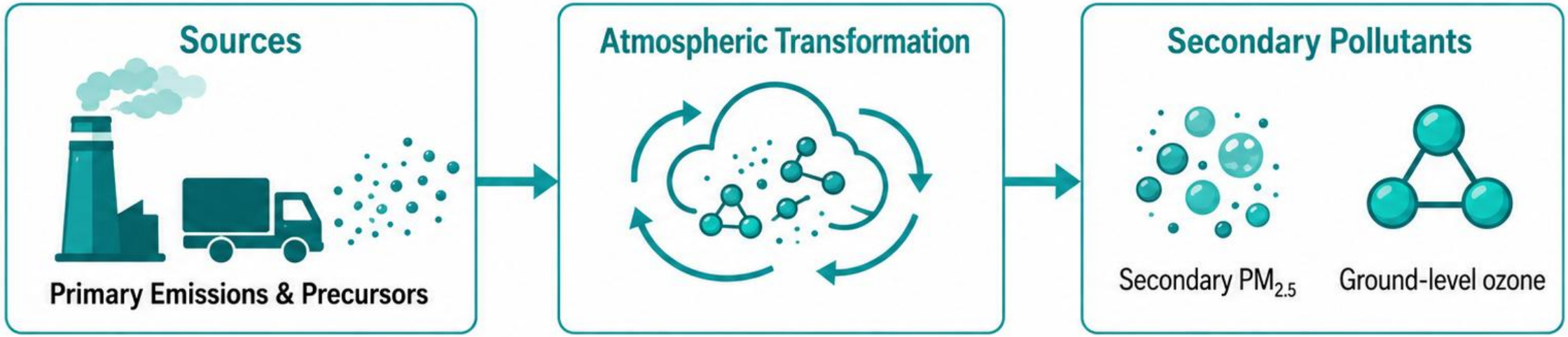
# Primary Emissions, Precursors and Secondary Pollutants




**A** $SO_2$ / $NO_x$ / $NH_3$ → atmospheric reactions → Secondary $PM_{2.5}$

**B** $NO_x$ / VOCs + sunlight → Ground-level ozone

*Methane increases background ozone.*

- Primary pollutants are emitted directly.
- Precursors react in the atmosphere to form new pollutants.
- Secondary $PM_{2.5}$ and ozone may form downwind of their sources.

**Effective management must target direct emissions and precursor sources.**

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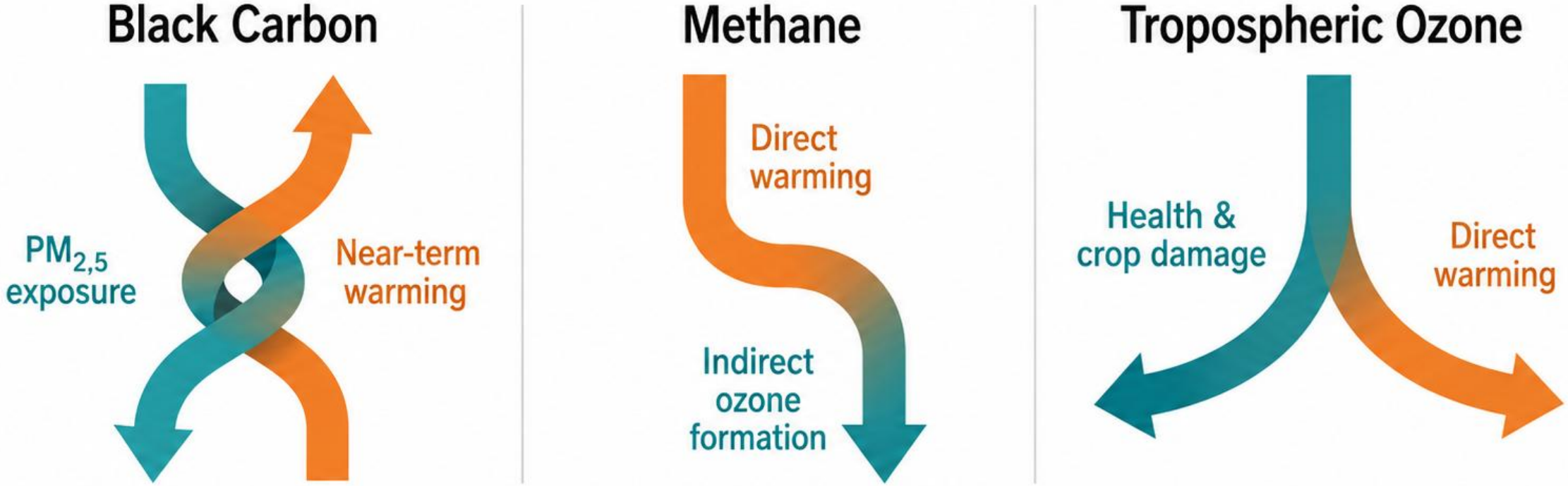
# The Overlap Zone: Black Carbon, Methane and Tropospheric Ozone




- Black carbon links $PM_{2,5}$ exposure with near-term warming.
- Methane warms directly and increases background ozone.
- Tropospheric ozone harms health and crops while warming climate.

**Different substances connect air quality and climate through different pathways.**

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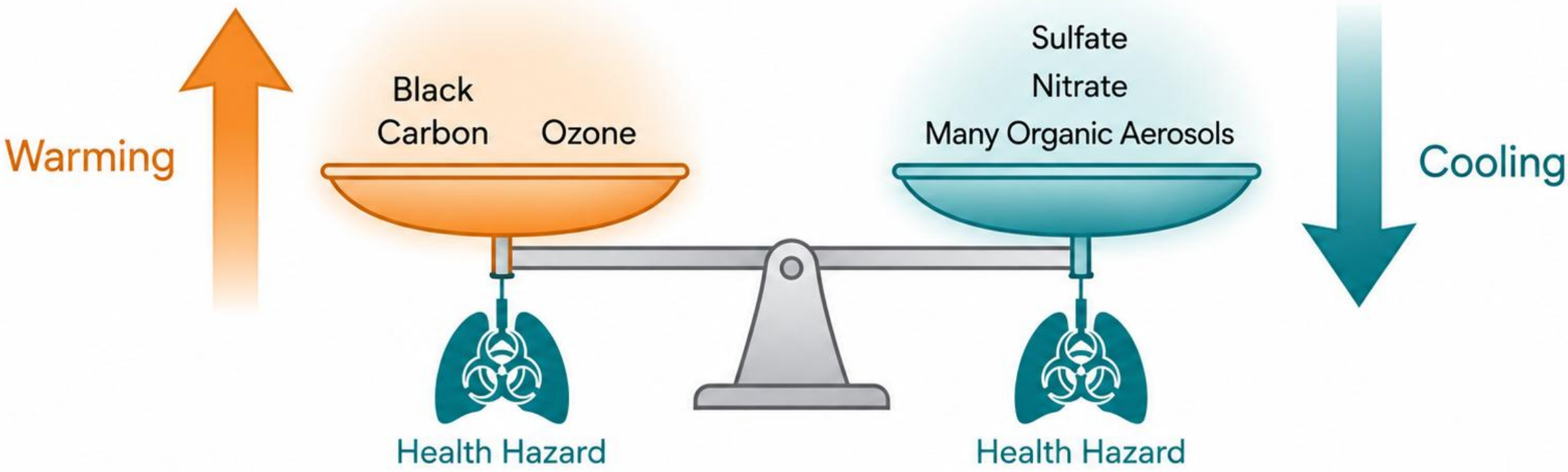
# Some Air Pollutants Warm the Climate; Others Cool It




- Black carbon and tropospheric ozone contribute to warming.
- Sulfate, nitrate and many organic aerosols cool temporarily.
- Cooling effects do not remove their health risks.

**Reducing cooling aerosols must be paired with rapid greenhouse-gas mitigation.**

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# Shared Sources Do Not Mean Equal Contributions

| | Importance for Local Air Quality | Importance for GHGs |
|---|---|---|
| Transport | High | Medium |
| Residential Heating | High | Low |
| Power/Industry | Medium | High |
| Agriculture | Low | High |
| Waste | Low | Medium |

*Illustrative qualitative comparison — not to scale*

- The largest GHG source is not necessarily the largest driver of local exposure.
- Low-level sources near homes can produce high exposure.
- Secondary formation and transport can obscure pollution origins.

**GHG inventories and air-quality assessments answer different questions.**

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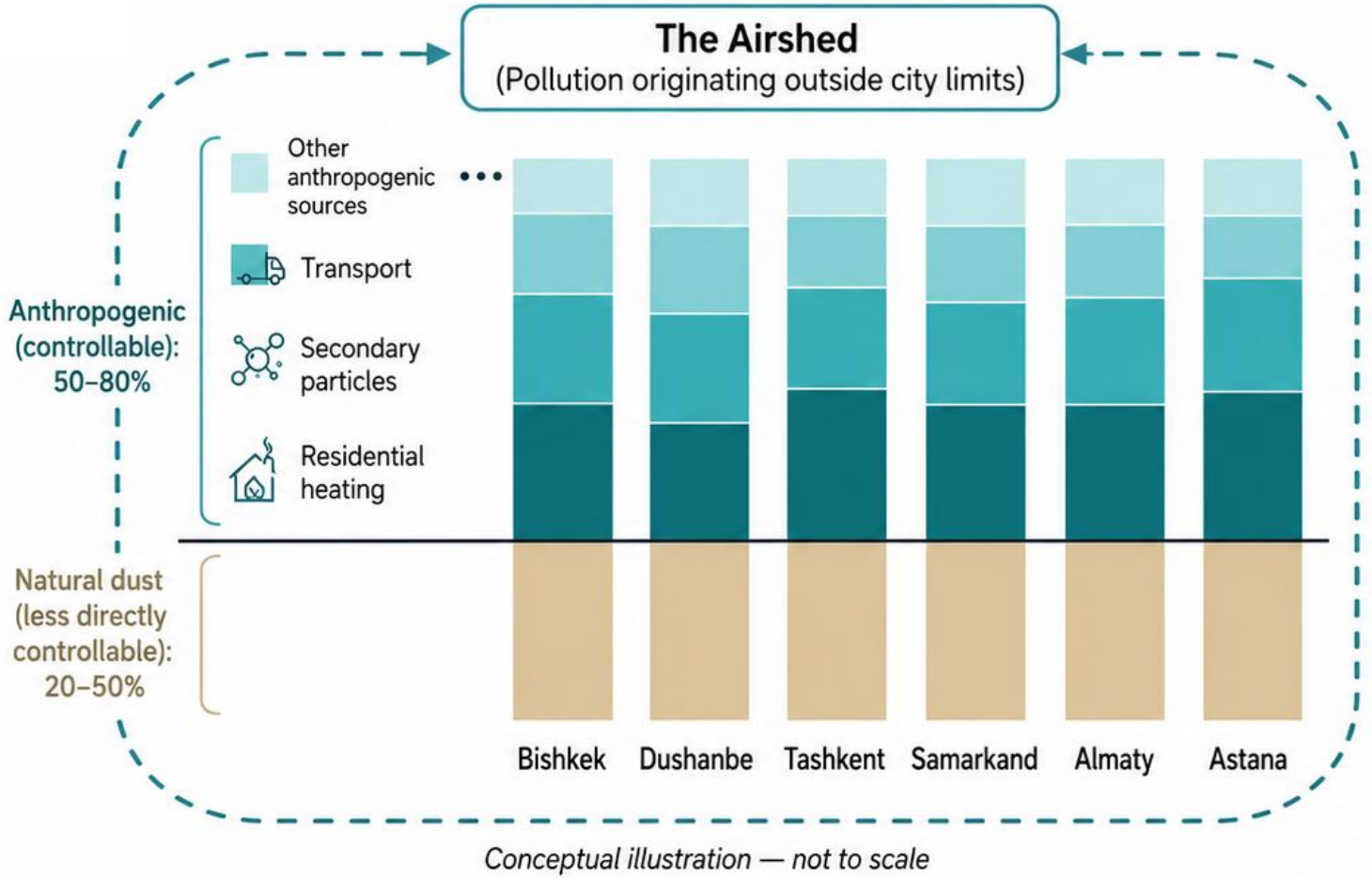
# Central Asian Cities: Local Emissions, Secondary Pollution and Regional Transport

- Natural dust contributes 20–50% of urban $PM_{2.5}$.
- Anthropogenic sources account for the remaining 50–80%.
- Much urban exposure forms or arrives from outside city boundaries.




*Conceptual illustration — not to scale*

**Urban clean-air strategies need local action and airshed-wide coordination.**

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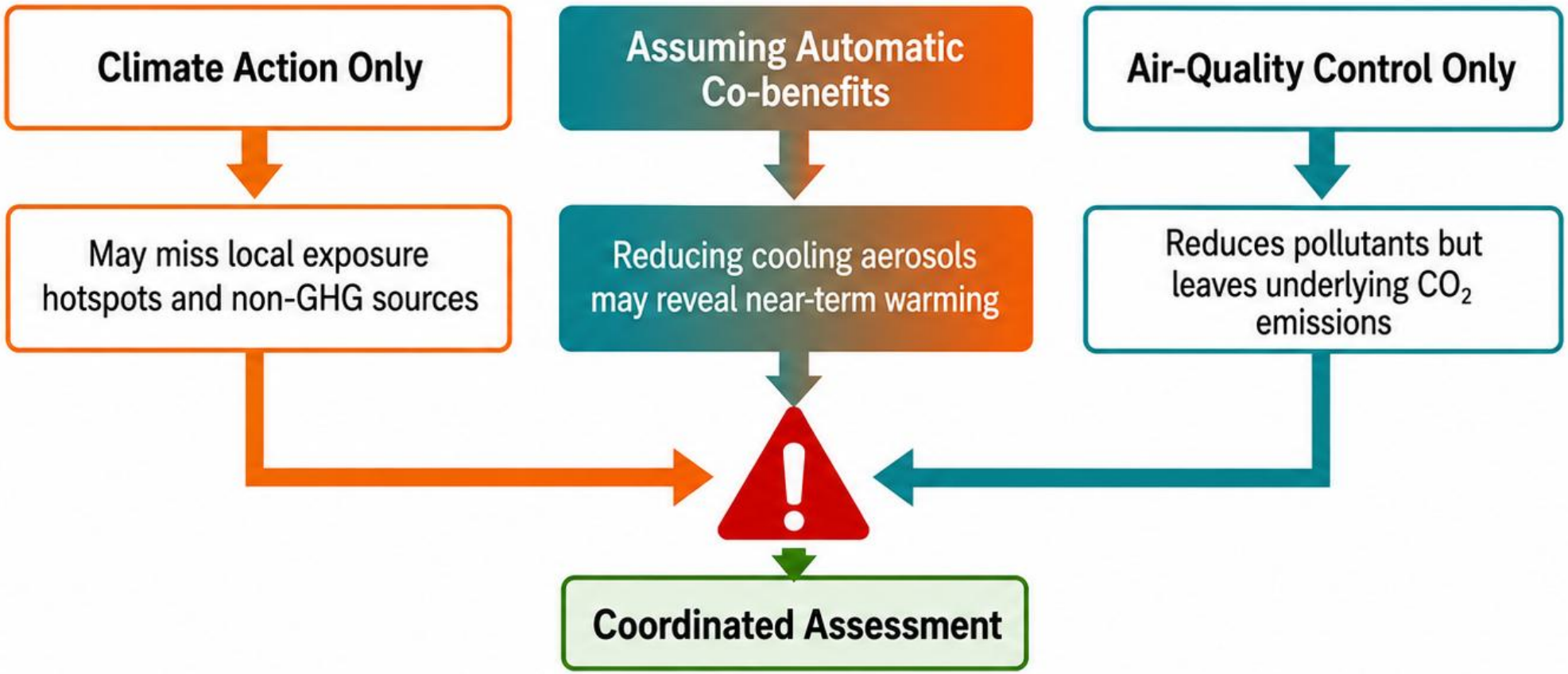
# The Policy Trap: Assuming That One Problem Will Solve the Other




- Climate policies may overlook local exposure and non-GHG sources.
- End-of-pipe controls reduce pollutants, not underlying $CO_2$.
- Co-benefits and trade-offs must be assessed explicitly.

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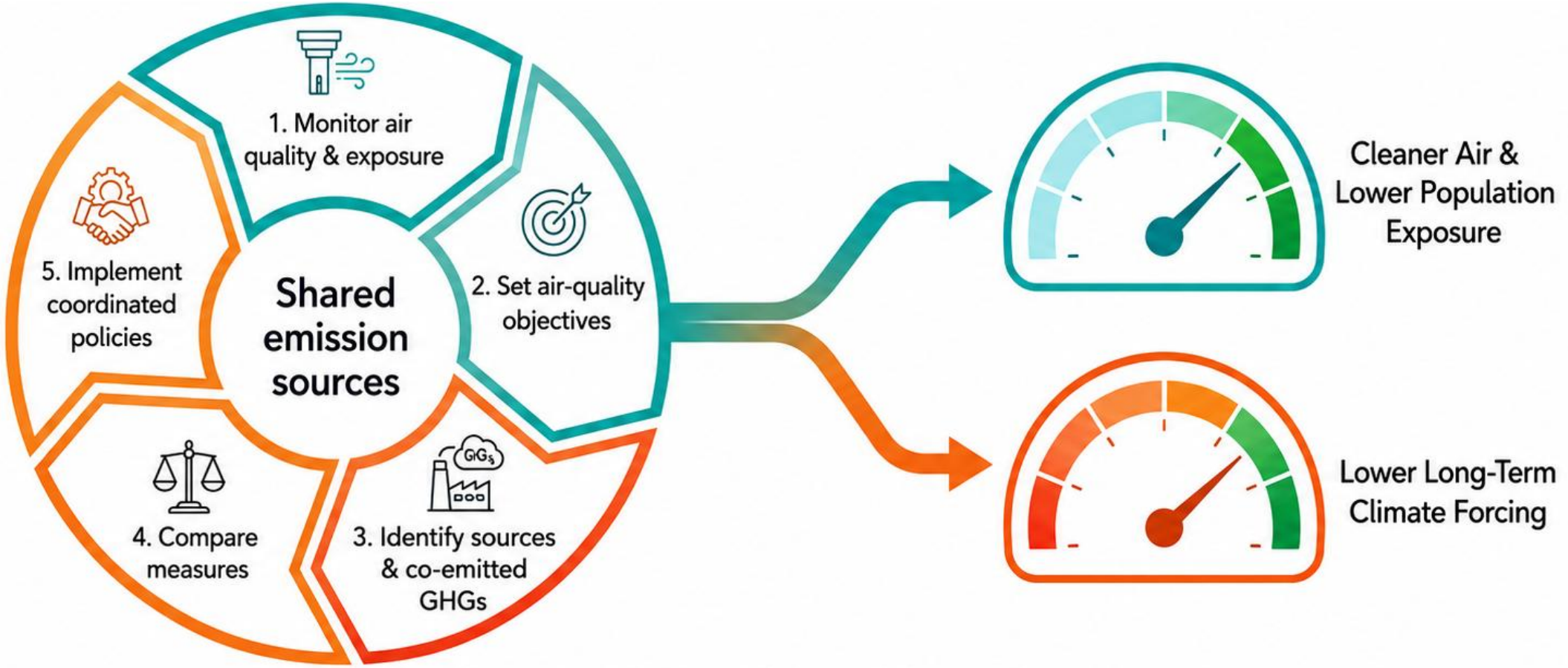
# Integrated but Differentiated Management




- Evaluate shared sources with air-quality and climate data.
- Compare synergies and trade-offs before selecting measures.
- Coordinate actions, but track separate outcomes.

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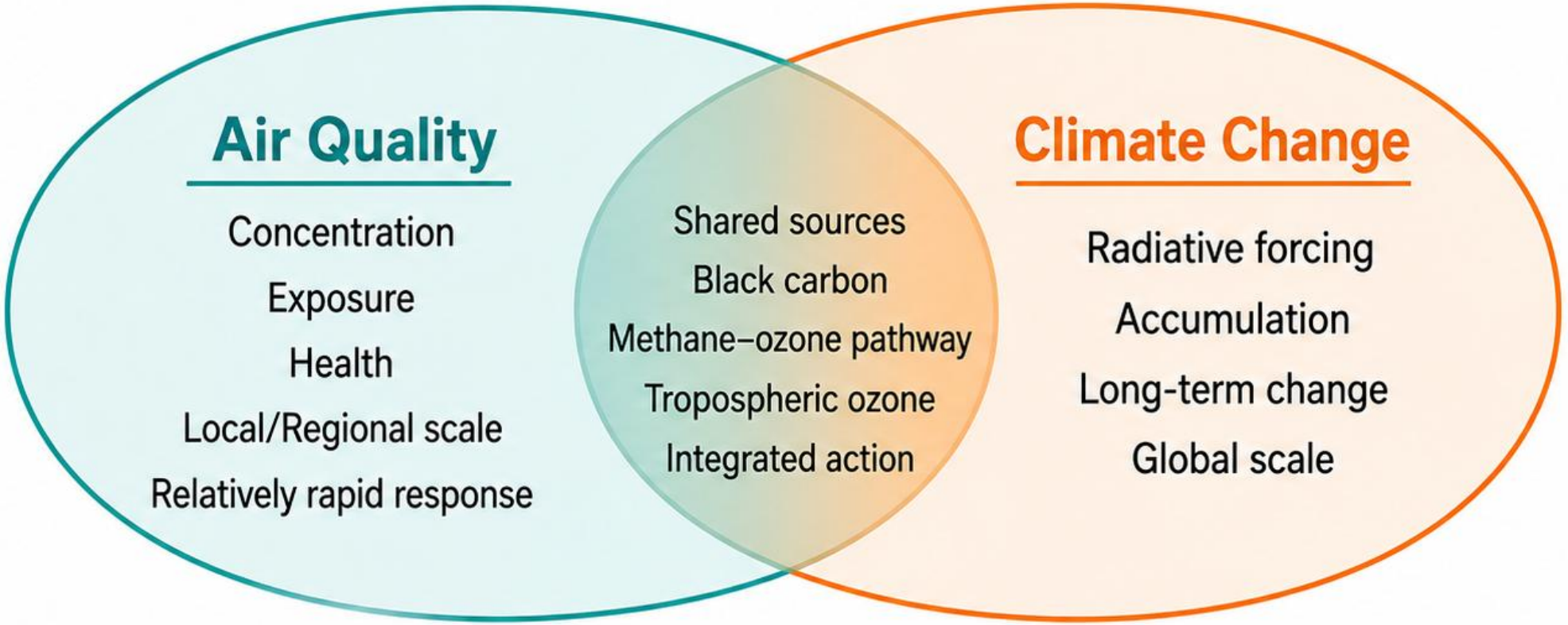
# Key Messages: Connected, but Not Interchangeable




- Air pollutants and GHGs differ in effects, lifetimes, and scales.
- Black carbon, methane, and ozone connect both problems through different pathways.
- Air-quality and climate benefits are not automatic.

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