

LOCAL APPROACH TO ATTRIBUTABLE DISEASE BURDEN

A case study for air pollution and mortality in Belgium

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Brecht Devleesschauwer

BACKGROUND

Nitrogen dioxide and particulate matter, their sources and dispersion

Background

Nitrogen dioxide (NO₂)

Gas of the NO_x family (= NO₂ + NO)

Particulate matter (PM_{2.5})

Solid and fluid particles of mixed composition

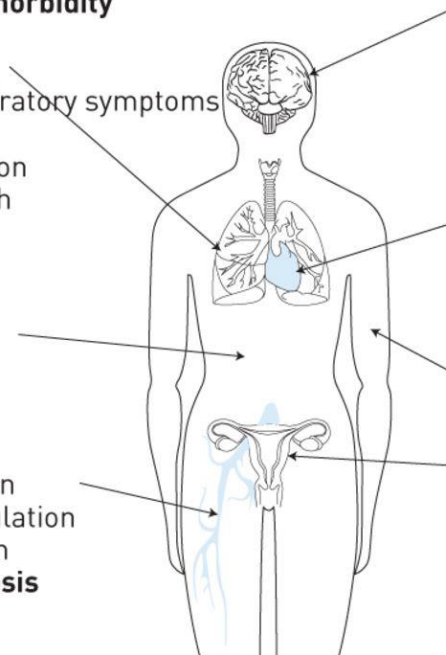
Health effects of air pollution:

Respiratory disease mortality
Respiratory disease morbidity
Lung cancer
Pneumonia

Upper and lower respiratory symptoms
Airway inflammation
Decreased lung function
Decreased lung growth

Insulin resistance
Type 2 diabetes
Type 1 diabetes
Bone metabolism

High blood pressure
Endothelial dysfunction
Increased blood coagulation
Systemic inflammation
Deep venous thrombosis



Stroke

Neurological development
Mental health

Neurodegenerative diseases

Cardiovascular disease mortality

Cardiovascular disease morbidity

Myocardial infarction

Arrhythmia

Congestive heart failure

Changes in heart rate variability
ST-segment depression

Skin ageing

Premature birth

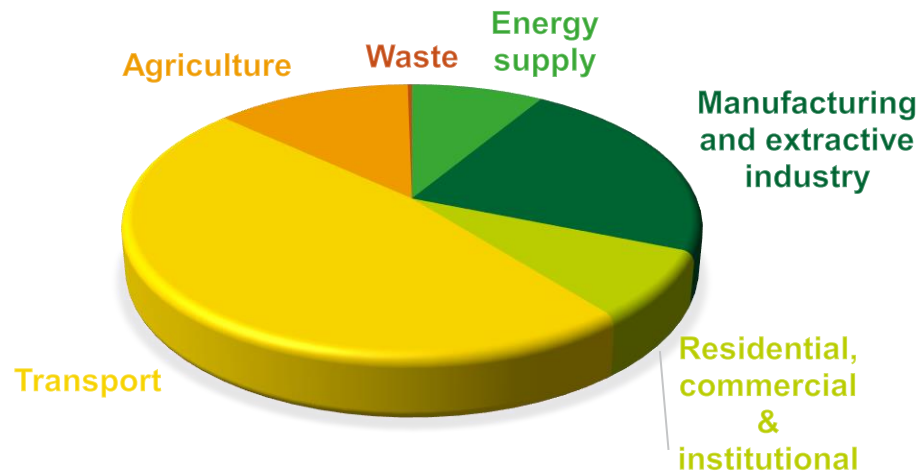
Decreased birthweight

Decreased fetal growth
Intrauterine growth retardation
Decreased sperm quality
Pre-eclampsia

Background

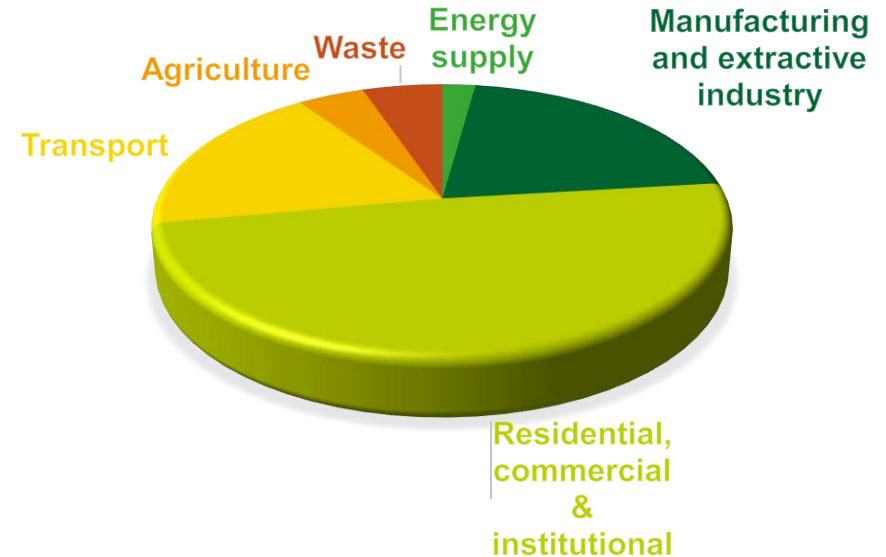
Nitrogen dioxide (NO₂)

Sources of NO_x in Belgium, 2019:



Particulate matter (PM_{2.5})

Sources of PM_{2.5} in Belgium, 2019:

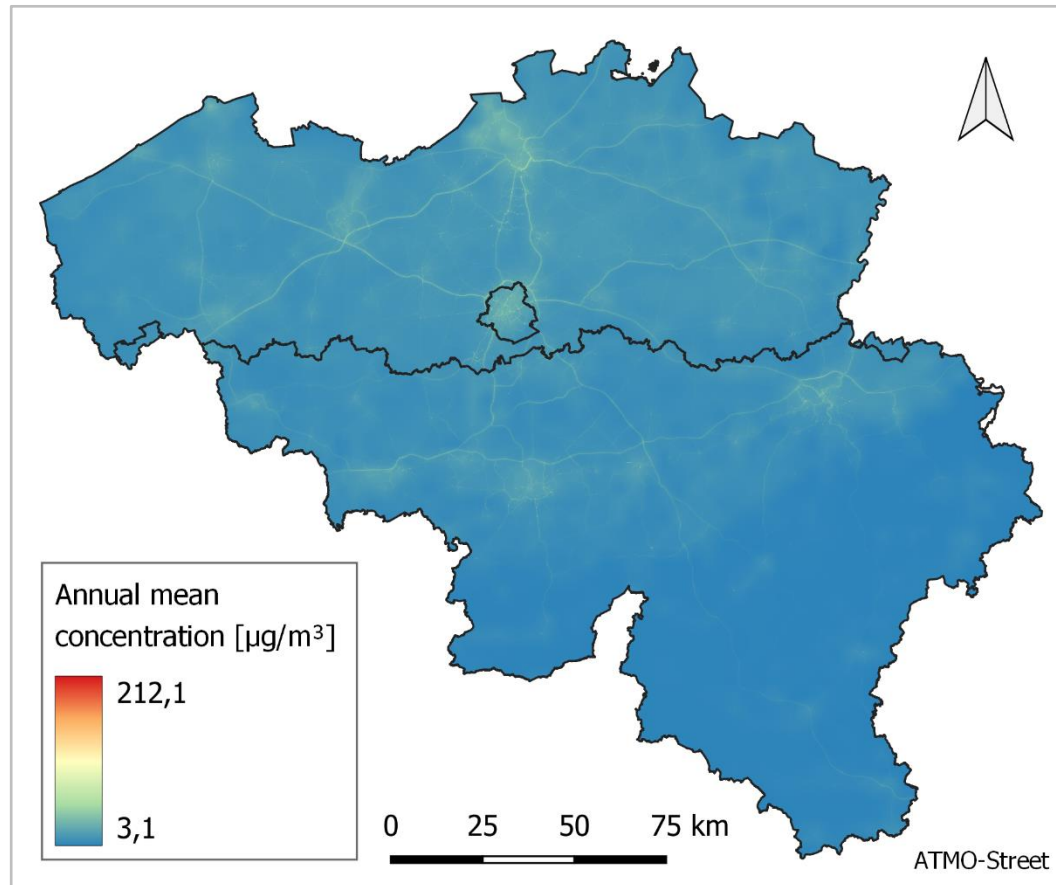


European Environment Agency (2023)

Background

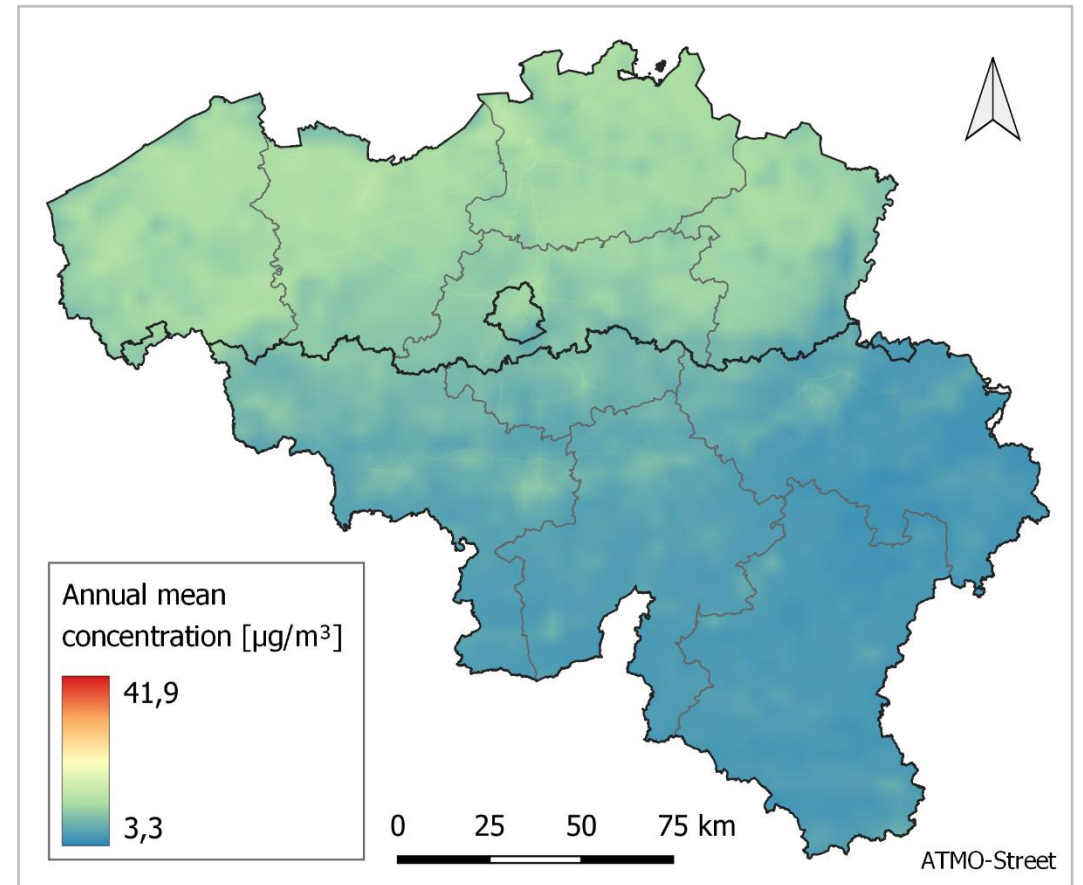
Nitrogen dioxide (NO₂)

Dispersion of NO₂ in Belgium, 2019:



Particulate matter (PM_{2.5})

Dispersion of PM_{2.5} in Belgium, 2019:



METHODS

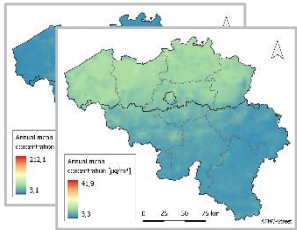
Comparative risk assessment: Global versus local approach

Comparative risk assessment

Global approach

Exposure

Annual population-weighted average concentration:



Area	Exposure
Belgium	12.3
Antwerp	4.56
Brussels	7.89
...	...

Relative risk

Risk of mortality from all causes (95% CI):

- NO₂: **1.045 (1.026 - 1.065)**
 - PM_{2.5}: **1.118 (1.060 - 1.179)**
- per 10 µg m⁻³ (Brunekreef *et al.*, 2022)

Population attributable fraction

Area	PAF
Belgium	0.34
Antwerp	0.12
Brussels	0.23
...	...

Total mortality

Total number of deaths:

Area	Total mortality
Belgium	123,456
Antwerp	78,901
Brussels	89,012
...	...

Attributable mortality

Number of deaths attributable to the air pollutant:

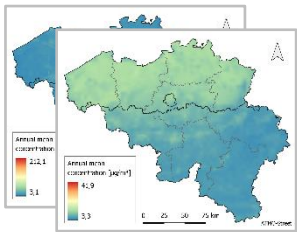
Area	Attributable mortality
Belgium	23,456
Antwerp	1,234
Brussels	2,345
...	...

Comparative risk assessment

Local approach

Exposure

Annual **spatial average** concentration per sector:



Sector	Exposure
11001A00-	9.87
11001A01-	6.54
11001A020	32.1
...	...

Relative risk

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Population attributable fraction

Sector	PAF
11001A00-	0.21
11001A01-	0.10
11001A020	0.32
...	...

Attributable mortality

Number of deaths attributable to the air pollutant:

Sector	Attributable mortality
11001A00-	23.4
11001A01-	12.3
11001A020	4.5
...	...

Total mortality

Total number of deaths:

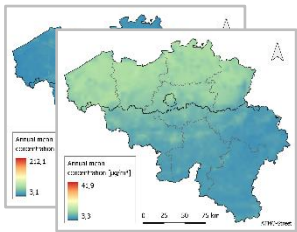
Sector	Total mortality
11001A00-	65
11001A01-	43
11001A020	21
...	...

Comparative risk assessment

Local approach

Exposure

Annual **spatial average** concentration per sector:



Sector	Exposure
11001A00-	9.87
11001A01-	6.54
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...	...

Population attributable fraction

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Total mortality

Total number of deaths:

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...	...

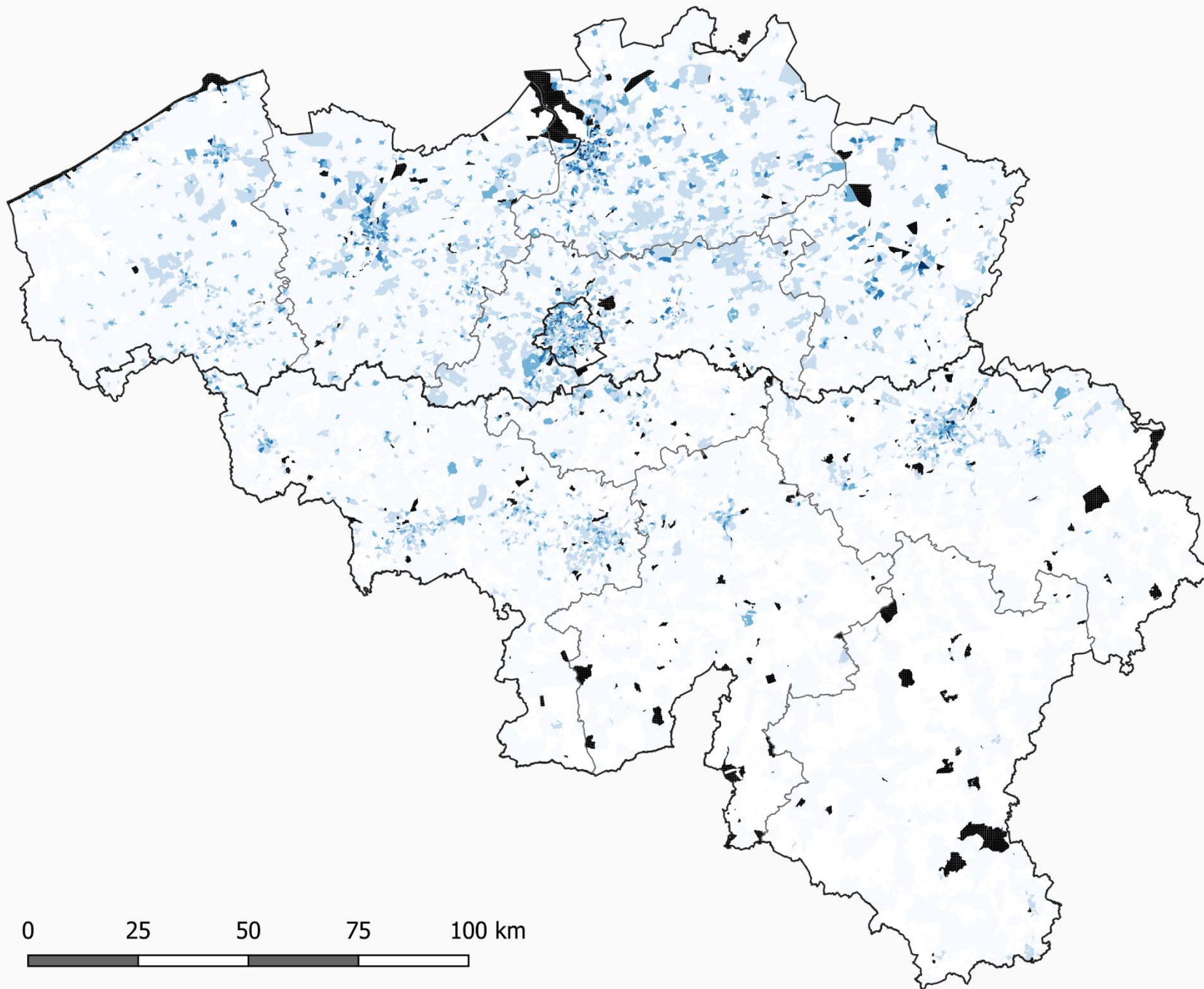
Aggregation

Aggregate sector results to wider areas and larger populations:


Area	Attributable mortality
Belgium	23,456
Antwerp	1,234
Brussels	2,345
...	...

RESULTS







Some maps and aggregated results

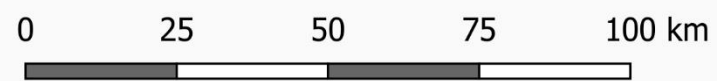


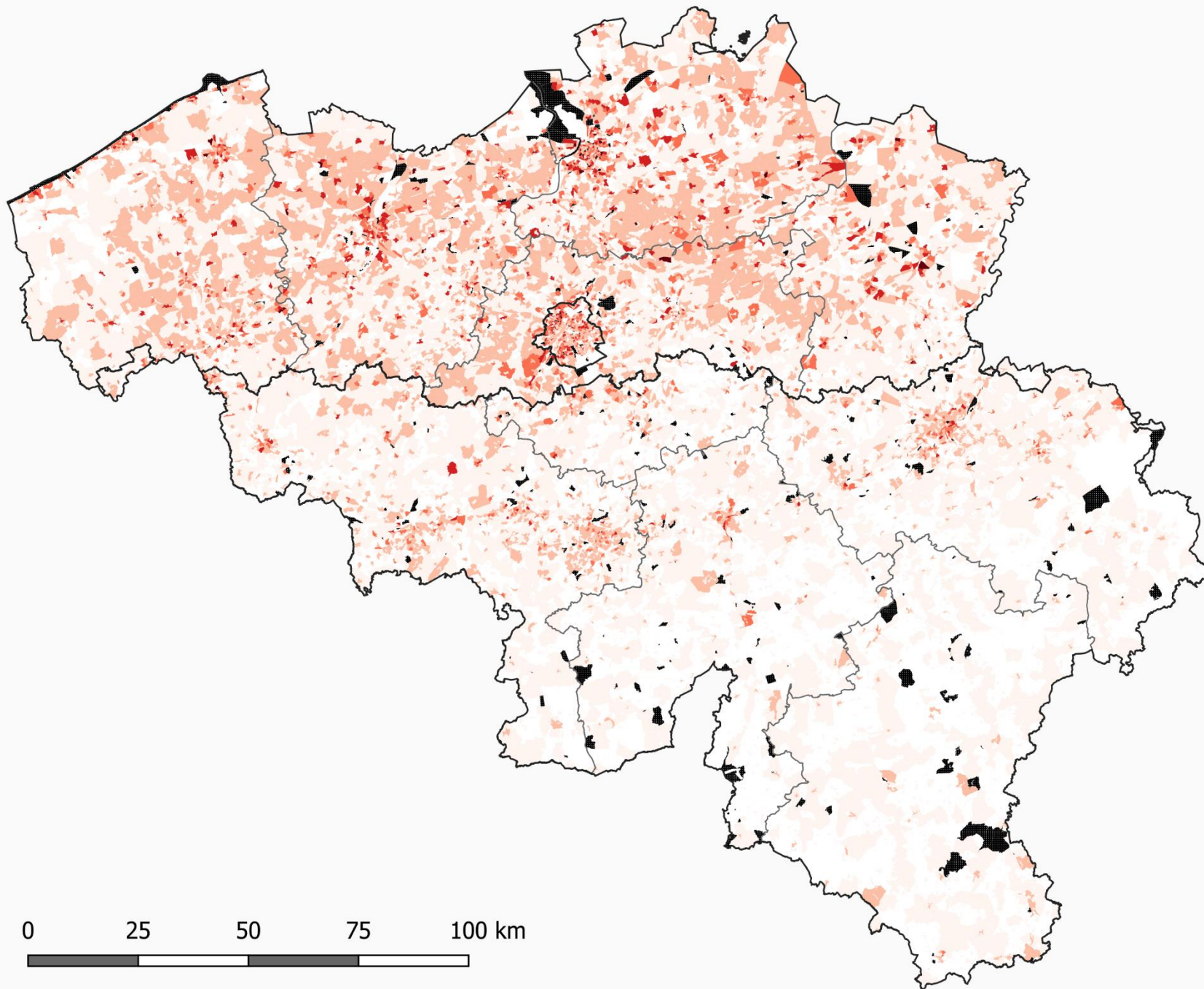
NO2 mortality

 No population


Cases

-  0
-  >0 - 0.5
-  0.5 - 1.5
-  1.5 - 3.0
-  3.0 - 6.5
-  6.5 - 14.14



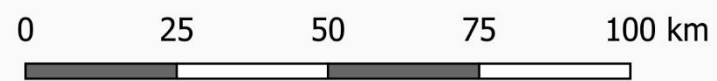


PM2.5 mortality

 No population

Cases

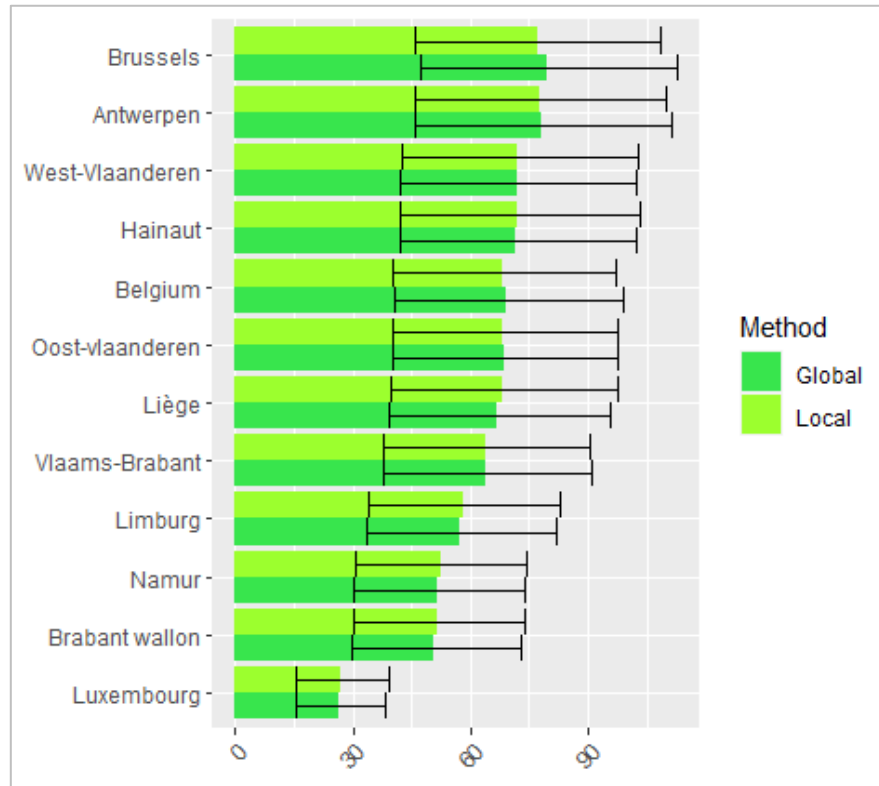
-  0
-  >0 - 0.5
-  0.5 - 2.0
-  2.0 - 4.0
-  4.0 - 8.5
-  8.5 - 18.8



Results

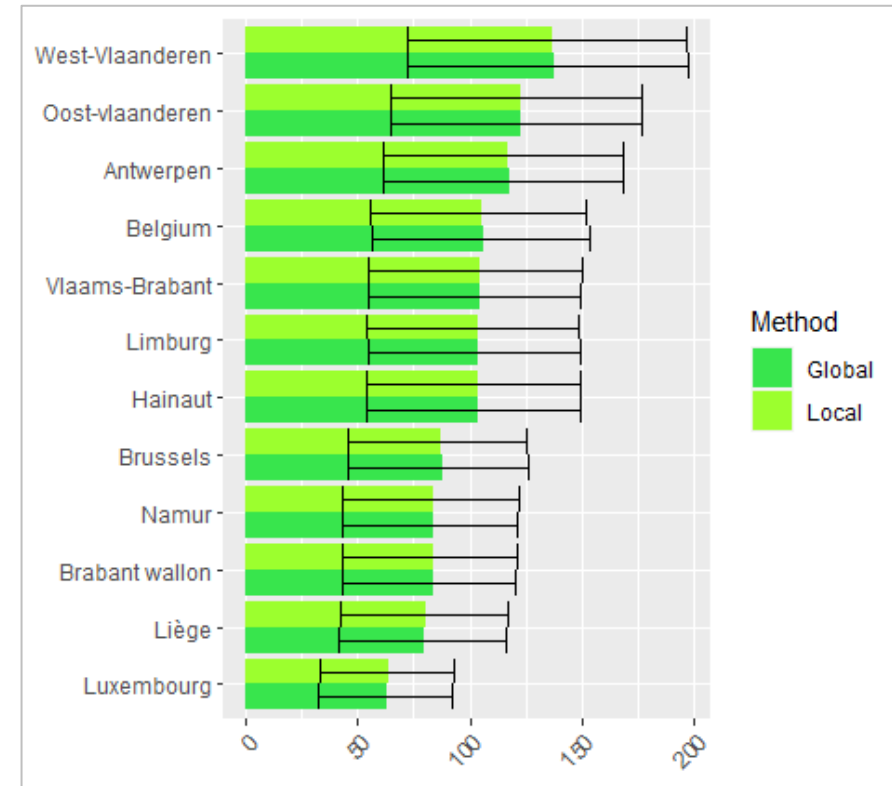
Nitrogen dioxide (NO₂)

NO₂ mortality in Belgium, 2019 (per 100,000 p.):



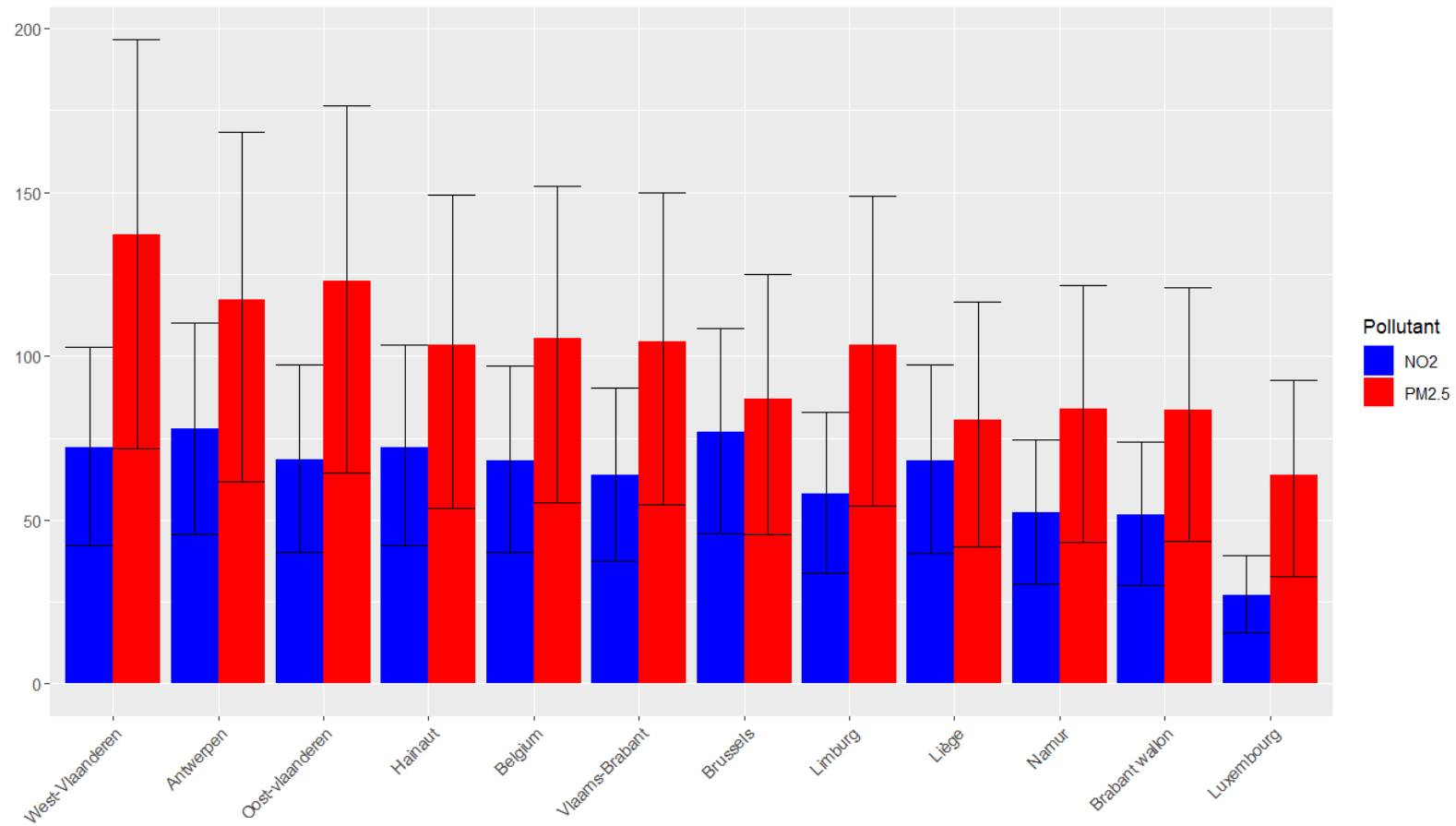
Particulate matter (PM_{2.5})

PM_{2.5} mortality in Belgium, 2019 (per 100,000 p.):



Results

NO₂ and PM_{2.5} mortality in Belgium, 2019 (per 100,000 persons):



Strengths and limitations

- + Flexibility in aggregation
- + Identify hotspots in burden
- + Stratification of estimates
- + Investigate correlations
- Local results potentially biased
- Aggregation ignores autocorrelation
- Limited data availability

References

Brunekreef, B., Andersen, Z. J., Forastiere, F., Hoffmann, B., & Boogaard, H. (2022). *A Proposal for Sensitivity Analyses of the Health Impacts of PM2.5 and NO2 in Europe, in Support of the Revision of the EU Ambient Air Quality Standards for These Pollutants.*

European Environment Agency. (2023). *National Emission reduction Commitments Directive emissions.* https://www.eea.europa.eu/ds_resolveuid/5639aceada674fc8b8a9d682b5d9952a

IRCEL-CELINE. (n.d.). *ATMO-Street*. Retrieved September 11, 2023, from https://www.irceline.be/en/documentation/models/atmo-street?set_language=en

Thurston, G. D., Kipen, H., Annesi-Maesano, I., Balmes, J., Brook, R. D., Cromar, K., De Matteis, S., Forastiere, F., Forsberg, B., Frampton, M. W., Grigg, J., Heederik, D., Kelly, F. J., Kuenzli, N., Laumbach, R., Peters, A., Rajagopalan, S. T., Rich, D., Ritz, B., ... Brunekreef, B. (2017). A joint ERS/ATS policy statement: What constitutes an adverse health effect of air pollution? An analytical framework. *European Respiratory Journal*, 49(1), 1600419. <https://doi.org/10.1183/13993003.00419-2016>

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