# Sensitivity analyses regarding $NO_2$ exposure assessment and health impacts at EU scale

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## CONTENT

- Project factsheet
- Recommendations from an expert workshop
- Sensitivity studies w.r.t. $NO_2$ exposure and health impact assessment
- Conclusions & recommendations

## PROJECT FACTSHEET

- EU Service contract 070201/2015/SER/717473/C.3 for DG ENV – Improved Tools for Assessing $NO_2$ Exposure
- Objective: "*Propose methods and tools that are coherent with the exposure metric used when deriving the appropriate exposure response relationships and compatible with currently used integrated assessment modelling tools of the EU*"
- Project team:

## RECOMMENDATIONS EXPERT WORKSHOP (MAY 17, 2016 – WHO, BONN)

Guidelines for an $NO_2$ health impact assessment methodology :

- Flexibility w.r.t. Concentration Response Functions (CRF's) → HRAPIE, COMEAP,…
- Applicable for whole of Europe
- Finer scales than existing chemistry-transport models (CTMs) → resolution ~100m
- Ignore street canyons for time being
- Long term $NO_2$ health impact is more important short team → annual averages
- Sensitive to emission (changes) & $NO_2$/NOx-emission ratio
- Coupling to Integrated Assessment Models (e.g. GAINS) → method should be fast

Sensitivity analyses of elements in the HIA
→ this presentation

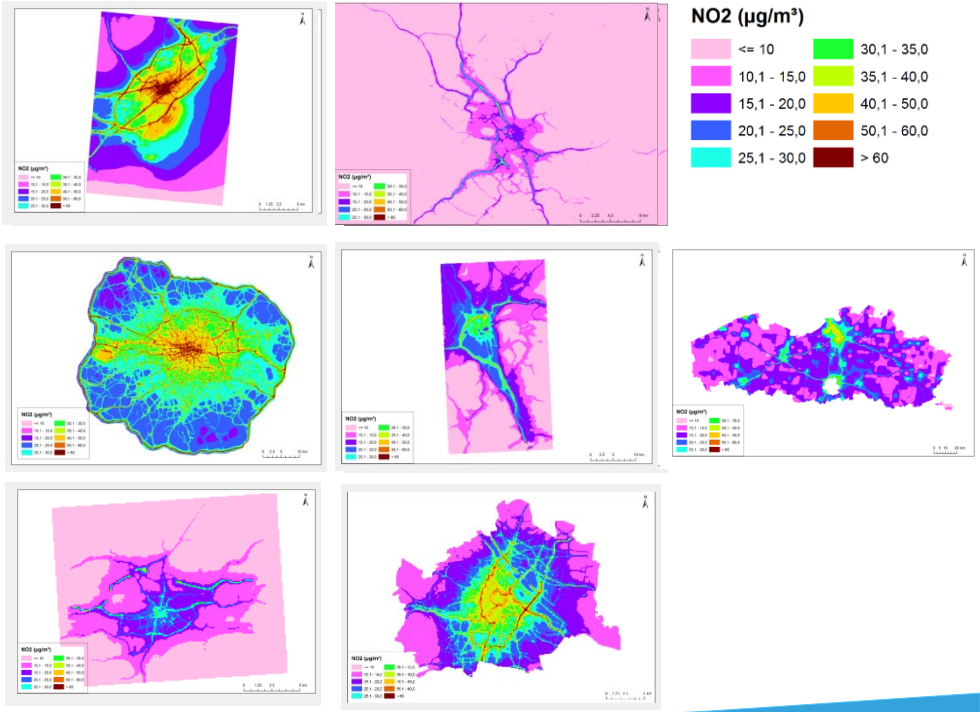
Resulting $NO_2$ mapping module
→ presentation by Wouter Lefebvre

# SENSITIVITY ANALYSES

SPATIAL RESOLUTION
CONCENTRATION RESPONSE FUNCTION
POPULATION DATA SETS
BASELINE MORTALITY
STATIC VS DYNAMIC EXPOSURE

# Sensitivity analysis: Spatial Resolution

| City/Region | Contact | Institute | Model (Type) | Grid scale | Year |
|---|---|---|---|---|---|
| Flanders | Stijn Janssen (stijn.janssen@vito.be) | VITO | IFDM (Gaussian) | 25 m | 2012 |
| London | Jenny Stocker (jenny.stocker@cerc.co.uk) | CERC | ADMS Urban (Gaussian) | 20 m | 2012 |
| Stockholm | Kristina Eneroth (kristina@slb.nu) | Environment and Health Administration, City of Stockholm | Airviro (Gaussian) | 30 m | 2015 |
| Styria | Dietmar Öttl (dietmar.oettl@stmk.gv.at) | Umwelt Steiermark (Austria) | GRAL (Lagrangian) | 25 m | 2010 |
| Vienna / Salzburg / Klagenfurt | Rafael Reifeltshammer (reifeltshammer@ivt.tugraz.at) | TU Graz (Austria) | GRAL (Lagrangian) | 10 m | 2010 |
| Barcelona | Joan Marc Craviotto i Arnau (jcraviotto@bcn.cat) | Departament d'Intervenicó Ambiental, Barcelone | ADMS Urban (Gaussian) | 5 m | 2013 |



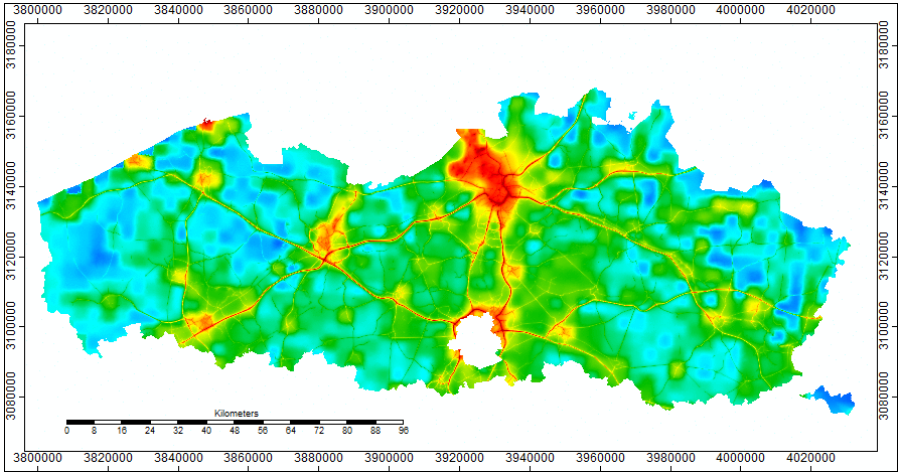
## Sensitivity analysis: Spatial Resolution

Resolution degrading (simple averaging)

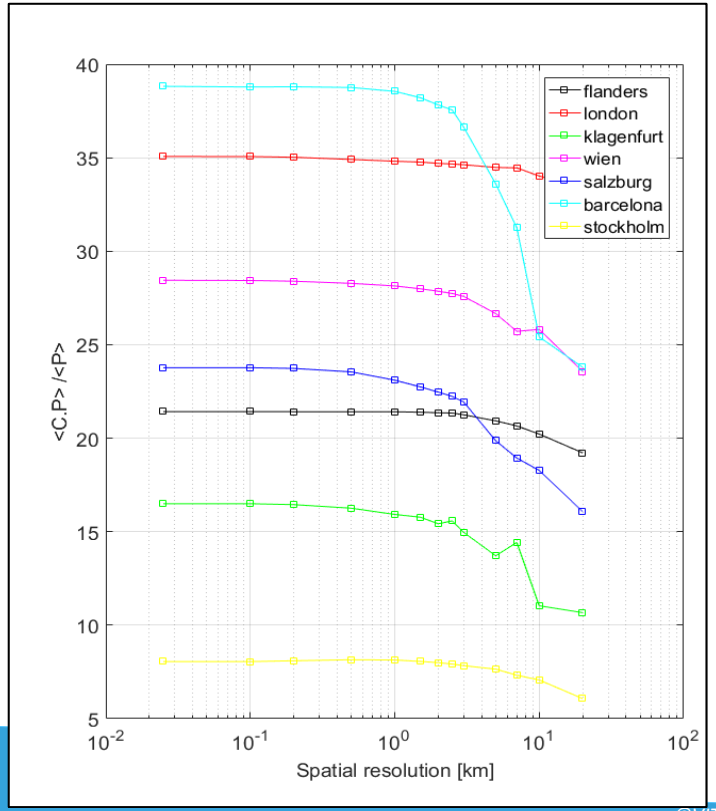
- Native (~20 m) → 100 m → 20 km
- Assessing population weighted mean concentration

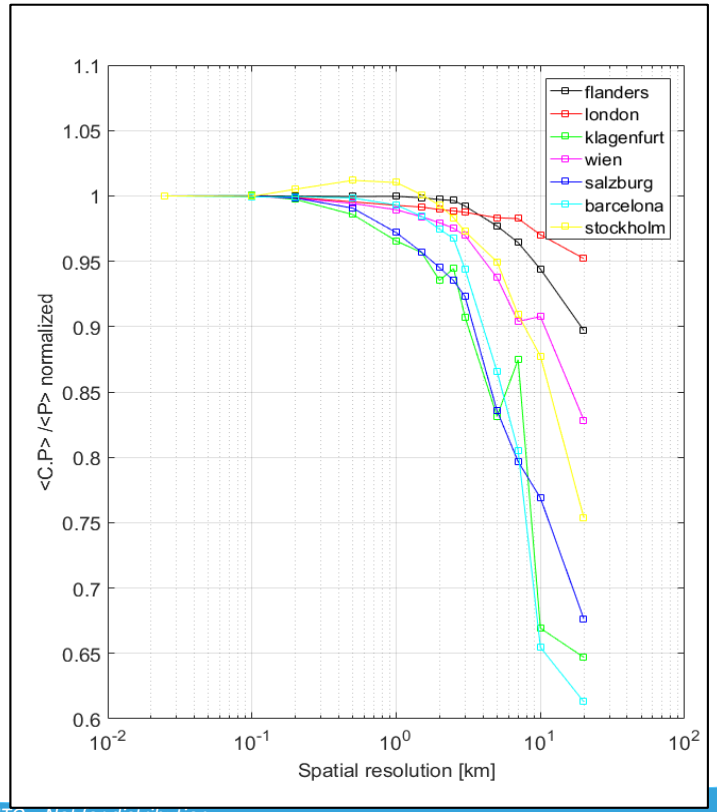
$$C_p = \frac{\sum C.P}{\sum P}$$

- Using JRC population map (Gallego, 2010)



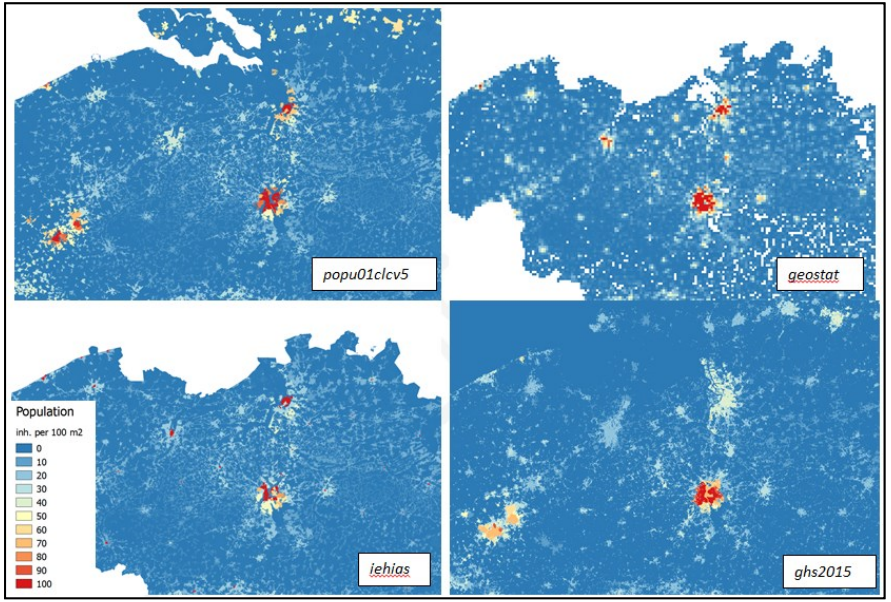
# Sensitivity analysis: Spatial Resolution



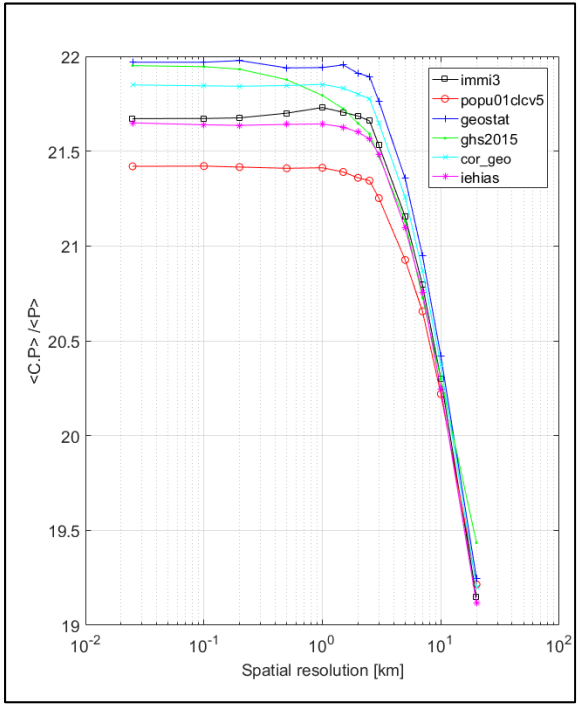
# Sensitivity analysis: Population datasets

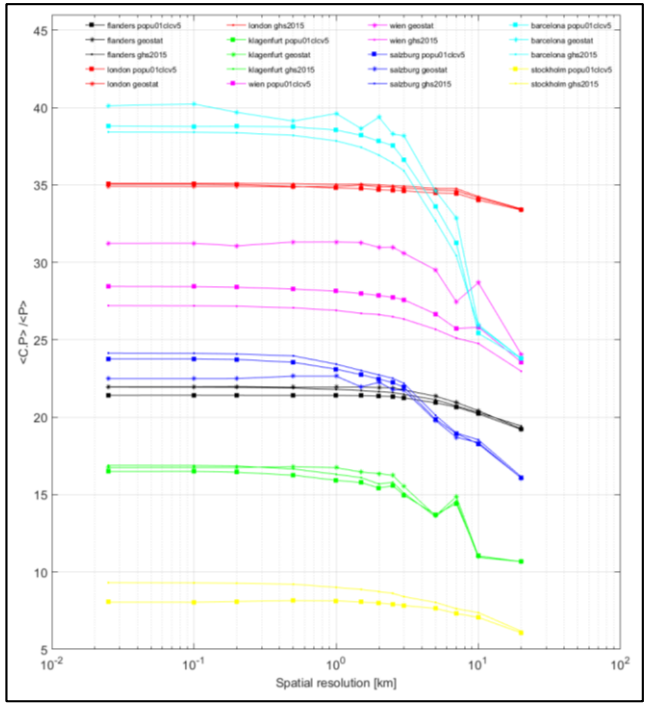
| Label | Census / Year | Scale (*) | References |
|---|---|---|---|
| popu01clcv5 | 2001 | 100 m | (Gallego, 2010) https://www.eea.europa.eu/data-and-maps/data/population-density-disaggregated-with-corine-land-cover-2000-2 |
| ghs2015 | 1975, 1990, 2000, 2015 | 250 m (and 1 km) | (Freire et al., 2016); European Commission, Joint Research Centre (JRC); Columbia University, Center for International Earth Science Information Network - CIESIN (2015): GHS population grid, derived from GPW4, multi-temporal (1975, 1990, 2000, 2015). European Commission, Joint Research Centre (JRC) [Dataset] PID: http://data.europa.eu/89h/jrc-ghsl-ghs_pop_gpw4_globe_r2015a See: http://data.jrc.ec.europa.eu/dataset/jrc-ghsl-ghs_pop_gpw4_globe_r2015a For GHSL project, see : http://ghsl.jrc.ec.europa.eu/ |
| geostat | 2011 | 1 km | http://ec.europa.eu/eurostat/statistics-explained/index.php/Population_grids |
| iehias | 2001 (?), data sourced in 2006 - 2007 | 100 m | http://en.opasnet.org/w/EU_age/sex_stratified_population:_100_metre_grid http://www.integrated-assessment.eu/eu/index53b1.html?q=resource_centre/eu_agesex_stratified_population_lau2 |
| immi3 | 2012 | 25 m | Flemish authories |



# Sensitivity analysis: Population datasets

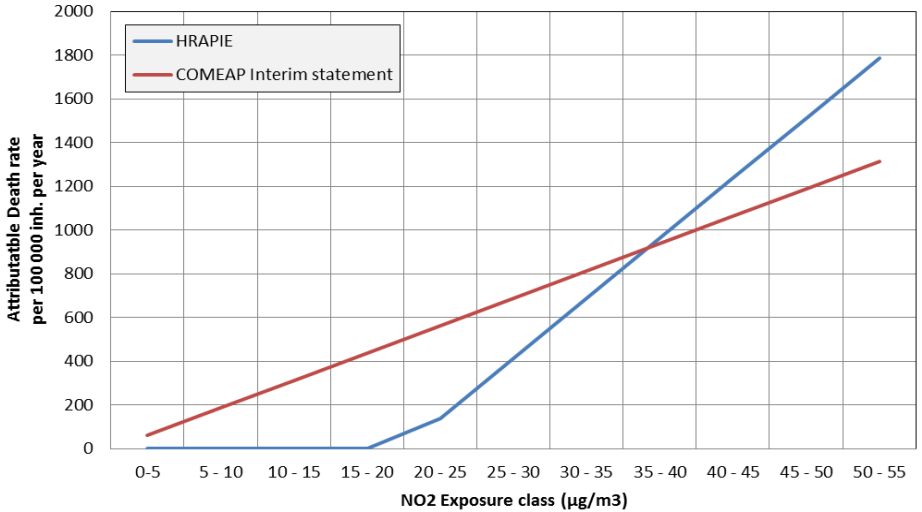
- Up to 7-8 % difference in population exposure
- Large differences between cities
- Interesting effect for high resolution population dataset (Flanders)



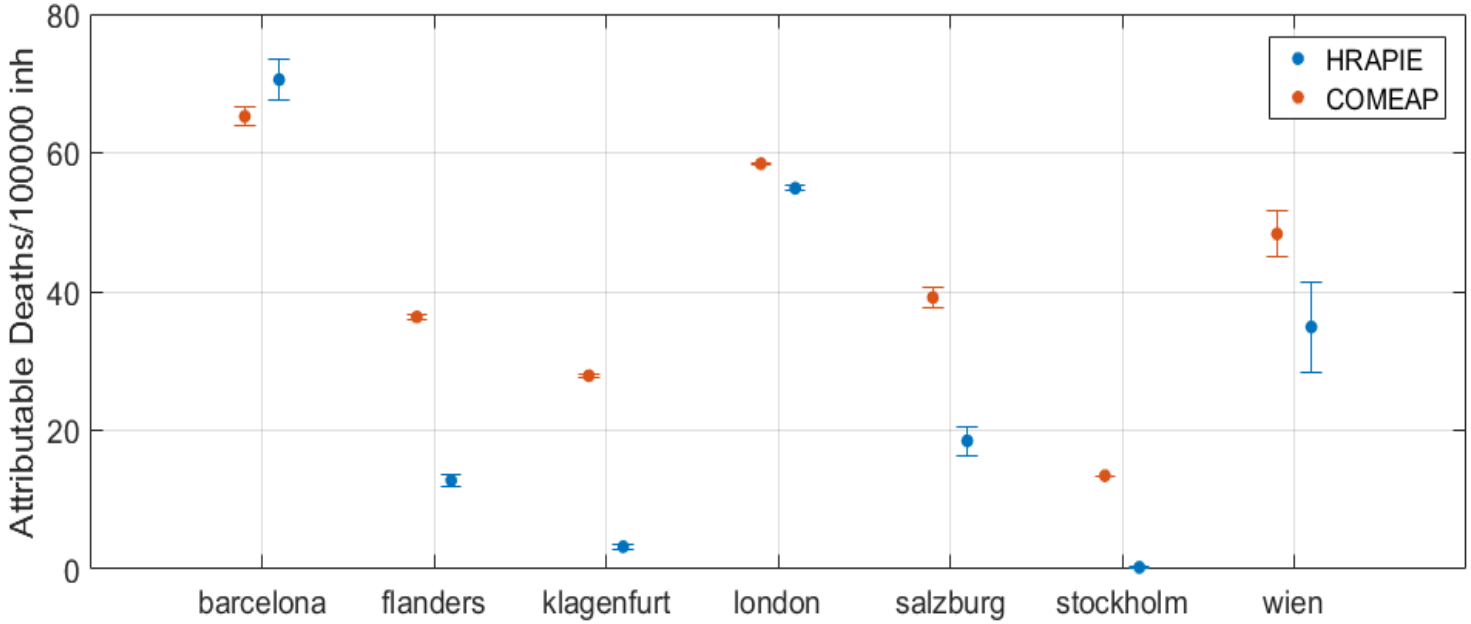



# Sensitivity analysis: Concentration Response Functions (CRF's)

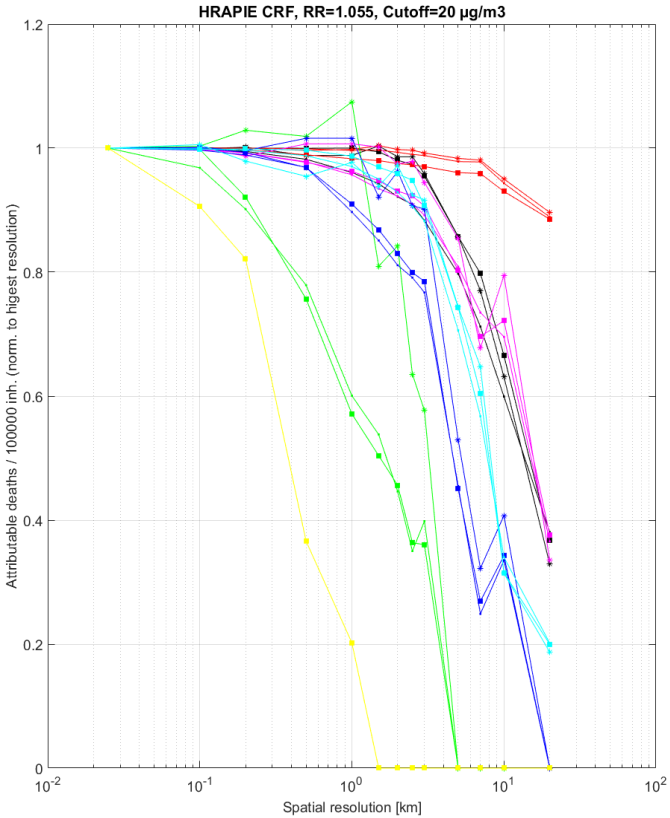
- **HRAPIE**: RR of 1.055 per 10 µg/m$^3$ (1.031 – 1.080 95% C.I. ) with a cut-off of 20 µg/m$^3$
- **COMEAP** Interim (2015 report): RR of 1.025 per 10 µg/m$^3$ (1.010 – 1.040) **without** cut-off
- Both to be reduced with 33 % for overlap with $PM_{2.5}$
- Using baseline mortality of 1 % throughout, no age threshold

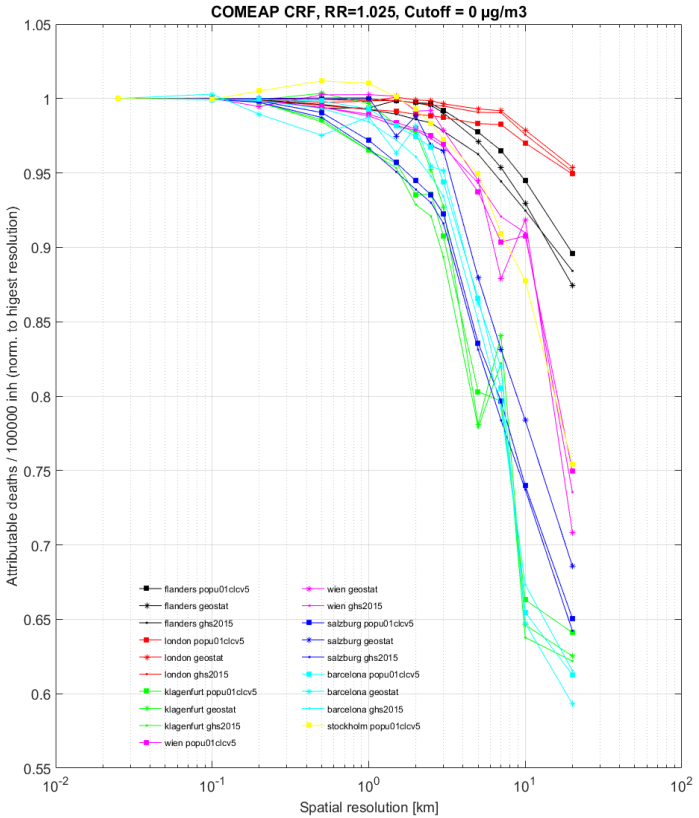


# Sensitivity analysis: CRF's



# Sensitivity analysis: CRF's & spatial scale

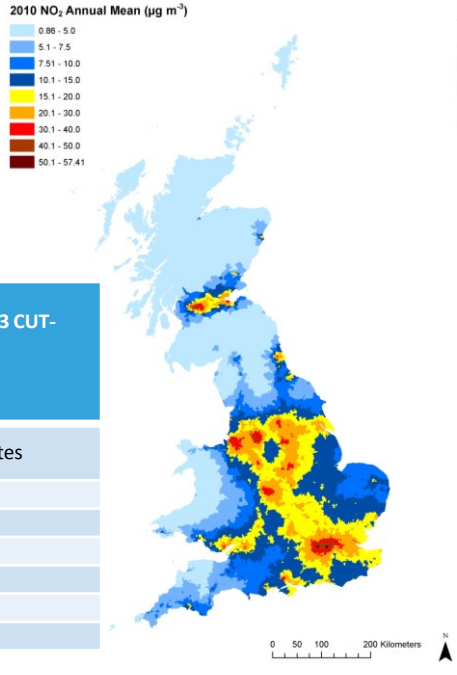


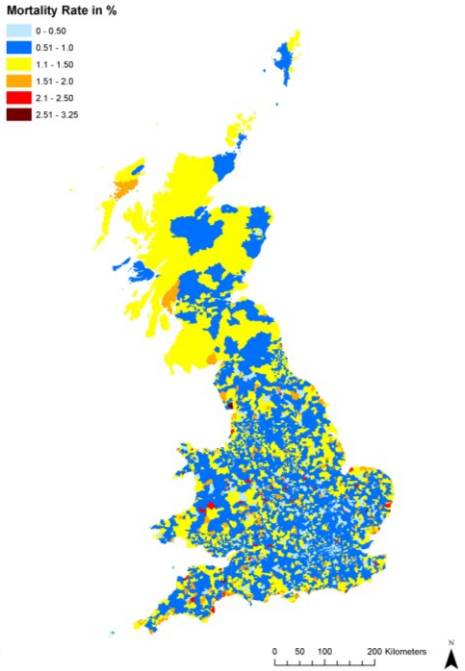



# Sensitivity analysis: Baseline mortality

- National vs. local mortality rate → underestimation of the health impact
- Percentage difference in life-years lost

| CONSTITUENT COUNTRY | COMEAP INTERIM STATEMENT, 5 µg/m3 CUT-OFF | COMEAP INTERIM STATEMENT, NO CUT-OFF | HRAPIE, NO CUT-OFF (TO ILLUSTRATE EFFECT OF CRF SIZE VS CUT-OFF) | HRAPIE, 20 µg/m3 CUT-OFF |
|---|---|---|---|---|
| | Underestimate in life-years lost over 105 years using country not local mortality rates | | | |
| England | 6% | 5% | 4% | 12% |
| Scotland | 8% | 6% | 6% | 13% |
| Wales | 6% | 4% | 4% | 15% |
| Great Britain | 6% | 5% | 4% | 12% |
| | Underestimate in life-expectancy from birth using country not local mortality rates | | | |
| Great Britain | 10% | 8% | 8% | 20% |




UK Office for National Statistics

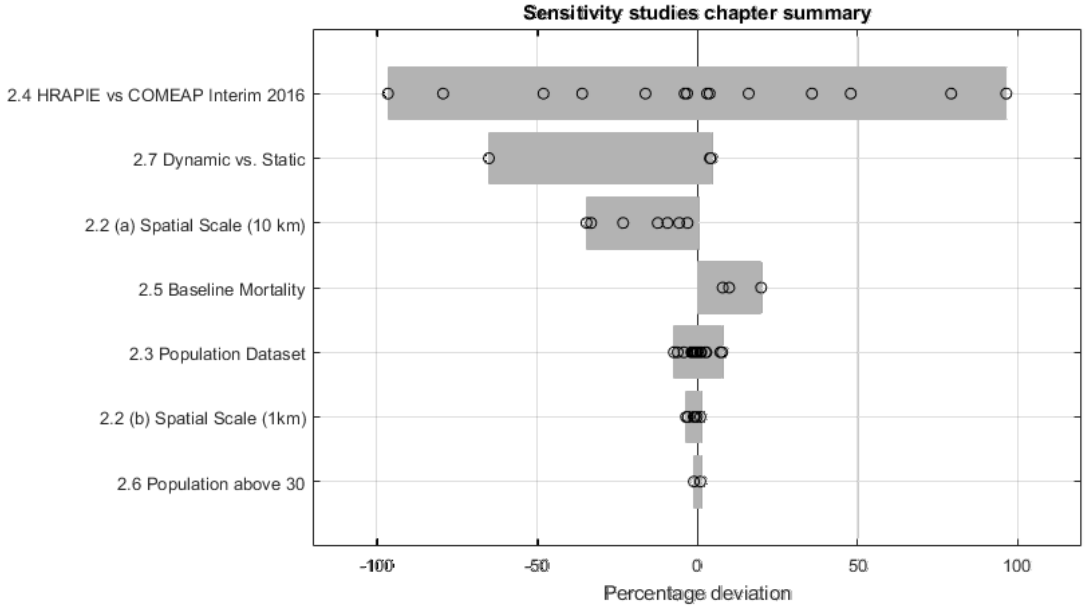
## Sensitivity analysis: Static vs. Dynamic exposure

- Currently dynamic exposure unfeasible at EU scale
  - Adequate input data (activity data) is lacking
  - No generally accepted CRF

- Differences from literature (incomplete)
  - ~4% increase comparing mobile phone based dynamic population maps with static maps (Dewulf et al., 2016) in Belgium, TECNAIRE-CM project in Spain (Rafael Borge et al), …
  - 63% reduction taking London travel demand & micro-environment concentrations (outdoor-based indoor estimates) (Smith et al., 2017)

# Sensitivity analysis: Summarizing tornado plot

- Reflects this work alone
- CRF uncertainty dominant
- Spatial scale of 10 km inadequate
- Uncertainty in population disaggregation currently larger than uncertainty due to 1 km $NO_2$ assessment, however may be underestimated



## CONCLUSIONS & RECOMMENDATIONS

- Concentration Response Functions (CRF's) are the main source of uncertainty in $NO_2$ health impact assessment
- Relevant uncertainties in input data: population, baseline mortality
- For $NO_2$ exposure assessment 1 km is minimum, but recommended to go down to 100 m
- Efforts for high resolution should not be reduced
  - Many of the EU limit value exceedances are at the level of street canyons
  - High resolution AQ assessments help in reducing uncertainty in CRFs (use in epi-studies, dynamic exposure)

# THANK YOU!

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