DEPARTMENT OF ENVIRONMENTAL SCIENCE
AARHUS UNIVERSITY

SPATIAL HIGH-RESOLUTION MAPPING OF NATIONAL EMISSIONS

Air Pollution 2018

19 – 21 June 2018, Naples, Italy

Ole-Kenneth Nielsen, Marlene Plejdrup & Henrik Bruun
Department of Environmental Science
Aarhus University

epa
Environmental Protection Agency
An Ghníomhaireacht um Chaomhnú Comhshaoil

Acknowledgements

› The Irish EPA for funding of the project as part of the Climate Research Call 2015 – Air Science
› The Irish emission inventory team for sharing expert knowledge on the Irish emission inventory and national circumstances
› The Steering Committee for valuable comments and advice regarding methodology and data availability
› Stakeholders and data providers for highly appreciated discussions, cooperation and sharing of data

Motivation

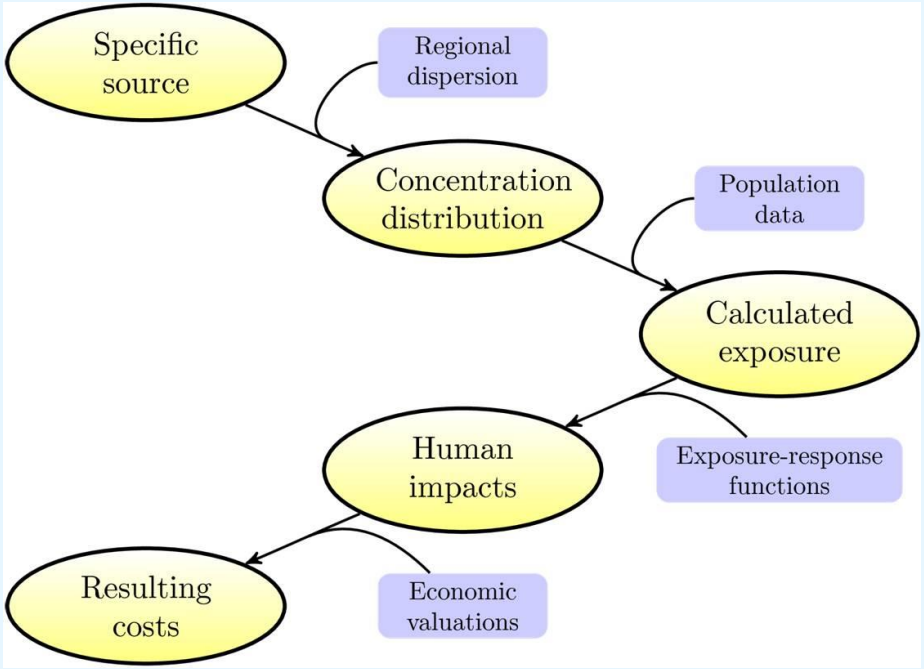
- Spatial emissions is a key element in assessing human exposure to air pollution through use of dispersion modelling
- High quality spatial emission mapping is crucial for the quality, applicability and reliability of modelled air pollution levels, estimated human exposure, incurred health effects and related costs
- Useful for policy makers on both national and local level in decision making and prioritising of environmental measures
- Enable more detailed regulation, implementing measures targeting areas where emissions are highest, allowing for more cost-effective initiatives on local, regional and national scale

Applications of the research

- Methodology can benefit other countries, which embark development of high-resolution spatial emission distributions
- Applicable for national, regional and local scale
  - Often a higher resolution is wanted for smaller areas
- Scenarios can be run for specific sectors or areas
- Important information for policy makers in decisions of implementation of environmental policies and measures
- Allows for a more detailed regulation, implementing spatially differentiated measures, allowing for more cost-effective initiatives

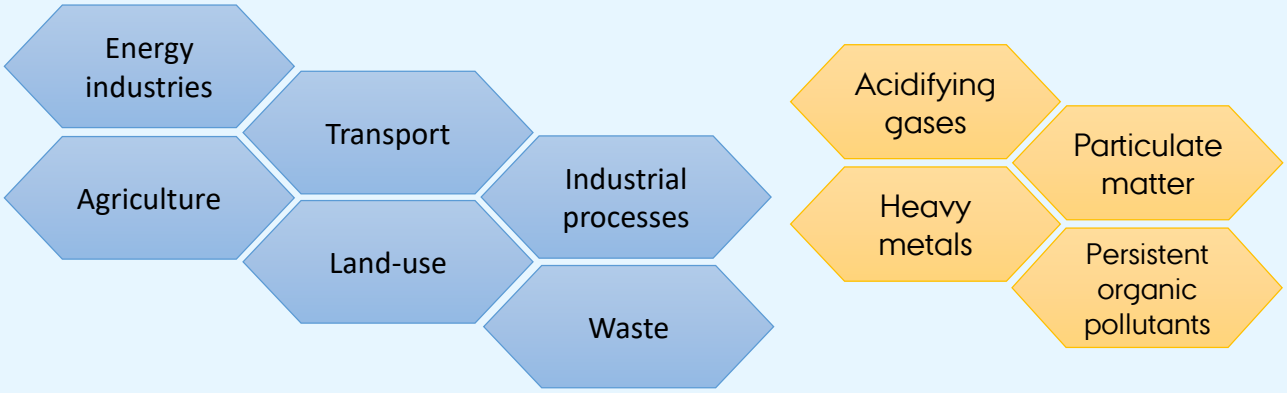
Applications of the research

- Important information for policy makers in decisions of implementation of environmental policies and measures
- Allows for a more detailed regulation, implementing spatially differentiated measures, allowing for more cost-effective initiatives



The spatial emission model

- Complete spatial emission mapping on 1 km x 1 km resolution for the Irish Exclusive Economic Zone
  - ~500.000 km^2
- State-of-the-art integrated database system focusing on performance optimisation
- Includes all sectors and all pollutants in the Irish emission inventory
  - 177 sectors
  - 32 pollutants



The spatial emission model

- Model setup focusing on user-friendliness and performance optimisation
  - Able to handle large data amounts and run complex calculations at high speed
  - Easy to update and include new sources and pollutants
  - Link to official emission reporting tables to ensure consistency
  - Simple user interfaces minimise risks of user-introduced errors

The spatial emission model

- Based on the most detailed data available regarding both emissions and spatial conditions
- Integrates official statistics with a large number of spatial datasets
  - Official statistics as the Irish emission inventory, and censuses of population, housing and agriculture
  - Spatial datasets as diverse as land cover, road network, building use and heat demand

Methodology

- Point sources
  - Plant specific data
    - Emissions
    - Fuel consumption
    - Address/location of facilities
  - Data sources, e.g. E-PRTR, ETS, annual environmental reports, industry associations,
- Area sources
  - Small point sources with common characteristics, but too numerous to be handled individually, e.g. households
  - Lines sources, e.g. roads and railways
  - Surface sources, e.g. agricultural fields
- Combination of point and area sources
  - E.g. the chemical industry sector covers both large plants with plant specific data and small plants, that are treated as an area source

Methodology

- Spatial distribution keys (GeoKeys) are used for emission allocation
  - Normalised tables holding shares of national total emission for a given sector, a given pollutant and a given year
- GeoKeys are based on integration of spatial data
  - Official statistics by administrative units
    - Agricultural census
    - Transport survey
  - Spatial proxy data
    - Population density
    - Road network
  - Selection or exclusion of specific areas
    - Emissions from grazing animals only allocated to agricultural areas
    - Emissions from residential coal combustion not in areas where the use of smoky coal is legally banned

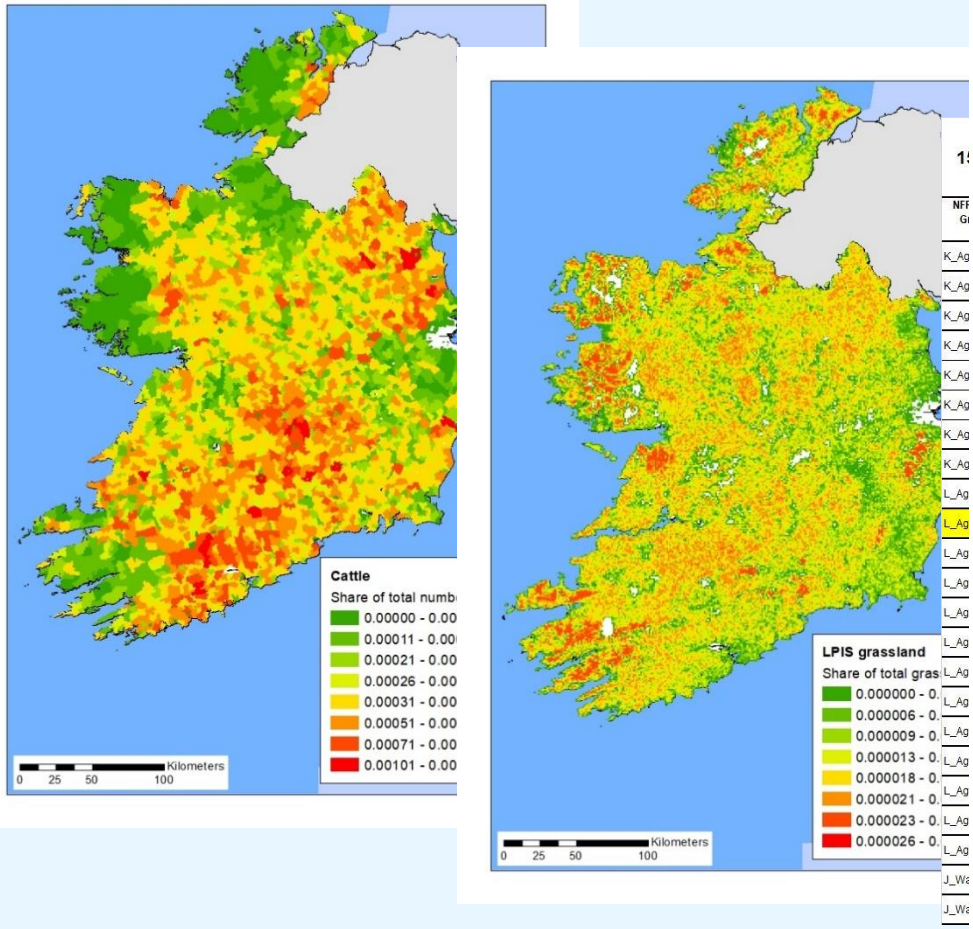
Criteria for selection of spatial data

- Coverage
  - Preferably cover the entire domain
- Accuracy of spatial data
  - Position
  - Attribute data
  - Level of detail
  - Update frequency
  - Time for latest update
  - Local or national data rather than international or global data
- Applicability as spatial proxy
- Integrate spatial data sets to improve the spatial distribution
  - Detailed data covering part of the domain with less detailed data covering the entire domain

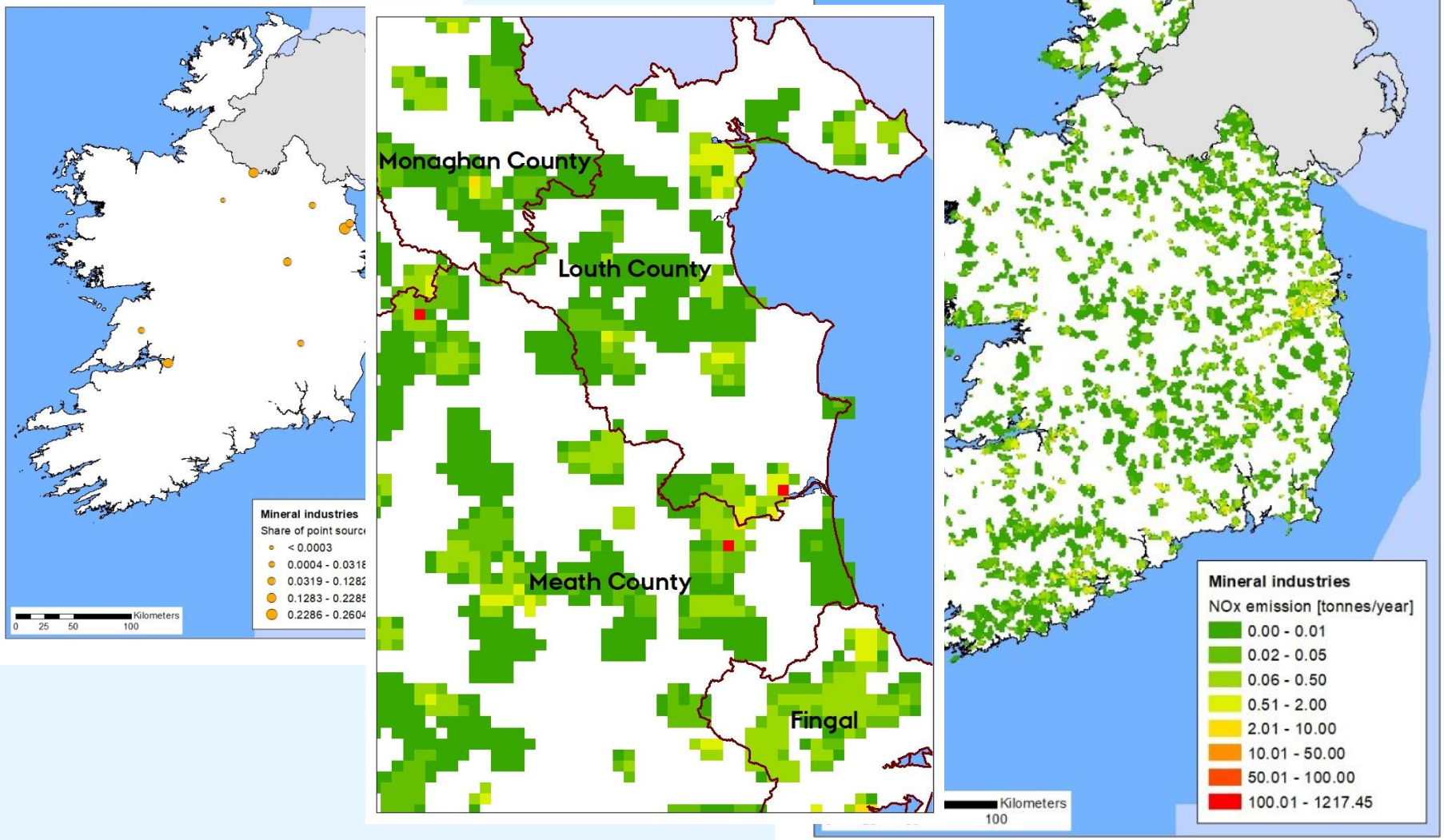
Data integration

- Integration of spatial data sets can improve the spatial distribution
  - Include detailed data covering part of an emission sector
    - Combining point and area sources in a common GeoKey
  - Statistics and spatial data
    - Integrating regional statistics with spatial maps
  - Include detailed data covering part of the domain
    - Mileage data for part of the road network integrated with a simple road network covering the entire domain
  - Spatial data sets describing different features relevant for a single emission source
    - Identification of cultivated organic soils via integration of the Land Parcel Identification System (LPIS) and soil map including organic soils

Data integration



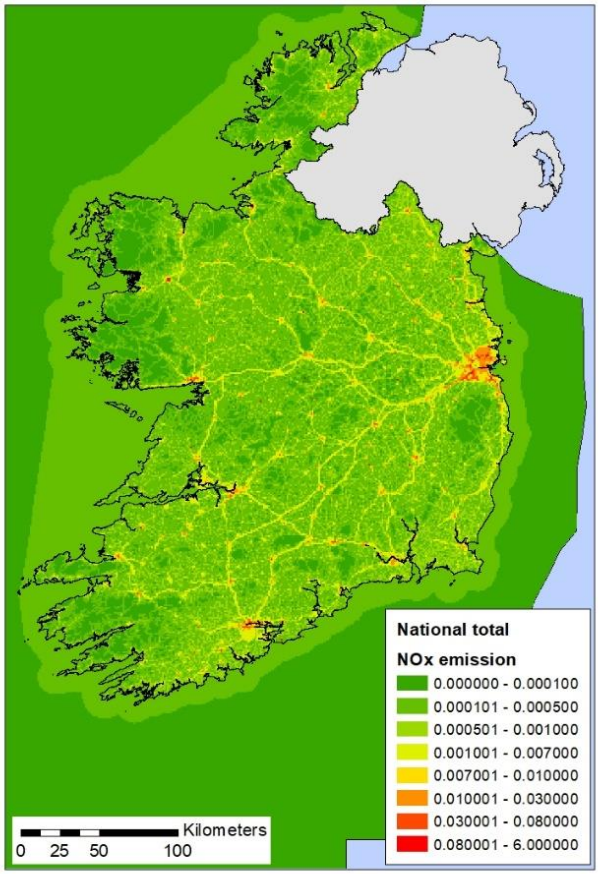
Data integration



Results

- Spatial emissions on a resolution of 1 km x 1 km
- National total or sector level
- Identification of emission hotspots
- Gridded emissions for reporting to the Convention on Long-Range Transboundary Air Pollution

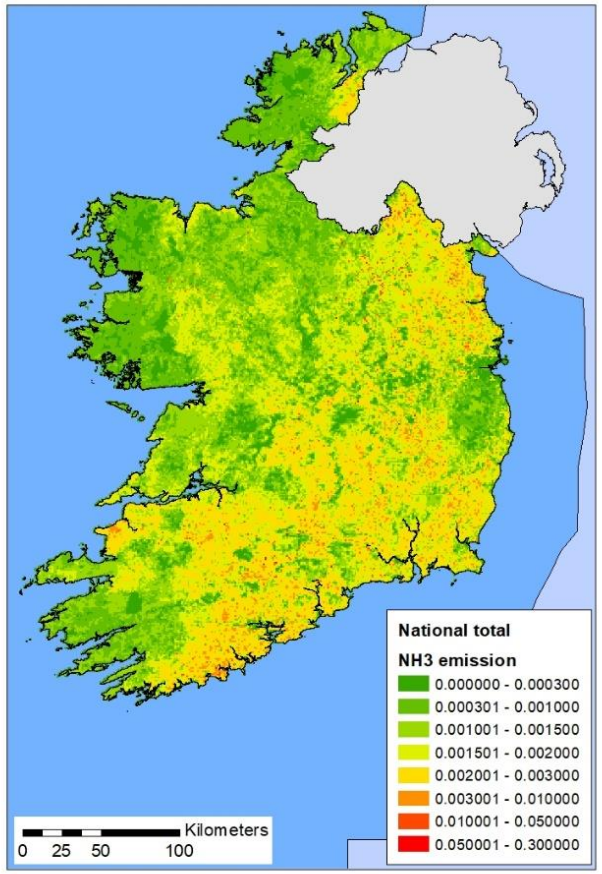
Results



- Main sources of NOx emissions are road transport and large combustion plants

Data is available for downloaded on the project webpage www.MapEIre.dk

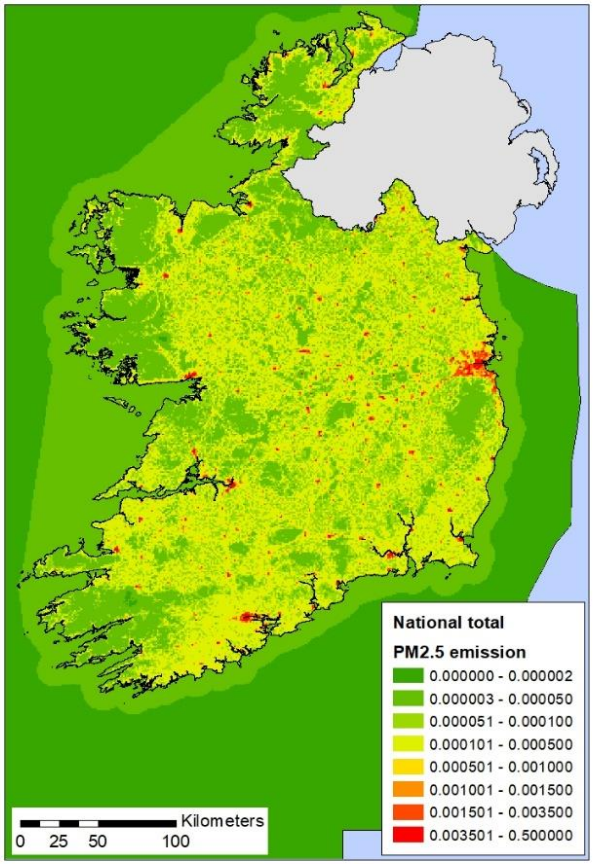
Results



- Main sources of NH3 emissions are manure management and agricultural soils

Data is available for downloaded on the project webpage www.MapEIre.dk

Results



- Main sources of PM2.5 emissions are small combustion plants using coal, wood or peat

Data is available for downloaded on the project webpage www.MapEIre.dk

Conclusions

- Detailed spatial emission inventories on a resolution of 1 km x 1 km have ben developed for all major pollutants
- Detailed sectorial breakdown enables detailed GeoKeys
- Identification of emission hotspots
- Solid foundation to further assess the human exposure and the deposition of harmful substances to vulnerable nature
- Methodology can be used as an example for others embarking on developing a detailed spatial emission inventory
- Still room for improving the GeoKeys and development of time-series to capture changes in spatial patterns
- ~~Gridded emissions for reporting to the Convention on Long-~~

› Questions?

› Thank you for your attention