Damage cost model for air pollution in Finland

Mikko Savolahti, Niko Karvosenoja, Ville-Veikko Paunu, Timo Lanki, Väinö Nurmi, Jaakko Kukkonen

Finnish Environment Institute

11th International Conference on Air Quality – Science and Application, 13 March 2018

SYKE

Contents

- Motivation for the work
- Modelling steps behind the end result
- Who should use the model and how?

SYKE

Monetary valuation of environmental impacts

SYKE

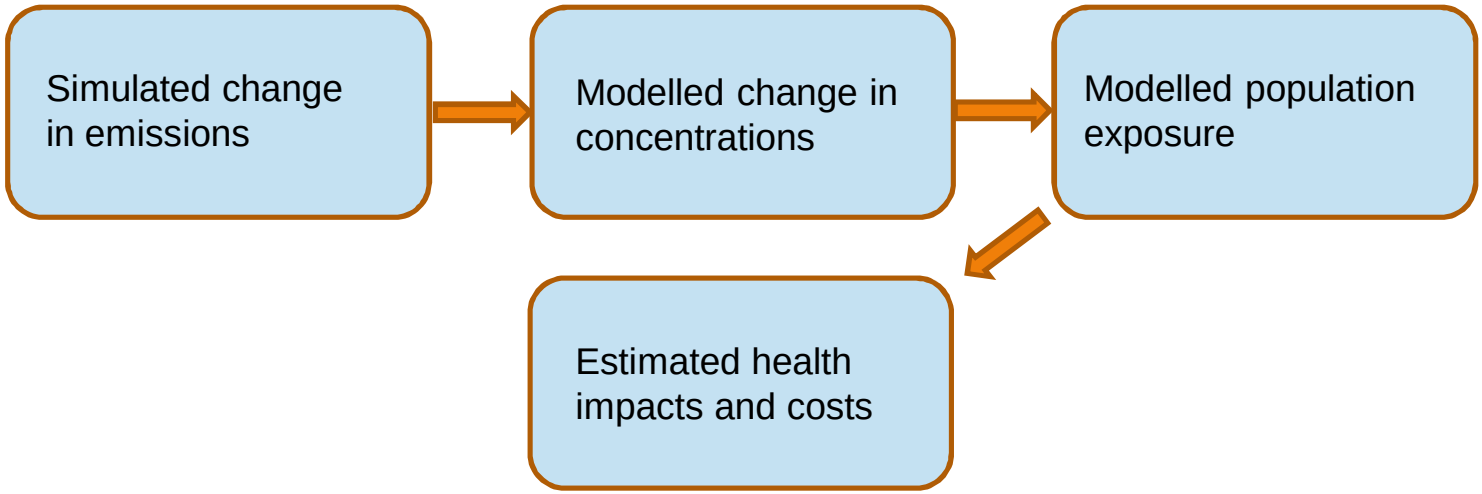
Health impacts of air pollution

- Pollution (mostly air pollution) is the leading cause of global estimated deaths by major risk factors
- The most hazardous environmental risk in Finland (1600 annual premature deaths), even though
  - Annual PM2.5 concentrations mostly below WHO guidelines
  - Sparcely populated country with a remote location
- Human activies cause external costs, that are not being paid by the actor
- Focus of emission reduction should be in mitigating damage
- Cost-benefit analysis needed to find the most efficient methods
  - National/local assessments important

SYKE

Modelling the health impacts caused by changing PM2.5 concentrations

- Studied pollutants: PPM2.5 and the most important precursors for secondary particles (SO2, NOx, NH3)
- Impacts and costs calculated using impact pathway approach

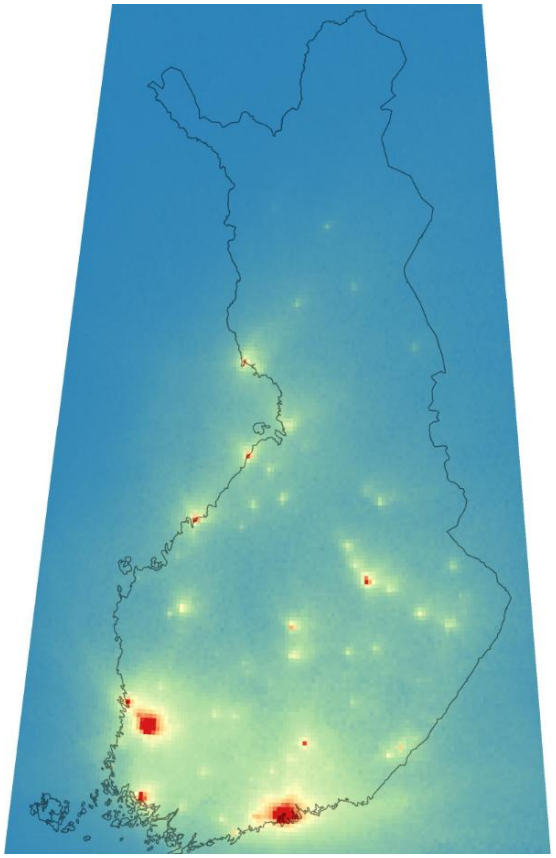


SYKE

Emissions and resulting concentrations

- All Finnish emissions calculated for 2015 and spatially distributed into a 250 m x 250 m grid
  - Distribution by plant locations, land/road use data, building registers, climate conditions and degree of urbanization
- Dispersion modelling
  - Source-receptor matrices for low-altitude PPM2.5 emissions (250 m x 250 m)
  - Atmospheric dispersion modelling (SILAM) for the rest (5 km x 5 km)

    Includes also other relevant pollutants as well as long-range transboundary pollutants

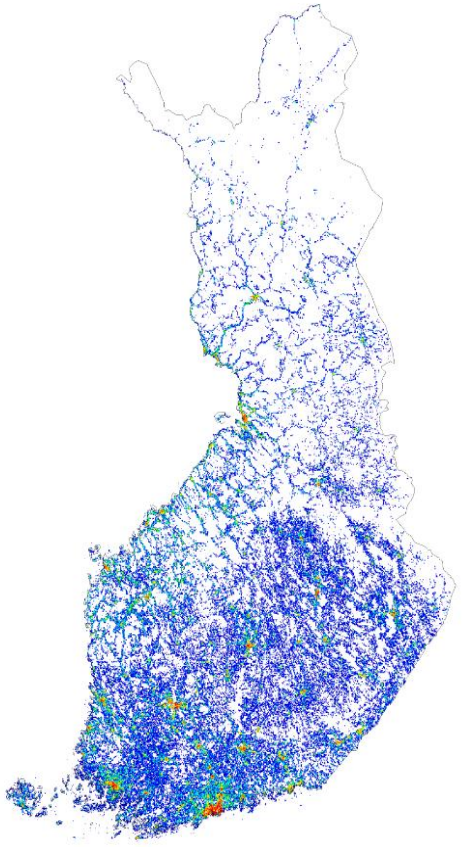


Industry and power plants, SO2 –> PM2.5
SILAM model

SYKE

Population exposure and health impacts

- Population data (250 m x 250 m grid) compared to changes in concentrations
- Included health impacts:
  - Premature mortality
  - Chronic bronchitis, asthma
  - Hospital treatment (heart/respiratory diseases)
  - Missed working days/reduced efficiency
- Premature mortality
  - Two common methods used:
  - VOLY (Value of Life Year)
  - VSL (Value of Statistical Life)



Population density

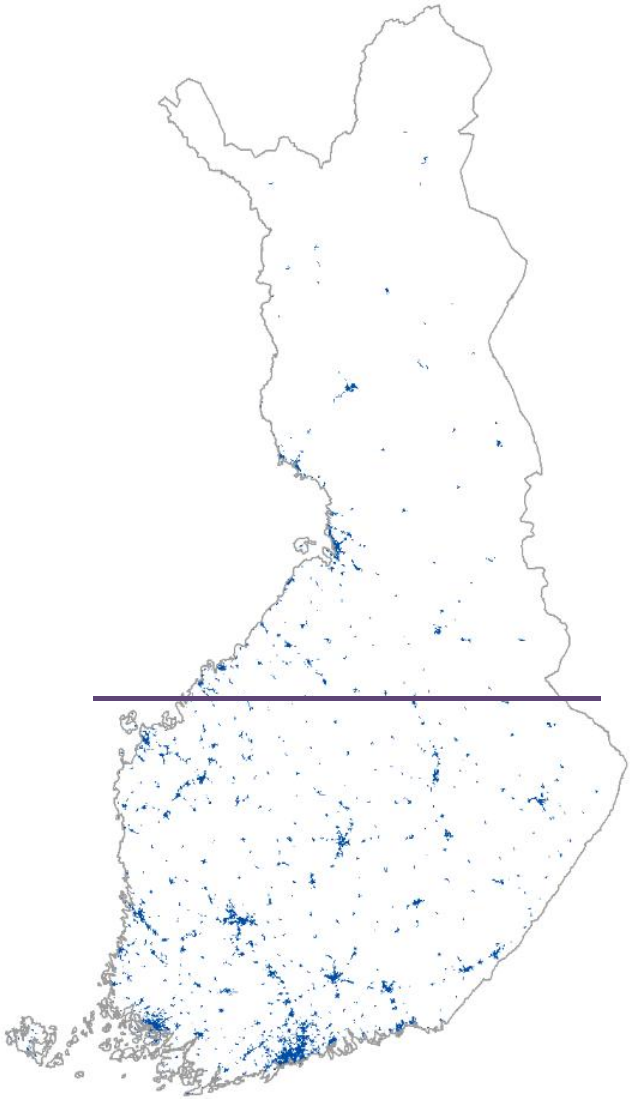
SYKE

Urban/non-urban areas

Urban area

- At least 200 residents in grid cell
- Buildings no further than 200m apart

Town of Ivalo, urban area.
www.mapio.net



Damage cost model

Monetary benefits from reduction of emissions (1000€/ton)

	Location of emission reduction	
Low emission height	**Urban area**	**Non-urban area**
Road transport, primary $PM_{2.5}$	140[1] (80[2]–320[3])	13 (7.6–31)
Non-road & machinery, Primary $PM_{2.5}$	170 (100–390)	5.0 (2.8–11)
Residential houses, wood stoves & sauna stoves Primary $PM_{2.5}$	70 (40–160)	8.7 (4.8–19)
	All of Finland	
Recreational houses, wood stoves & sauna stoves, Primary $PM_{2.5}$	5.5 (3.1–13)	
Residential houses, wood boilers, Primary $PM_{2.5}$	12 (6.6–27)	
Road transport, NO_x-> secondary $PM_{2.5}$	0.82 (0.46–1.8)	
Agriculture, NH_3-> secondary $PM_{2.5}$	1.2 (0.70–2.8)	
High stacks	**Southern Finland**	**Northern Finland**
Industry & power plants, Primary $PM_{2.5}$	10 (5.8–24)	5.7 (3.2–13)
	All of Finland	
Industry & power plants SO_2-> secondary $PM_{2.5}$	1.3 (0.73–3.1)	
Industry & power plants, NO_x-> secondary $PM_{2.5}$	0.43 (0.24–1.0)	

[1] *VOLY average (Value Of Life Year) 160 000 €*
[2] *VOLY median (Value Of Life Year) 69 000 €*
[3] *VSL average (Value of Statistical Life) 2,65 milj. €.*

https://wwwp.ymparisto.fi/IHKU/haittakustannuslaskuri/

SYKE

Where to use the model?

- National level strategies
  - Strategies for energy use
  - National Air Pollution Control Programme
  - Other mitigation strategies
- Municipal level strategies
- Individual plants?

- Challenges
  - Requires an estimate for the amount of emission reduction in tons
  - Gives average values
    - Not accurate in small-scale assessments
  - Only includes health impacts

SYKE

Conclusions

- Model is easy to use and easily available
- Only includes health impacts from fine particulates (and only only the most certain ones)
  - Appears to be the biggest cost factor
  - Air pollution causes many environmental hazards that are difficult to monetarize
  - Unit costs are probably underestimations
- Cost estimates are averages
  - Uncertainties increase when scale decreases
- Even with the realtively clean air of Finland, reduction of domestic emissions can bring significant health benefits
- Low height, urban emissions of primary particles an order of magnitude more harmful than others

SYKE

Thanks!

Web:

http://www.syke.fi/hankkeet/ihku/ihkumalli

Contact:

mikko.savolahti@ymparisto.fi

+358 29 5251595

Finnish Environment Institute SYKE

SYKE