Damage cost model for air pollution in Finland

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

Finnish Environment Institute

TFIAM 47

SYKE

Air Quality Programme 2030
As requested in the NEC directive

- A delegation with representatives from ministries, research institutes and industry to make the national programme during 2018
- Calculation of baseline (CLE) emission projection not finished, but looks like all other targets except ammonia could be met without additional measures
- Possibly additional PaMs to improve air quality and reduce health impacts
  - Domestic wood combustion: Information campaigns, sauna stove measures
  - Road dust: Street cleaning, dust binding, studded tire restrictions
  - However, they are most likely to be descriptive and voluntary
  - **Prioritisation of black carbon** when taking PaMs to reduce PM2.5

SYKE

Damage cost model: Contents

- Motivation for the work
- Modelling steps and the result
- Observations

SYKE

Motivation

- Work requested by the Finnish Ministry of the Environments
  - What damage costs should be used when planning air quality policies in Finland?
  - What are the differences in damage costs between high/low altitude and urban/non-urban sources
  - How valid are costs from other European studies in Finnish impact assessments
- We* wanted to make the model as simple to use as possible for all interested parties

*Finnish Environment Institute, Finnish Meteorological Institute & National Institute for Health and Welfare

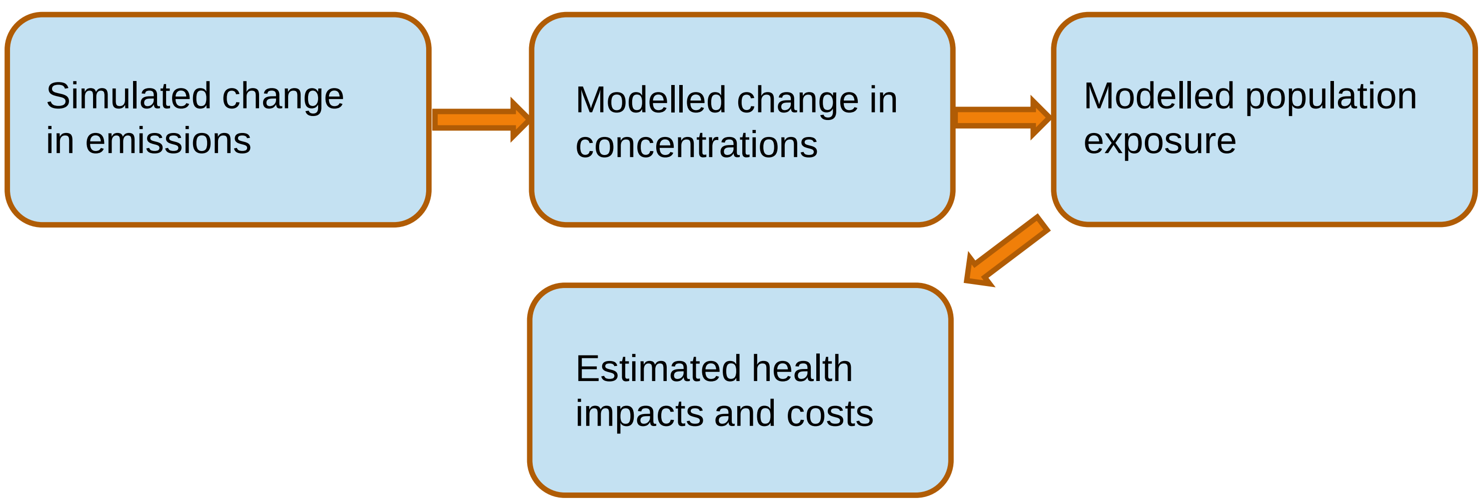
SYKE

Monetary valuation of environmental impacts is challenging

SYKE

Modelling the health impacts caused by changing PM2.5 concentrations

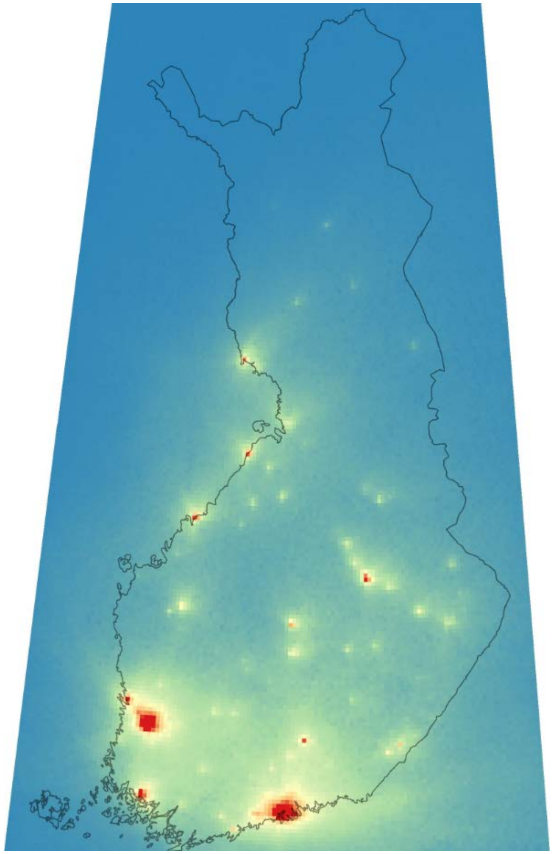
- Studied pollutants: PPM2.5 and the most important precursors for secondary particles (SO_2, NO_x, NH_3)
- Impacts and costs calculated using impact pathway approach



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

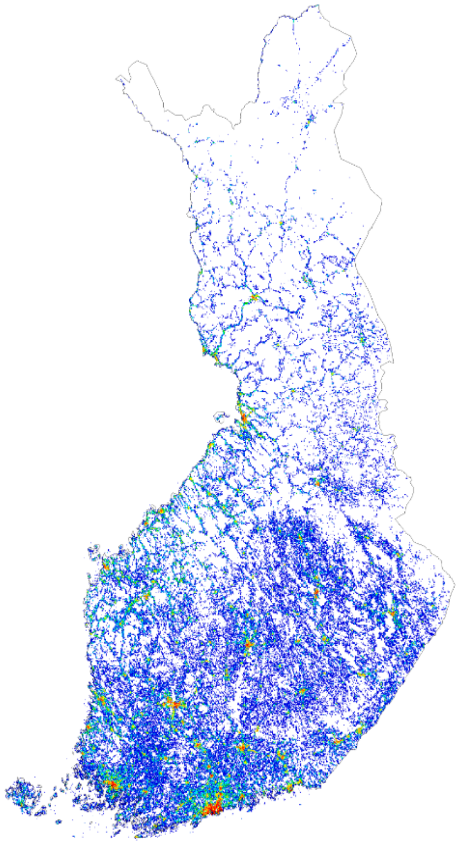


Industry and power plants, SO2 –> PM2.5
SILAM model

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)

*From the NewExt study



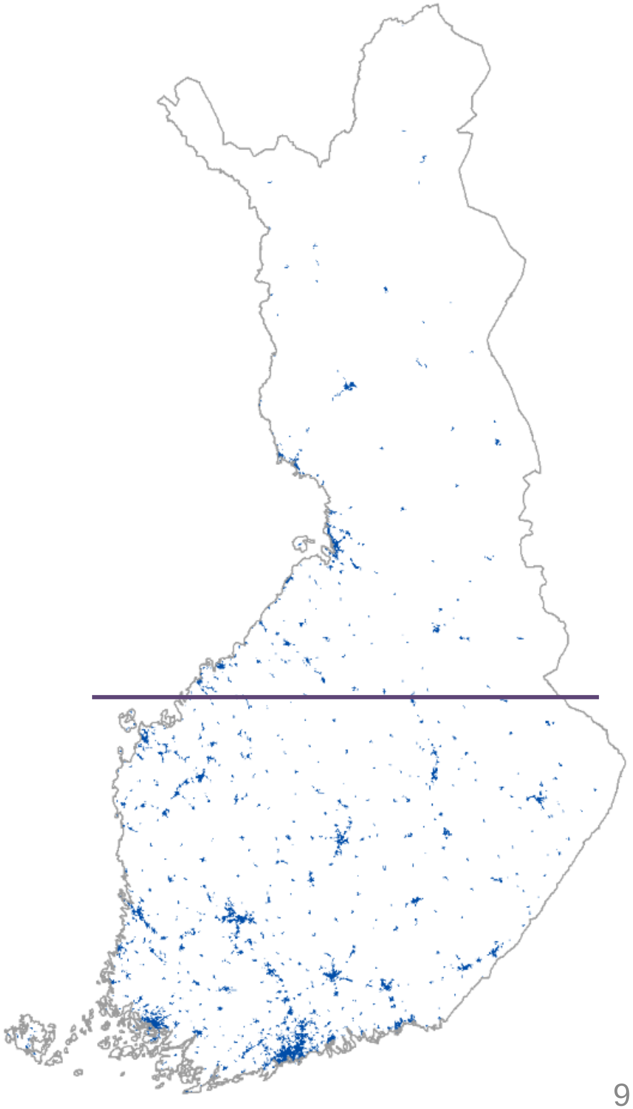
Population density

Urban/non-urban areas

Urban area

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

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



SYKE

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

Comparison to earlier studies

Health damage cost for ton of PM2.5

Study	Emission source	Unit cost
EEA, 2014 Brandt et al., 2013 Preiss et al., 2008 **Our study**	High stacks High stacks High stacks **High stacks, Southern/Northern Finland**	16 000€ 23 000€ 12 000€ **10 000/6000€**
Bickel et al., 2003 (UNITE) Gynther et al. 2012 **Our study**	Traffic, Helsinki Traffic, Finnish towns **Traffic, Finnish urban areas**	526 000€ 23 000 – 680 000€ **140 000€**

- Reasonably good comparability with normalized parameters

SYKE

Where should the model be used

- Expert work for policy support
  - National level 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 (and only part of them)
  - Cost for premature mortality ”not up to date(?)”

SYKE

Observations 1/2

- My takeaways from the study
  - Money talks, so these kind of tools are in demand
  - Other environmental impacts should be included somehow
    - NEEDs project shows that biodiversity costs are relevant
  - Valuing loss of life makes things difficult
    - Recent studies show much higher VSL values than the high end of our range
    - Everything is underestimated, this message is probably lost in the policy making process
  - Even with an easy user interface, a lot of expertize is needed to actually use the model
    - Maybe some additional help for the user to make calculations, e.g. ”1000 stoves produce x ton of PM2.5 emissions annually”

SYKE

Observations 2/2

- Questions
  - What cost should we use for premature death?
  - How should ecosystem damage be included?

SYKE

Thanks!

Web:

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

Contact:

mikko.savolahti@ymparisto.fi

+358 29 5251595

Finnish Environment Institute SYKE