OPERATIONAL HEALTH DAMAGE COST MODEL FOR MUNICIPALITY POLICY ASSESSMENTS

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Outline

- Introduction: $PM_{2.5}$ health impacts and damage costs
- Modelling setup behind the on-line tool *ihQ*
- Use of *ihQ* and challenges
- Next steps to further develop the tool
- Conclusions

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Health impacts of $PM_{2.5}$ in Finland

- Air pollution is a major risk factor for premature deaths globally
- Fine particles ($PM_{2.5}$) is the most harmful air pollutant
- In Finland, $PM_{2.5}$ cause the biggest disease burden from air pollution – approx. 1600 premature deaths in 2015
- Mainly caused by LRT, however, local sources important and regional differences large

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Article

Health Impacts of Ambient Air Pollution in Finland

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Table 5. Estimates of attributable disease burden for four main air pollutants in Finland in 2015.

Pollutant	DALY	(95% CI)	YLL/YLD	Deaths	YLL/Death
$PM_{2.5}$	26,000	(17,000–36,000)	61	1600	16
PM_{10}	3800	(1900–5700)	3	160	18
NO_2	4400	(2400–7100)	10	240	17
O_3 [a]	750	(330–1300)	11	40	17
Total	35,000	(25,000–46,000)	17	2000	17

DALY disability-adjusted life years, YLL years of life lost, YLD years lived with disability, CI confidence interval.
[a] Ozone impacts are based on SOMO35.

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Health damage costs

- External costs: Human activities cause costs that are not paid by the actor
- Health damage costs of $PM_{2.5}$
  - Market costs: hospitalization, absence from work etc.
  - Non-market costs: how people valuate extra years without disabilities/illnesses
  - Macroeconomic effects: how air pollution affect economic growth (not included in this study)
- Why monetize health impacts?
  - Enables cost-benefit analysis to support decision-making and find the most cost-efficient measures to improve AQ
- Why sector-specific municipality-level tool?
  - Emission reductions in different sectors and different parts of the country lead to strongly different health improvements
  - Many AQ measures are planned and implemented by municipality/city authorities

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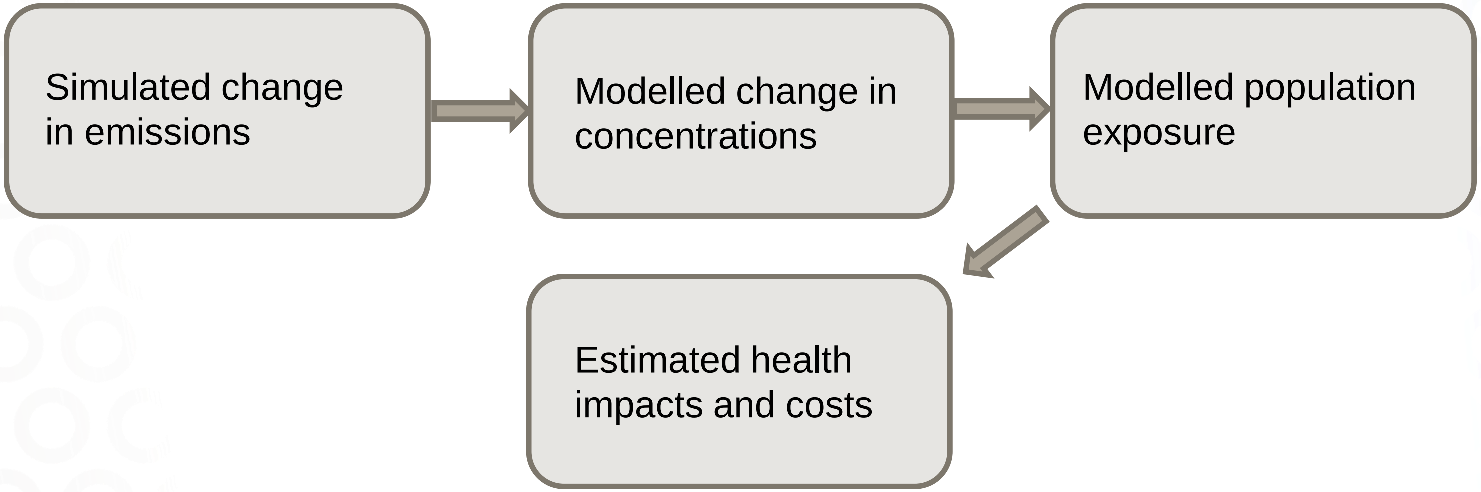
Modelling setup

Emission reductions -> health improvement

- Studied pollutants: primary $PM_{2.5}$ and precursors for secondary particles (SO_2, NO_x, NH_3)
- Impacts and costs calculated using impact pathway approach



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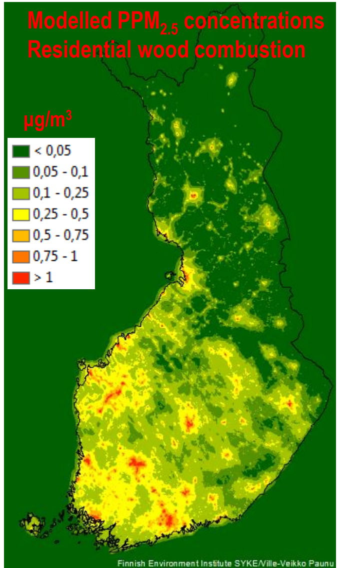
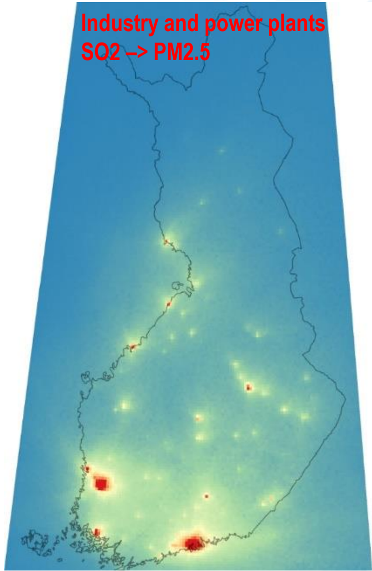
Modelling setup

Emission reductions -> health improvement

- Area **emissions** at 250 m spatial resolution; Industry and power plants as point sources
- **Dispersion** modelling
    - Source-receptor matrices based on *UDM-FMI* for low-altitude PPM2.5 emissions (250 m x 250 m)
    - Chemical transport model *SILAM* for the rest (5 km x 5 km)
- **Population** data 250 m resolution
- **Health impacts**
    - Premature mortality
    - Chronic bronchitis, asthma
    - Hospital treatment (heart/respiratory diseases)
    - Missed working days/reduced efficiency
- **Health valuation**
    - Nordic VSL (Value of Statistical Life) 3.5 M€

syke.fi/emissionmap; syke.fi/projects/fres





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Damage cost model for air pollution *IHKU*

- *IHKU* (2018): Easy-to-use tool for national level policy-makers to assess health benefits of AP or climate mitigation measures as monetary values
- However, need from municipality policy-makers for spatially more explicit tool

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Modelling of the public health costs of fine particulate matter and results for Finland in 2015

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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/

Municipality damage cost model *ihQ*

- *ihQ* (2020): Tool for municipality level policy-makers
- Damage costs are separately calculated for different municipalities and sources
- User can select from the list of 310 municipalities
- Annual reductions in emission sources are fed in (weak spot of the tool, how to estimate emissions)

Figure: User interface of ihQ with calculation examples:

#1: Inner city resident parking fee doubling to decrease 1.1% of total traffic amounts in Helsinki

#2: Information campaign about proper wood stove use to decrease 5% of stove $PM_{2.5}$ emissions in Helsinki

#3: Heat recovery and heat pumps to replace 25% of Hanasaari B district heating plant production

The IHKU damage cost calculator can be used as an indicative estimate of the financial benefits of emission reductions measures. The model is intended primarily for expert use.

Helsinki

Emission reductions

Input an estimation of the amount of emission reduction in tonnes per year (t/a) to the cells below.

Low altitude emission sources

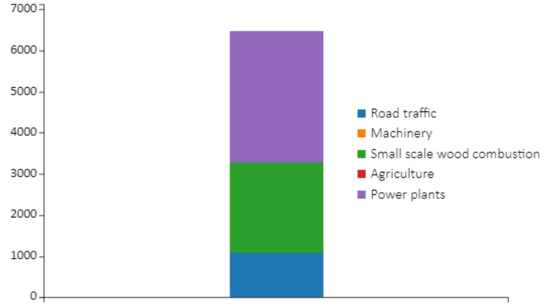
The calculated emissions for the year 2015 are shown for each municipality in brackets. Emissions from road traffic only include emissions from the street network managed by the municipality (i.e. no highroad traffic). Other low-emission sources include all emissions within the municipal boundaries. For more information, hover over each sector.

Road traffic, road dust, $PM_{2.5}$ (17 t)	0.19
Road traffic, exhaust, $PM_{2.5}$ (36 t)	0.40
Machinery, $PM_{2.5}$ (37 t)	0
Fireplaces and stoves, small houses, $PM_{2.5}$ (35 t)	1.7
Fireplaces and stoves, summer cottages, $PM_{2.5}$ (1 t)	0
Boilers for small houses, $PM_{2.5}$(<1 t)	0
Traffic and machinery, NO_x (1790 t)	16
Agriculture, NH_3 (11 t)	0

High altitude emission sources

Power plants and industry, $PM_{2.5}$	1.9
Power plants and industry, SO_2	290
Power plants and industry, NO_x	470

Financial benefits of health effects gained by reducing emissions (1000€/year)



The cost estimates take into account the following health risks caused by fine particles:

- Premature Deaths
- Chronic bronchitis and asthma
- Hospital visits related to respiratory and circulatory symptoms
- Absences from work and reduced ability to function

The cost estimate includes both concrete measures affecting the national economy and changes in the quality of life, the so-called valued costs. Premature Deaths are the most significant cost factor. For this, a method has been used in which all deaths cause an equal cost (Statistical value of life, VSL = 3.6 million €).

More Information

Calculation examples

- ▶ Example 1: Pricing for resident parking
- ▶ Example 2: Information campaigns on wood burning
- ▶ Example 3: Replacement of coal-fired district heating in a power plant

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https://ihkulaskuri.netlify.app/

Municipality damage cost model *ihQ*

Way forward – how to better connect with measures

- Municipality scenario tool *ALasSken* enables user to study climate measures on-line
- User can use the slider and see the effect on ghg-emissions
- 2021: *ihQ* will be integrated within *ALasSken* - the tool will show health impacts and damage costs for the studied measures

Figure: User interface of ALasSken – as an example for private cars, user can vary:

Accessibility of grocery stores, schools, public transport etc.

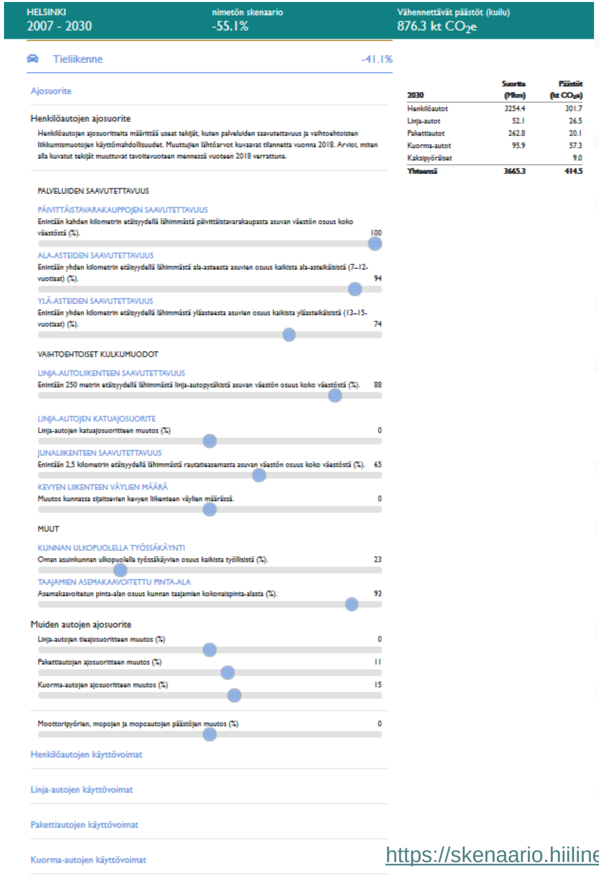
Congestion outside the municipality

Shares of transport modes

Share of fuels of vehicles

Improvements of cycling infrastructure

etc.



https://skenaario.hiilineutraalisuomi.fi/

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Conclusions

- Publicly available computation tool *ihQ* for municipality level experts and policy-makers to evaluate public health costs of air pollution
- Enables assessment of health benefits of climate and air pollution measures as monetary values
- Enables cost-benefit analysis of climate or air pollution mitigation investments
- Challenge at the moment: estimation of air pollution emission changes
- Next steps: integration with municipality climate scenario tool

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Thank you for your attention

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