Bayesian estimation of small-area (healthy) life expectancy: Methodology & Applications

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Structure of presentation

1. Introduction
2. Methodology
3. Real-life applications
4. Key points to remember

Introduction (1)

- Many urban policies aim to improve areas and address socioeconomic deprivation
- The resulting investment is often delivered through area-based programmes
  - targetting complete neighborhoods instead of individuals
- Validating evidence is scarce: 'population health' is extremely difficult to quantify and compare at the small-area level
  - Which neighborhoods should be targetted?
  - Are area-based programs succesful?

Introduction (2)

Theoretically, LE and HLE are ideally suited for this:

- .. combines mortality and morbidity into a single indicator;
- .. can be readily compared between areas (i.e. corrected for important confounders);
- .. can be easily communicated to a broad audience;
- .. can be calculated for a large number of areas;
- .. is comparable over time.

2. Small area problems

a) Standard life table methodology is developed for large populations and unsuitable for small-area analyses

b) Health surveys often have sample sizes that are too small (for small-area analyses)

Sparse data problems!

1. Large SE **2. unreliable SE** **3. biased estimates**

Solution: Bayesian random effects modelling

Statistical methodology that efficiently combines information from similarities between:

a) adjacent age groups (age-mortality curve, but not relational);
b) males/females (within the same area);
c) morbidity/mortality (within the same area);
d) surrounding area's.

Structure of the model (without priors)

1. Mortality model

$Deaths_{[s,i,x]} \sim Poisson(pop_{[s,i,x]} * mrate_{[s,i,x]})$

$log(mrate_{[s,i,x]}) <- b0_{[s]} + b1_{[s,x]} + b2_{[s,i]}*b3_{[s,x]}$

2. Morbidity model

$nrHealthy_{[s,i,x]} \sim Binomial(prob_{[s,i,x]} , nrSurvey_{[s,i,x]})$

$logit(prob_{[s,i,x]}) <- b4_{[s]} + b5_{[s,x]} + (b5_{[s,x]})^2 * b6_{[s,i]} + b7_{[s,i]}$

3. (standard) HLE life table calculations

Bayesian random effects approach performs much better than traditional LE estimation approach:

		Size of simulated population					
		500	1,000	2,000	5,000	10,000	25,000
Traditional:	bias	1.1	0.7	0.6	0.3	0.2	0.1
Bayesian:	bias	0.1	0	0	0	0	0

Source: Jonker et al., American Journal of Epidemiology (2012)

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Traditional:	**bias**	1.1	0.7	0.6	0.3	0.2	0.1
	rmse	6.3	4.5	3.1	2.2	1.5	0.9
Bayesian:	**bias**	0.1	0	0	0	0	0
	rmse	3.8	2.8	2.0	1.5	1.1	0.8

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	coverage	86%	90%	91%	92%	93%	94%
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	rmse	3.8	2.8	2.0	1.5	1.1	0.8
	coverage	89%	92%	94%	95%	96%	96%

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How is it implemented?

Neither available nor easily implemented in SAS..

Instead, programmed in the “BUGS” language

(i.e. Bayesian Inference Using Gibbs Sampling)

and fitted using software called “OpenBUGS”

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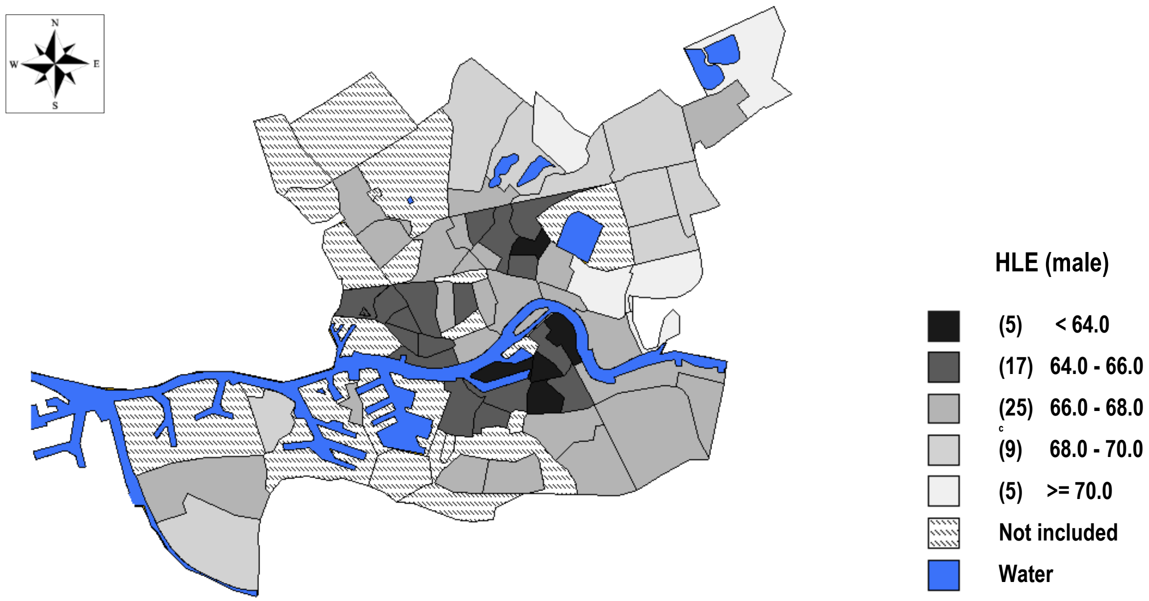
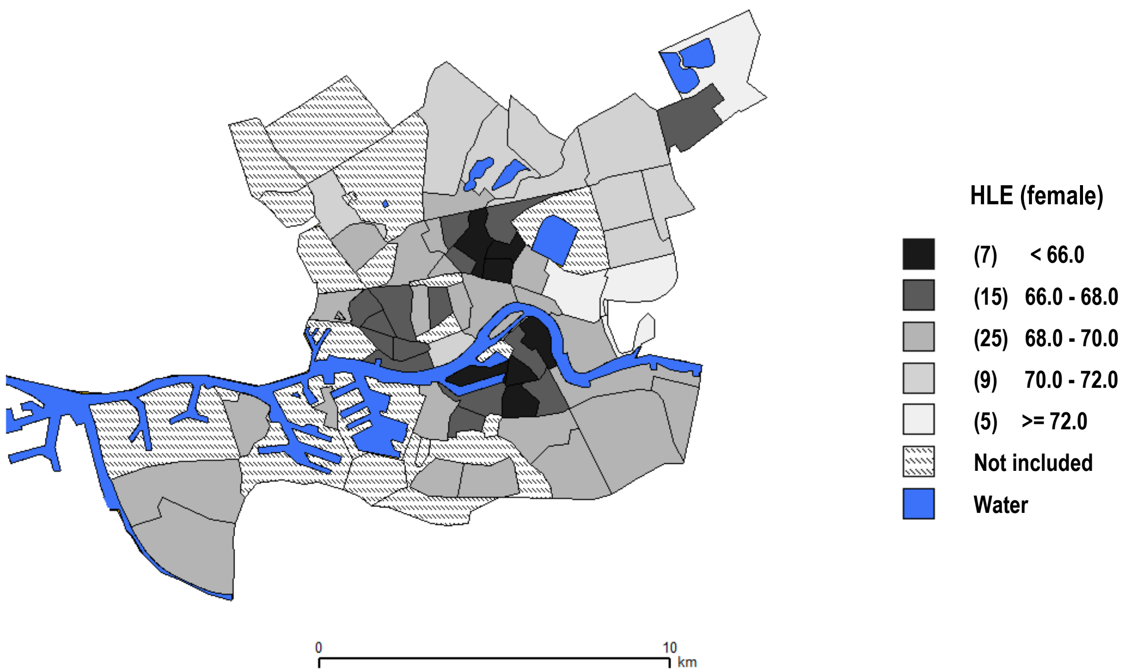
Example 1. Targetting of neighborhoods

5. HLE Results for Rotterdam (2004-06)

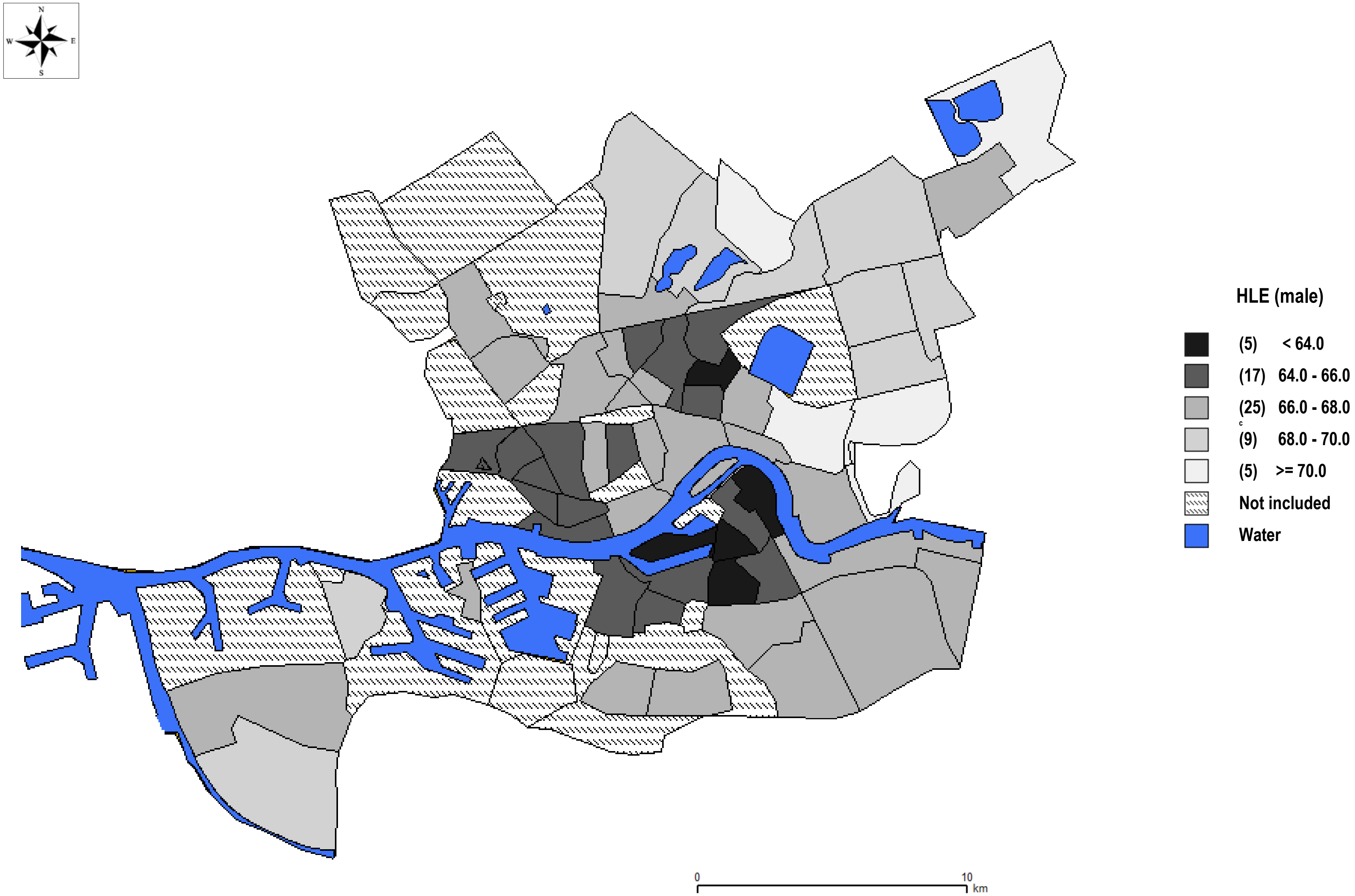
Males



Females

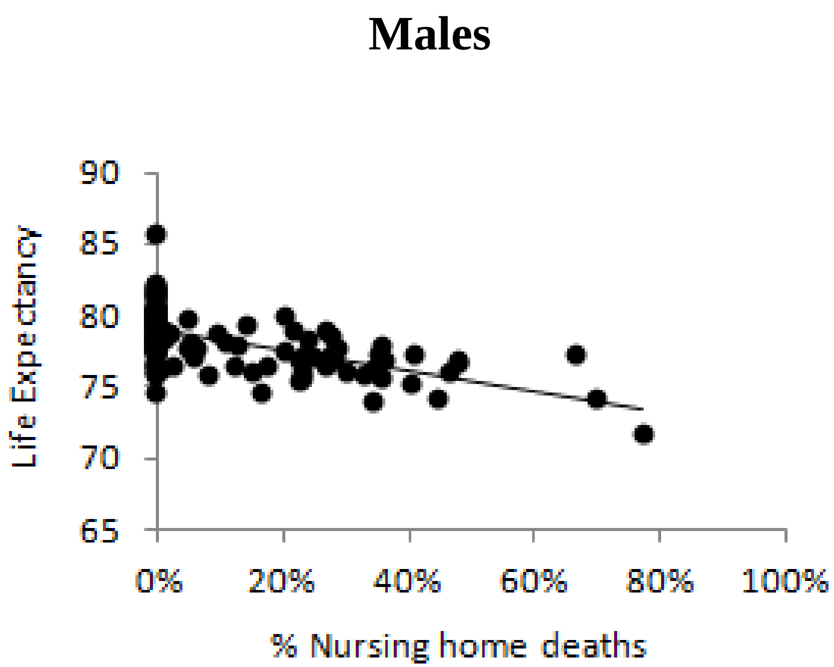


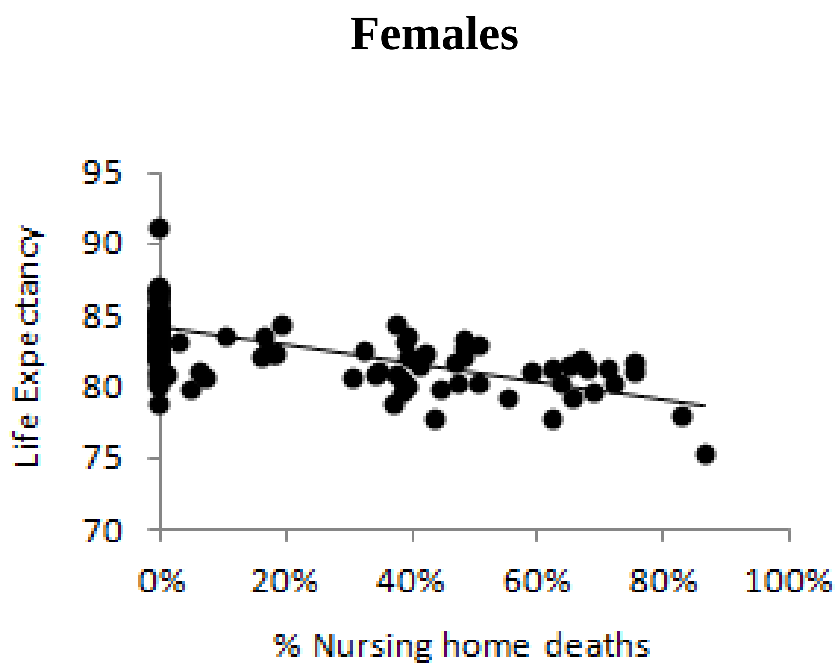
5. HLE Results for Rotterdam (2004-06)



Example 2. The impact of nursing homes

Impact of location of nursing homes

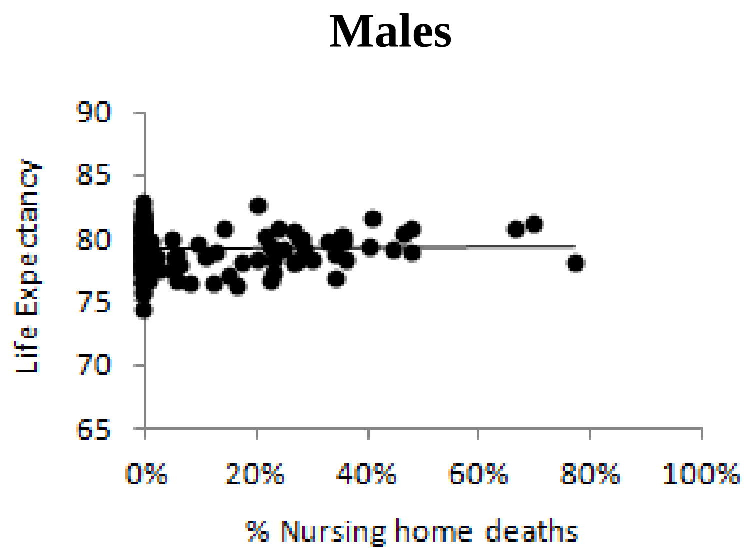




Source: Jonker et al., Health & Place (2013)

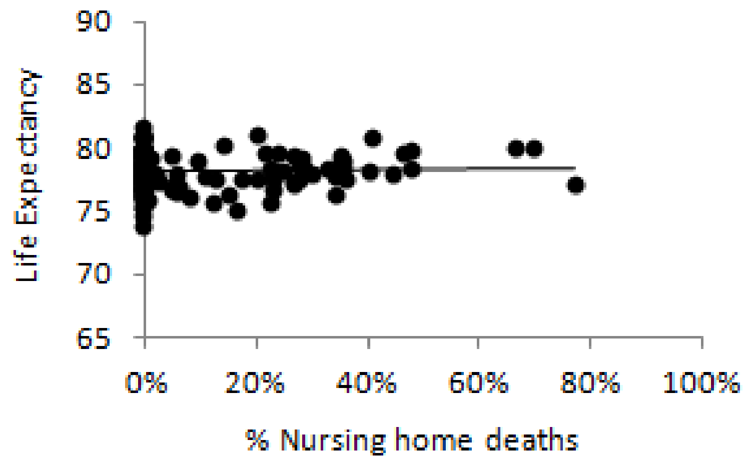
The Bayesian approach corrected for the location of nursing homes (!)

a) Bayesian modelling approach



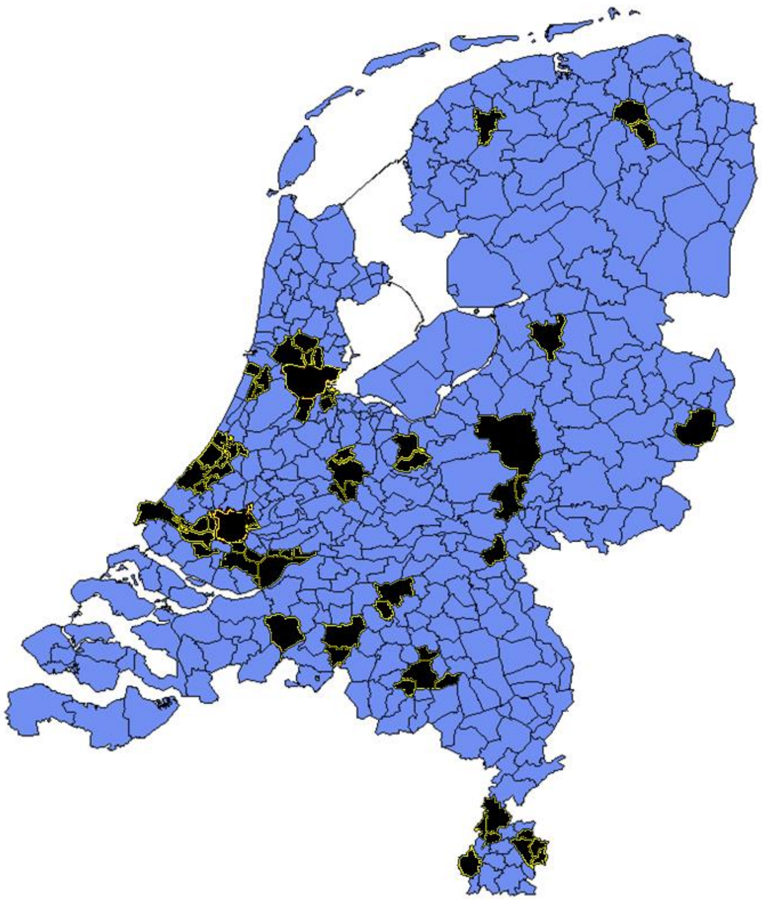
b) True values

- based on registry data

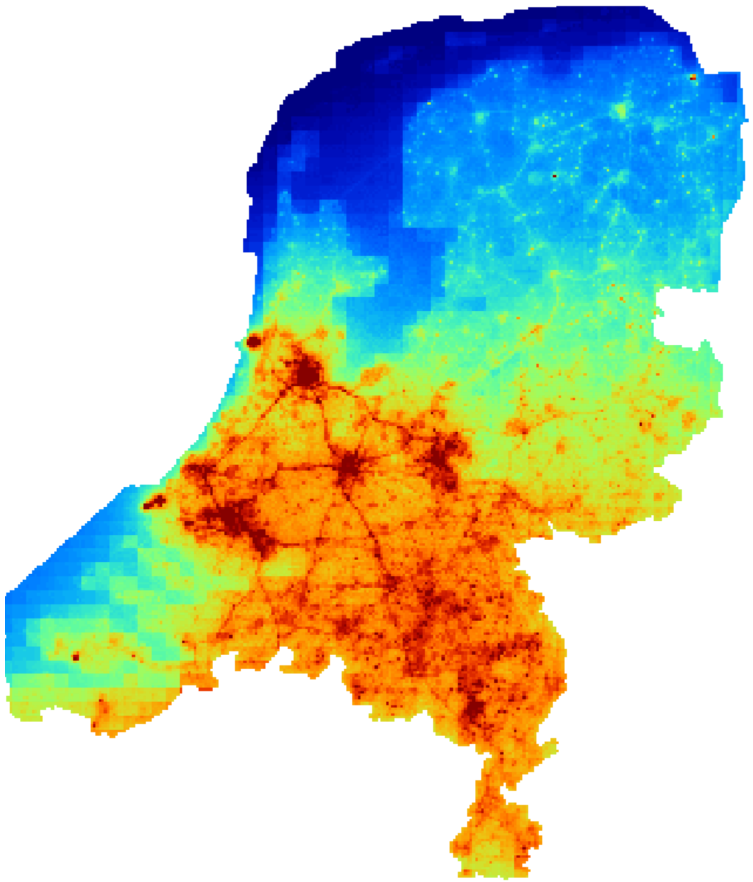


Example 3. The effect of air pollution on (H)LE

Big-25 cities
(1500 neighborhoods)



Air pollution (PM_{10})



.. also temperature (during heatwaves), urban green, etc.

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Summary

Key-points:

1) small-area health: sparse data & location of nursing homes.
2) Bayesian modelling approach: unbiased, efficient, and reliable method to improve small-area estimates
3) Availability of LE and HLE opens up new possibilities to:

   a) target and evaluate health policies,

   b) investigate the impact of determinants (e.g. air pollution).

Thank you.


Strakke kontjes!
Homo Moeder 2010
Oma zoekt toyboy bel: 0685374361
Madonna sucks!!! Lady Gaga for President!
Pro Darkroom
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