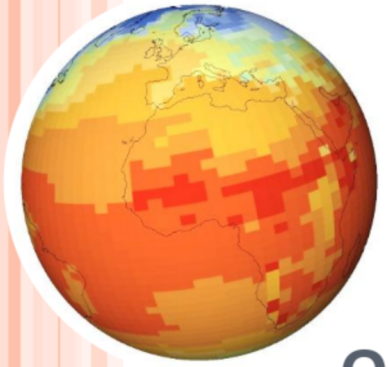


University of Nottingham
UK | CHINA | MALAYSIA

Quantitative comparison of temperature-related mortality adaptation modelling methods

Simon N. Gosling [1]

David Hondula [2]

Aditi Bunker [3]

Xinxin Zhang [4]

Dolores Ibarreta [5]

Junguo Liu [6]

Rainer Sauerborn [7]

1 University of Nottingham, Nottingham, UK.
2 Arizona State University, Arizona, USA.
3 University of Heidelberg, Heidelberg, Germany.
4 Beijing Forestry University, Beijing, China.
5 European Commission Joint Research Centre, Seville, Spain.
6 South University of Science and Technology of China, Shenzhen, China.
7 University of Heidelberg, Heidelberg, Germany; and Harvard University, USA.

simon.gosling@nottingham.ac.uk

@simon_gosling

Context and research questions

University of Nottingham
UK | CHINA | MALAYSIA

- Epidemiological evidence shows that over time, human sensitivity to heat has declined over time[1].

- Past studies have used different methods to statistically model autonomous and planned adaptation to climate change impacts on heat-related mortality.

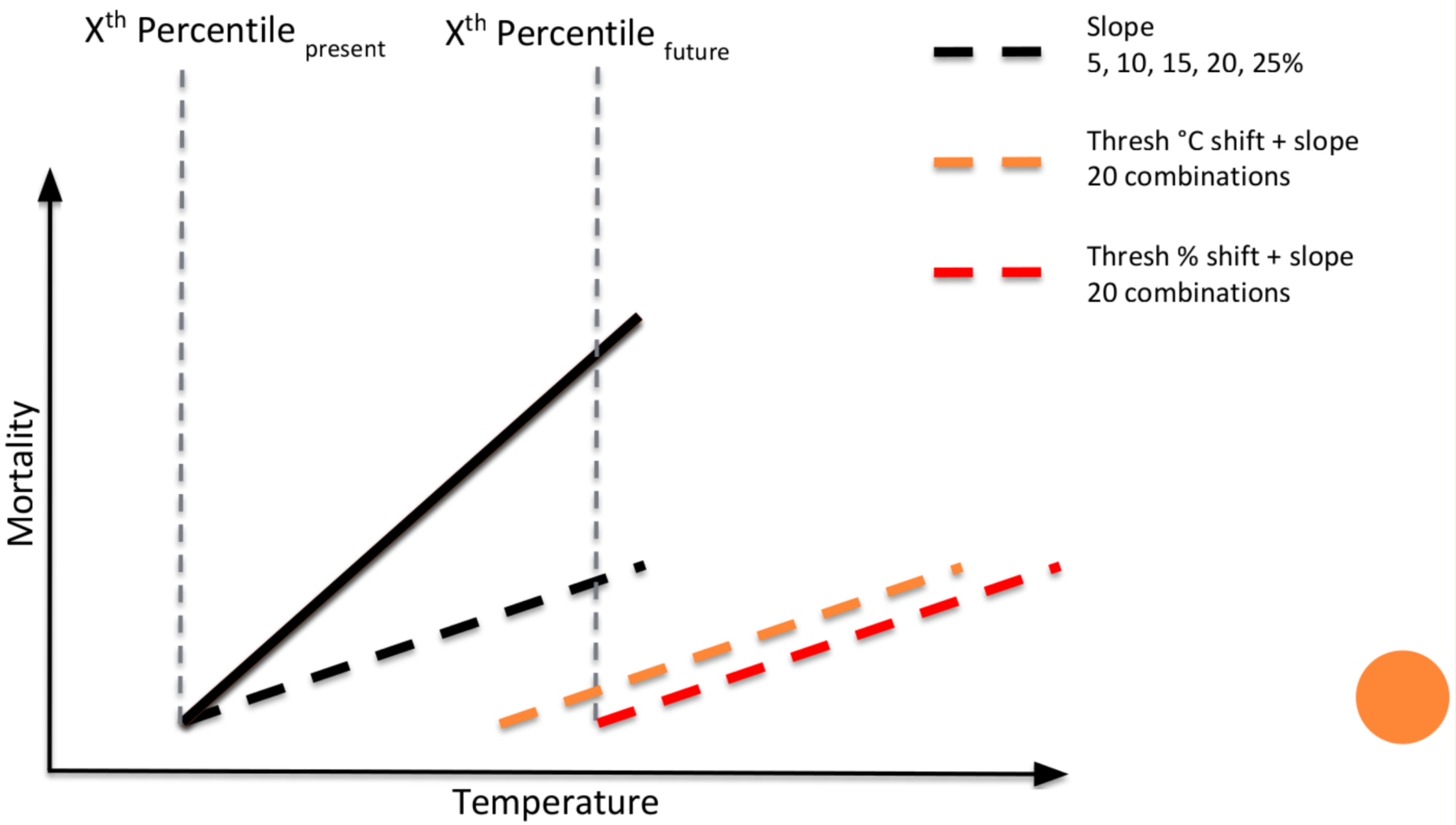
1. How **different** are the projected impacts of climate change when **different adaptation modelling methods** are used?

2. How does the **range in impacts** from **adaptation uncertainty** compare to the ranges from climate model and emissions uncertainty?

1 Barnett 2007; Bobb et al. 2014; Gasparrini et al. 2015; Guo et al. 2012; Ha and Kim 2013; Petkova et al. 2014; Schwartz et al. 2015; Sheridan et al. 2008

Adaptation modelling methods

- Various statistical methods have been used to model adaptation:



No adaptation

Thresh °C shift
1, 2, 3, 4°C

Thresh % shift
25, 50, 75, 100%

Slope
5, 10, 15, 20, 25%

Thresh °C shift + slope
20 combinations

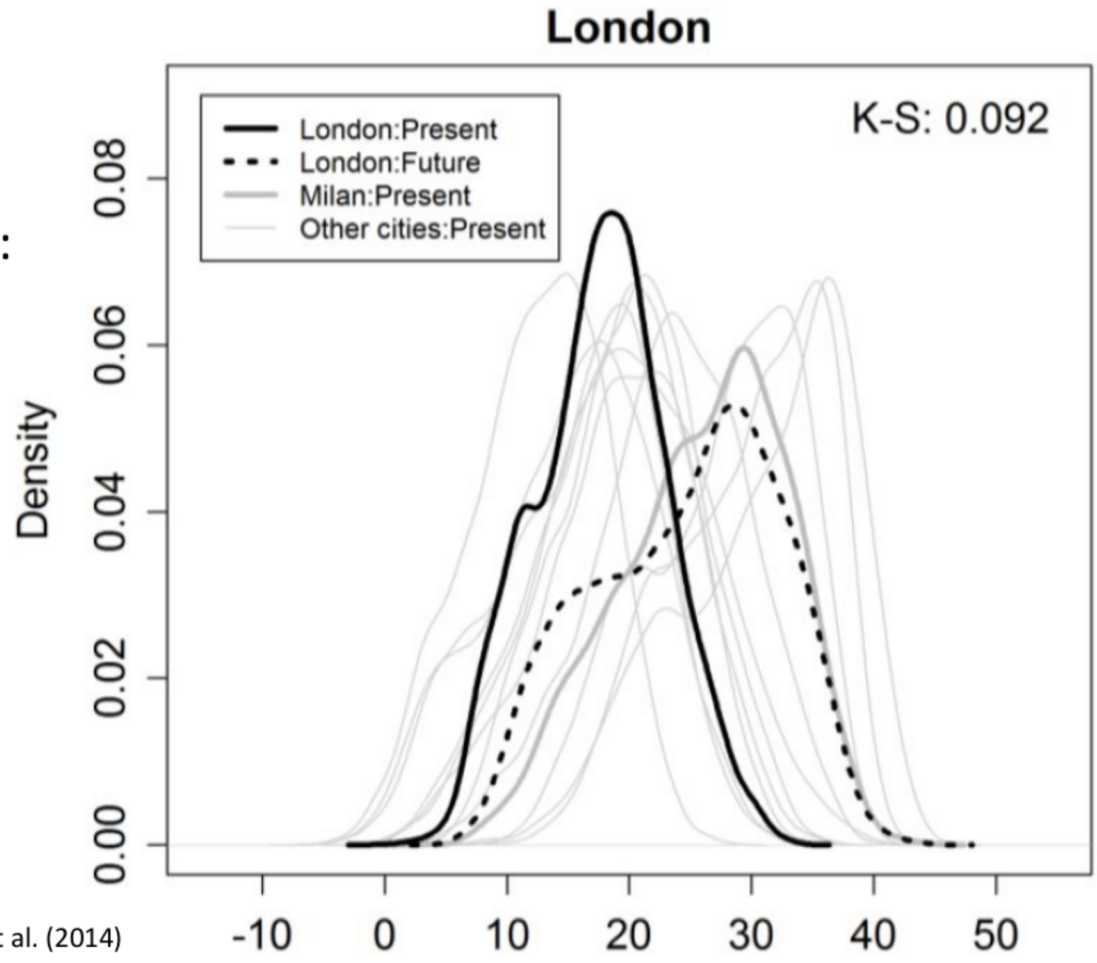
Thresh % shift + slope
20 combinations

Observed changes in thresholds:

- Absolute threshold temperatures have increased by:
  - **1.5–3 ^{o}C** between 1972 and 1994 in Tokyo (Honda etal.2006).
  - **10 ^{o}C** between 1901 and 2009 in Stockholm (Åströmetal. 2016).
  - **0.7 ^{o}C** from 1981 to 2009 in France (Todd and Valleron, 2015).

Adaptation modelling methods

- Analogue city method [1]
  - For a given city, use an ERF from another city whose present temperature distribution is similar to that of the given city's future temperature distribution.
  - E.g. use the ERF for Milan, for projecting future impacts in London:



[1] e.g. Hayhoe et al. (2004), Knowlton et al. (2007), Mills et al. (2014)

Method

University of Nottingham
UK | CHINA | MALAYSIA

- Applied projections of apparent temperature from climate models to temperature-mortality ERFs for 14 European cities (Baccini et al. 2008).
  - Mainly used one climate model (HadGEM2) with one emissions scenario (high emissions, RCP8.5) to control for climate change uncertainties.
  - But also used four other climate models to explore how adaptation uncertainty compares with climate model uncertainty.
  - Also a low emissions scenario (RCP2.6) to explore emissions uncertainty.

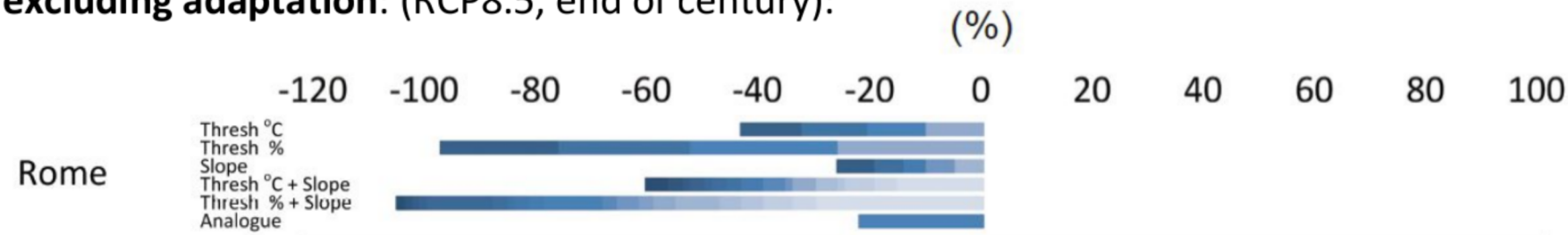
- Calculated the mean annual heat-related mortality rate attributable to climate change for 2070-2099 (ΔMort-CC).

- ΔMort-CC was calculated without adaptation and with adaptation respectively, using each adaptation modeling method.

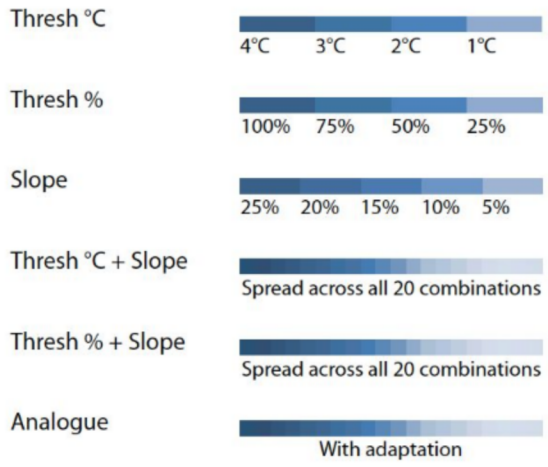
Results: sensitivity of impacts to adaptation method

University of Nottingham
UK | CHINA | MALAYSIA

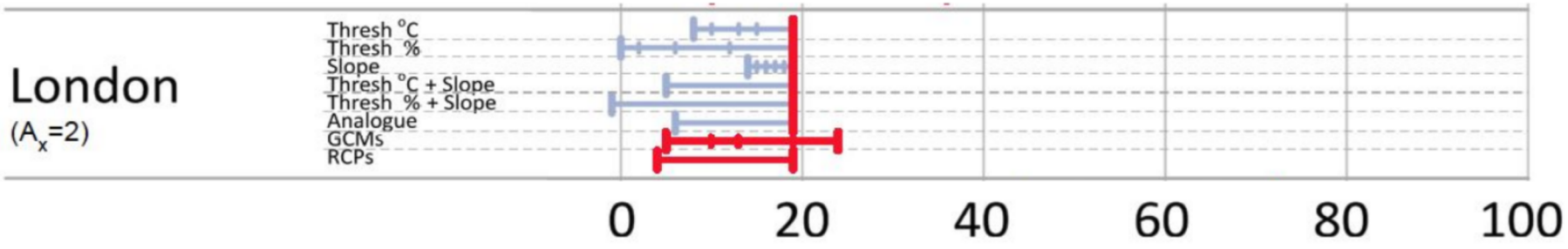
Difference (%) in mortality under climate change **between including adaptation and excluding adaptation**: (RCP8.5, end of century):



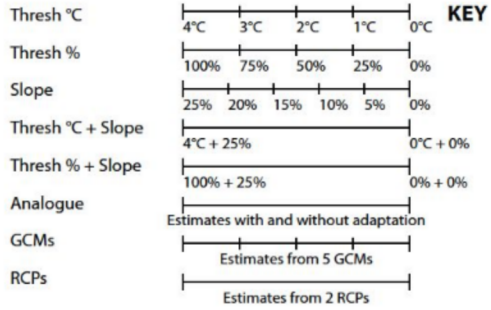
- Choice of adaptation modelling method has a significant influence on magnitude of impact.
- Results suggest some methods (analogue city) might be inappropriate.



RESULTS: MAGNITUDE OF ADAPTATION UNCERTAINTY TO OTHER UNCERTAINTIES



Annual heat-related deaths (per 100,000 of population)



Annual heat-related deaths (per 100,000 of population)

Revisiting the research questions

University of Nottingham
UK | CHINA | MALAYSIA

1. How **different** are the projected impacts of climate change when different adaptation modelling methods are used?

   - Large differences.
   - As a mean across 14 cities, mortality can be 28% lower with one adaptation method (slope), and 103% with another method (% thresh+slope).

2. How does the **range in impacts** from adaptation uncertainty compare to the ranges from climate model and emissions uncertainty?

   - The range in impacts due to adaptation uncertainty is often larger than those associated with climate modelling and emissions uncertainty.

Recommendations

University of Nottingham
UK | CHINA | MALAYSIA

- Adaptation modelling should be included in future climate change impact assessments because it affects significantly the magnitude of impacts compared to other sources of uncertainty.

- Growing empirical evidence for historical adaptation means that shifts in threshold and reduction in slope are plausible statistical methods for modelling adaptation.

- However, research is needed, on a city-by-city basis, to justify the magnitude of adaptation employed in modelling studies.

ehp ENVIRONMENTAL HEALTH PERSPECTIVES

RESEARCH AUGUST 2017 | VOLUME 125 | ISSUE 8

Environ Health Perspect; DOI:10.1289/EHP634

Adaptation to Climate Change: A Comparative Analysis of Modeling Methods for Heat-Related Mortality

Simon N. Gosling,[1] David M. Hondula,[2] Aditi Bunker,[3,4] Dolores Ibarreta,[5] Junguo Liu,[6] Xinxin Zhang,[7] and Rainer Sauerborn[4]

Author Affiliations close

[1]School of Geography, University of Nottingham, Nottingham, United Kingdom

[2]School of Geographical Sciences and Urban Planning, Arizona State University, Tempe, Arizona, USA

[3]Network Aging Research, University of Heidelberg, Heidelberg, Germany

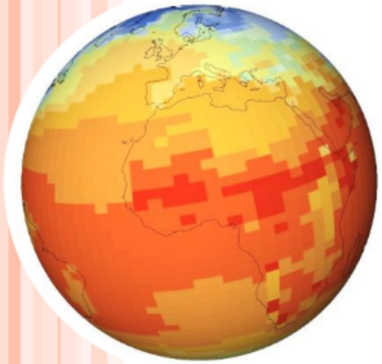
[4]Institute of Public Health, University of Heidelberg, Heidelberg, Germany

[5]European Commission, Joint Research Centre (JRC), Seville, Spain

[6]School of Environmental Science and Engineering, South University of Science and Technology of China, Shenzhen, China

[7]School of Nature Conservation, Beijing Forestry University, Beijing, China

PDF Version (2.9 MB)



University of Nottingham
UK | CHINA | MALAYSIA

Thanks for your attention!

Dr Simon Gosling

Director of Research and Associate Professor in Climate Risk

School of Geography, University of Nottingham, UK

simon.gosling@nottingham.ac.uk

@simon_gosling

Method

- Used a set of established exposure response functions (ERFs) for 14 European cities, developed by Baccini et al. (2008):