HERA

Health Enviroment Research Agenda for Europe

HERA project final meeting
Final meeting, Paris, March 2022

WP5 - From Effects to Impacts:
Health, societal and economic impacts of environmental factors and climate change – Setting guidelines

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On behalf of HERA WP5 partners

HERA CONSORTIUM

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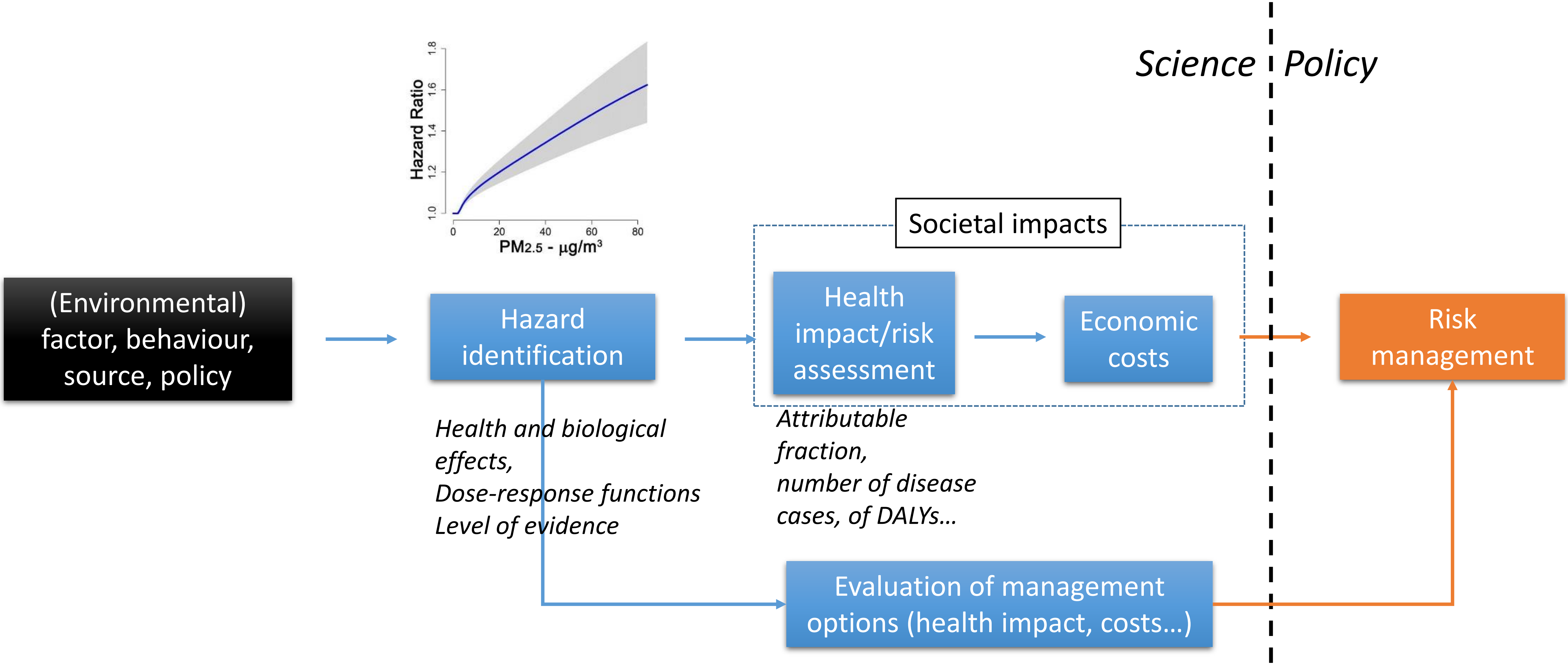
From hazard identification to risk management



Example:
Deaths attributable to selected environmental factors worldwide

(million deaths/yr.)

	GBD study best estimate (95% CI)
Air (total)	6·5 (5·7–7·3)
Household air	2·9 (2·2–3·6)
Ambient particulate	4·2 (3·7–4·8)
Ambient ozone	0·3 (0·1–0·4)
Water (total)	1·8 (1·4–2·2)
Unsafe sanitation	0·8 (0·7–0·9)
Unsafe source	1·3 (1·0–1·4)
Occupational	0·8 (0·8–0·9)
Carcinogens	0·5 (0·5–0·5)
Particulates	0·4 (0·3–0·4)
Soil, heavy metals, and chemicals	0·5 (0·2–0·8)
Lead	0·5 (0·2–0·8)
Total	9·0

(Landrigan, *Lancet*, 2018)

WP5 general aim

- To move towards a harmonized methodology in health impact assessment studies considering environmental factors and the societal and economic impacts thereof

Main steps of Health impact assessment studies

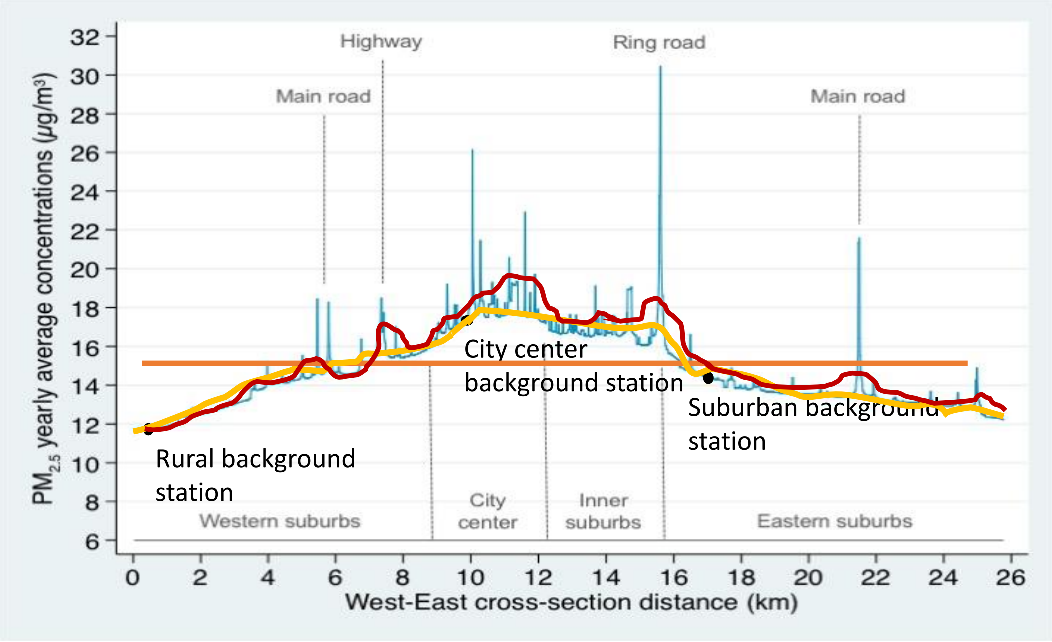
- Description of the counterfactual situations compared (policies…)
- Definition/identification of the environmental factors/policy/plan… considered (including *hazard identification* and *assessment of the level of evidence*)
- Definition of the study area and population study
- Assessment of "exposures"
- Characterization of health impact measures (e.g. DALYs)
- Characterization of the health impact
- Characterization of the social and economic impacts
- Uncertainty analyses
- Reporting/recommendations and evaluation
- Public involvement
- Issues related to terminology

Some recommendations (1) – Issues related to exposure assessment

- Exposure misclassification is (also) an issue of HIA studies
  - Spatial resolution and population density matter

Hypothesis (spatial resolution)	$PM_{2.5}$ exposure: 5th–50th–95th percentiles (µg/m^3)	PAF (%) (95% CI)
Main model	8.2–13.8–21.8	3.6 (1.7–5.4)
Sensitivity analyses		
H1: median of population-weighted $PM_{2.5}$ exposure		
(a) Department	9.7–13.8–19.1	3.6 (1.7–5.4)
(b) Country	13.8–13.8–13.8	3.2 (1.5–4.9)
H2: median of raw $PM_{2.5}$ concentration		
(a) Department	6.0–11.1–16.4	2.4 (1.1–3.6)
(b) Country	11.2–11.2–11.2	1.0 (0.5–1.6)

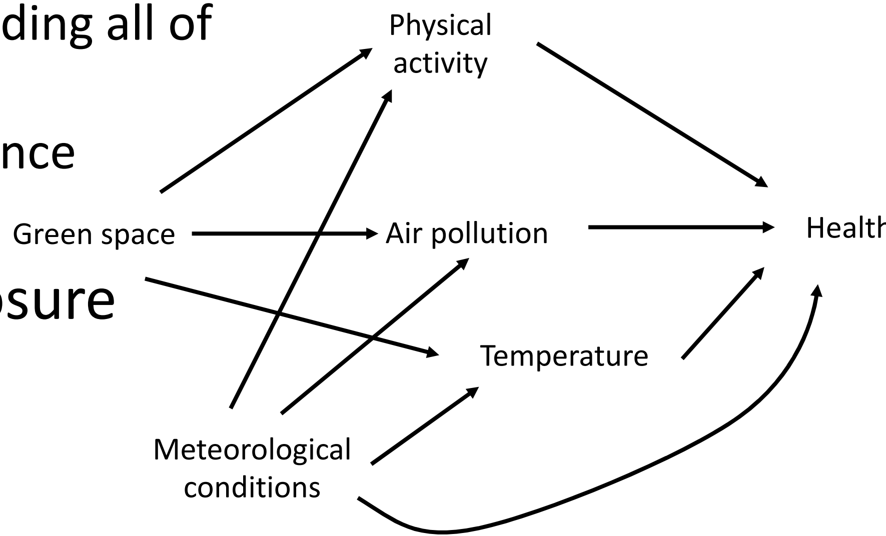
(Kulhanova et al. 2018)



- Bias-variance trade-off: simple and cheap approaches *vs.* more cumbersome ones (e.g. relying on personal dosimeters or exposure biomarkers)

Some recommendations (2) – Characterization of the health impact

- Level of evidence regarding a health effect: Historically, only factors for which the level of evidence was deemed very high were considered in HIAs (e.g., lead, PM…)
  - Specific situation of the (numerous) chemicals factors for which the level of evidence is *moderate*
  - In the context of a “slow” science with limited funding in relation to the large number of factors to evaluate, some of these levels of evidence will eventually turn out to have a proven effect
  - Excluding these factors may underestimate the impact – but including all of them possibly to an overestimation of the impact
  - One option is to weight the impact according to the level of evidence regarding the exposure-effect pair (see Trasande, *JCEM*, 2015)
- Need to consider complex relations between various exposure factors



Some recommendations (3)–A need to clarify terminology

- Multiplicity of related terms: Health Impact Assessment (**HIA**), comprehensive HIA, analytical HIA, **risk assessment**, safety assessment, **burden of disease** (BoD), Environmental Health Impact Assessment (EHIA), Integrated Environmental Health Impact Assessment (IEHIA), Human Impact Assessment (HuIA)…
- The multiplicity of terms relates to the **multiple origins of the approach**
  - epidemiology (population attributable fraction…), chemical safety and regulatory toxicology (risk assessment), regulatory assessment of future policies (impact assessment).
- Some differences exist between some types of studies in terms of aims
  - E.g. risk *vs.* safety assessment (is there a risk *vs.* can I be sure that we are safe?)
- Some real (methodological) differences exist between studies relying on human dose response functions as opposed to purely toxicological dose response functions or threshold values/benchmark doses
  - Not sure however that this justifies to use different names for the corresponding designs, if they share a similar aim
- Similarly, I would argue that there is no compelling reason to use different terms for impact studies according to the family of evaluated factors (e.g., evaluating a complex policy *vs.* evaluating the impact of exposure to a single chemical)
- Further effort needed to build a consensus across research and users communities.

Summary

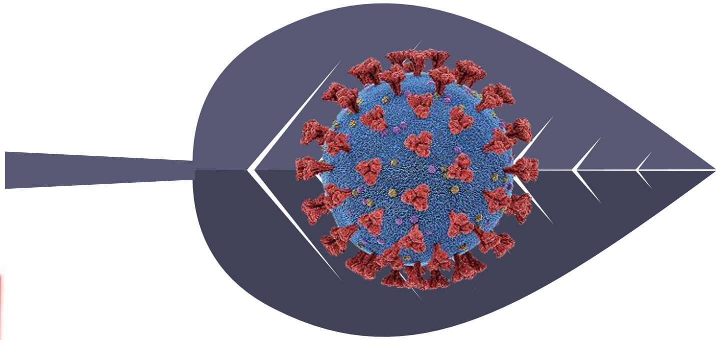
- Health impact assessment studies still raise numerous methodological scientific issues
- Some of these issues relate to the need to efficiently consider the exposome (i.e. a large number of inter-related factors)(Shaffer, *EHP*, 2019)
- *Uncertainty* trade-off: focusing on well-characterized hazards *vs.* considering more factors for which uncertainties are larger (bias-variance trade-off)
- Remember that HIA studies crucially need to be fed by more fundamental research (typically cohort studies) and biomonitoring/exposure studies
- Need to “reconciliate” the impact assessment done by toxicologists with that relying on purely human data
- Strong need to build consensus and to simplify the terminology of health impact studies
- Further progressing on these issues will be essential to characterize the impact of multiple chemical and biological exposures, future policies, climate change and strategies considered to move towards a carbon-neutral society.

QUANTITATIVE MODELLING TOOLS

- Quantitative modeling is meant to help in estimating impacts of developments, policies and interventions, in identifying group differentials, comparing scenarios, ranking interventions, and thus to support governance and decision-making.
- A range of impact quantification tools are available and strongly proposed, providing approaches to strengthen “foresight” awareness, and to contribute to the development of health impact modelling as a component of good Public Health practice.
- During the last decades, different approaches, methods and tools for integrated environmental and health impact assessment have been developed and are more and more used for supporting policy decisions, especially in the field of pollution control and transport project appraisal.
- The most recent developments are focusing on exposure modelling with the aim to cover social, economic, and health impacts of different policy options.
- Although health impacts related to environmental burden of disease are related to multi-pathway and multi-route exposure to environmental stressors, at the moment, particular focus is paid on the urban background ambient air pollution levels.

RISK MODELLING TOOLS

Environmental Risk Modeling Tools							
EcoSense	INTEGRA	UTOPHIA	MCRA	PACEM	ConsExpo	EUSES	ECETOC



Disease Risk Modeling Tools			
ECoNNDA	UKHF	IMPACT	CORE

Generic Risk Modeling Tools
Dynamo-HIA

INTEGRATION IN THE HERA RESEARCH GOALS

RG4: *Improve health impact assessment of environmental factors and promote implementation research*

- HERA focuses on the need to develop new harmonized methodologies to evaluate the burden of environmental and climate change on health and to identify and assess the health benefits of human environmental interaction. Moreover, research should promote optimal ways to implement science-based decisions and policies as this is a limiting factor in many fields.

RG 4.1

A unified European approach on quality of life and burden of disease

RG 4.2

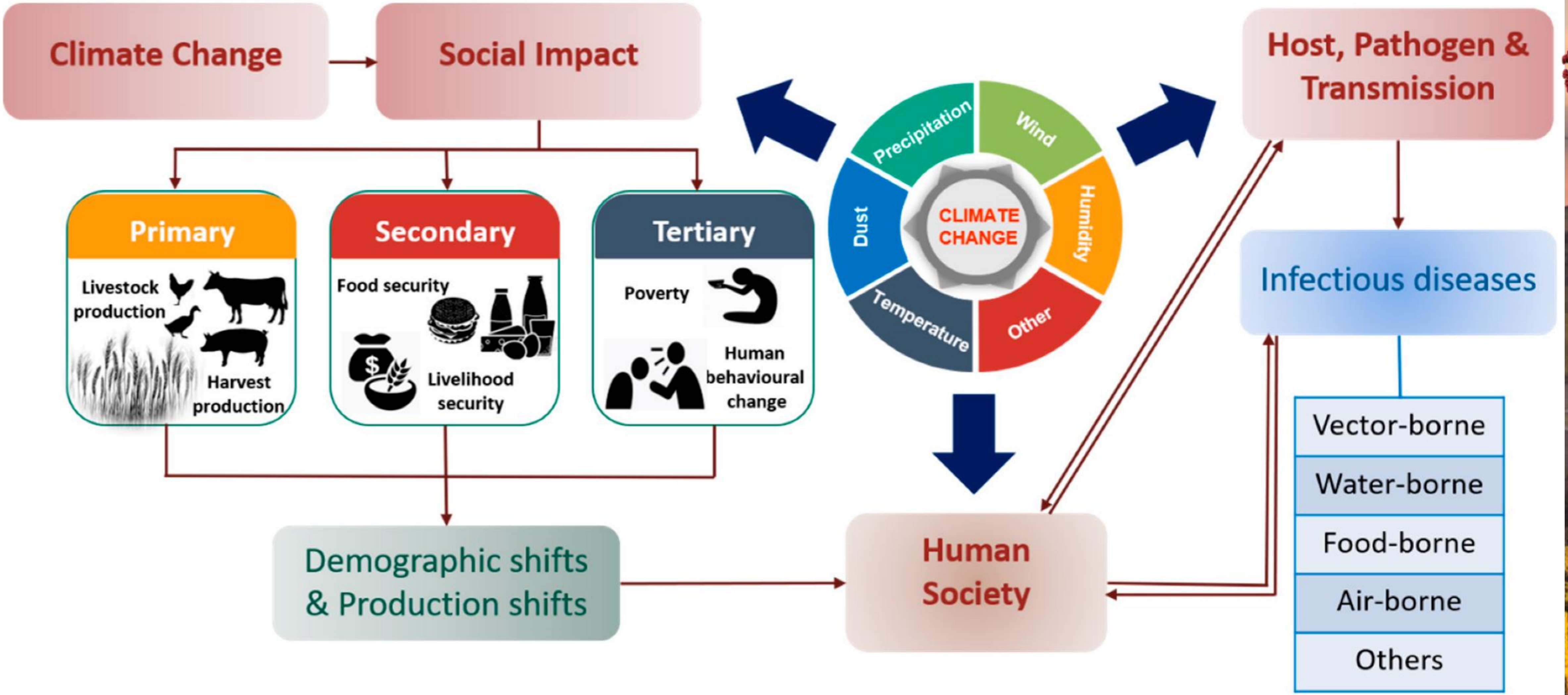
Develop tools and methodologies for integrative environmental health risk assessment

RG 4.3

Advance and systematize implementation research in environment and health

Integrated Environmental Health Impact Assessment – the study of interactions

Climate – Environment – Society - Health



Climate Crisis Health Challenges

CLIMATE DRIVERS

- Increased temperatures
- Precipitation extremes
- Extreme weather events
- Sea level rise

ENVIRONMENTAL & INSTITUTIONAL CONTEXT

- Land-use change
- Ecosystem change
- Infrastructure condition
- Geography
- Agricultural production & livestock use

EXPOSURE PATHWAYS

- Extreme heat
- Poor air quality
- Reduced food & water quality
- Changes in infectious agents
- Population displacement

SOCIAL & BEHAVIORAL CONTEXT

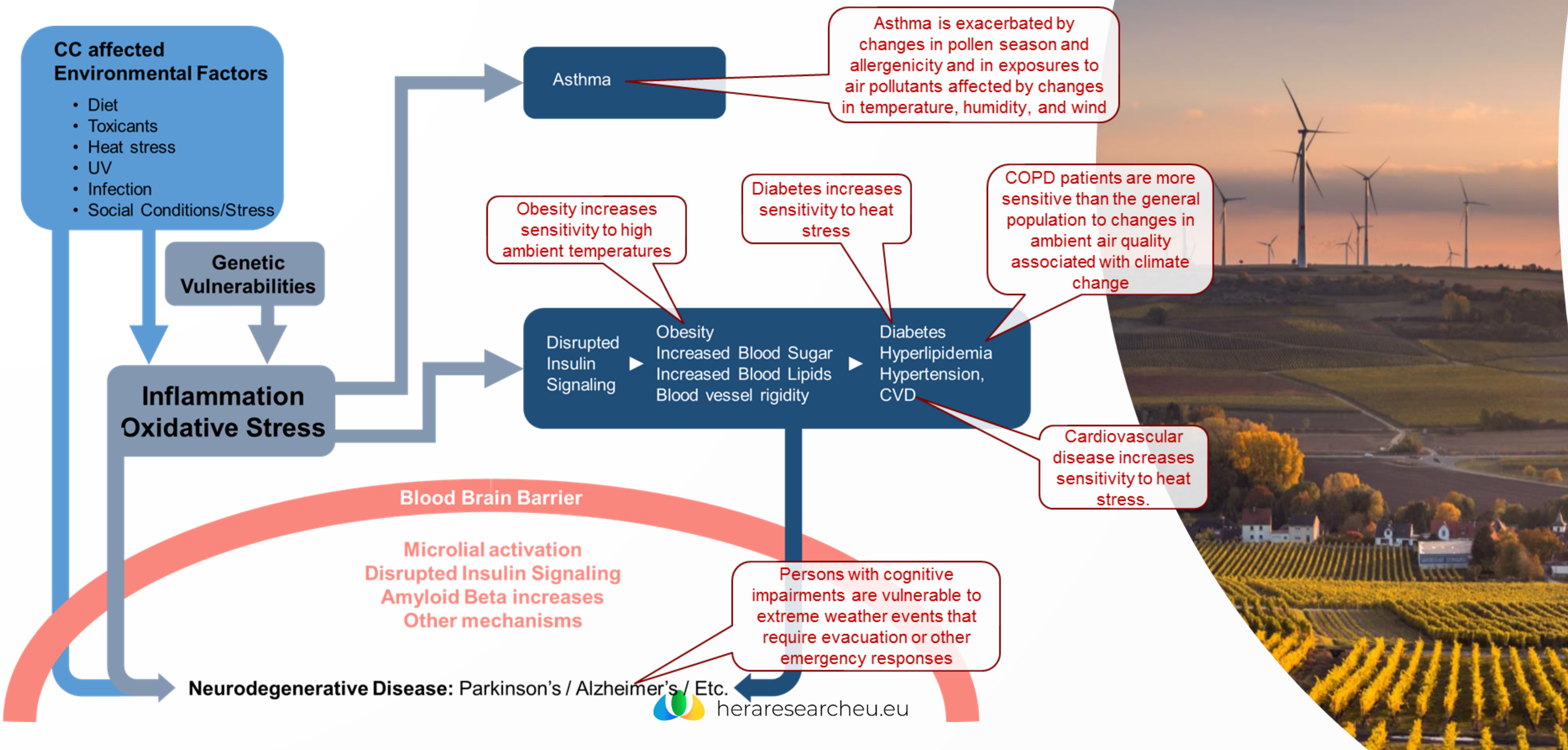
- Age & gender
- Race & ethnicity
- Poverty
- Housing & infrastructure
- Education
- Discrimination
- Access to care & community health infrastructure

HEALTH OUTCOMES

- Heat-related illness
- Cardiopulmonary illness
- Food-, water-, & vectorborne disease
- Mental health consequences & stress

Understanding common pathways of disease

enhanced by Climate Change or enhancing susceptibility to Climate Change



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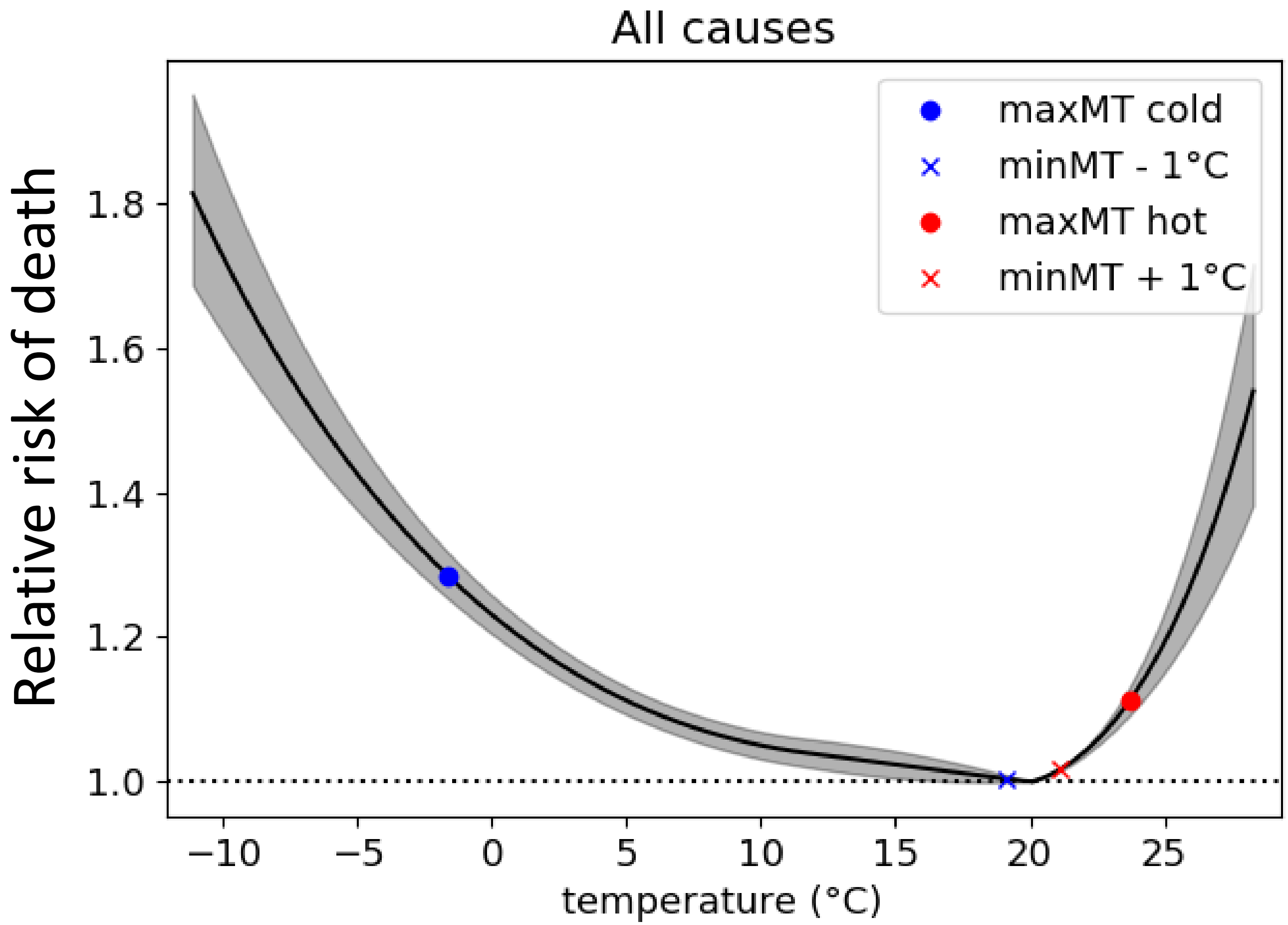
Additional slides

Illustration: paving the way for a health impact assessment of climate change in the EU (case study)

- Issues related to identification of all relevant hazards
- Issues related to (non-linear) dose-response functions
- Issues related to uncertainties

Temperature short-term effects on all-cause mortality



Time series analysis of all deaths in France (1968-2016; data: CépiDc)

(Lehmann et al., *in revision*)

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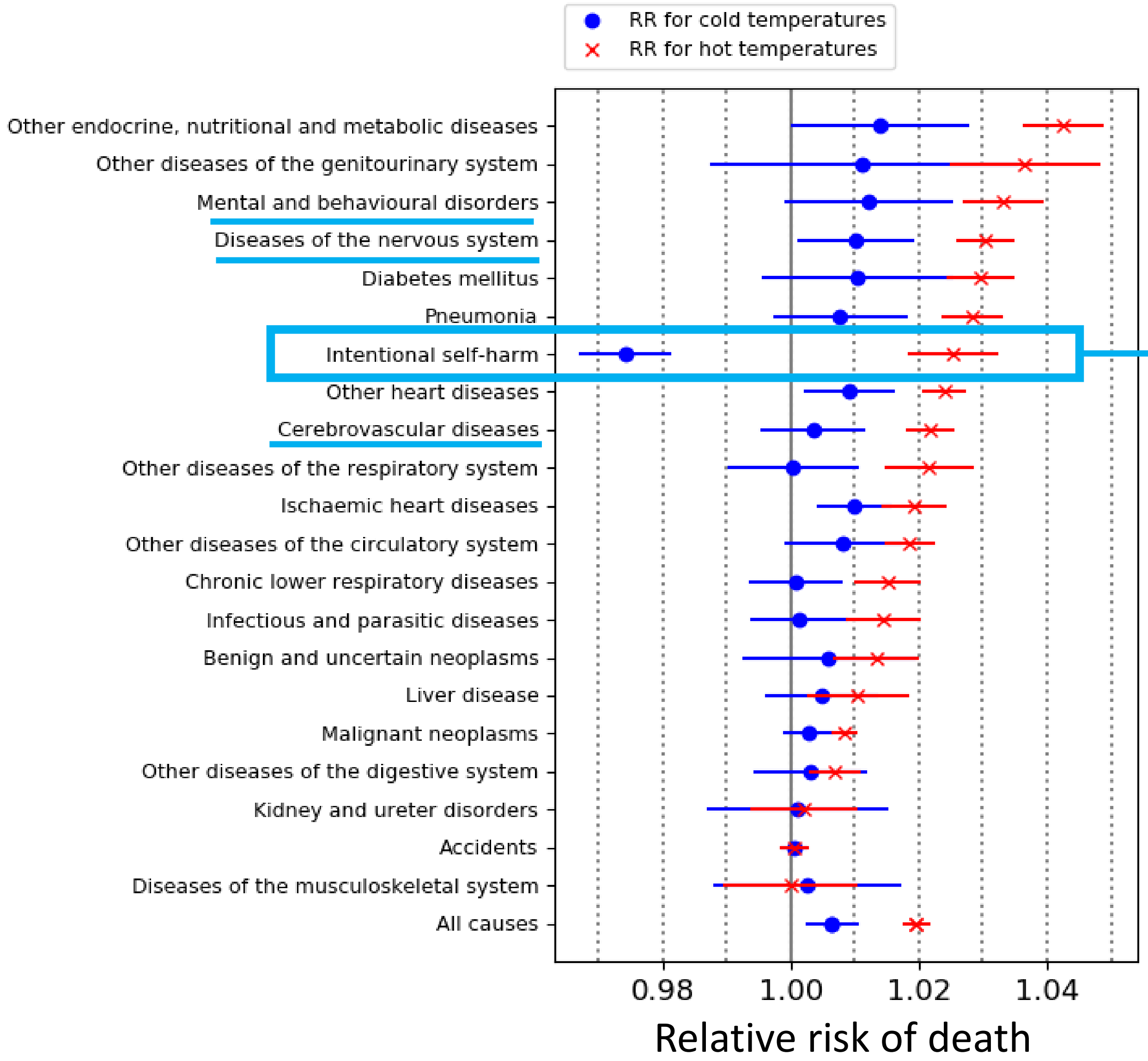
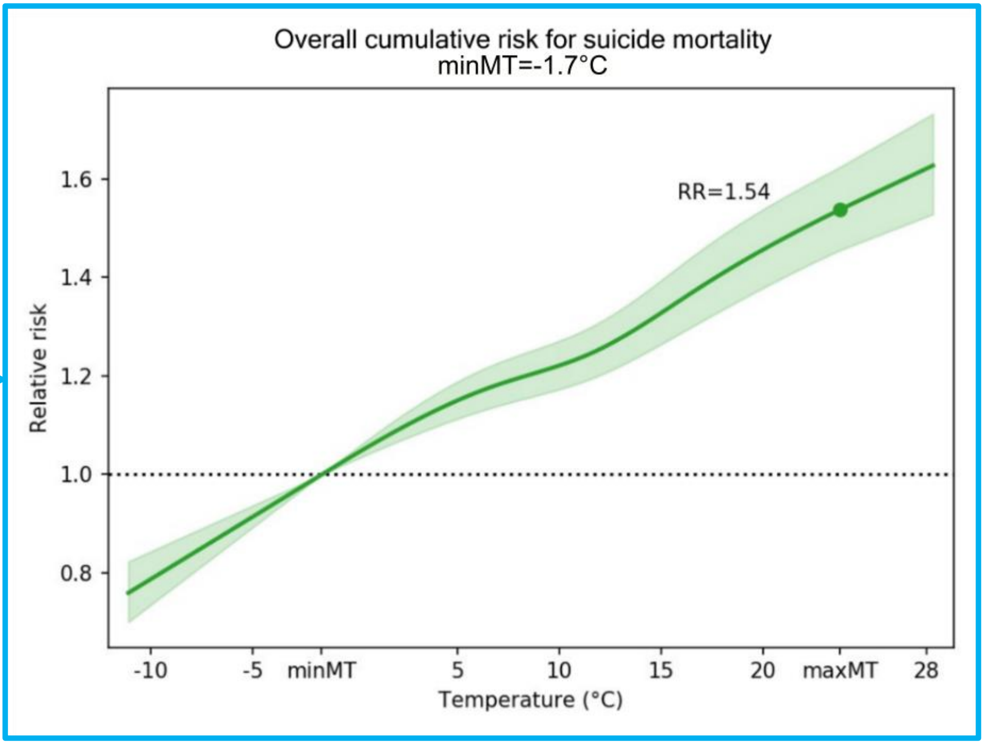
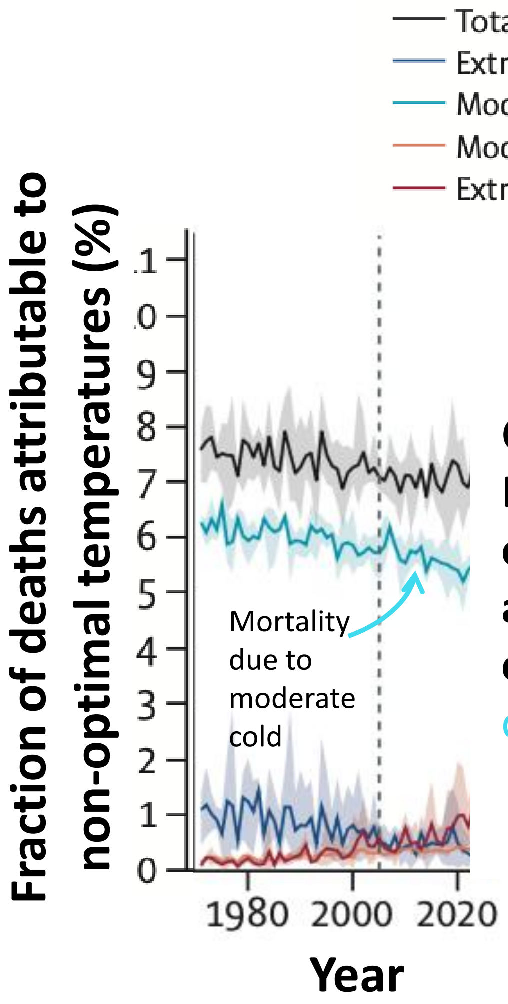
Temperature short-term effects on specific causes of death





Relative risks are given for a 1°C increase in temperature above (red) or below (blue) the temperature minimizing mortality. Time series analysis of all deaths in France (1968-2016; data: CépiDc) (Lehmann et al., *in revision*)

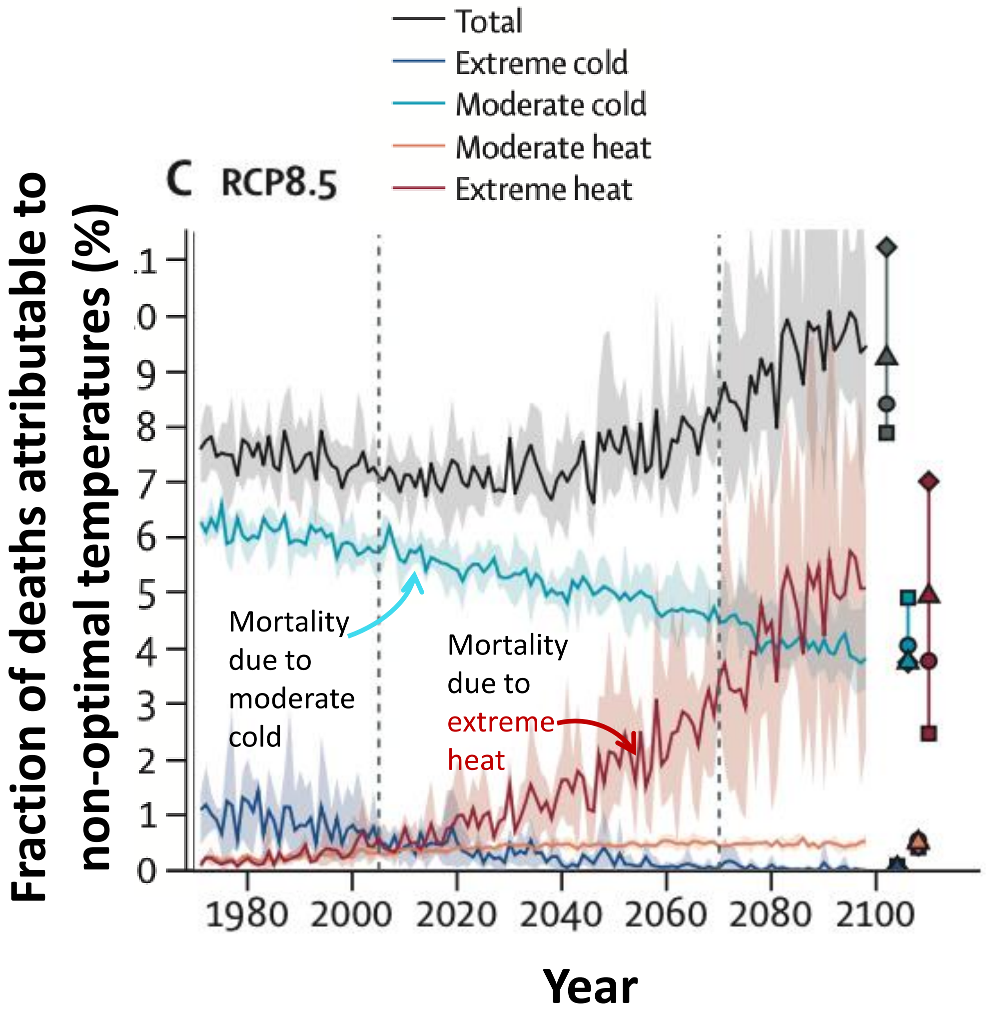
Predicted changes in the mortality attributable to extreme temperatures in Europe under various scenarios



Currently, in Europe, about **7% of deaths are attributed to non-optimal** (mostly cold) **temperatures**

(Martinez-Solanas … Ballester J, *Lancet Plan Health*, 2021)

Predicted changes in the mortality attributable to extreme temperatures in Europe under RCP8.5 scenario (no strong action against climate change)



RCP: Representative concentration pathway

Without action against climate change and greenhouse gas emissions (RCP8.5 emission scenario), in Europe,

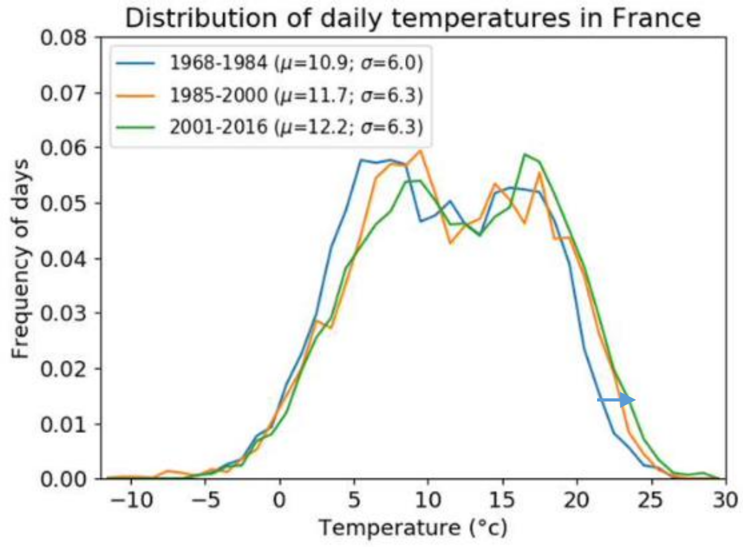
- deaths attributed to cold temperatures temperatures are likely to decrease,
- and those attributable to extremely hot temperatures will increase even more,

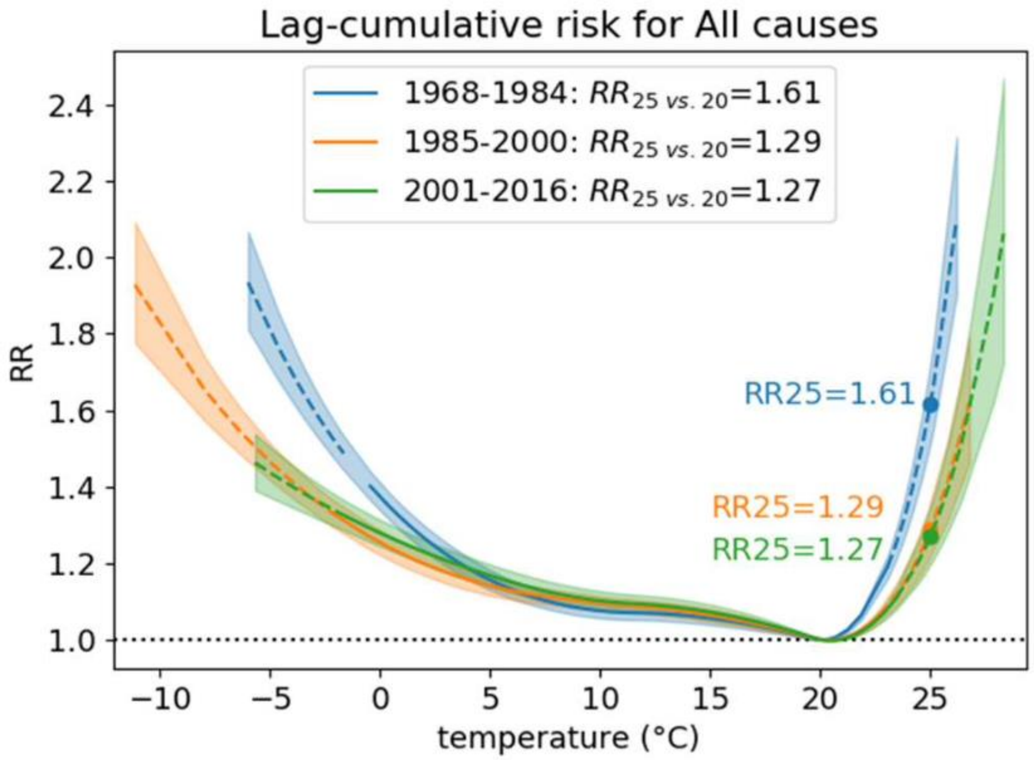
so that without control of GHG emissions**, mortality attributed to non-optimal temperatures is likely to increase in the 2nd half of the century.**

Similar situations are expected in areas with currently temperate or warm climates.
(Estimates assume **lack of adaptation** to warm temperatures and lack of increased sensitivity to cold as climate gets warmer)

(Martinez-Solanas … Ballester J, *Lancet Plan Health*, 2021)

Is there evidence for societal adaptation to extreme temperatures?





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(Lehmann et al., *in revision*)