Climate Change, Environmental Change and Health:

Extending the Environment-Health Research and Policy Agenda

Tony McMichael

National Centre for Epidemiology and Population Health
The Australian National University
Canberra

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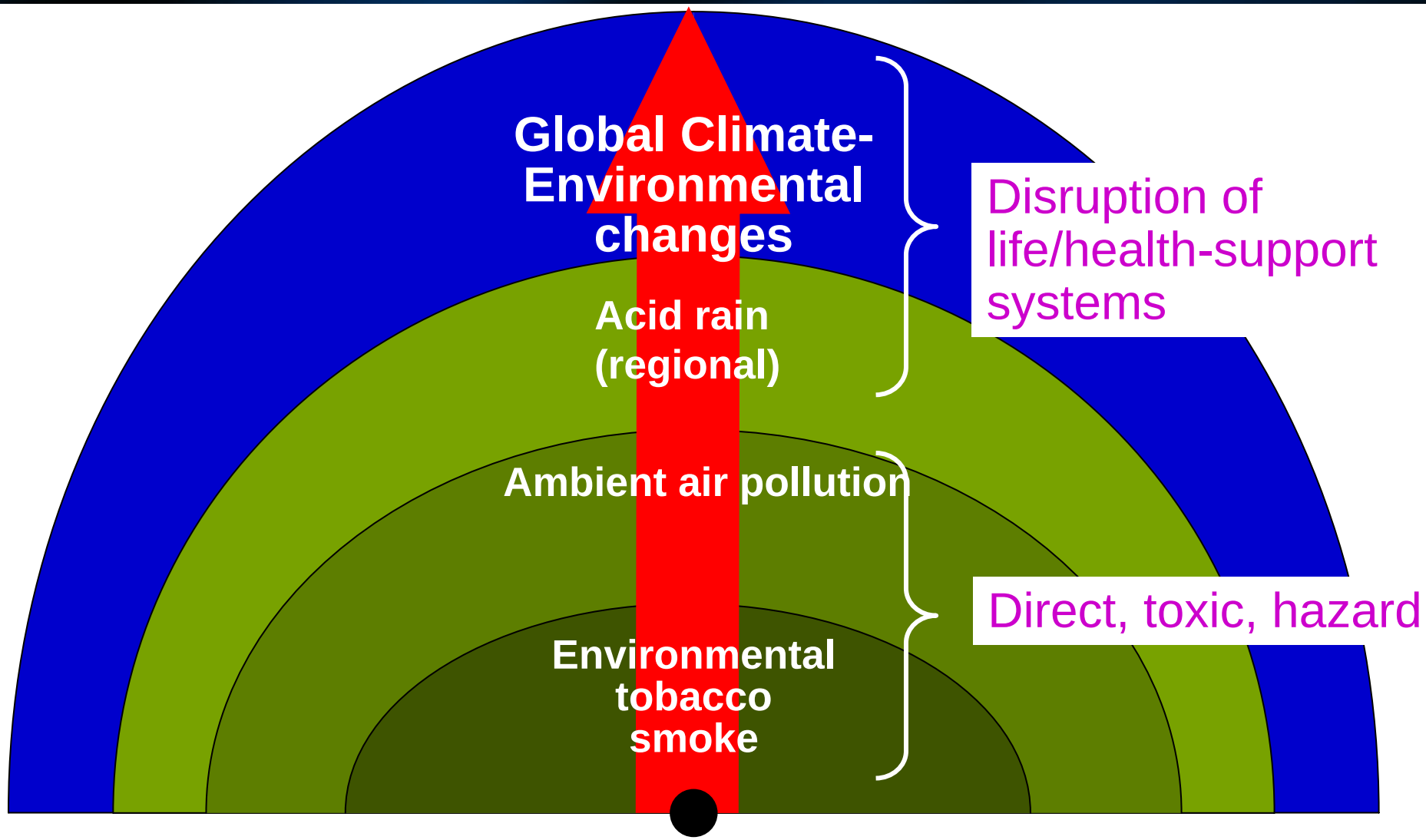
Environmental Health Risks
Scale and Type



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Environment & Health: Background

- **Industrialization and urbanization → continuation of 'classic' direct-acting environmental exposures:**
  - → **chemicals, physical hazards and microbes (food/water)**
- **WHO: one-quarter of global disease burden (and one-third of burden in children) due to modifiable environmental factors** **(Pruss-Ustun & Corvalan, 2006)**
  - → **main contributors: diarrhoea, lower respiratory infections, unintentional injuries, malaria**
  - → **burden much higher in low-income than in high-income countries (25% of all deaths, versus 17%)**

Environmental Lead Exposure and Early Childhood Cognitive Development

(McMichael et al)

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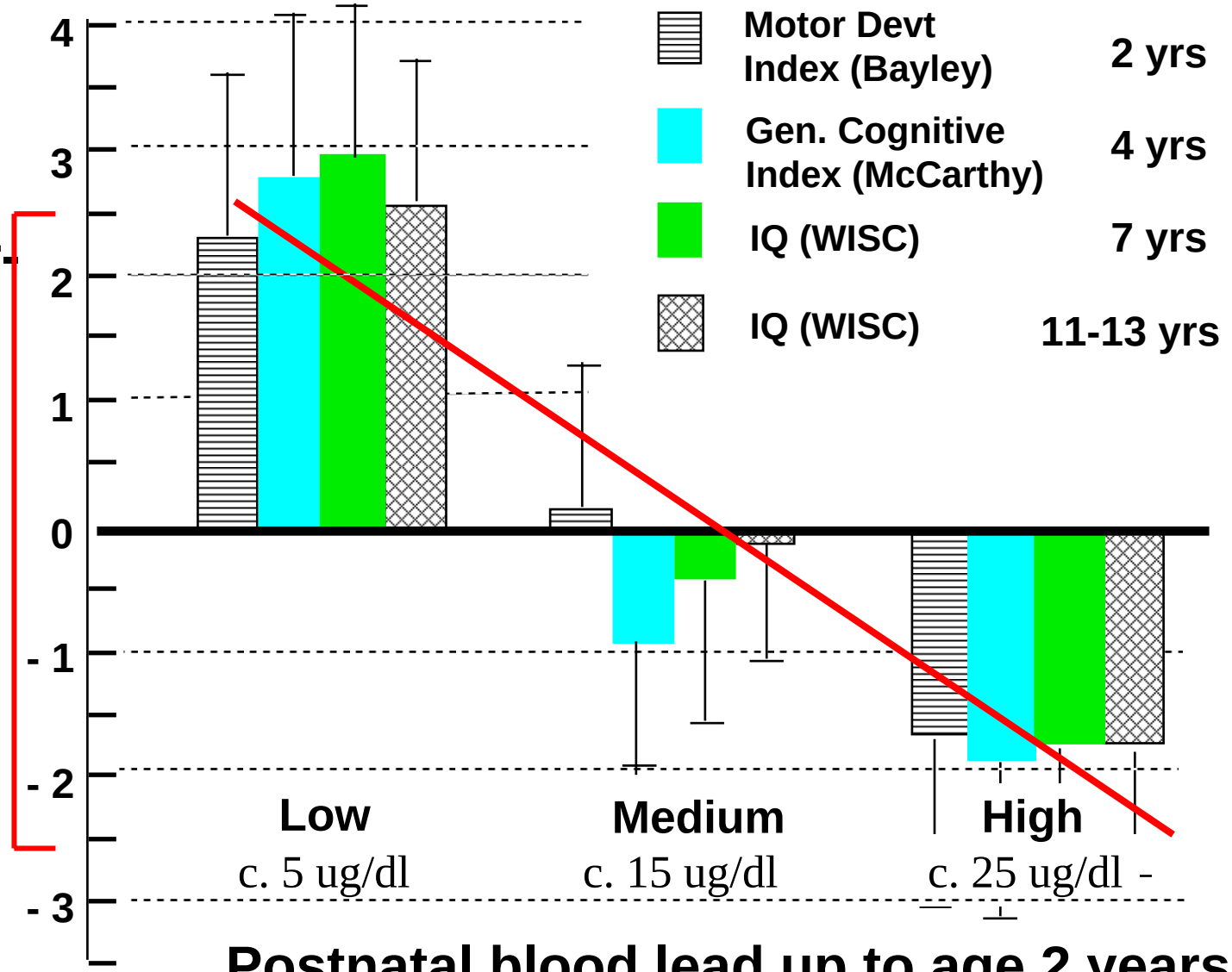
Variation in confounder-adjusted score

(one point approximates to a one percent change in IQ)

5 IQ points per 20 ug/dl PbB



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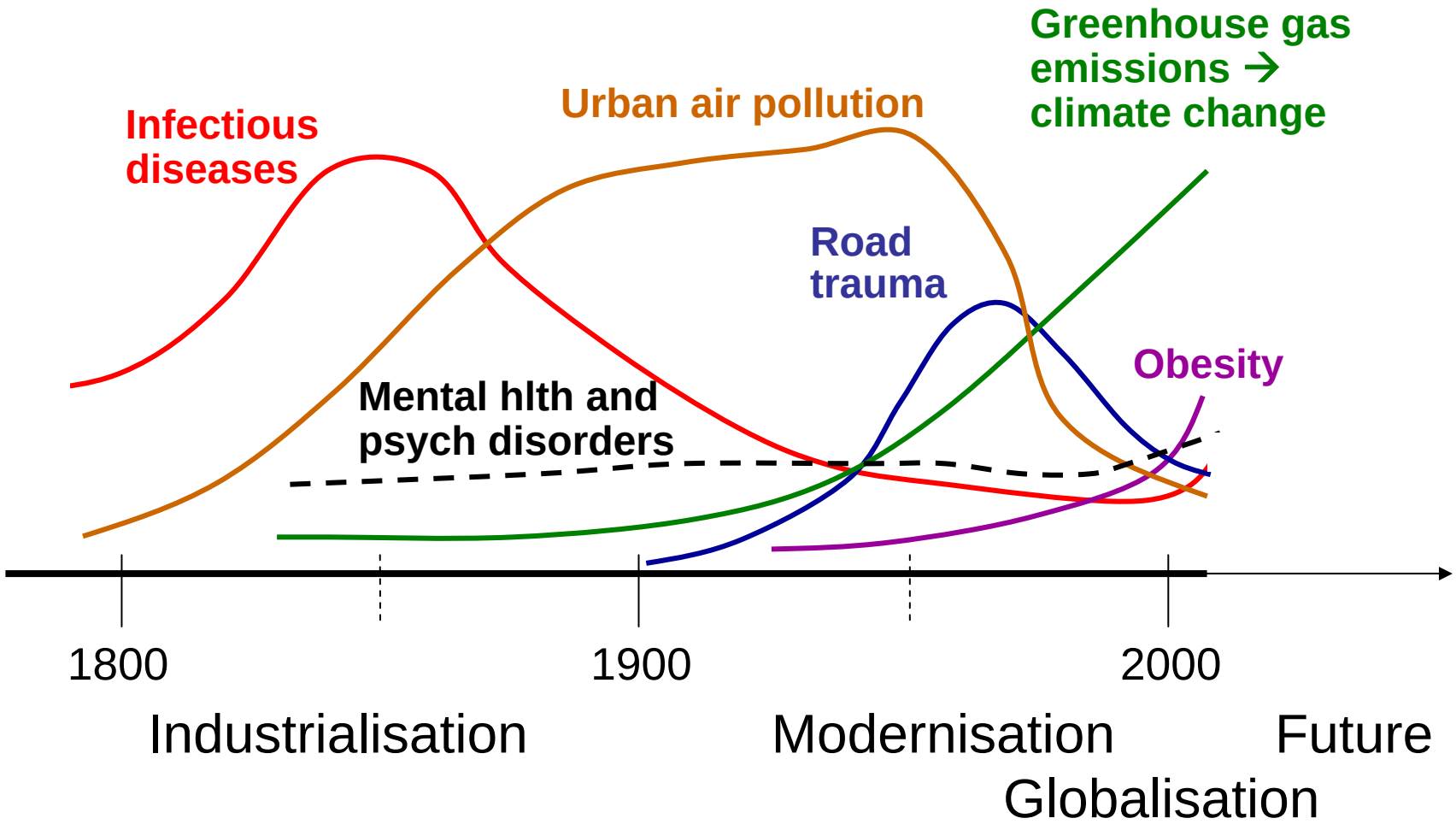
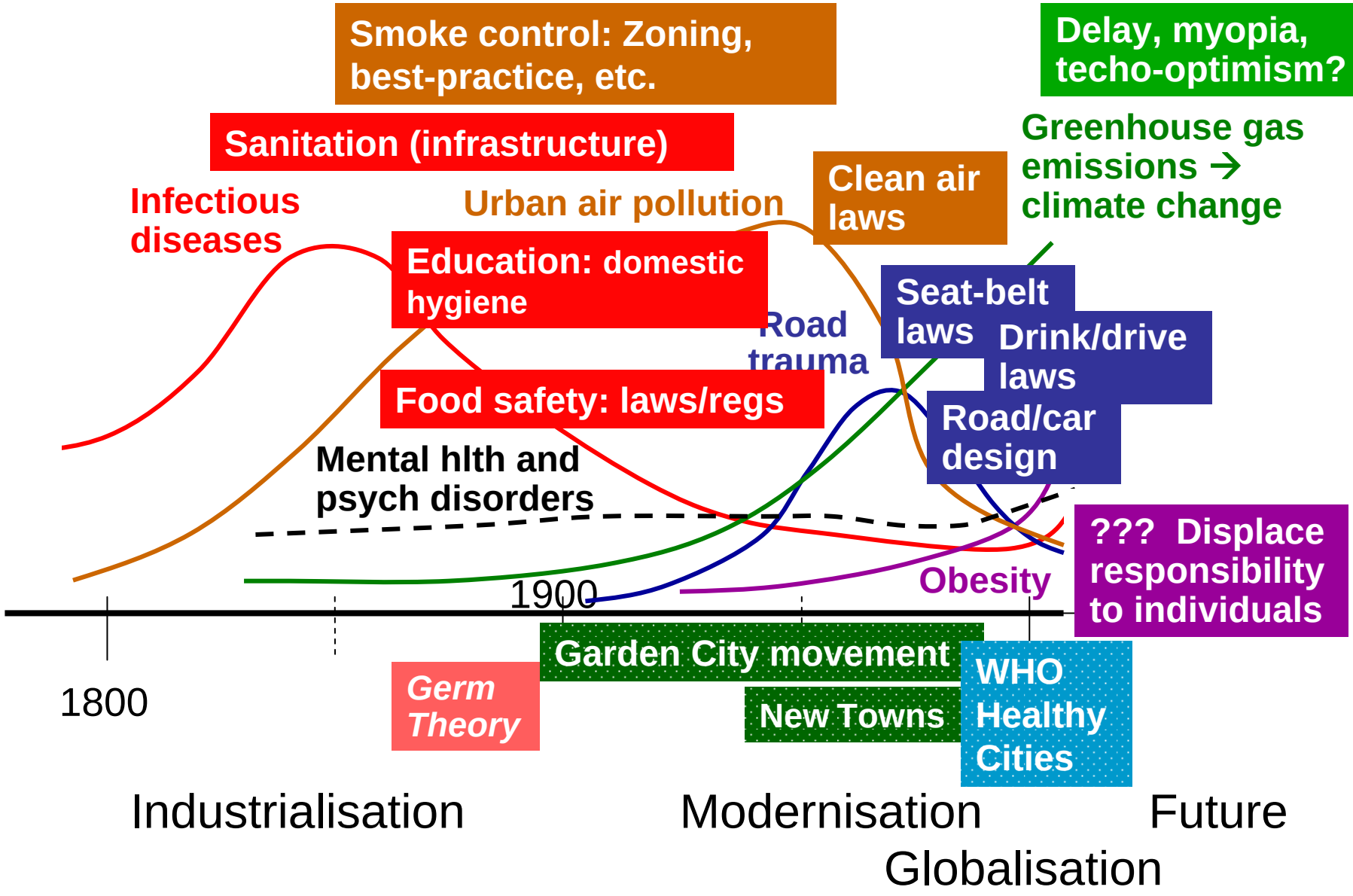
Rise and Fall of Urban Health Penalties



Rise and Fall of Urban Health Penalties



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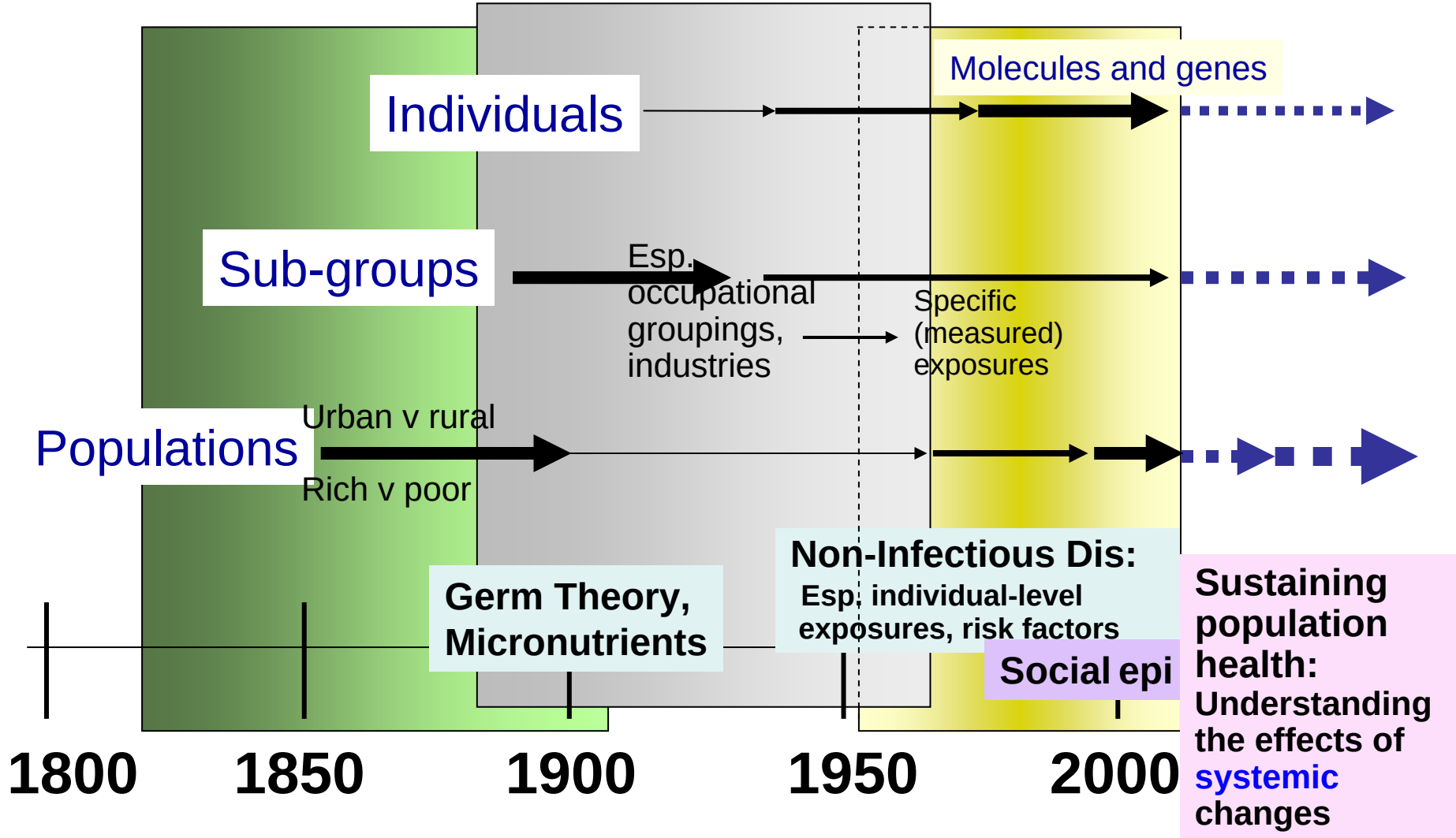
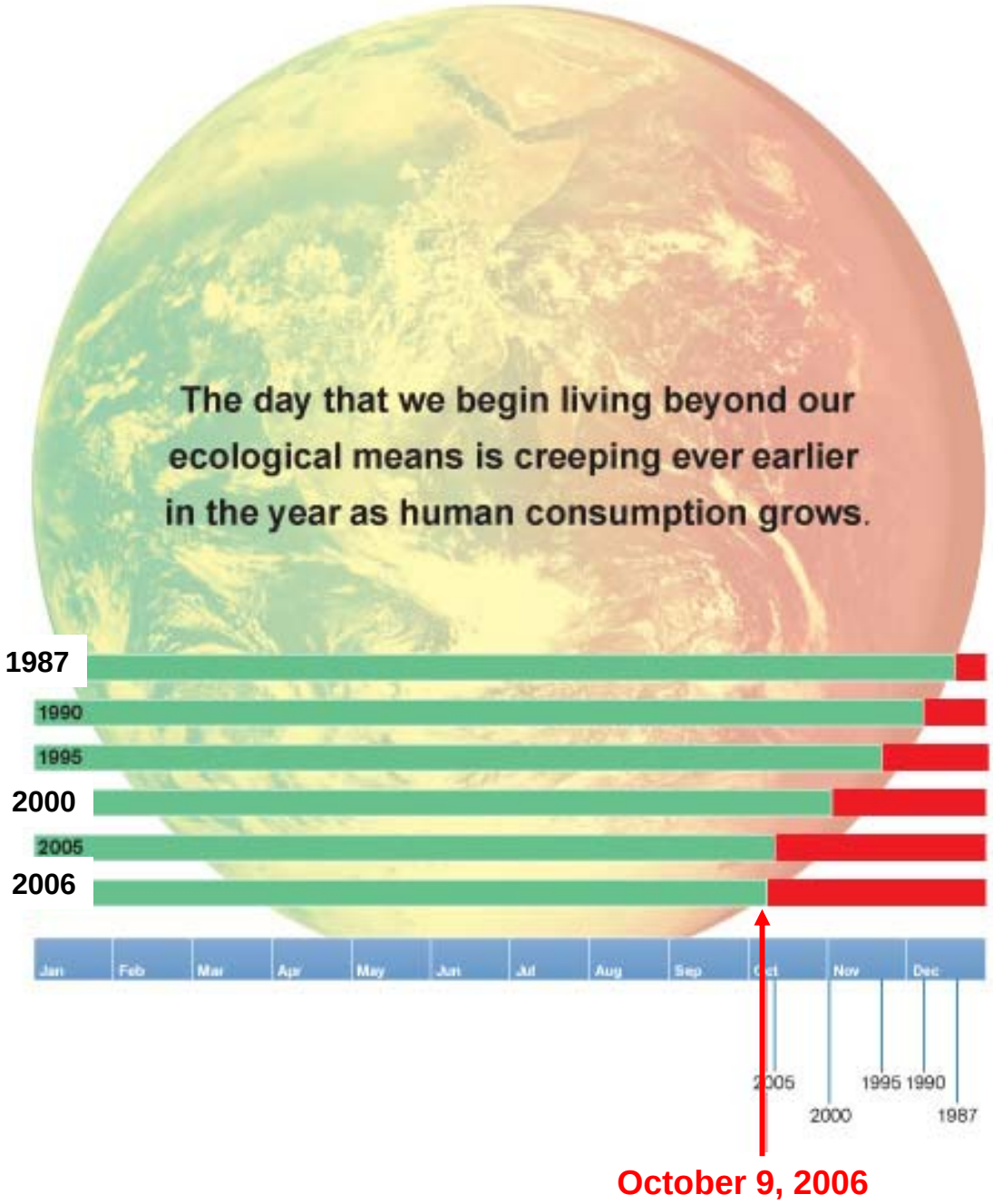
Epidemiology since ~1850: Changes in emphasis on different levels/units of analysis



Sustaining population health: Understanding the effects of systemic changes



As humanity's resource consumption increases, World Overshoot Day occurs earlier each year. The first Overshoot Day was Dec 19, 1987. Today, it is on October 9 – i.e., our Ecological Footprint is almost 30% larger than the planet's biocapacity.

World Overshoot Day = [**World biocapacity / World Ecological Footprint**] **x 365**

This year, in just 282 days, we consumed the biosphere's entire capacity for 2006.

www.footprintnetwork.org/gfn_sub php?content=overshoot

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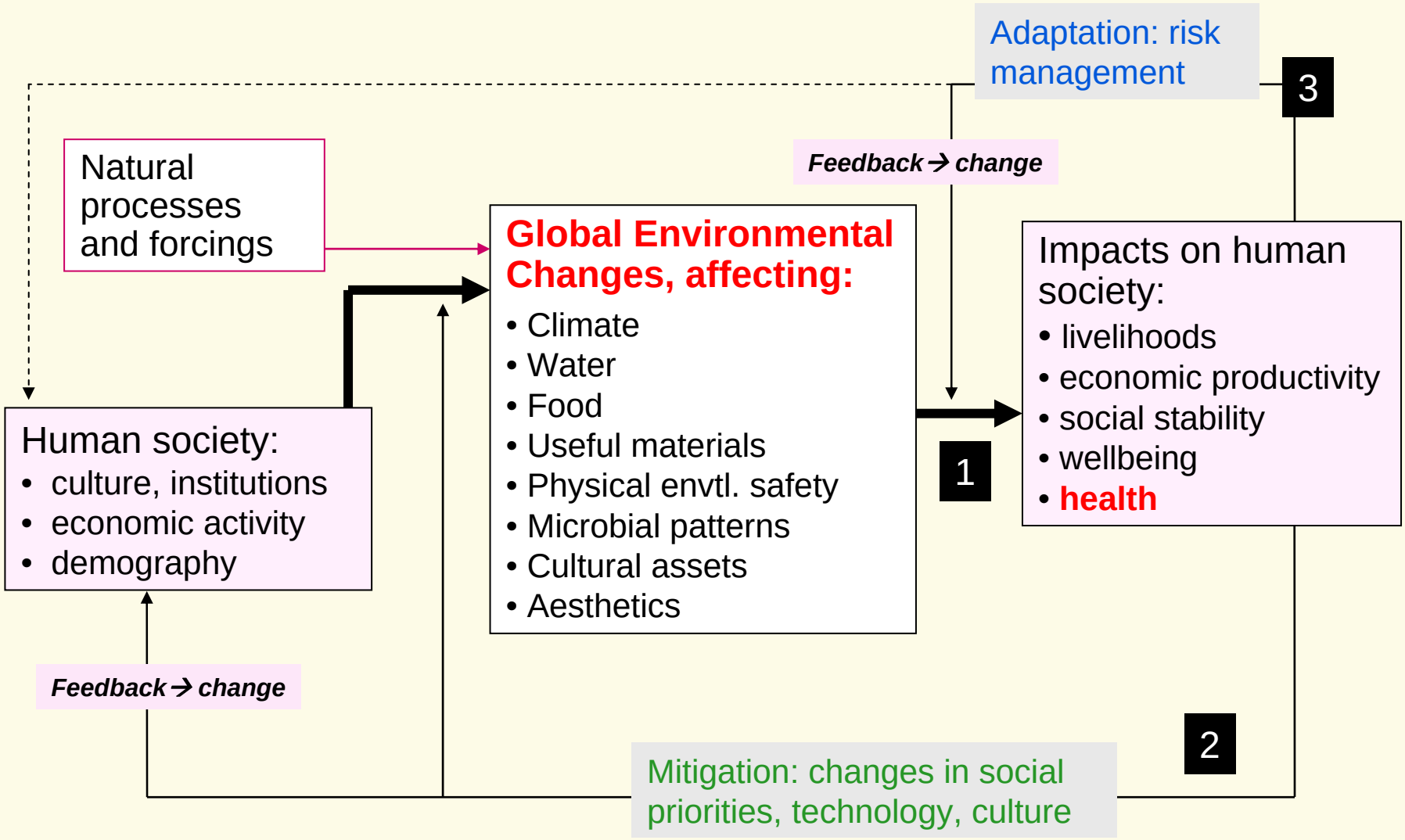
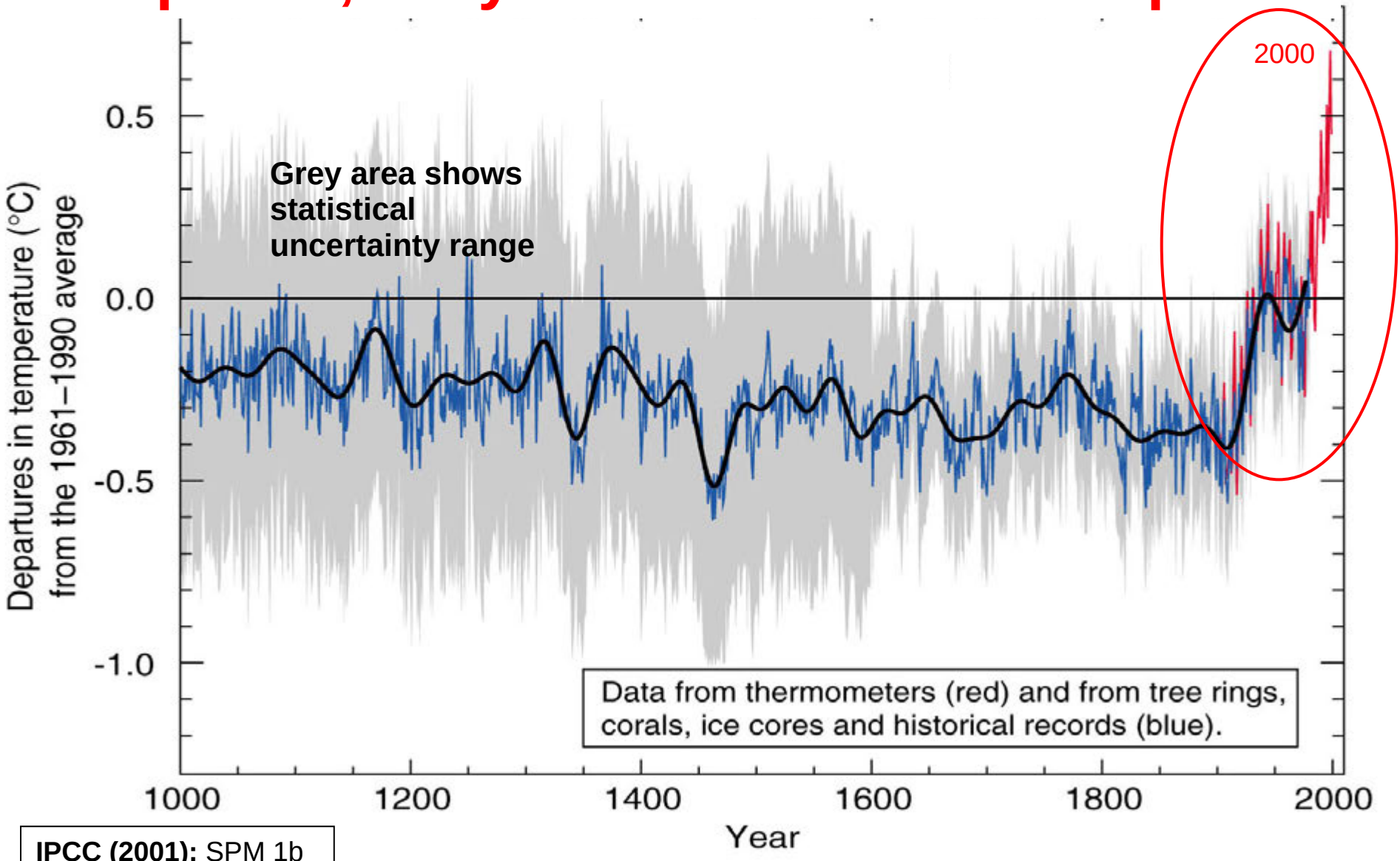
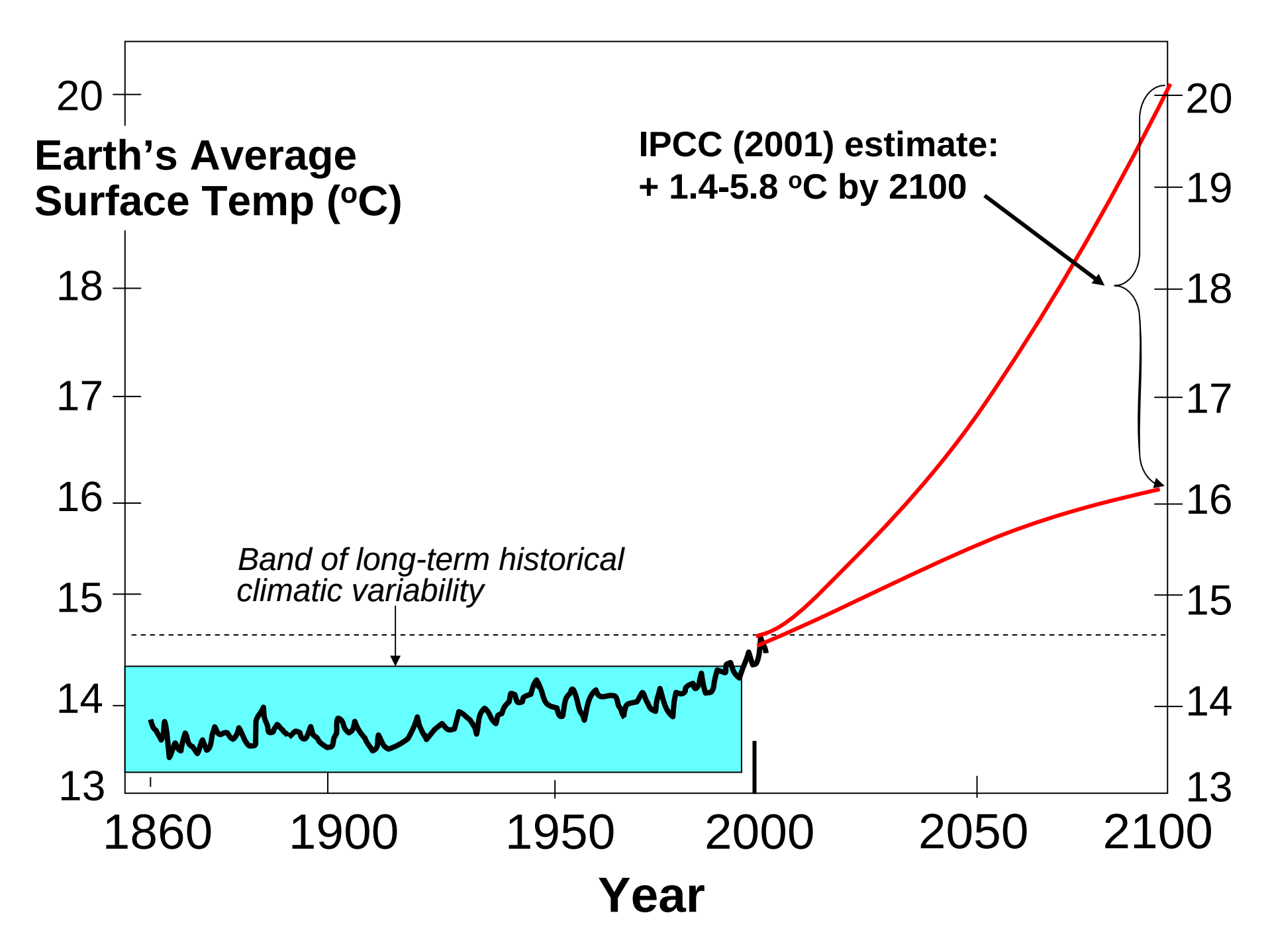
Global Environmental Changes: Health Impacts, Social Responses



Variations in Earth's surface temperature for past 1,000 years: Northern hemisphere



IPCC (2001): SPM 1b


Earth's Average Surface Temp (°C)
IPCC (2001) estimate:
+ 1.4-5.8 °C by 2100
Band of long-term historical climatic variability
20
19
18
17
16
15
14
13
1860
1900
1950
2000
2050
2100
Year

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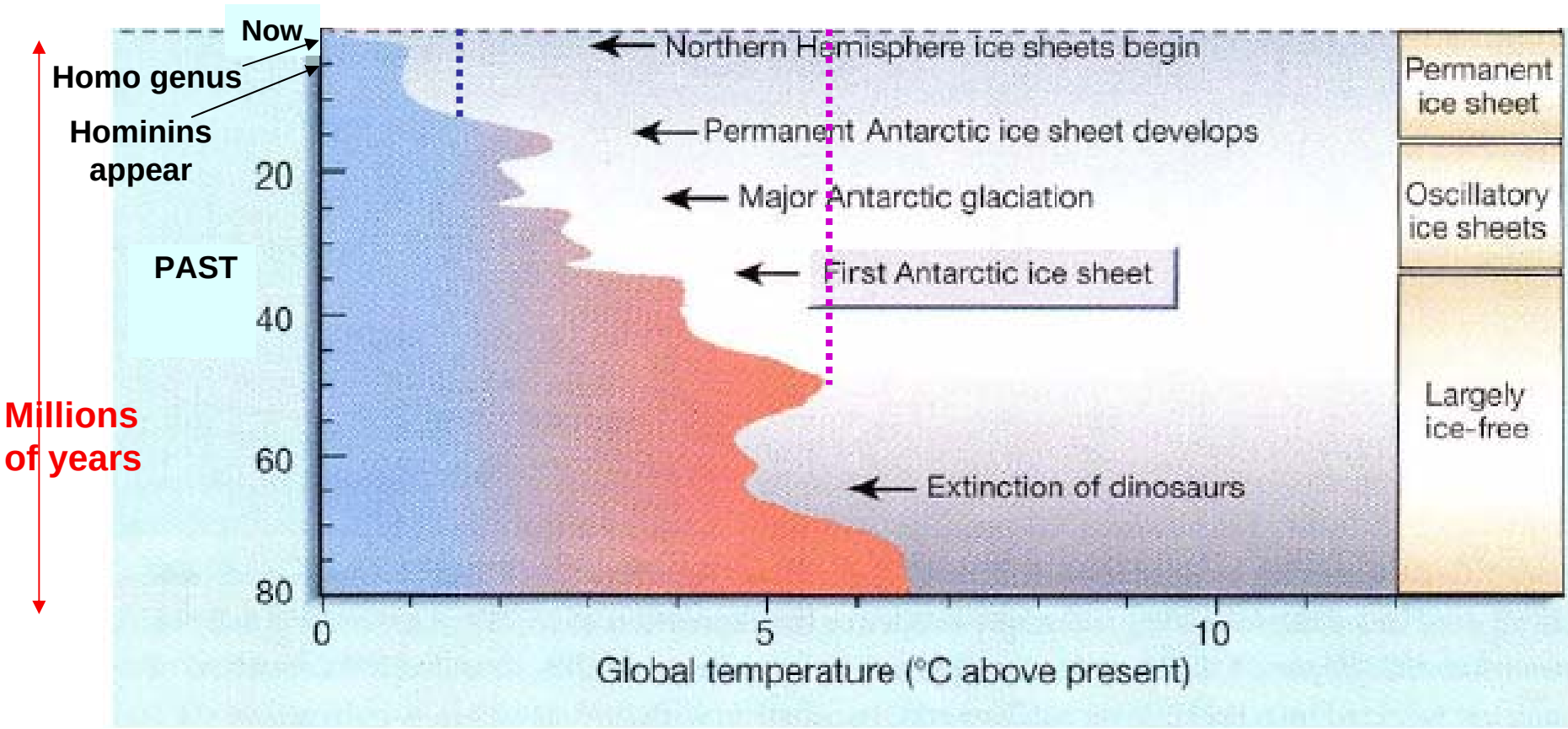
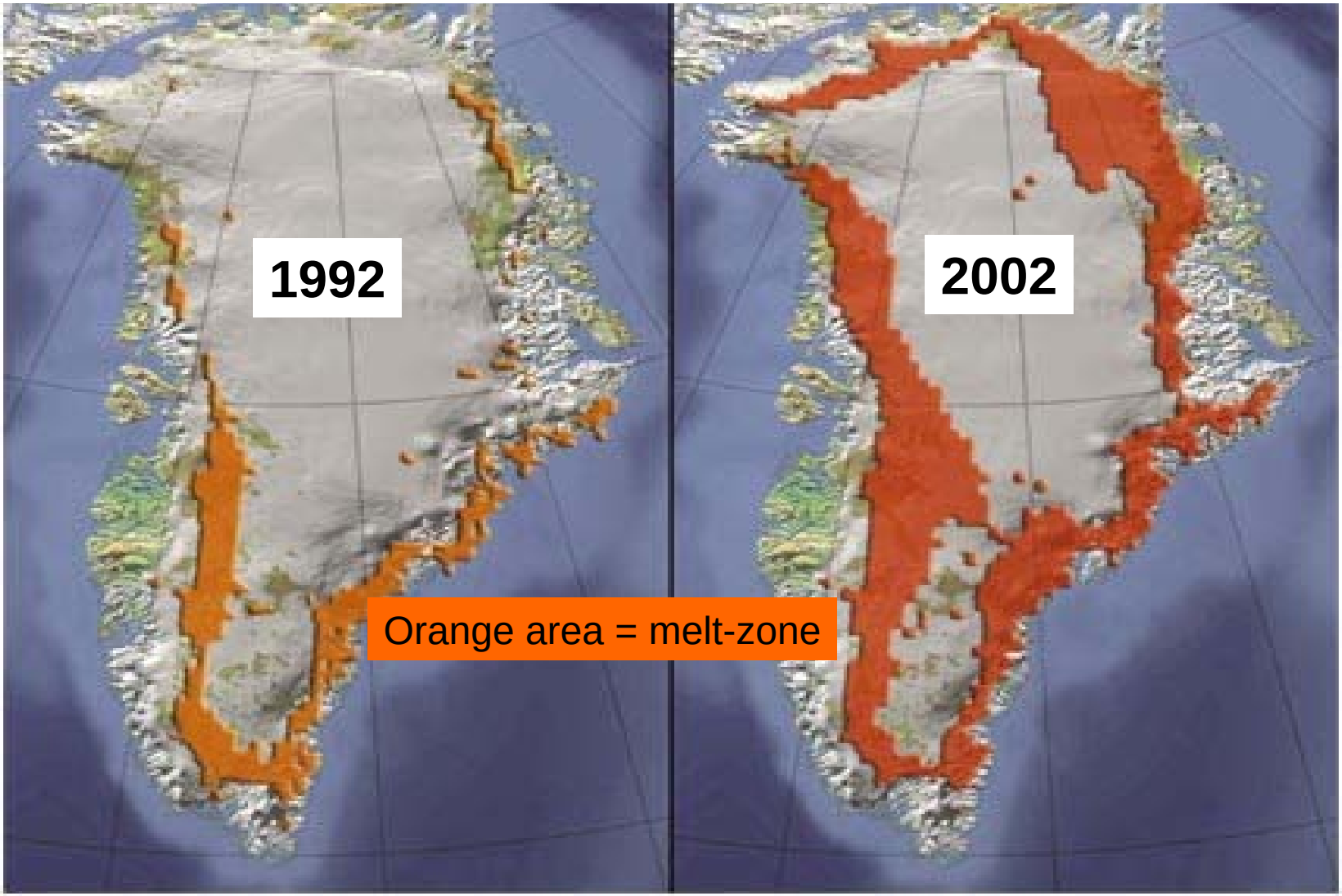
Changes in Earth's temperature over past 80 million years, and upper/lower estimates for next several centuries

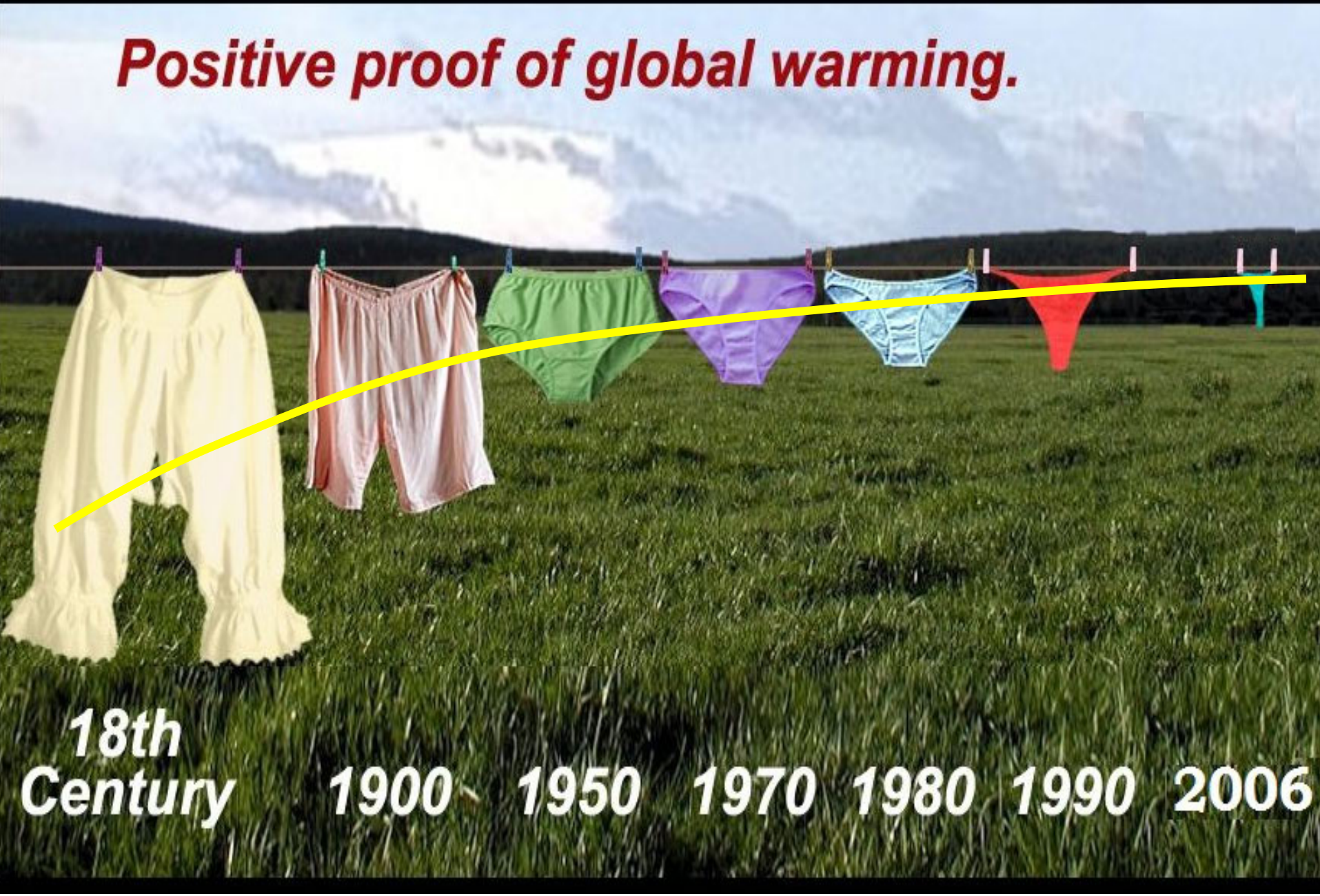


Barrett, *Nature*, 2003

Greenland Ice Sheet: Increase in Area Melted in Summer, from 1992 to 2002

(Arctic Climate Impact Assessment, 2004)




Positive proof of global warming.
18th Century
1900
1950
1970
1980
1990
2006

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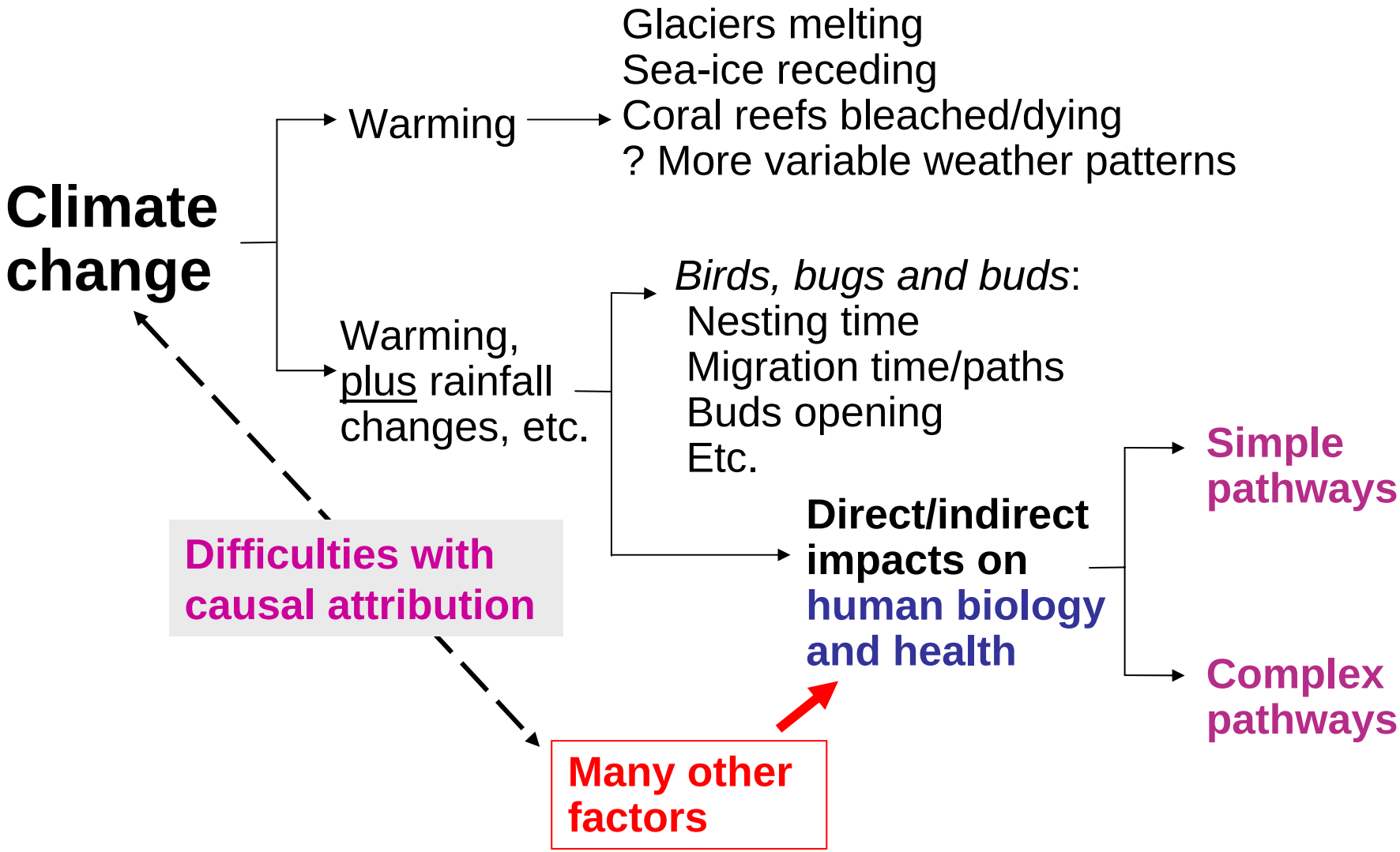
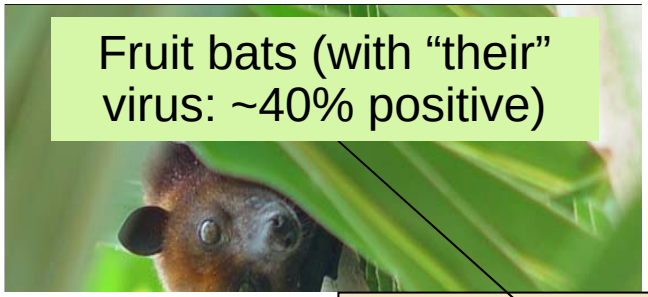
Climate Change Impacts on Natural Environment and Biological Systems



Nipah Virus Disease: Outbreak in Malaysian Pig Farmers, 1997-1999



Fruit orchards

Virus-contaminated fruit, bat droppings

Eaten by pigs

Infected (sick) pigs

Forest clear

El Ni

rming

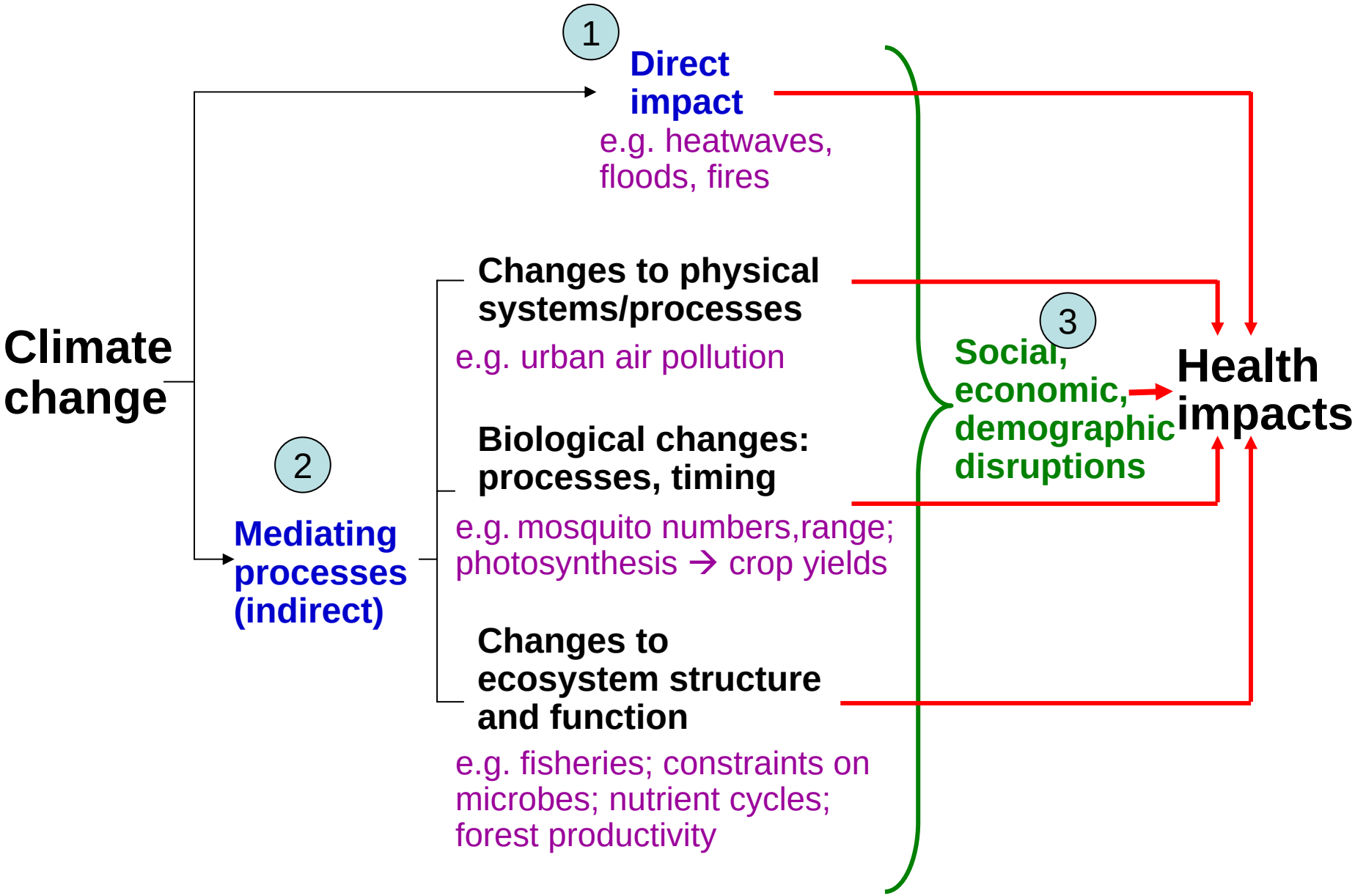
i.e., ?? influences
Deforestation,
El Niño conditions,
Smoke haze:
→ Decline in fruit

with seas
fruiting – bat
diet

Forest-fire smoke (?)

265 humans infected:
JE-like illness
~40% fatal
~105 deaths

Climate Change and Health: Pathways



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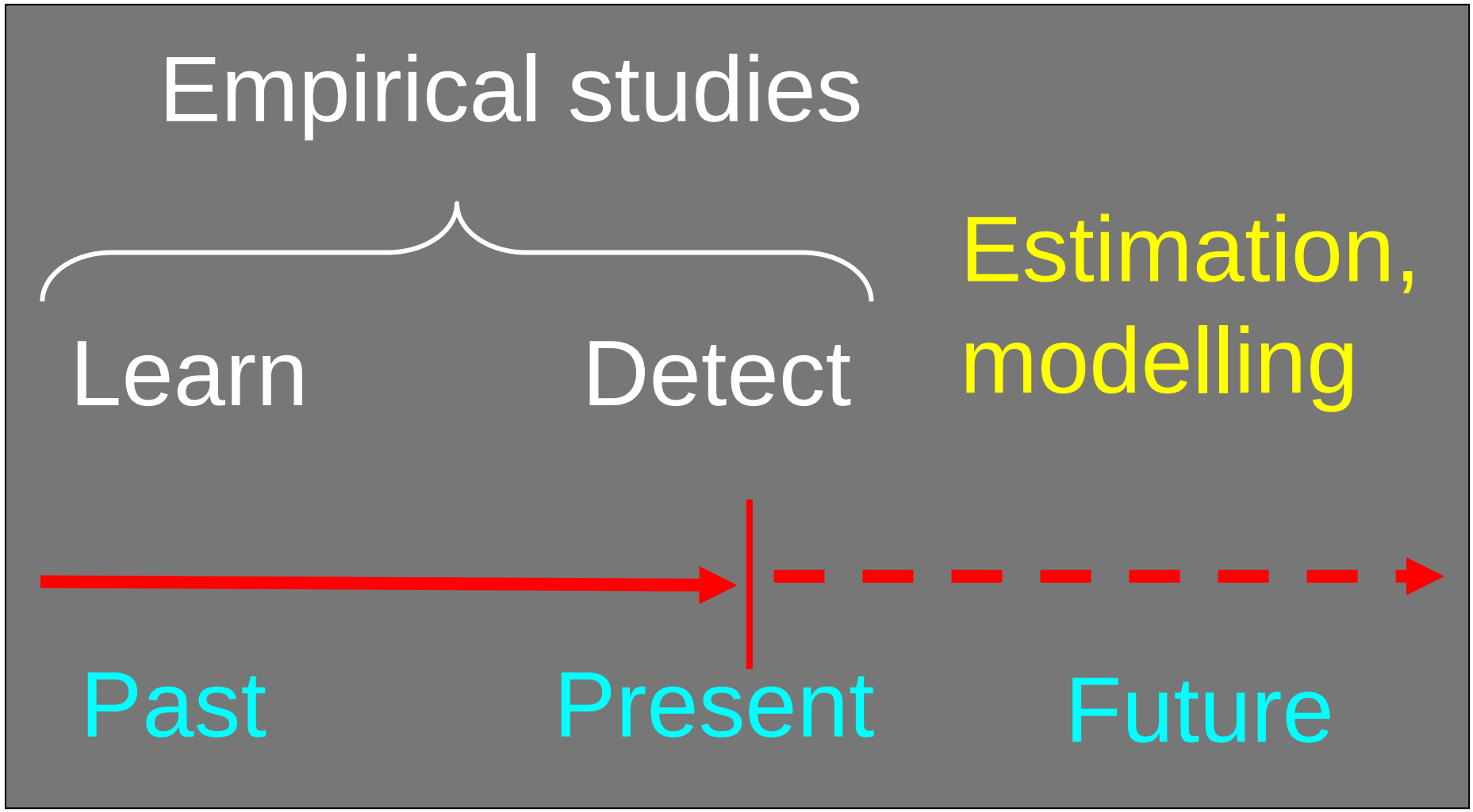
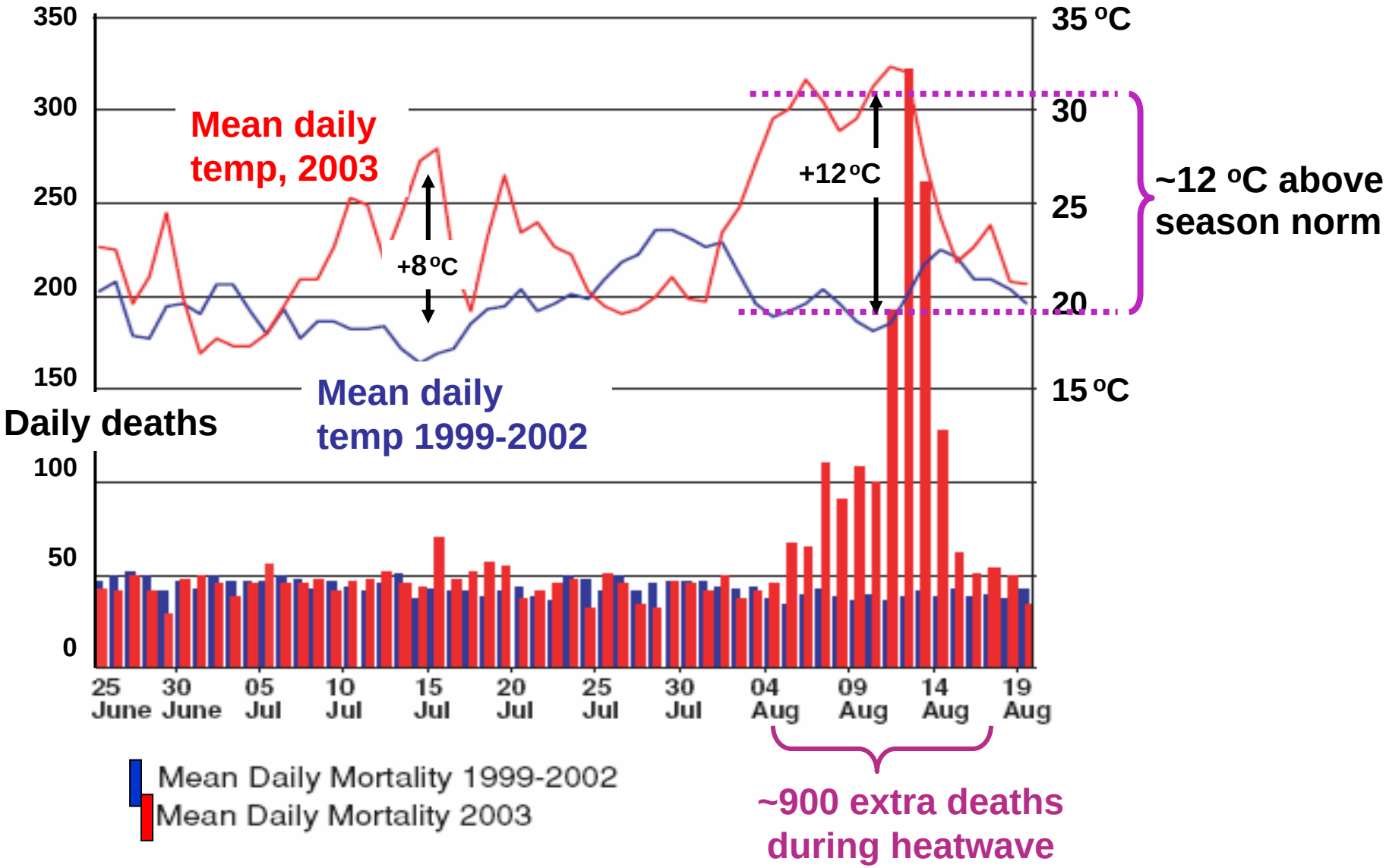
Three Types of Study

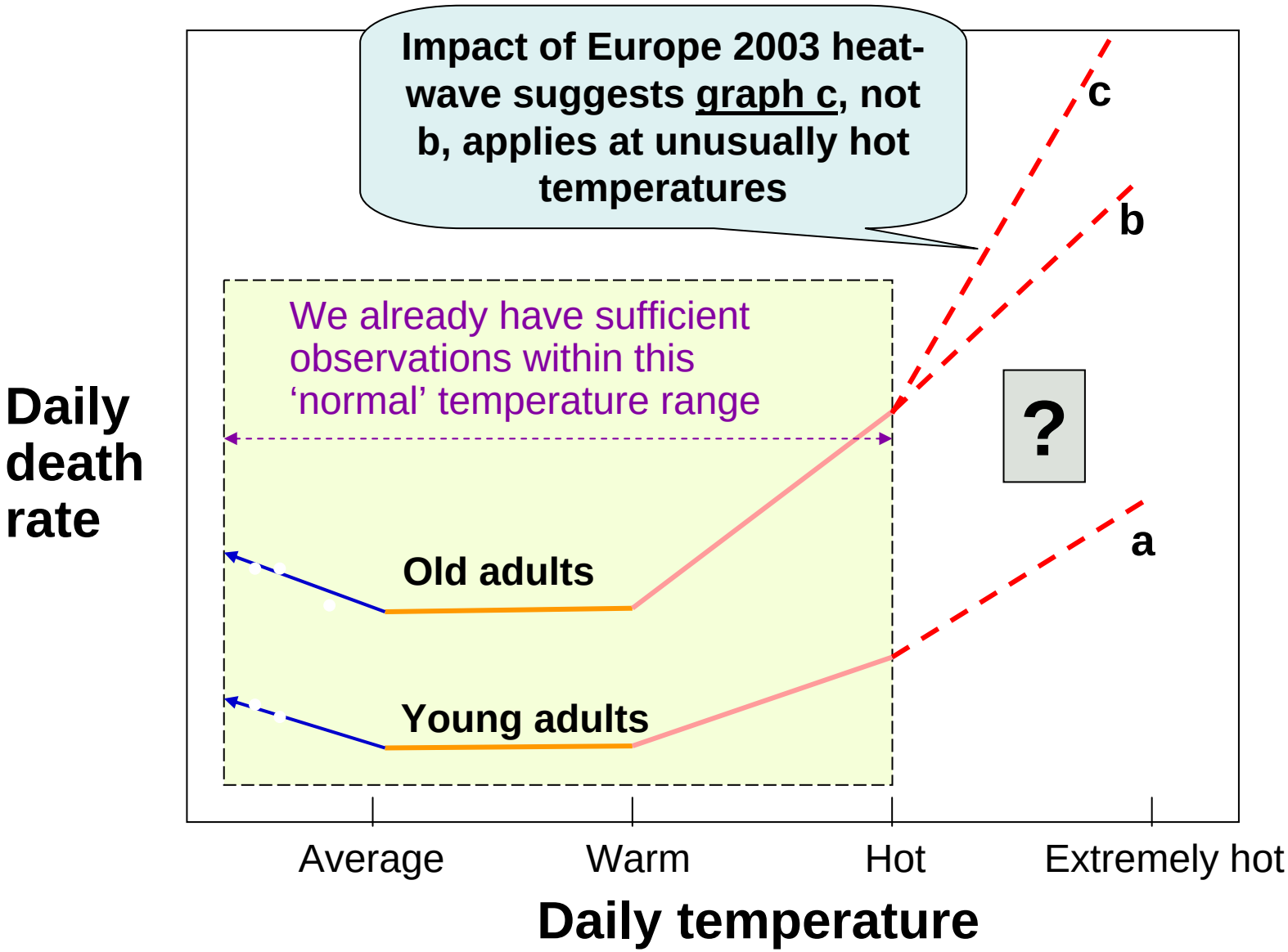


Paris, Heatwave (Aug 2003): Daily Mean Temps and Deaths

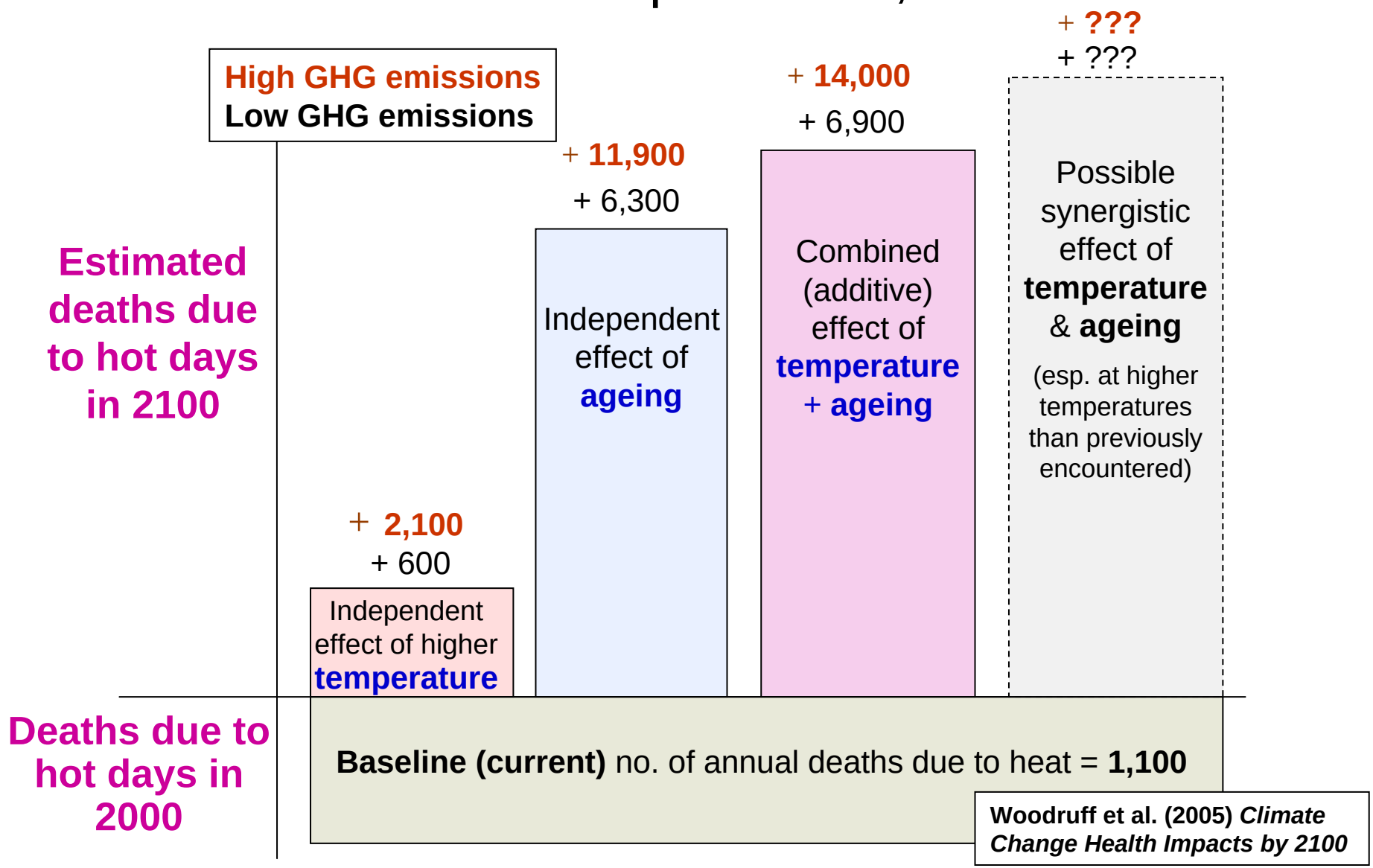


Kalkstein et al, in press

Daily temperature and deaths: what happens at temperature extremes?



Forecast heat-related deaths in people aged 65+, due to higher mean annual temperatures: Australian capital cities, 2100



Woodruff et al. (2005) *Climate Change Health Impacts by 2100*

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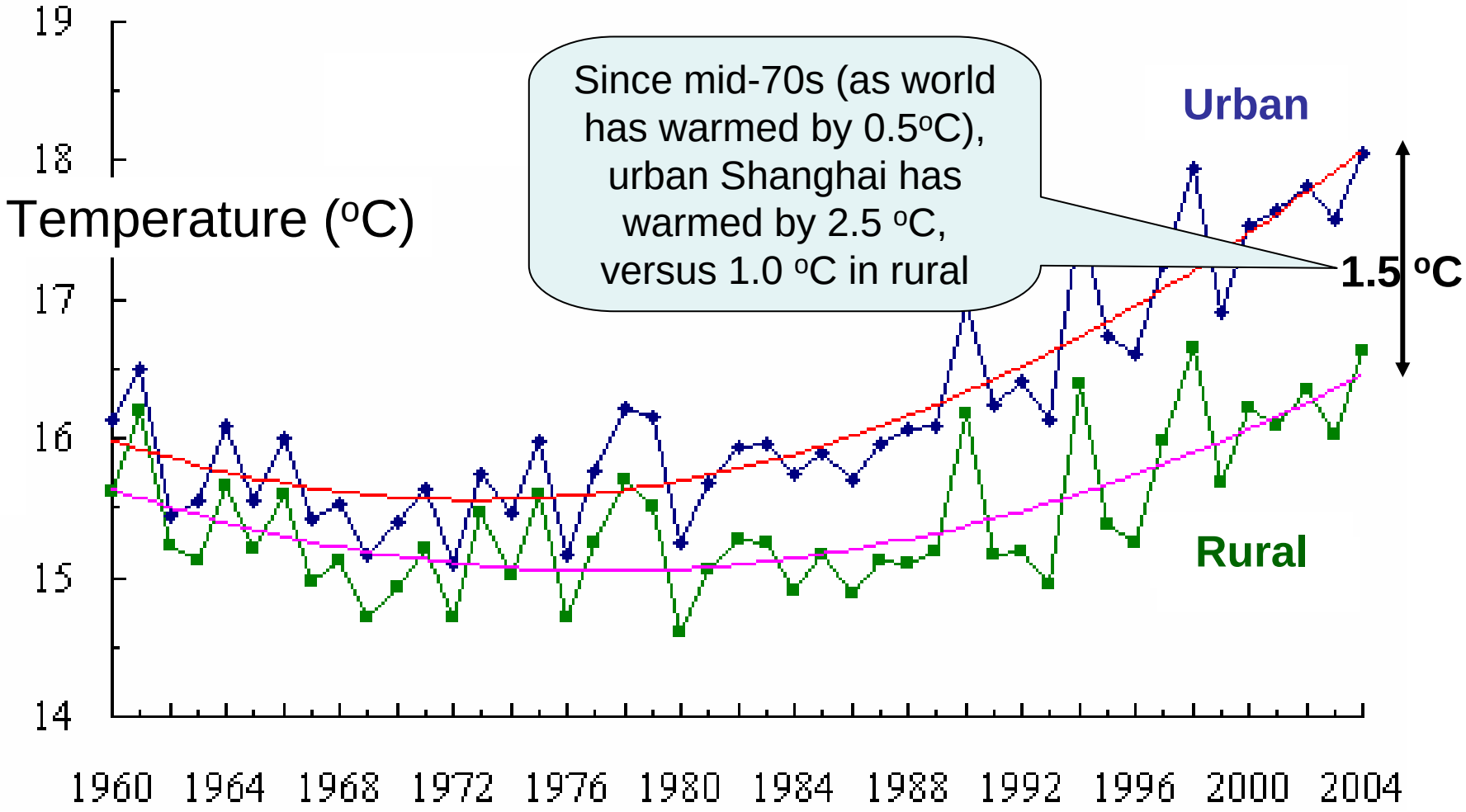
‘Heat Island’ effect: Comparison of annual mean temperature in urban vs rural Shanghai



Tan Jianguo, 2005 (Beijing)

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Food Systems: Yields, Access, Health

FAO data: ~840 million under-nourished persons

Absolute *increase* since 2000

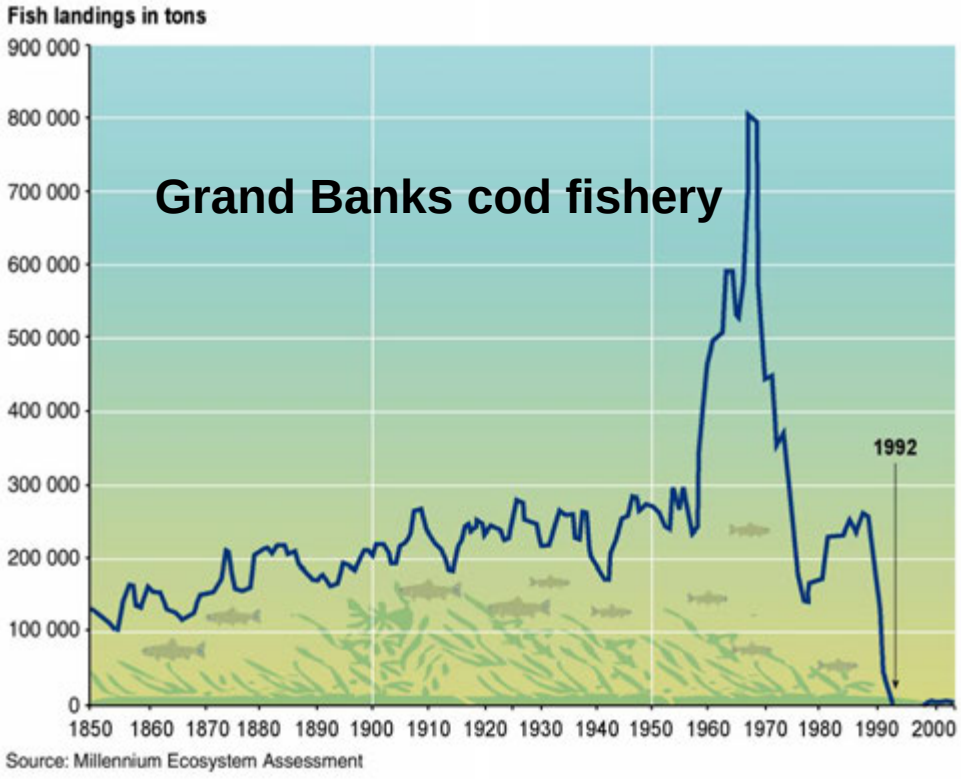
- **Over-worked soils (organic matter, etc.)**
- **Chemicalisation (fertilisers)**
- **Irrigation (water-logging, salination)**
- **Climate change**
  - → **temperature, soil moisture, monsoon systems, floods/droughts, etc.**
- **Ecosystem disruption (e.g. weeds, pollinators)**
- **Mono-culture vulnerability to pests/infections**
- **Livestock: pests/infections (CC and blue-tongue virus?)**
- **Access '(entitlement') – social institutions, policies**

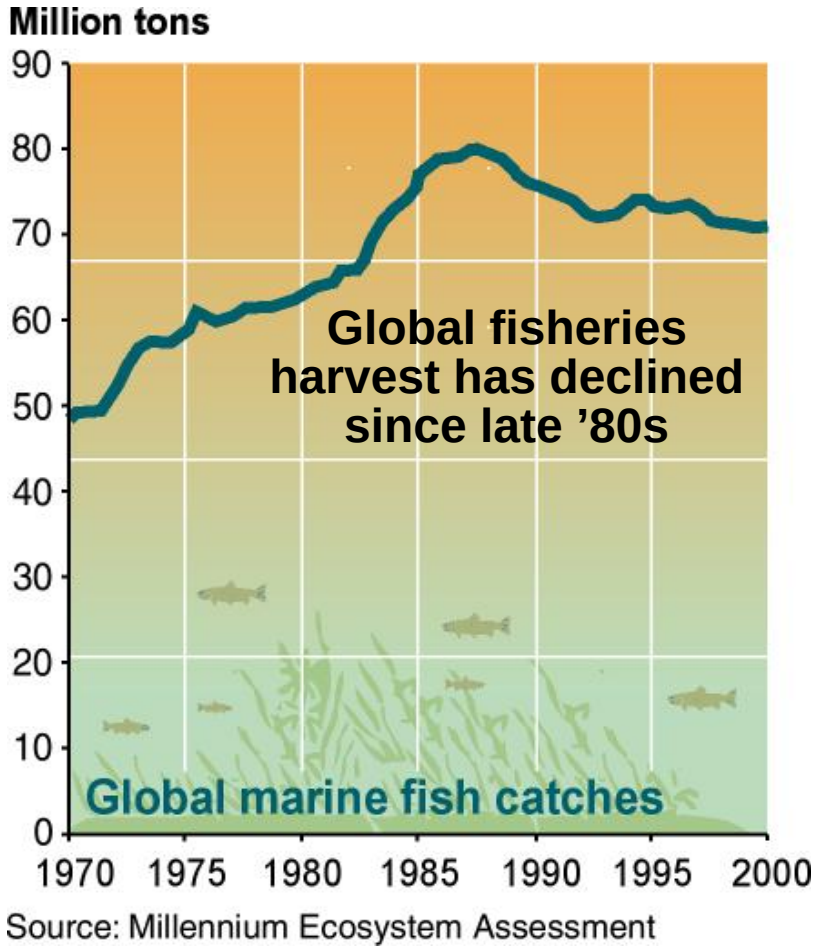
Worldwide Capture-Fisheries

Fish account for high proportion of animal protein in world diet – especially in developing-country coastal communities.

25% of commercial marine fish stocks now seriously over-harvested

(*Millennium Assessment, 2005*)





Climate Change and Distribution Shifts in Marine Fishes

Allison L. Perry,[1*] Paula J. Low,[2†] Jim R. Ellis,[2] John D. Reynolds[1*]

"… the distributions of both exploited and non-exploited North Sea fishes have responded markedly to recent increases in sea temperature…over 25 years. … Further temperature rises are likely to have profound impacts on commercial fisheries."

24 JUNE 2005 VOL 308 SCIENCE www.sciencemag.org

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Climate Change and Ocean Acidity

Report by (UK) Royal Society, June 2005

Increase in atmospheric carbon dioxide has increased ocean acidity (pH↓ 0.1 units).

Chair: "Failure to cut CO_2 emissions may mean that there is no place in the oceans of the future for many of the species and ecosystems that we know today."

Calcification – in zooplankton, crustaceans, shellfish – is very sensitive to pH.
These species are base of marine food web.

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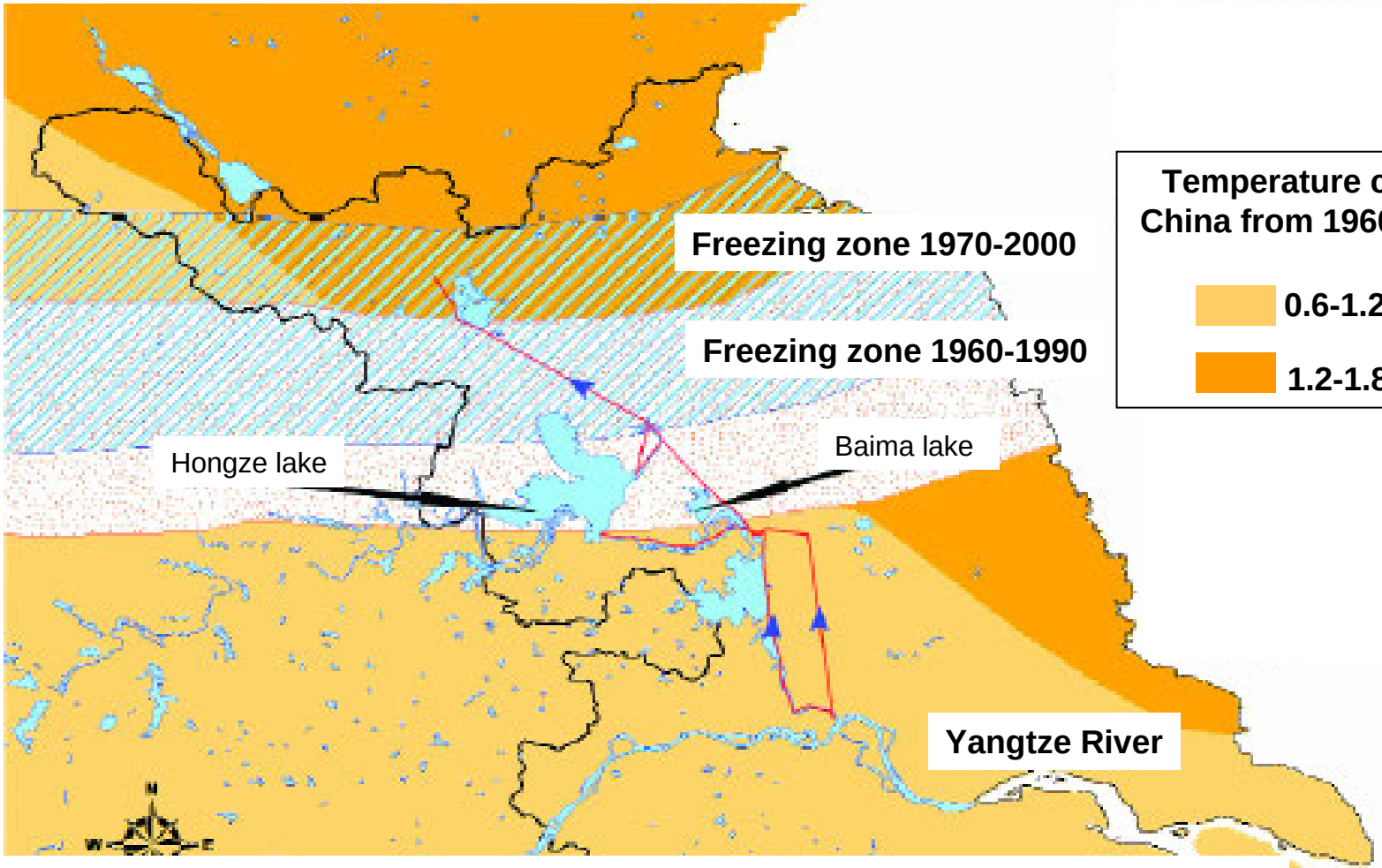
That is, in combination:

- **Over-fishing**
- **Ocean warming**
- **Ocean acidification**

…all impair productivity of ocean fisheries

Illustrates well the (often) multi-causal nature of environmental non-sustainability

Schistosomiasis: Potential transmission of *S. japonicum* in Jiangsu province due to raised avg January temperature. [Red lines = part of planned Sth-Nth water canal.]



Recent studies indicate that recent increase in recorded incidence of schistosomiasis may in part reflect warming. “Freeze line” limits survival of intermediate host (Oncomelania water snails), limiting transmission of *Schistosomiasis japonica*. Parasite has moved northwards, putting 20.7 million extra people at risk (**Yang et al. 2005**).

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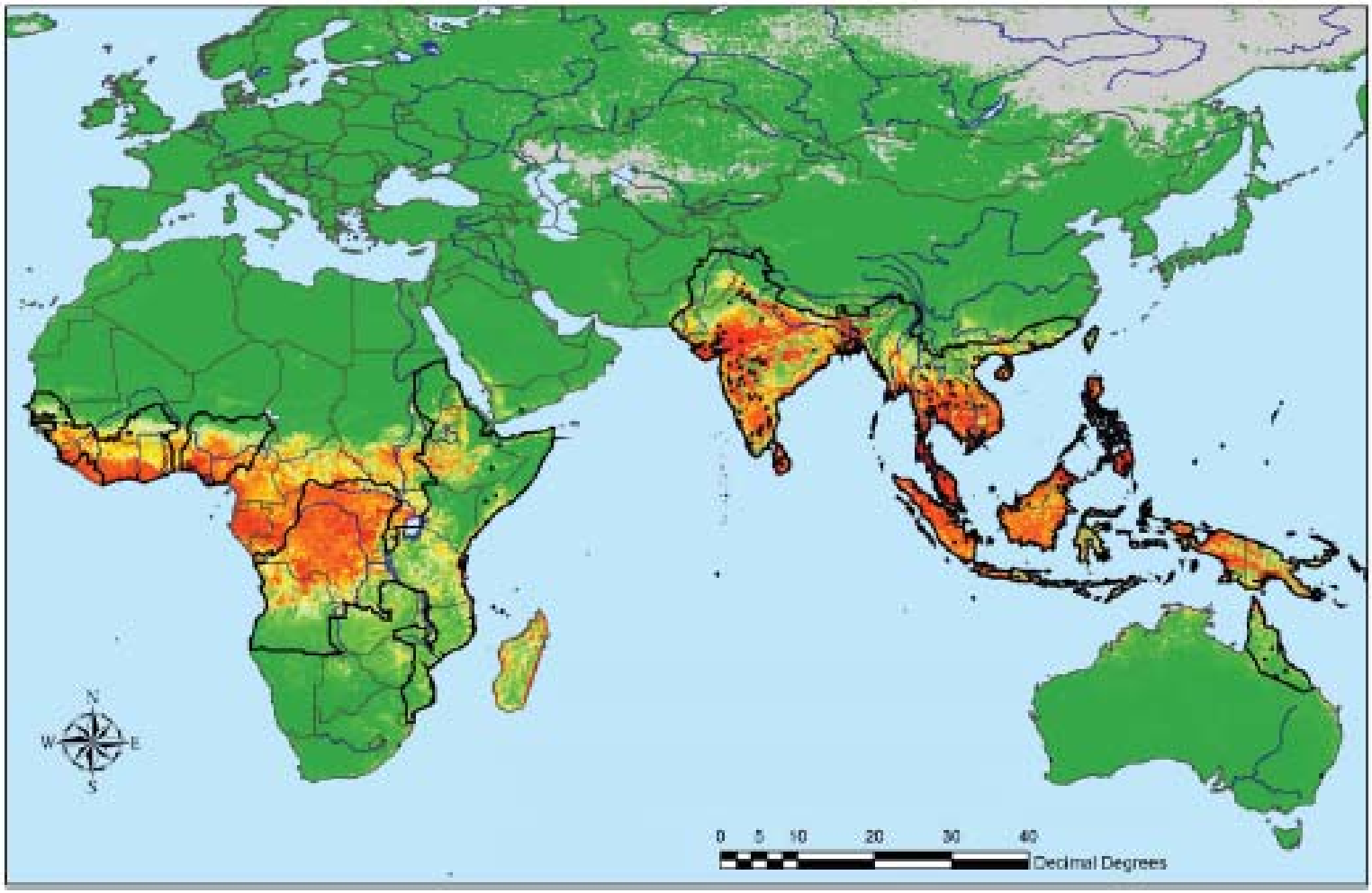
Risk Map (current) for Dengue:
average of 100 bootstrap models

Green (prob < 0.5) = not suitable. Yellow → Red = increasing suitability



For comparison: WHO map for dengue, 2003, is shown with black lines

Rogers D, et al. *Advances in Parasitology* 2006

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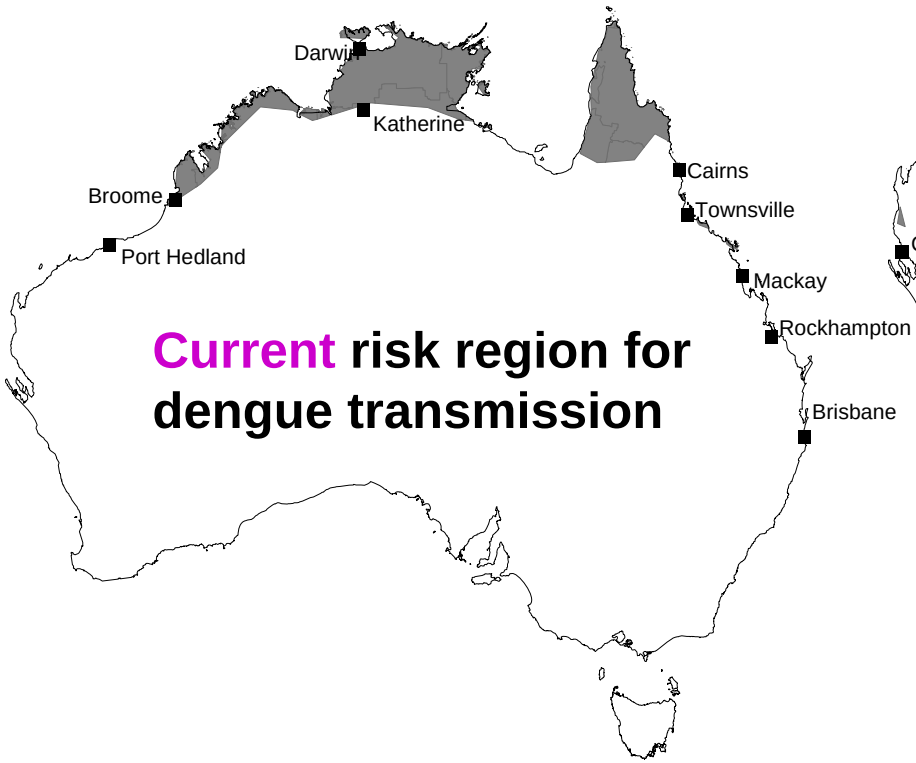
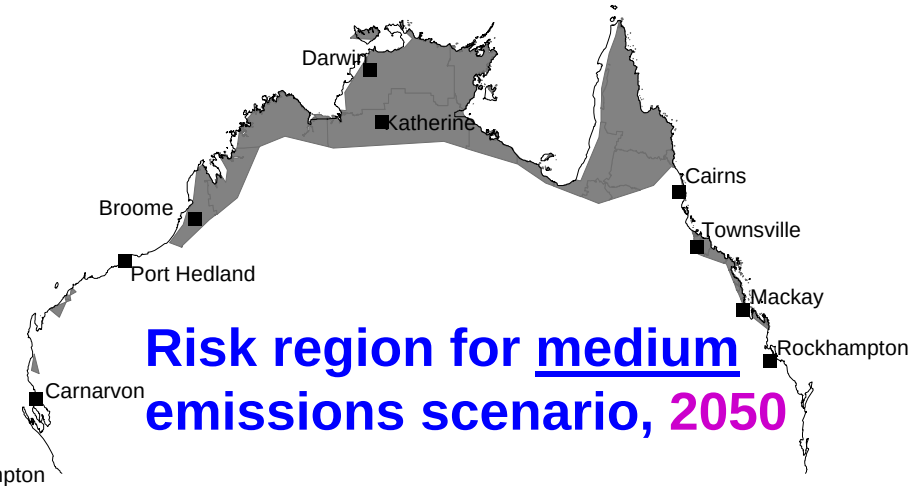
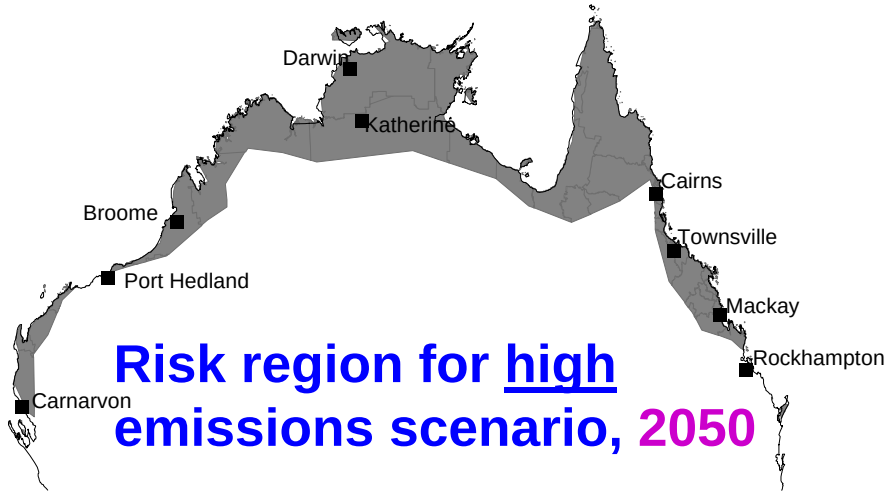
Dengue Fever: Modelling of receptive geographic region for *Ae. Aegyptii* mosquito, under alternative climate-change scenarios for 2050

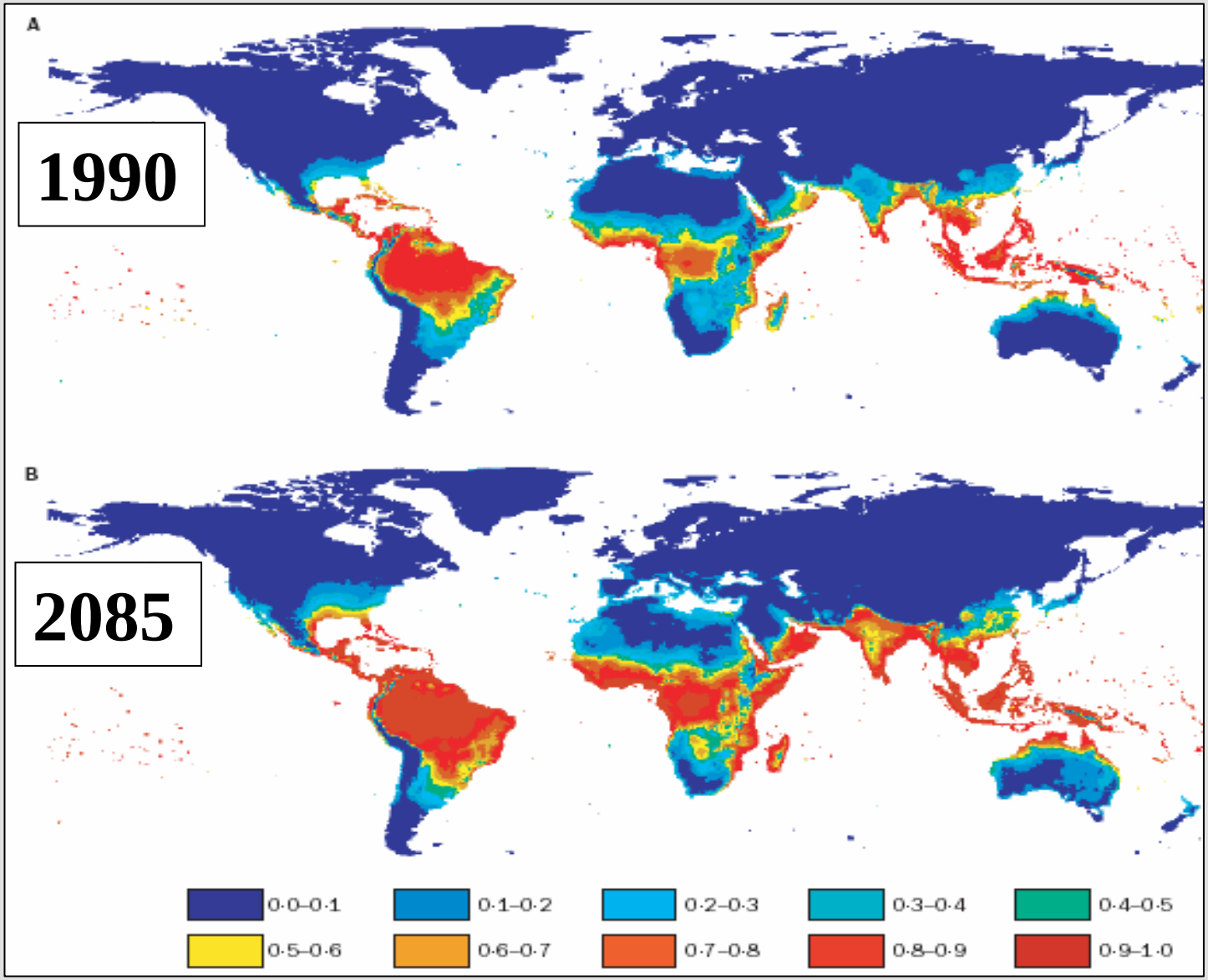






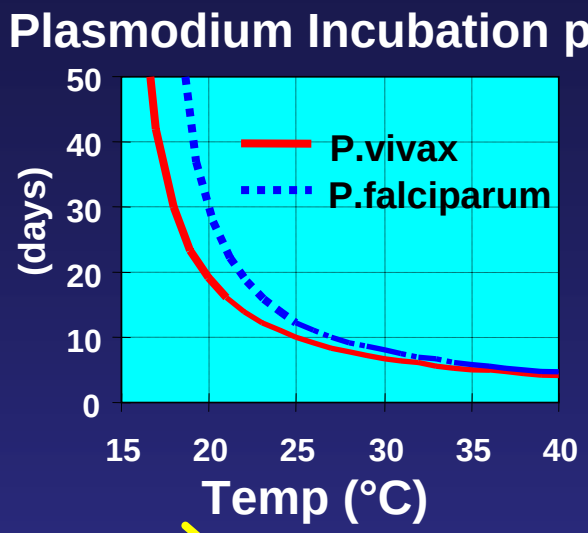
NCEPH/CSIRO/BoM, 2003

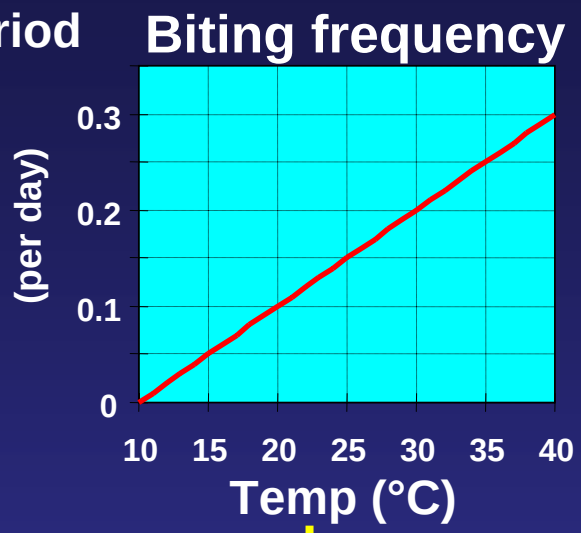
Estimated population at risk of Dengue Fever (i.e. vector climate envelope) under mid-range climate change scenario: 2085 (vs 1990)

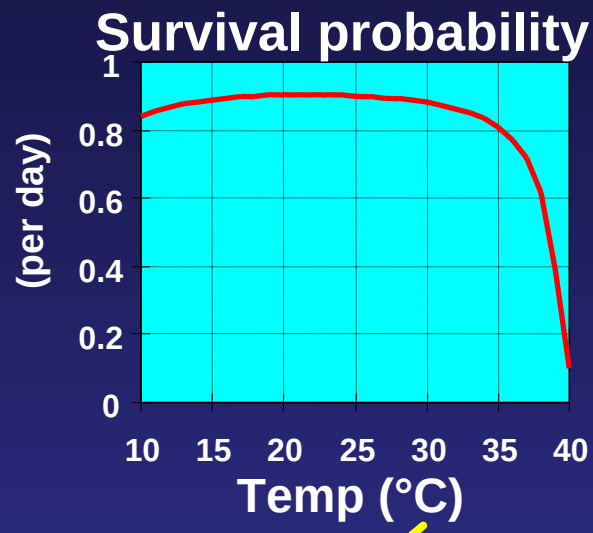


Source. Hales, Woodward, et al. Lancet (online) 6 Aug 2002. http://image.thelancet.com/extras/01art11175web.pdf

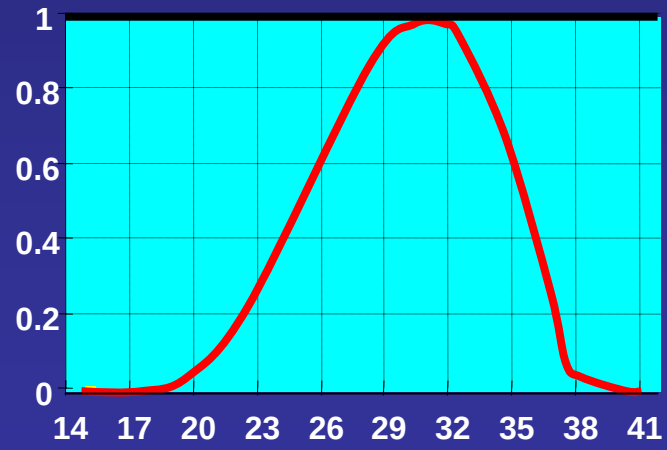
Malaria Transmissibility: Temperature and Biology







TRANSMISSION POTENTIAL



See also:
Pascual et al 2006

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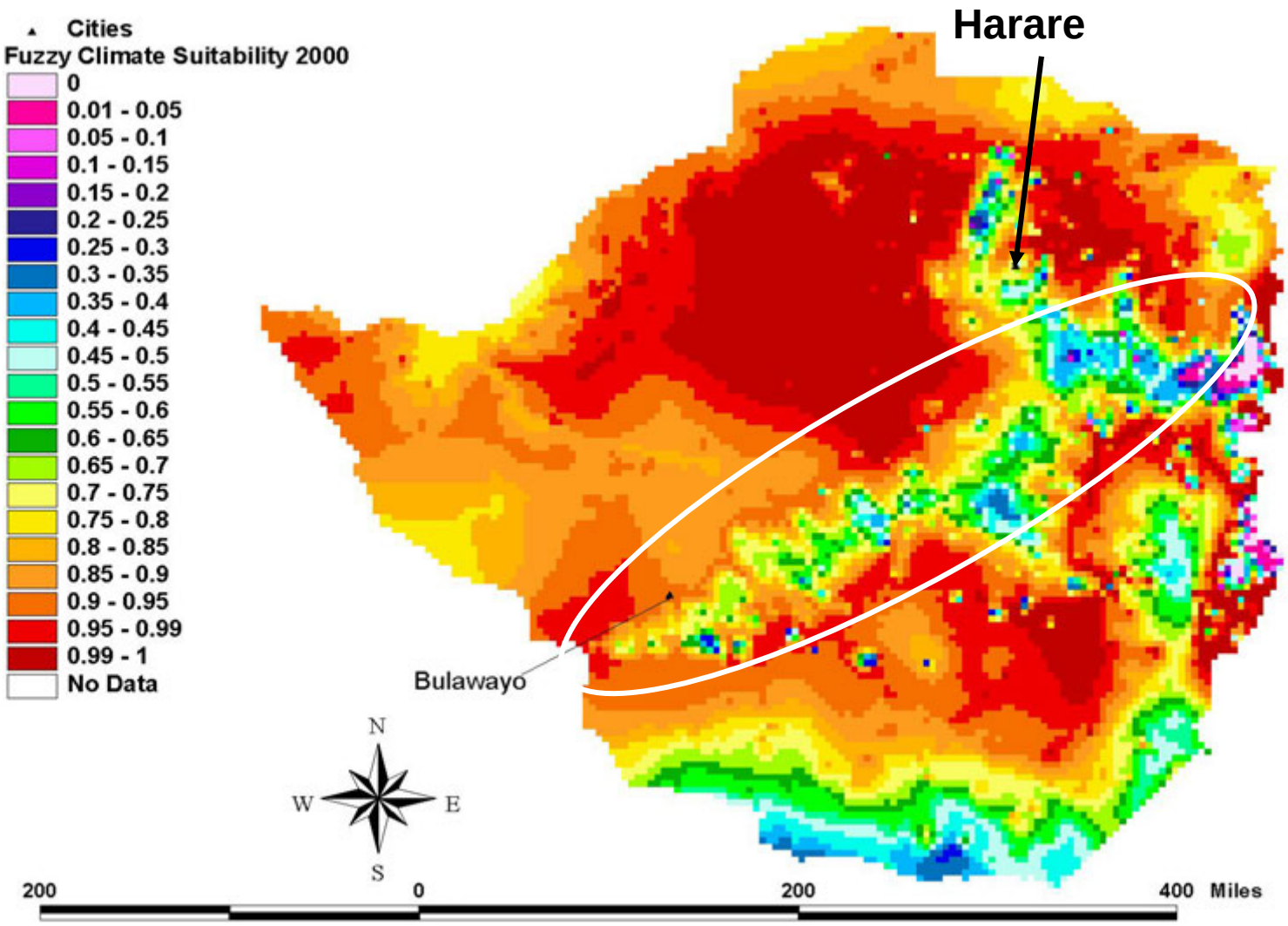
Climate Change & Malaria (potential transmission) in Zimbabwe

Baseline *2000* 2025 2050



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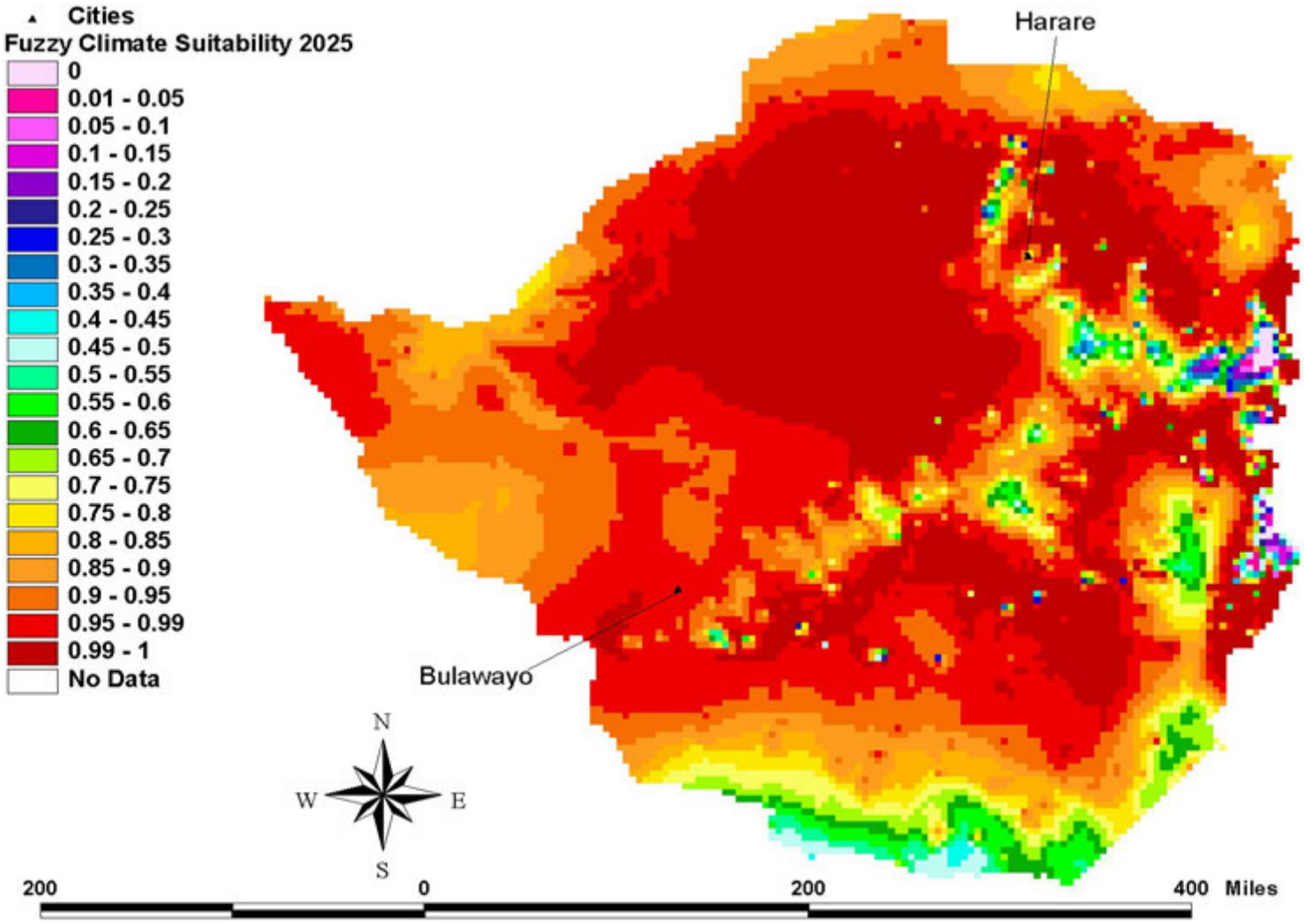
Climate Change & Malaria (potential transmission) in Zimbabwe

Baseline 2000 *2025* 2050



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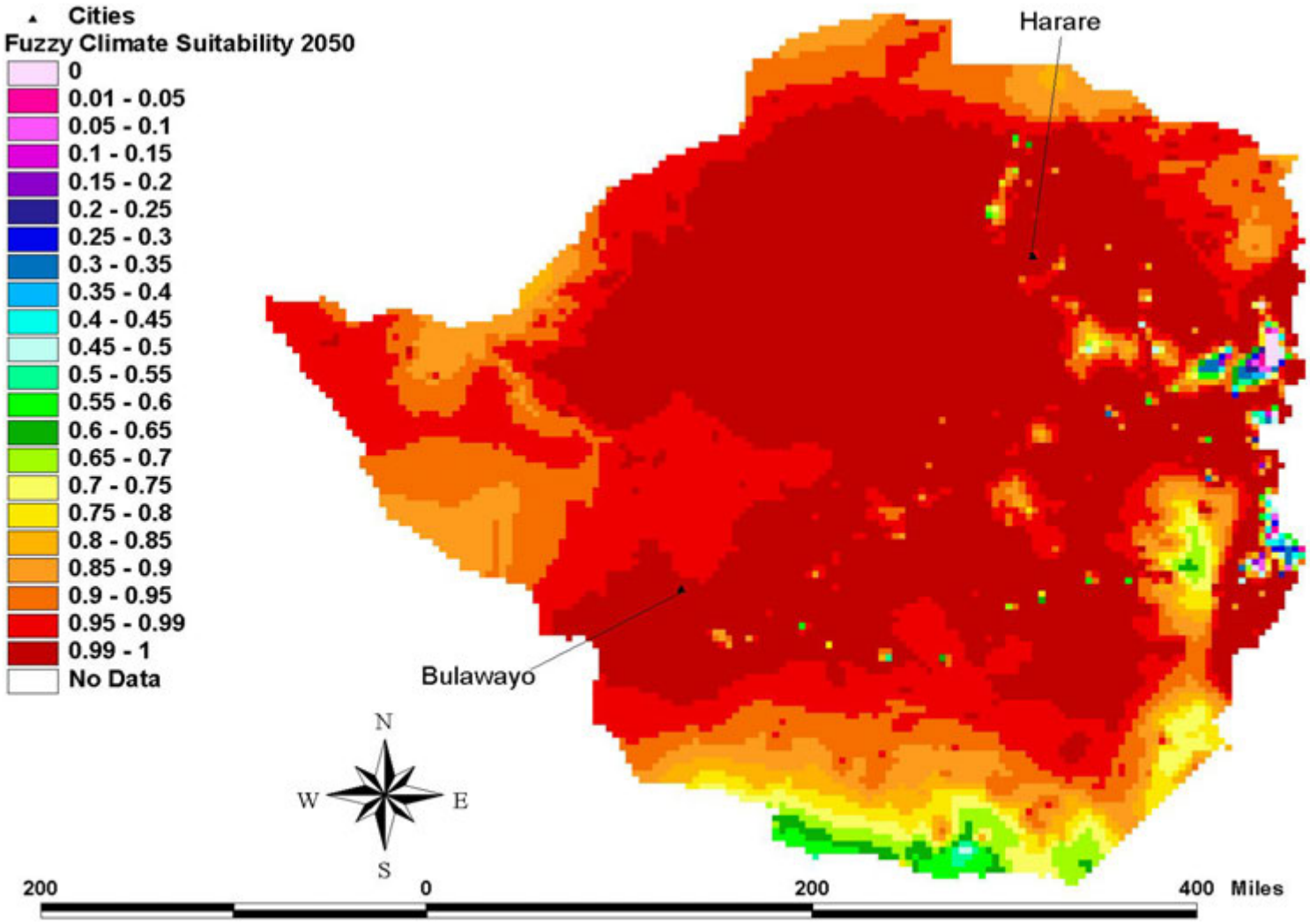
Climate Change & Malaria (potential transmission) in Zimbabwe

Baseline 2000 2025 *2050*



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Environmental Refugees

UN projection (2006)

- **By 2020: up to 50 million people escaping effects of environmental deterioration.**
  - → **order-of-magnitude increase vs. 2005**
- **Inevitable spectrum of health risks – infectious, nutritional, physical, mental, and conflict situations**

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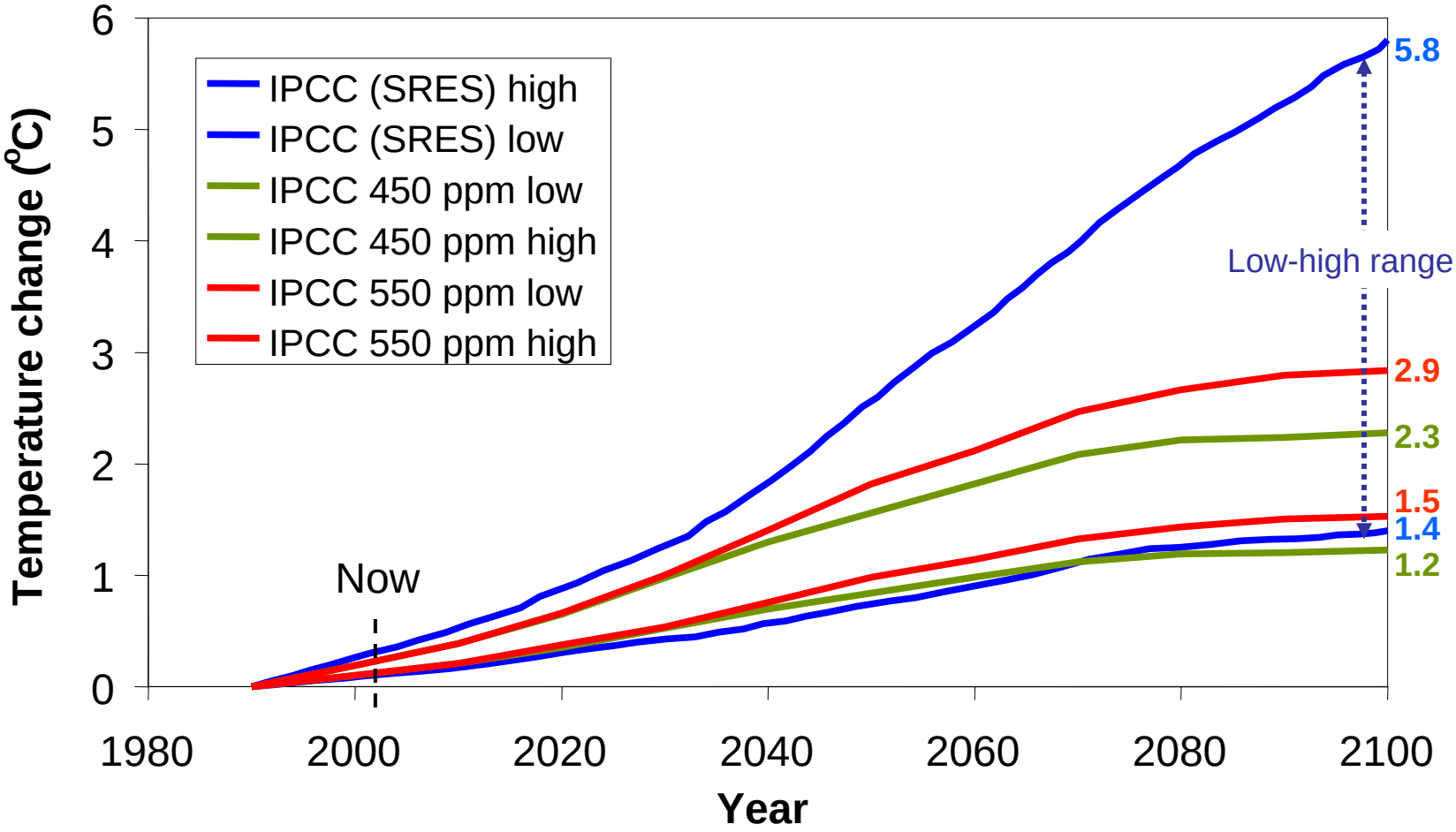
Global warming: scenarios

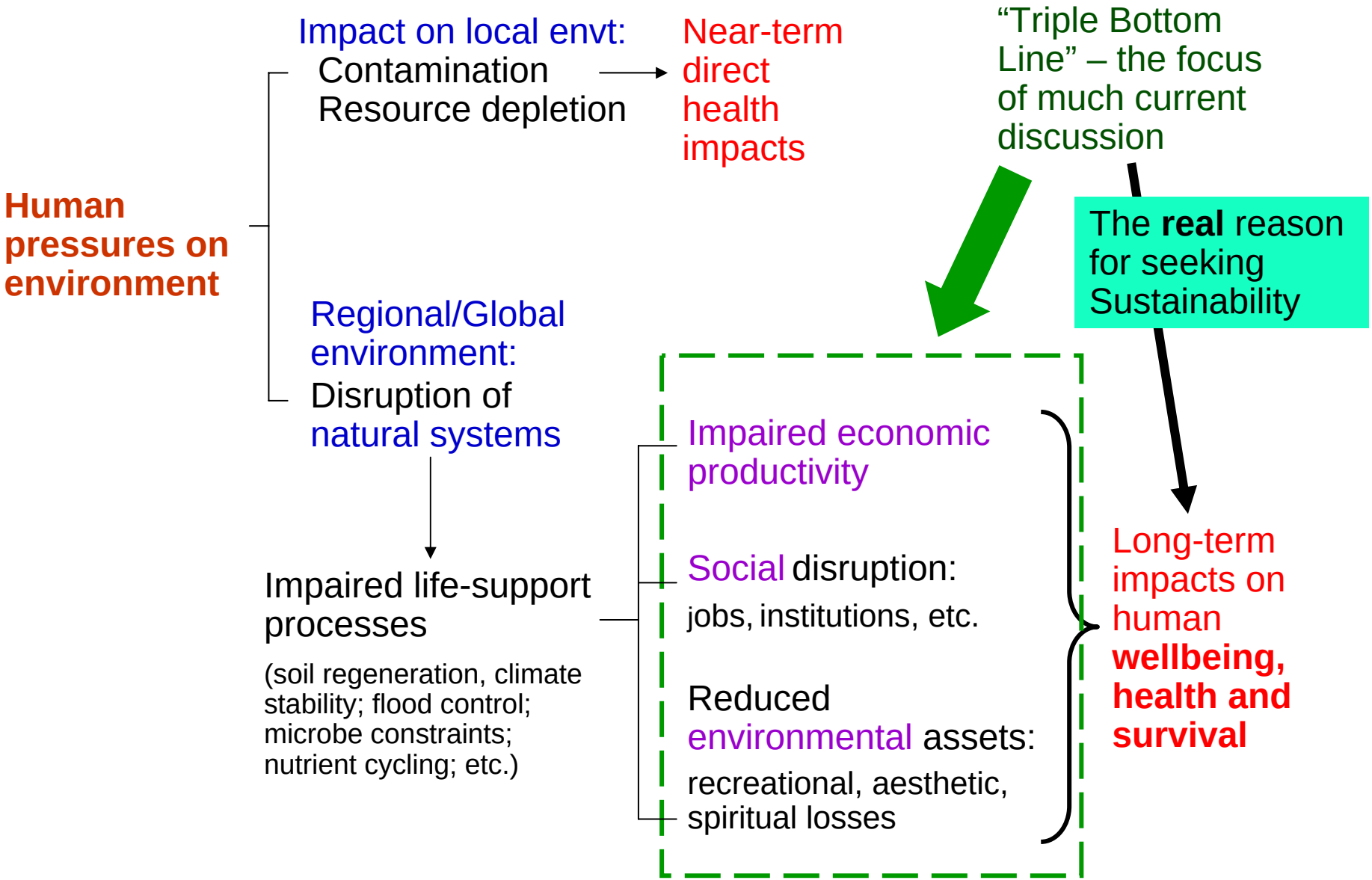


Stabilising CO_2 at 550 ppm by 2150 could limit warming to 1.5-2.9°C by 2100.

Stabilising CO_2 at 450 ppm by 2090 could limit warming to 1.2-2.3°C by 2100.

Pre-industrial CO_2 = 275 ppm; Current level = 385 ppm

Population Health as Key Criterion of Sustainability



The End

…The future will depend on the nature of human aspirations, values, preferences and choices…

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Health and Sustainability

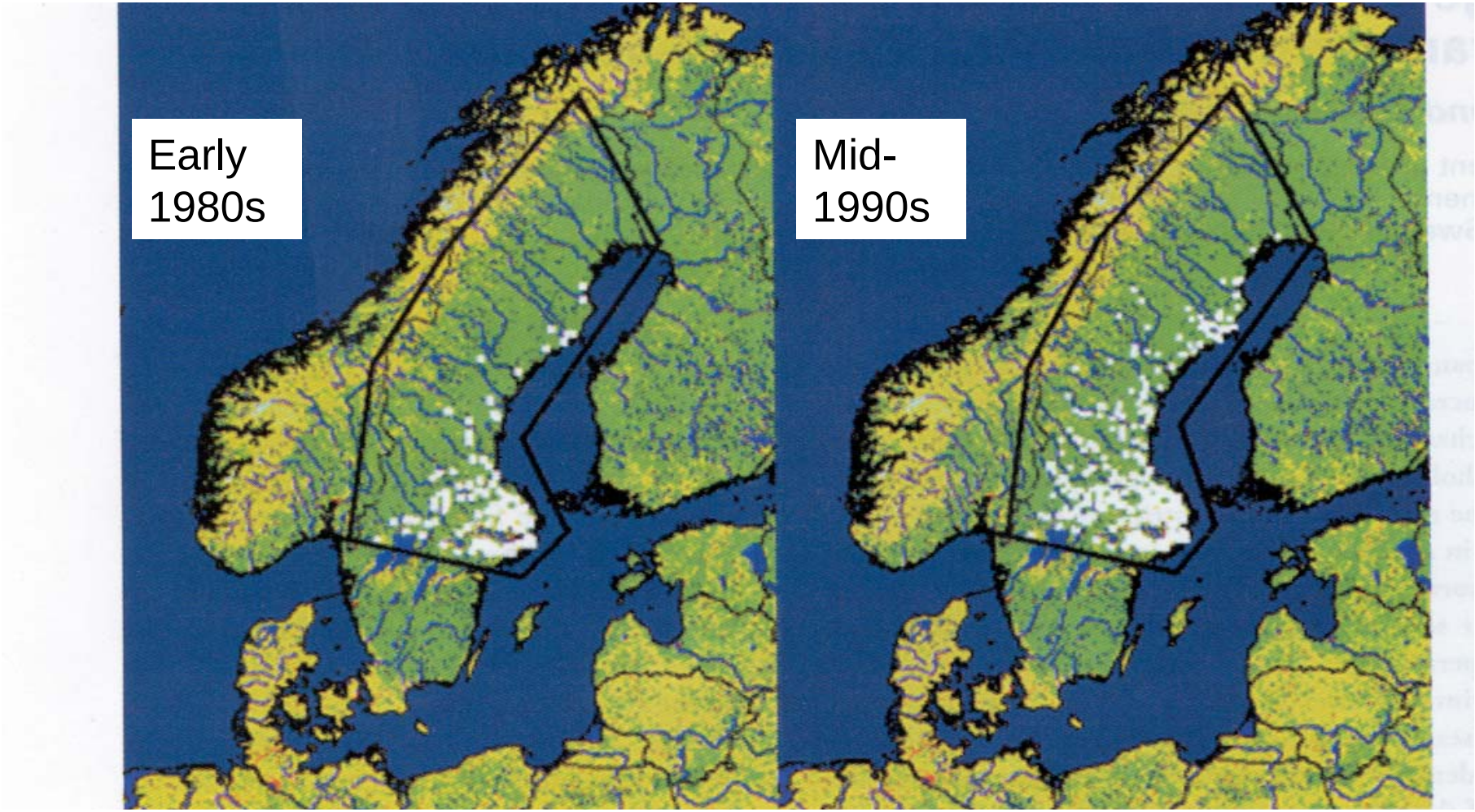
Population health is both:

- **input to sustainable development, and**
- **criterion (especially in the long term) for the achievement of sustainability**

i.e. Population health is the real *bottom line* (i.e., the purpose) of Sustainability

Tick-borne (viral) Encephalitis, Sweden: 1990s v 1980s (winter warming)

Northward Trend in Distribution of Tick Vector



White dots indicate locations where ticks were reported. Black line indicates study region.

Lindgren et al., 2000, 2001

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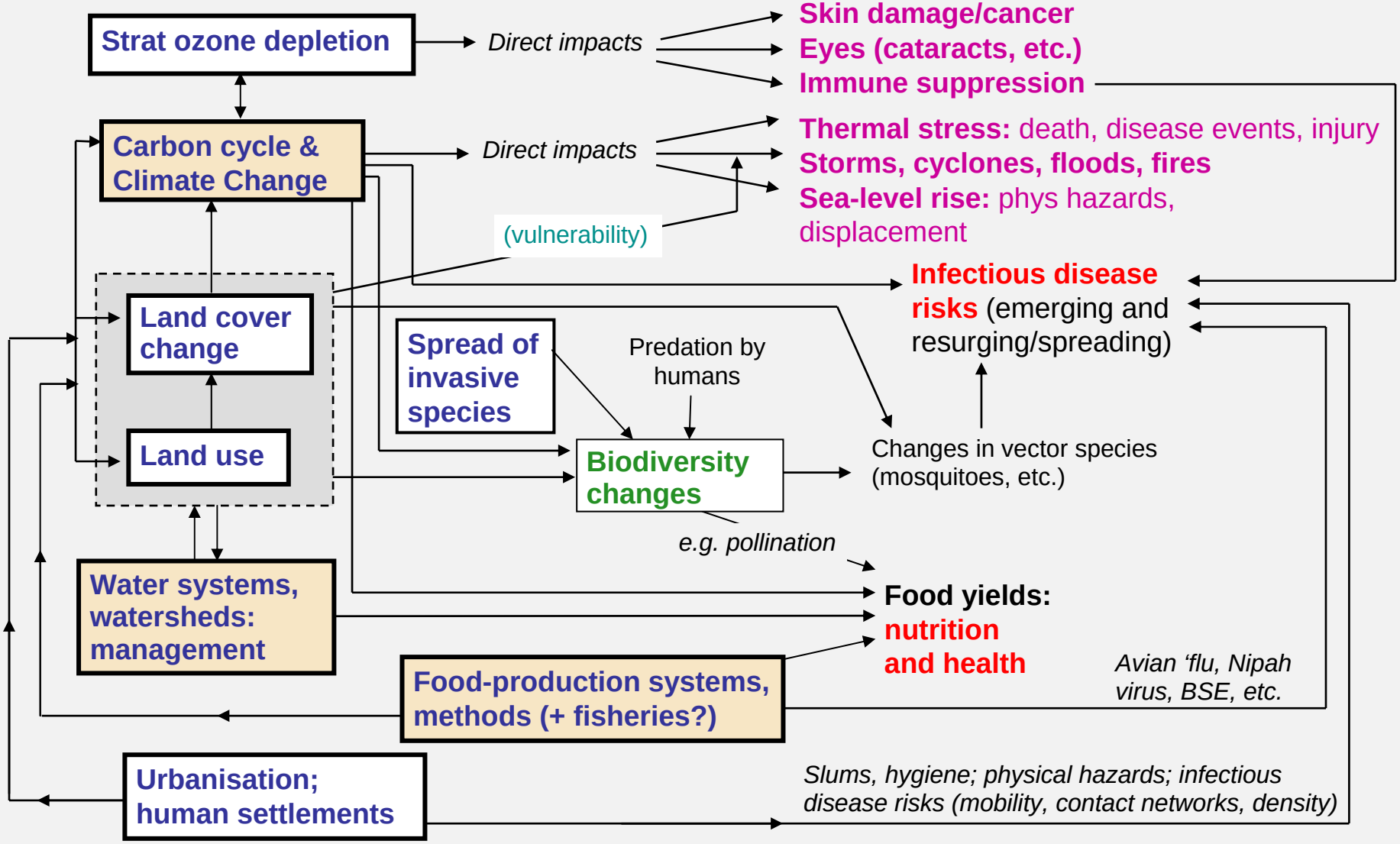
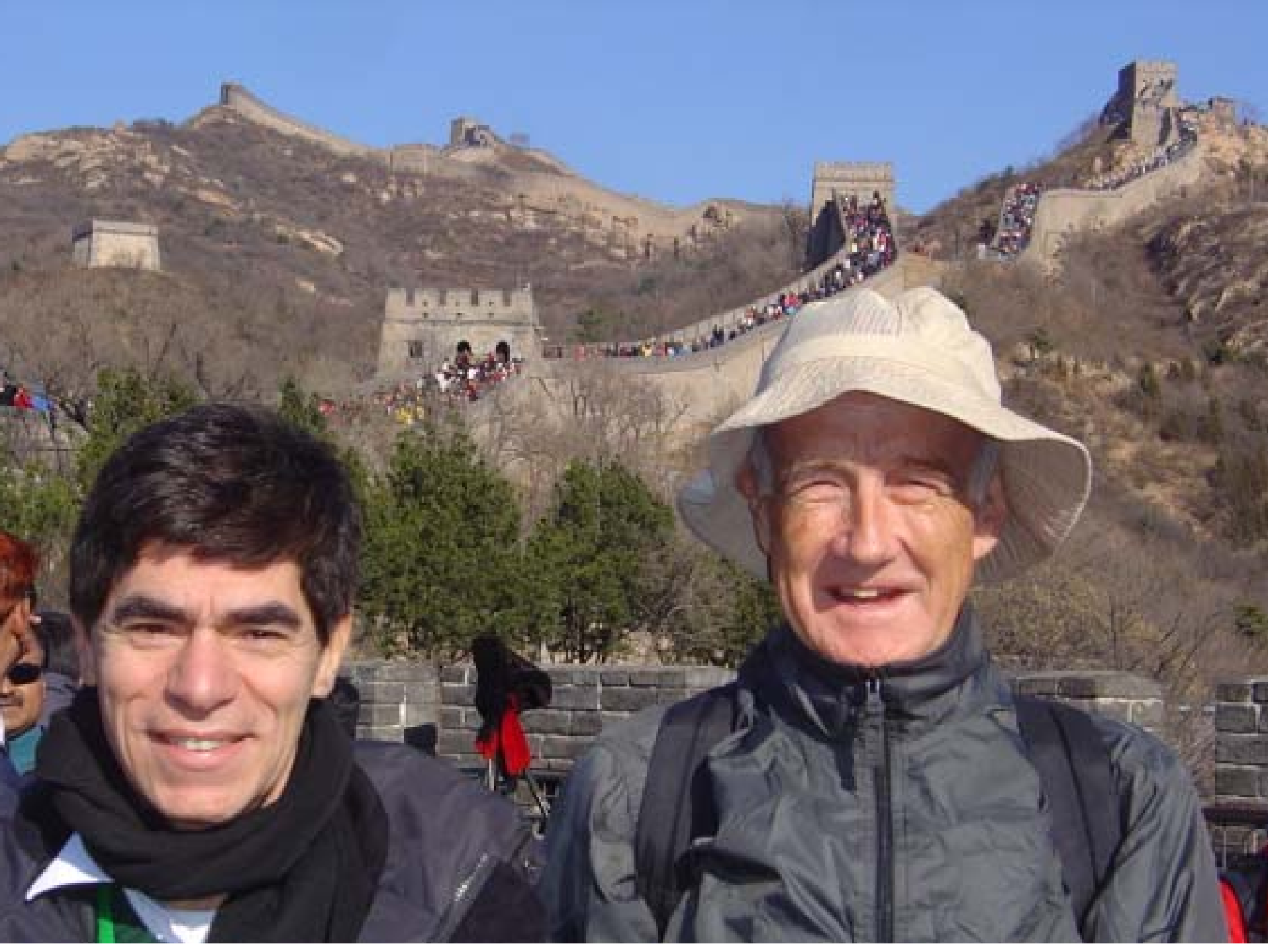
Global Environmental Change & Health: causes, impacts, linkages





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Climate change blamed for surge in Legionnaires' Disease
The Independent, UK, 18 October 2006

"Britain has suffered its first deaths from infectious disease attributable to global warming, official figures suggest.

"Cases of Legionnaires' disease, the bacterial lung infection which kills more than one in 10 of those it infects, reached record levels in August and September and experts say the extreme summer weather is the most likely cause of the rise."

http://news.independent.co.uk/uk/health_medical/article1886640.ece

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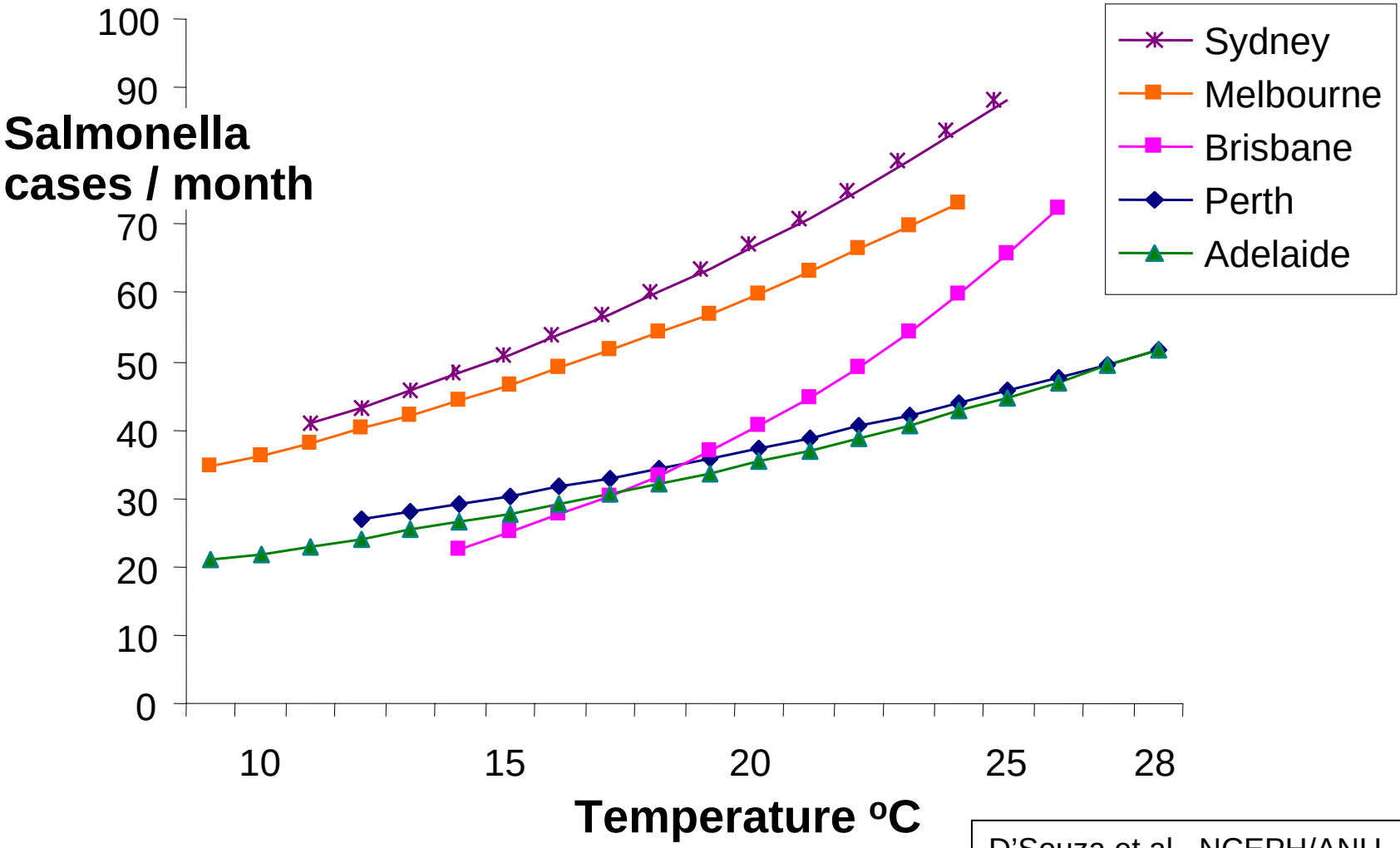
Monthly *Salmonella* food-poisoning cases in relation to monthly temperature

Australian cities, 1991-2001 (modelled best-fit graphs)



D'Souza et al., NCEPH/ANU, 2003