

Climate Change and Human Health

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CLIMATE CHANGE 2007

SYNTHESIS REPORT

8

Human health

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A Report of the Intergovernmental Panel on Climate Change

Climate Change Futures

Health, Ecological and Economic Dimensions



A Project of:
The Center for Health and the Global Environment
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Swiss Re



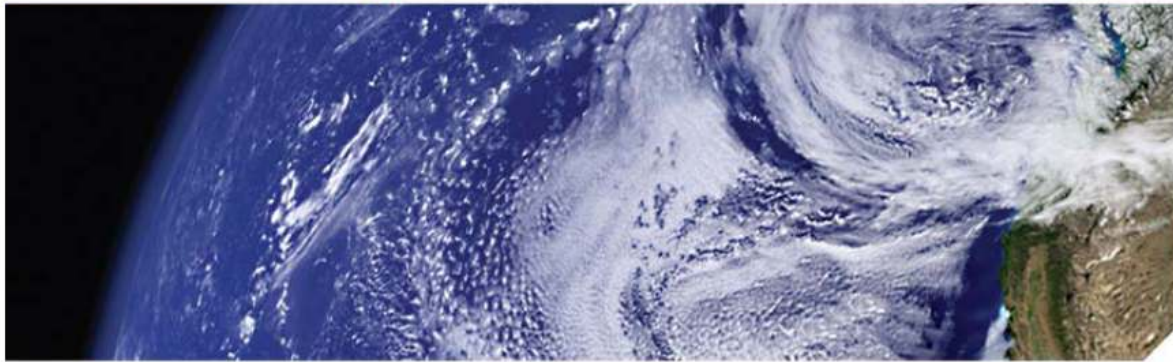
Epstein and Mills (Eds.) 2005.



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science in ACTION

BUILDING A SCIENTIFIC FOUNDATION FOR SOUND ENVIRONMENTAL DECISIONS



GLOBAL **CHANGE**
RESEARCH PROGRAM

REPORT ASSESSES EFFECTS OF GLOBAL CHANGE ON HUMAN HEALTH, WELFARE, AND SETTLEMENTS

FINDINGS OF THE U.S. CLIMATE CHANGE SCIENCE PROGRAM SYNTHESIS AND
ASSESSMENT PRODUCT 4.6

July 2008

Why be concerned about Health when discussing Climate Change?

- Humanitarian concerns
- Contribute to the policy debate
- Contribute data for quantifying the economic impact of climate change
- **ADAPTATION to Public Health Threats**
 - Measures aimed at Disease Prevention
 - Adaptation of public health infrastructure to response to health events.

Climate Change and Health

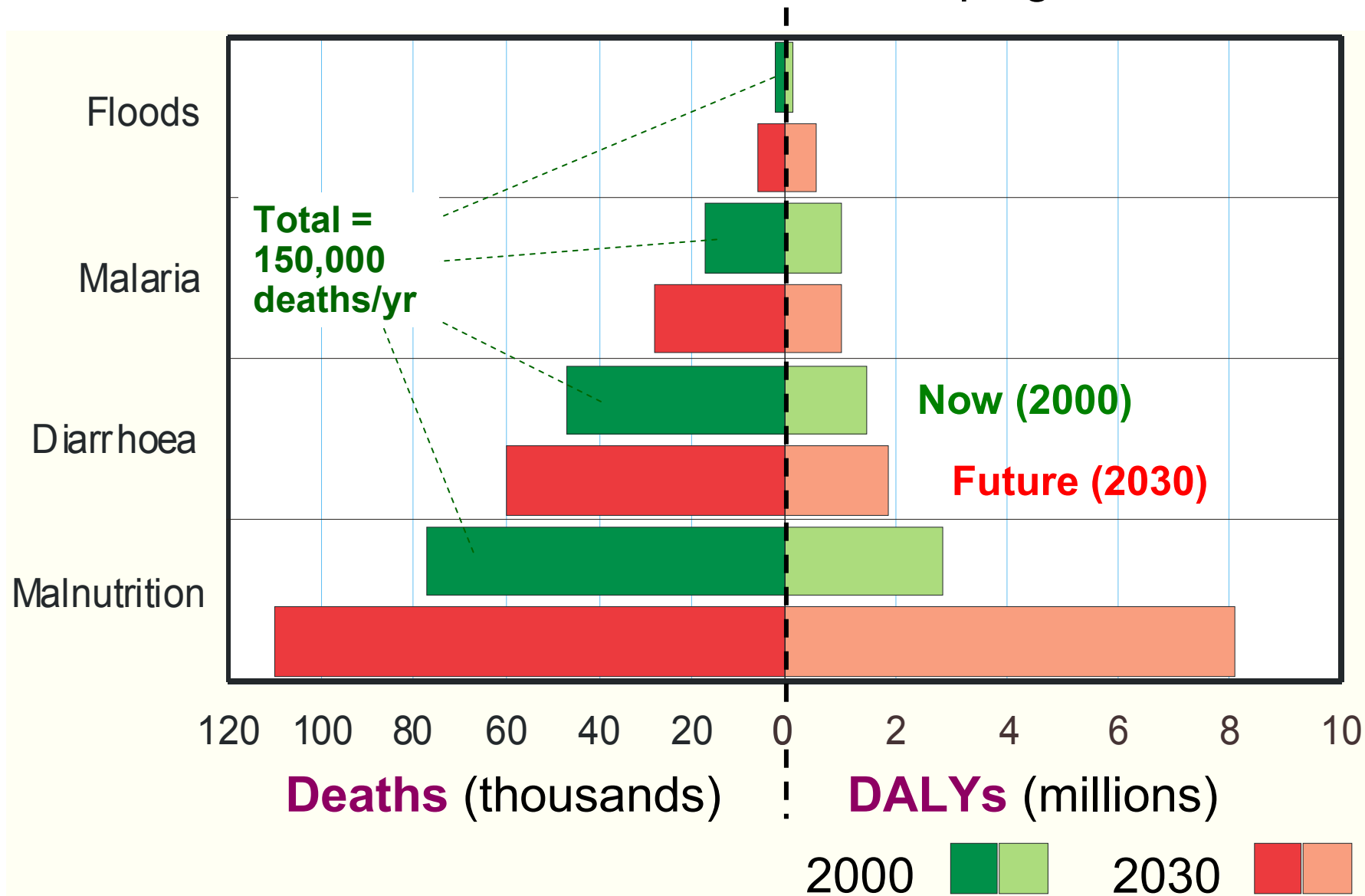
- How do we characterize the overall health impact?
- What are the pathways?
 - Direct Exposure: Extreme weather events
 - Indirect Exposure
 - Effects on food security and malnutrition
 - Impacts on disease transmission
 - Health-related airborne exposures
 - Social and Economic Disruption
- Complex interaction of effects
- What can be done?

How do we estimate the impact of Climate Change on Human Health?

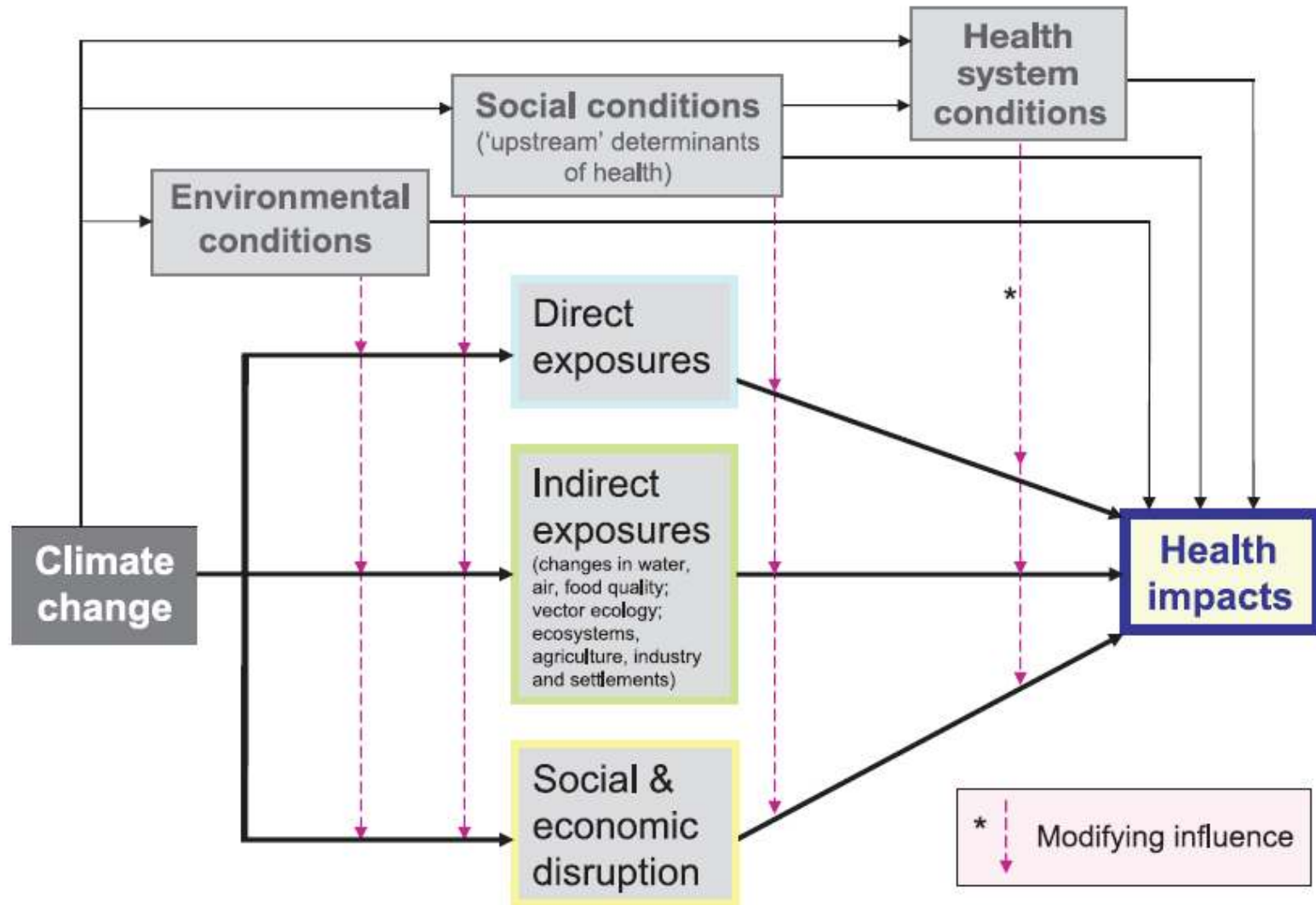
- Quantifiable estimates (e.g., DALYs) include a great deal of uncertainty
- Systems approach includes
 - complex relationship between direct/indirect “exposures” to Climate Change; and
 - Climate Change-related impacts that can have a modifying influence on health effects

Estimated deaths and DALYs attributable to climate change










Selected health outcomes in developing countries



Pathways by which climate change could affect health



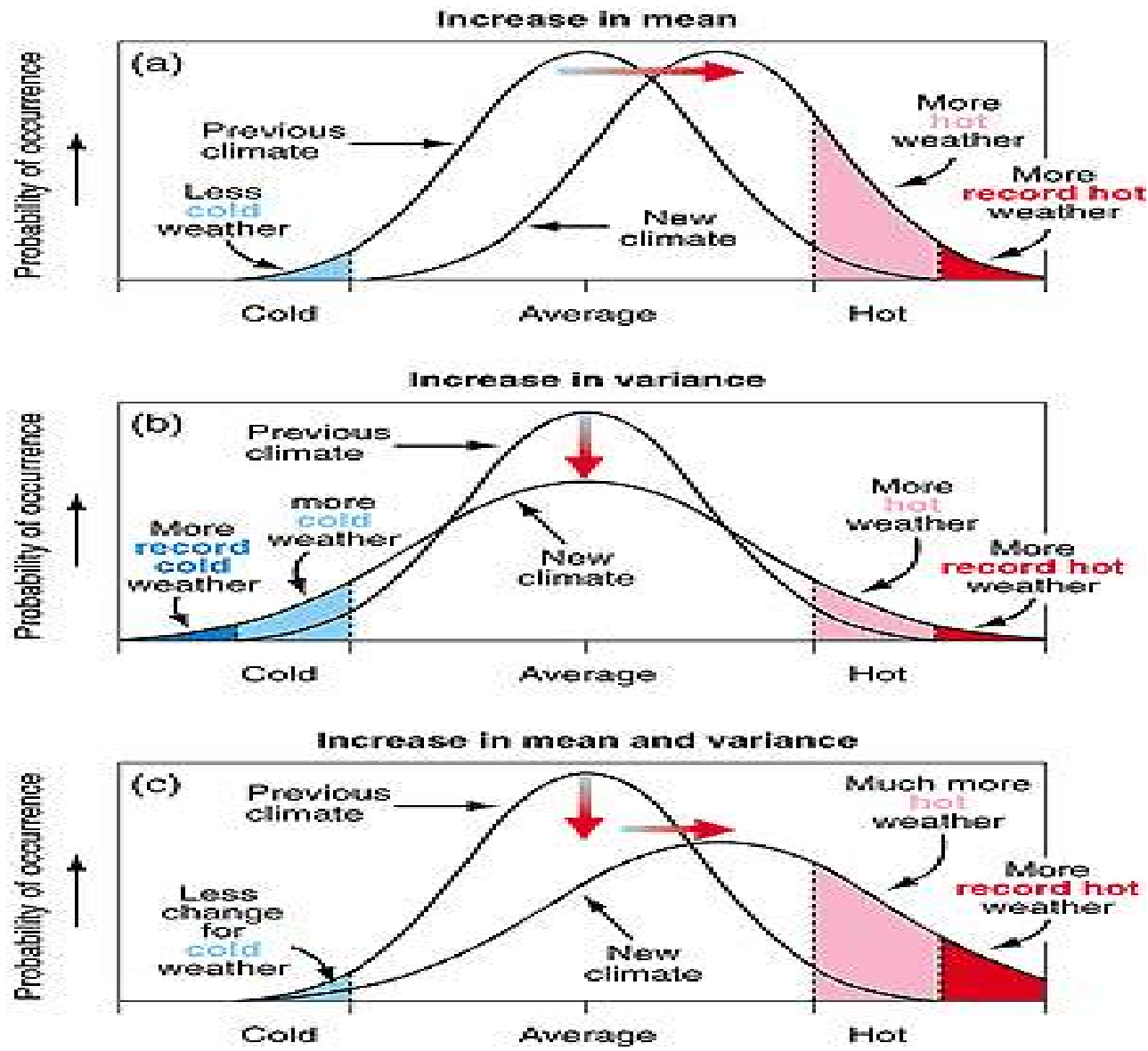
Summary of Direction, Magnitude, and Certainty of Projected Health Impacts

	Negative Impact	Positive Impact
<u>Very High Confidence</u>		
<i>Effects on geographic range & incidence of malaria</i>		
<u>High Confidence</u>		
<i>Undernutrition & consequent disorders</i>		
<i>Extreme events (heatwaves, storms, floods, droughts)</i>		
<i>Illness/death due to (amplified) poor air quality</i>		
<i>Change in range of disease vectors</i>		
<i>Cold-related deaths</i>		
<u>Medium Confidence</u>		
<i>Diarrhoeal diseases</i>		

Direct effects of climate change on health

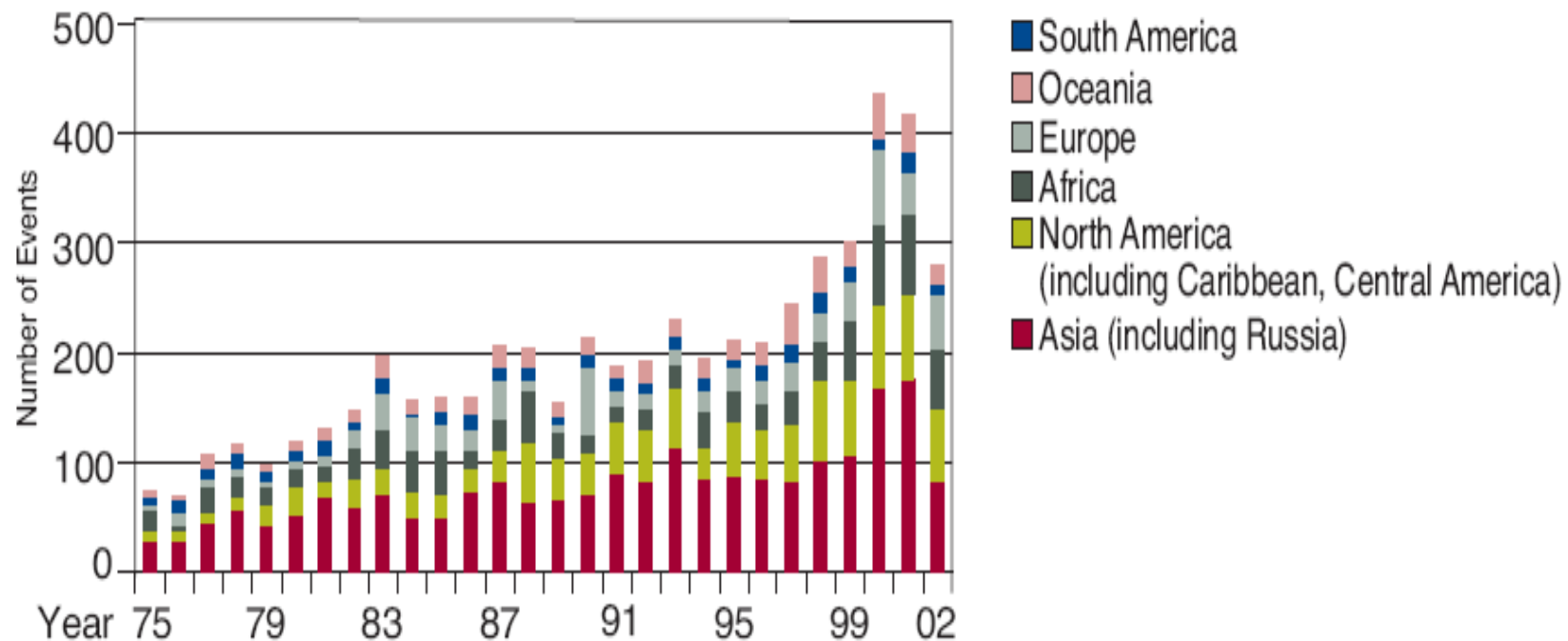
- Extreme weather events
- Storms and floods

Increases in temperature mean and variance

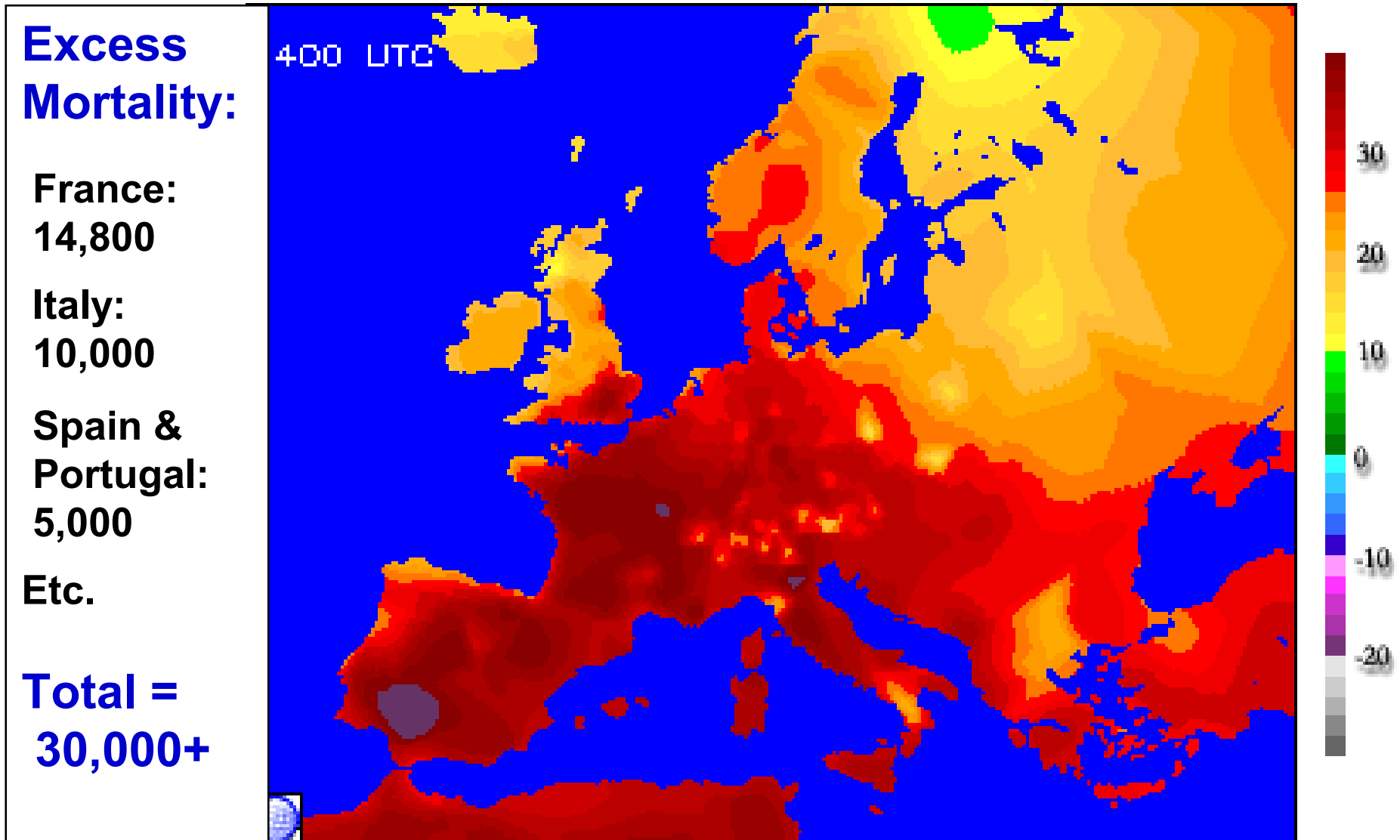


Increased frequency of extreme weather events: Emergency Events Database, 1975-2002

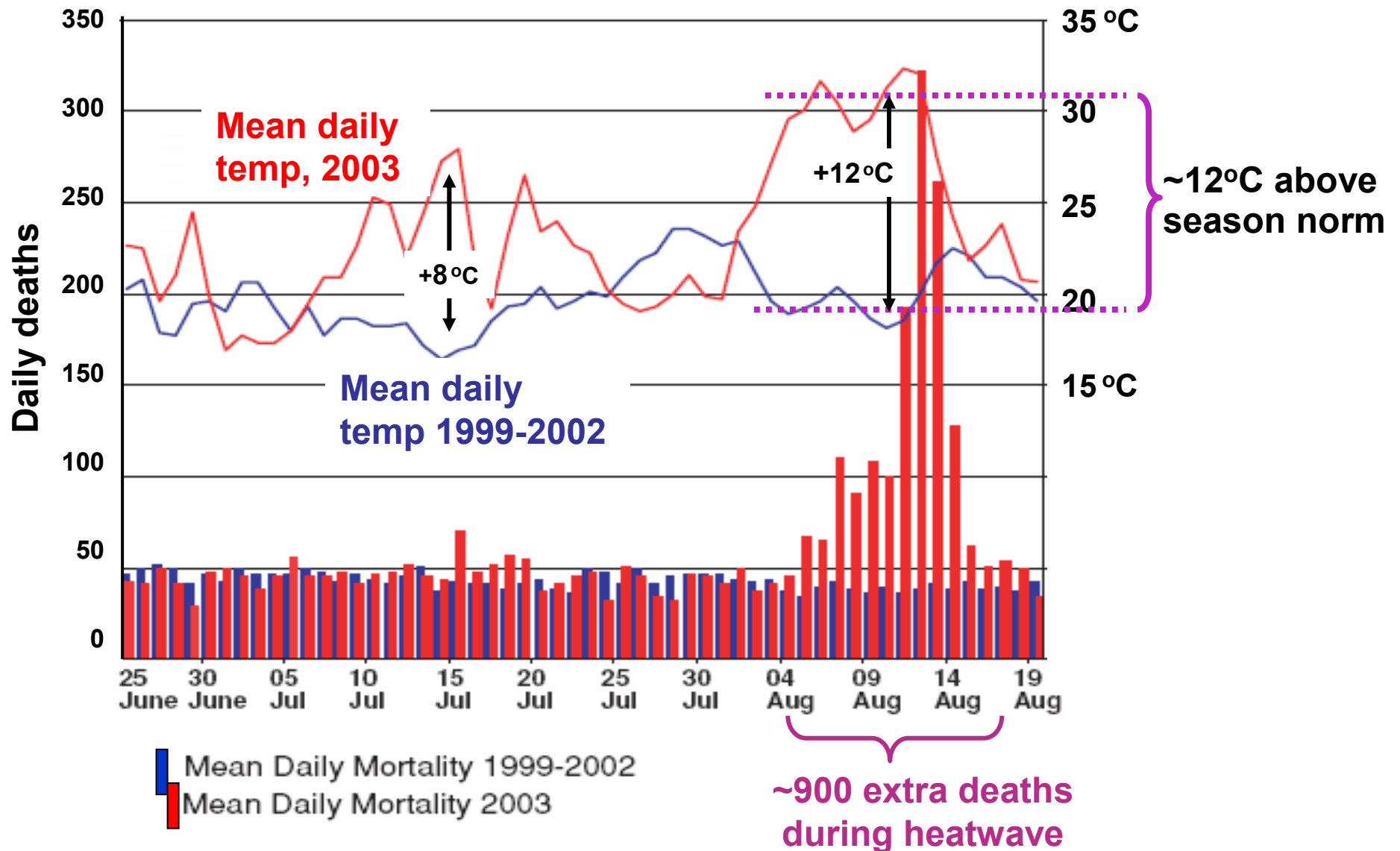
Extreme Weather Events by Region



European Heatwave: August 3-14, 2003

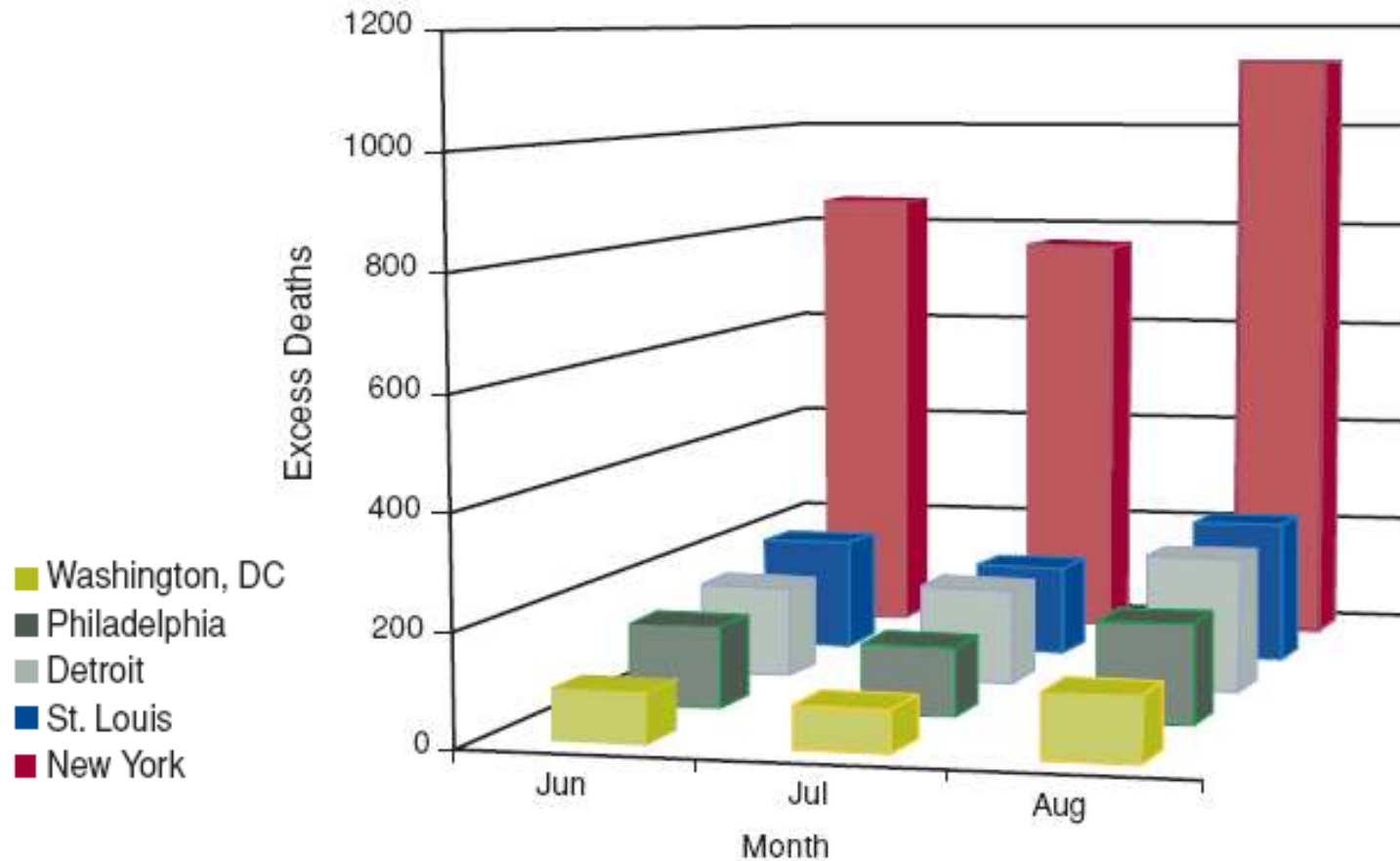


Paris, Heatwave (Aug 2003): Daily Mean Temps and Deaths



Based on: Vandentorren S, et al. AJPH 2004;94:1518-20.

Projected Excess Death in 5 U.S. Cities Under Europe 2003 Conditions



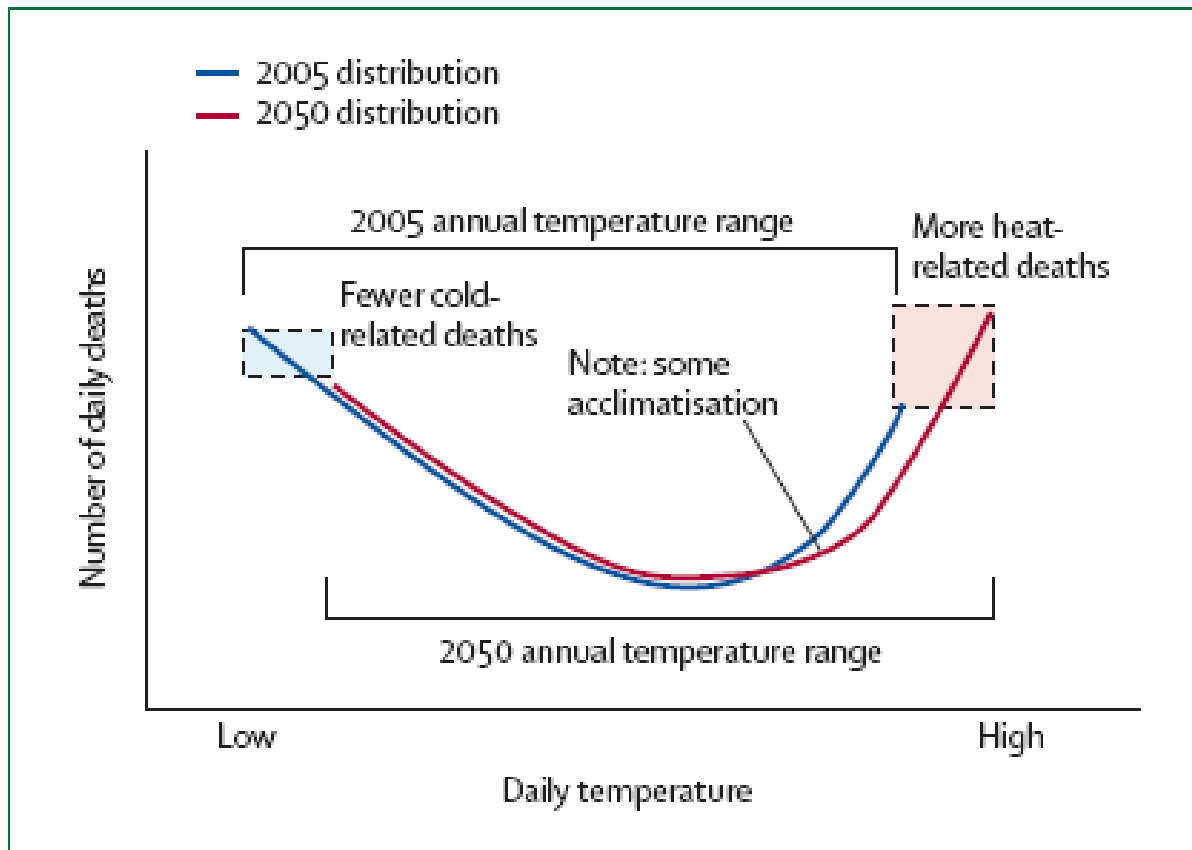


Figure 2: Schematic representation of how an increase in average annual temperature would affect annual total of temperature-related deaths, by shifting distribution of daily temperatures to the right

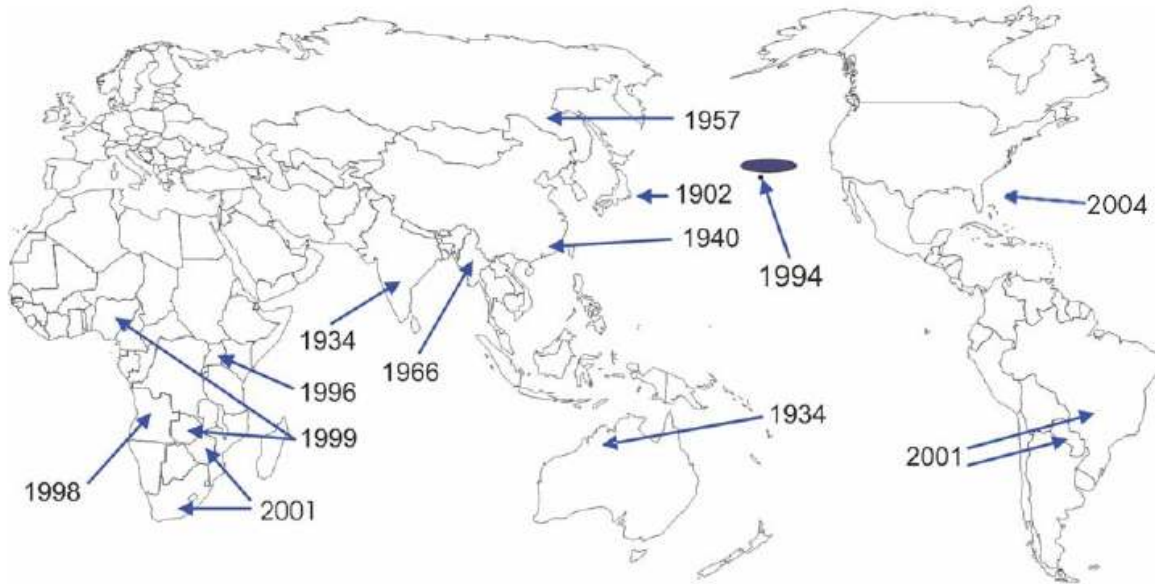
Indirect effects of climate change on health

- Effects on food security and malnutrition
- Impacts on disease transmission
 - Water-related diseases
 - Vector-borne diseases
 - Food-borne diseases
- Health-related airborne exposures
 - Pollution
 - Aeroallergens

Nutrition and Food Security

- Regional water scarcity
- Salinization of agricultural lands
- Destruction of crops
 - Flood events
 - Plant diseases/pests (e.g., soybean rust)
- Disruption of food logistics/trade through disasters
- Threat to ocean food sources (e.g., harmful algal blooms)

Soybean rust spread



Soybean rust is believed to have the U.S. via dust transported by Hurricane Ivan in 2004.



Soybean yield reductions in the Americas resulted in price rise from \$5/bu in 2003 to \$11-\$14/bu in 2004.

Indirect effects of climate change on health

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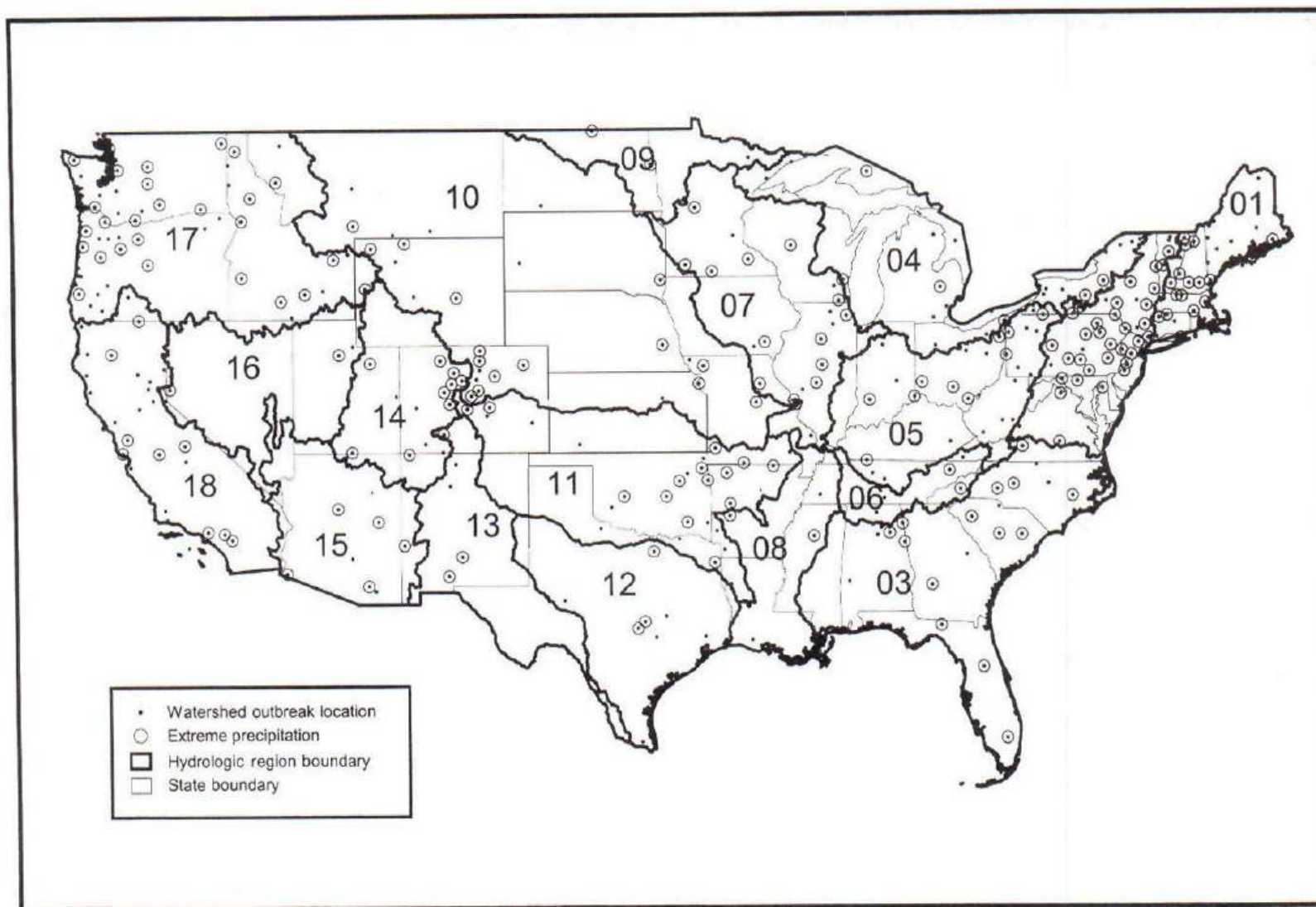
Disease Transmission: water-related diseases

- Climate change has effects on rainfall, water availability, and water quality
- Floods/storms can result in blocked drains, resulting in increased disease transmission
- Storm surges can result in failures of water treatment systems
- Reductions in rainfall results in low river flows, reducing effluent dilution and resulting in increased pathogen loading

Disease Transmission: water-related diseases

- Low income countries with less infrastructural adaptability are more prone to the water-related disease effects resulting from extreme weather events;
- But associations between precipitation and water-borne outbreaks are observed in the United States as well...

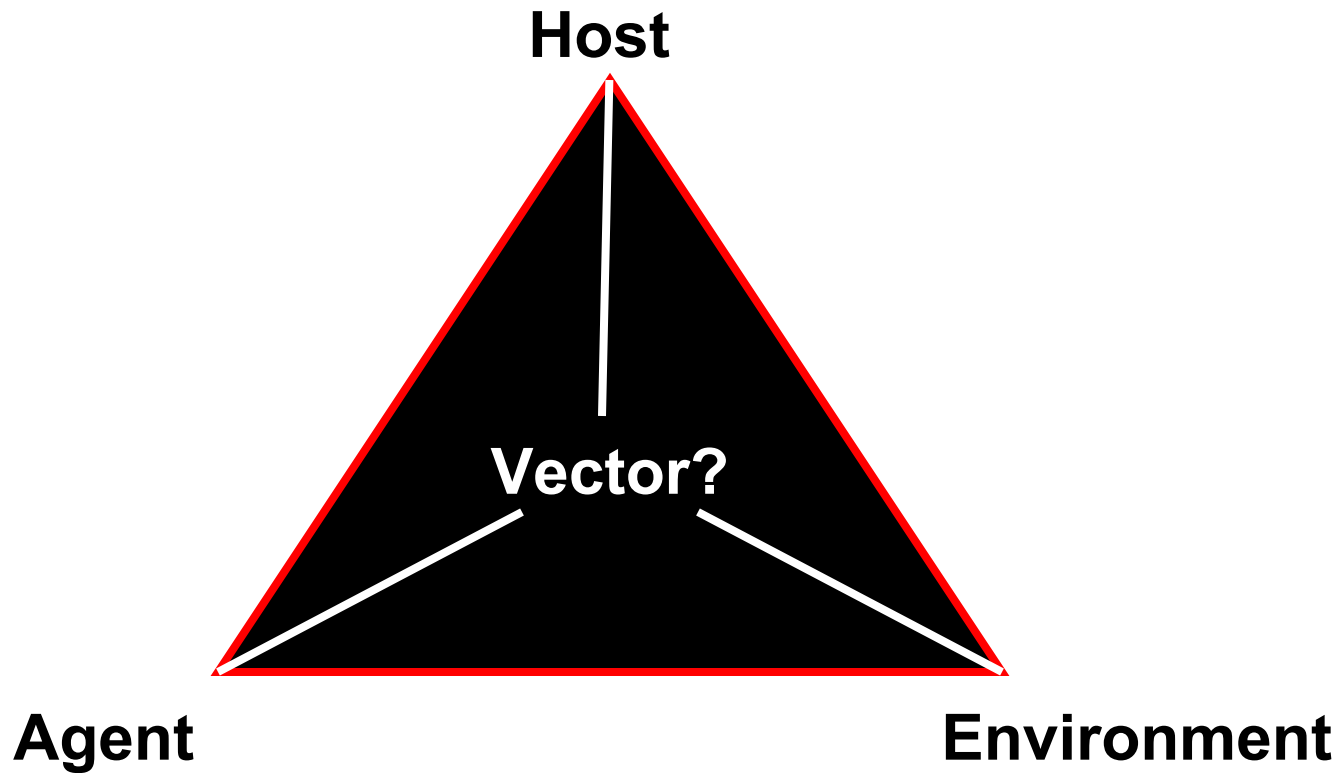
Waterborne outbreaks associated with extreme precipitation events (>90%ile) with 2-month lag, US, 1948-94



Indirect effects of climate change on health

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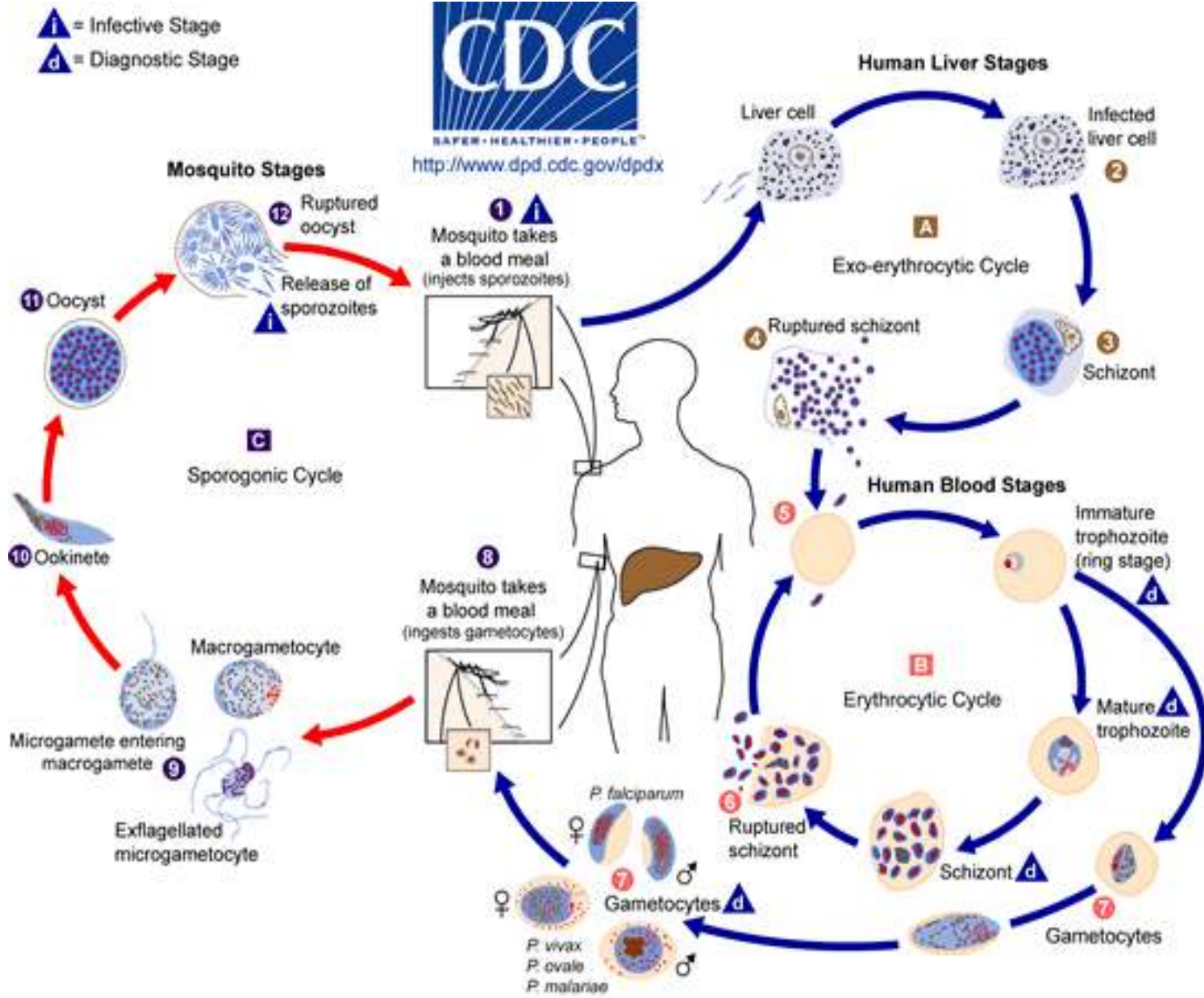
Traditional Epidemiology Triad



Disease transmission: vector-borne diseases

- Climate changes affect habitat of disease vectors (e.g., mosquitoes, ticks, fleas...)
- Examples
 - Malaria
 - Dengue in Australia
 - Tick borne encephalitis in Sweden
 - Schistosomiasis in China
 - Lyme disease in United States and Canada

Malaria



MONTANE REGIONS

BEFORE 1970

Cold temperatures caused freezing at high elevations and limited mosquitoes, mosquito-borne diseases and many plants to low altitudes

DENGUE FEVER
OR MALARIA

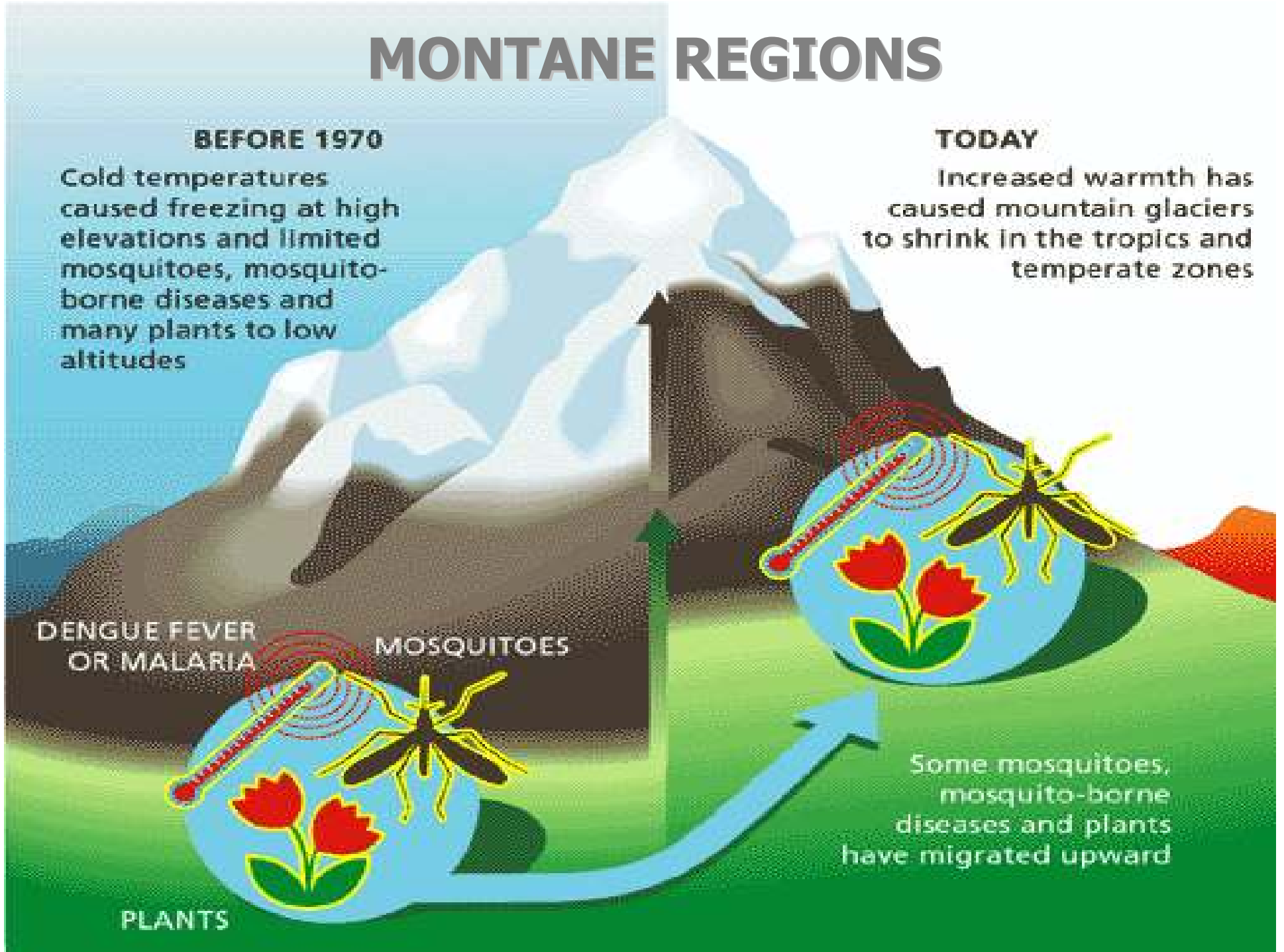
MOSQUITOES

PLANTS

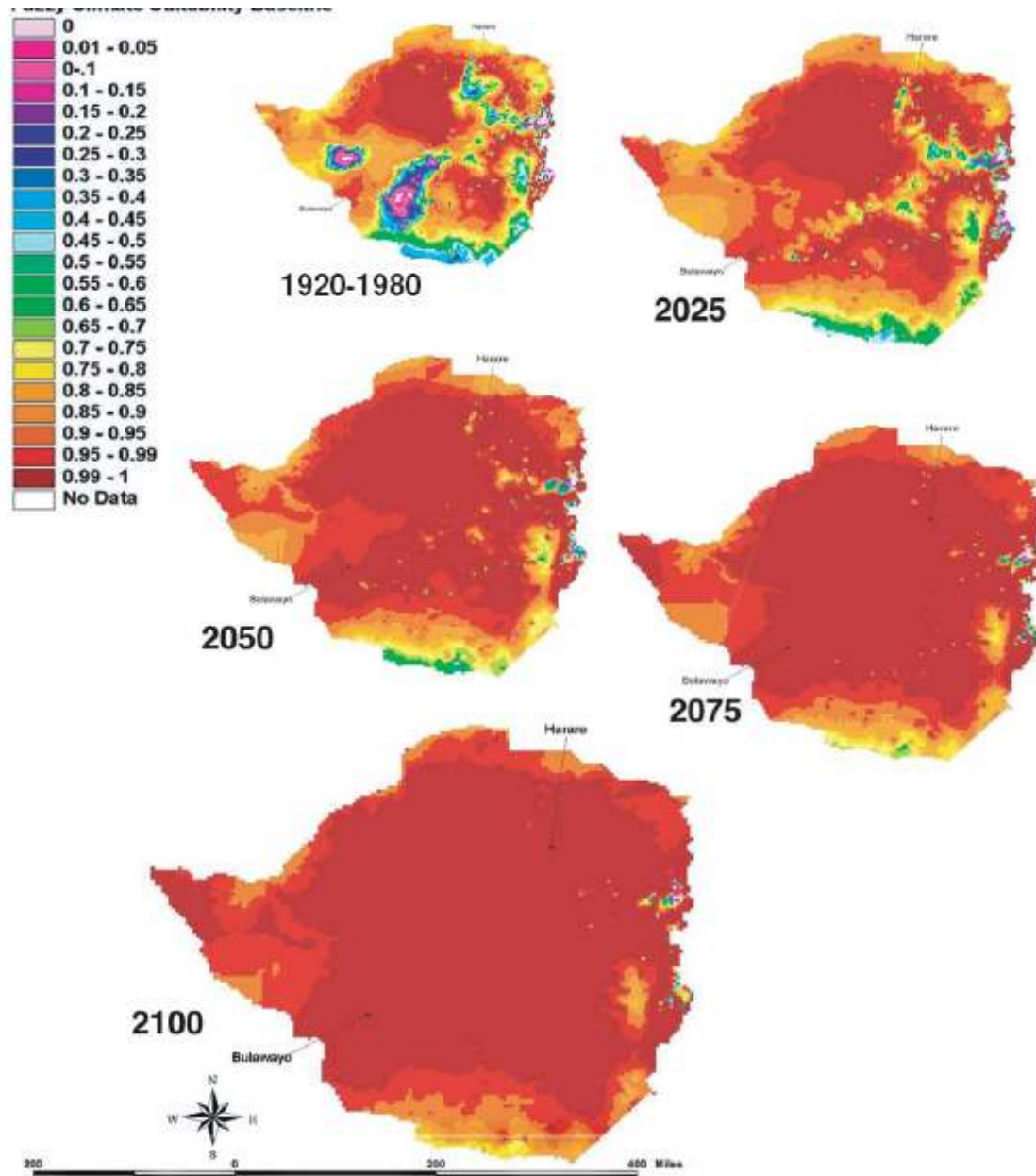
TODAY

Increased warmth has caused mountain glaciers to shrink in the tropics and temperate zones

Some mosquitoes, mosquito-borne diseases and plants have migrated upward



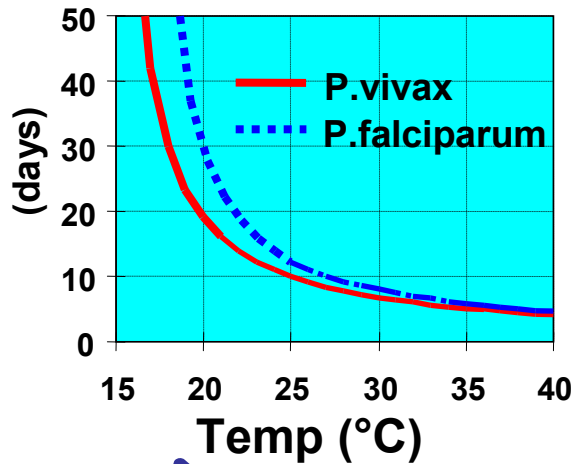
Climate Suitability for Stable Malaria Transmission: Zimbabwe



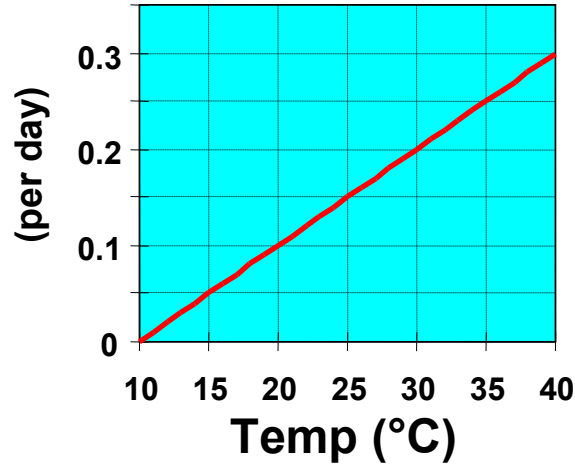
Ebi et al., 2005

Malaria Transmissibility: Temperature and Biology

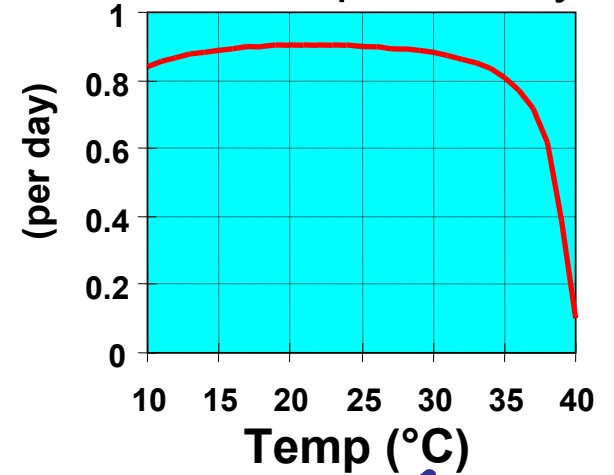
Plasmodium Incubation period



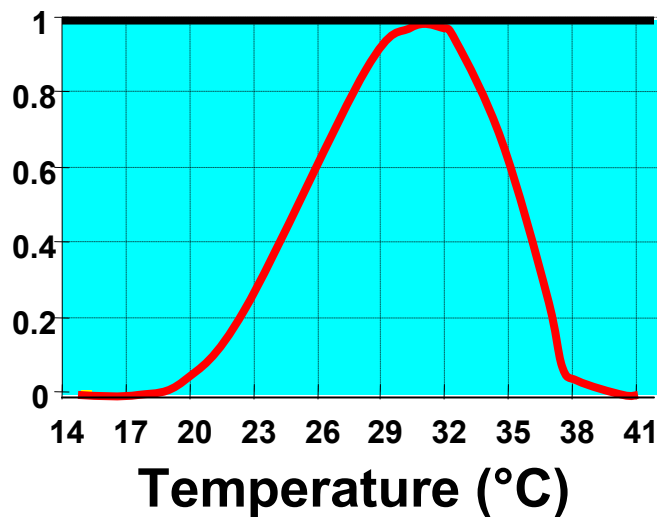
Biting frequency



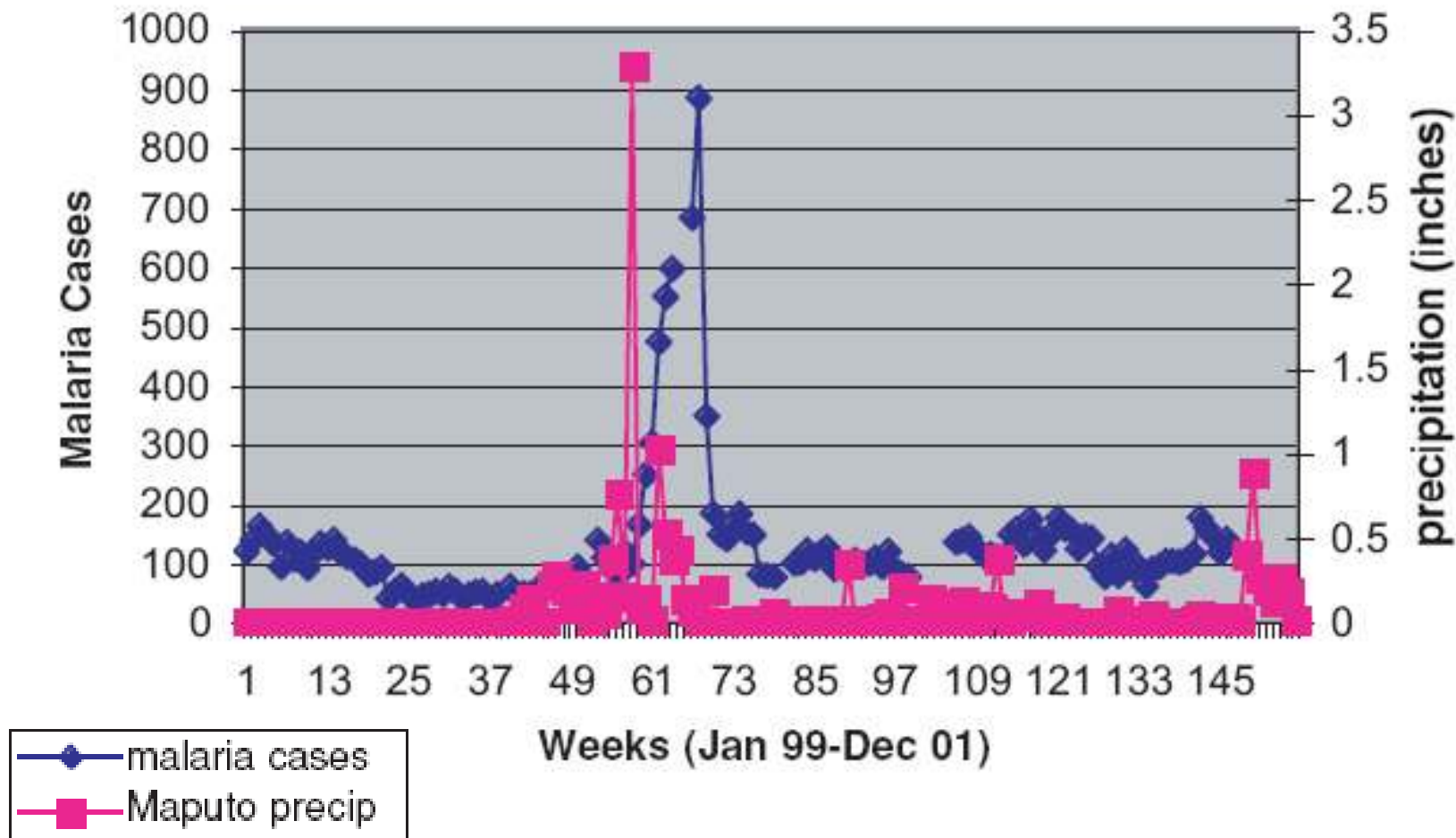
Survival probability



TRANSMISSION POTENTIAL

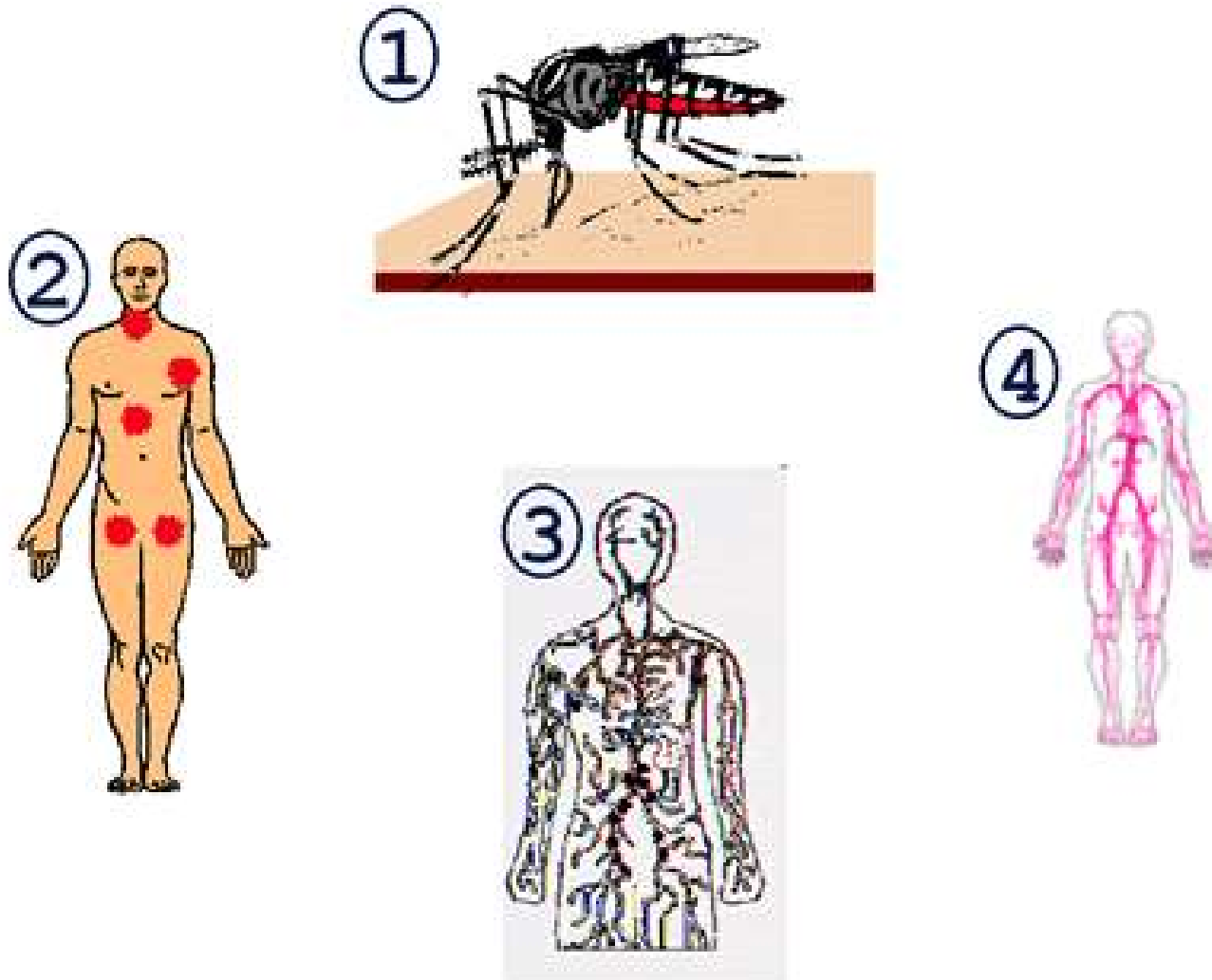


Impact of Precipitation on Malaria Transmission: Mozambique



Climate Change Futures. Epstein and Mills (Eds.) 2005.

Dengue Fever



Projected increase in range of dengue vector: *A. aegyptii*

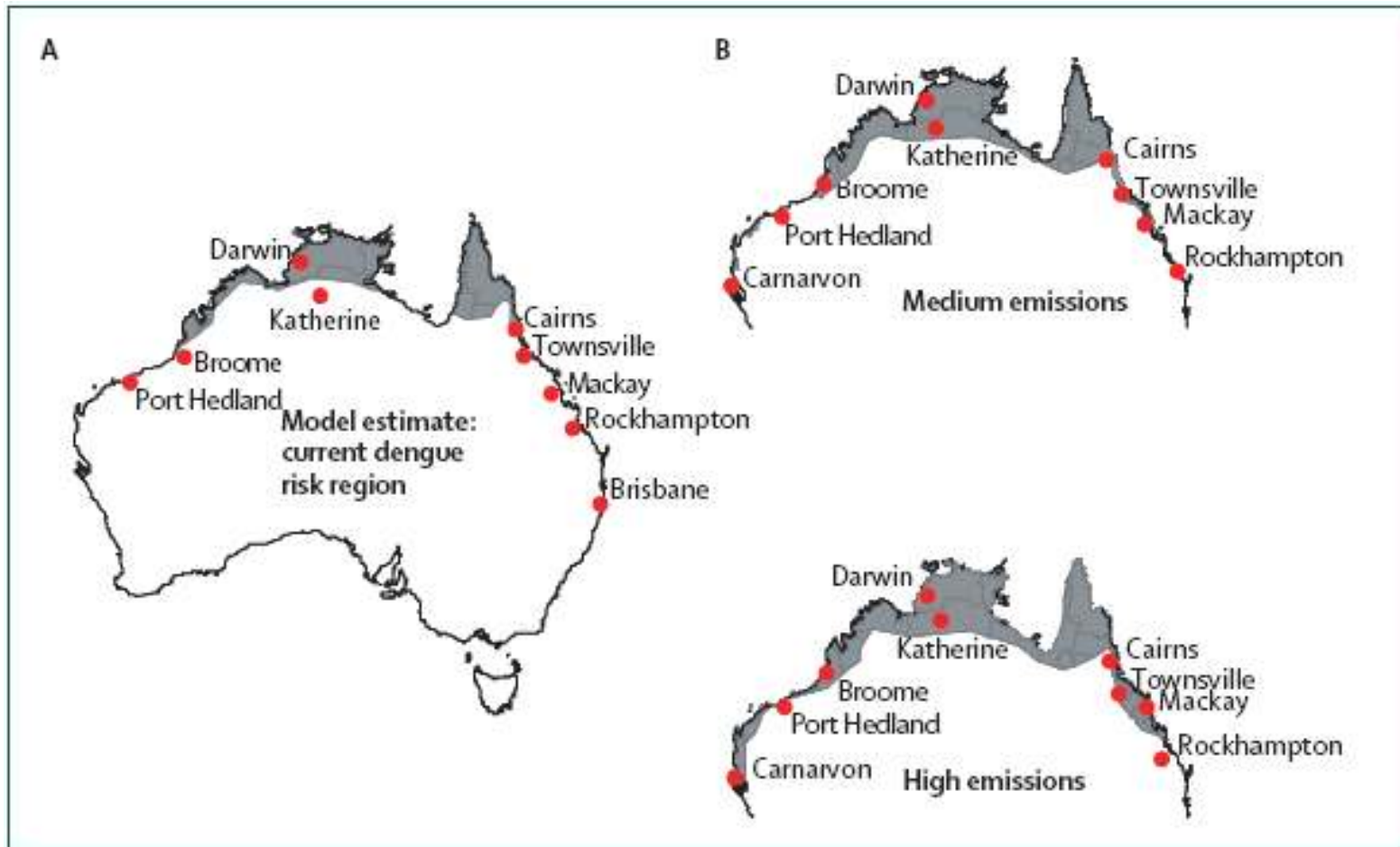
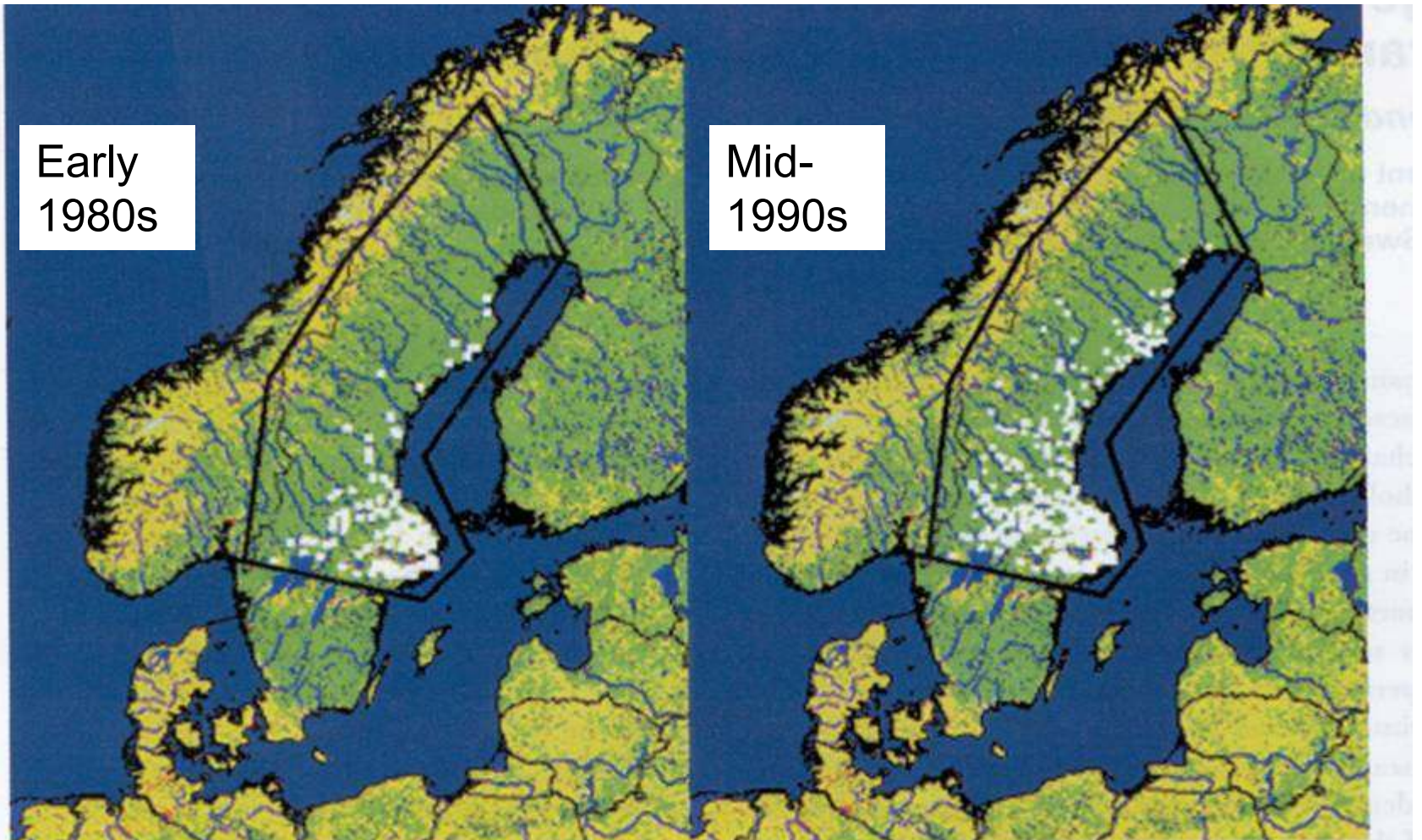


Figure 4: Modelled estimates of the current (A) and future (2050) (B) geographic regions (shaded areas) suitable for maintenance of the dengue vector *Ae aegyptii* in Australia

Model based on baseline (1961–90) estimates of water vapour pressure estimates for current climate and for future climate, in settings of medium and high global emissions of greenhouse gases.³⁵

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

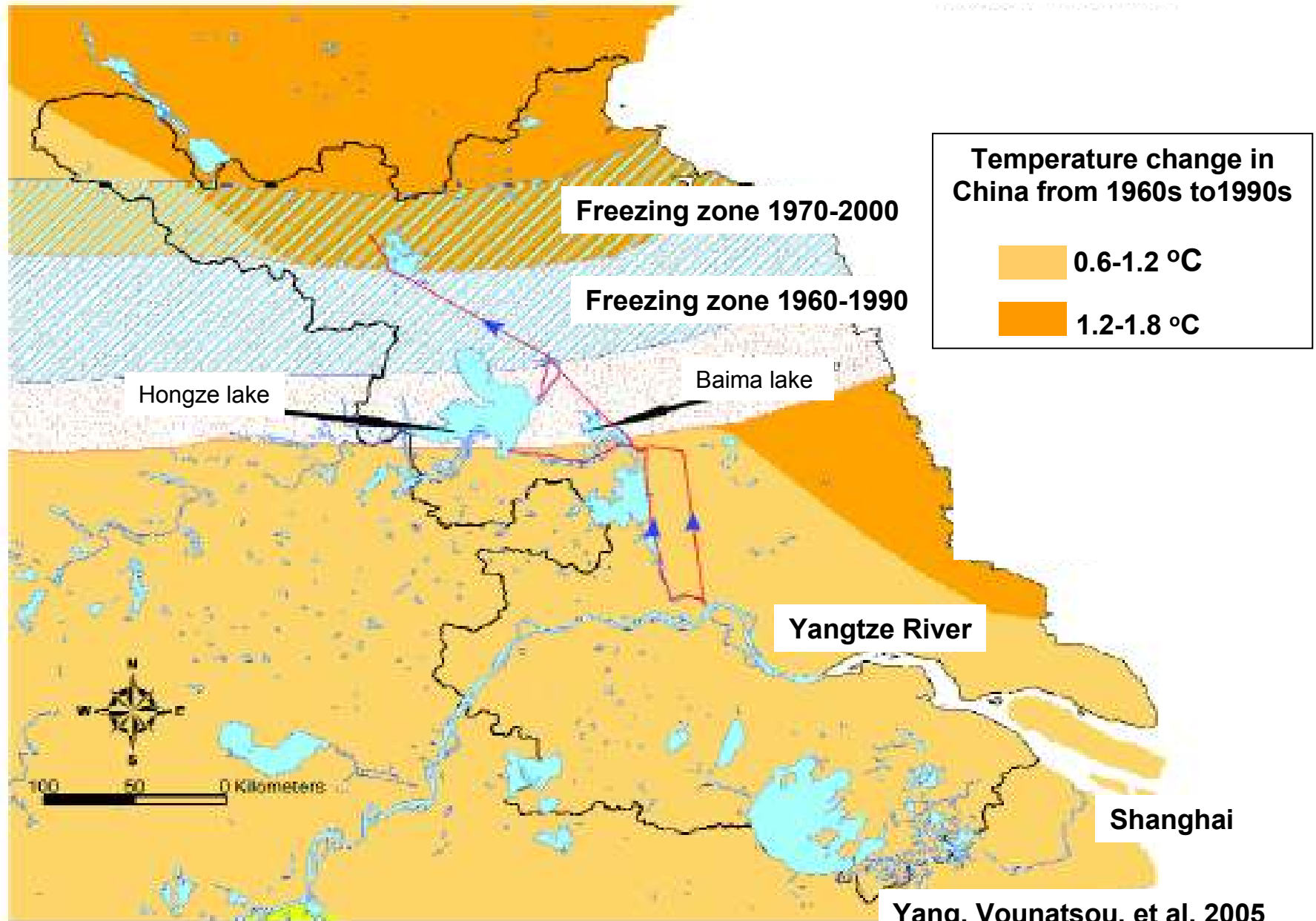
Changing Distribution of the Tick Vector



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

Lindgren et al., 2000, 2001

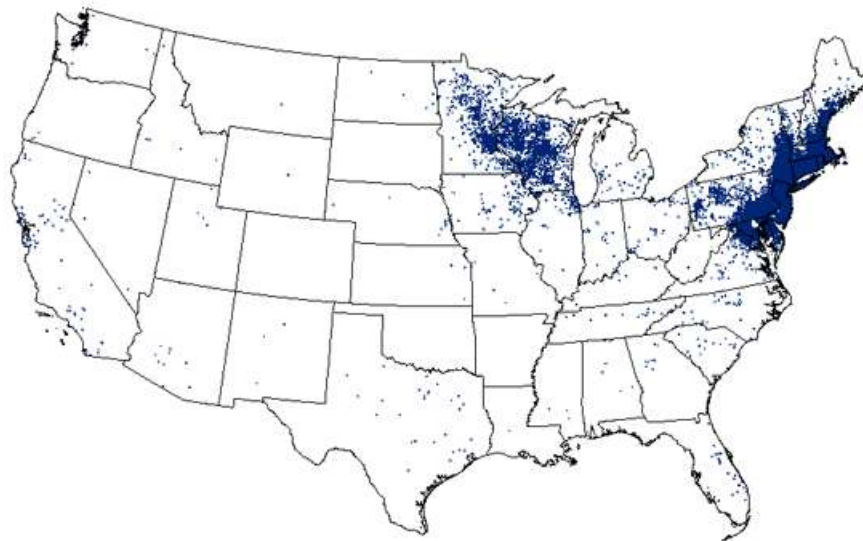
Schistosomiasis: Potential transmission of *S japonicum* in Jiangsu province due to raised average January temperature.



Yang, Vounatsou, et al. 2005

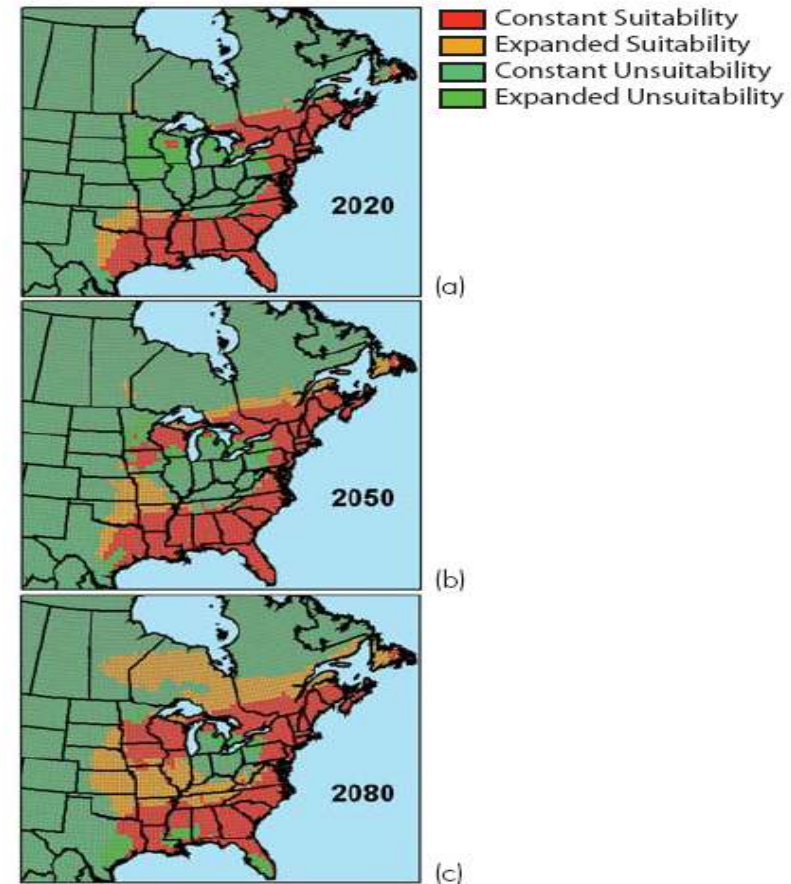
Projected change in potential for Lyme disease transmission

Reported Cases of Lyme Disease -- United States, 2006



1 dot placed randomly within county of residence for each reported case

Figures 2.11 Lyme Model Projections



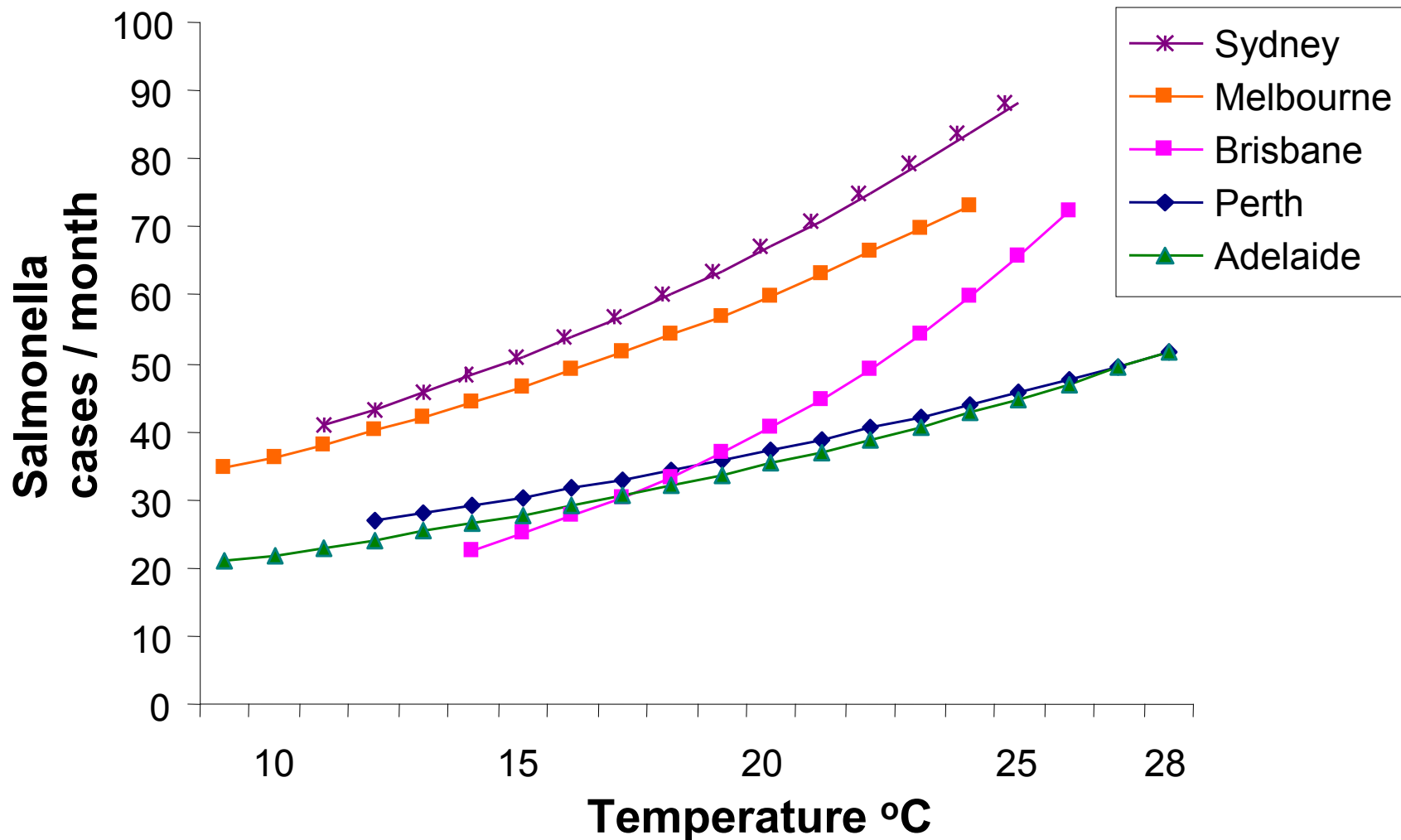
Projected distribution of climate-based habitat suitability for *Ixodes scapularis* during three future time periods: the 2020s (a), the 2050s (b), and the 2080s (c). The models project an increase in suitable habitat of 213% by the 2080s.
Source: Brownstein et al. 2005

Indirect effects of climate change on health

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

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



Indirect effects of climate change on health

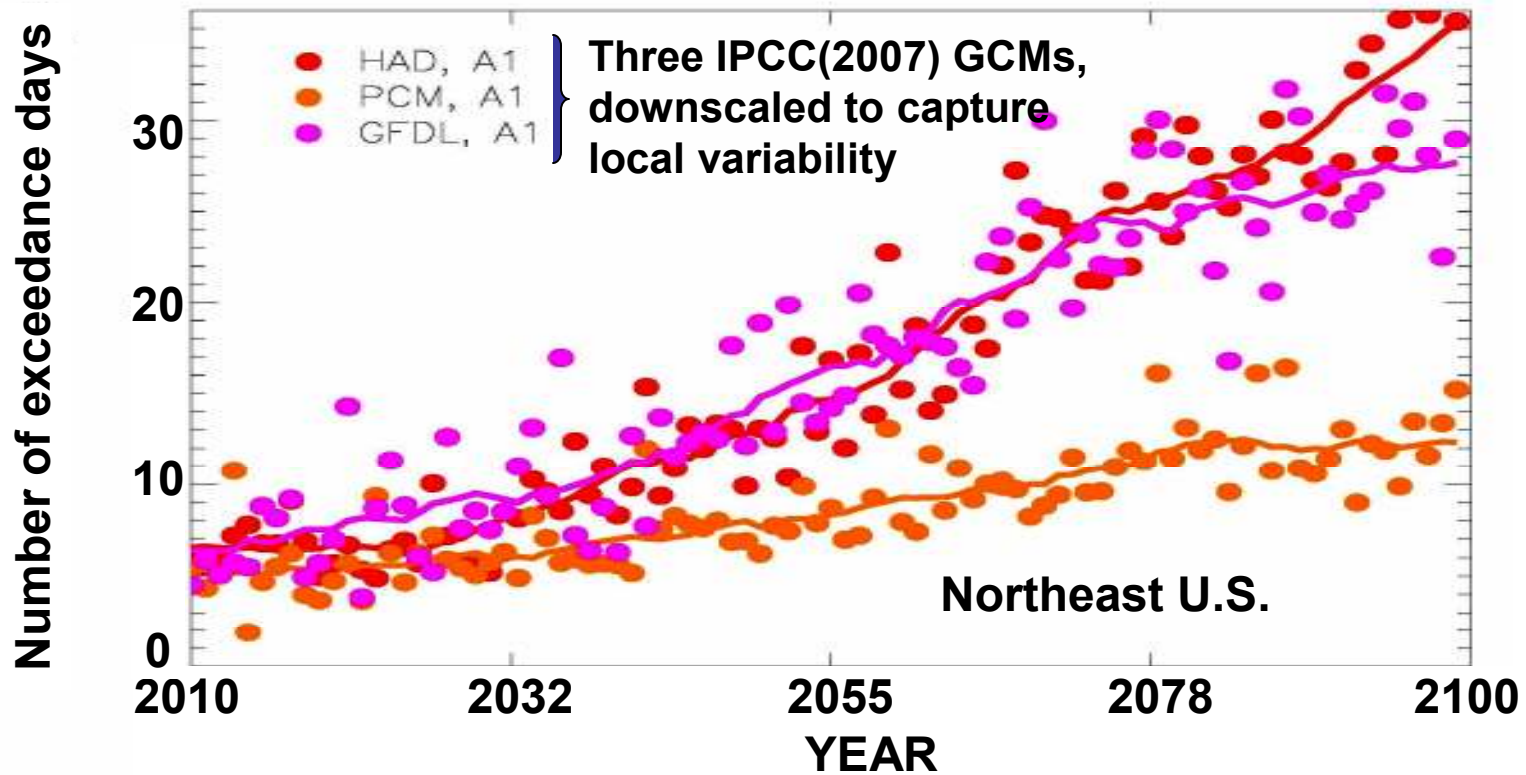
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Climate Change impacts on Health-related airborne exposures

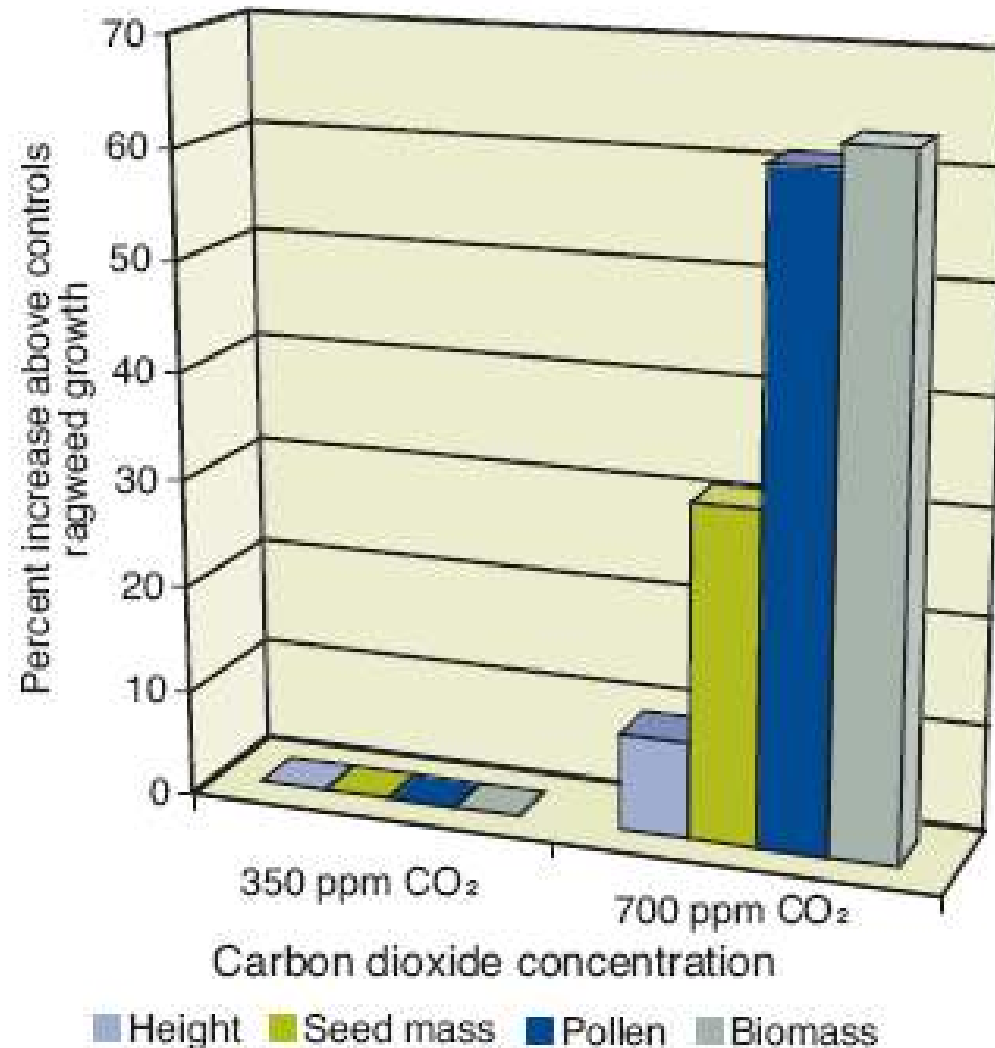
- Ground-level Ozone
- Particulate matter (PM) (e.g., forest fires)
- Aeroallergens
- Ultraviolet Radiation (UV)

Projection of future exceedances of ozone NAAQS in the Northeast United States

Average for the 257 AIRS sites of Lin et al. [2001]



Ragweed pollen production under elevated CO₂

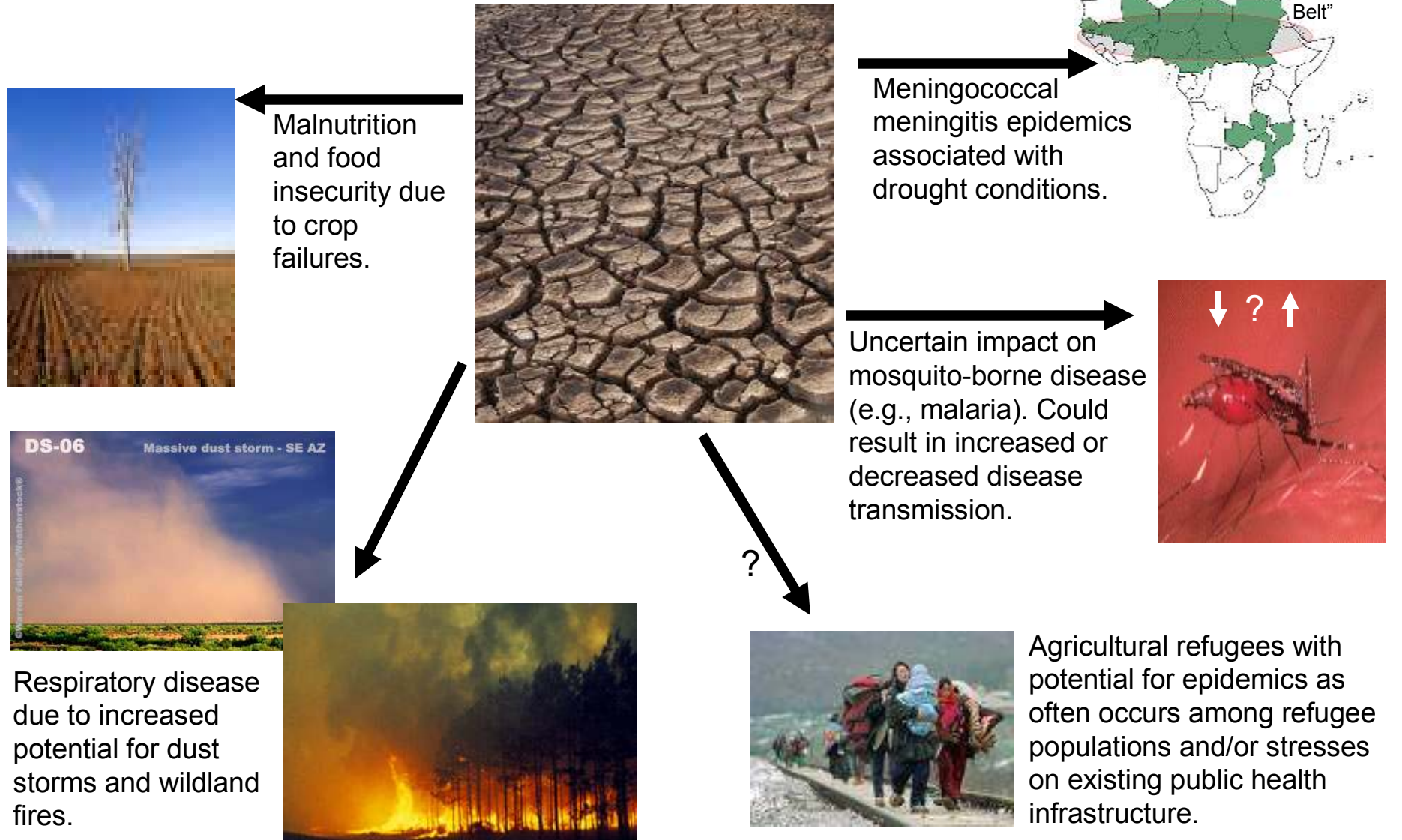


Climate Change Futures. Epstein and Mills (Eds.) 2005.

Social and Economic Disruption

- Environmental catastrophes
 - Example: Hurricane Katrina
- Populations displaced by gradual environmental shifts
 - Desertification
 - Diminishing water supplies
 - Rising sea levels

Example: complex impact of drought on health



How confident are we in these health-related projections?

There are numerous potential modifiers, for example:

- Infectious diseases could become more prominent due to failing health systems or newly emergent pathogens.
- Improvements in medical technology could partially offset anticipated adverse health outcomes from climate change, but this could serve to further highlight health disparities.
- Unanticipated large-scale migrations could overwhelm global capacity to respond.

Major Domains of Adaptation

- Strengthening natural and infrastructural defences against physical disasters
 - Institutional disaster preparedness
- Advance warning of epidemic outbreaks
- Managing water resources
 - Safety/quality and access
 - Mosquito breeding
- Reducing urban vulnerability
 - Protecting energy systems (decentralisation?)
 - Minimising heat islands
- Protecting food-producing systems and food access
- Data systems: Monitoring, surveillance, analysis, dissemination
- Health-care system: structure, staffing, connectedness
- Engage in inter-sectoral discussions and policy development

Summary

- Human health effects associated with Climate Change can be described in quantitative (e.g., mortality, DALYs) or qualitative (directionality coupled with measures of confidence). Each approach has advantages and disadvantages.
- Human health effects associated with Climate Change could be discussed as
 - Direct health impacts;
 - Indirect health impacts; or
 - Impacts on Social/Economic disruption
- These potential effects cannot be considered in isolation. They must be considered within a complex system of inter-relating effects (e.g., drought).
- Adaptation strategies can help in preventing, or responding to, the health impacts of climate change, but inter-regional disparities will be highlighted by countries ability to implement these strategies.