Climate Change and Health

Estimating the Burden of Impacts

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Overview

- Outline steps involved in estimating the burden of disease from climate change
- Present examples for several of the health impacts assessment of burden of disease from climate change
- Present overall results from this assessment, and describe usefulness and limitations for informing policy

We Know that There are Many Important Links to Health

- Some expected impacts will be beneficial but most will be adverse
- Expectations are mainly for changes in frequency or severity of familiar health risks

Health effects

- **Temperature-related illness and death**
- **Extreme weather- related health effects**
- Air pollution-related health effects
- Water and food-borne diseases
- Vector-borne and rodent-borne diseases
- Effects of food and water shortages
- Effects of population displacement

Based on Patz et al., 2000

But Policy-Makers also Want Quantification

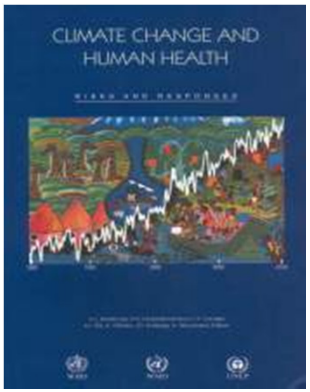
- We want to know not only if health will be affected, but also
  - How important are these effects?
  - Which diseases could have the biggest impacts?
  - Which populations are most at risk, and how?

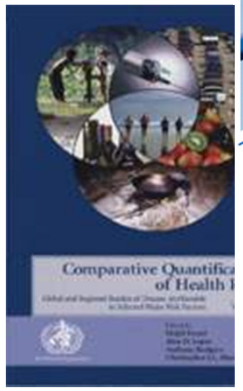
Burden of Disease Assessment

- **Burden of disease methods:**
  - Use standardized approaches to provide quantitative mortality and morbidity information
  - Use death and summary population health measures (e.g., Disability Adjusted Life Years — DALYs)
  - Can be applied either to diseases (e.g., total burden from all sequelae of diarrhoea), or risk factors (e.g., the overall burden from all health effects of smoking, lung cancer, cardiovascular disease) in a defined population
  - Can also inform on the distribution of burdens, by disease, population subgroup, etc.

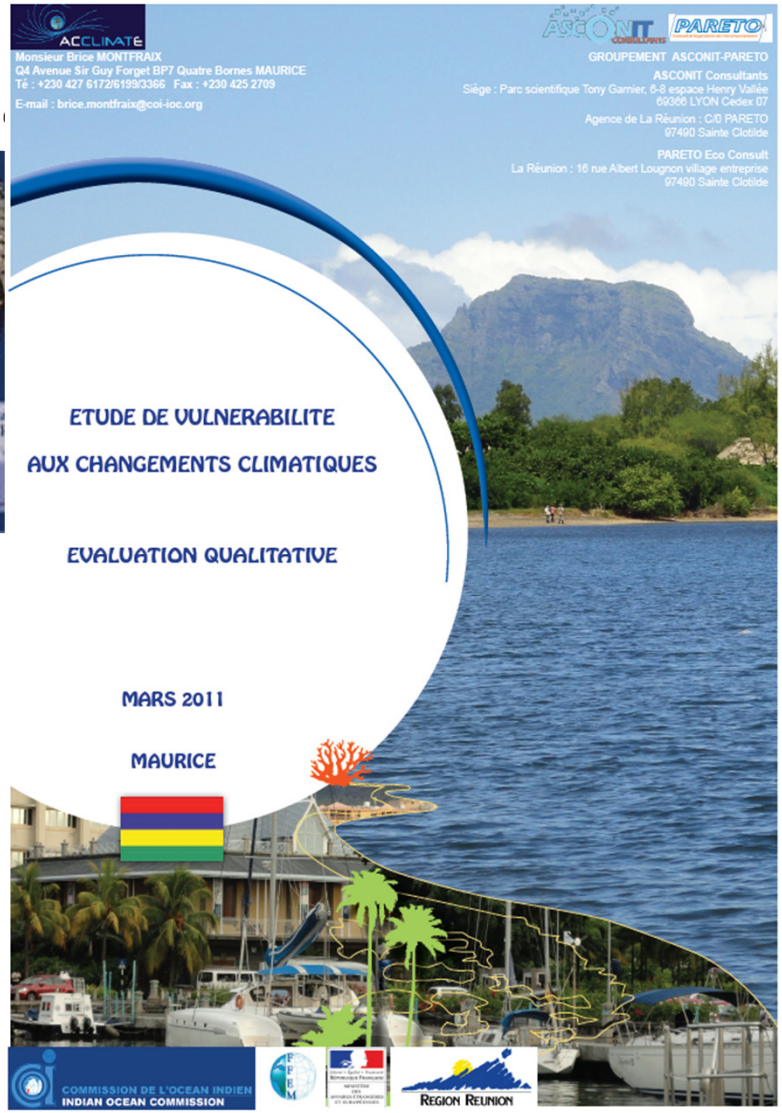
Burden of Disease Estimates due to Climate Change

- Completed at the glob



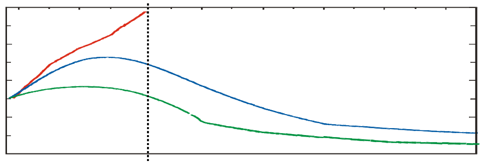


- And for the Republic of Maurice...

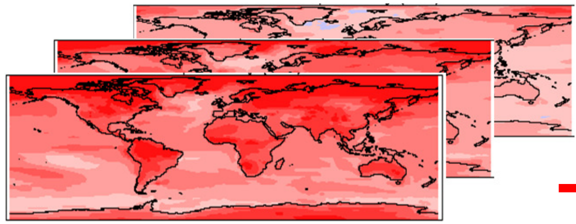


Steps in Estimating Burden of Disease from Climate Change

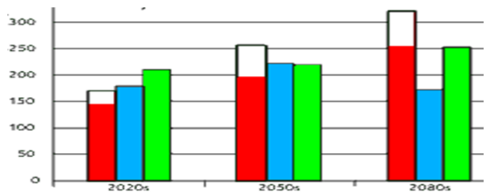
Step 1: Greenhouse gas emissions scenarios



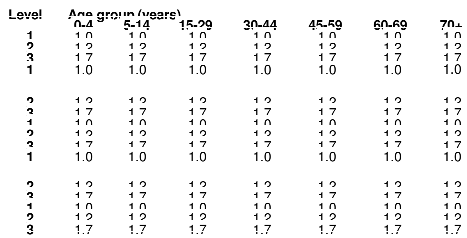
Step 2: Global climate modeling to generate maps of predicted future climate



Step 3: Health impact model to estimate change in relative risk of specific diseases



Step 4: Conversion to a single health measure



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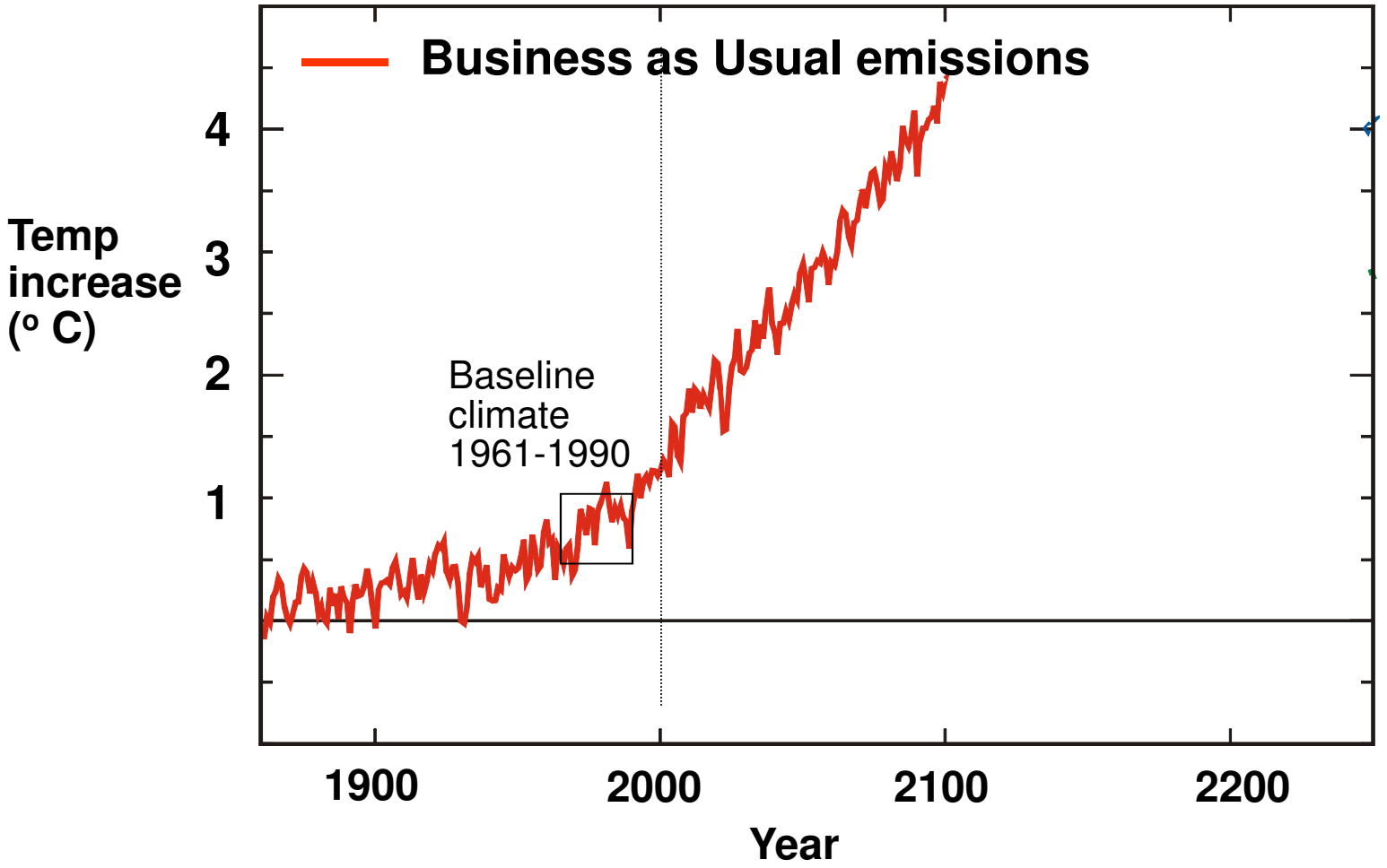
Step 1: Defining Climate Scenarios

- Exposure scenarios used in the global assessment:
  - Discrete climate scenarios derived from **alternative future trajectories of GHG emissions**
    1) **1961-1990 levels of GHGs and associated climate (baseline)**
    2) **Stabilization at 550 ppm CO_2-equivalent in 2170**
    3) **Stabilization at 750 ppm CO_2-equivalent in 2210**
    4) **Unmitigated current GHG emissions trends**

Projected Future Climate Change



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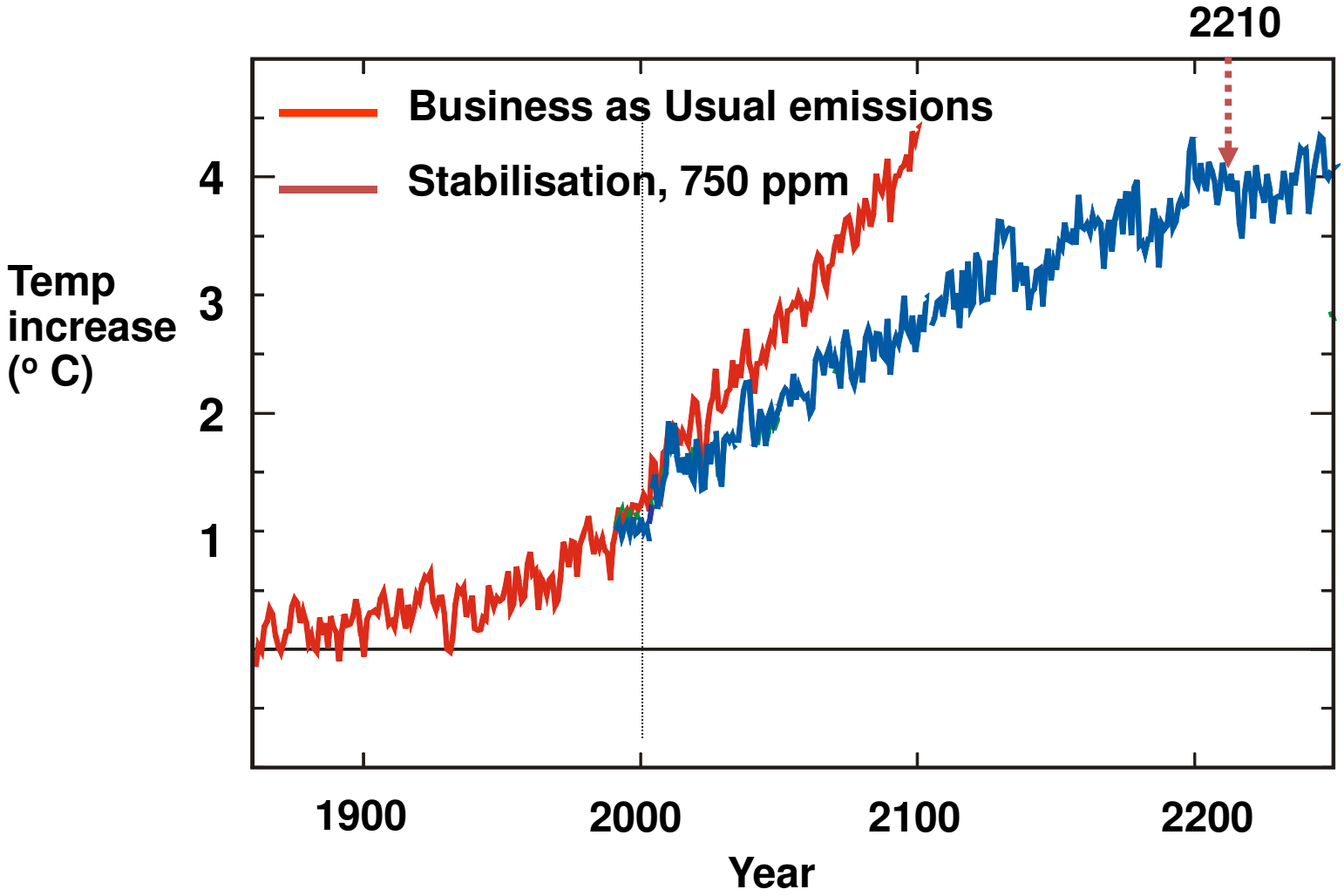
Projected Climate Change with Emissions Stabilization



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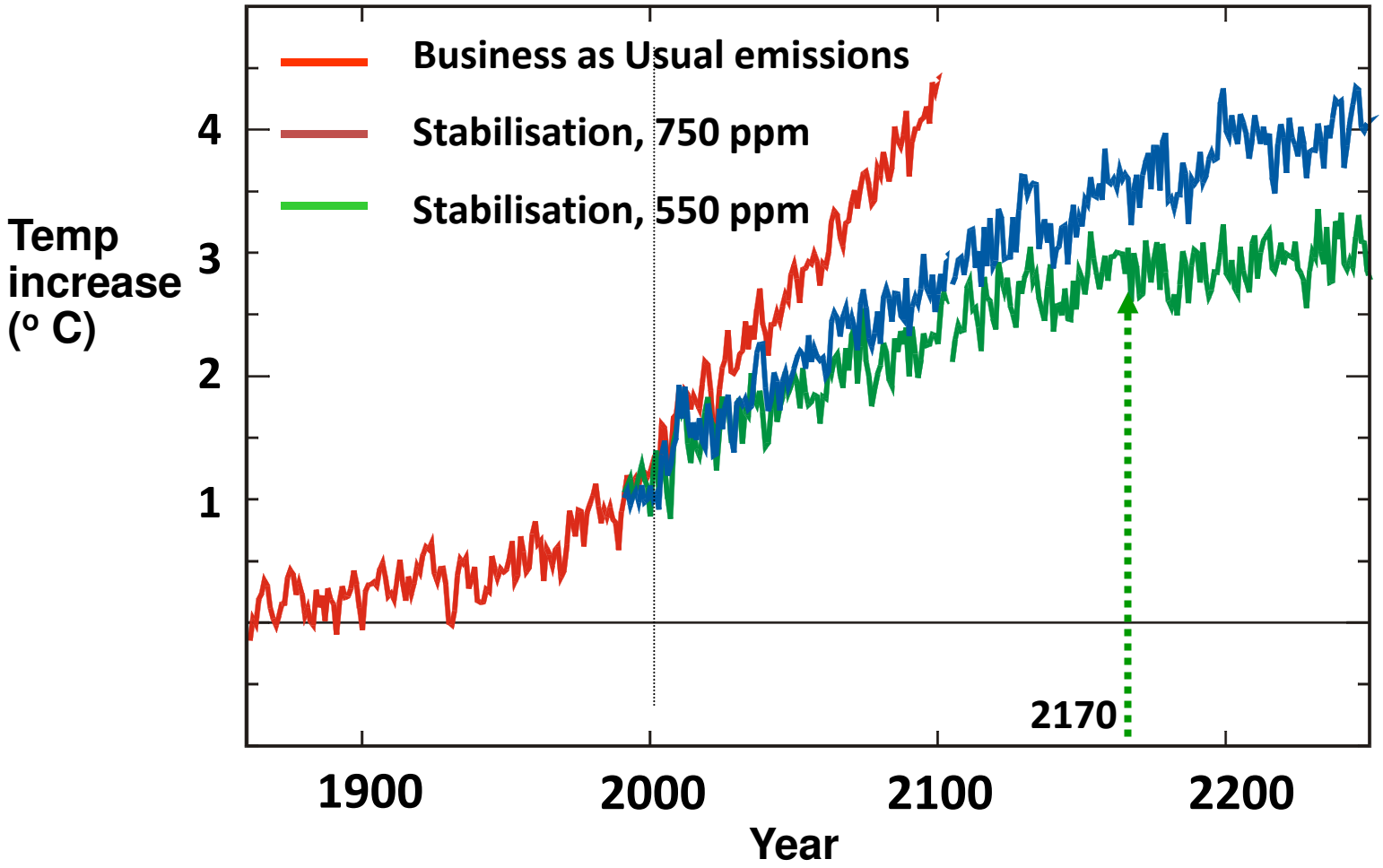
Projected Climate Change with Emissions Stabilization



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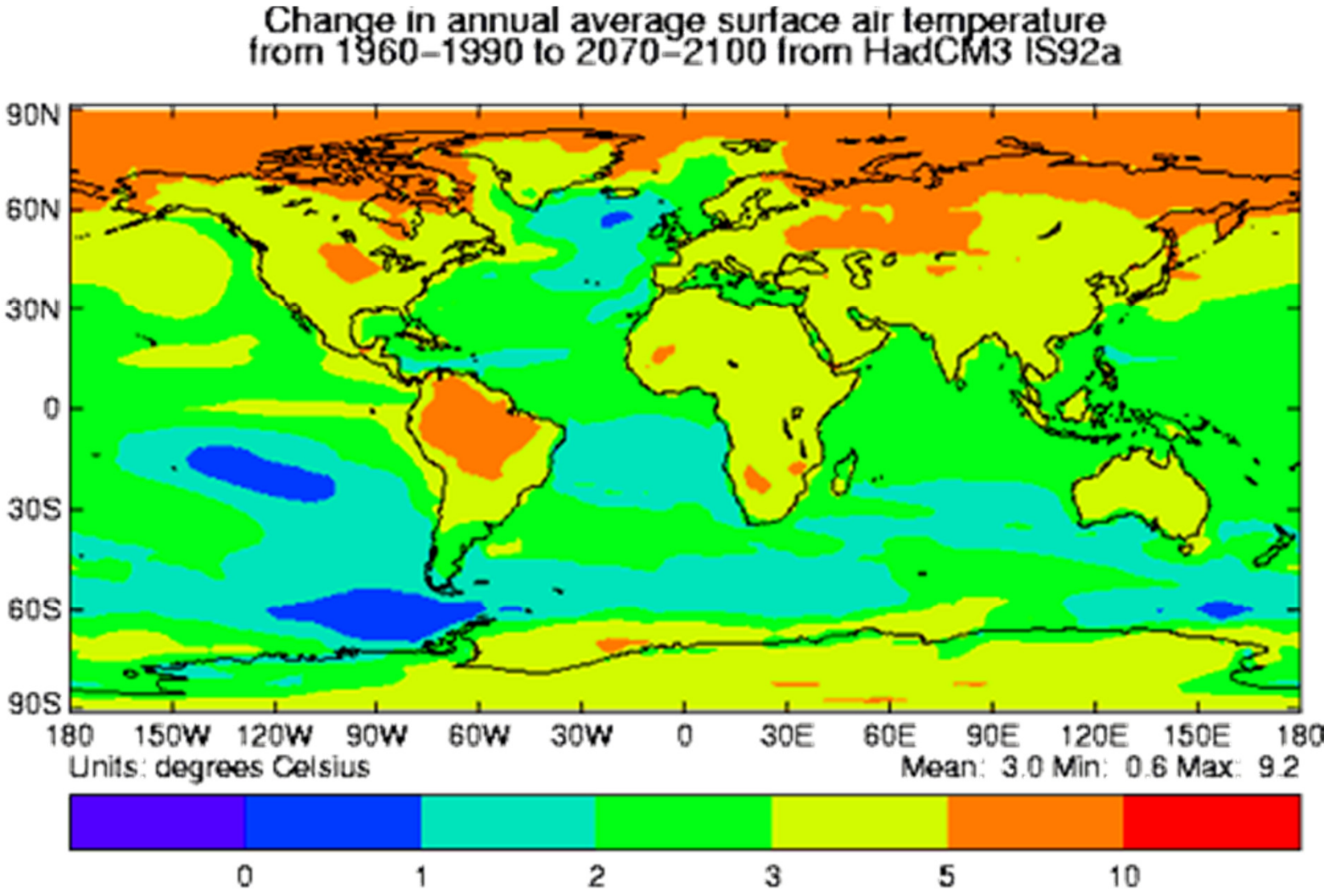
Step 2: Describing Climate Exposures



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Step 3: Selecting Likely Health Outcomes — Proposed Criteria

- Sensitive to climate
  - Disease incidence should correlate with seasonal or intra-annual climate variation
- Important health impact
  - Based on estimates of current mortality and/or morbidity
- Already modeled at an appropriate scale
  - For example, existing models relating distribution of a disease to climate variables

Examples of Important Climate-Sensitive Diseases

- Climate affects food production, water scarcity, and infectious disease transmission, which influence some of the biggest killers

- Already, globally each year:
  - Undernutrition kills 3.5 million
  - Diarrhea kills 2.2 million
  - Malaria kills almost 1 million

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Availability of Studies that Estimate Effects of Climate Change on Health

Health impact	*Available studies of climate change effects*
Thermal extremes	Temperature-mortality relationships examined in multiple cities throughout world
Extreme weather (floods, high winds, droughts)	No complete analysis of linkage from climate change to changes in extreme events and health impact projections
Diarrhea	Two local time series studies, no global model
Malaria	Three distinct global or continental models
Dengue	Two global models
Malnutrition	One global model of climate change to regional food availability

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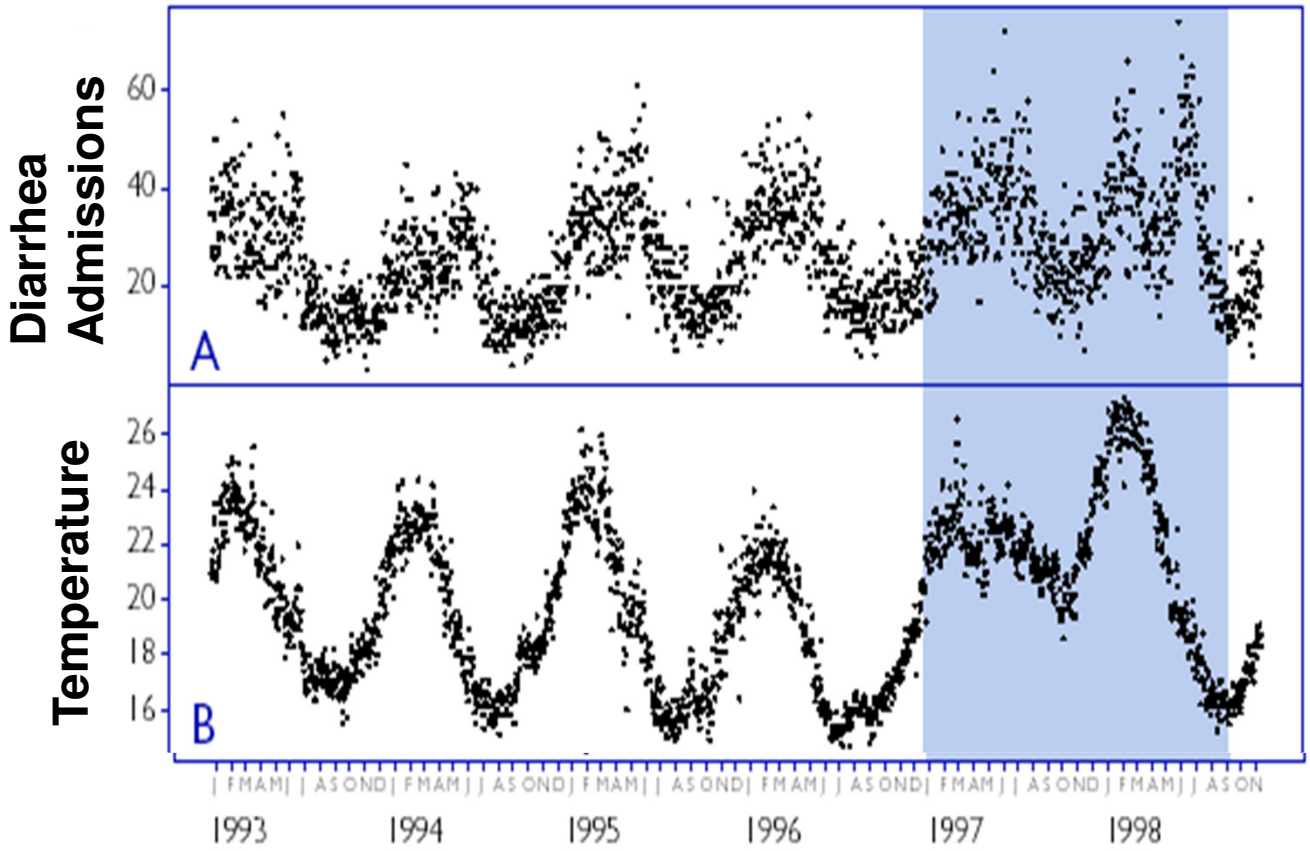
Step 3: Modeling Climate-Health Relationships

Health Impact 1:

Diarrhea

Quantifying Climate-Diarrhea Relationships



Daily measurements Jan 1993 – Dec 1998

Incidence of diarrheal disease is strongly related to climate variables. In Lima, Peru, diarrhoea increased 8% for every 1°C temperature increase.

Checkley et al., 2000

Converting to an Approximate Global Estimate

- **Climate sensitivity**
  - 5% increase in diarrhea per 1°C temperature increase in developing countries
- **Change in relative risk**
  - Projected temperature changes overlaid on population distribution map to give per capita increase in diarrhea risk
- **Disease burden attributable to climate change**
  - Relative risk under each scenario/time point multiplied by WHO estimates of current/future "baseline" diarrhoea burden in each region
- **RESULT: Health impacts attributed to climate effects** on diarrhea in the year 2000:
  - 47,000 deaths globally
  - 23,000 in WHO Southeast Asia region

Step 3: Modeling Climate-Health Relationships

Health Impact 2:

Dengue

Converting to an Approximate Global Estimate

- **Climate sensitivity**
  - Relationship between climate variables and dengue distribution based on Hales et al. (2002) global model
- **Change in relative risk**
  - Projected future climate scenarios applied to global model to map changes in disease distribution. Overlaid on population distribution map to give changes in population at risk (PAR).
- **Disease burden attributable to climate change**
  - Percent changes in PAR applied to WHO estimates of "baseline" burden in each region (e.g., 50% increase in PAR assumed = 50% increase in mortality and morbidity).
- **RESULT: Health impacts on dengue attributed to climate** in the year 2000:
  - 1,000 deaths globally

Step 4: Aggregating Across Different Diseases

Subregion	Malnutrition	Diarrhoea	Malaria	Floods	CVD*	All causes
AFR-D	8	5	5	0	1	19
AFR-E	9	8	18	0	1	36
AMR-A	0	0	0	0	0	0
AMR-B	0	0	0	1	1	2
AMR-D	0	1	0	0	0	1
EMR-B	0	0	0	0	0	0
EMR-D	9	8	3	1	1	22
EUR-A	0	0	0	0	0	0
EUR-B	0	0	0	0	0	0
EUR-C	0	0	0	0	0	0
SEAR-B	0	1	1	0	1	3
SEAR-D	52	22	0	0	7	80
WPR-A	0	0	0	0	0	0
WPR-B	0	2	1	0	0	3
World	78	47	27	2	12	166

CVD* = Net changes in Cardiovascular disease deaths associated with both hot and cold temperatures

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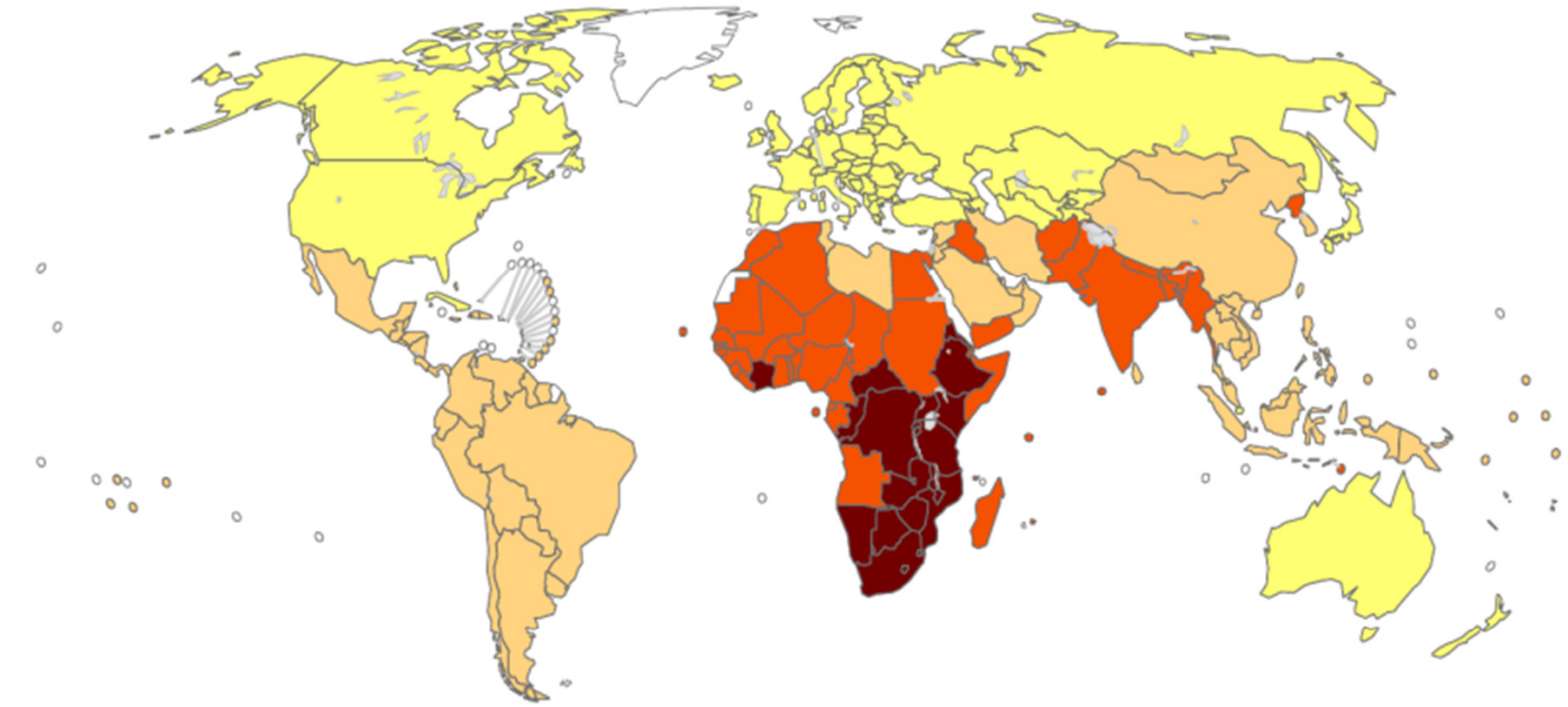
Conclusions: Poorest Populations are Most Vulnerable



Estimates by WHO sub-region for the year 2000
(WHO World Health Report, 2002)

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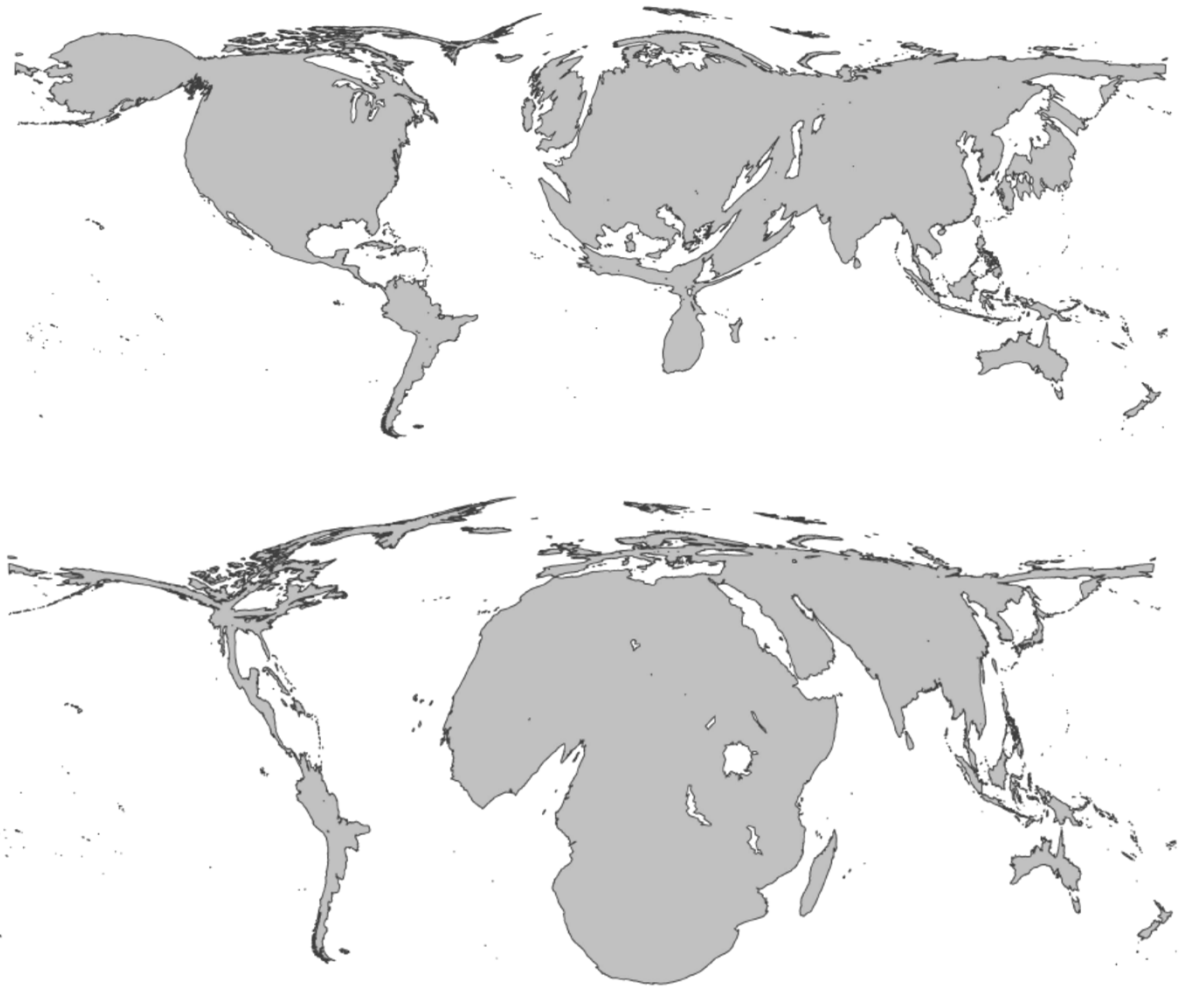
Poorest are Least Responsible for Causing Climate Change



Cumulative emissions of greenhouse gases, to 2002

WHO estimates of *per capita* mortality from climate change, 2000

Map projections from Patz et al., 2007

Limitation 1: Crude Representation of Non-Climate Effects

Health impact	"Adaptive" effects over time
Direct physiological effects of heat and cold	Temperature associated with lowest mortality changes as temperature increases

Limitation 2: Many Impacts Cannot be Reasonably Modeled

- **Examples**
  - Leishmaniasis, cholera, sleeping sickness, filariasis…
  - Flooding impacts on diarrhoea, mental health, non-communicable diseases (NCDs)…
  - Increased frequency of severe tropical storms
  - Floods from melting glaciers, water shortages from melting glaciers
  - Salination of water sources from sea-level rise
  - Aeroallergens

Limitation 2: Many Impacts Cannot be Reasonably Modeled

- **Examples**
  - Forest fires
  - Dust storms
  - Effects on crop pests
  - Effects via species extinction and biodiversity loss
  - Social effects of population displacements

Interpreting and Using the Results

- Estimates of burden of disease from climate change are **just one dimension of a health assessment**. They should be presented alongside:
- Estimates of the **underlying disease burden**, irrespective of climate change
  - How bad is the problem already?
- Information on the **distribution of risks** within a population
  - Who is most vulnerable?

Interpreting and Using the Results (cont.)

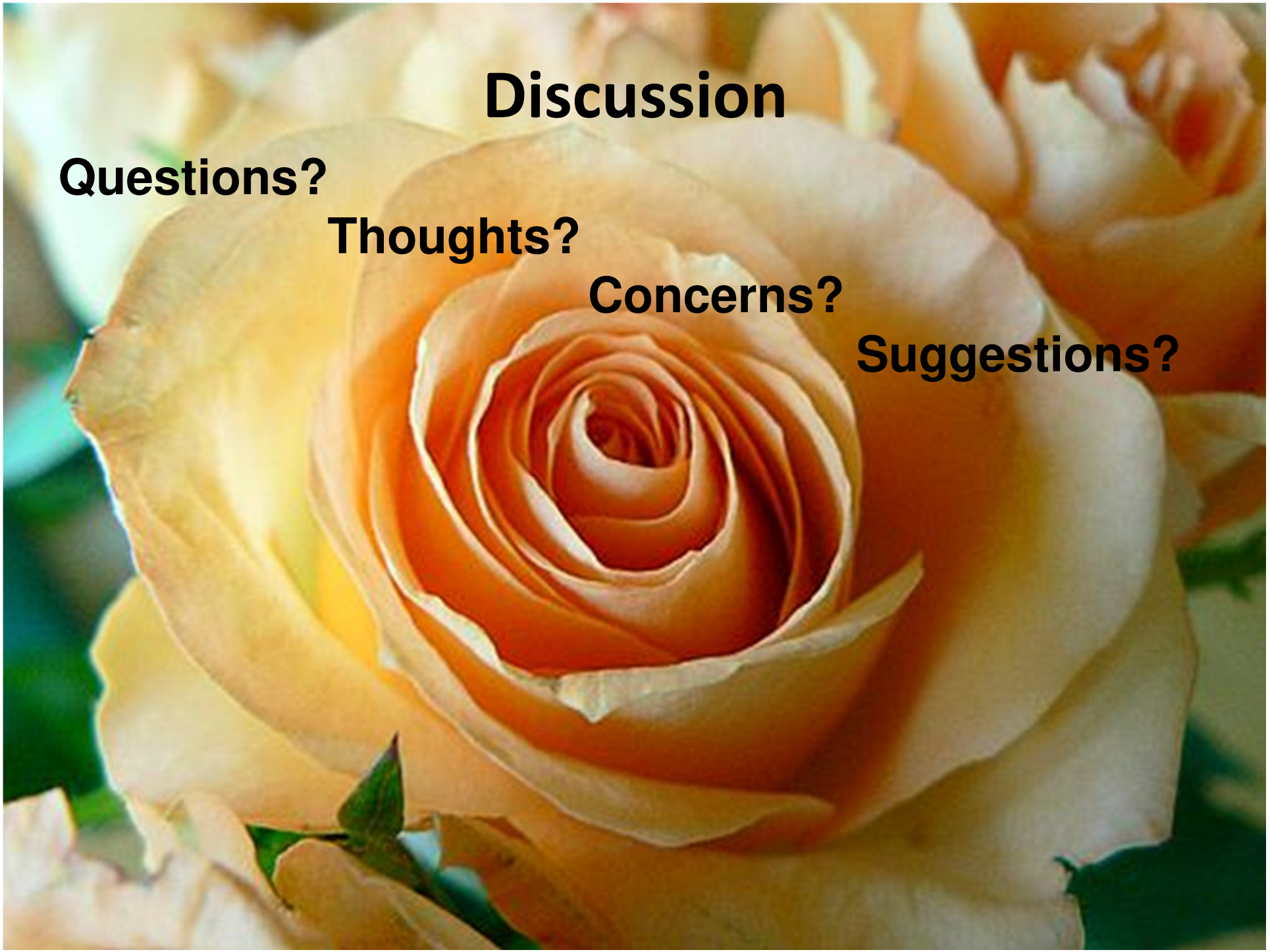
- Qualitative assessment of potential health **impacts that are difficult to quantify**, or the possibility of extreme events
  - What else could happen?
- Assessments of interventions
  - What can we do about it?

Conclusions

- Global burden of disease studies show:
  - Much of the global burden of disease, especially in the poorest countries, is climate-sensitive.
  - Failure to stabilize climate may already cause the loss of over 5.5 million years of healthy life (or over 150,000 lives) per year. This is expected to rise in future decades.
  - There is a need for strengthened control of climate-sensitive diseases (in the short-term), and reducing climate change (in the long-term).

Conclusions (cont.)

- National burden of disease studies would:
  - Give more local, accurate, and context-specific measurements, with a stronger link to control interventions
  - Provide a stronger basis for accessing global “adaptation funds” for health protection


Discussion
Questions?
Thoughts?
Concerns?
Suggestions?

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