

global energy assessment conference 2013

Global Energy Assessment

w e s t c o a s t l a u n c h

Stanford University

Energy and Health

Kirk R. Smith, CLA Chapter 4

UC Berkeley

May 21, 2013



Stanford
Precourt Institute
for Energy

Chapter 4: Lead Authors

- **Kalpana Balakrishnan** (Sri Ramachandra University, India)
- **Colin Butler** (Australian National University)
- **Zoe Chafe** (University of California, Berkeley, USA)
- **Ian Fairlie** (Consultant on Radiation in the Environment, UK)
- **Patrick Kinney** (Columbia University, USA)
- **Tord Kjellstrom** (Umea University, Sweden)
- **Denise L. Mauzerall** (Princeton University, USA)
- **Thomas McKone** (Lawrence Berkeley National Laboratory, USA)
- **Anthony McMichael** (Australian National University)
- **Mycle Schneider** (Consultant on Energy and Nuclear Policy, France)
- **Kirk R. Smith** (University of California, Berkeley, USA)
- **Paul Wilkinson** (London School of Hygiene and Tropical Medicine, UK)

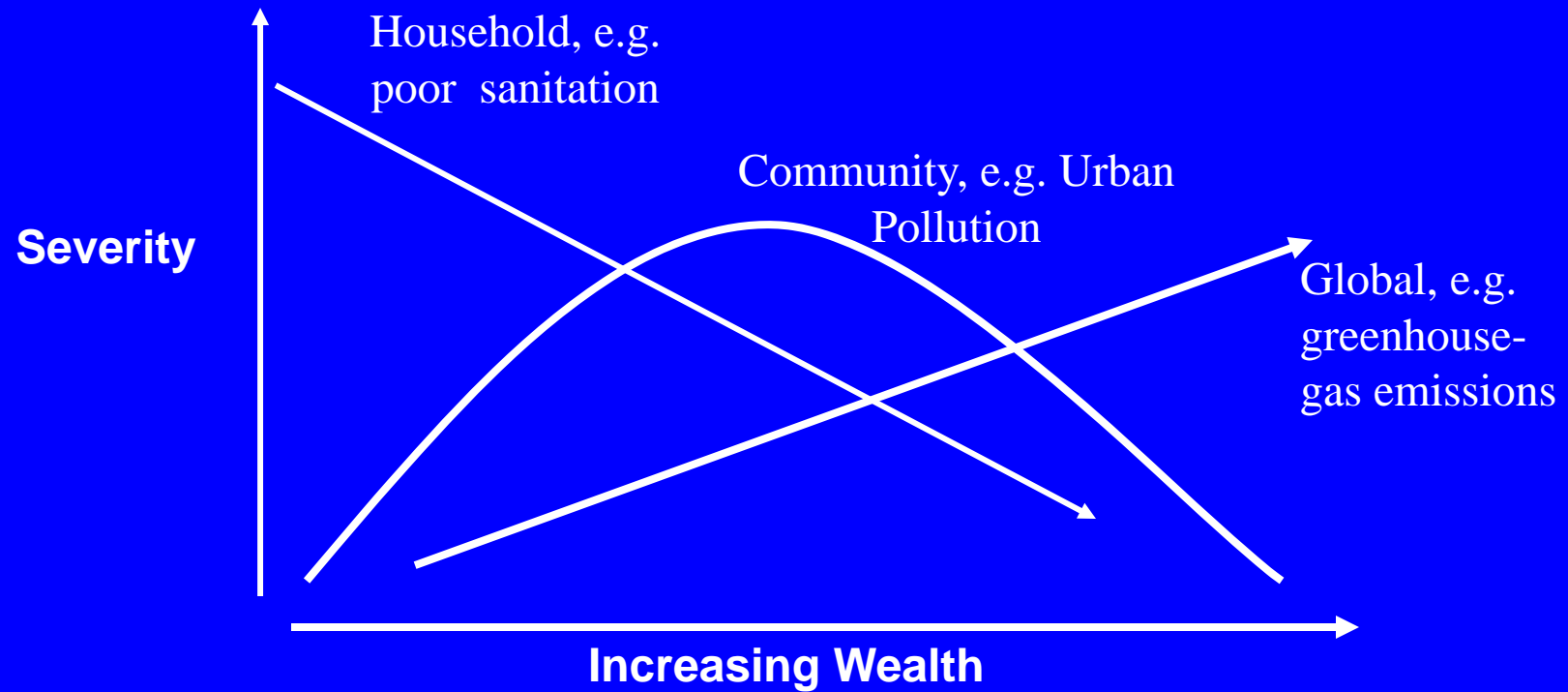
Framing of the Analysis

- Not on the many important health benefits of access to reliable clean energy services
- Focus on how energy systems affect the distribution of global health in major ways.
- Not the reverse, i.e., the ways relative health impacts affect the distribution of energy systems
- Secondary focus on the ways that mitigating climate change through changes in energy systems might achieve important health improvements – co-benefits.

Framing of the Analysis, cont

- Chapter 4 focuses on attributable risk, i.e., the amount of ill-health currently due to energy systems.
- The avoidable risk, i.e., the amount of ill-health that could be avoided by changes in energy systems, is mostly found in Ch 17 – Pathways
- Use Environmental Risk Transition as an organizational mechanism

The Environmental Risk Transition



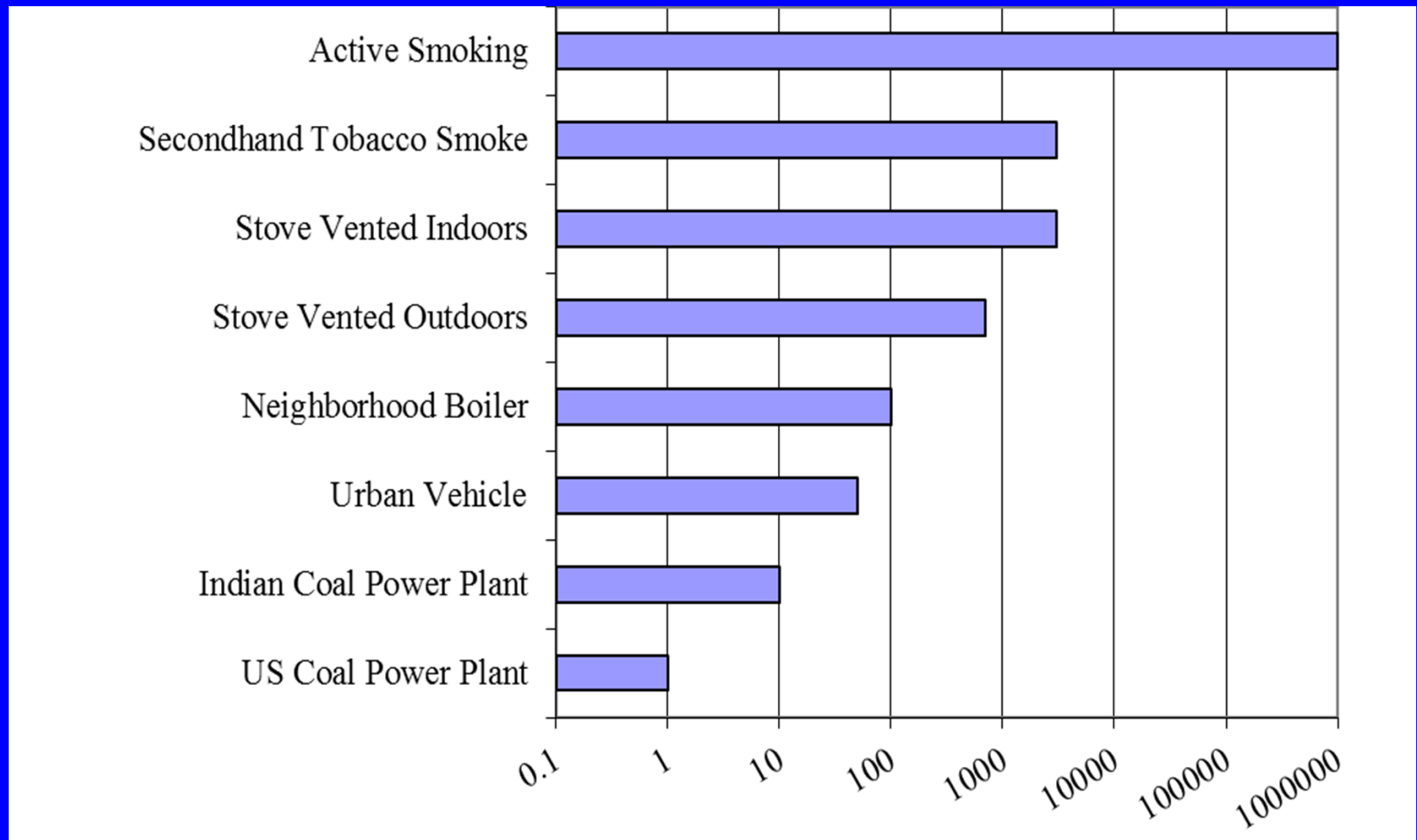
Shifting Environmental Burdens



Environmental Risk Transition

- Household, e.g., biomass fuels
- Workplace, e.g., coal mining
- Community, e.g., urban air pollution
- Regional, e.g., widespread tropospheric ozone
- Global, e.g., climate change
- Special topics
 - Energy efficiency in buildings
 - Nuclear fuel cycle – routine operation
 - Emerging technologies

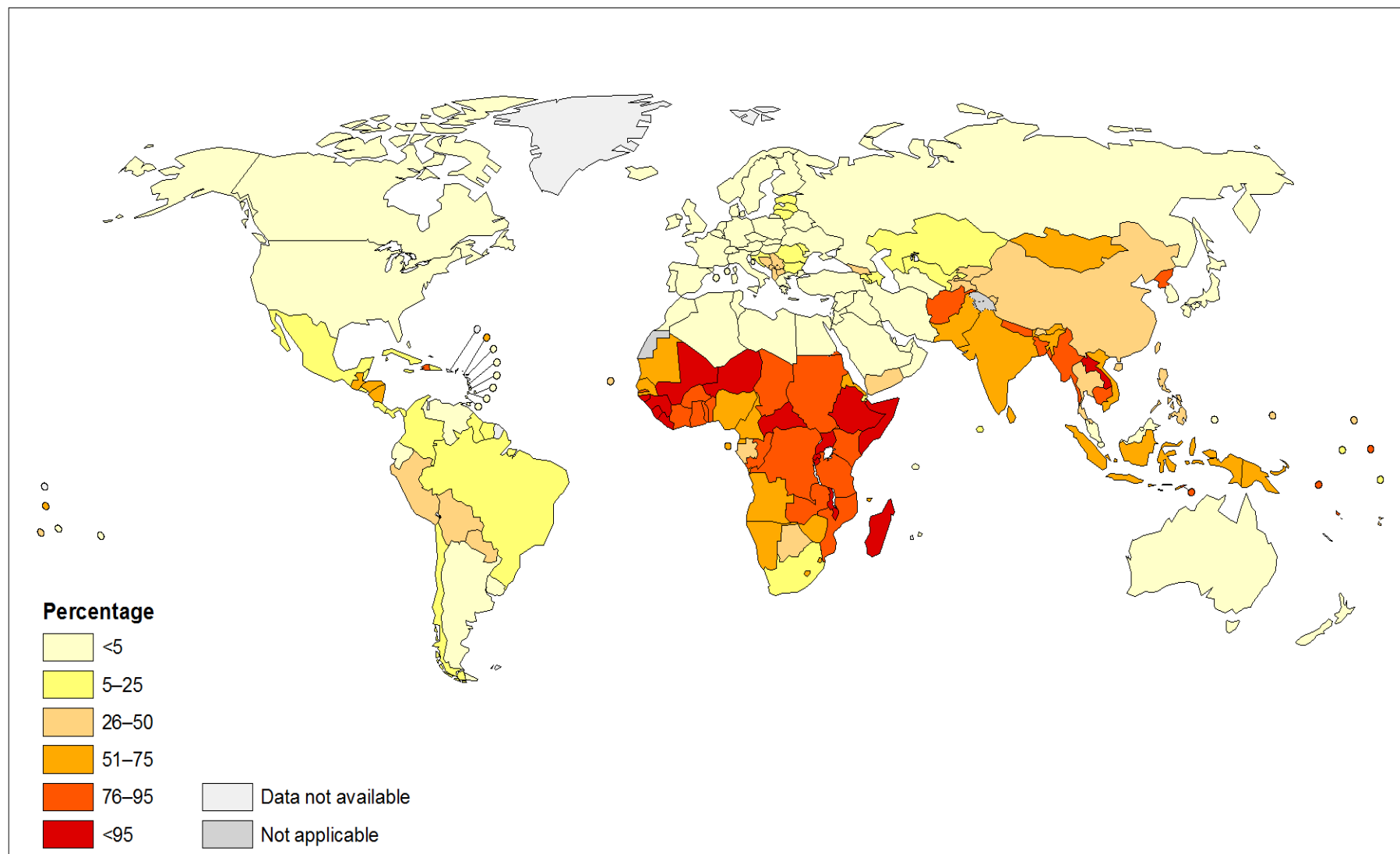
Intake fractions for typical sources of air pollution (g/t emitted)



Bottom Lines

- Poorly managed energy systems are currently responsible for a significant portion of the global burden of disease – perhaps 6-7 million premature deaths annually – approaching 10% of the global burden of disease
- Air pollution from incomplete combustion of fuels is the major reason, but there are other interactions as well.

Population Cooking with Solid Fuels in 2010 (%)



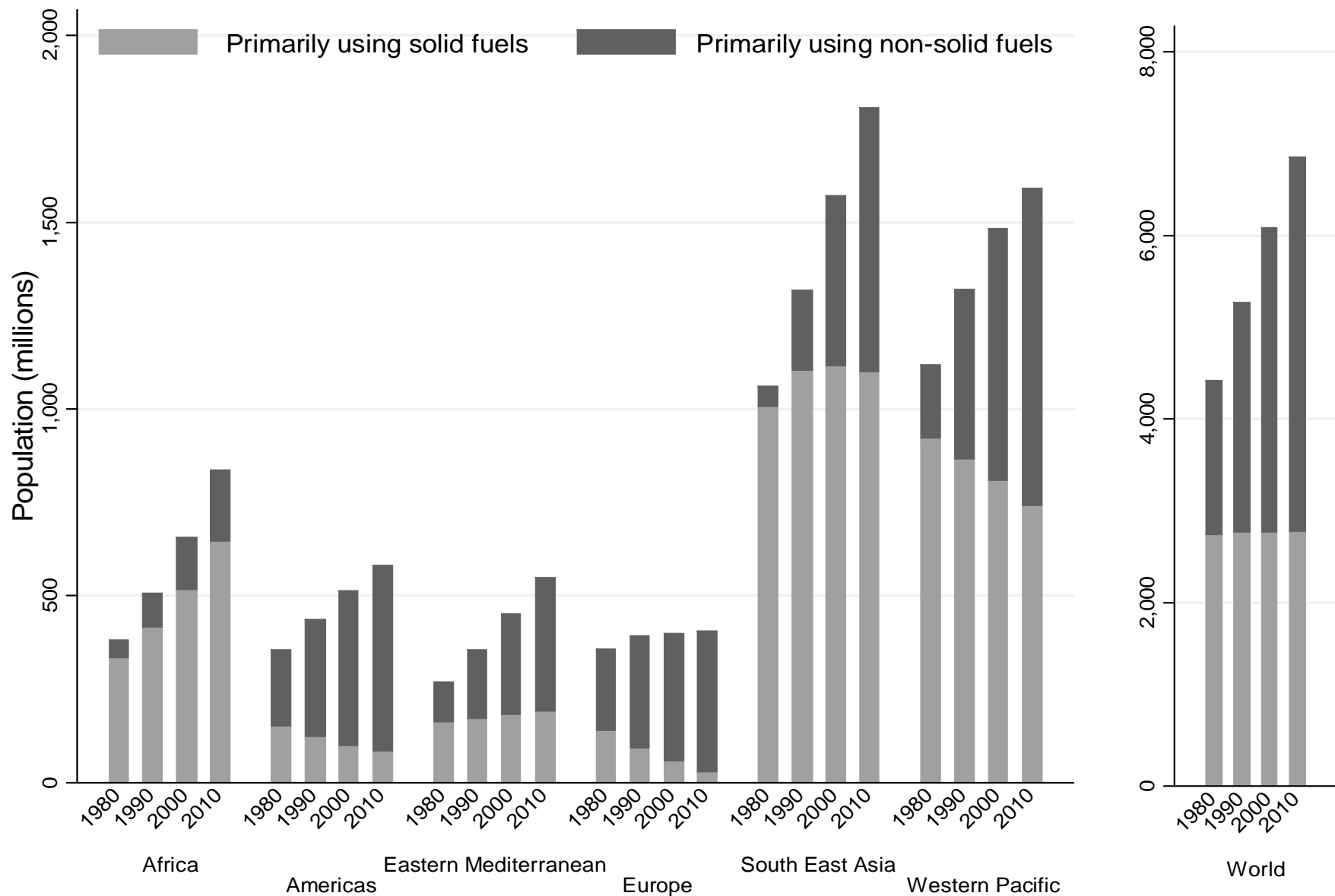
The boundaries and names shown and the designations used on this map do not imply the expression of any opinion whatsoever on the part of the World Health Organization concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries. Dotted and dashed lines on maps represent approximate border lines for which there may not yet be full agreement.

Data Source: World Health Organization
Map Production: Public Health Information
and Geographic Information Systems (GIS)
World Health Organization



**World Health
Organization**

© WHO 2012. All rights reserved.

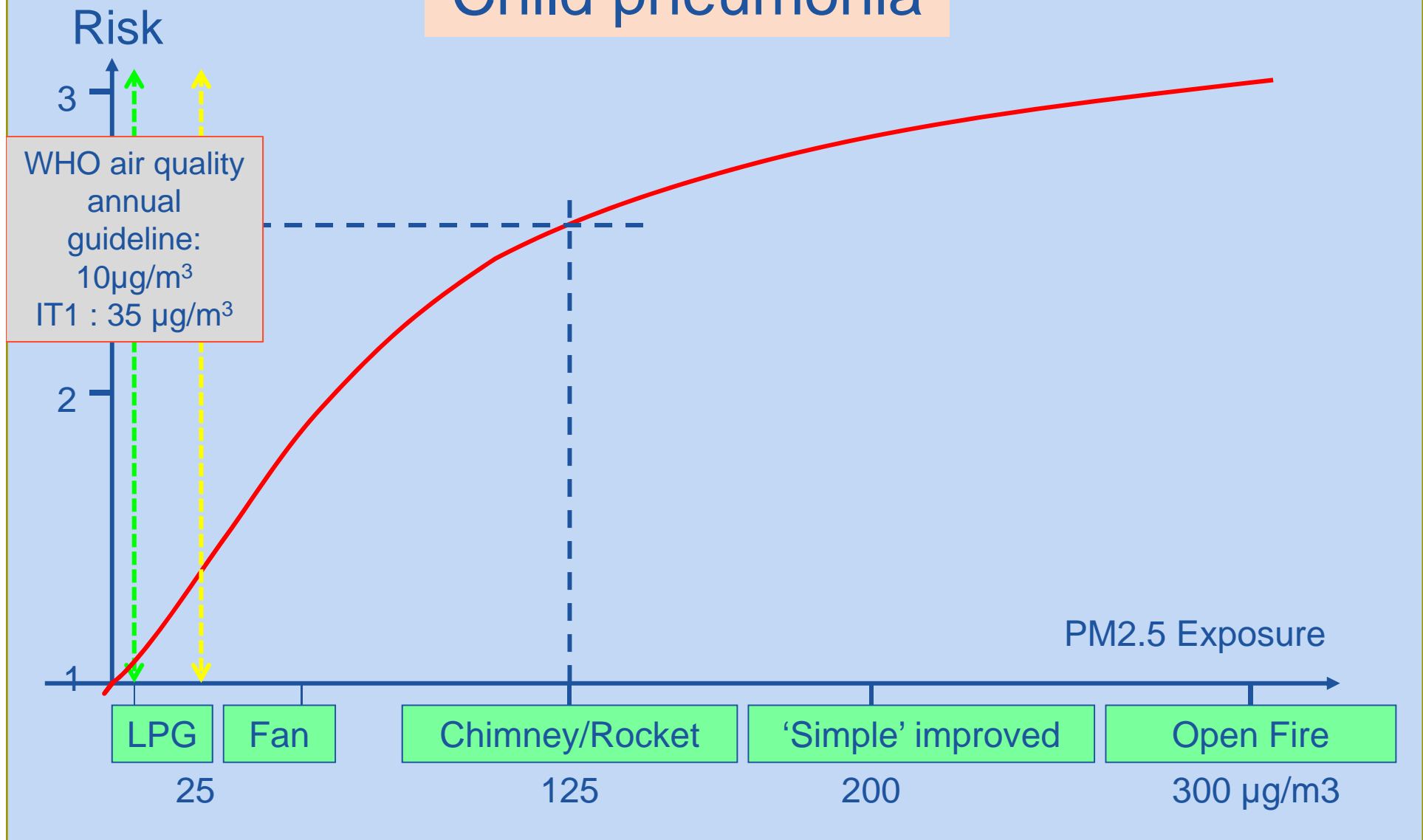


Total Population Cooking with Solid Fuels

Bonjour et al., 2013

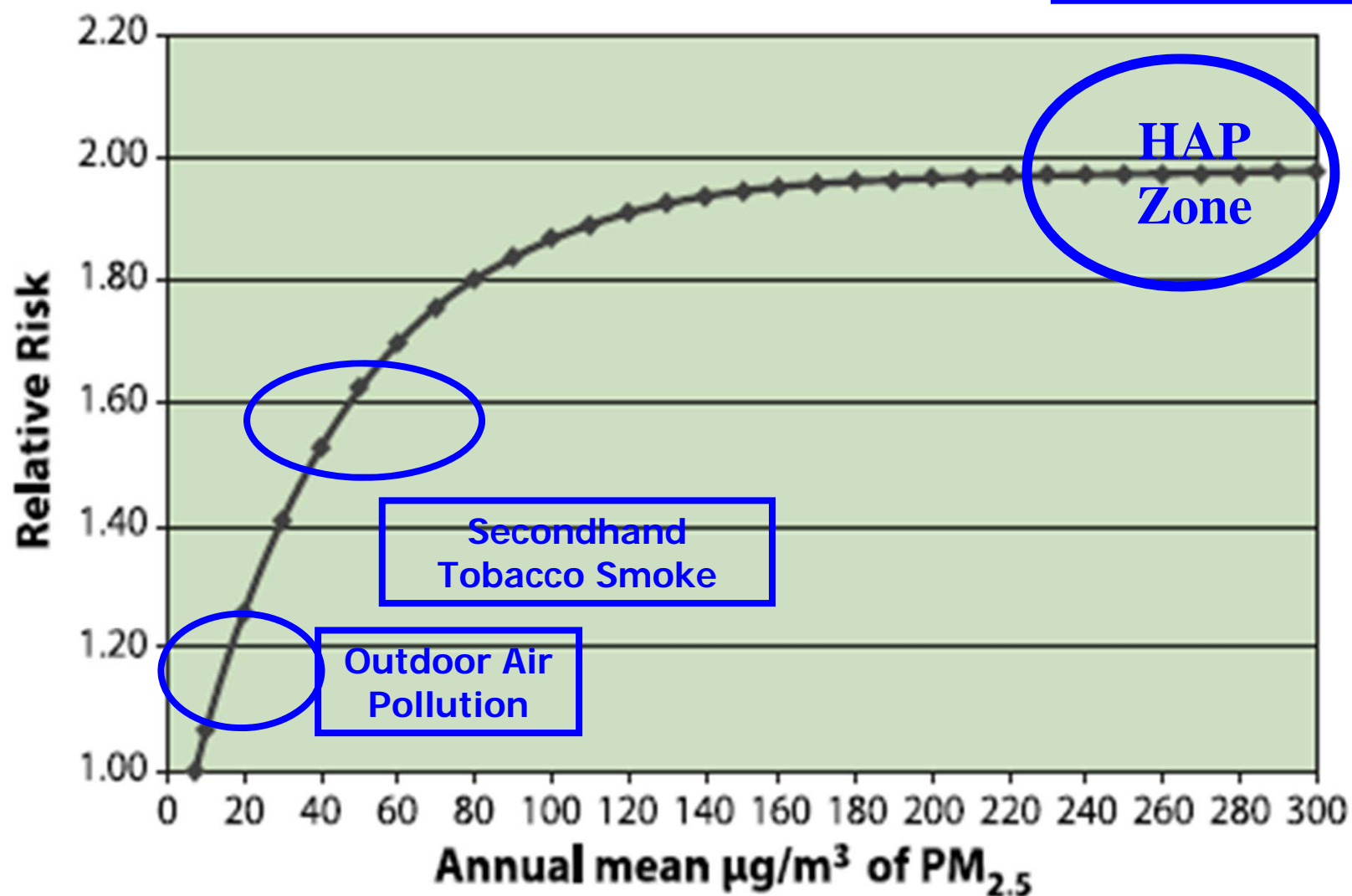
Exposure-response relationship

Child pneumonia

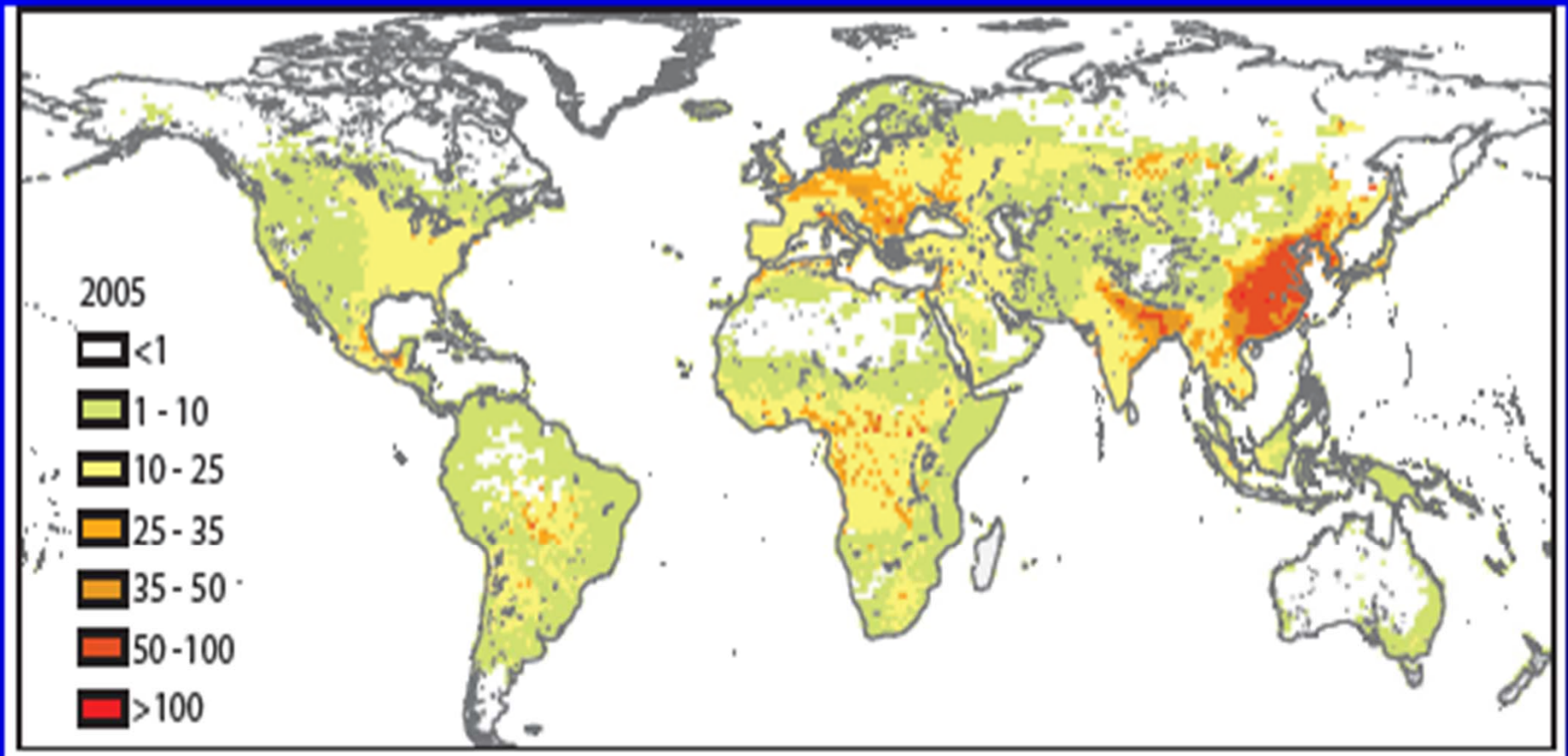


Integrated Exposure-Response: Outdoor Air, SHS, and Smoking and Heart Disease

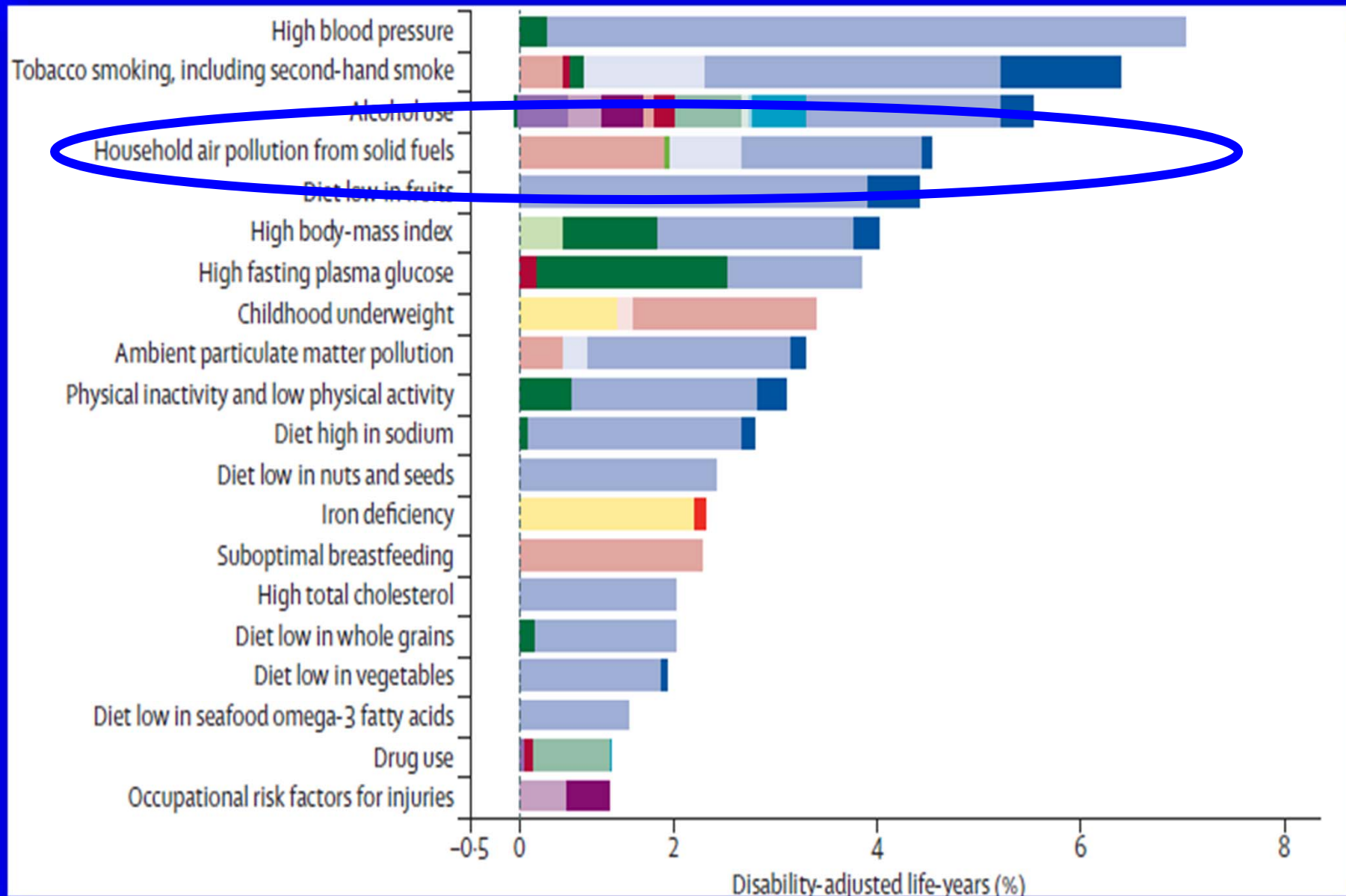
Smokers →



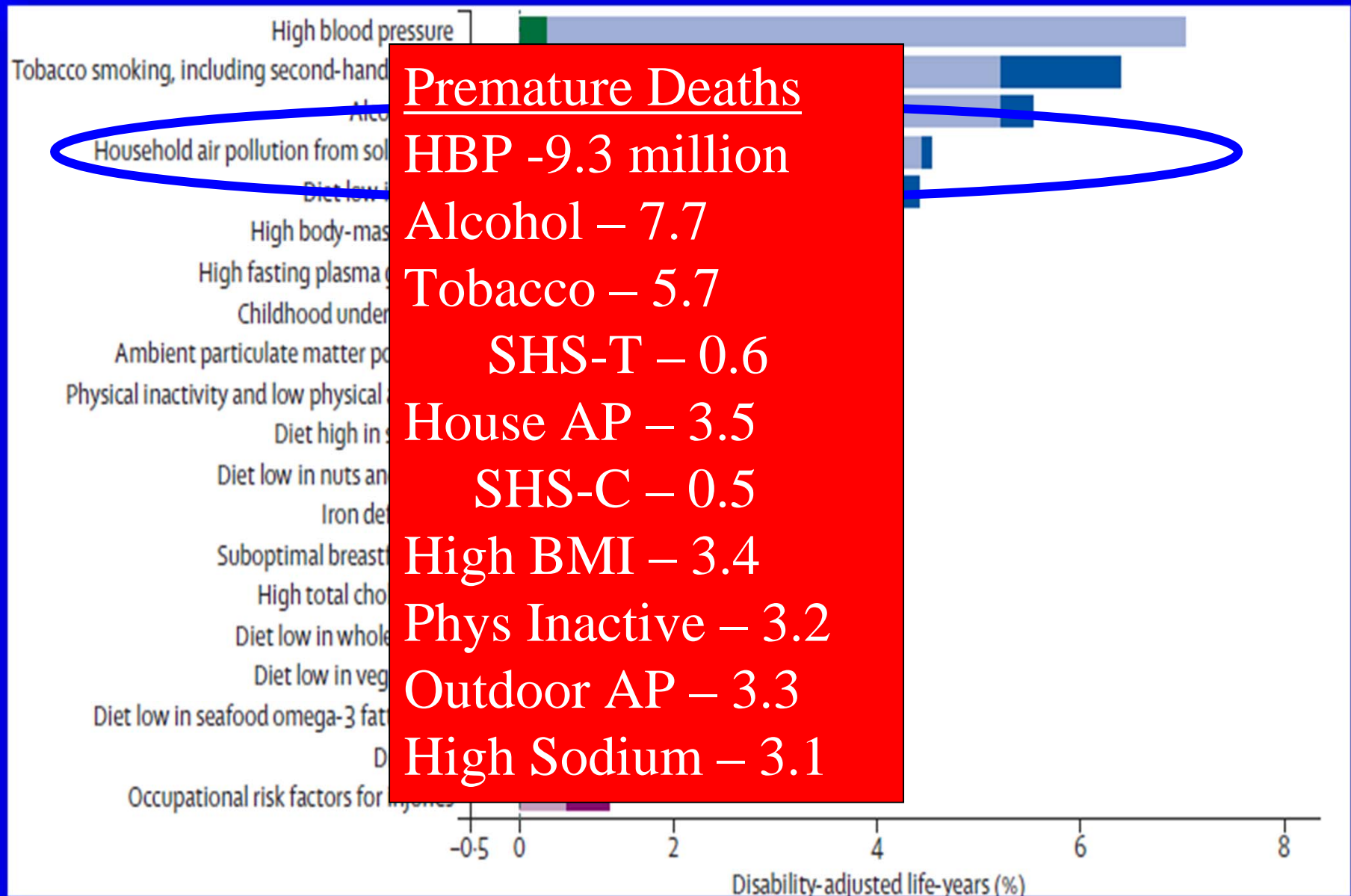
**Estimated 2005 annual average PM_{2.5}
concentrations ($\mu\text{g}/\text{m}^3$)
Perhaps 80% from energy**



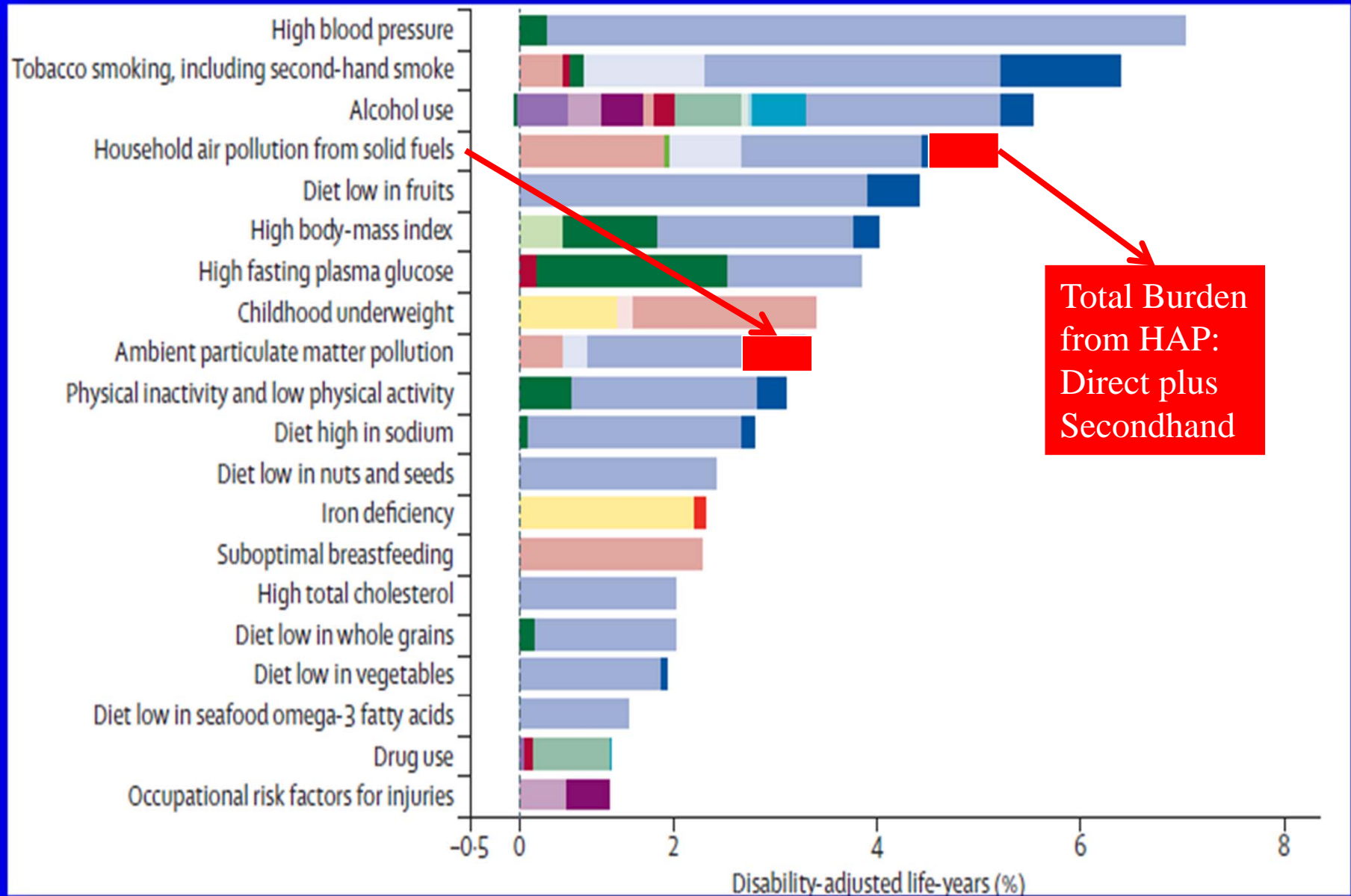
Global DALYs 2010: Top 20 Risk Factors



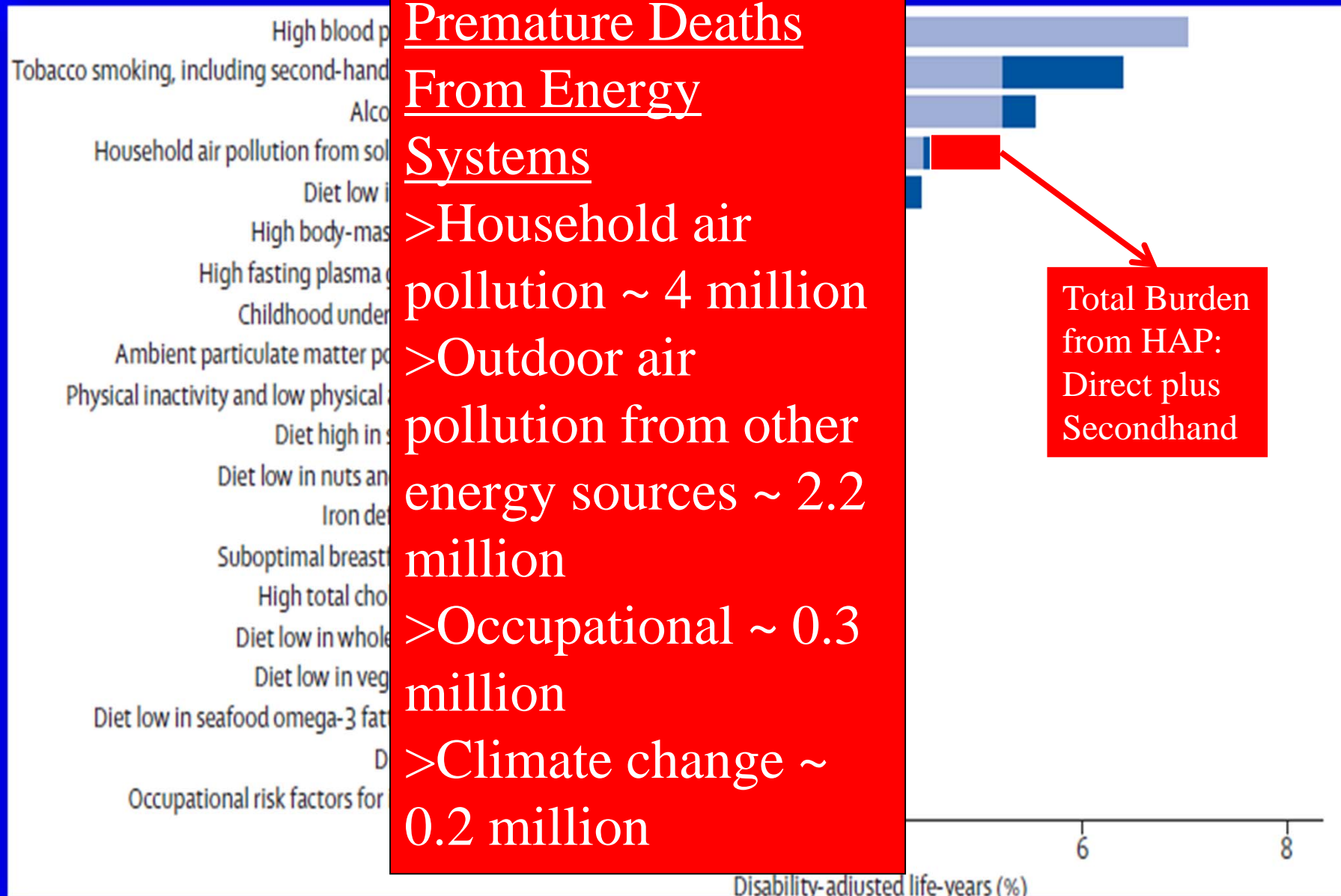
Global DALYs 2010: Top 20 Risk Factors



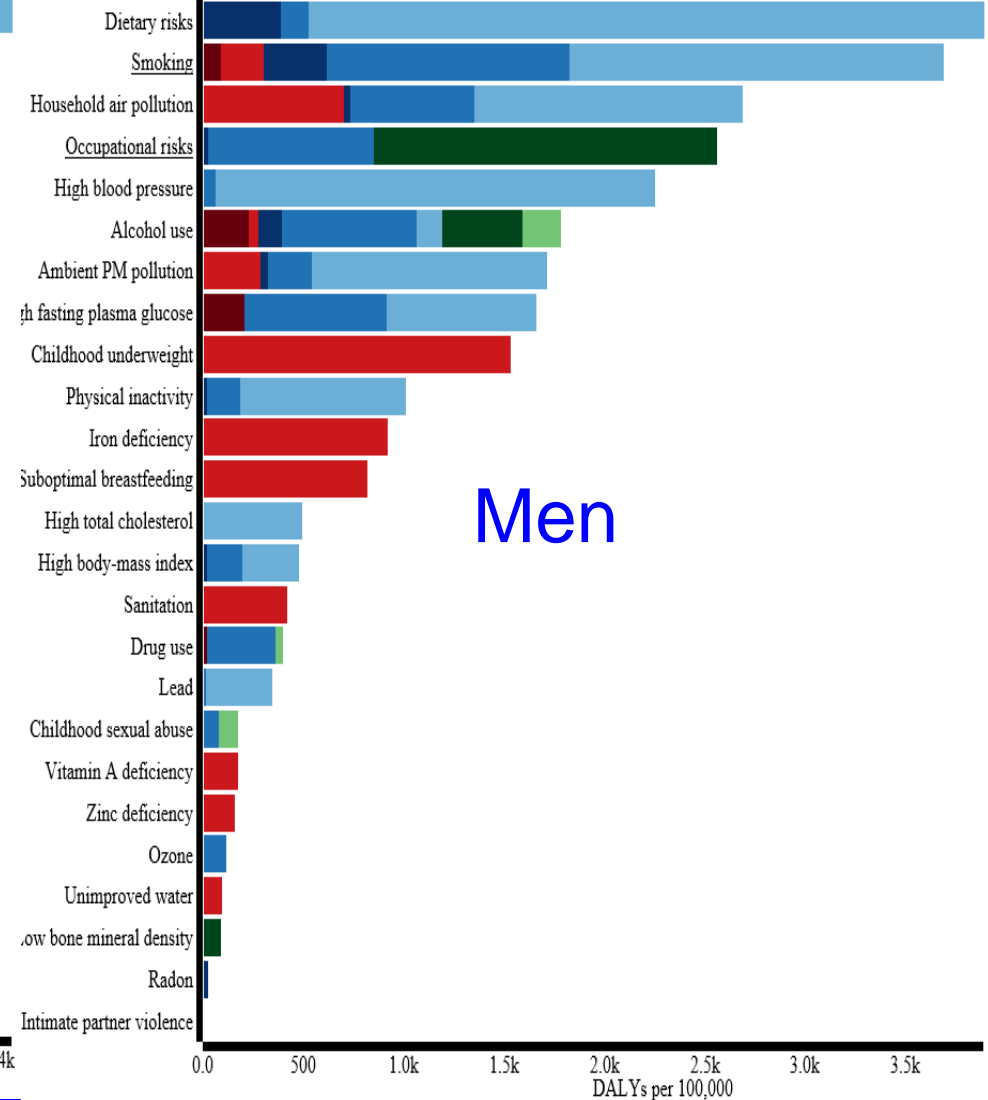
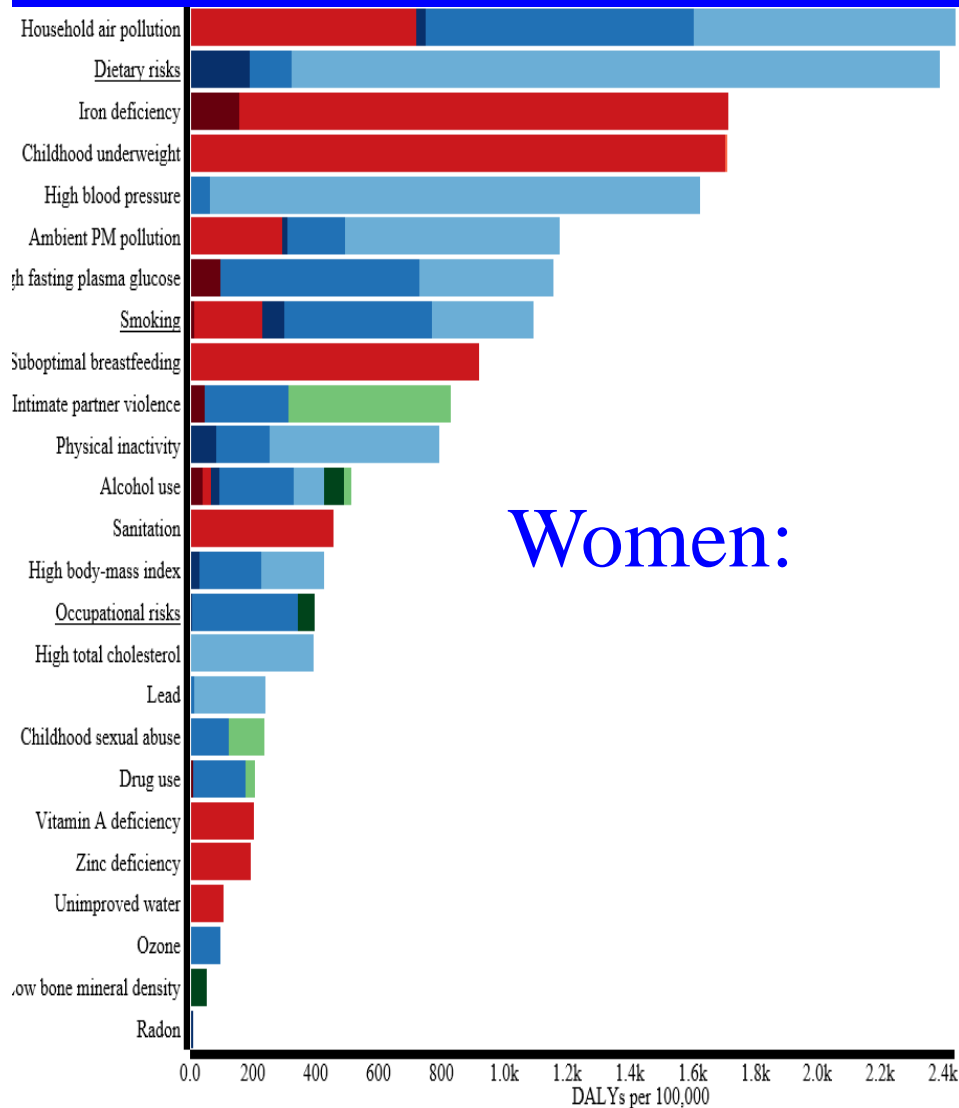
Global DALYs 2010: Top 20 Risk Factors



Global DALYs 2010: Top 20 Risk Factors



Causes of Ill-health in India for 2010



HAP : 1,022,130 Deaths; 31,415,900 DALYs

Poor Combustion is the Largest Cause of Health Impacts from Energy

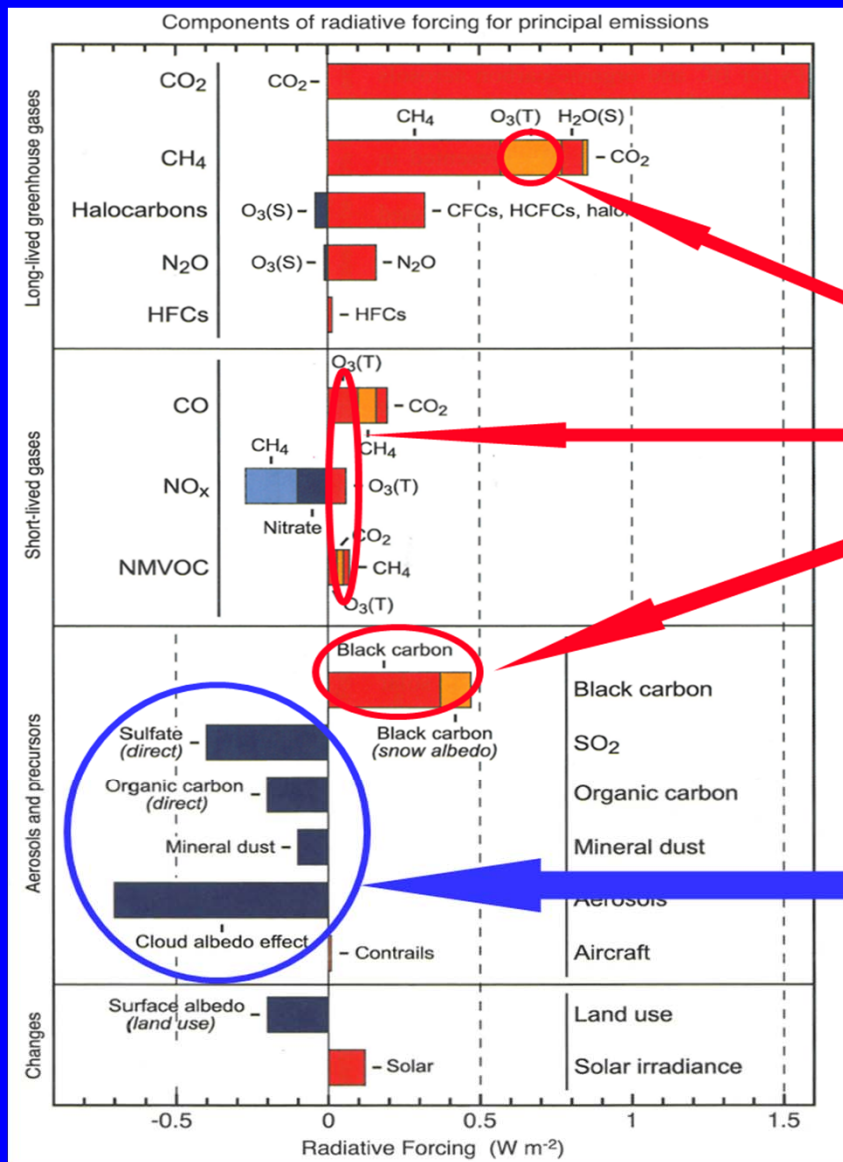
Poor management of fuel combustion is a major cause of ill health globally through emissions of particles and other pollutants

- Largest amount is due to solid fuels: coal and biomass
- Significant impact on child health, perhaps causing 10-15% of child mortality in poor countries
- Important impact on adult health, particularly among poor women, single largest risk factor in many poor countries

Incomplete Combustion is Bad but so is Complete Combustion if from Fossil Fuels – CO₂ and More

- Adds to global warming
- Acidifies the ocean
- Health impacts of global warming are low today, but expected to grow steadily.
- Essentially occur in direct proportion to the vulnerability of populations
- Thus main impacts will be among the poor everywhere
- And largest in third-world children – currently 88% of all impacts

Global Radiative Forcings due to Emissions Changes, 1750–2005 (AR4)

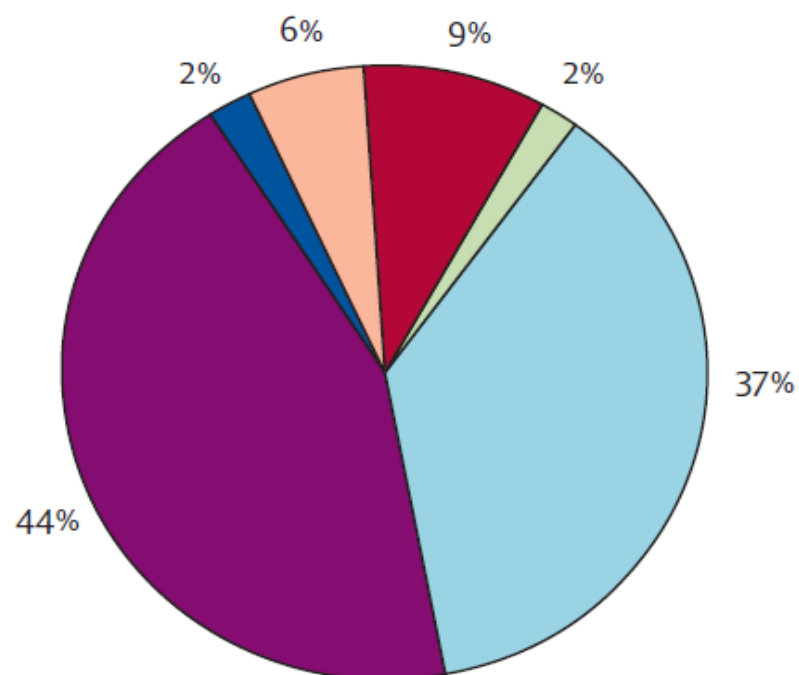


Tropospheric ozone (O₃T) and black carbon have positive radiative forcing

Sulfate and organic carbon have negative radiative forcing both directly and indirectly by making clouds whiter (increasing cloud albedo).

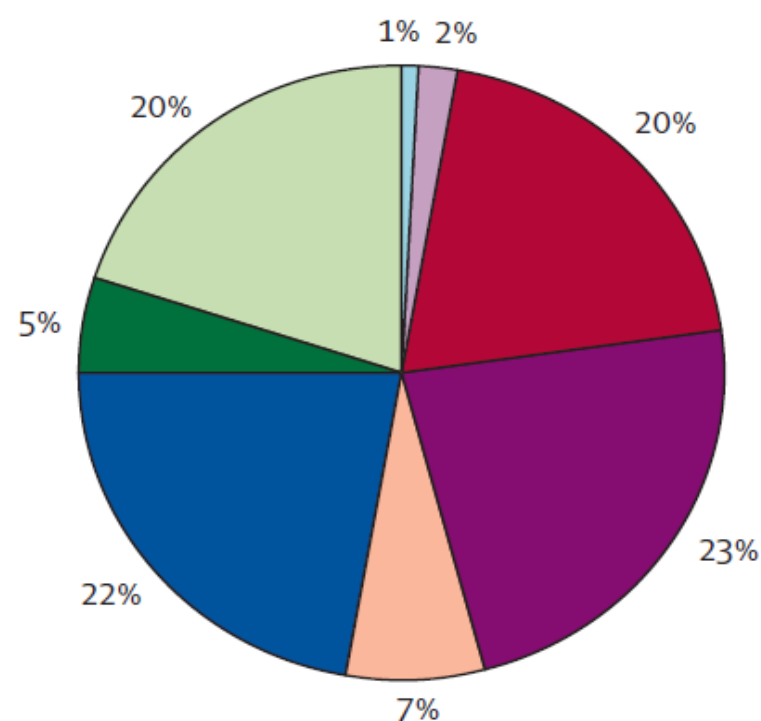
Sulfur Dioxide and Black Carbon Sources

A Sulphur dioxide emissions



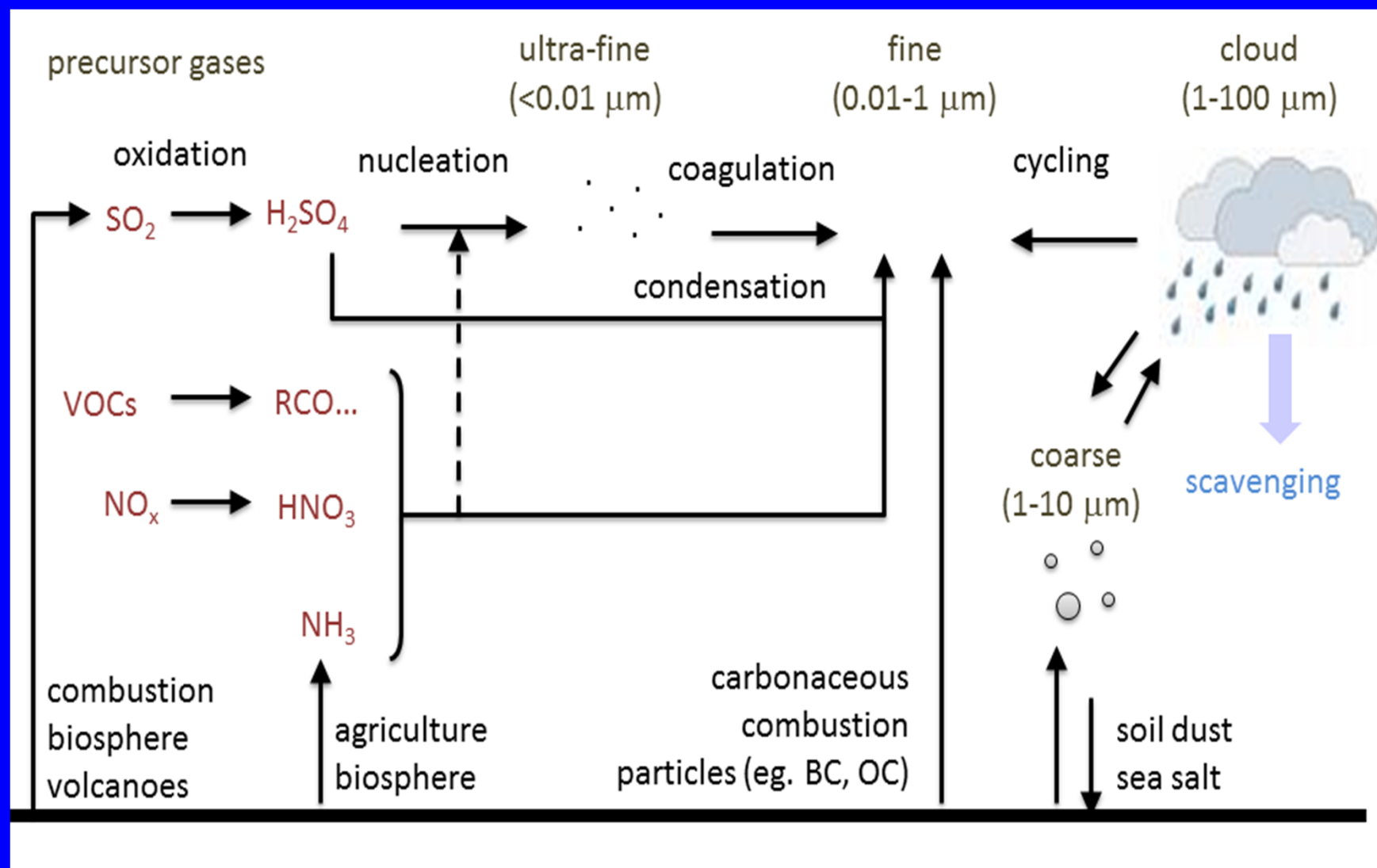
■ Household fossil fuel
■ Transportation
■ Forest, grassland and agriculture burning
■ Power
■ Industry
■ Household biomass fuel

B Black carbon emissions



■ Power
■ Ships and aircraft
■ Ground transport
■ Industry
■ Household fossil fuel
■ Household biomass fuel
■ Agriculture waste
■ Forest and grassland

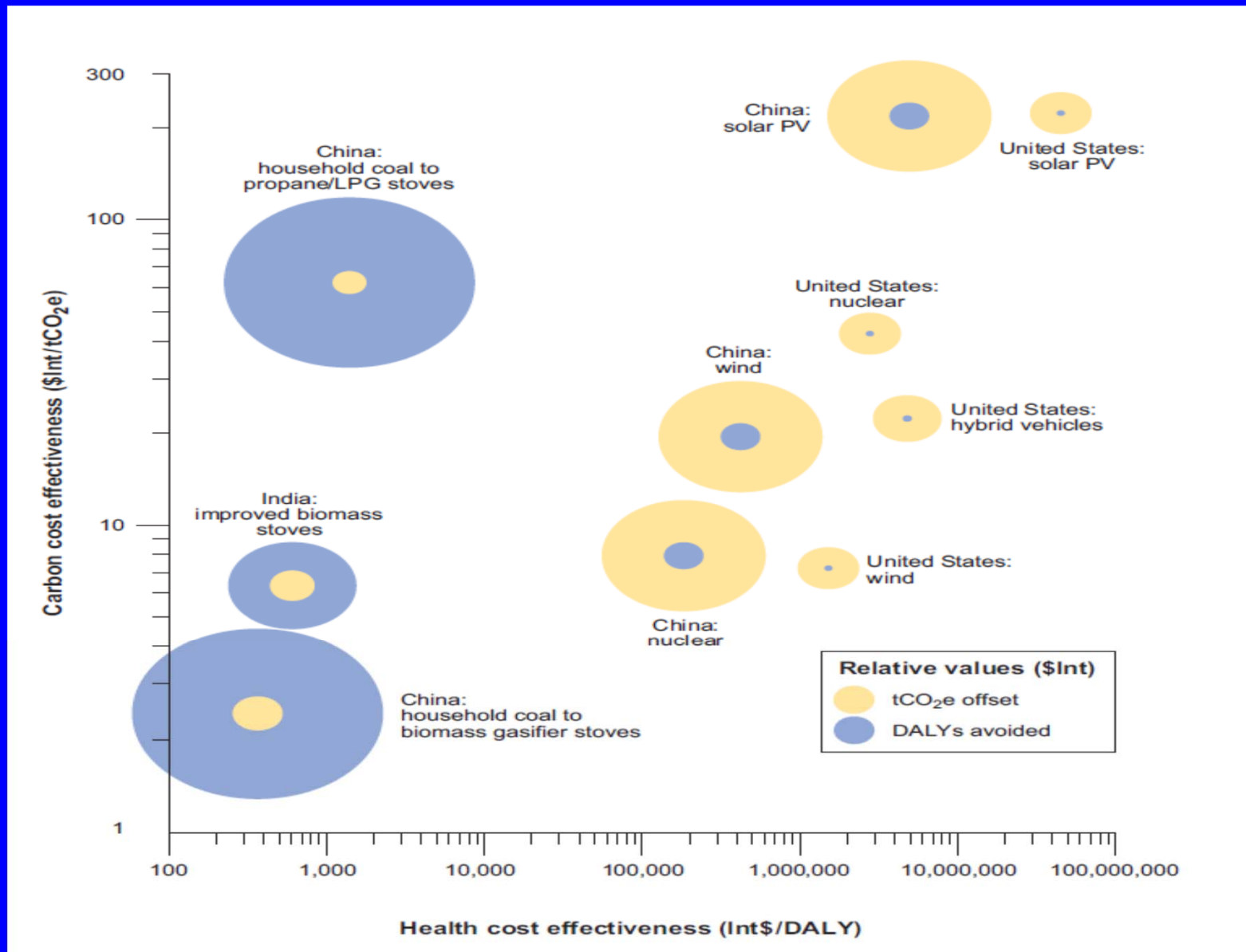
Particulate Matter Sources and Processes



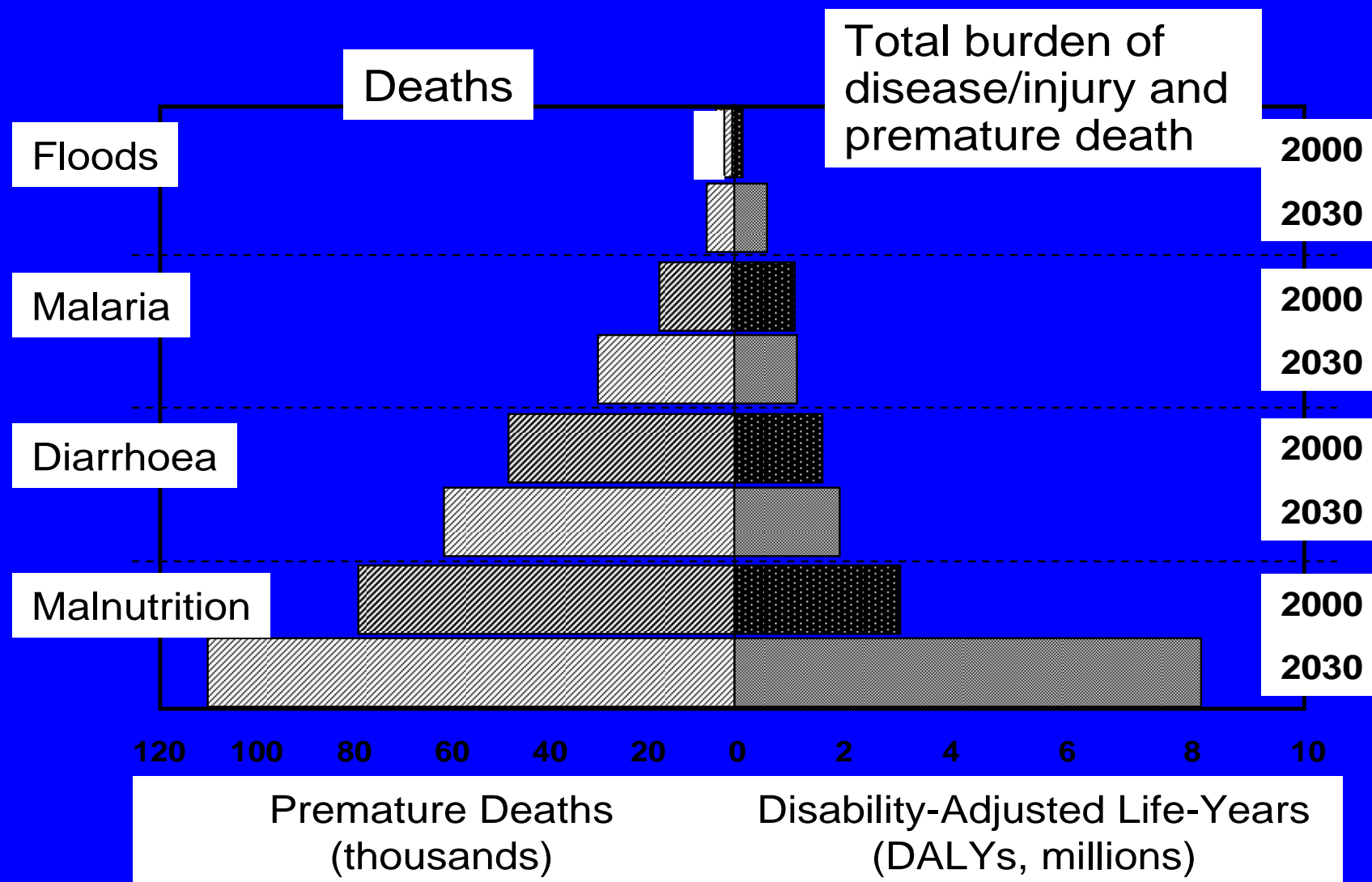
Co-benefits

- Although a wide ranges of changes in energy systems will be needed to fully combat climate change,
- There is a smaller set of interventions that have significant health benefits as well.
- Important energy-system co-benefits opportunities are found in the building, transport, and residential sectors.
- As well as in reproductive health services
- And management of the built environment
- Mitigation benefits are higher in developed countries, but health benefits are much greater in developing countries.
- These actions should be considered first so that society continues to move toward meeting health goals as well as mitigating climate change.
- In addition, improving health in poor communities will make the world less vulnerable to climate change's impacts.

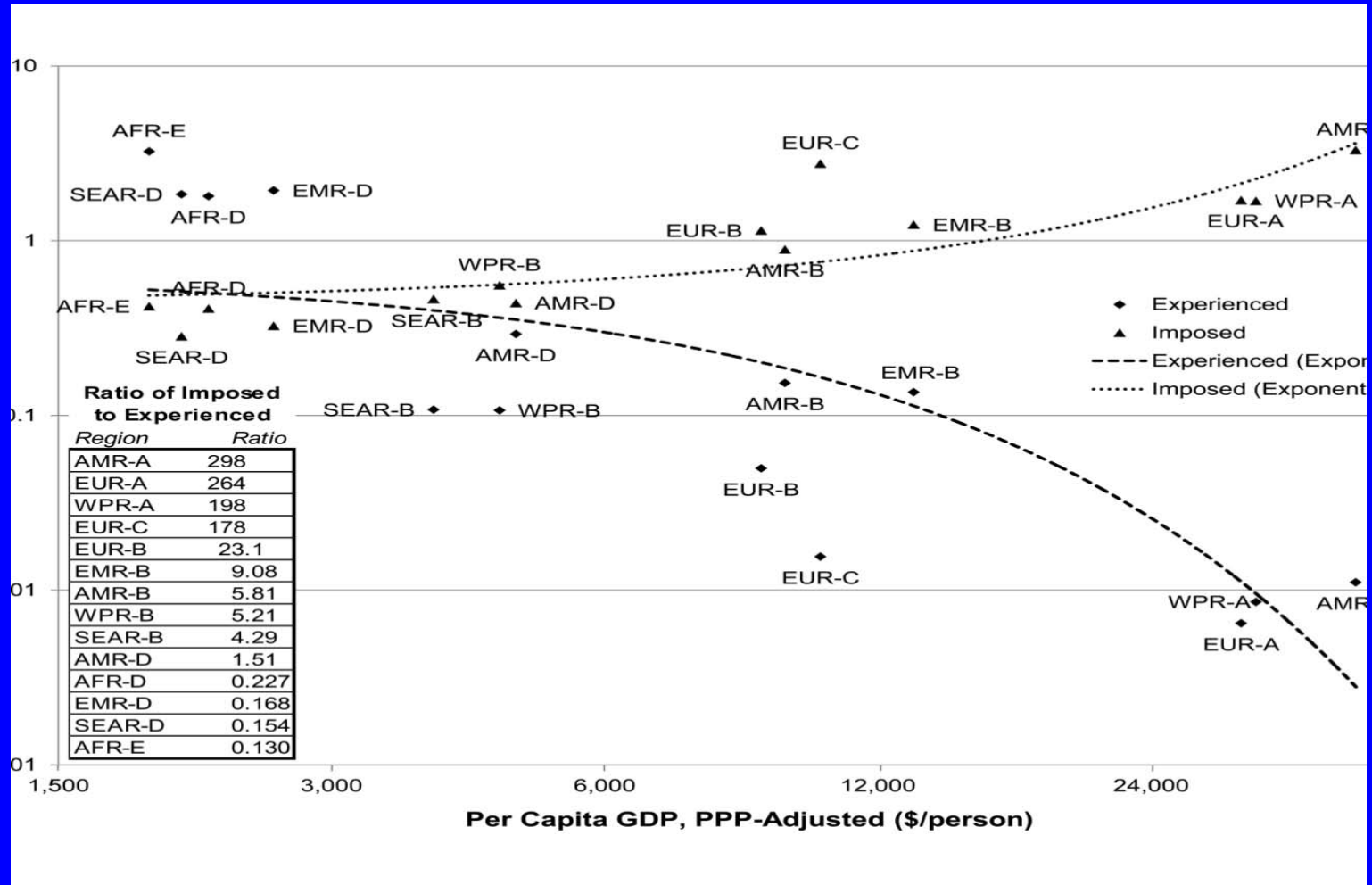
Examples of Co-benefits Analysis



Deaths and Total Burden of Disease Attributable to Climate Change

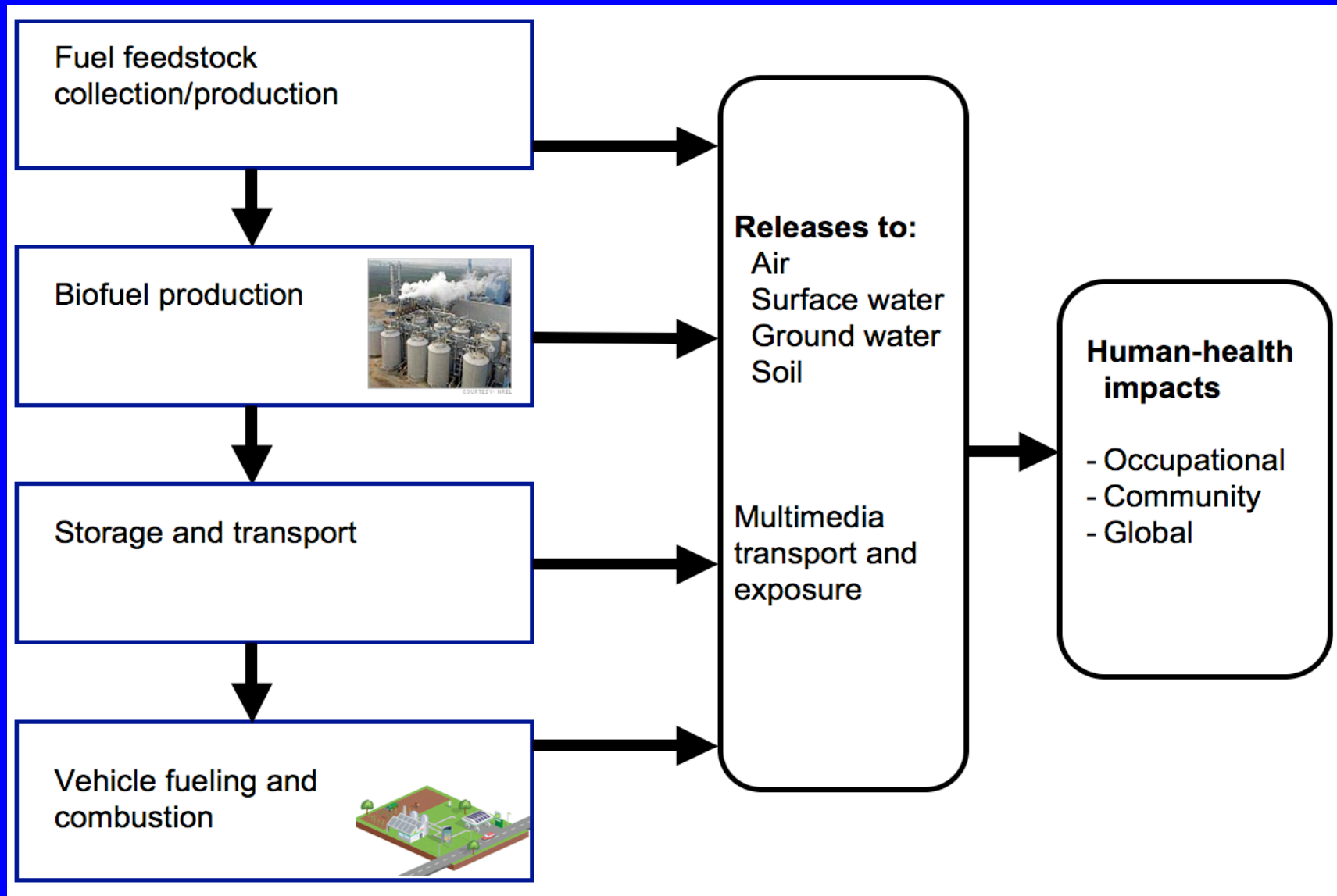


Climate Change and Health: Global Distribution

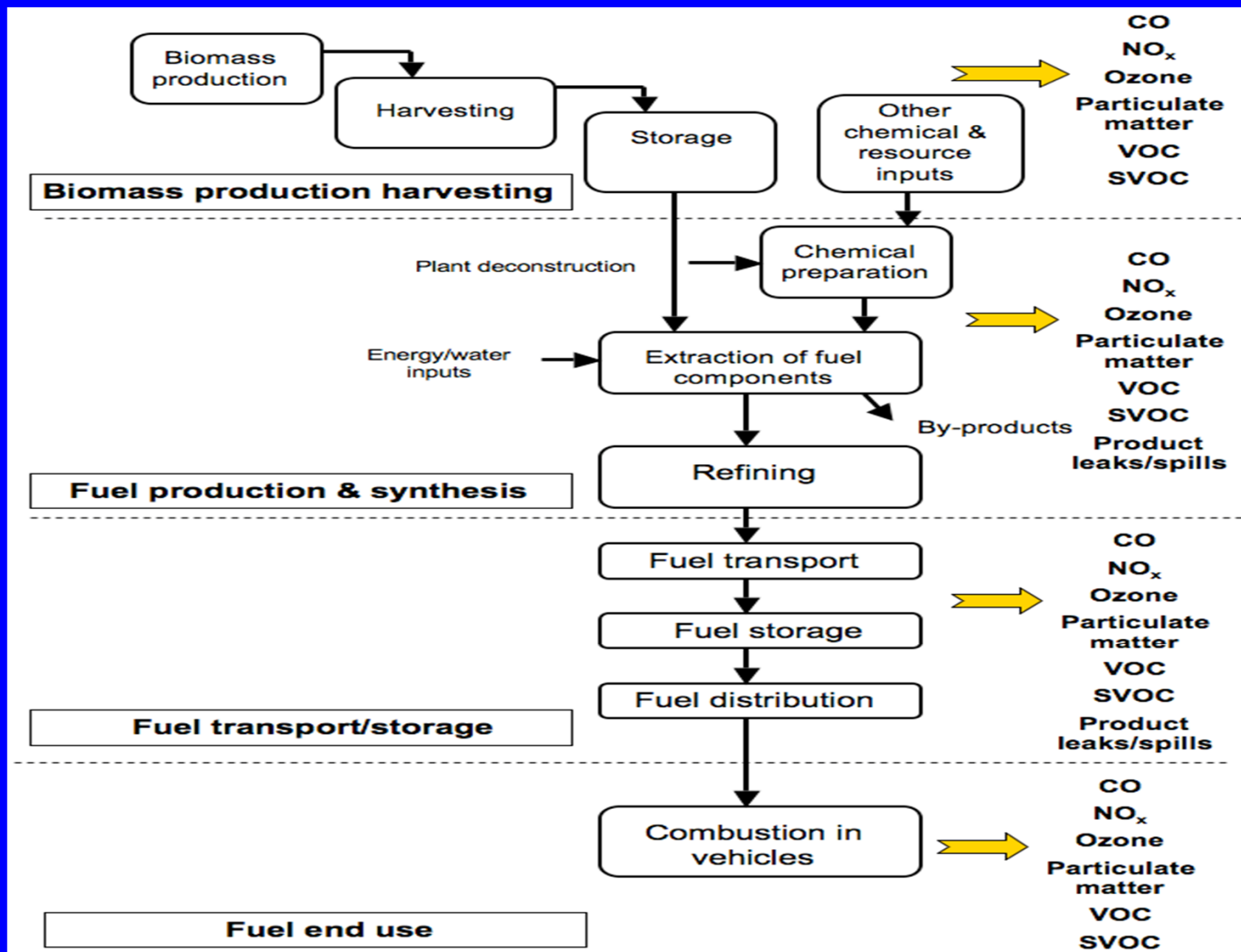


Experienced ill-health due to climate change last decade, lower line
Imposed ill-health from CO₂ & CH₄ emissions last decade, upper line

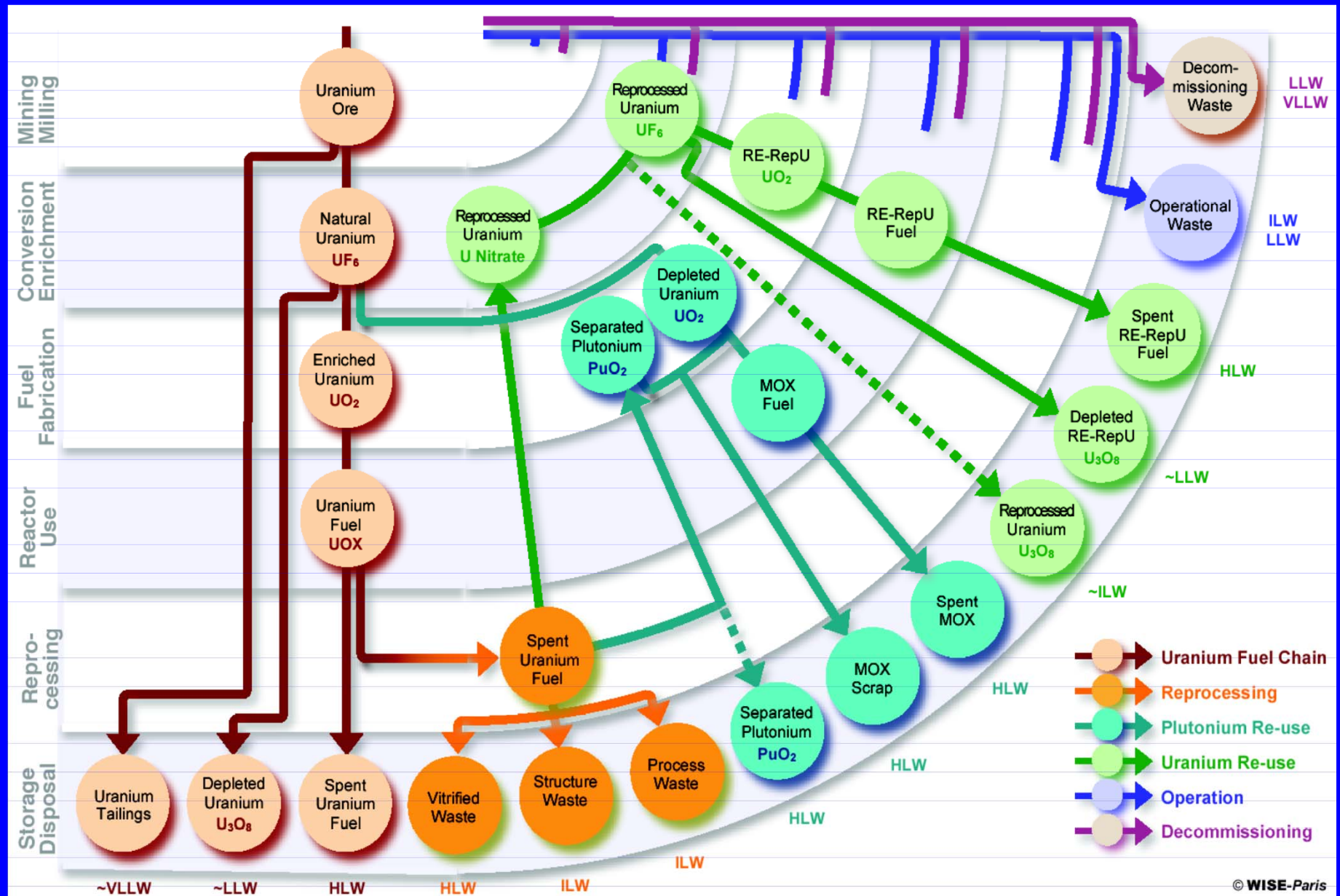
Life-cycle Approach



Pollutants Associated with Biofuel Production, Transport and Use



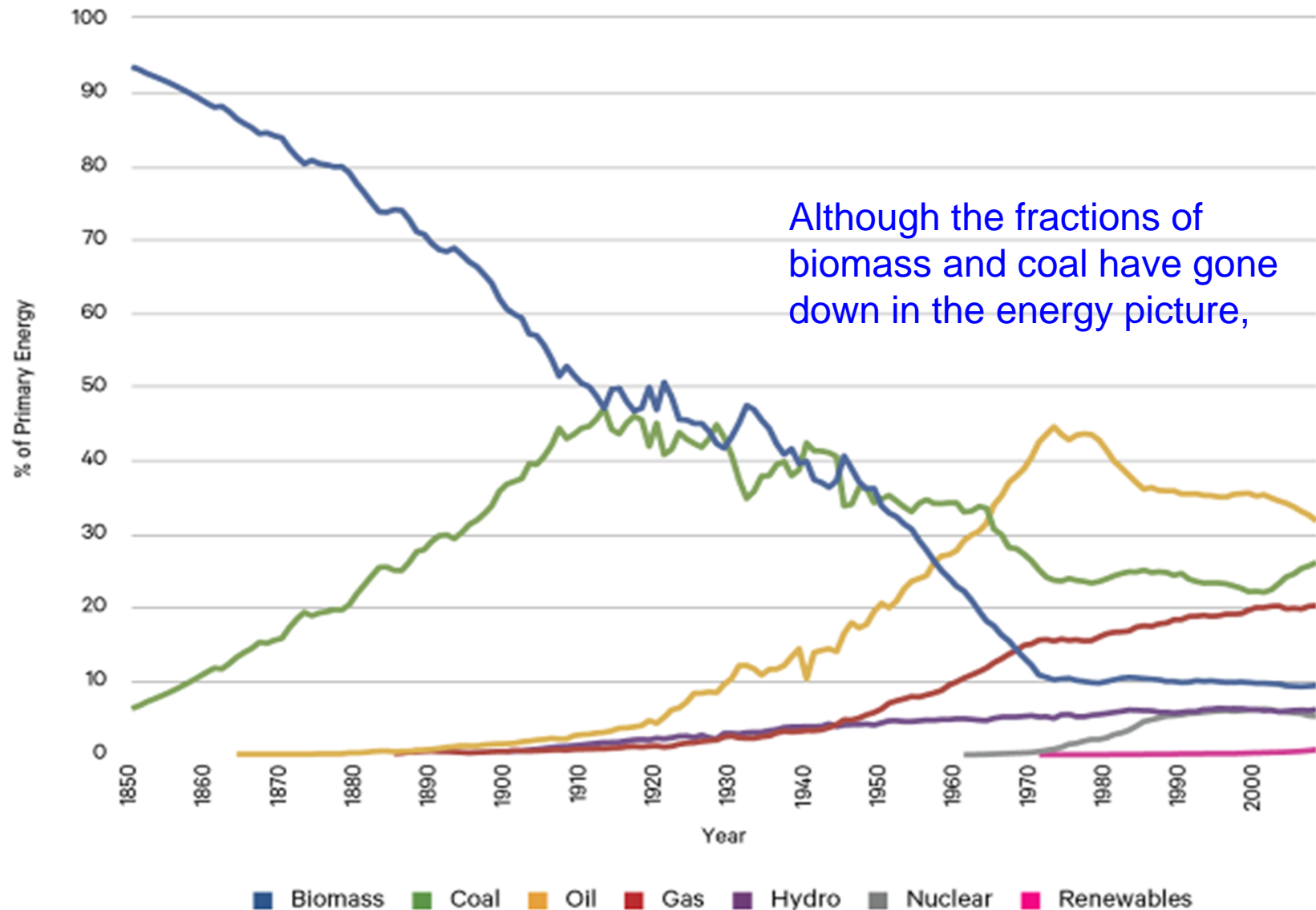
The Nuclear Fuel Chain



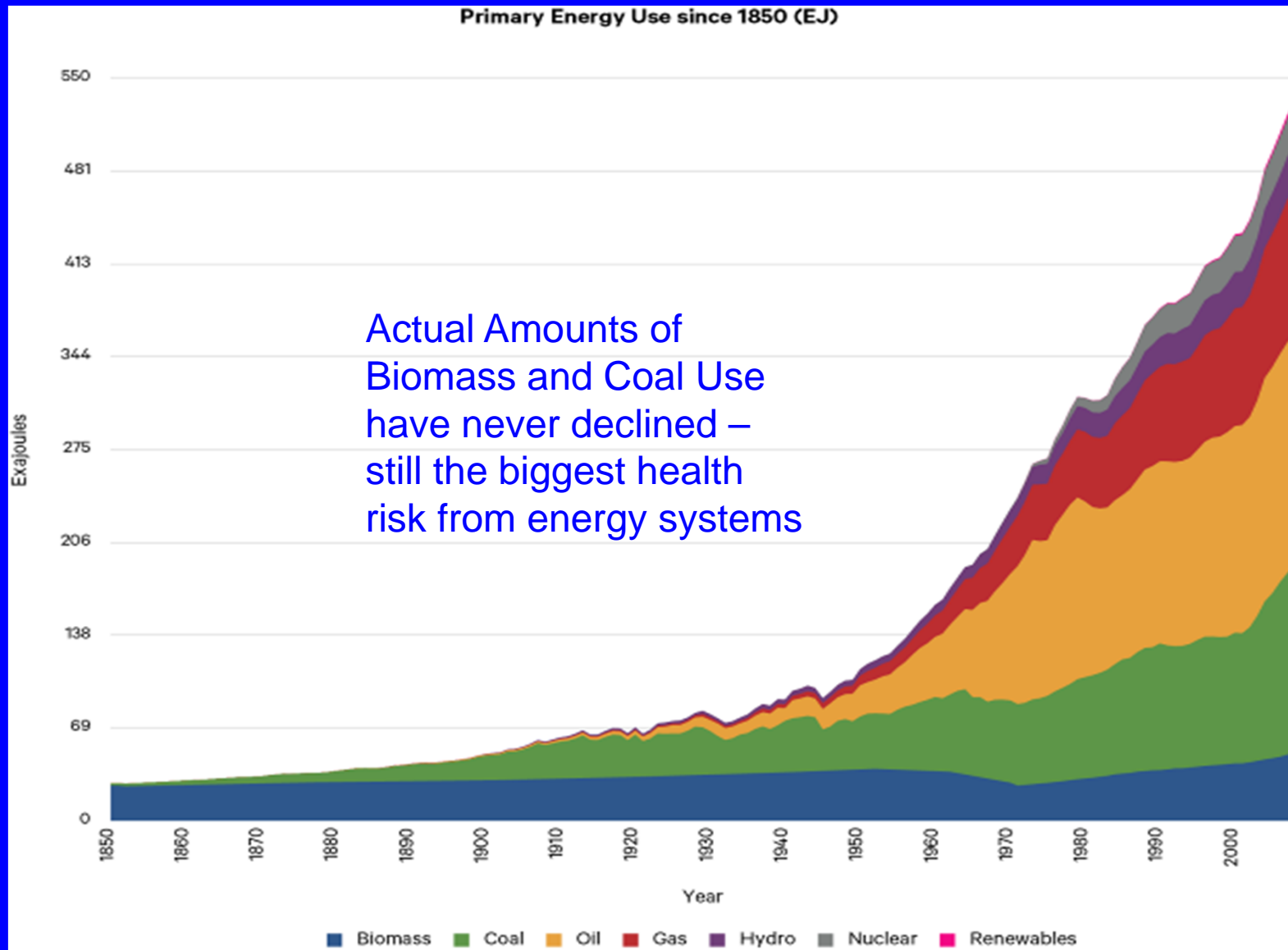
Major Impacts on Global Health from Energy Systems

- Biomass/coal for household use – lack of clean fuels and good combustion
- Outdoor air pollution – not just urban, mostly from fossil fuels but also from biomass
- Occupational impacts from solid fuel harvesting and processing (coal and biomass)
- Climate change – mostly CO₂ from fossil fuels, but also shorter-lived GHPs from incomplete combustion of fuels and other parts of fuel cycles.

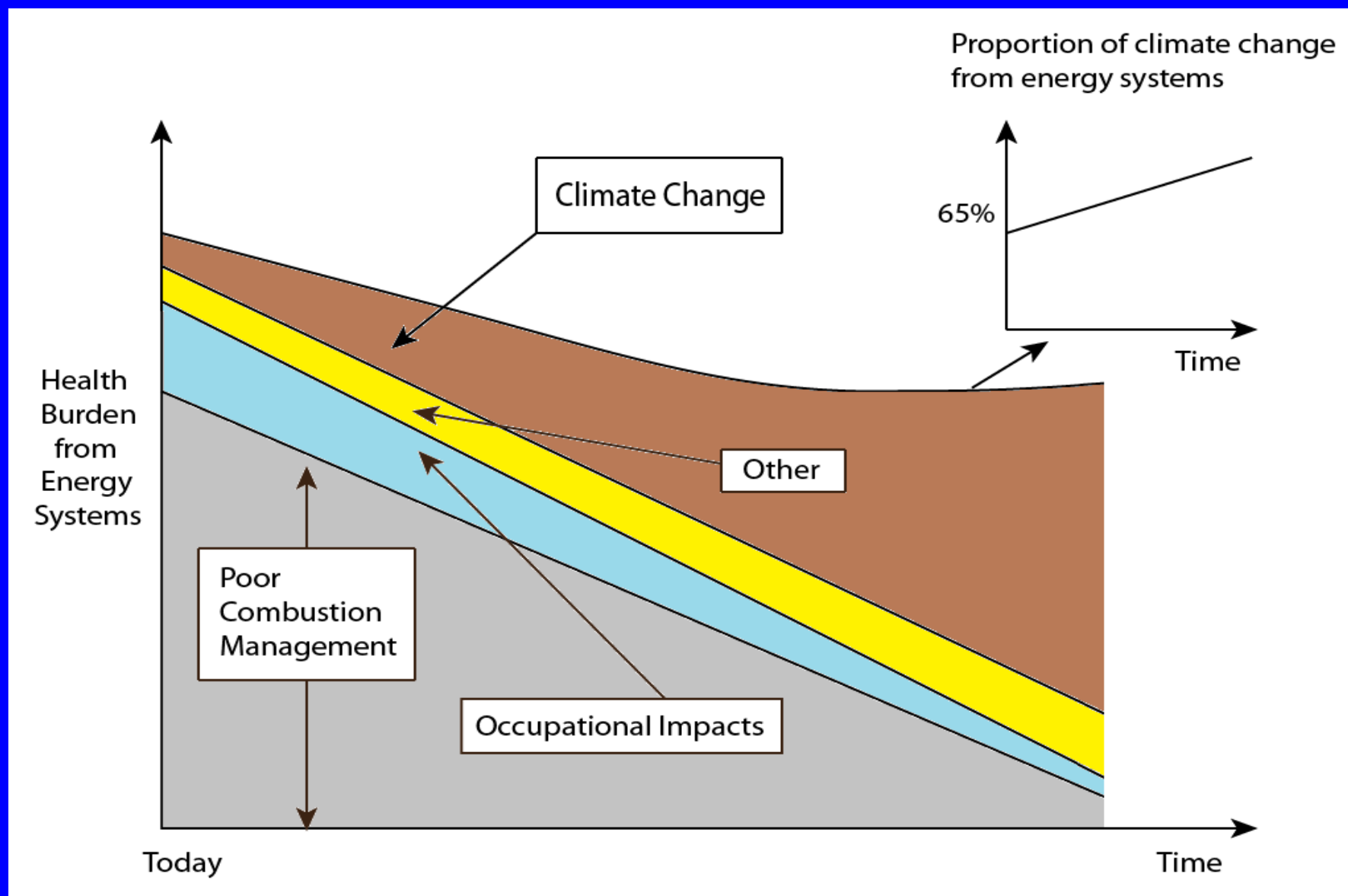
World Primary Energy Shares



World Primary Energy Use



Trends in Health Impacts from Energy Systems



Based on the GEA chapter, a shorter version was recently published

“Energy and Human Health”

*Annual Review of Public Health,
34: 159-188, 2013*

Kirk R. Smith, Howard Frumkin, Kalpana Balakrishnan,
Colin D. Butler, Zoe A. Chafe, Ian Fairlie, Patrick
Kinney, Tord Kjellstrom, Denise L. Mauzerall, Thomas
E. McKone, Anthony J. McMichael, and Mycle
Schneider