Health and climate co-benefits: a survey of the mitigation landscape

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Why Worry about Co-benefits?

- Helps reduce the cost of mitigation by sharing cost with other sectors.
- Recognizes that society still has major goals besides avoiding climate change, such as providing acceptable levels of health protection
- Potentially reduces political gap between developed and developing countries in international climate negotiations – early achievement of more certain benefits that directly relate to development needs (“no regrets investments”)

Major Categories of Co-benefits

- There is no sector that does not have at least some relation to energy, health, and climate
- Here, however, are listed examples only in sectors that have potentially significant positive impacts on health and climate protection.
- Here, I do not include climate mitigation measures that may have significant negative impacts on health, such as promoting biofuels from agricultural land, etc.

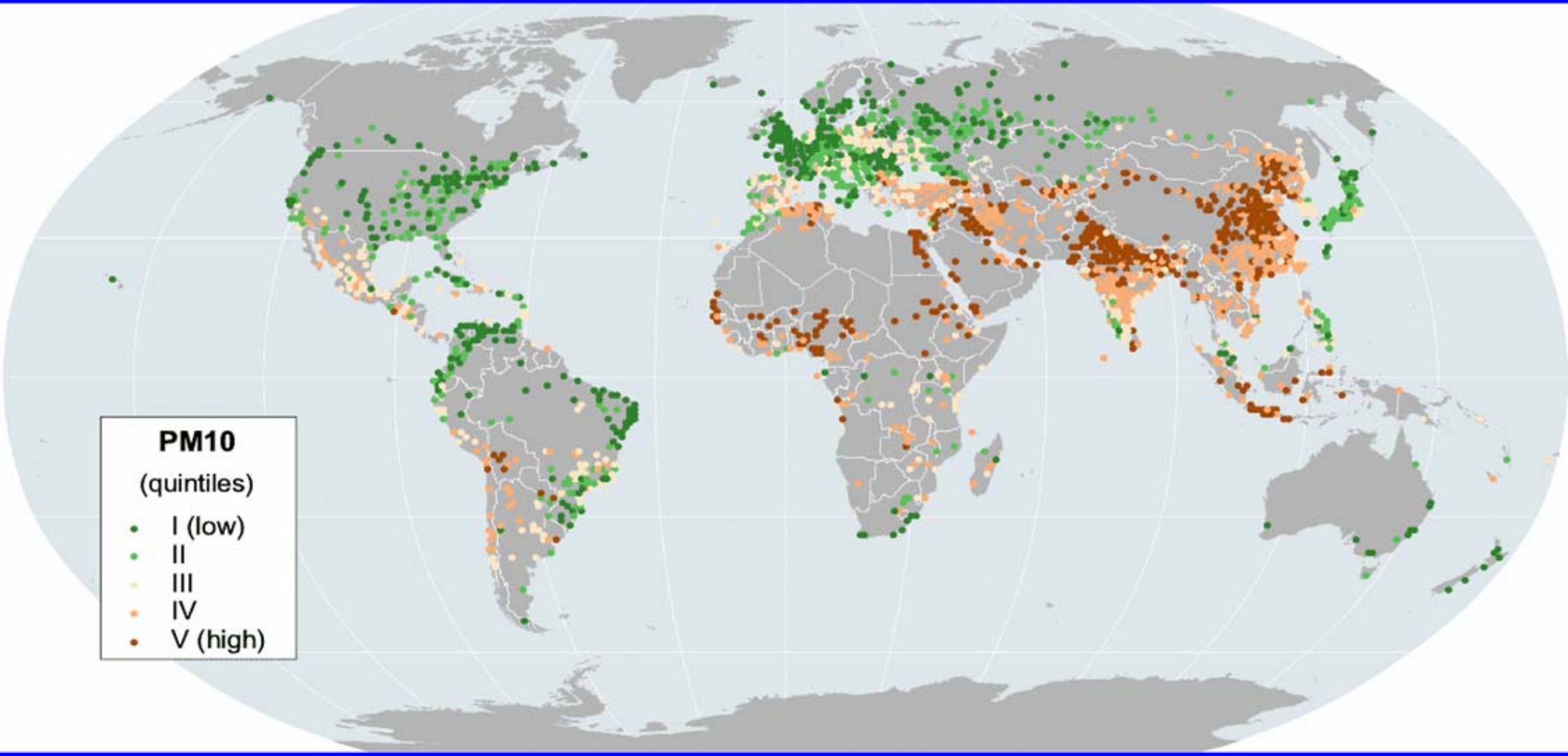
World Views Not The Same

- Climate change mitigation is aimed to avoid changing climate from today – current climate is thus the de facto “ideal”
- The current global health situation, however, is neither ideal nor acceptable, but much change is already needed
- The implications of this difference in perspective is often not recognized when co-benefits projects are framed.

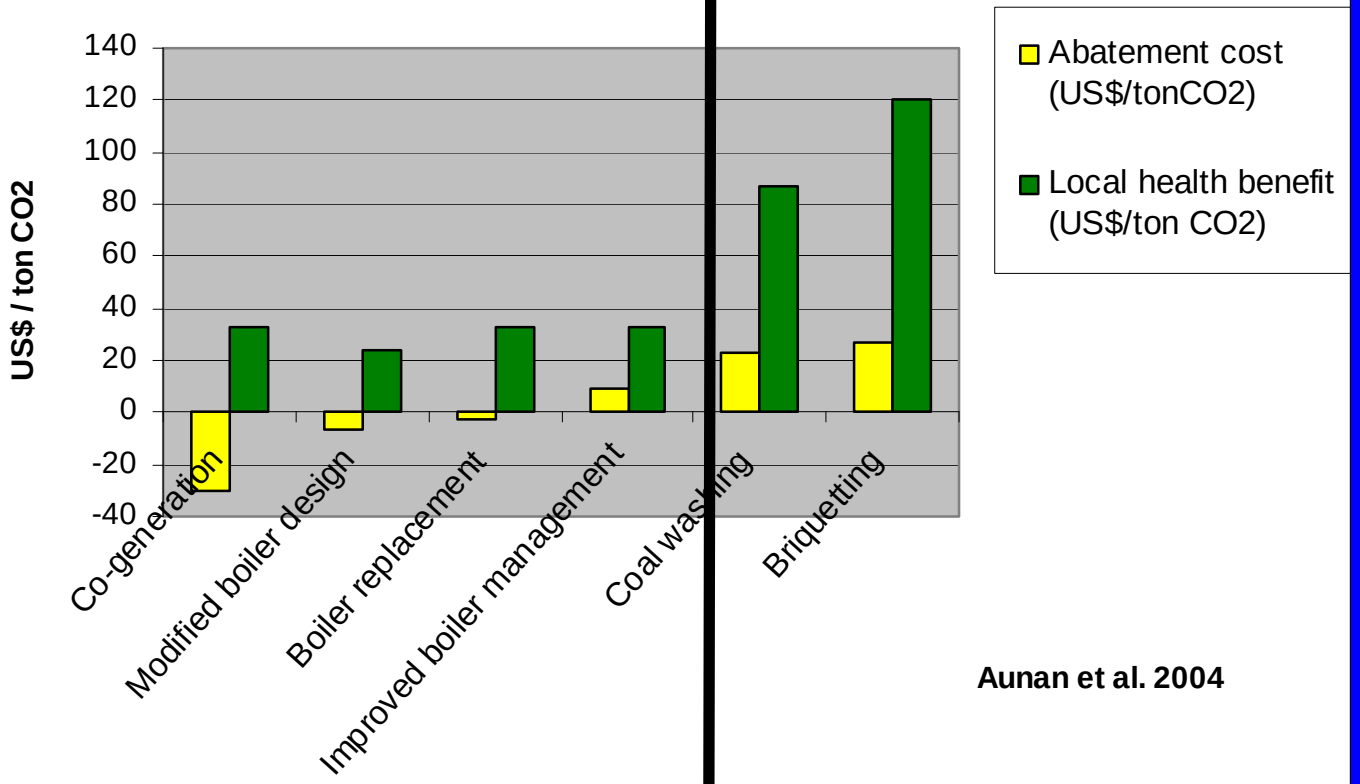
Air Pollution from Energy Use

- Household solid fuels
  - Large source of ill-health worldwide in poorest populations – 1.6 million premature deaths
  - Non-renewable biomass and coal carbon emissions
  - Poor combustion leads to non-CO2 GH-related emissions
- Outdoor emissions from energy systems
  - 0.8 million premature deaths
  - Most well documented benefits, climate and health
- Some difficult issues related to relative climate impacts of different aerosols, e.g., BC, sulfates, organic carbon, brown carbon

Estimated PM10 Concentration in World Cities (pop=100,000+)



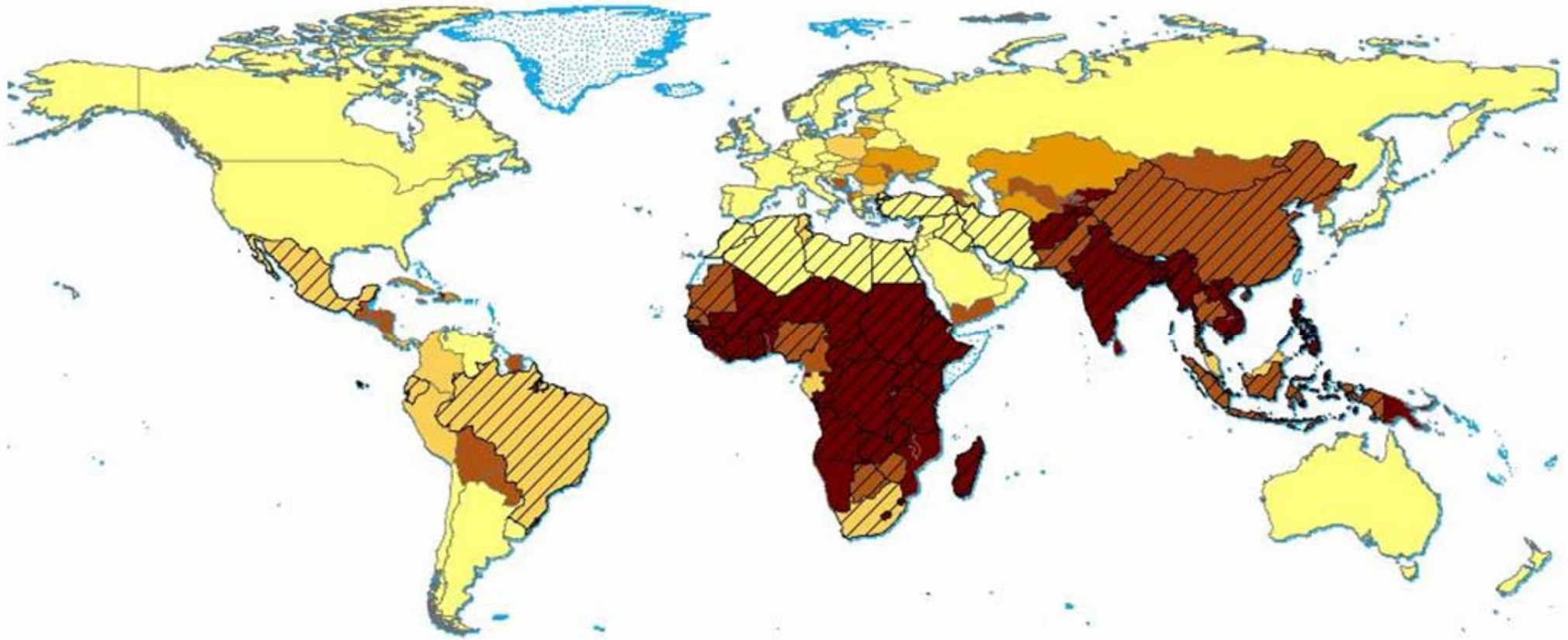
Value of Health Benefits from Energy System Improvements in Shanxi, China



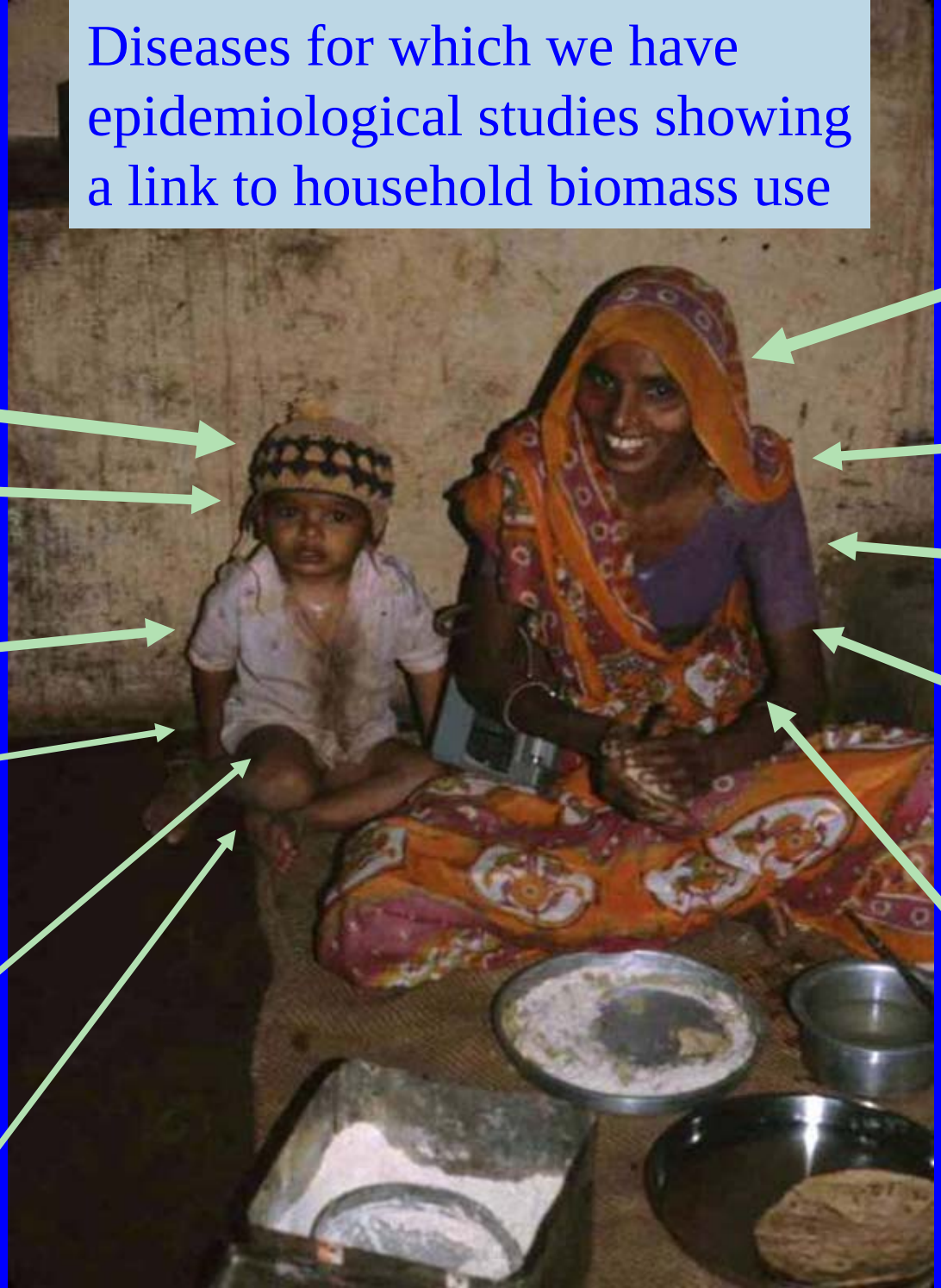
Aunan et al. 2004

Outdoor | **Indoor**

National Household Solid Fuel Use, 2000



Diseases for which we have epidemiological studies showing a link to household biomass use



ALRI/ Pneumonia (meningitis)

Low birth weight

Asthma?

Early infant death?

Birth defects?

Cognitive Impairment?

Chronic obstructive lung disease

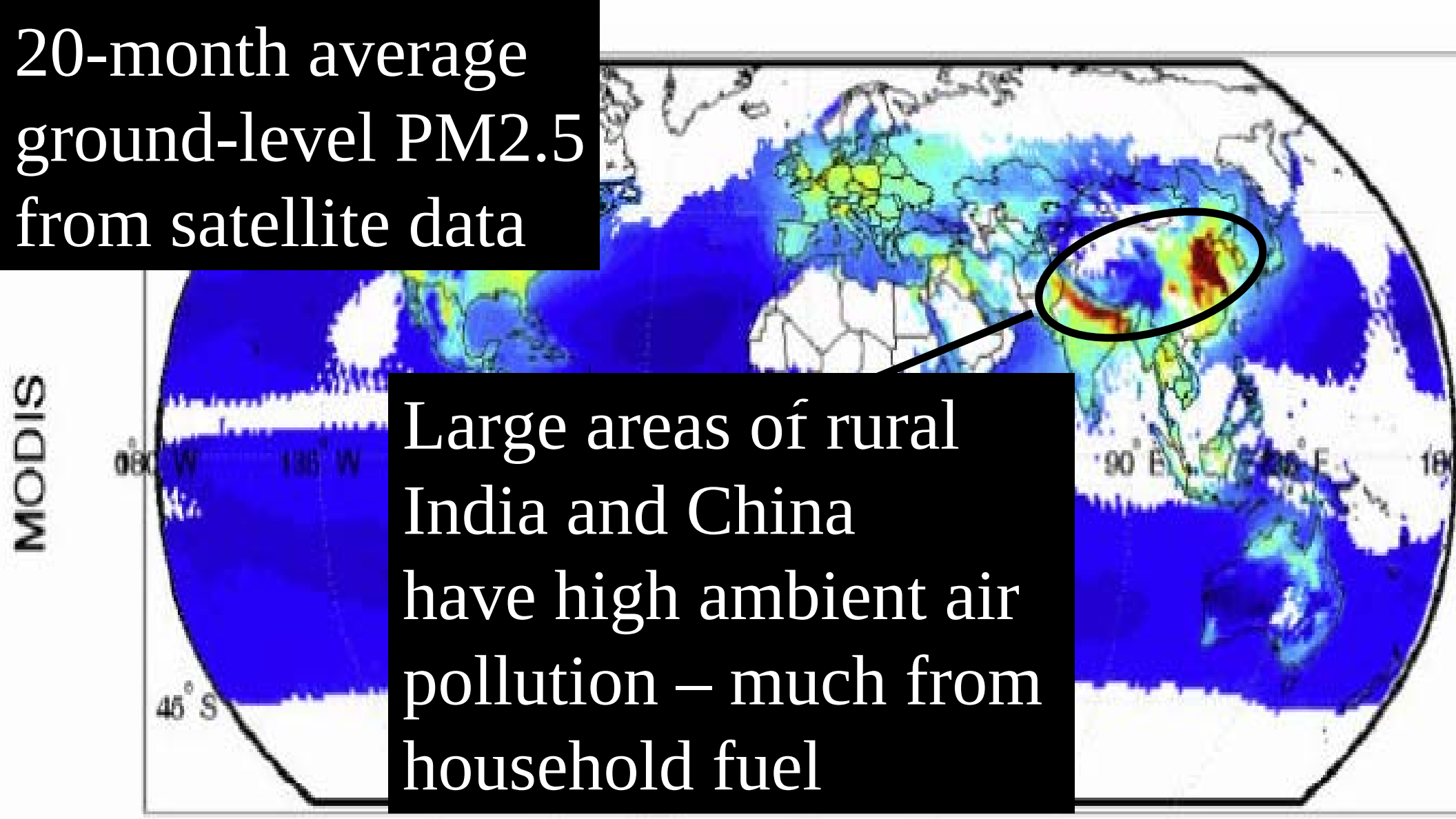
Tuberculosis

Blindness (cataract trachoma)

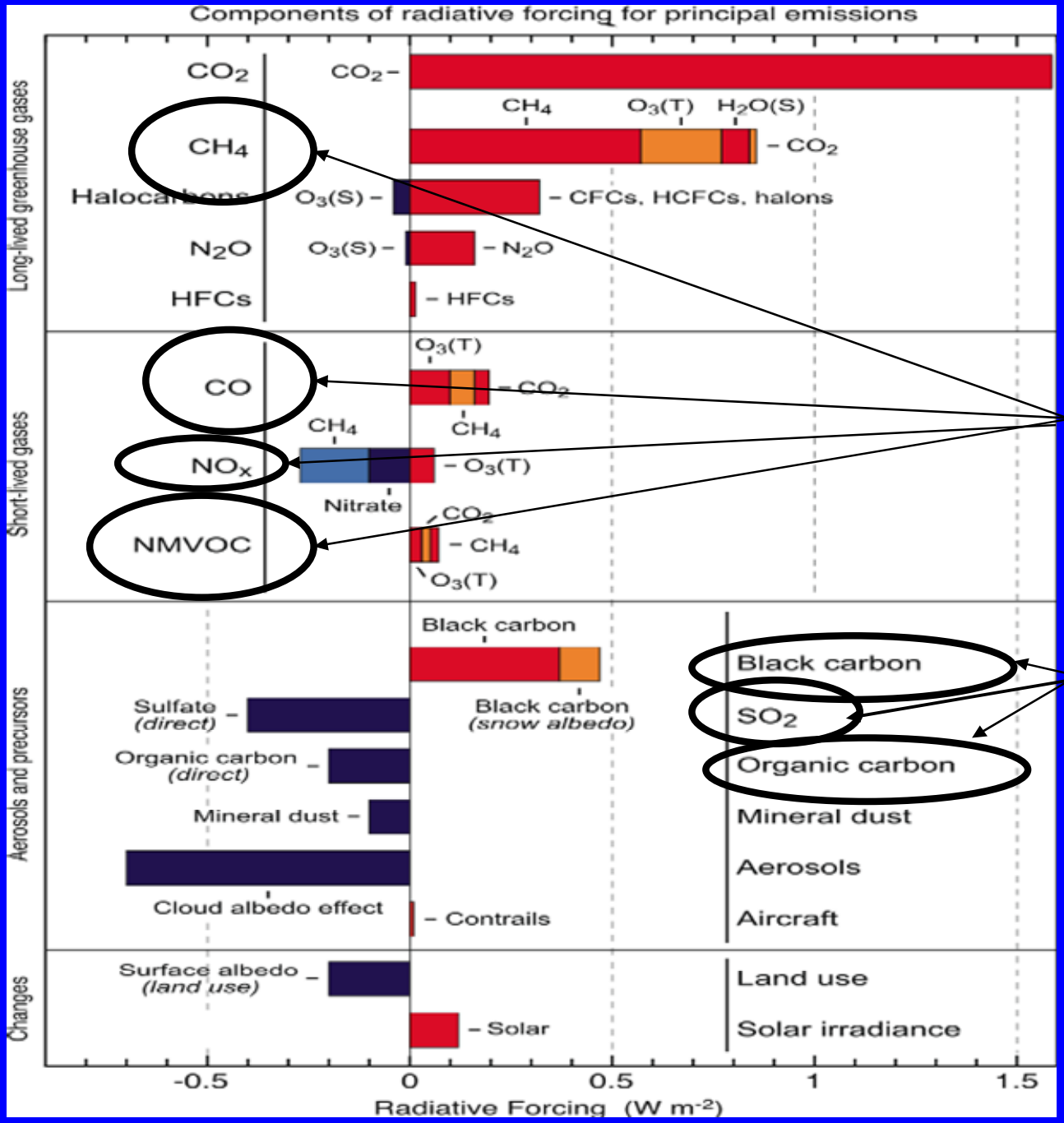
Cancer? (lung, NP, cervical, aero-digestive)

Heart disease

20-month average ground-level PM2.5 from satellite data



Large areas of rural India and China have high ambient air pollution – much from household fuel



Warming in 2005 from emissions since 1750 (IPCC, 2007)

Health-damaging air pollutants largely from energy systems

Modifying the Built Environment

- Obesity, traffic accidents, and lack of physical activity responsible for 3+ million additional premature deaths annually
- Reduce vehicle use (air pollution, obesity, safety, etc)
- Change urban design to increase physical activity (obesity, air pollution, safety)
- Improve energy efficiency of buildings (avoid health risks of energy poverty)

Enhancing Biomass Carbon Storage

- Reforestation in river basins to reduce flood risks – Yangtze River Basin Commission
- Increase green space in cities and forests in rural areas – identifiable mental, livelihood, and other benefits to local populations

Redirecting Diet Preferences

- Livestock responsible for 20+% of global greenhouse emissions – methane from animal digestion plus operation of meat/dairy feed/supply systems
- Converge on lower mean global red meat consumption
  - Suggested 90 g/wk – Lancet 2007
  - Major health benefits: heart disease, stroke, obesity, bowel and breast cancer
- Similar benefits to convergence in global dairy consumption
- China/India have the major global growth potential

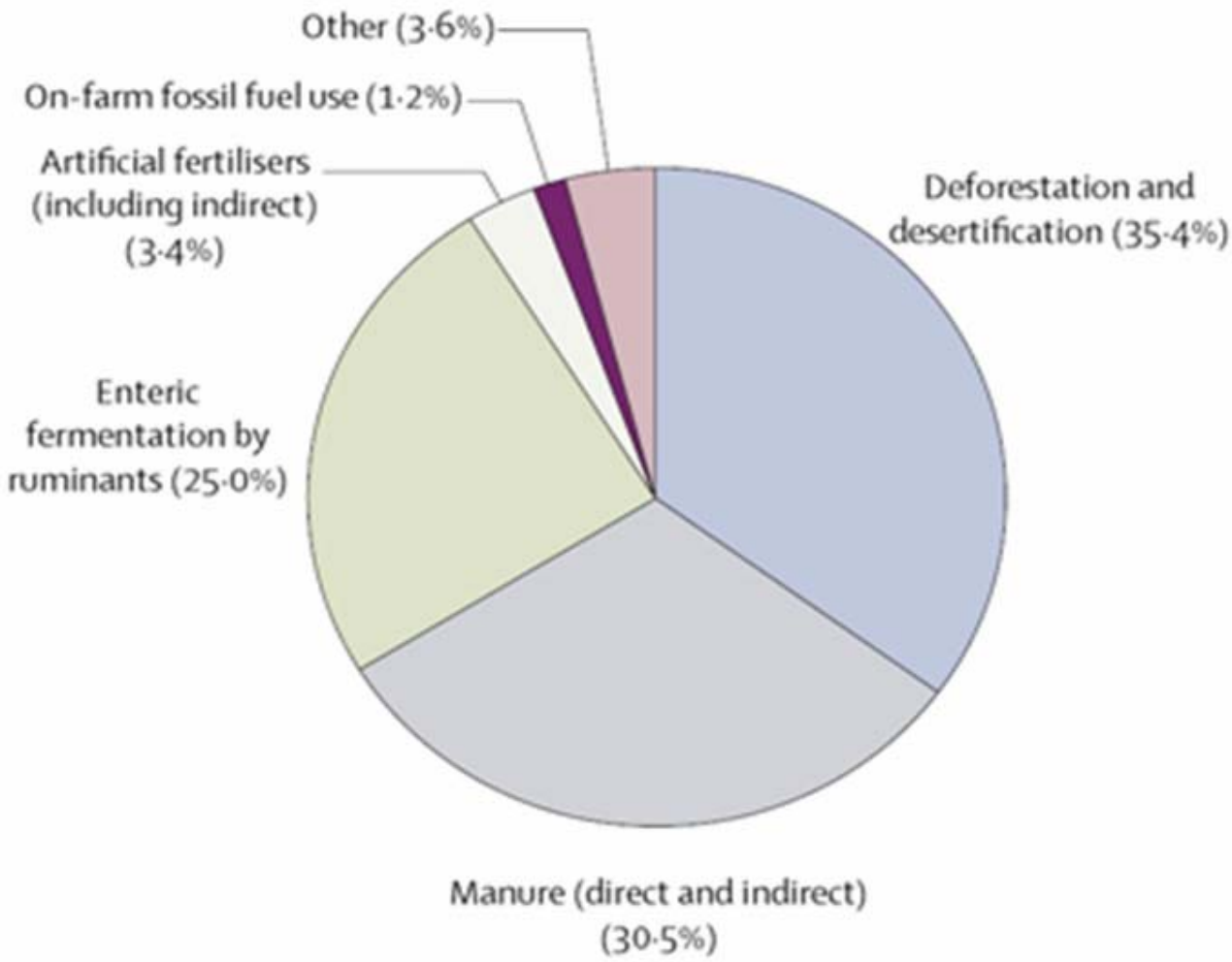
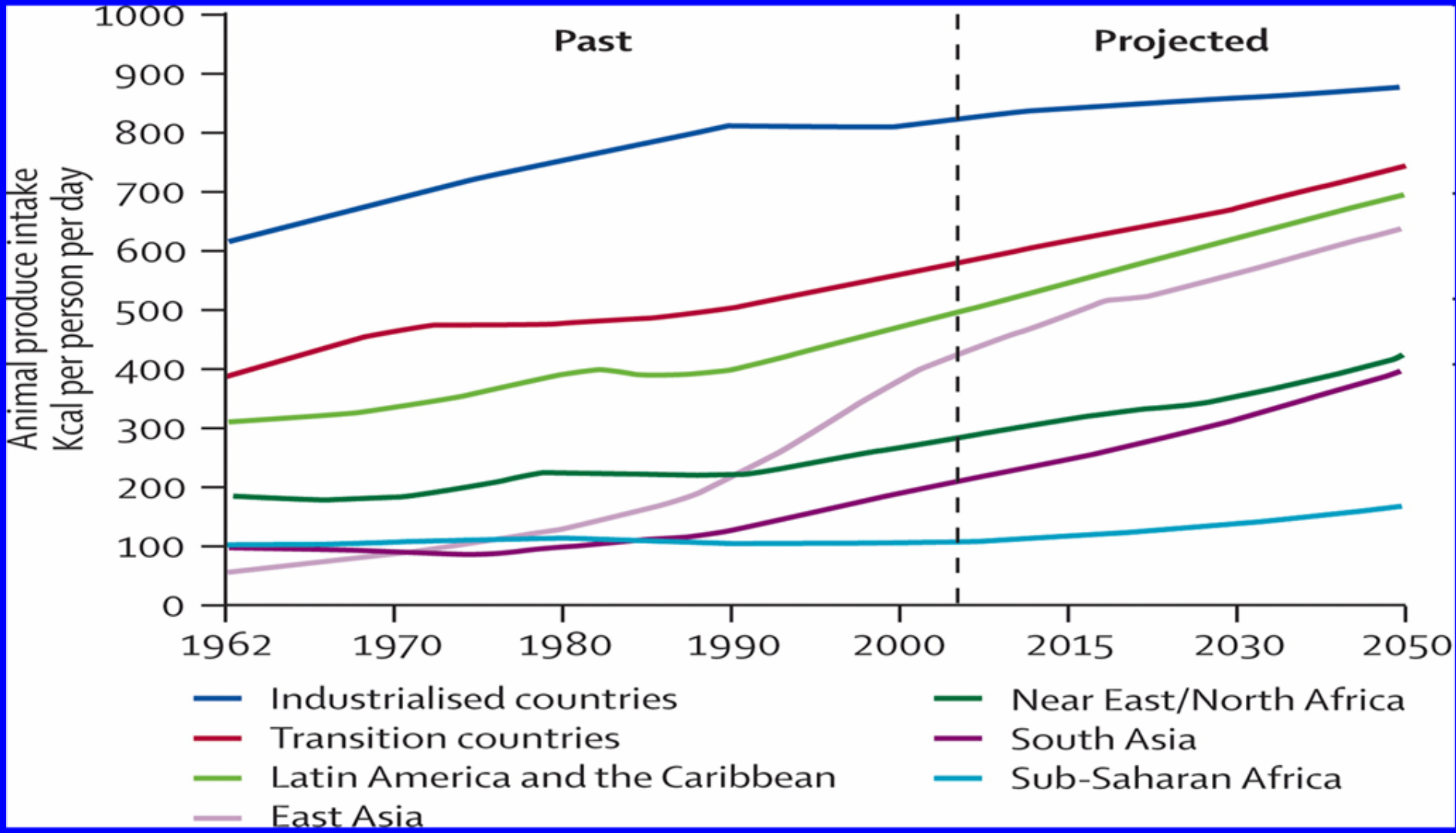


Figure 2: **Proportion of greenhouse-gas emissions from different parts of livestock production**

Adapted from FAO.[42]

Trends in consumption of livestock products per person



FAO

Direction and change in health outcomes under international target of 90 g meat per day per person in all countries

	High-income countries		Low-income countries
Current approximate total meat consumption (g per day per person)	200–250		25–50
Change in:			
Heart disease*	– – –		+
Stroke	No substantial effect		– – –
Colorectal cancer	– – –		++
Breast cancer	– –		+
Childhood growth stunting	No substantial effect		– – – –
Overweight/obesity	– –		(+)

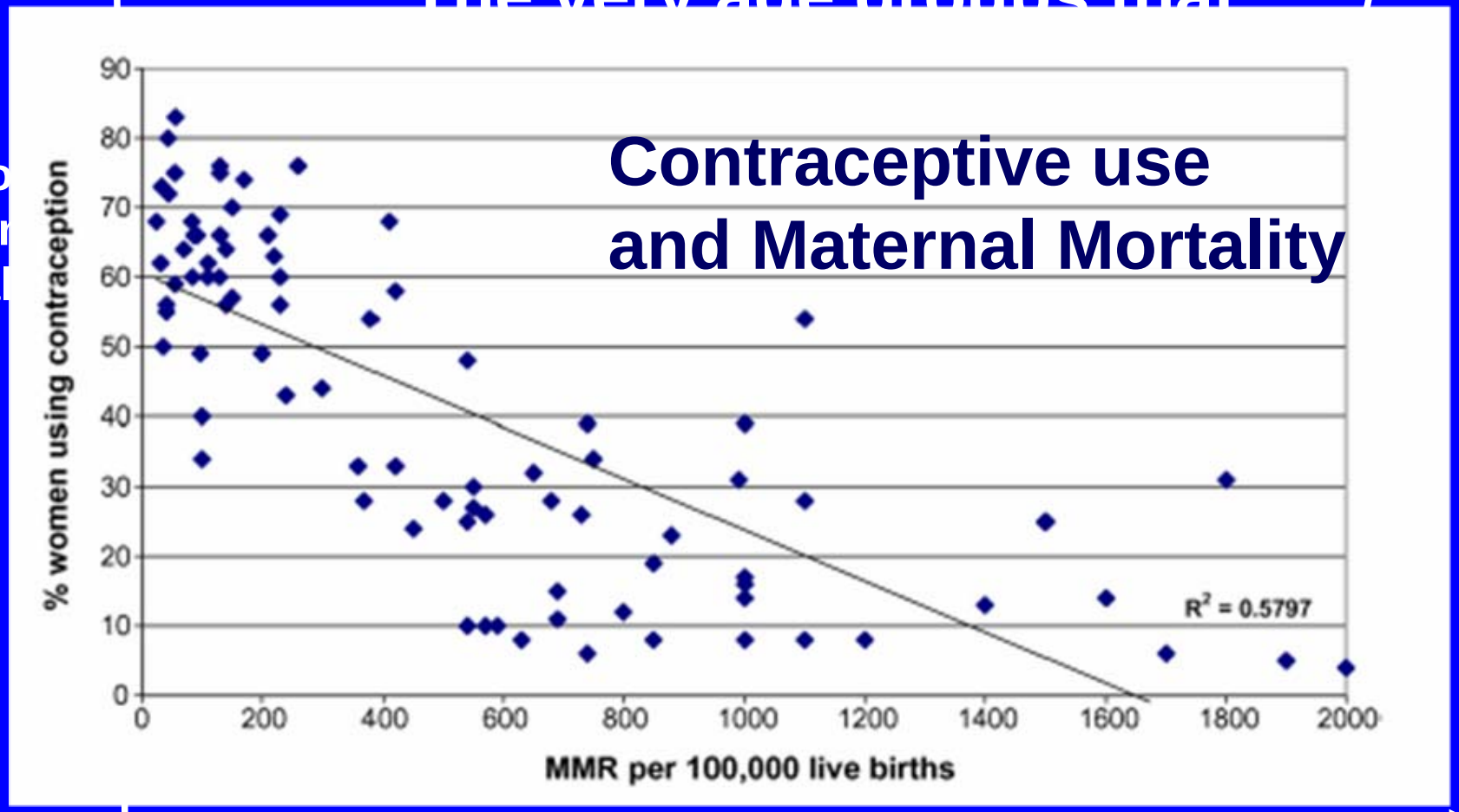
McMichael et al., 2007

Most cost-effective GHG control device is probably a condom

- Many tens of millions of women wish to have fewer children, but do not have access to contraceptives
- Giving them access could mean 1-2 billion fewer people by 2100 – a major reduction of stress on the Earth
- Many health benefits, particularly child and maternal mortality, to smaller, more planned families

The very age groups that

Risk o
Materr
Mortal

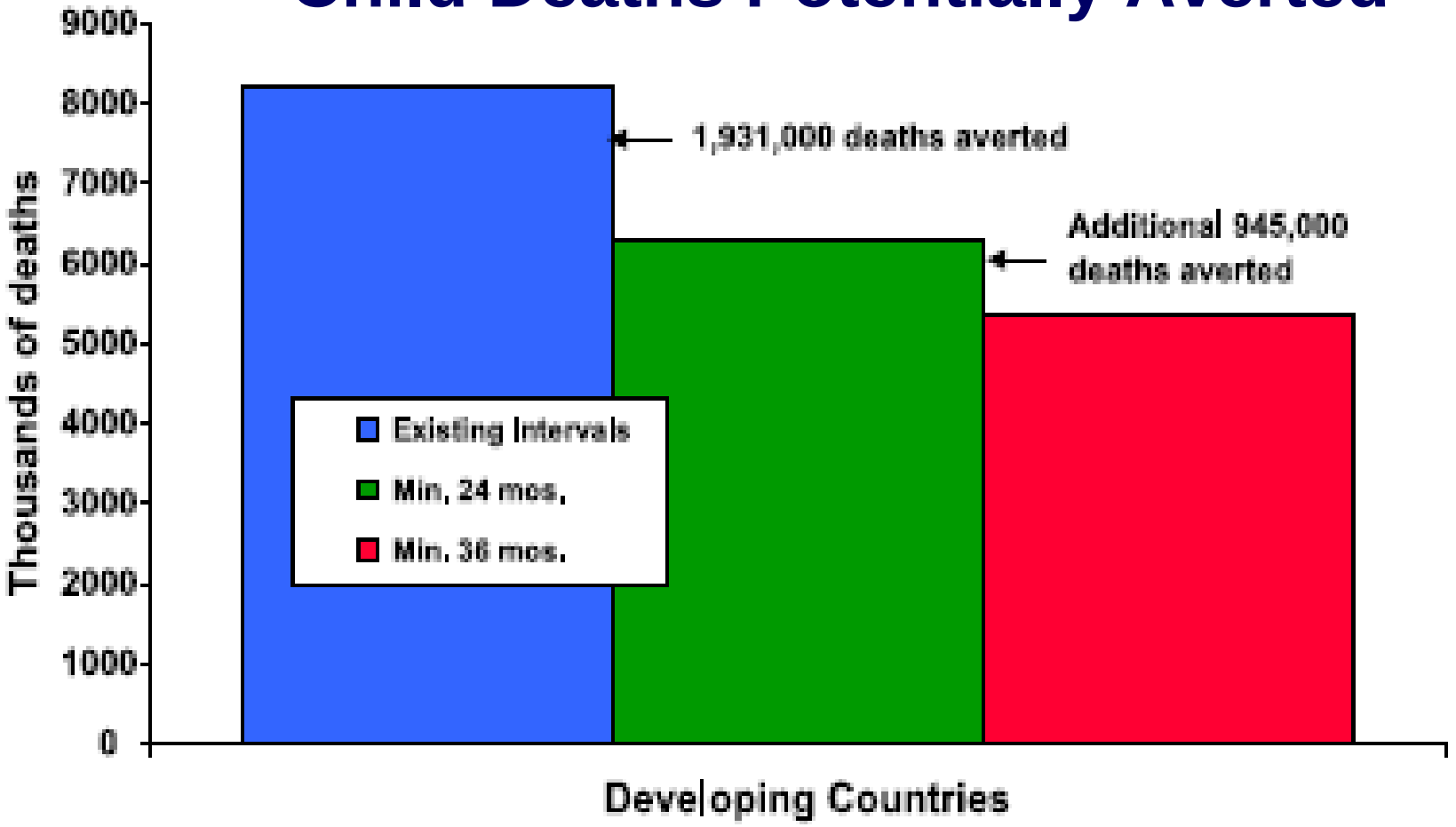


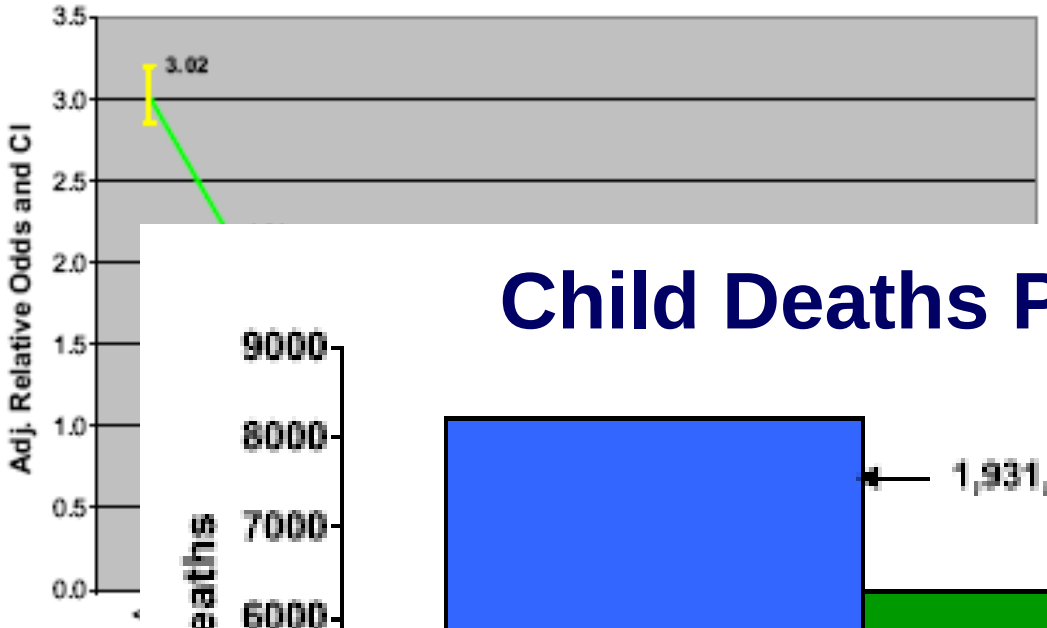
13

Age of Mother

45

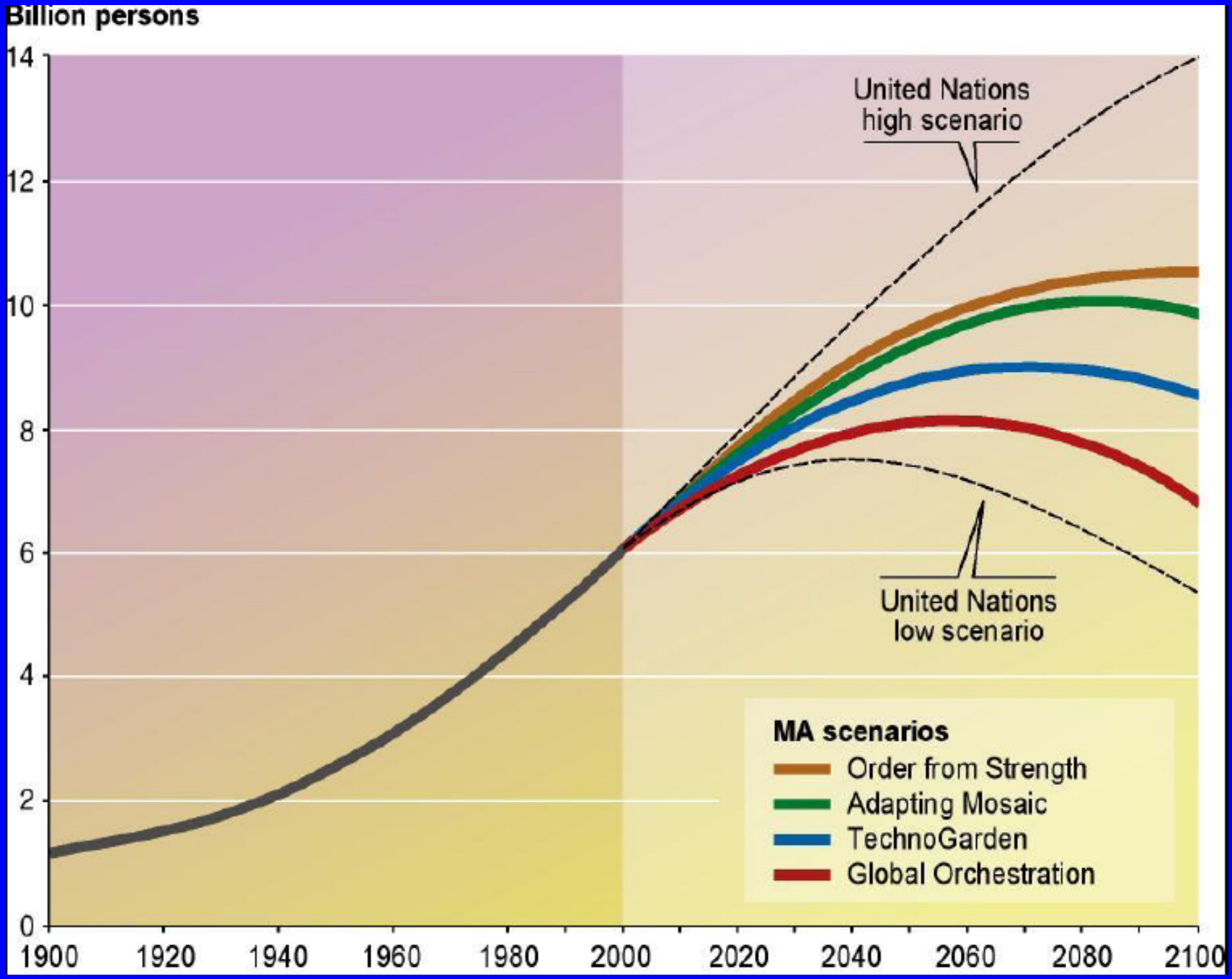
Child Deaths Potentially Averted





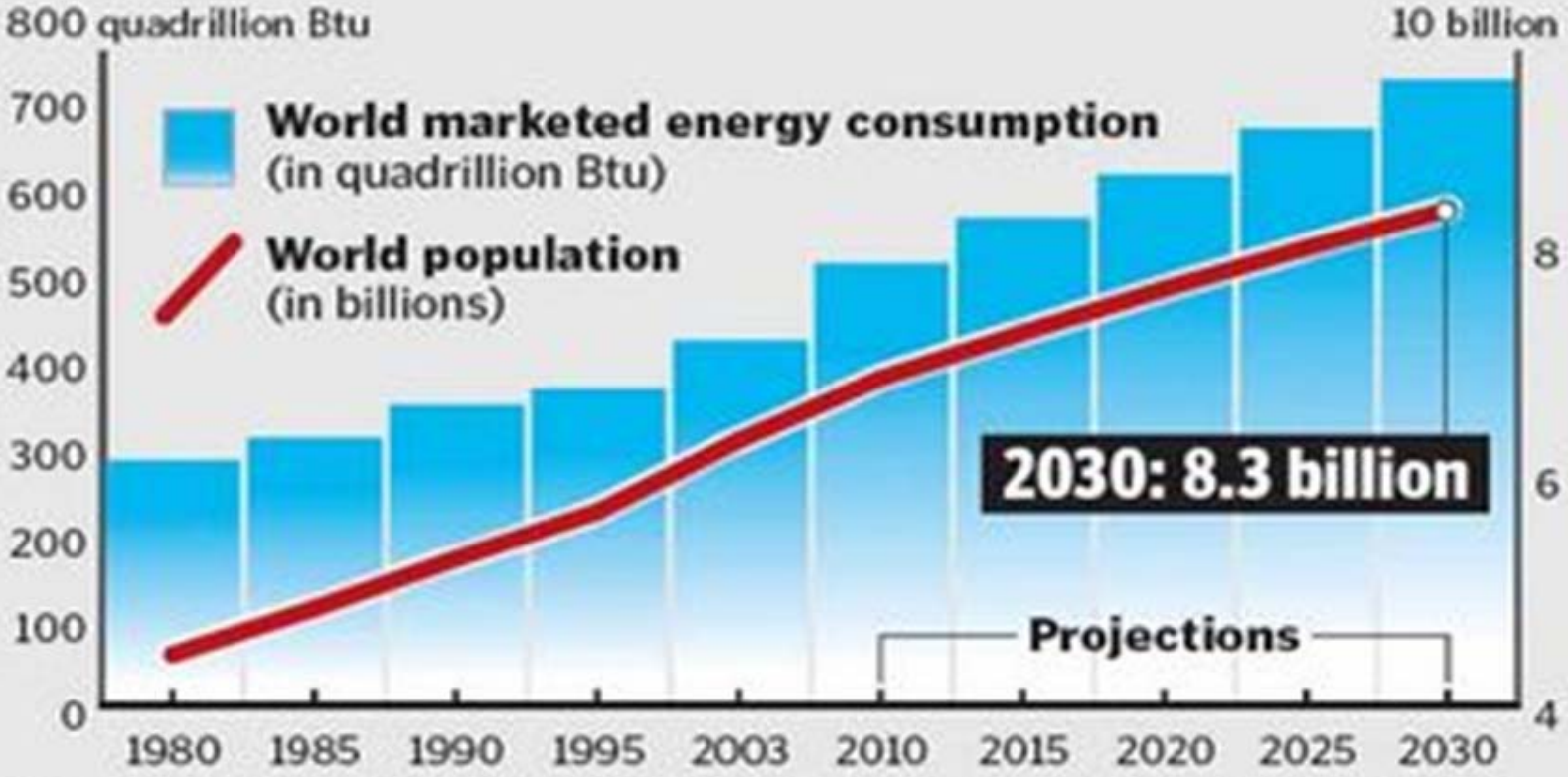
Figure

Figure 5 Child malnutrition by birth interval.


Billion persons
14
12
10
8
6
4
2
0
1900
1920
1940
1960
1980
2000
2020
2040
2060
2080
2100
United Nations
high scenario
United Nations
low scenario
MA scenarios
Order from Strength
Adapting Mosaic
TechnoGarden
Global Orchestration

Energy consumption projected to increase

As the world's population goes up, the demand for energy grows at a similar rate.



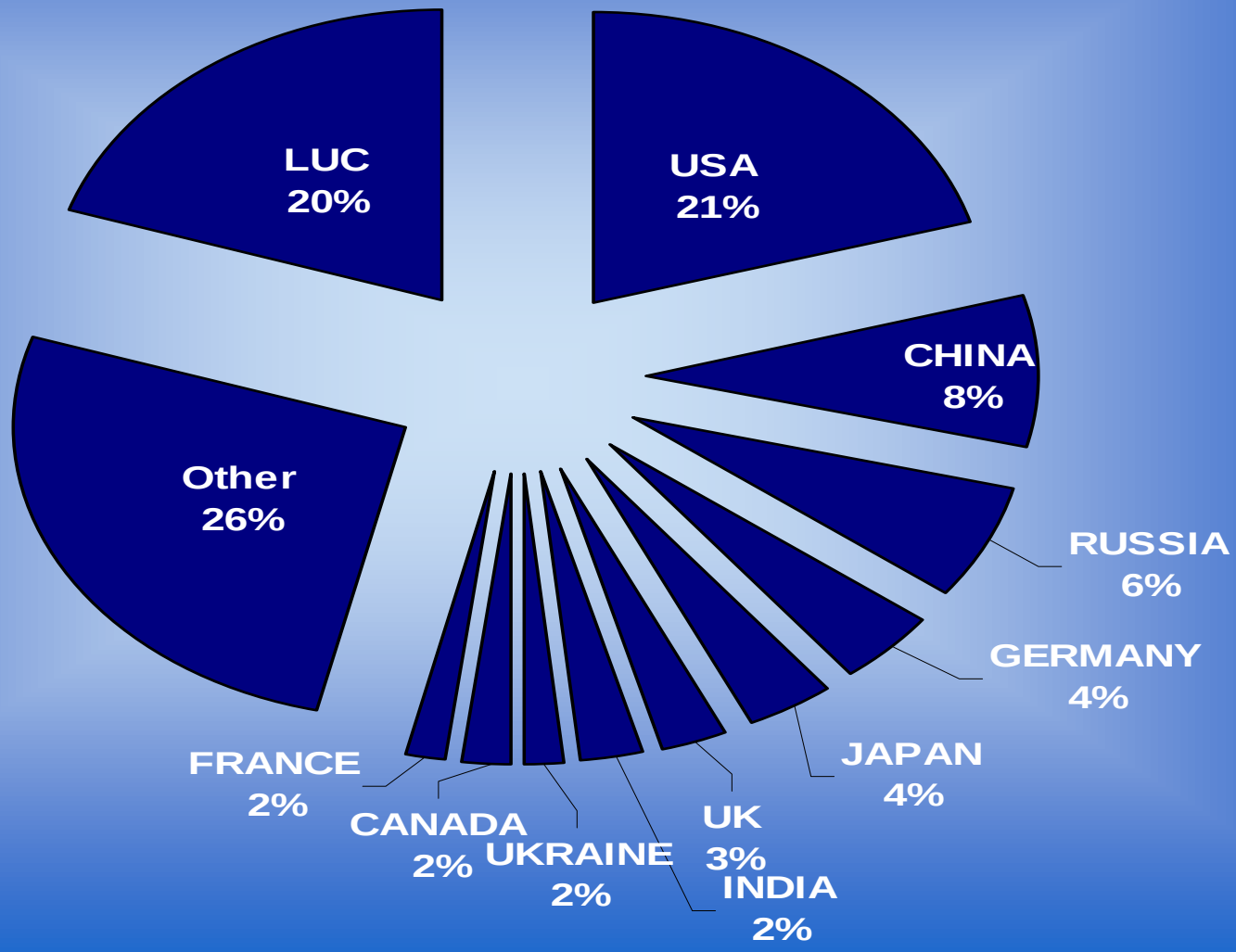
Sources: Energy Information Administration; System for the Analysis of Global Energy Markets

Methane Reduction

- Major and probably undervalued global GHG
- Major cause of rise in global tropospheric ozone concentrations – important health-damaging and crop-damaging pollutant
- Livestock major source, as noted above
- Leaks: Coal mines, gas pipelines, etc.
- Waste management: Landfills, wastewater
  - Other health benefits here also
- Incomplete combustion: biomass and coal in households

Distribution of Global Natural Debt Among Top 10 Nations

CO2 only in 2005

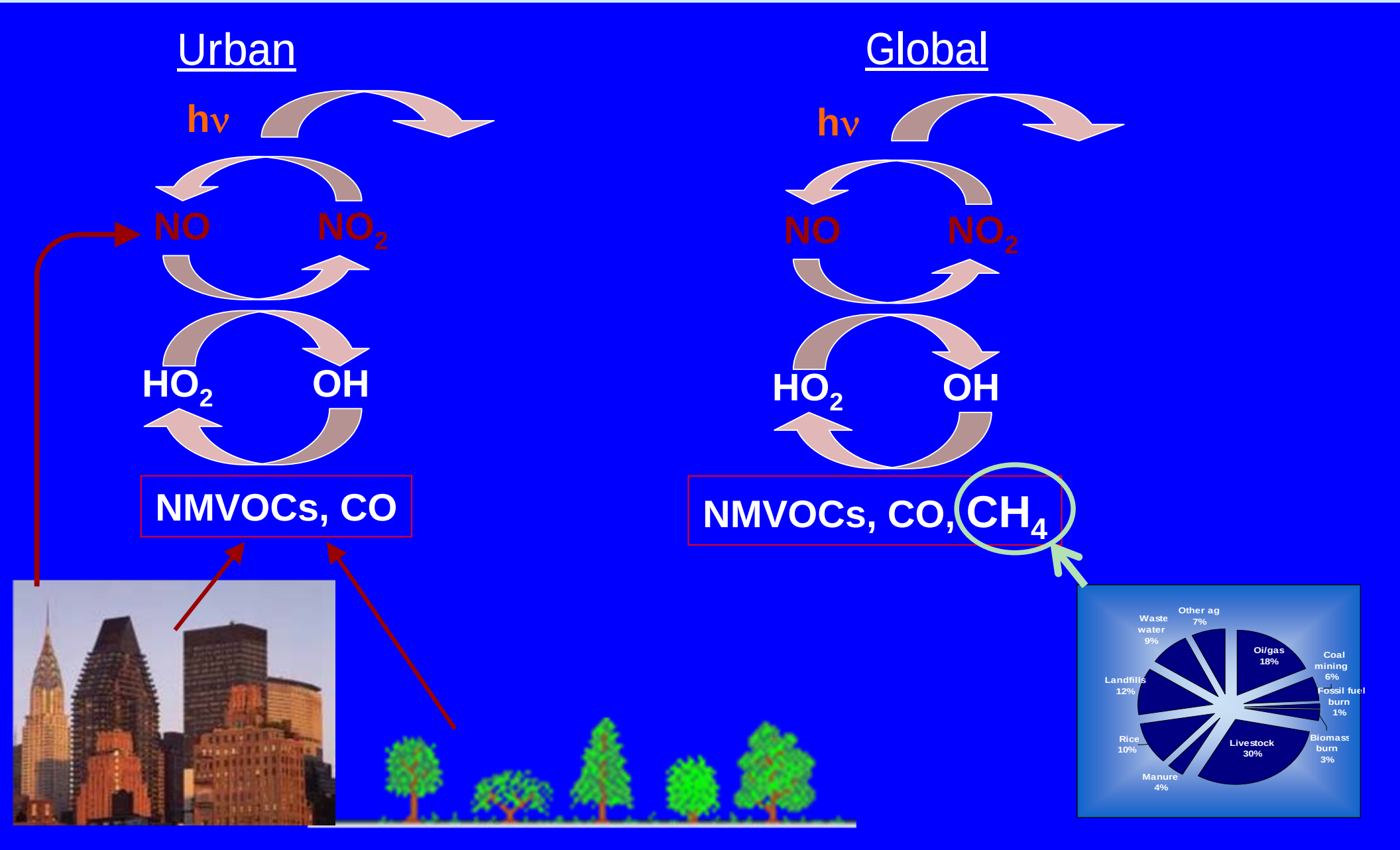


Brazil: 0.8%

Nb. Land-use change emissions not are parsed out by country

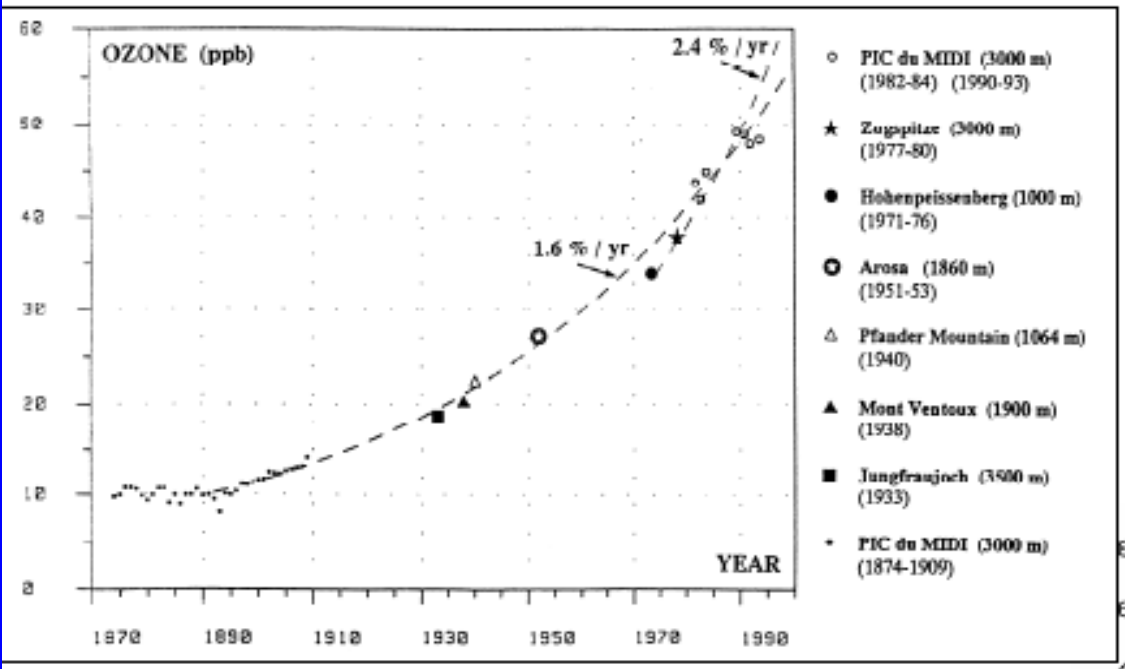
Smith and Rogers, in preparation

Methane as a Global Ozone Precursor



Background Ozone is Growing …

… and Will Continue to Grow!

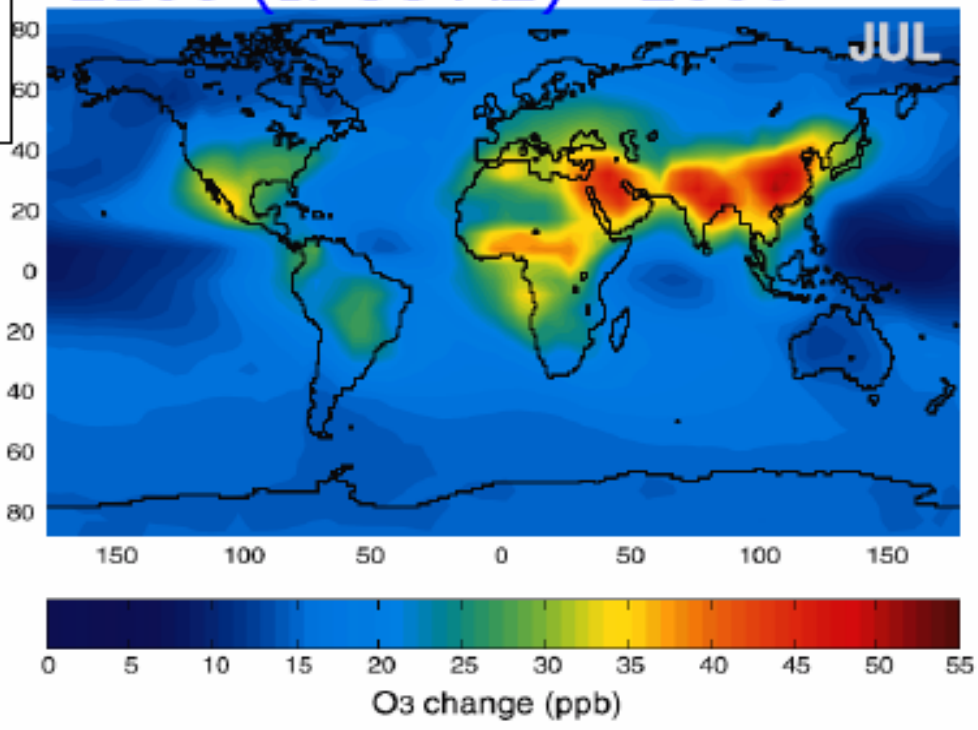


Ozone trend at European mountain sites, 1870-1990 (Marenco et al., 1994).

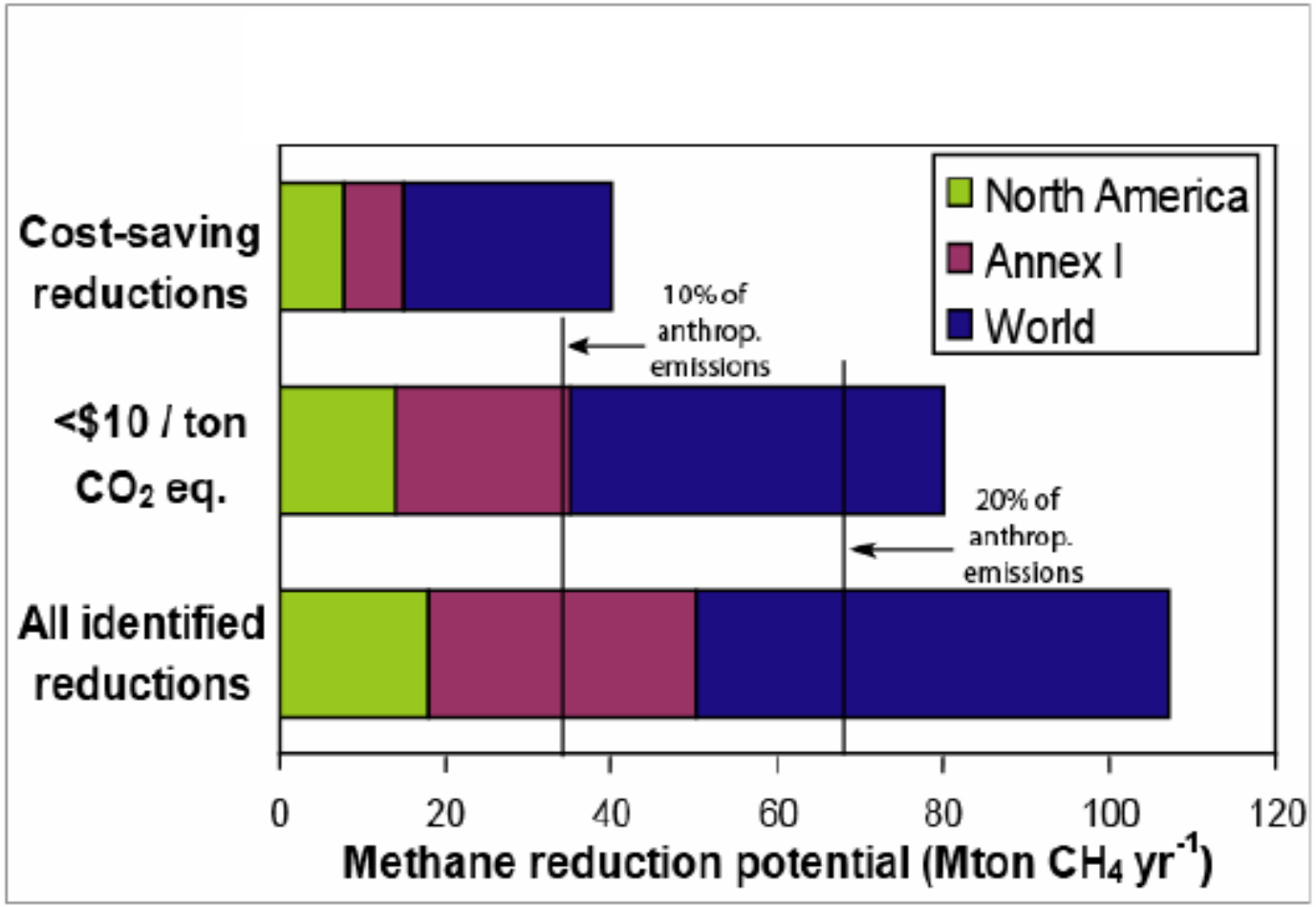
Mauzerall 2007

Historic and future increases in background ozone are due mainly to increased methane and NO_X emissions (Wang *et al.*, 1998; Prather et al., 2003).

2100 (IPCC A2) - 2000

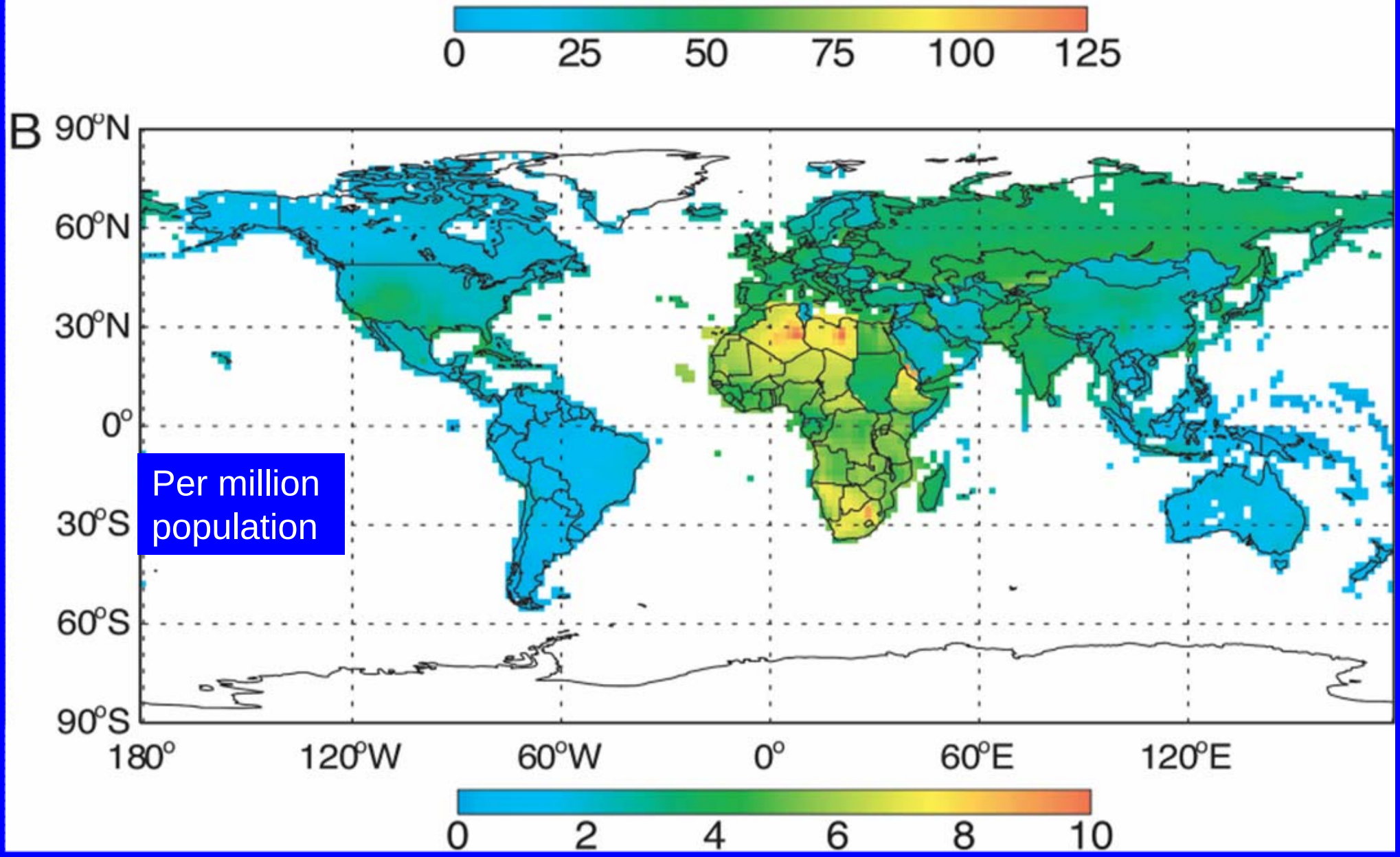


How Much Can Methane Be Reduced?



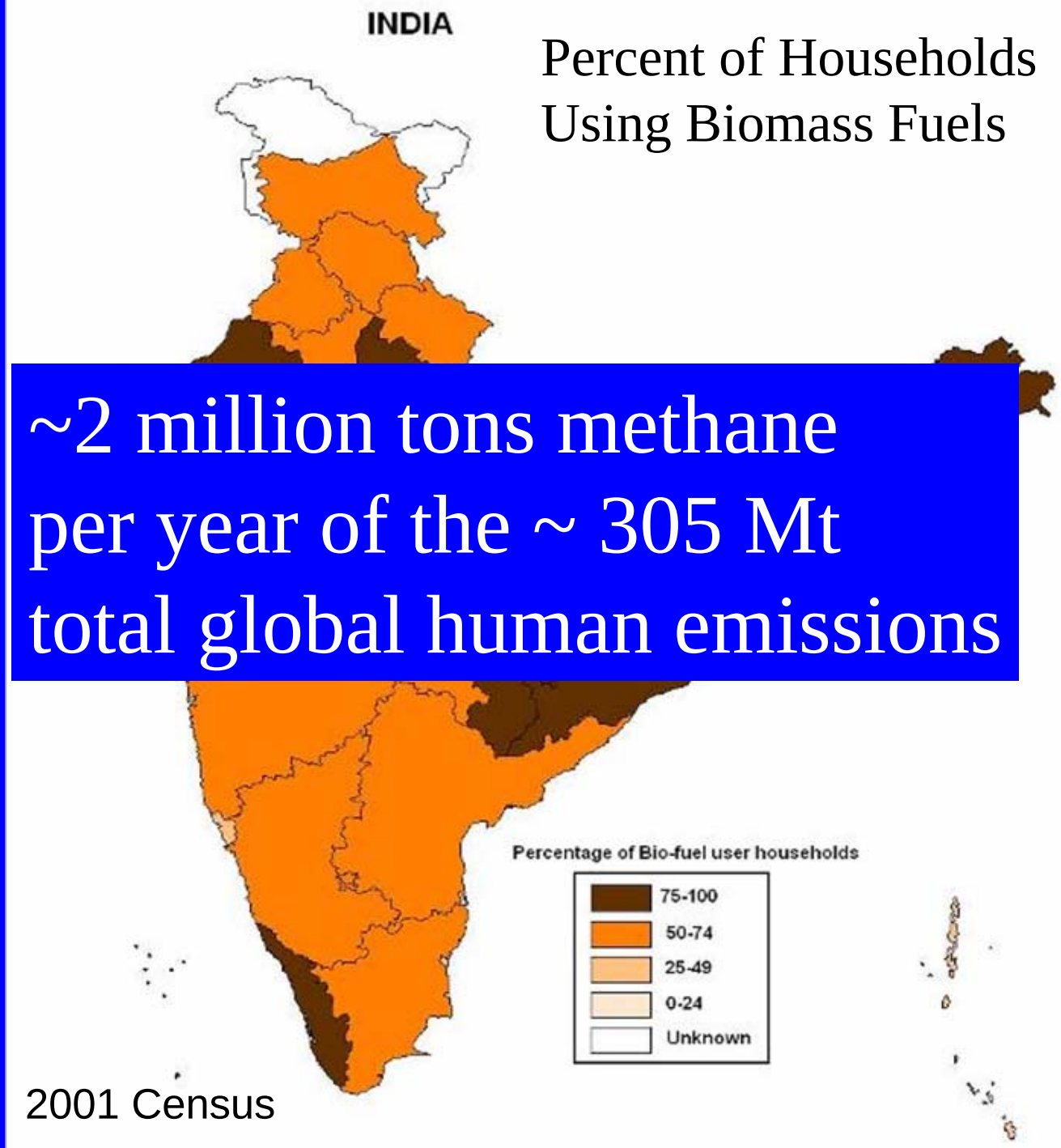
West & Fiore (2005)

Methane reduction potential from IEA (2003), for coal, oil and gas operations, wastewater, and landfills; maximum technically feasible in 2010.



Reduction in ozone mortality from
20% reduction in methane emissions

West et al, PNAS, 2006

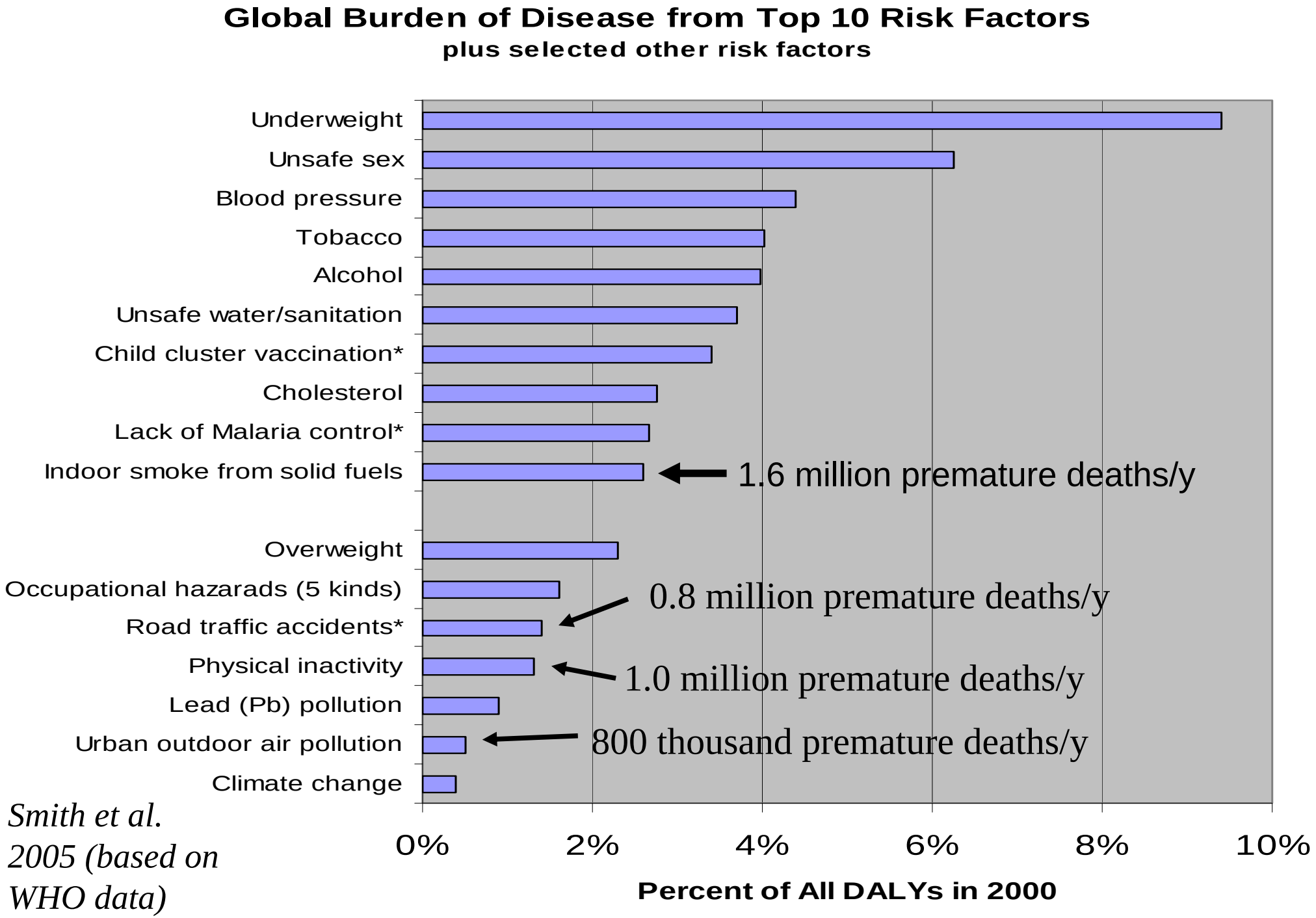


Smith,
et al.
2000

Need for Comparability

- Current co-benefits analyses are difficult or impossible to combine into common frameworks for comparison.
- Different, unstated, or unclear
  - Exposure-response relationships
  - Ill-health extrapolation methods, e.g., total mortality versus cause-specific; age adjustment or not; etc.
  - System boundaries in time and space
  - Discount rates
  - Financial analysis methods

Gas		Lifetime (years to reach 37% (1/e) of its original level)	GWP (time horizon)		
			20 years	100 years	500 years
Kyoto[a]					
Carbon dioxide	CO_2	[complex]	1	1	1
Methane[b]	CH_4	12	56	21	6.5
Nitrous oxide	N_2O	114	280	310	170
Non-Kyoto (unofficial values)[c]					
Carbon monoxide	CO	~0.1	7	3	2
Total nonmethane hydrocarbons[d]	TNMHC	~0.05	29	10	6


Global Burden of Disease from Top 10 Risk Factors
plus selected other risk factors
Underweight
Unsafe sex
Blood pressure
Tobacco
Alcohol
Unsafe water/sanitation
Child cluster vaccination*
Cholesterol
Lack of Malaria control*
Indoor smoke from solid fuels
1.6 million premature deaths/y
Overweight
Occupational hazarads (5 kinds)
0.8 million premature deaths/y
Road traffic accidents*
Physical inactivity
1.0 million premature deaths/y
Lead (Pb) pollution
Urban outdoor air pollution
800 thousand premature deaths/y
Climate change
0%
2%
4%
6%
8%
10%
Percent of All DALYs in 2000
Smith et al. 2005 (based on WHO data)

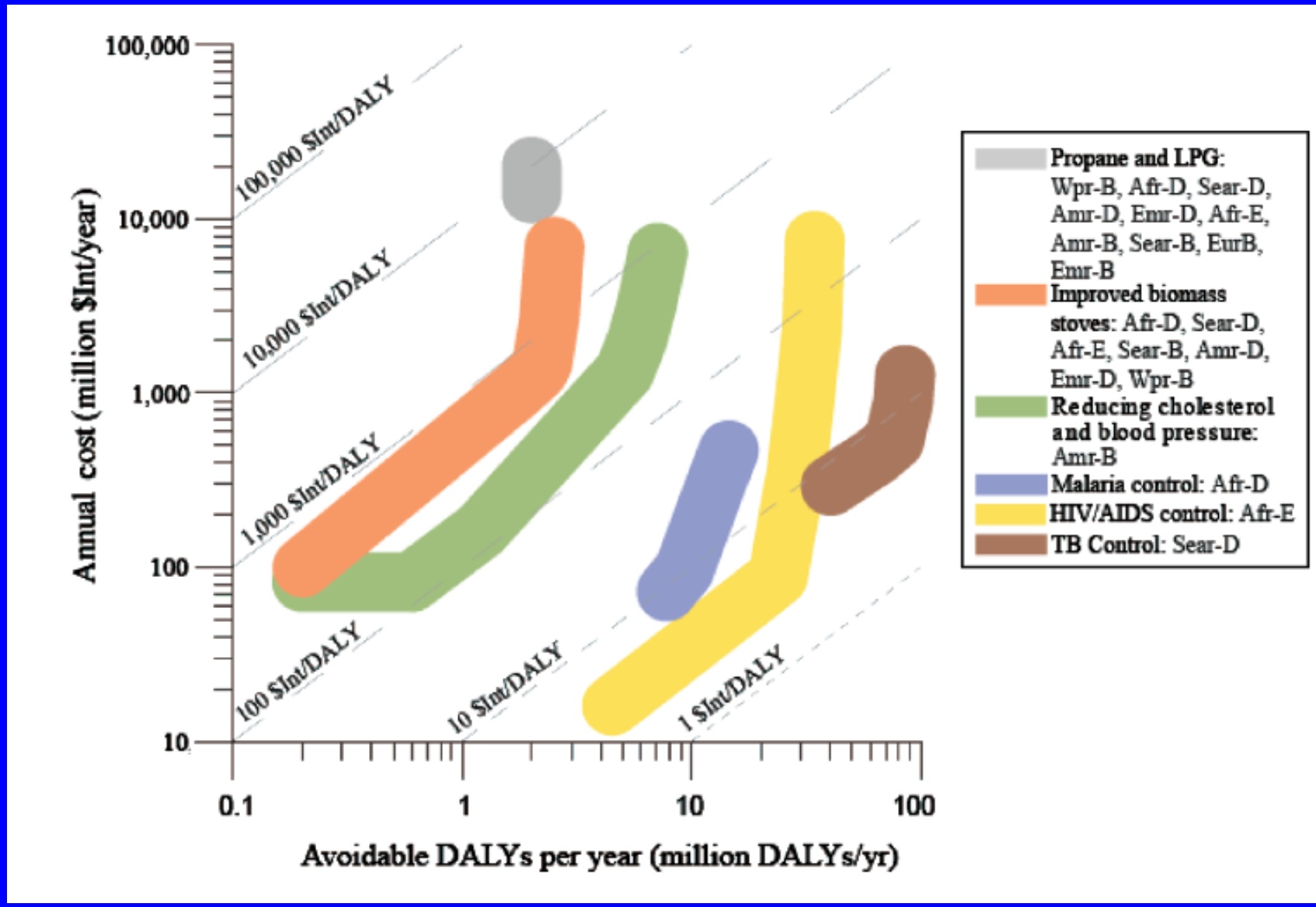
Risks of Air Pollution in China from the Global Comparative Risk Assessment

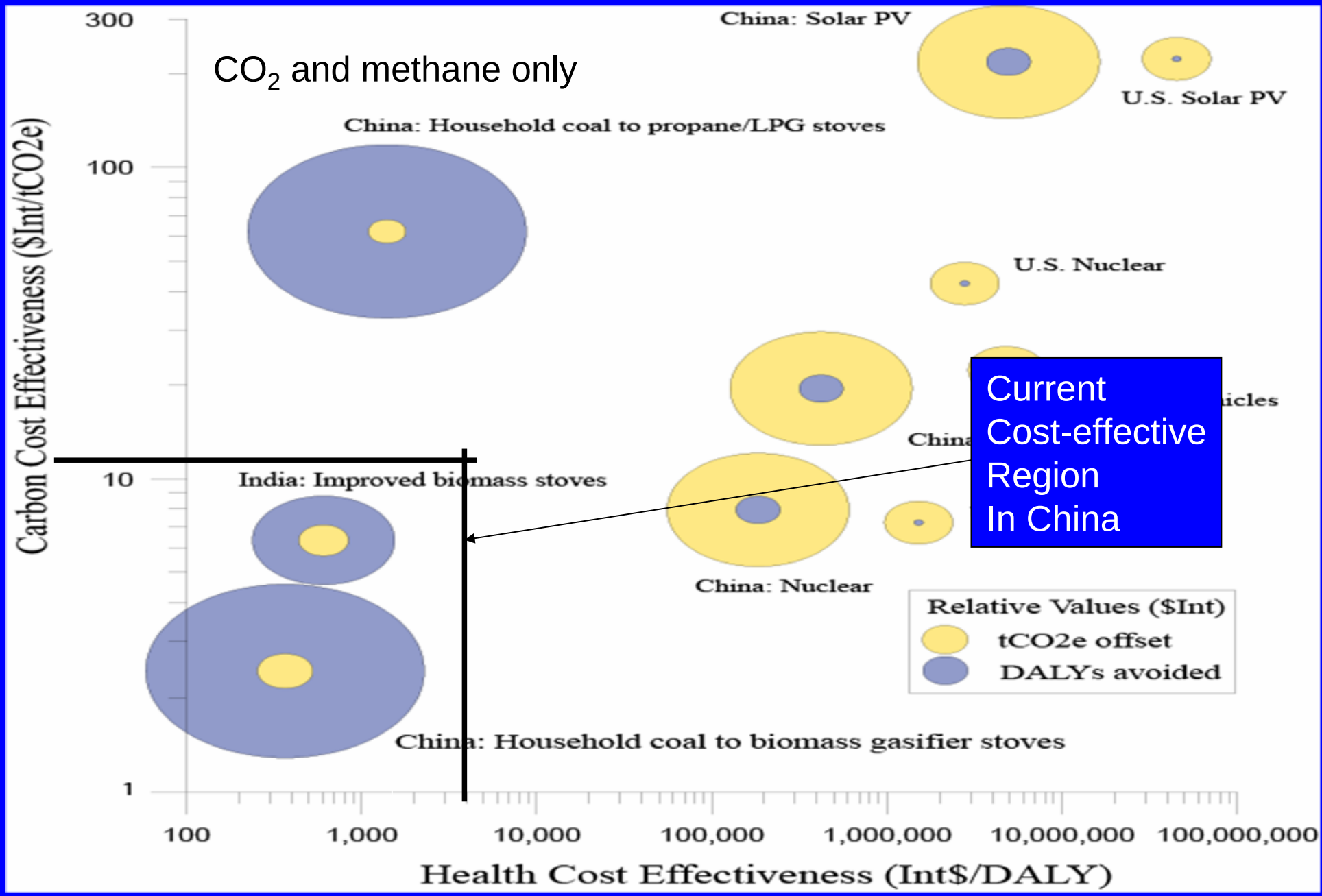
	Population	Exposure metric	Relative risk per unit	DALYs/exposure[a]	
Outdoor		1000 people		3% DALY	0% DALY
Cardiovascular	Adults >30	10 $\mu g/m^3$ PM2.5	1.059	1.56E-01	3.1E-01
Lung cancer	Adults >30	10 $\mu g/m^3$ PM2.5	1.082	2.26E-02	4.4E-02
Acute lower respiratory infections (ALRI)	Children <5	10 $\mu g/m^3$ PM10	1.01	1.64E-02	3.8E-02
Indoor		Household (HH)			
Chronic obstructive pulmonary disease (COPD)	Adults >30	Solid fuel use	3.2	2.72E-02	5.4E-02
Lung cancer	Adults >30	Solid fuel use	1.9	1.00E-03	2.0E-03
ALRI	Children <5	Solid fuel use	2.3	1.48E-02	3.4E-02

Table 3 Summary metrics for use in co-benefits scoping

Smith & Haigler, 2008

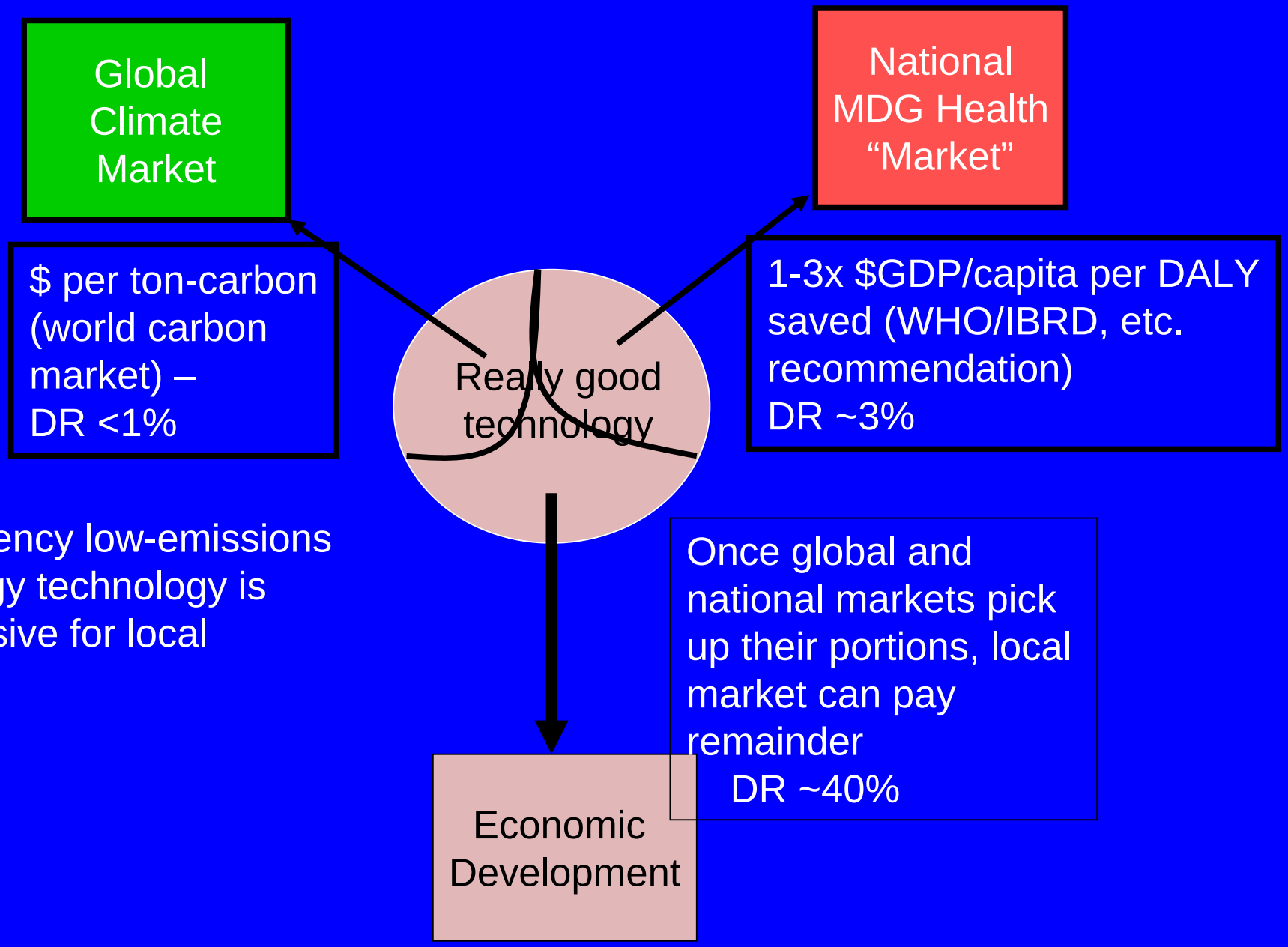
	Health	Climate change	Finances[a]	
Metric	Lost life years	Total warming	International dollars	
	Disability-adjusted life years (DALY)	Global warming commitment	For interntional comparisons but not for intra-country comparisons, direct currrency exchange	
Unit	Years	Tons CO_2 equivalent	U.S. dollars	
Formulation	Years lost from premature death plus weighted years lost to disability	Tons CO_2 plus tons other GHGs multiplied by their global warming potentials (GWPs)	In general, for international comparisons, use purchasing power parity (PPP) corrections	
Source of information	WHO Comparative Risk Assessment, if no local information	Intergovernmental Panel on Climate Change (IPCC) GWPs and default emission factors if needed	WHO Cost-Effectiveness Guidelines	
Valuation	1–3x local gross domestic income/capita per DALY. From **http://hdr.undp.org/hdr2006/statistics/**	International market value from **http://www.carbonpositive.net**	PPP conversions from **http://hdr.undp.org/hdr2006/statistics/**	
Discount rates	DALYs[b]	GWPs	Benefits	Costs
Kyoto case	0%	100-year ~ 0.7%	1%	3%
Base case	3%	20-year ~ 4.3%	3%	3%
Financial case	3%	20-year ~ 4.3%	3%	6%


100,000
10,000
1,000
100
10
Annual cost (million $Int/year)
100,000 $Int/DALY
10,000 $Int/DALY
1,000 $Int/DALY
100 $Int/DALY
10 $Int/DALY
1 $Int/DALY
0.1
1
10
100
Avoidable DALYs per year (million DALYs/yr)
Propane and LPG: Wpr-B, Afr-D, Sear-D, Amr-D, Emr-D, Afr-E, Amr-B, Sear-B, EurB, Emr-B
Improved biomass stoves: Afr-D, Sear-D, Afr-E, Sear-B, Amr-D, Emr-D, Wpr-B
Reducing cholesterol and blood pressure: Amr-B
Malaria control: Afr-D
HIV/AIDS control: Afr-E
TB Control: Sear-D



Smith & Haigler, 2008

Paying for Rural Energy Development



High-efficiency low-emissions rural energy technology is too expensive for local markets

Thank you