

Climate Co-benefits and Child Mortality Wedges

Health Co-benefits of Climate Change Mitigation
Wellcome Trust Frontiers Meeting

May 27, 2008

Kirk R. Smith

Professor of Global Environmental Health
University of California, Berkeley

Three Kinds of Co-benefits

- Directing climate change research and adaptation so that it enhances other important health goals
- Achieving health and climate protection with the same activities
- The co-benefits of moral energy










	Negative impact	Positive impact
Very high confidence		
Malaria: contraction and expansion, changes in transmission season		
High confidence		
Increase in malnutrition		
Increase in the number of people suffering from deaths, disease and injuries from extreme weather events		
Increase in the frequency of cardio-respiratory diseases from changes in air quality		
Change in the range of infectious disease vectors		
Reduction of cold-related deaths		
Medium confidence		
Increase in the burden of diarrhoeal diseases		

Figure 8.3. *Direction and magnitude of change of selected health impacts of climate change (confidence levels are assigned based on the IPCC guidelines on uncertainty, see <http://www.ipcc.ch/activity/uncertaintyguidancenote.pdf>).*

COMPARATIVE QUANTIFICATION OF HEALTH RISKS

GLOBAL AND REGIONAL BURDEN OF DISEASE
ATTRIBUTABLE TO SELECTED MAJOR
RISK FACTORS

VOLUME 1

EDITED BY

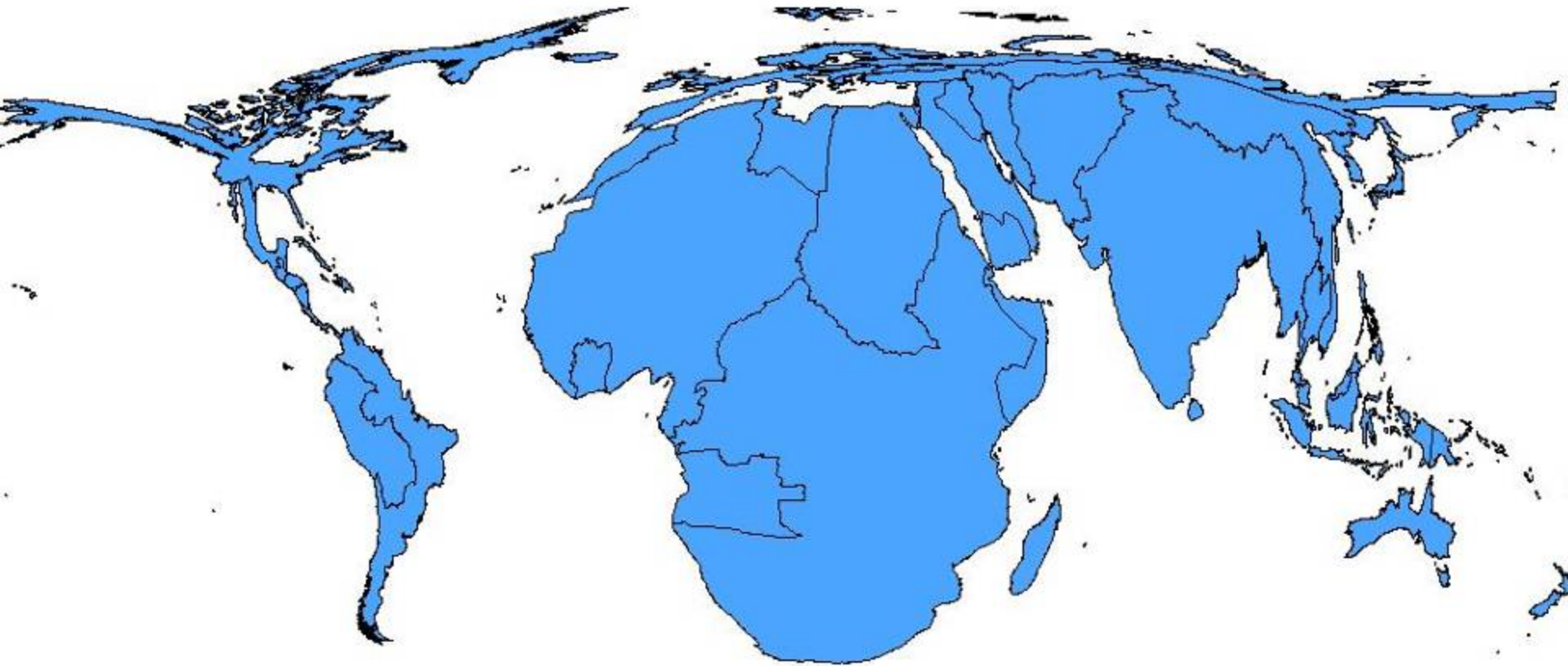
MAJID EZZATI, ALAN D. LOPEZ, ANTHONY RODGERS
AND CHRISTOPHER J.L. MURRAY



World Health Organization
Geneva

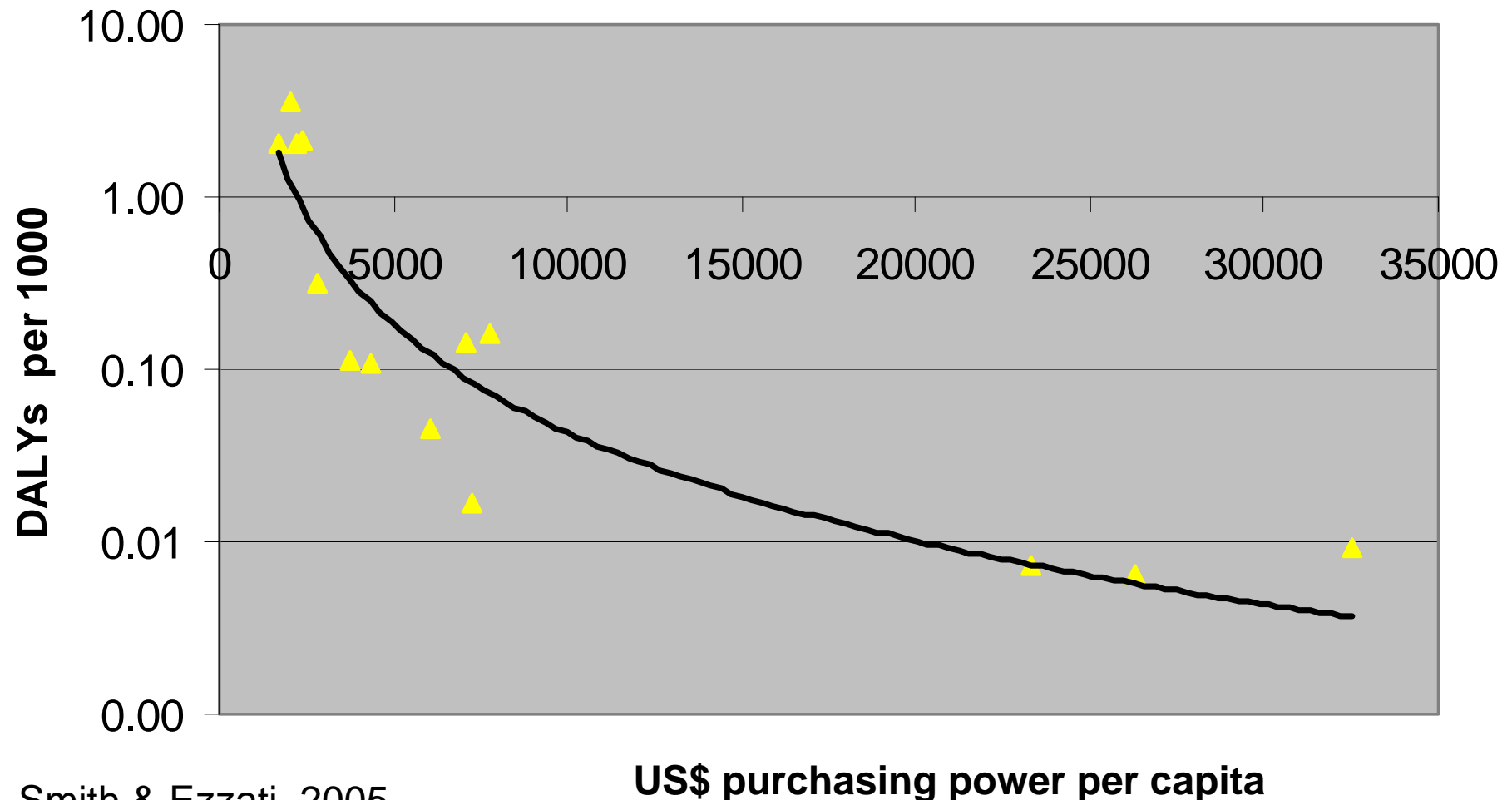
Published in 2004, 2 vols, ~2500 pp
(available on WHO CRA website)

Cartogram of Climate-related Mortality (per million pop) yr. 2000



Patz JA, Gibbs HK, Foley JA, Rogers JV, Smith KR, 2007, **Climate change and global health: Quantifying a growing ethical crisis**, EcoHealth 4(4): 397–405, 2007.

Health Impacts from Climate Change by Income Level across the World



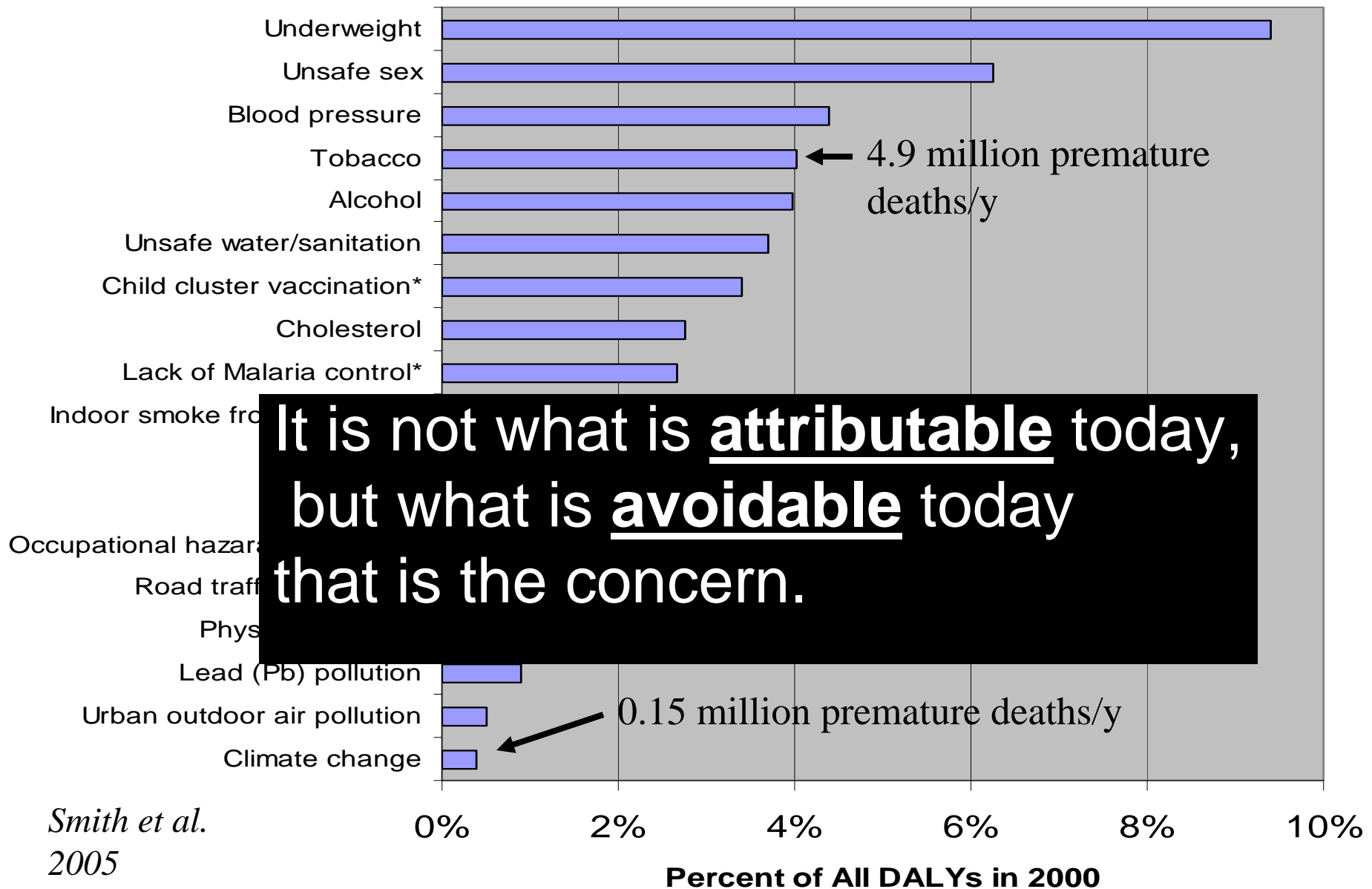
Smith & Ezzati, 2005

US\$ purchasing power per capita

WHO Comparative Risk Assessment Climate Change Health Impacts as of 2000

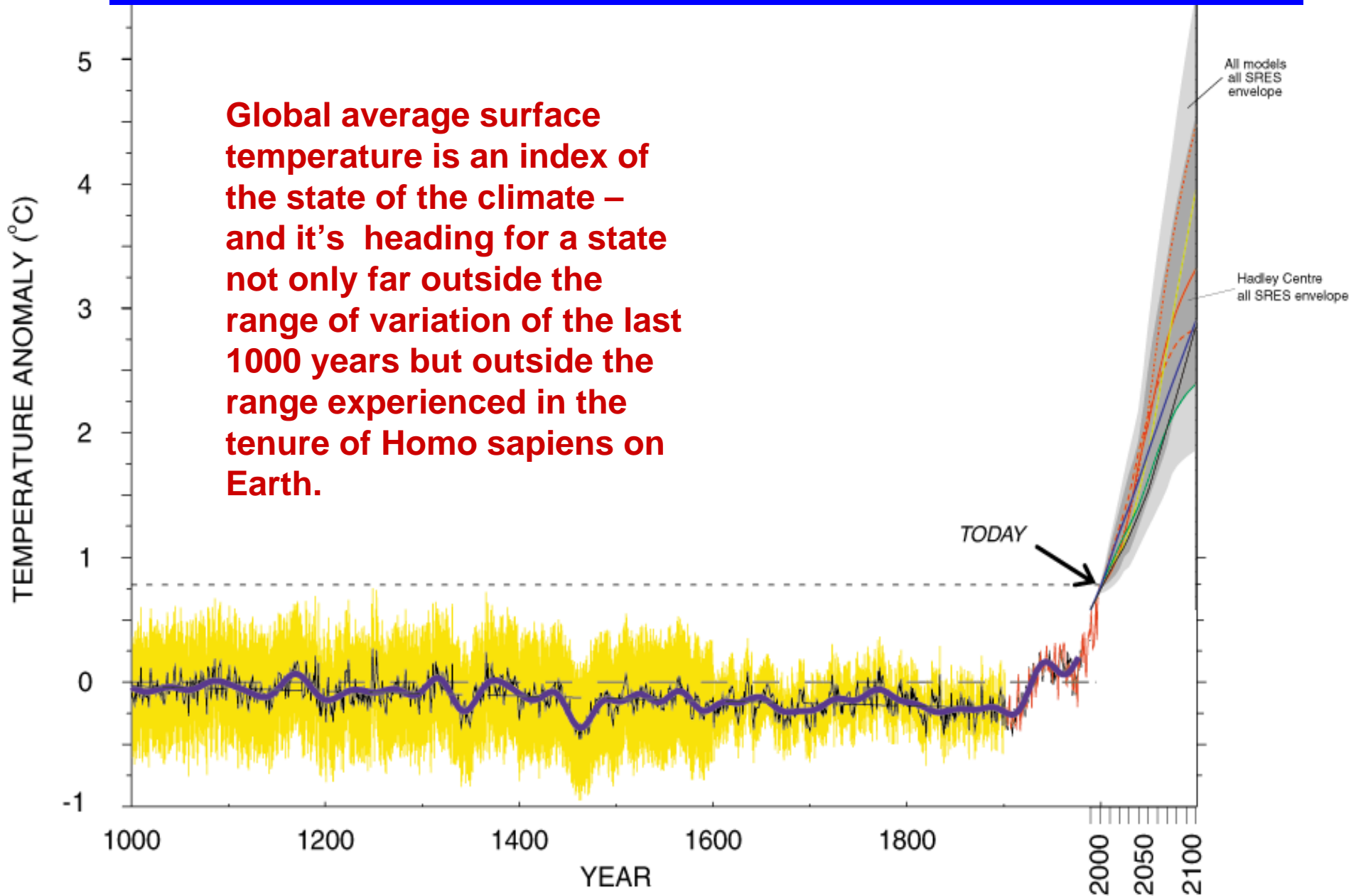
- Diarrhea – 2.4% of global burden
- Malaria – 2%; 6% in some regions
- 17% of protein-energy malnutrition
- 7% of dengue fever in some rich countries
- 150,000 deaths, 99% in poor countries (46% in South Asia)
- 0.4% of all DALYs (lost healthy life years)
- Most (88%) of impact in children under 5

Global Burden of Disease from Top 10 Risk Factors plus selected other risk factors



1000 years of Earth temperature history...and 100 years of projection

Global average surface temperature is an index of the state of the climate – and it's heading for a state not only far outside the range of variation of the last 1000 years but outside the range experienced in the tenure of Homo sapiens on Earth.



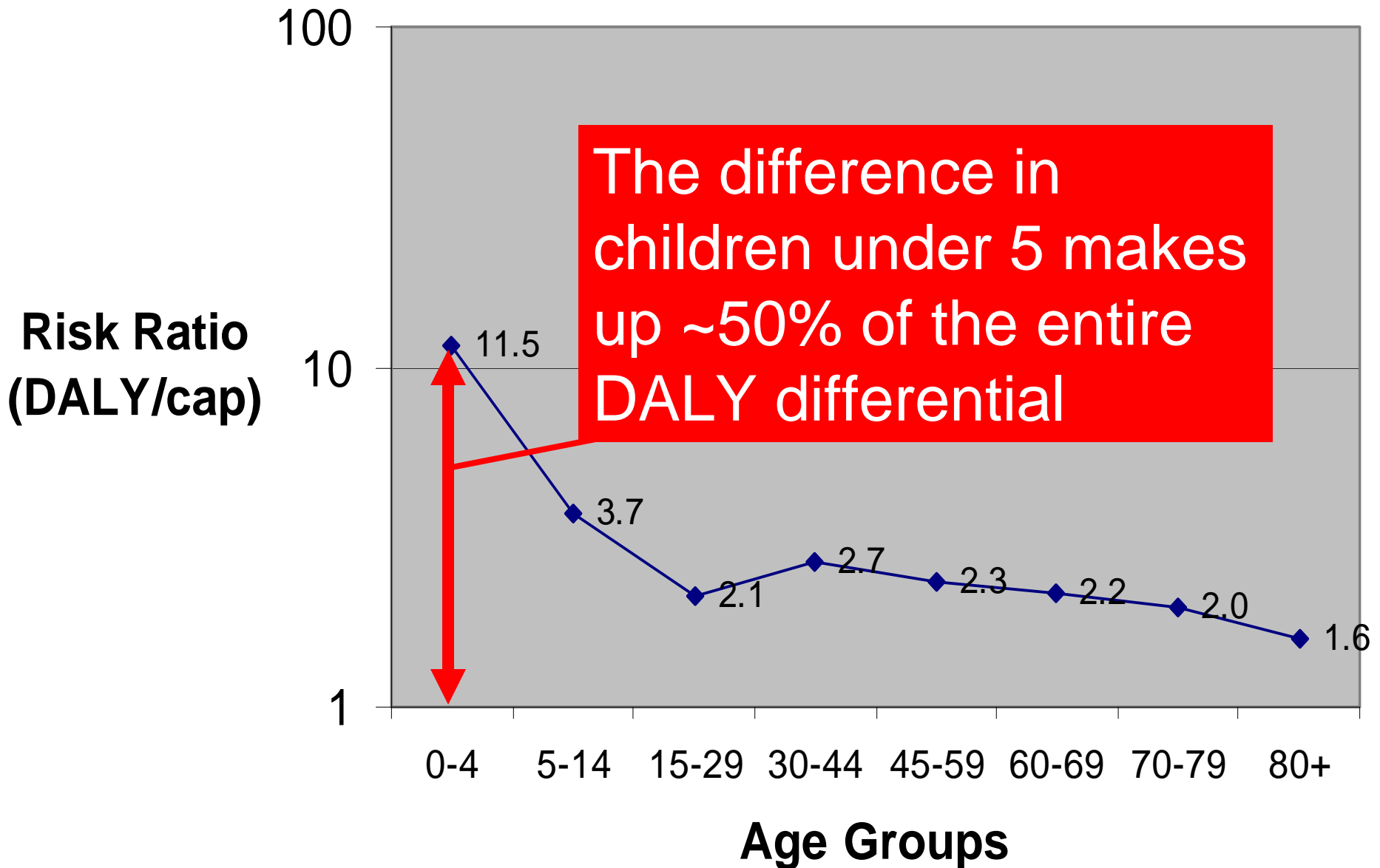
Society has three basic options for responding to human-caused climate change

- **Mitigate** by working to reduce greenhouse gas (GHG) emissions from energy and land use or to capture them from the atmosphere in order to slow or, perhaps, reverse warming
- **Adapt** by reducing the negative effects of climate change through protecting coastlines, moving populations away from impacted areas, increasing efforts to control climate-related vectorborne diseases, insulating cities from heat stress, and so on.
- **Suffer**, i.e., given that efforts in the first two arenas above are moving slowly, there is very likely to be suffering, perhaps considerable in poorer parts of the world, because of the climate change committed already
- We will be doing all three, but can reduce the third if we put more effort into the first two.

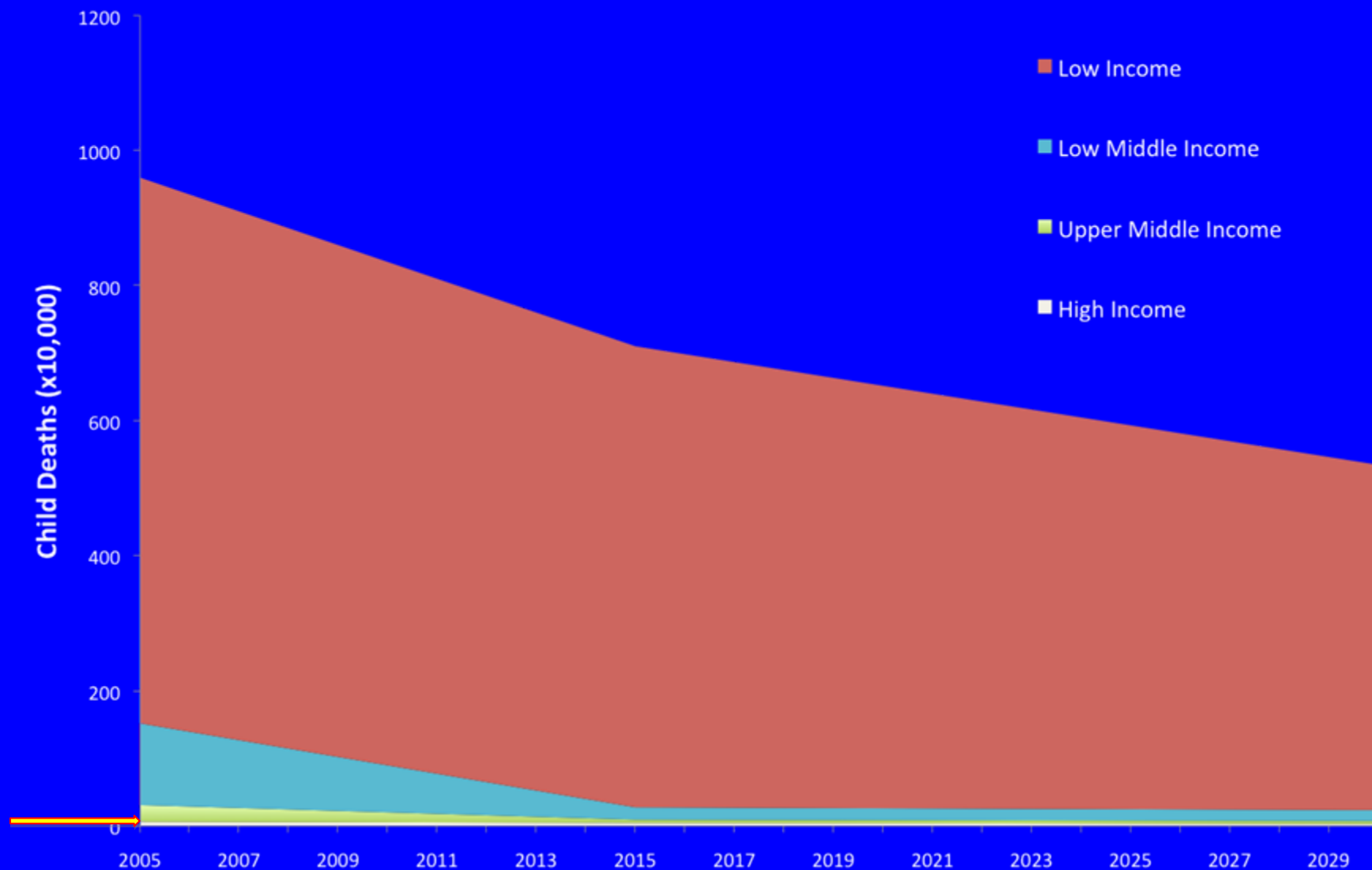
We have other health goals

- These are put into jeopardy by climate change, both directly and indirectly
- Biggest problem are the huge health disparities that exist in the world

DALY Excess in Low-Income Countries by Age



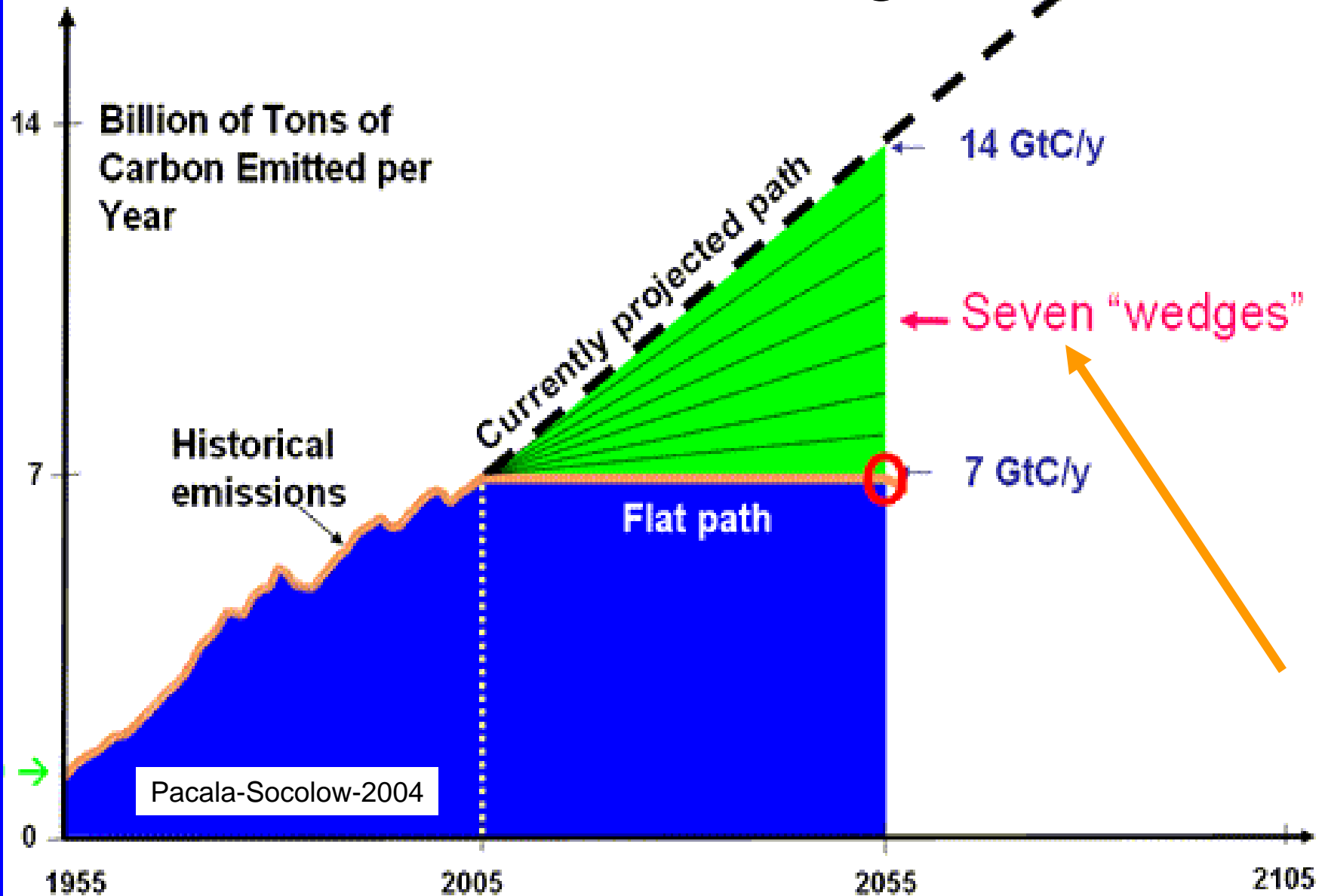
0-4 mortality by income group 2005-2030

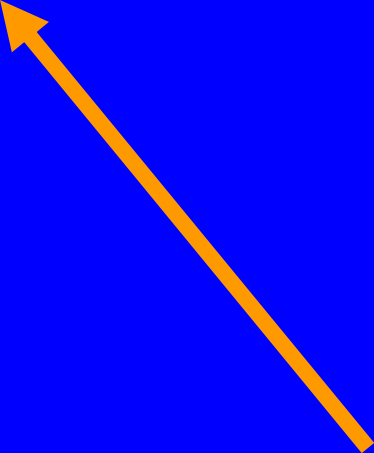


Ten Million Excess Child Deaths: The World's Greatest Scandal

- Because it is so damaging and so avoidable
- Damaging well beyond death
 - Lower child mortality necessary part of reducing birth rates
 - Reducing child mortality is a population control measure
 - For every child who dies, several others suffer life-long impacts
 - Lower cognitive capacity (ability to learn)
 - Chronic disease of many kinds
- Whatever your goal (economic growth, stable population, democratic institutions, global equity, art, literature, science, an educated electorate, etc.), it is impaired by excess child mortality

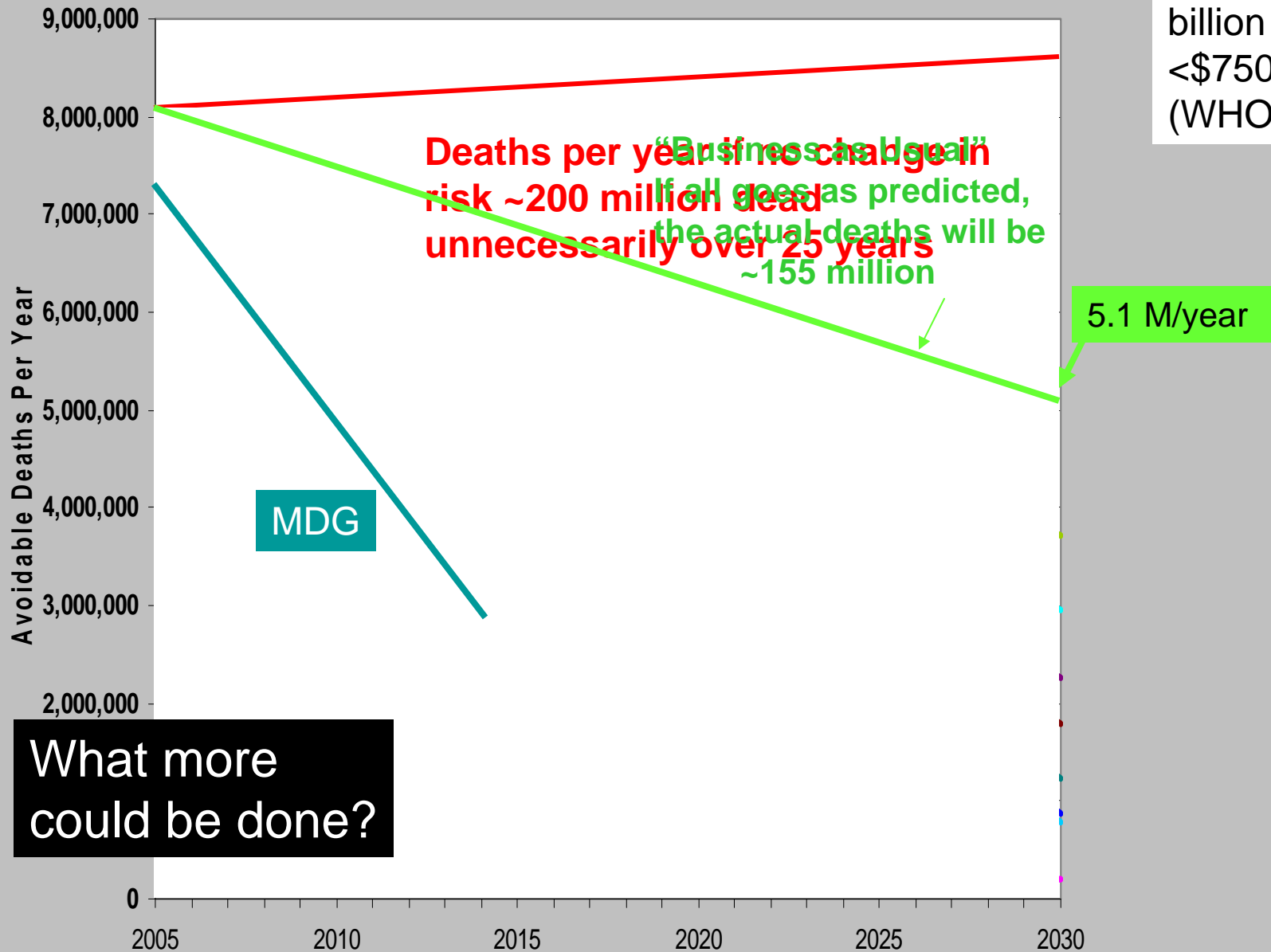
"Stabilization Wedges"



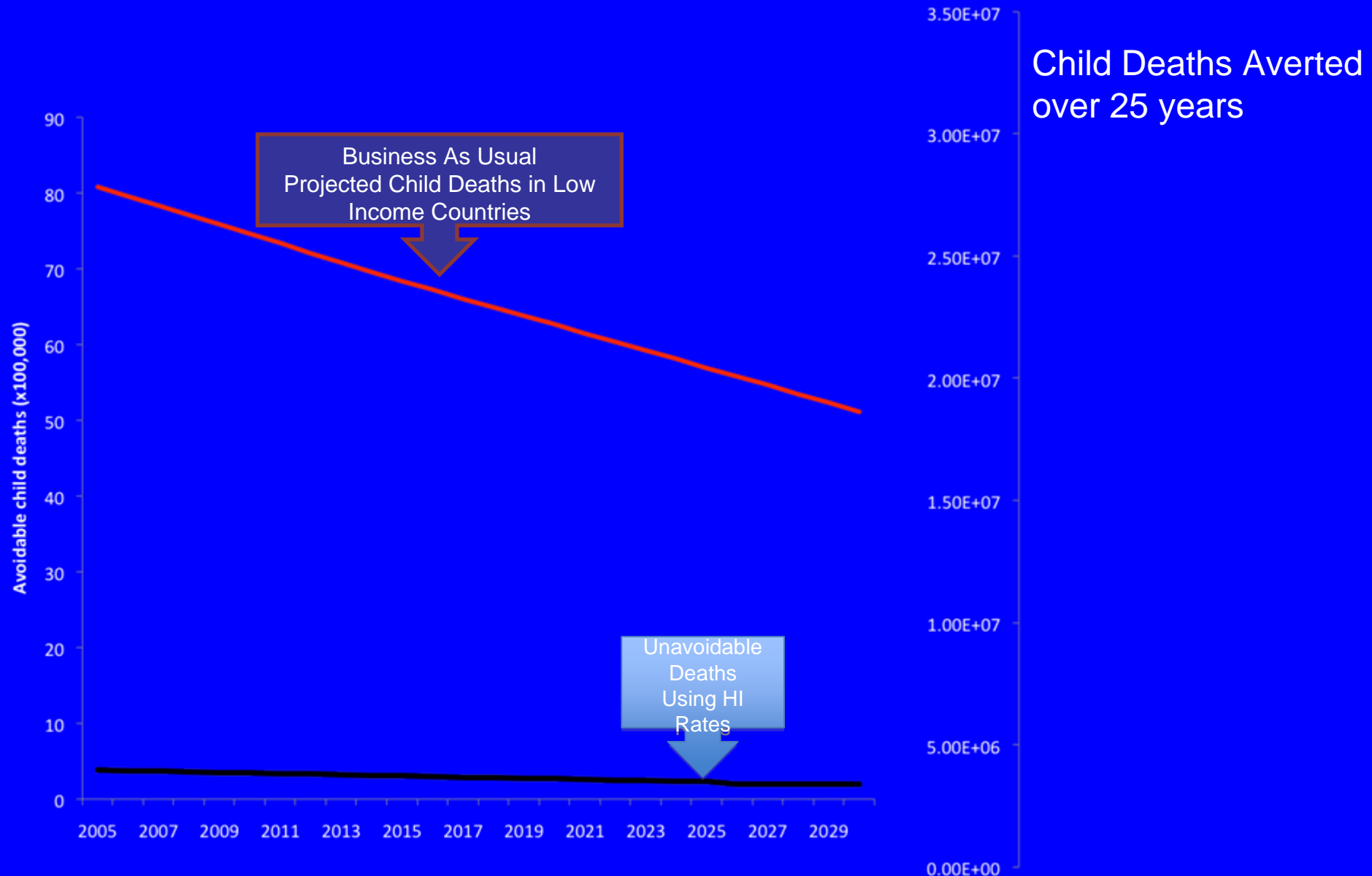
- 
1. Efficient vehicles
 2. Reduced use of vehicles
 3. Efficient buildings
 4. Efficient coal power plants
 5. Gas instead of coal power plants
 6. Capture CO₂ at baseload power plant
 7. Nuclear power for coal power
 8. Wind power for coal power
 9. PV power for coal power
 10. Capture CO₂ at H₂ plant
 11. Capture CO₂ at coal-to-synfuels plant
 12. Wind H₂ in fuel-cell car for gasoline in hybrid car
 13. Biomass fuel for fossil fuel
 14. Reduced deforestation, plus reforestation, afforestation, and new plantations.
 15. Conservation tillage for soil management

Child Mortality Wedges: 2005-2030

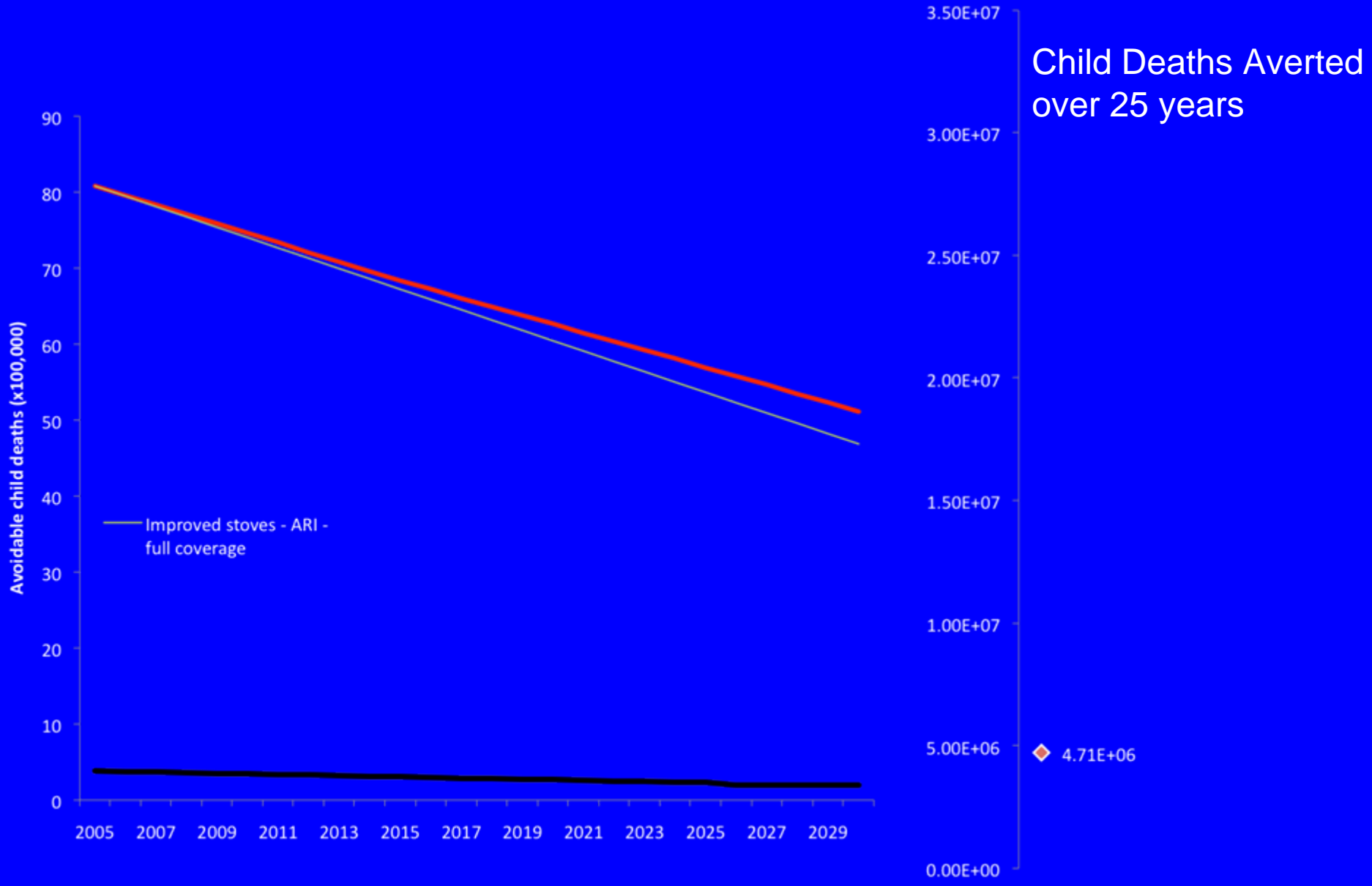
Children in the poorest nations with 2.7 billion people: <\$750/year-person (WHO databases)



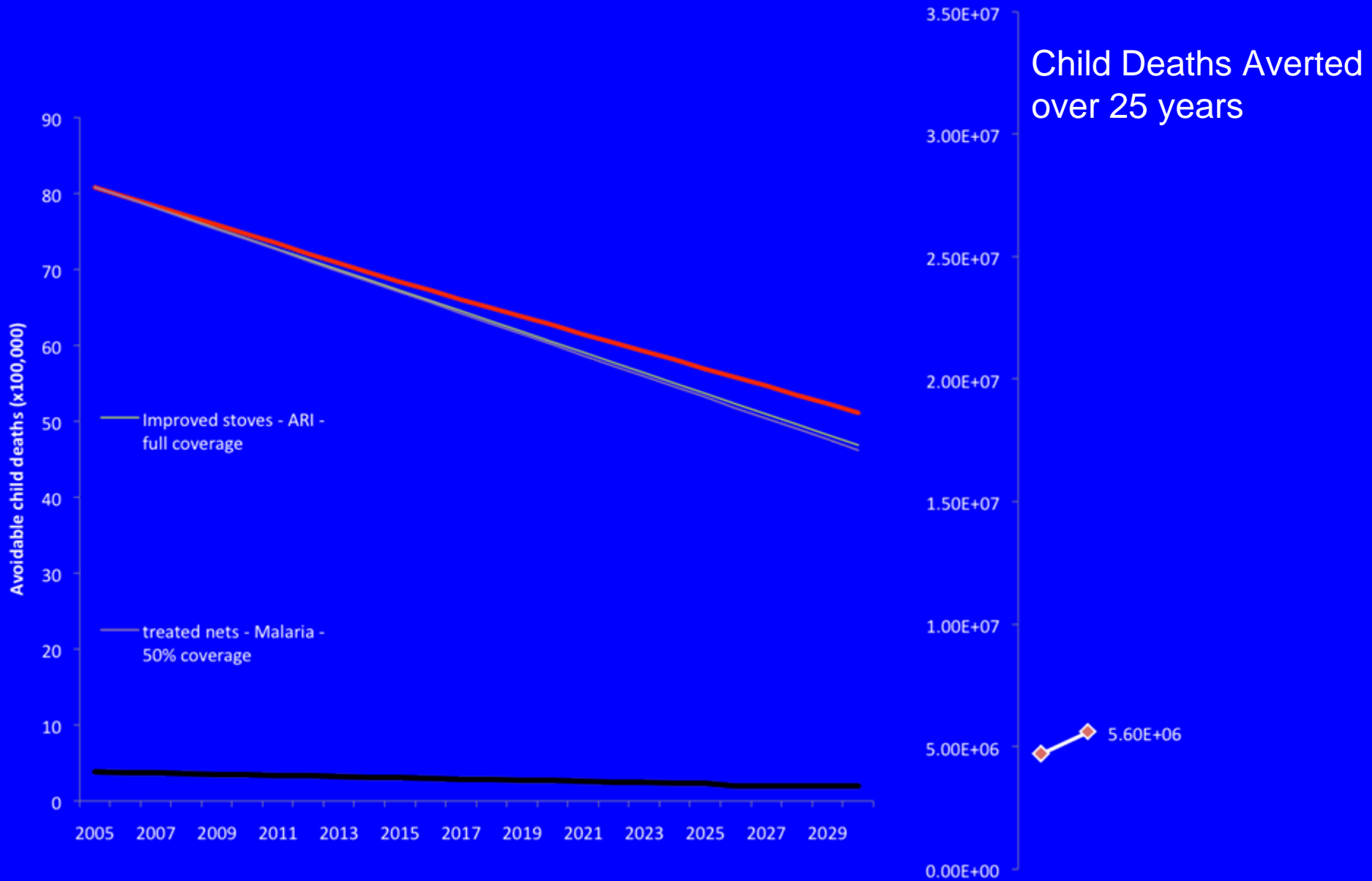
Potential Impacts of Health Interventions on Child Mortality in Low Income Countries



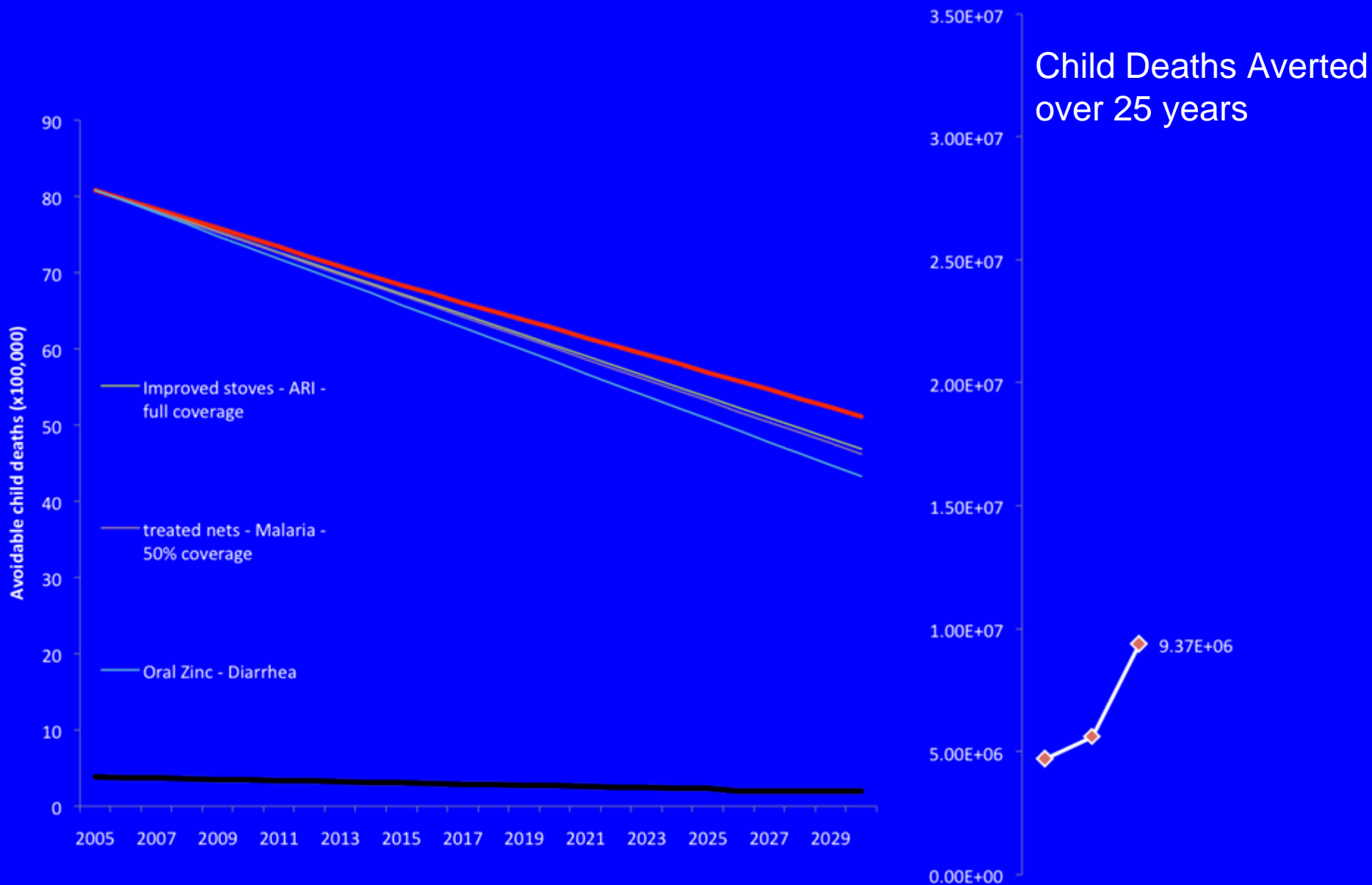
Potential Impacts of Health Interventions on Child Mortality in Low Income Countries



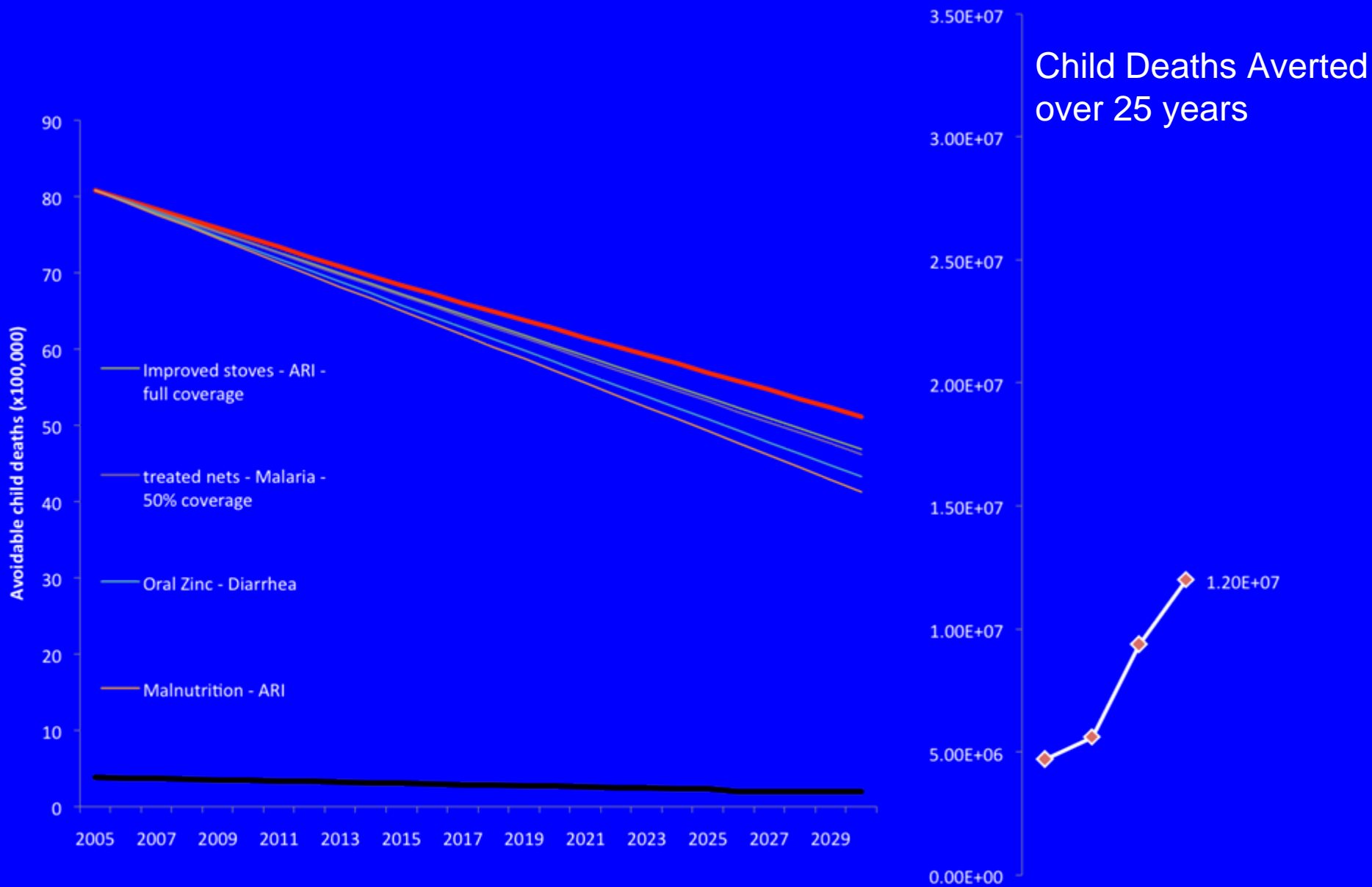
Potential Impacts of Health Interventions



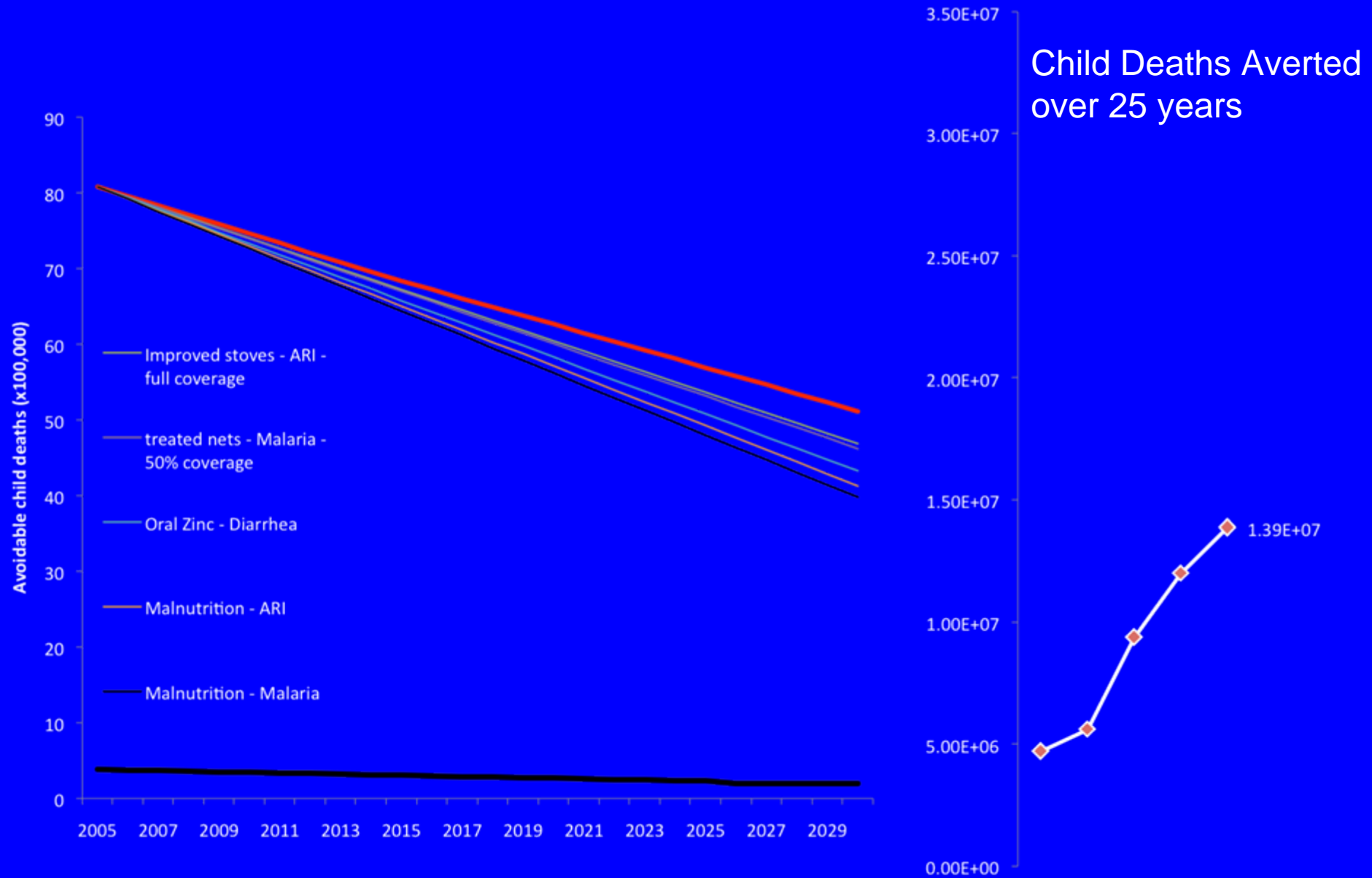
Potential Impacts of Health Interventions on Child Mortality in Low Income Countries



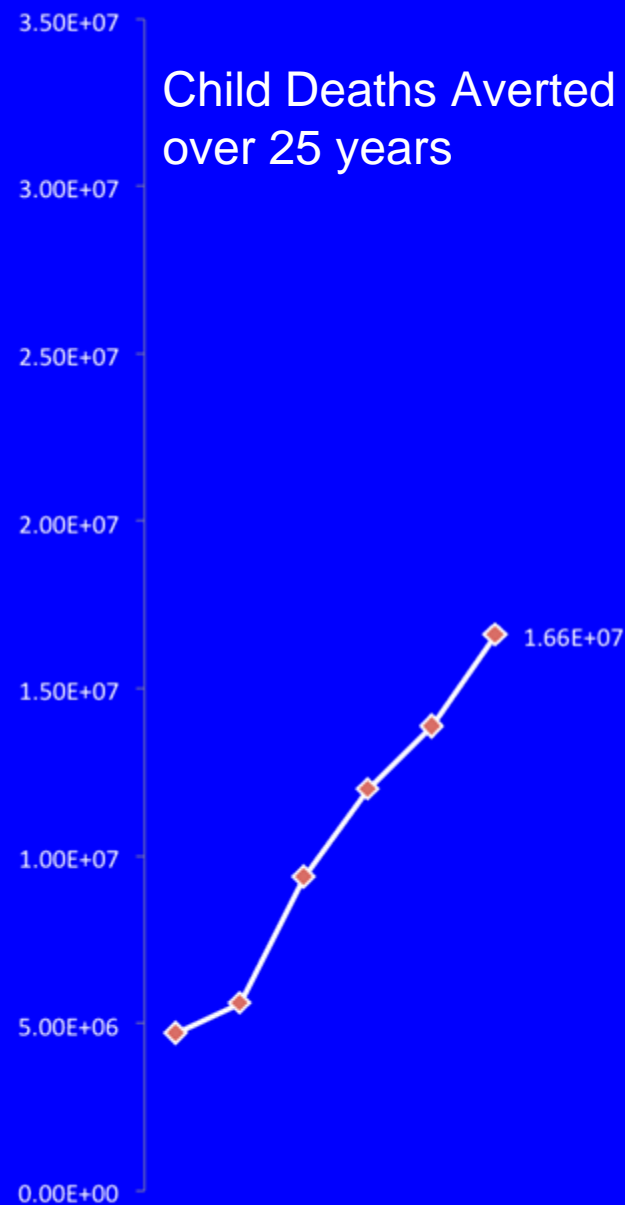
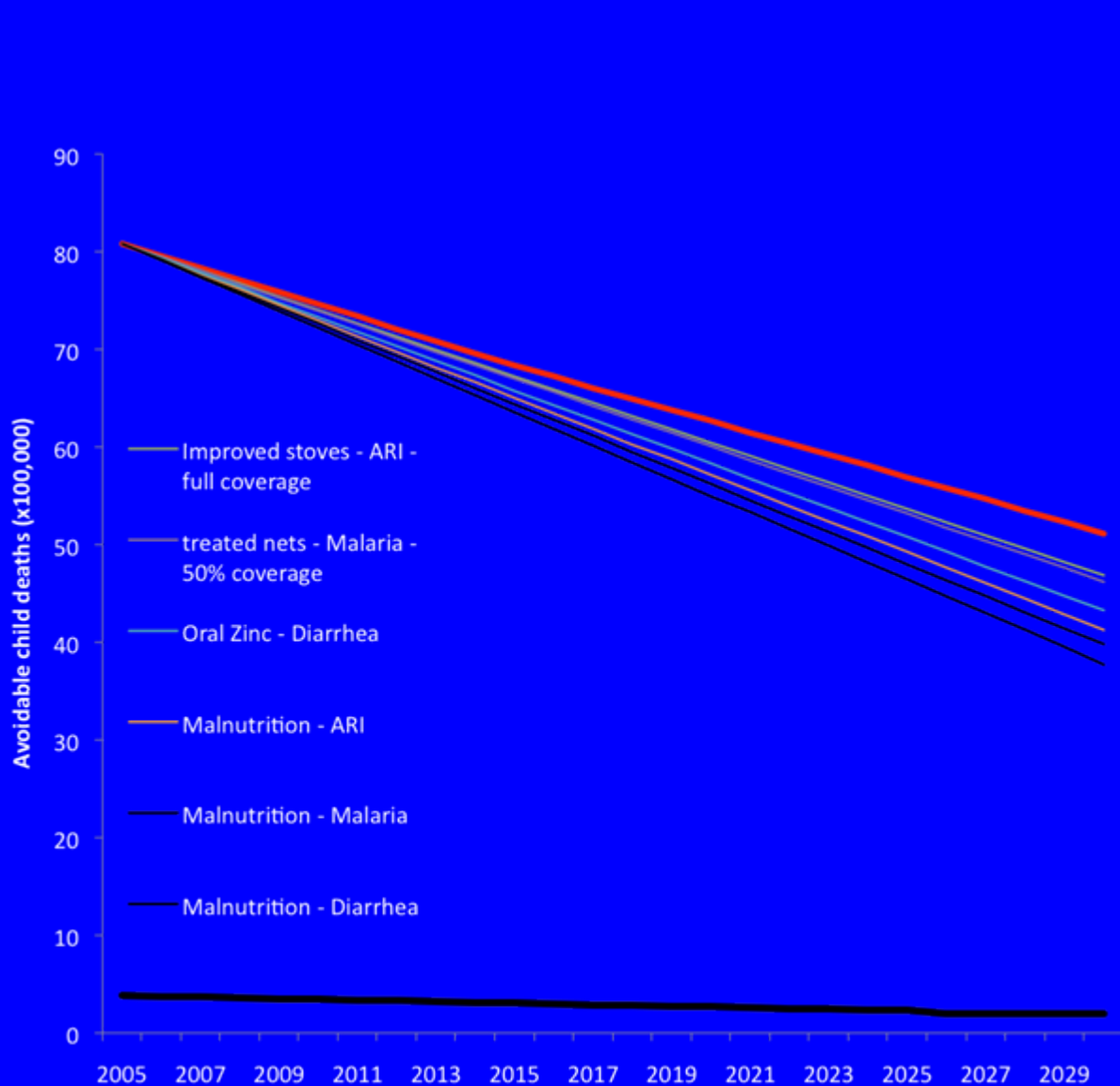
Potential Impacts of Health Interventions on Child Mortality in Low Income Countries



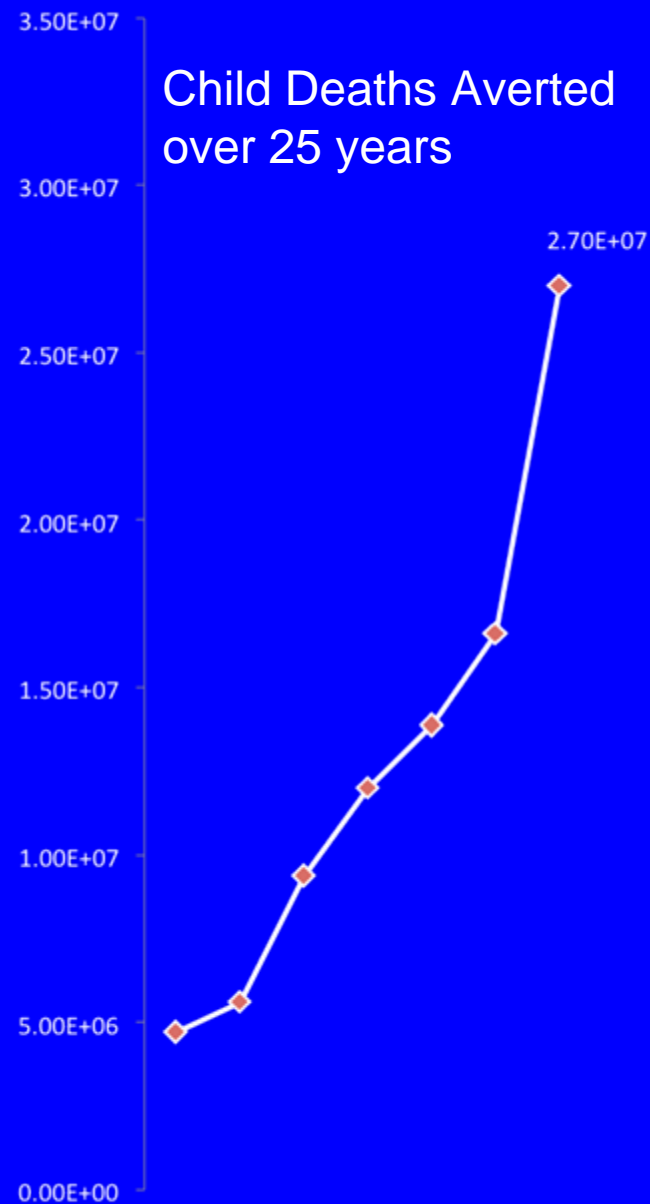
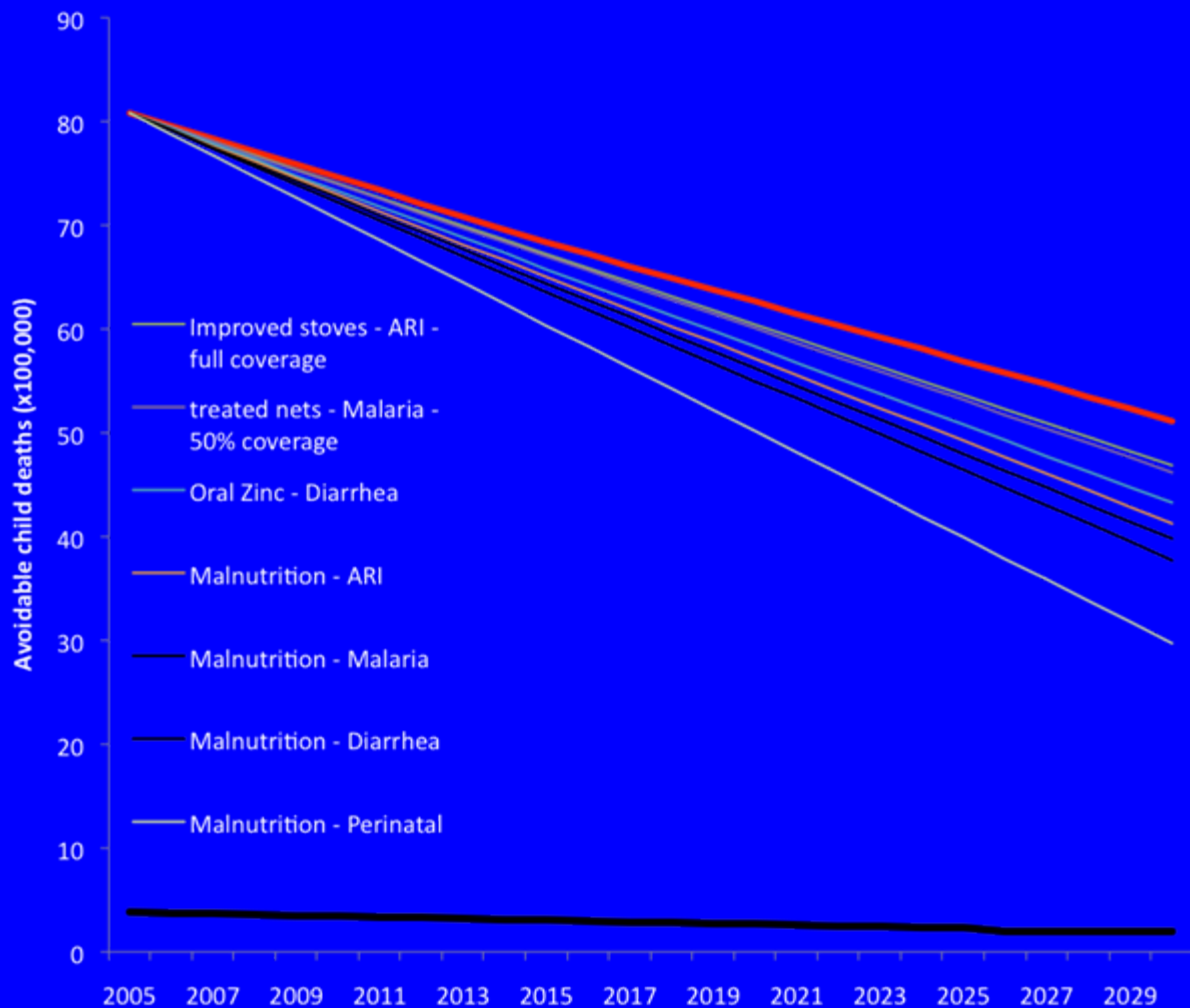
Potential Impacts of Health Interventions on Child Mortality in Low Income Countries



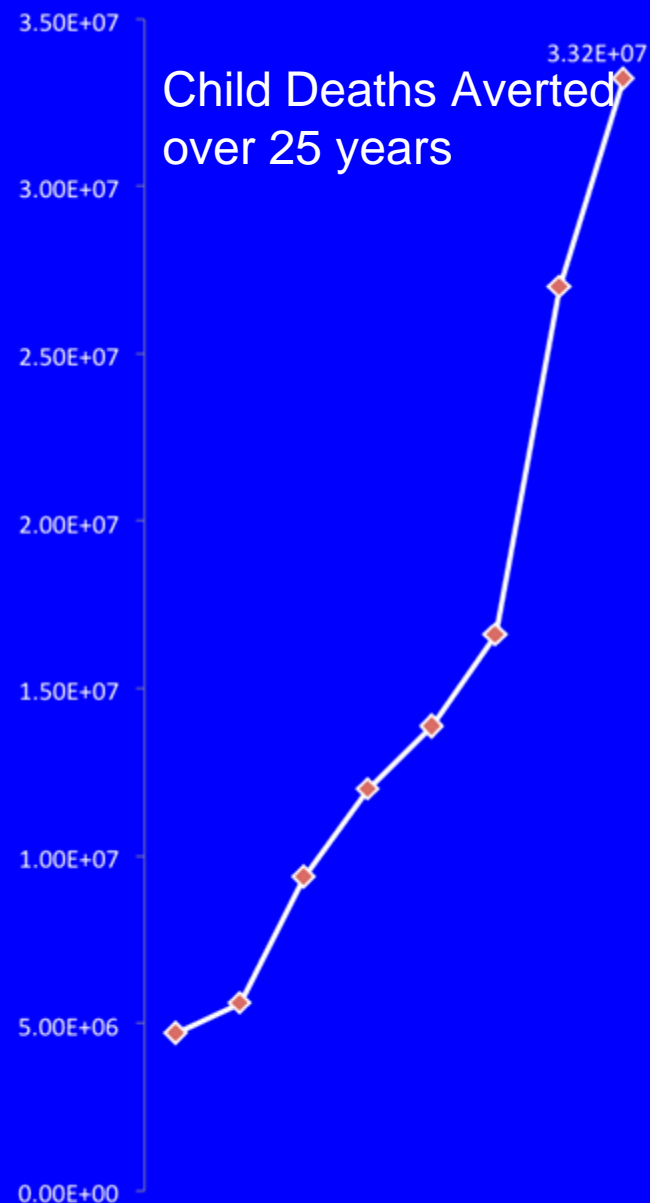
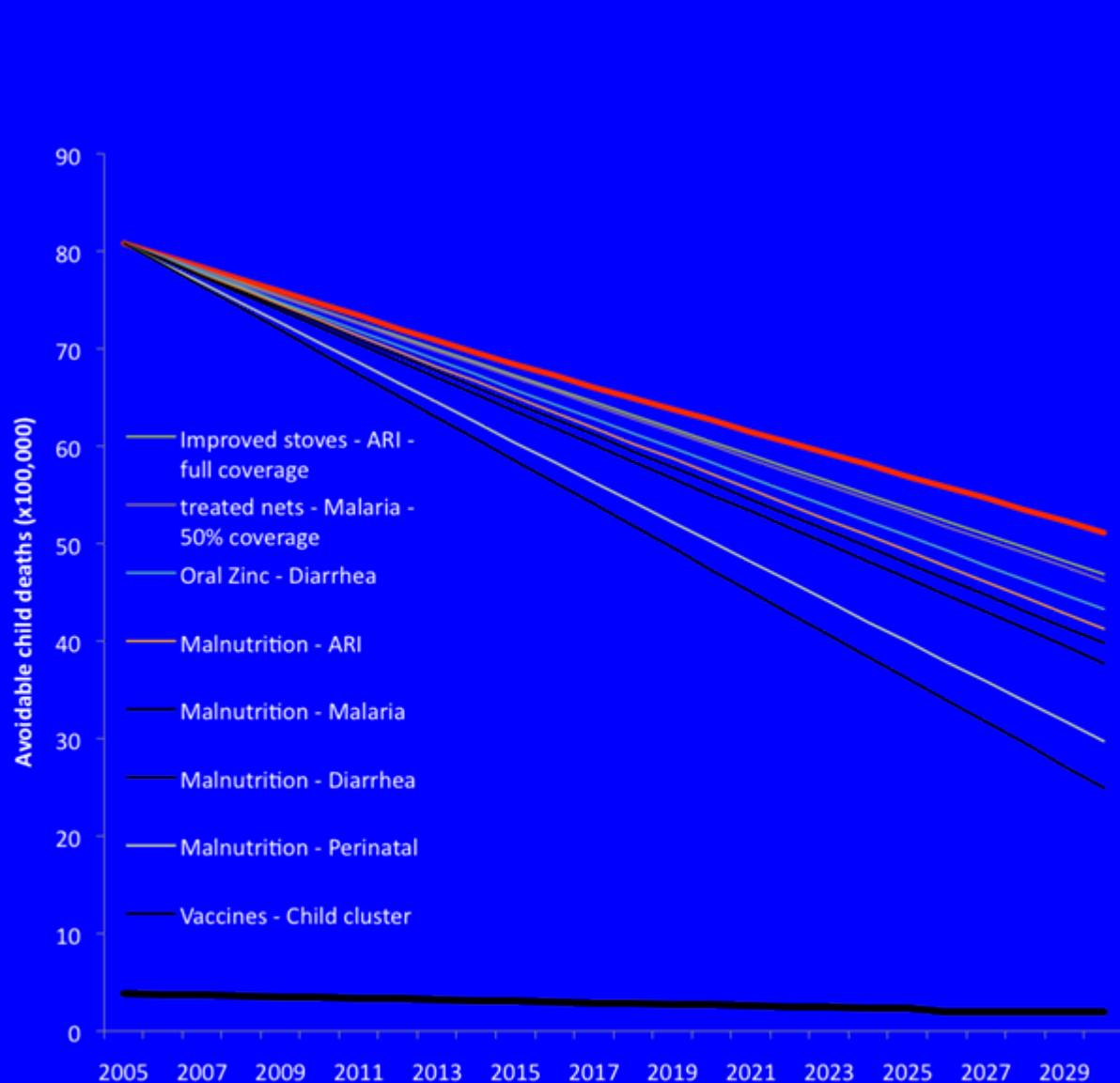
Potential Impacts of Health Interventions on Child Mortality in Low Income Countries



Potential Impacts of Health Interventions on Child Mortality in Low Income Countries



Potential Impacts of Health Interventions on Child Mortality in Low Income Countries

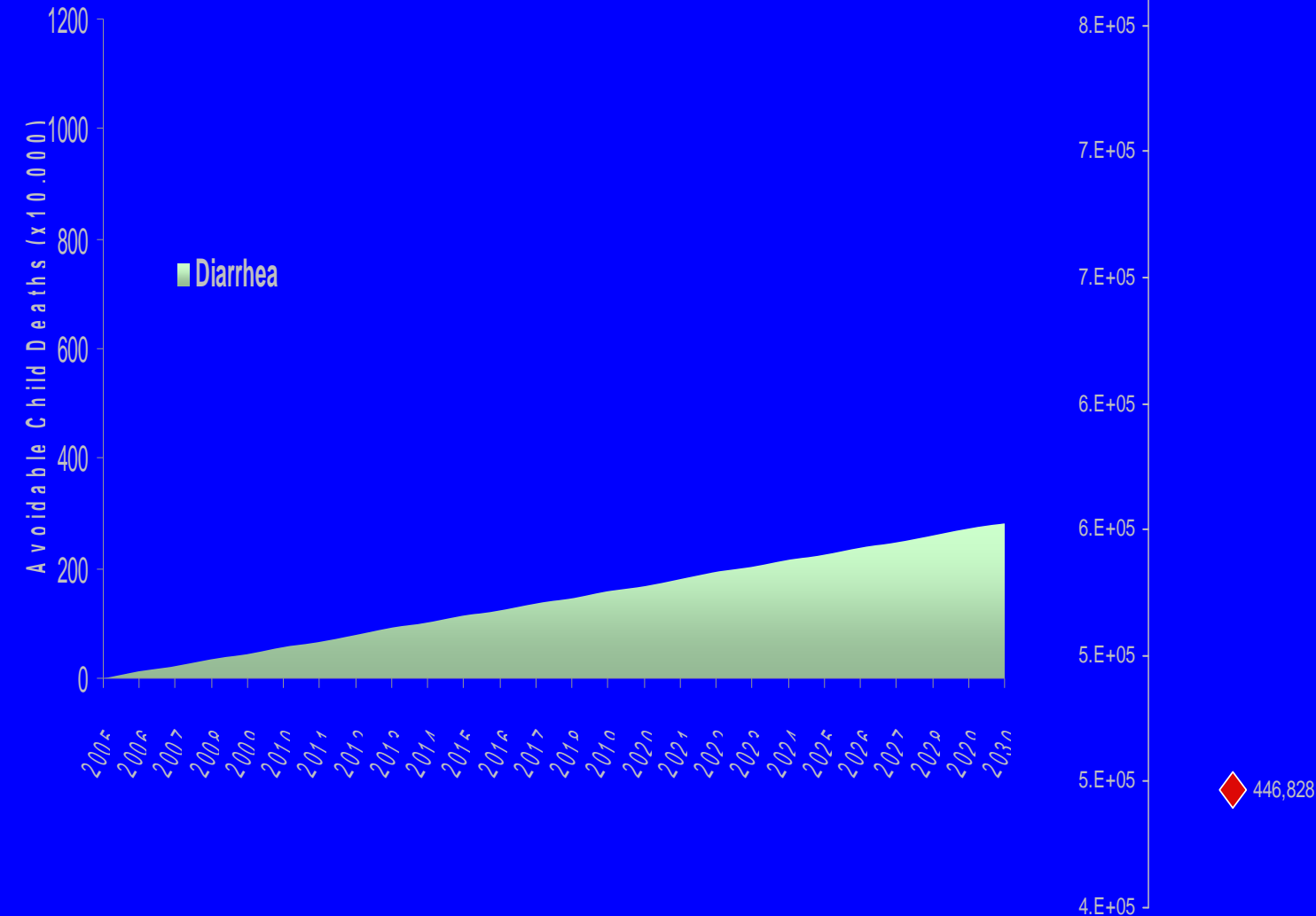


Based mainly on *Lancet* Child Mortality Series

Potential Impacts of Climate Change on Child Mortality in Low Income Countries

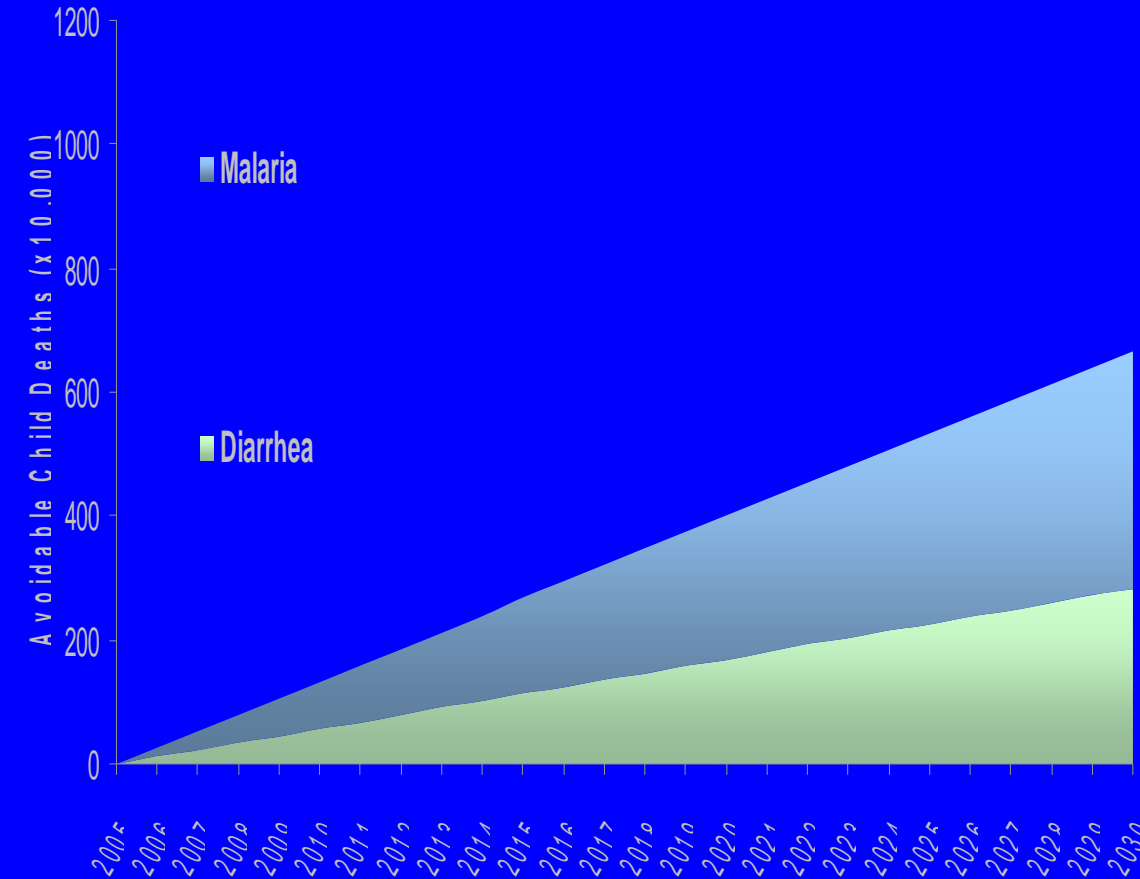
550ppm

Deaths

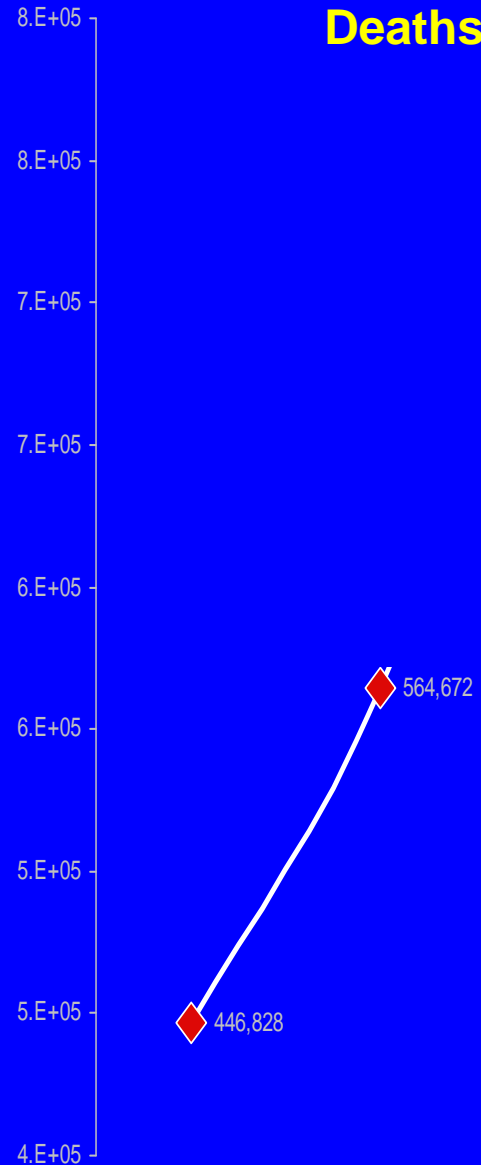


Potential Impacts of Climate Change on Child Mortality in Low Income Countries

550ppm

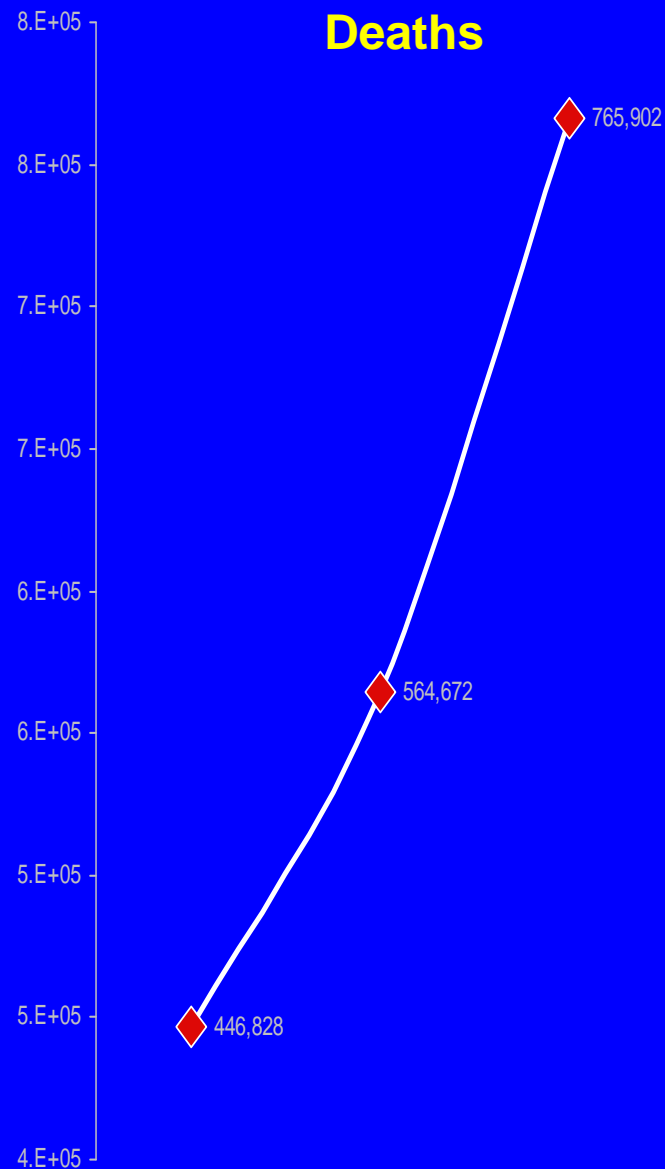
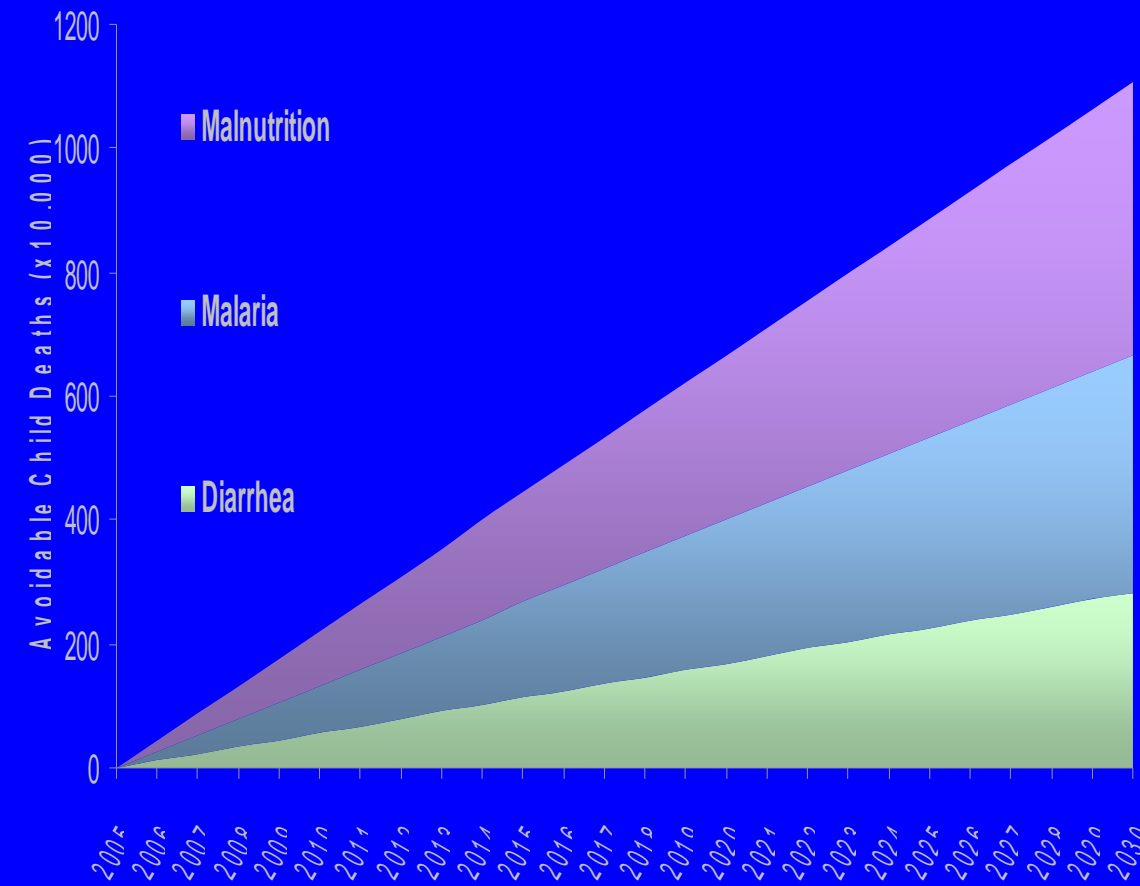


Deaths



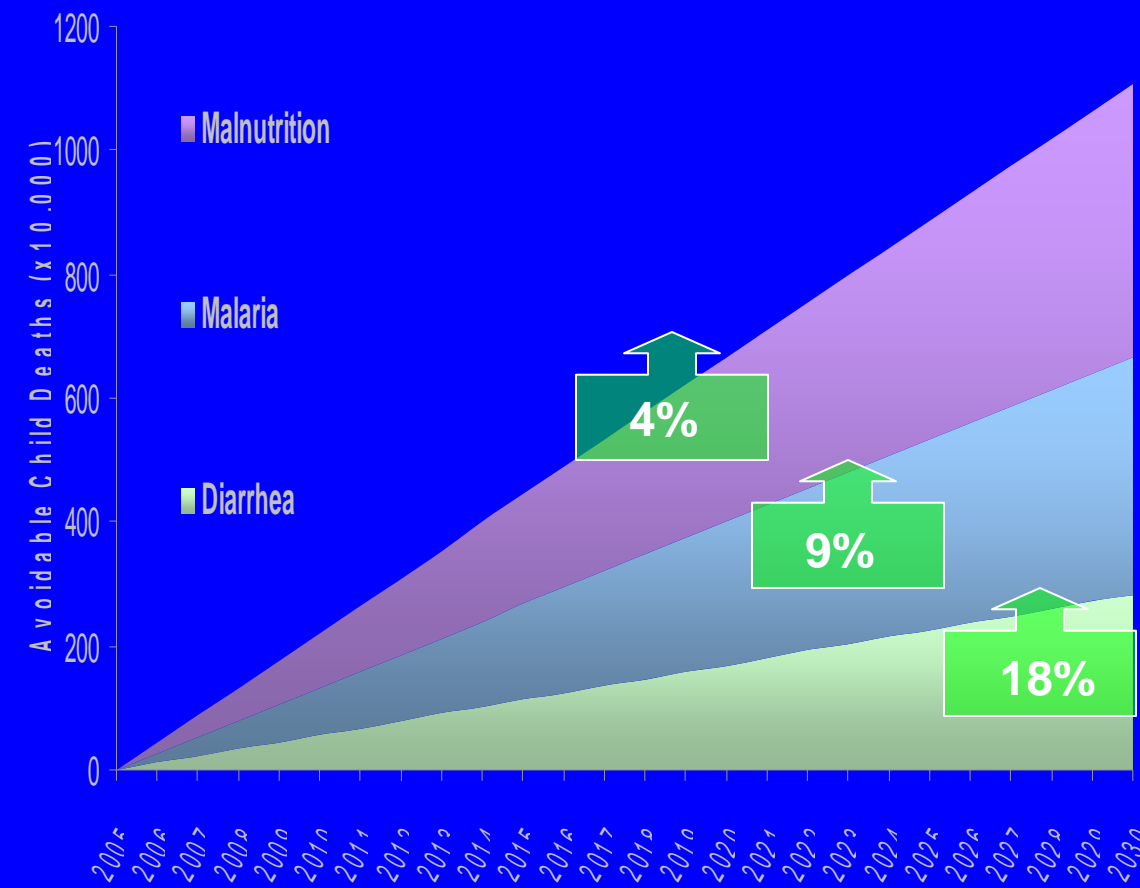
Potential Impacts of Climate Change on Child Mortality in Low Income Countries

550ppm

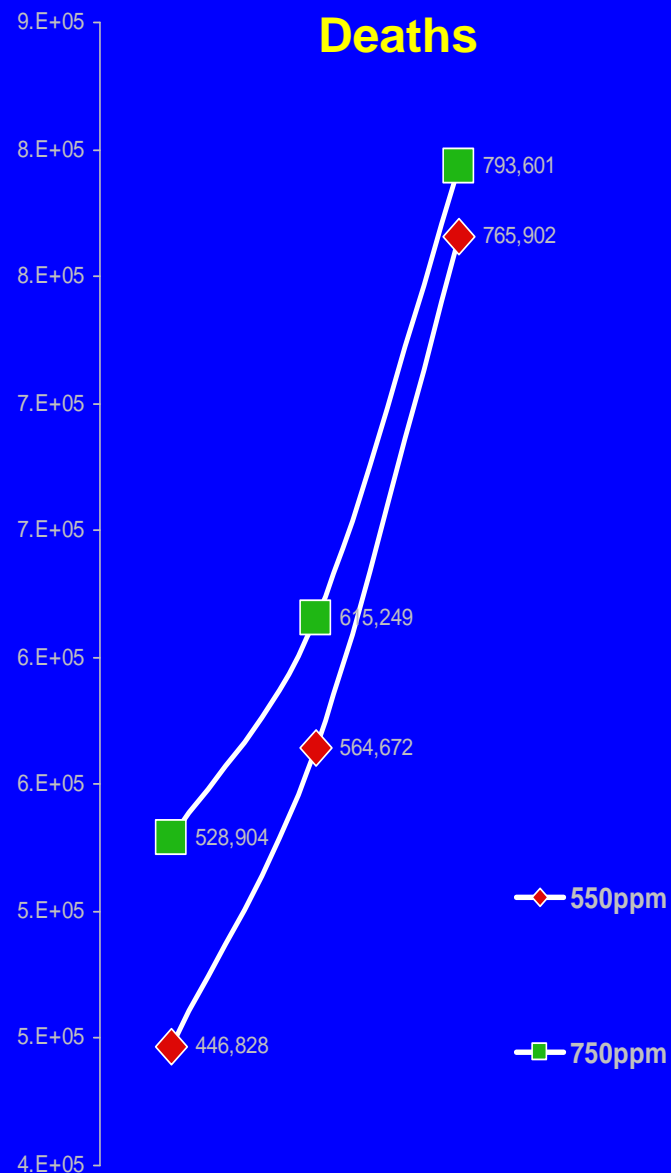


Potential Impacts of Climate Change on Child Mortality in Low Income Countries

750ppm



McMichael et al., Climate Change CRA

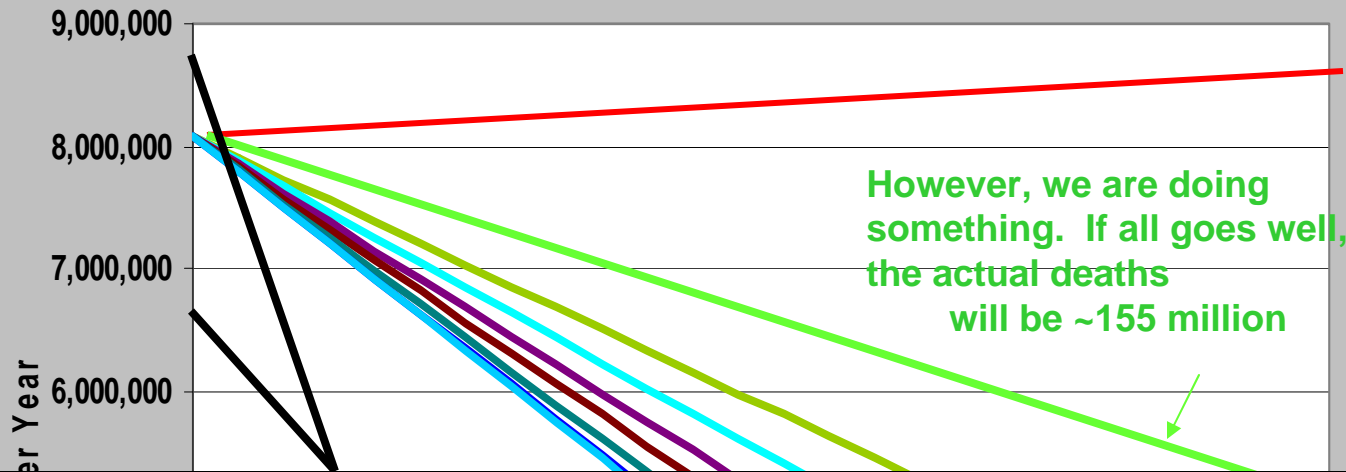


Bottom Line on Climate Health Effects

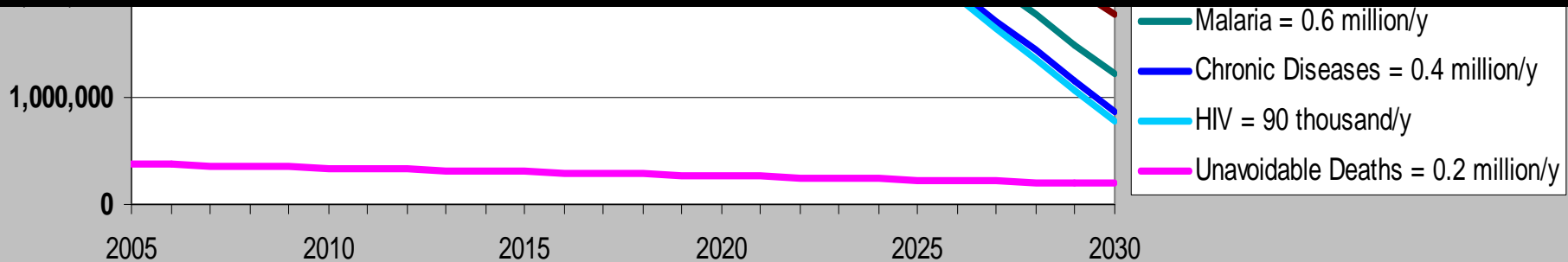
- Mostly affect the most vulnerable populations in the world – especially children in poor countries
- This population already highly impacted ~ 10 million avoidable deaths each year
- Progress has been slow in reducing this toll, but the knowledge and resources to do better are available
- Doing so is threatened by climate change
- Not all diseases affected equally
- Has implications for altering our plans to take climate change into account by both
 - accelerating efforts to do what we should be doing anyway
 - Shifting our priorities among diseases

Child Mortality Wedges: 2005-2030

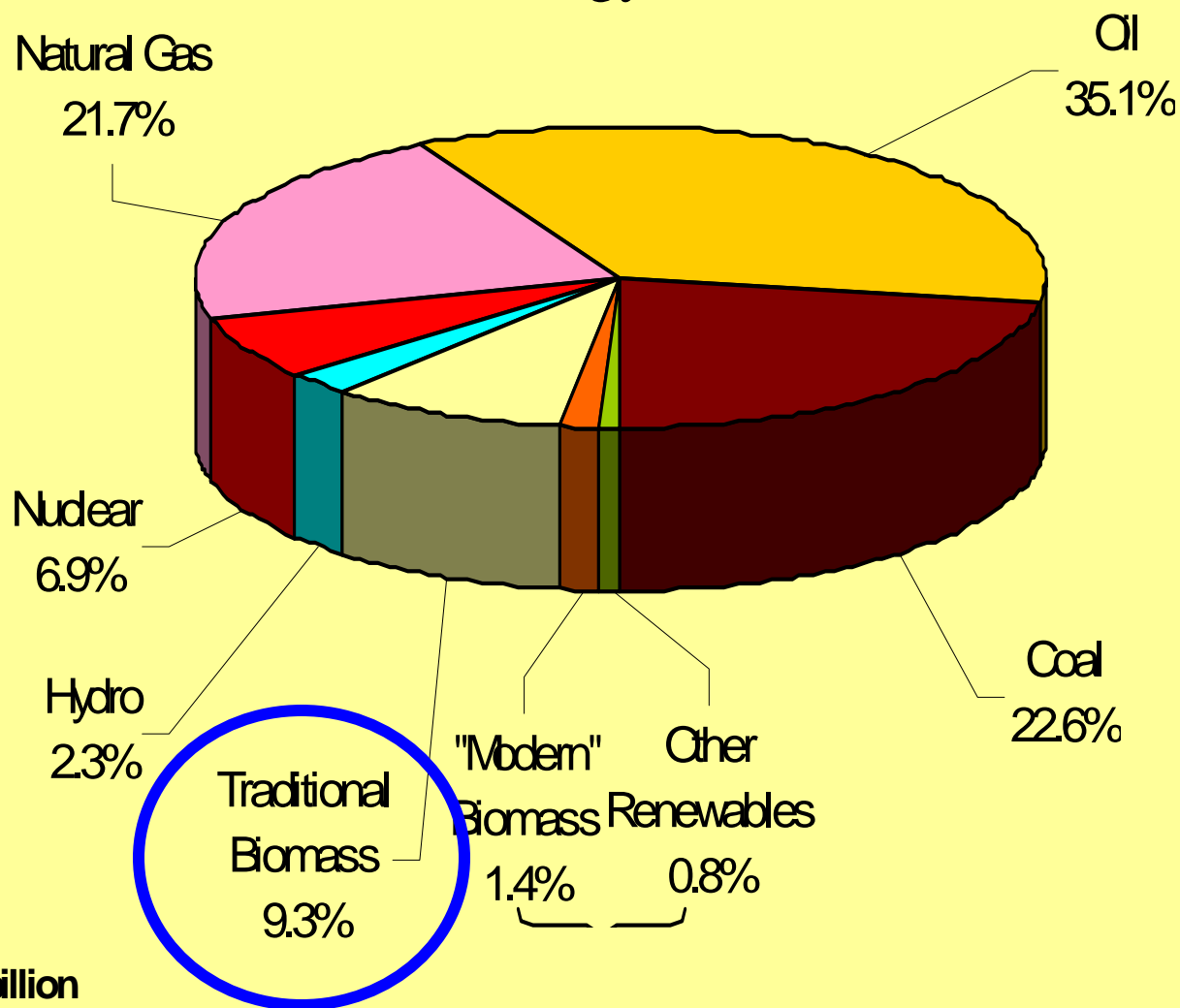
Children in the poorest nations with 2.7 billion people: <\$750/year-person (WHO databases)



ARI has strong links to inefficient energy use, which offers a great opportunity for “Co-benefits” -- achieving both climate mitigation and health protection with the same policies



World Energy – 2001

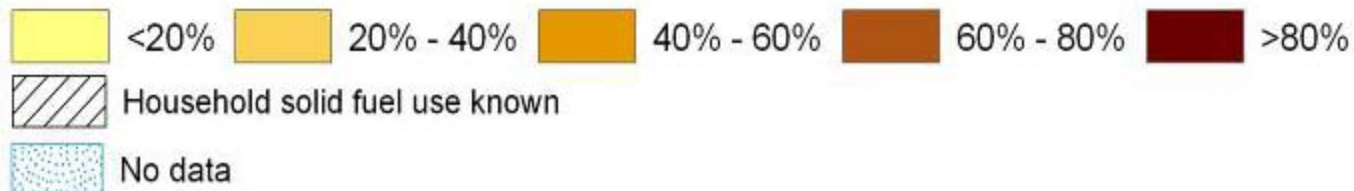
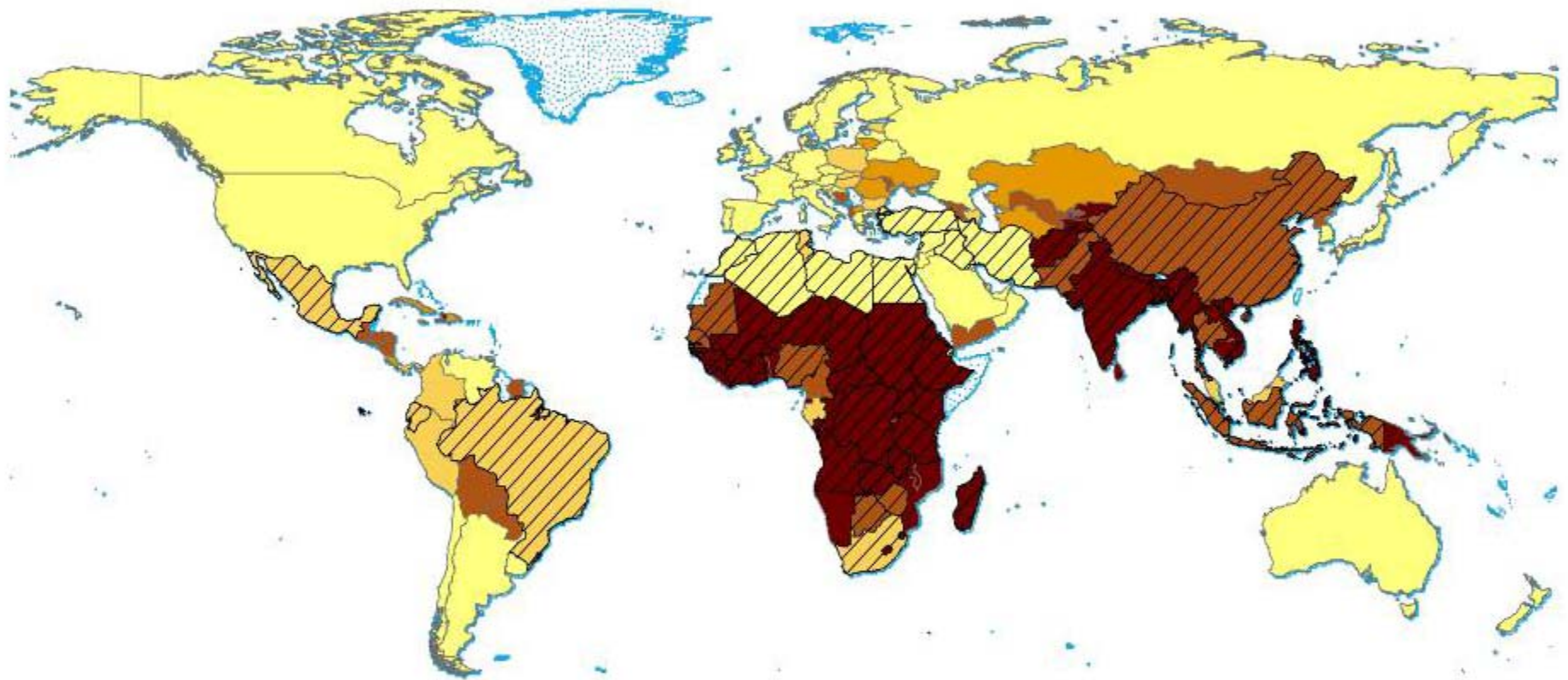


Population: 6.102 billion

Total energy use: 102 Gtoe

Per capita energy consumption: 167 toe

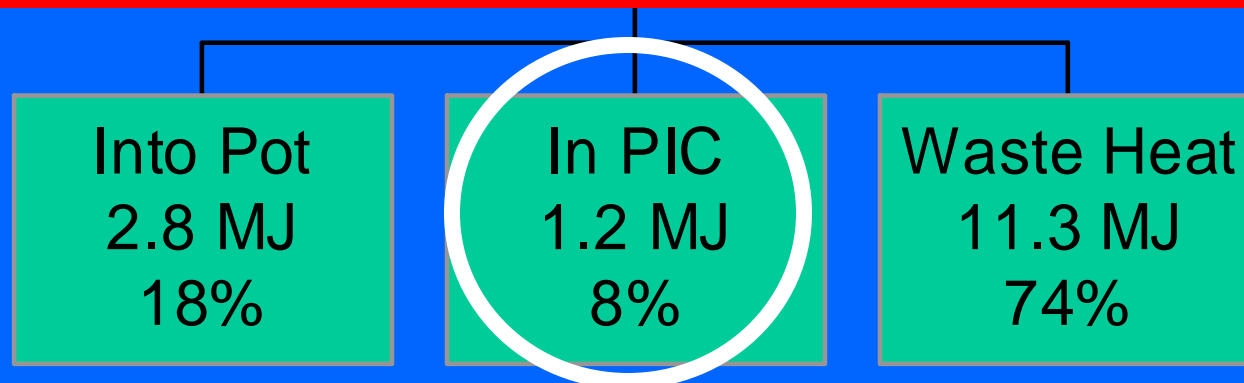
National Household Solid Fuel Use, 2000



Energy flows in a well-operating traditional wood-fired Indian cooking stove

A Toxic Waste Factory!!

Typical biomass cookstoves convert 6-20% of the fuel carbon to toxic substances



PIC = products of incomplete combustion = CO, HC, C, etc.

Source:
Smith,
et al.,
2000

Toxic Pollutants in Biomass Fuel Smoke from Simple (poor) Combustion

- Small particles, CO, NO₂
- Hydrocarbons
 - 25+ saturated hydrocarbons such as *n-hexane*
 - **Plus methane,**
 - **a powerful GHG!**
 - 25+ unsaturated hydrocarbons such as *1,3-butadiene*
- Oxygenated organics
 - 20+ aldehydes including *formaldehyde* & *acrolein*
 - 25+ alcohols and acids such as *methanol*
 - 33+ phenols such as *catechol* & *cresol*
 - Many quinones such as *hydroquinone*
 - Semi-quinone-type and other radicals
- Chlorinated organics such as *methylene chloride* and *dioxin*

Naeher, et al.
2007

First person in human history to have her exposure measured doing one of the oldest tasks in human history



Gujarat, India
1981

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

ALRI/
Pneumonia
(meningitis)

Asthma

Low birth
weight

Early
infant
death

Cognitive
Impairment?

Chronic
obstructive
lung disease

Interstitial lung
disease

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

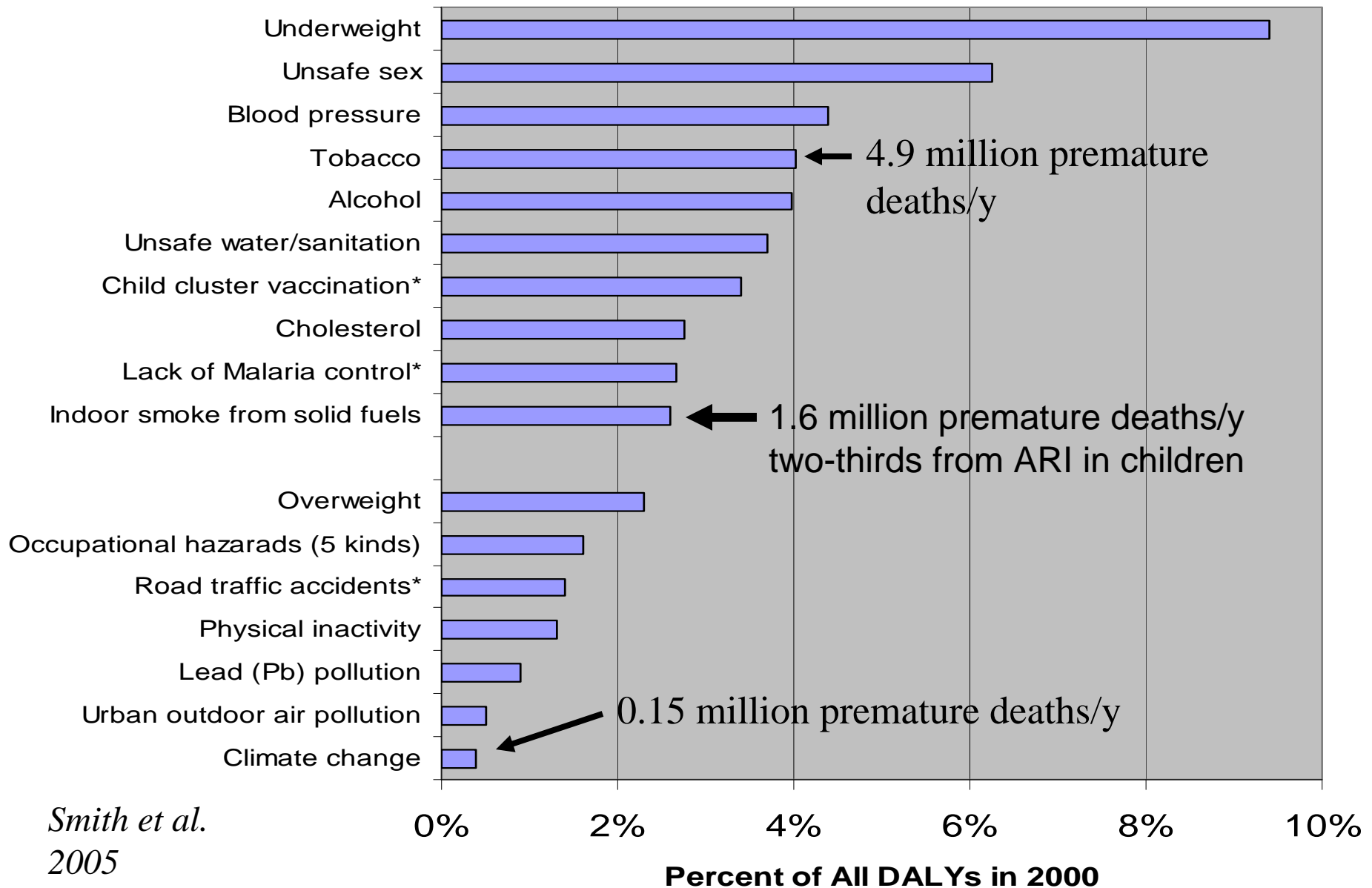
Blindness
(cataracts, trachoma)

Tuberculosis

Heart disease?



Global Burden of Disease from Top 10 Risk Factors plus selected other risk factors



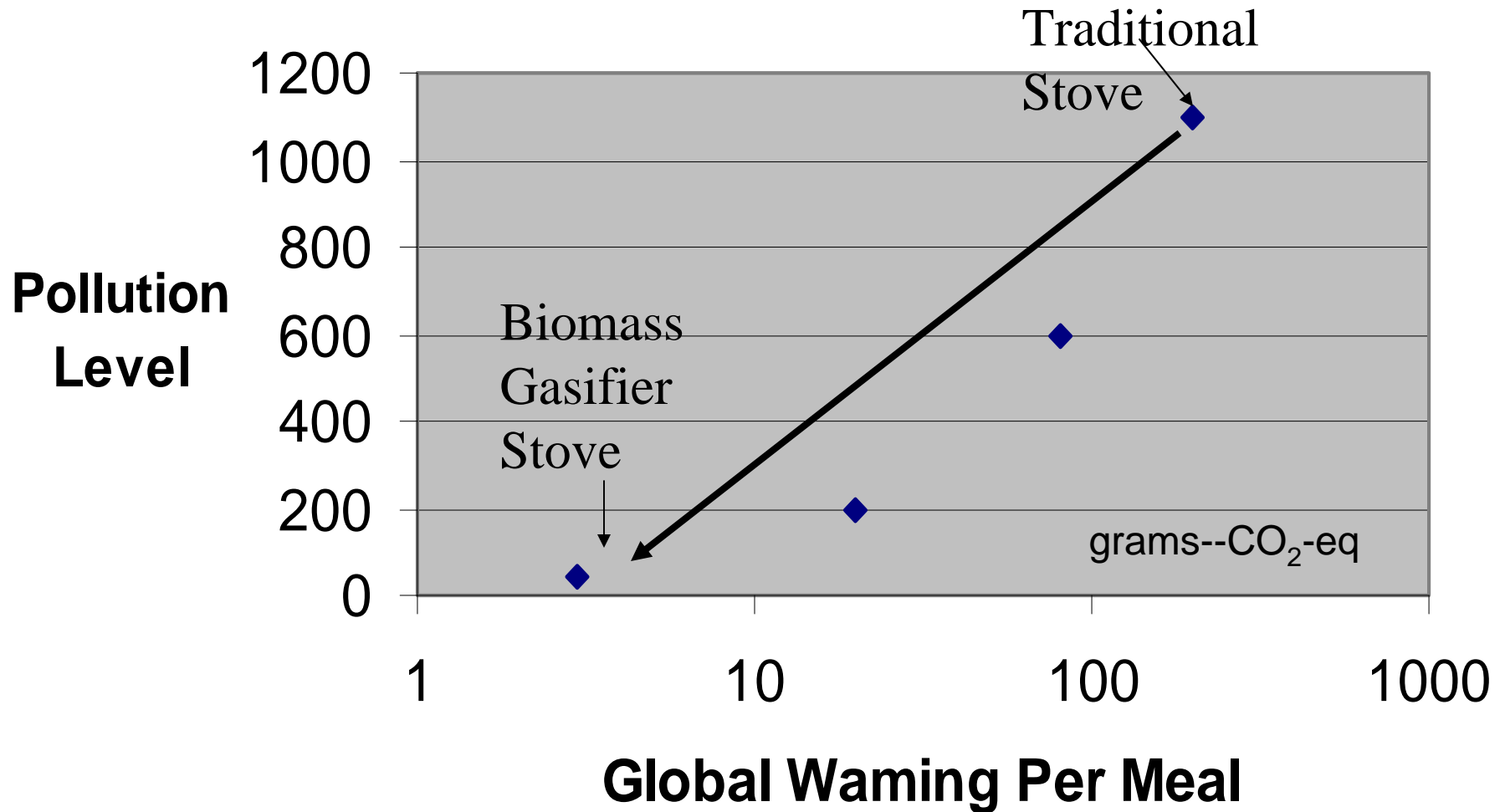
A Biomass Gasifier Stove

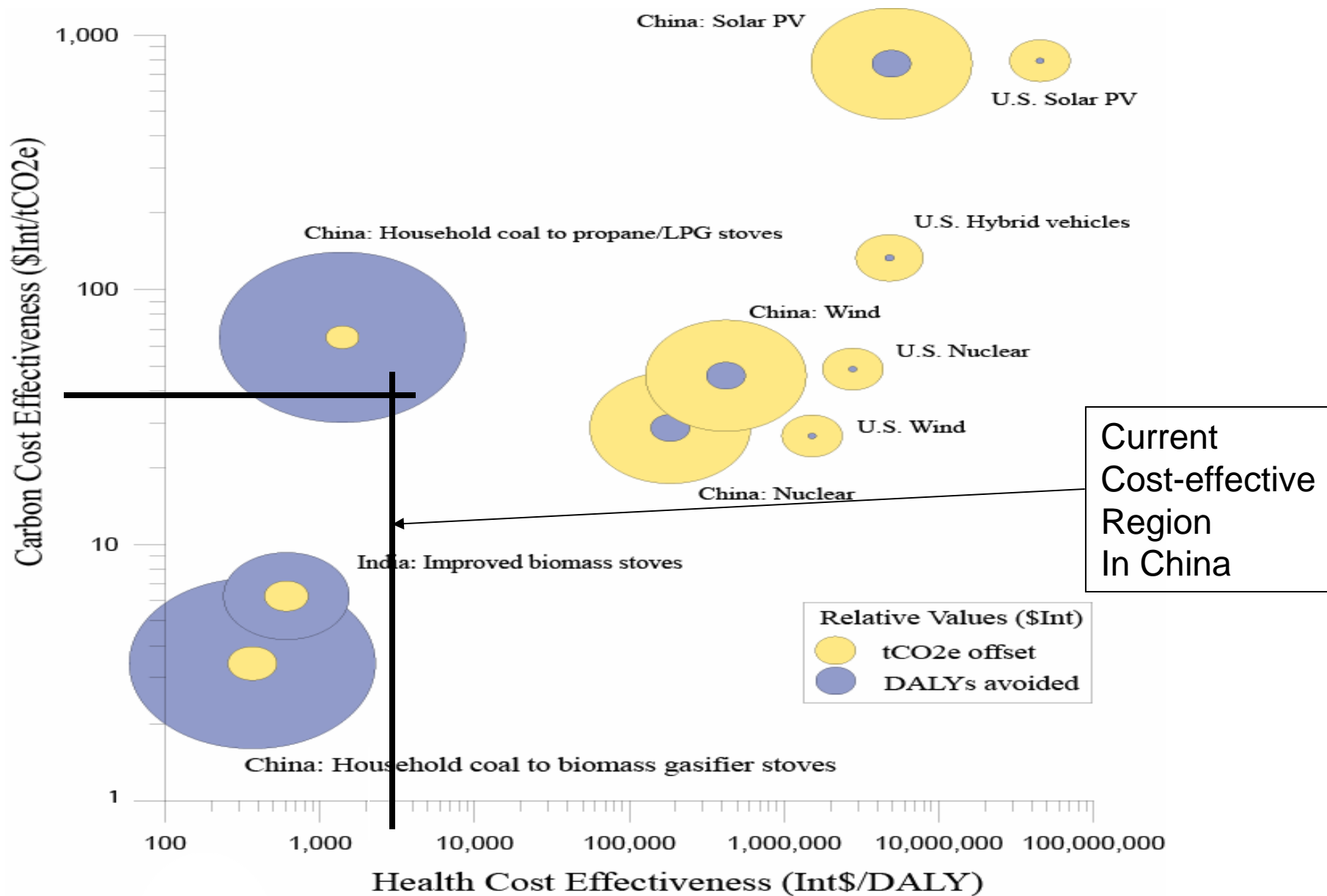
Tests show emissions nearly at levels of gas stoves:
Low health risk and essentially no greenhouse emissions

Winner of Chinese national contest
announced March 2007 for best stove meeting
emissions and reliability criteria:
cost ~\$40

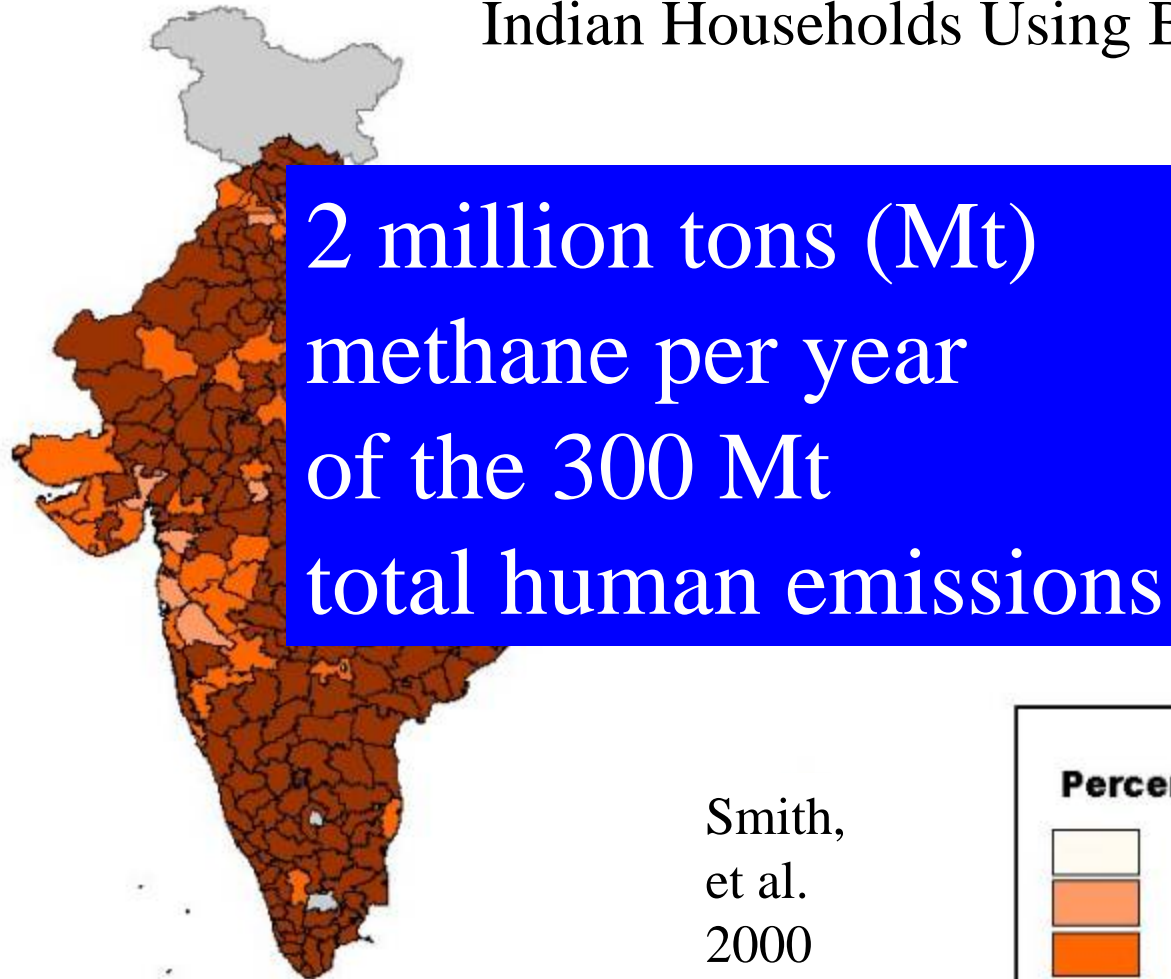


Health and Greenhouse Gas Benefits of Biomass Stove Options










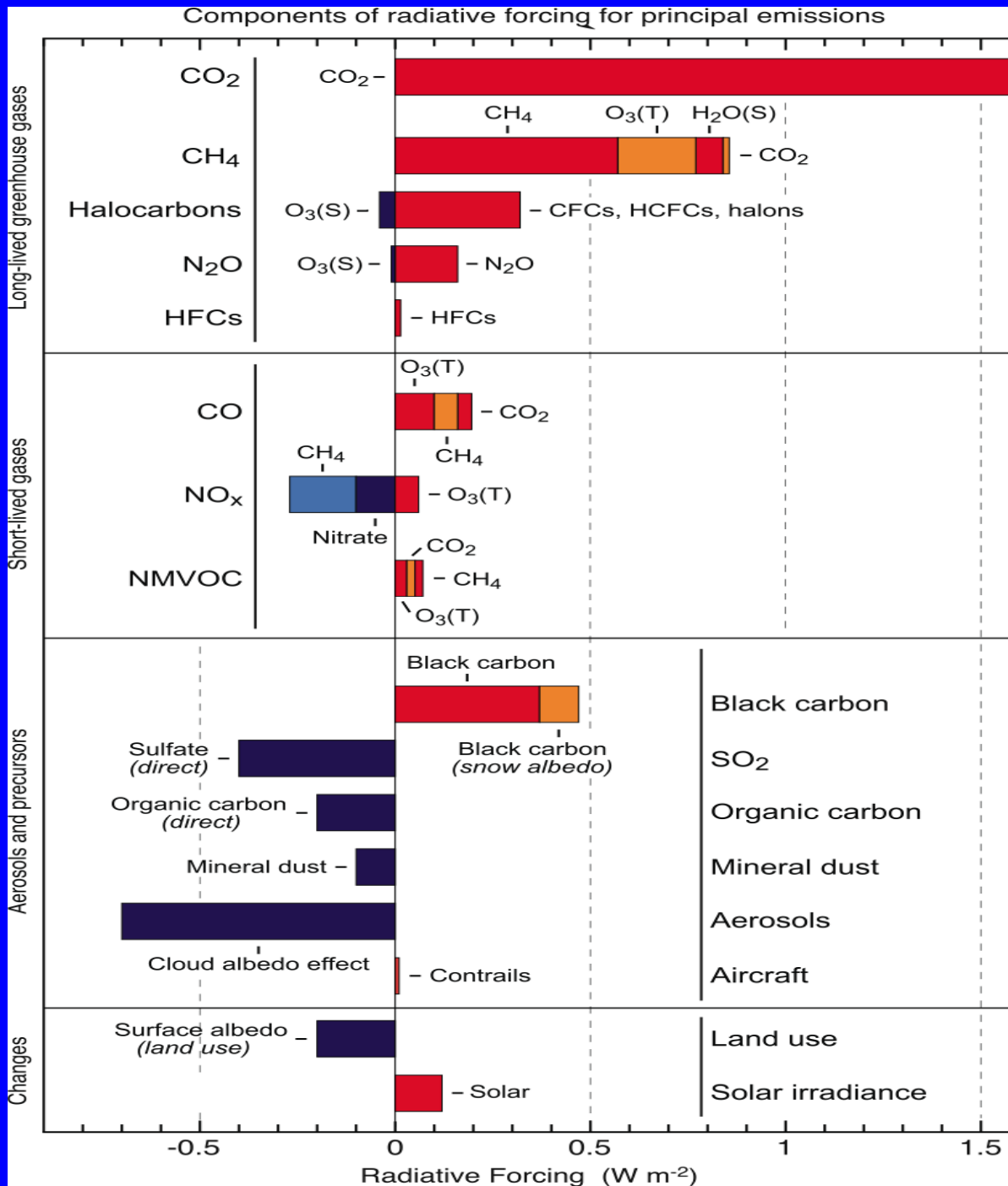
Indian Households Using Biomass Fuels



Smith,
et al.
2000

Percentage of Households

	0-24
	25-49
	50-74
	75-100
	unknown



Radiative forcing in 2005 from emissions since 1750

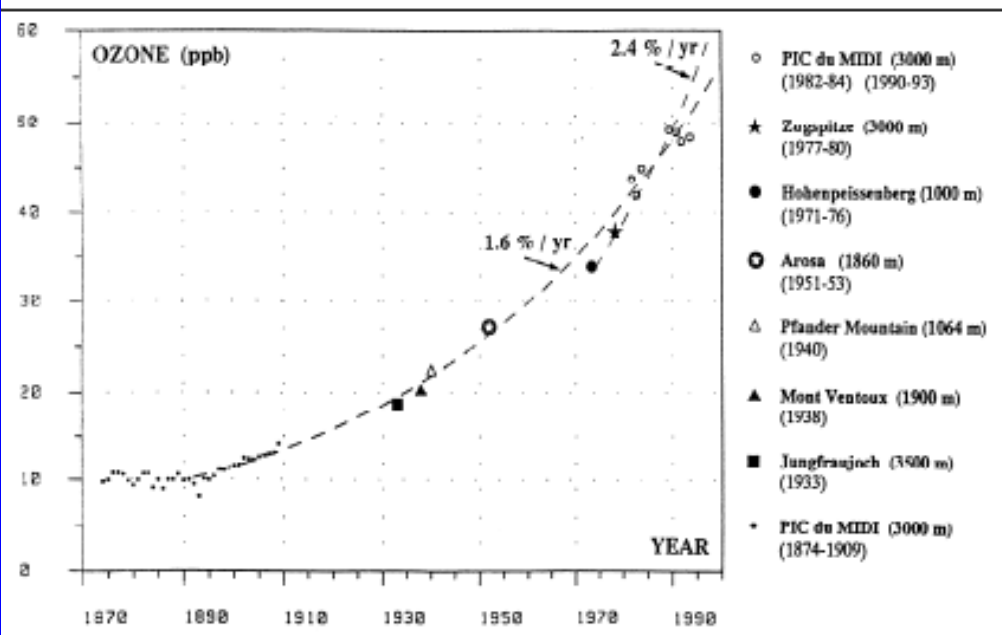
IPCC, 2007

Methane Co-benefits

- Increases of wide-scale ground-level ozone is becoming a major world problem
- A significant health-damaging pollutant
- Methane emissions are one of its causes
- Ozone levels are rising worldwide
- Reduction of methane emissions, therefore, will help protect health worldwide

Background Ozone is Growing ...

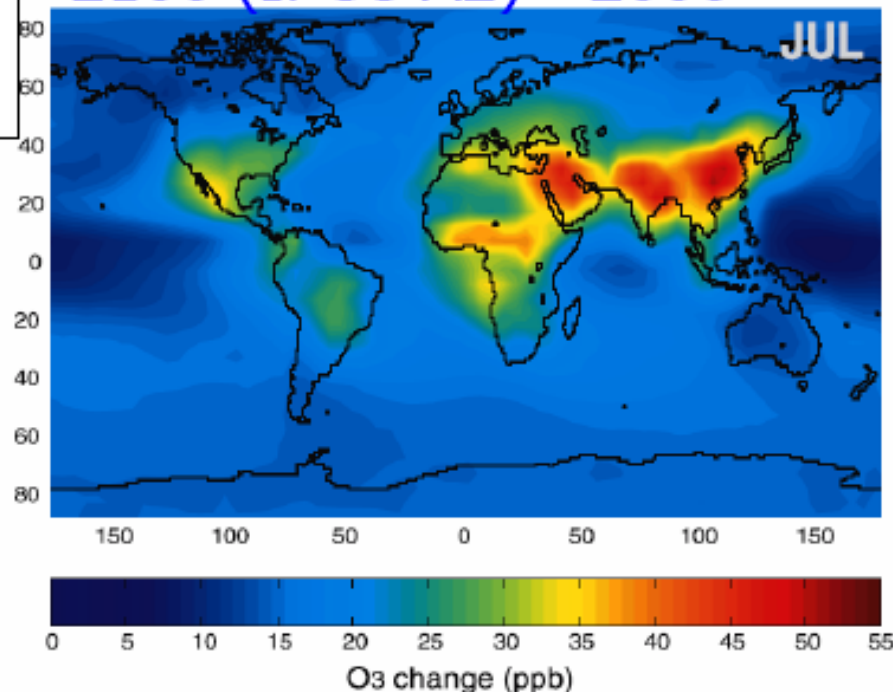
... and Will Continue to Grow!



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

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



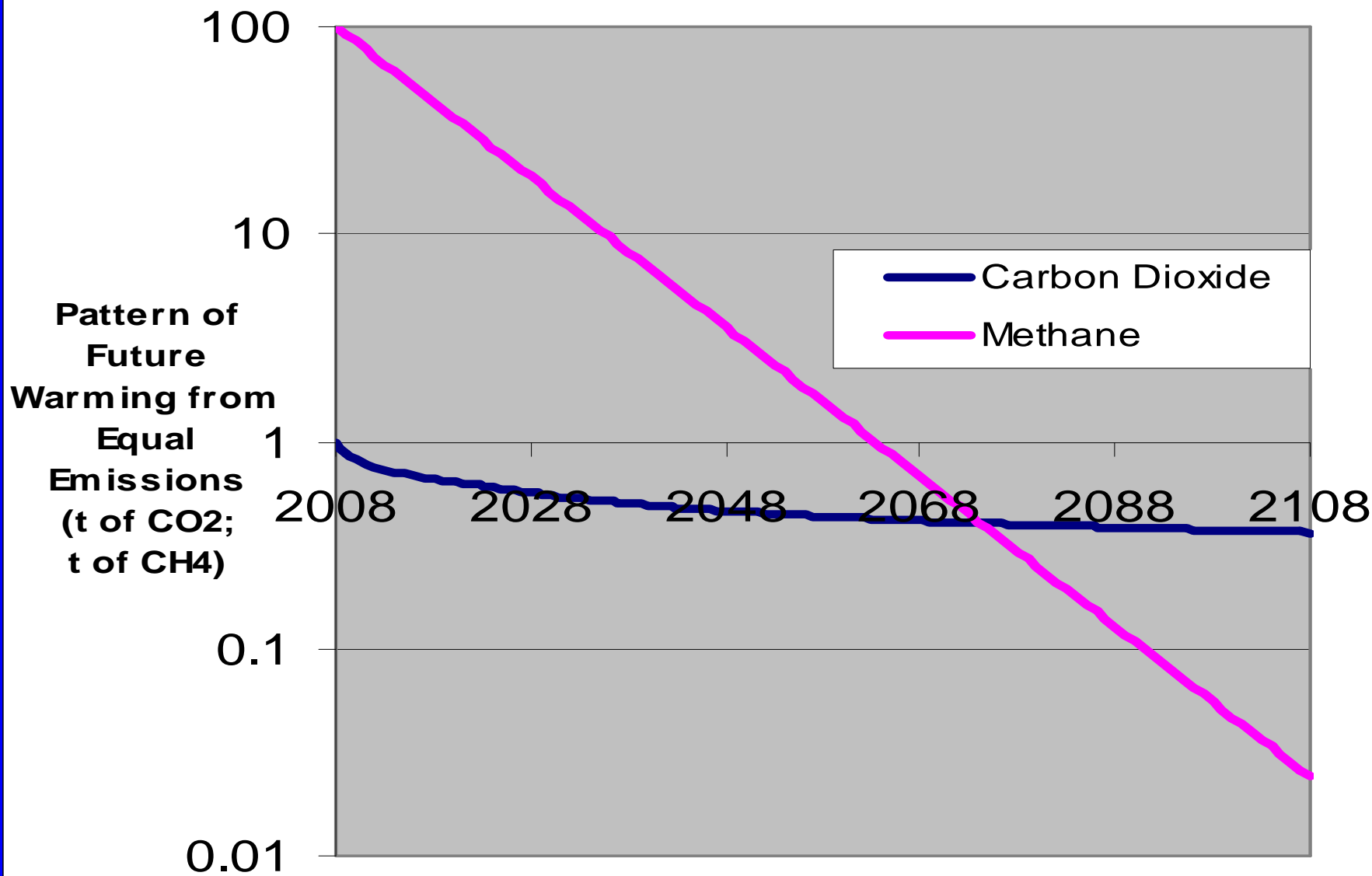
Multiple Benefits of Reducing Methane

Reducing **~20% of anthropogenic methane emissions** will:

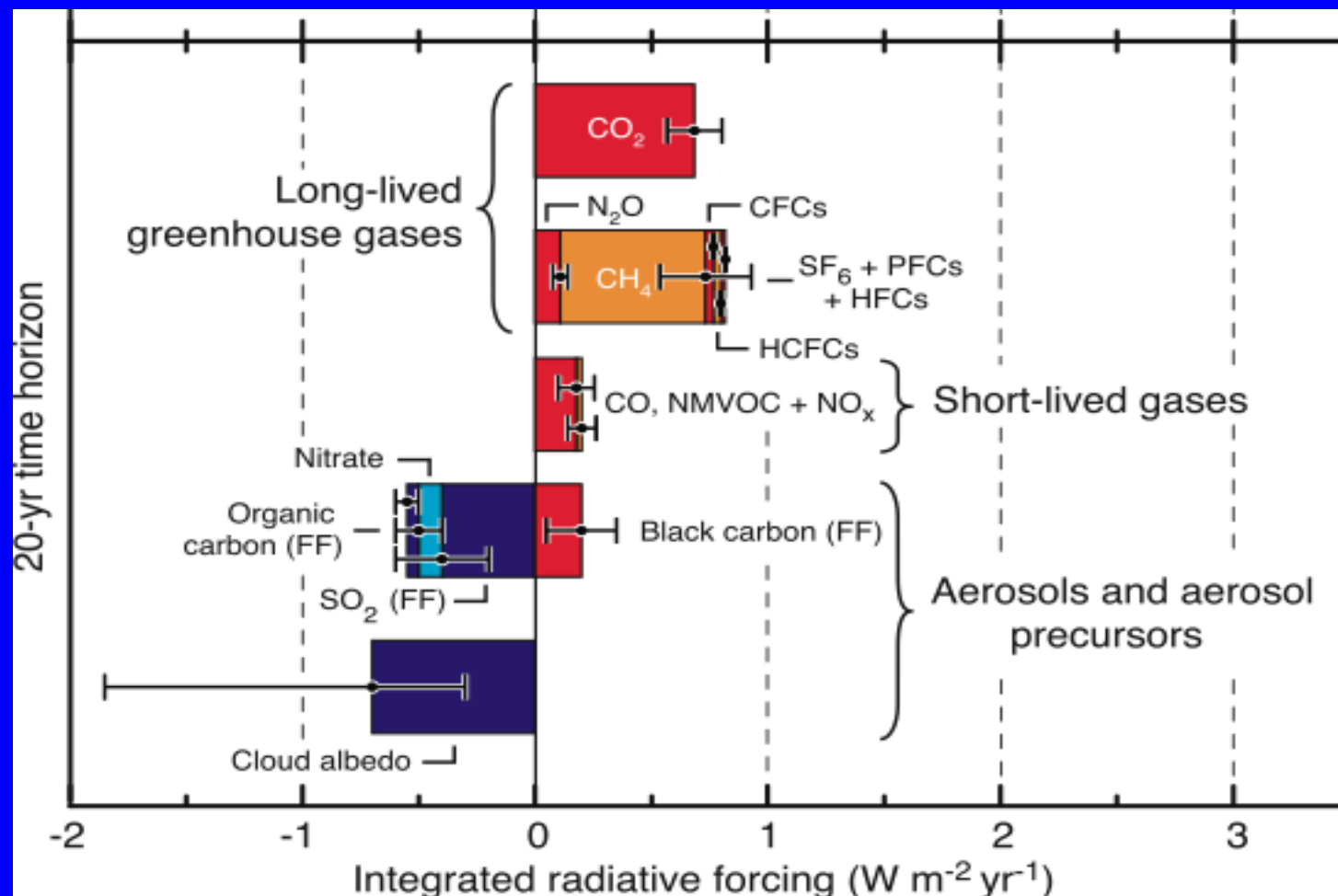
- Be possible at a **net cost-savings**.
- Reduce 8-hr. average ozone globally by **~1 ppb**.
- Reduce global radiative forcing by **~0.14 W m⁻²**.
- Provide **~2%** of global natural gas production.
- Prevent **~30,000** premature deaths globally in 2030, **~370,000** from 2010-2030.

Mauzerall, 2007

Relative Warming from CO2 and CH4 emitted in 2008



Warming through 2020 from all emissions in 2000



Tapping Moral Energy

- Among the most important problems in the world are the huge and mostly growing inequities in human society
- This dominates both ends of the climate change spectrum
 - Emissions are highly unevenly distributed
 - Impacts will make current health inequities worse
 - Responses may act this way also – biofuels
- Remember, however, that even the most extreme estimate of the health effects of climate change does not come close to the hundreds of millions of children slated to die already because of our inaction in the next generation.

Food for a Week, Germany

© 2005 PETER MENZEL PHOTOGRAPHY



ALLEMAGNE 1500 sortes de saucisses, 1200 restaurants McDonald's, 750 millions de kebabs

avalés chaque année... Plus de la moitié des Allemands sont en surpoids ou obèses.

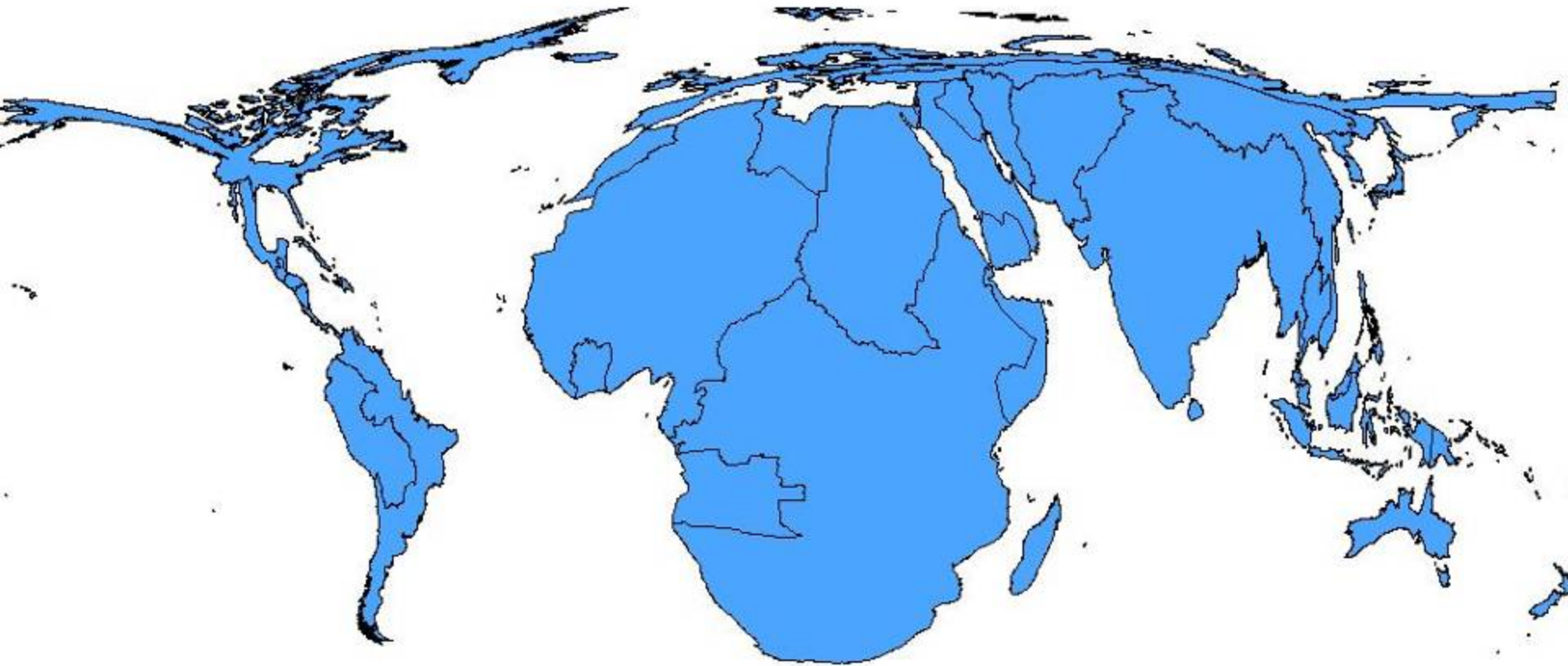
Food for a Week, Darfur Refugees, Chad

© 2007 PETER MENZEL PHOTOGRAPHY



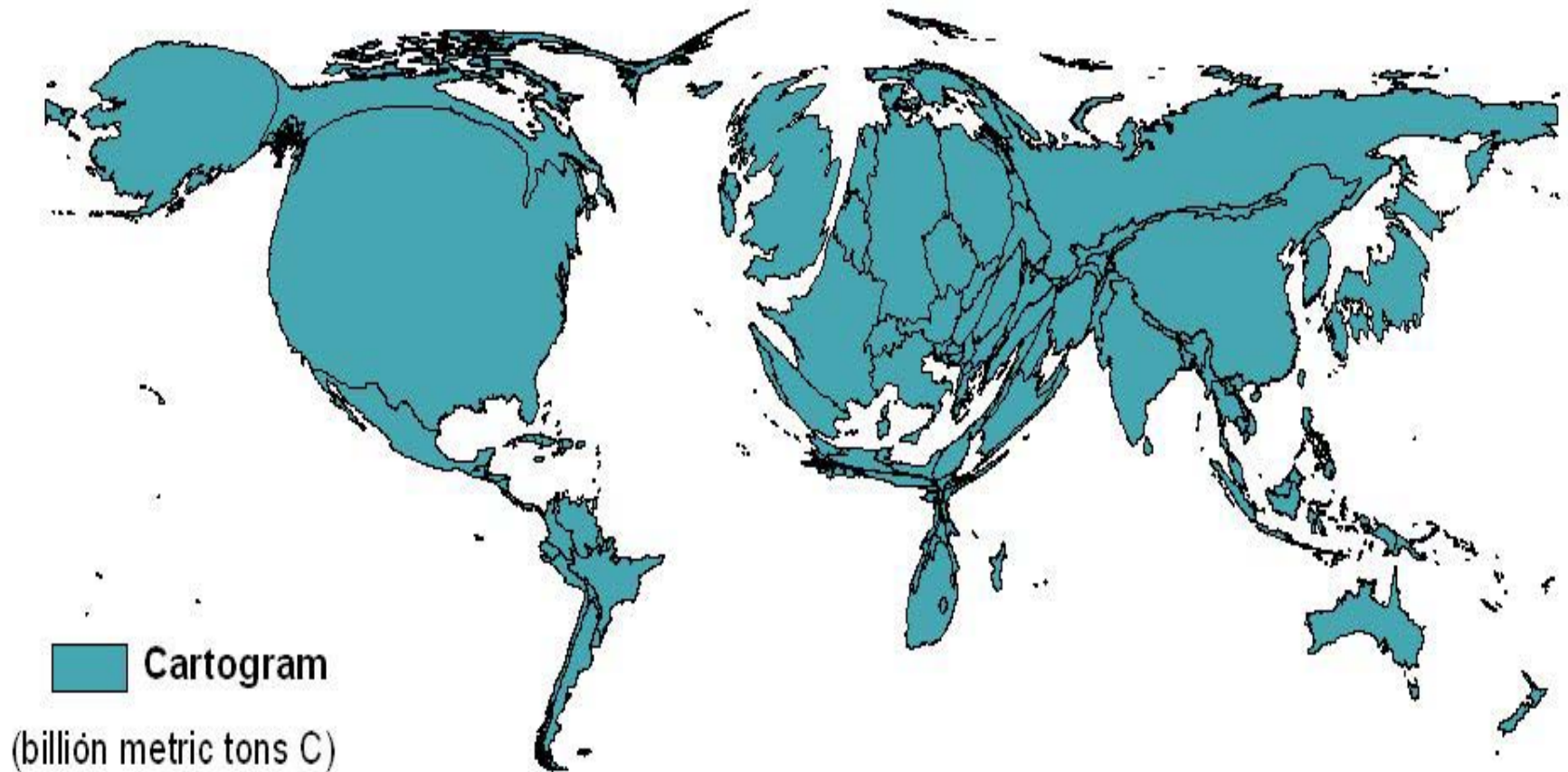
TCHAD 230 000 réfugiés de guerre soudanais vivent dans les camps de l'Onu. Chacun a droit à 2100 Cal par jour: céréales, sucre, sel, huile, légumes secs et farine vitaminée.

Cartogram of Climate-related Mortality (per million pop) yr. 2000



Patz JA, Gibbs HK, Foley JA, Rogers JV, Smith KR, 2007, **Climate change and global health: Quantifying a growing ethical crisis**, EcoHealth 4(4): 397–405, 2007.

Cumulative CO₂ emissions from fossil fuels (as depleted by natural processes)



Patz JA, Gibbs HK, Foley JA, Rogers JV, Smith KR, 2007, **Climate change and global health: Quantifying a growing ethical crisis**, EcoHealth 4(4): 397–405, 2007.

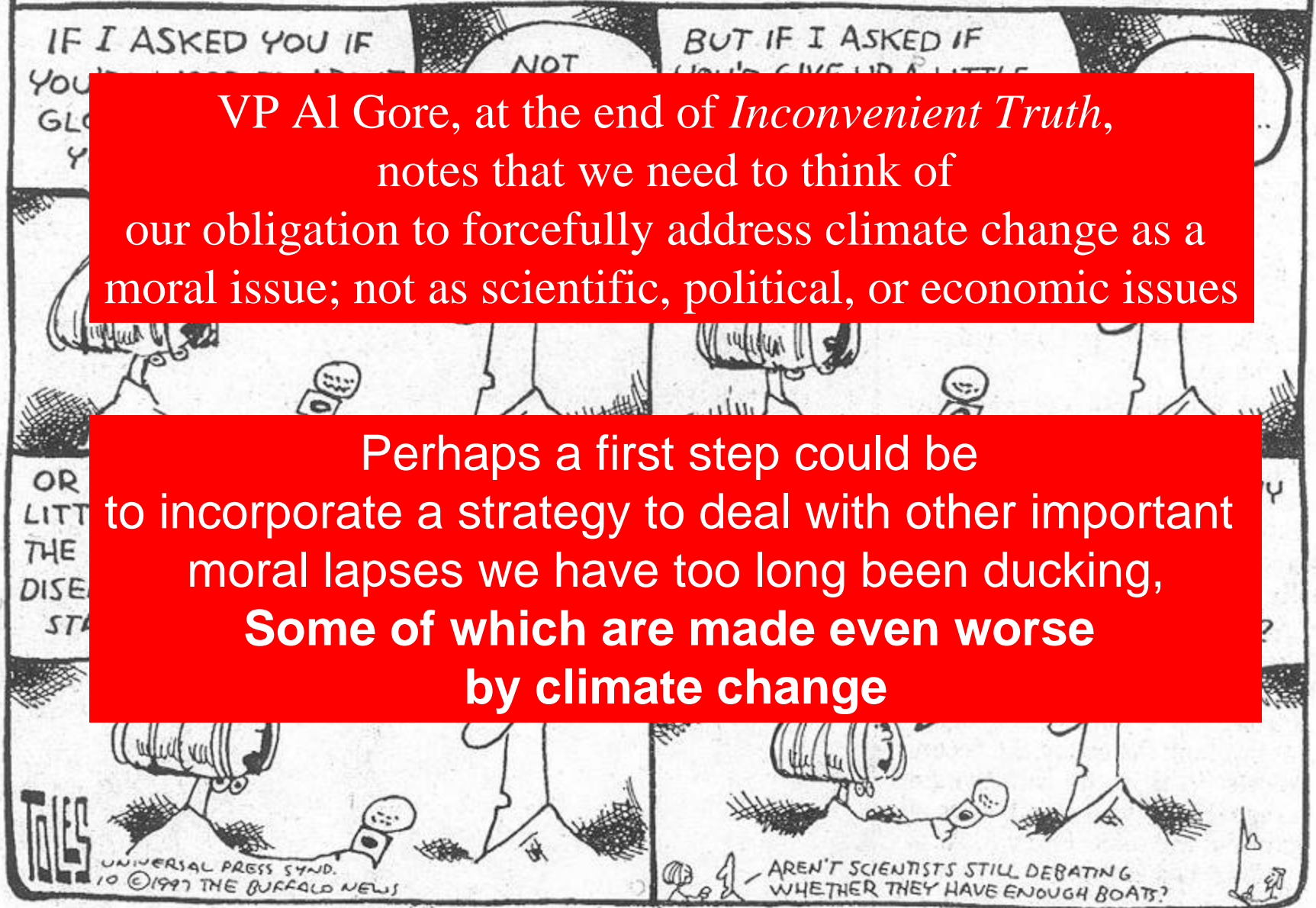
Sins of Omission and Commission

- That children die unnecessarily in poor countries is mostly seen as a Sin of Omission – we do not cause it and our lapse is just in not doing more to stop it.
- Awareness of climate change has the effect of shifting it more to a Sin of Commission, i.e., at least in part directly due to our actions.

Hard questions about climate change

VP Al Gore, at the end of *Inconvenient Truth*, notes that we need to think of our obligation to forcefully address climate change as a moral issue; not as scientific, political, or economic issues

Perhaps a first step could be to incorporate a strategy to deal with other important moral lapses we have too long been ducking, **Some of which are made even worse by climate change**



Operating Planet Earth Sustainably

- This is our goal – climate change is the latest and perhaps largest symptom of us not doing so
- In addition to being climate neutral, no matter how one might define sustainability, it does not include 100s of millions of children dying unnecessarily in the next generation.
- We need to find ways to bring ourselves to sustainability in ways that push us jointly toward a spectrum of goals, some with us already and others just now coming into prominence
- The co-benefits of moral energy

Categories of Co-benefits

- Not letting climate change get in the way of other important health goals
- Achieving health and climate protection with the same activities
- The co-benefits of moral energy
- There are also potential health disbenefits from mitigation and adaptation actions, e.g., food price rise from biofuels

Research Issues

- Malaria and diarrhea are two of the major causes of child mortality as well as thought to be directly influenced by climate change.
- Other infectious and vectorborne diseases, natural disasters, etc. affected by climate change also have impacts on children.
- Other major risks, however, may not be affected as much: lack of vaccines and HIV, for example.
- This potentially argues for a shift in priorities over time to reflect changing reality.
- Or perhaps not, if the changes due to climate change have minimal effect on any of the factors that lead to child mortality reduction.

Cont.

- Malnutrition, the single most important distill risk factor for child mortality by affecting each of the separate causes is thought to be increased by both climate change itself and, potentially, by efforts to combat climate change through biofuel expansion, energy price rises, etc.

Cont.

- Some ways to deal with climate change offer substantial co-benefits in the form of both substantial reduction in carbon emissions as well as better health,
- Lower risk of pneumonia, low birth weight, adult respiratory disease etc. by improved household combustion.
- Lower regional tropospheric ozone levels
- Lower general air pollution through energy efficiency and fuel switching

Cont.

- Alternatively, efforts to mitigate climate change, by carbon taxes for example, may interfere with what is needed for running the infrastructure required to combat child mortality, including rural clinics, cold supply chains, pumping for clean water, driving people back to biomass from LPG, etc.
- Too great an attention to the worrisome but long-term impacts of climate change could also divert public resources away from the more immediate and mundane needs of public health, particularly child mortality.
- Do not want to repeat the hazardous waste error.

Methods

- Carefully conducted epidemiologic studies, particularly in vulnerable third-world settings.
- Serious attention to “impact science” – application of biomedical evidence in a rigorous policy framework
- Burden estimates, system boundaries, discount rates, common metrics, uncertainty analyses, economic valuations, etc.

Cont.

- On the other hand, climate change issues bring into greater prominence that all the world's people are linked together and that we all have a stake in creating a sustainable path for the planet and no such path can allow for 10 million avoidable child deaths each year.

The Silver Lining

- One of the few positive sides of the climate change crisis is that the global village is no longer just an intellectual construct
- That we have one planet, one atmosphere, one set of mutual responsibilities, and one fate – these are now clear

Thank you

Acknowledgements for data analyses by

Nick Lam
Jimmy Tran

Publications available at
<http://ehs.sph.berkeley.edu/krsmith/>

References

- Smith KR, 2008, **Mitigating, Adapting, and Suffering: How Much of Each?**, (Symposium on *Climate and Health*, KR Smith, ed), Annual Review of Public Health, 29: xxiii
- Smith KR, Haigler E, 2008, **Co-benefits of climate mitigation and health protection in energy systems: Scoping methods**, *ibid.* 11-25
- Patz JA, Gibbs HK, Foley JA, Rogers JV, Smith KR, 2007, **Climate change and global health: Quantifying a growing ethical crisis**, EcoHealth 4(4): 397–405, 2007.
- Smith KR, Ezzati M, 2005, **How environmental health risks change with development: The Epidemiologic and Environmental Risk Transitions revisited**. Annual Review of Energy and Resources, 30: 291-333.
- Smith KR, Desai M, 2002, ***The Contribution of Global Environmental Factors to Ill-health***, Ch 3 in Martens P and McMichael AT, eds, **Environmental Change, Climate, and Health: Issues and Research Methods**, pp.52-95, Cambridge Univ. Press.

Lancet Series on Energy, Climate, and Health

Sept 13, 2007

Wilkinson P, Smith KR, Joffe M, Haines A,
A global perspective on energy: Health effects and injustices,

Markandya A, Wilkinson P,
Electricity generation and health,

Woodcock J, Banister D, Edwards P, Prentice AM, Roberts I,
Energy and transport,

Wilkinson P, Smith KR, Beevers, Tonne C, Oreszczyn T,
Energy, energy efficiency, and the built environment,

McMichael AJ, Powles JW, Butler CD, Uauy R,
Food, food production, energy, climate change, and health,

Haines A, Smith KR, Anderson D, Epstein P, McMichael A, Roberts I,
Wilkinson P, Woodcock J, Woods J,
Policies for accelerating access to clean energy, improving health,
advancing development, and mitigating climate change,