Methane and Natural Debt and Impacts on India's Workers Of Extreme Climate Change

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Health Impacts, Adaptation, and Co-Benefits
Nobel Laureate (2007)

At the 0.1% level

Allocating Responsibility for Global Warming: The Natural Debt Index

***Smith, KR. AMBIO*, <u>20</u>(2): 95, 1991**

Cumulative Depleted Historical Emissions:

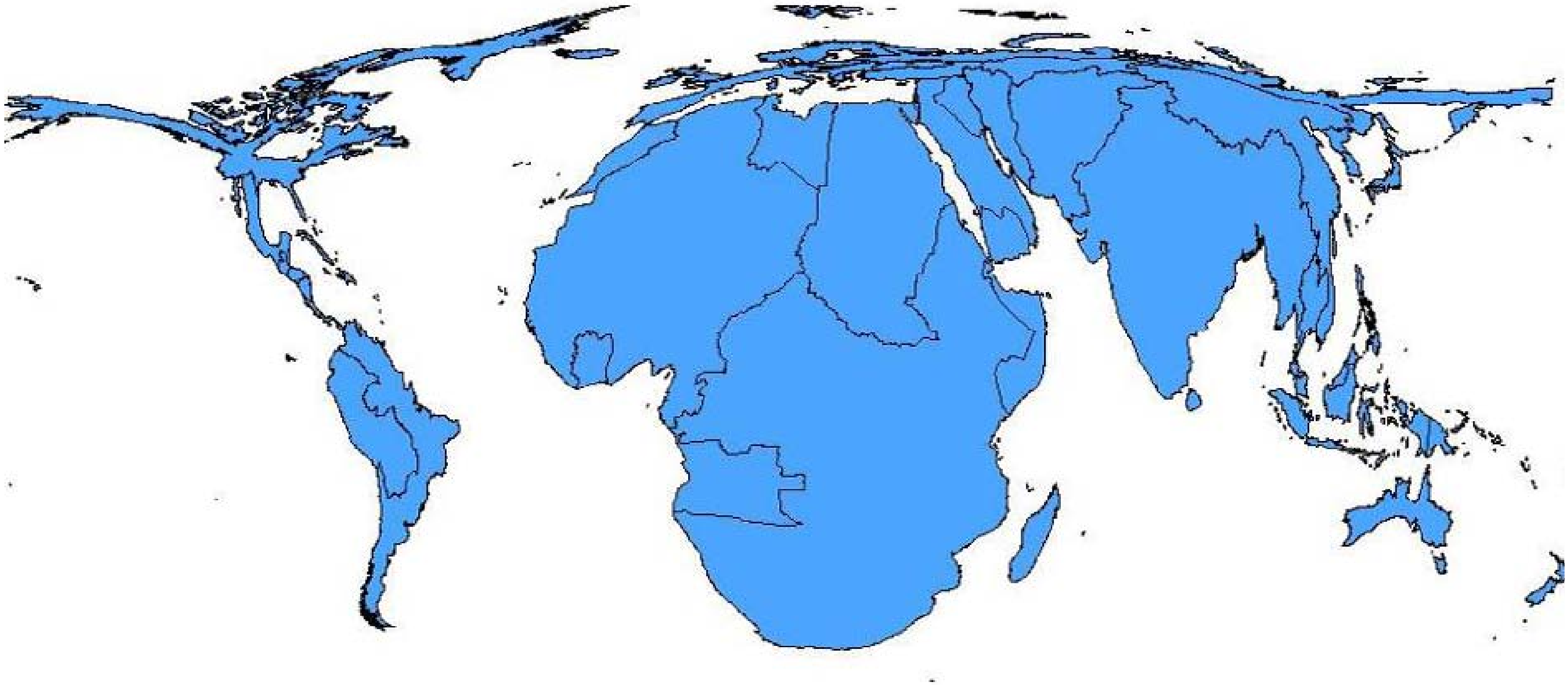
Surviving historical emissions as reduced by natural depletion mechanisms

What remains in the atmosphere today from emissions in the past

Paying off a significant fraction of the natural debt may not be easy, but it should not be dismissed out of hand. It may well be the only way to reach a world in which basic needs are met for all of humanity in a sustainable fashion.

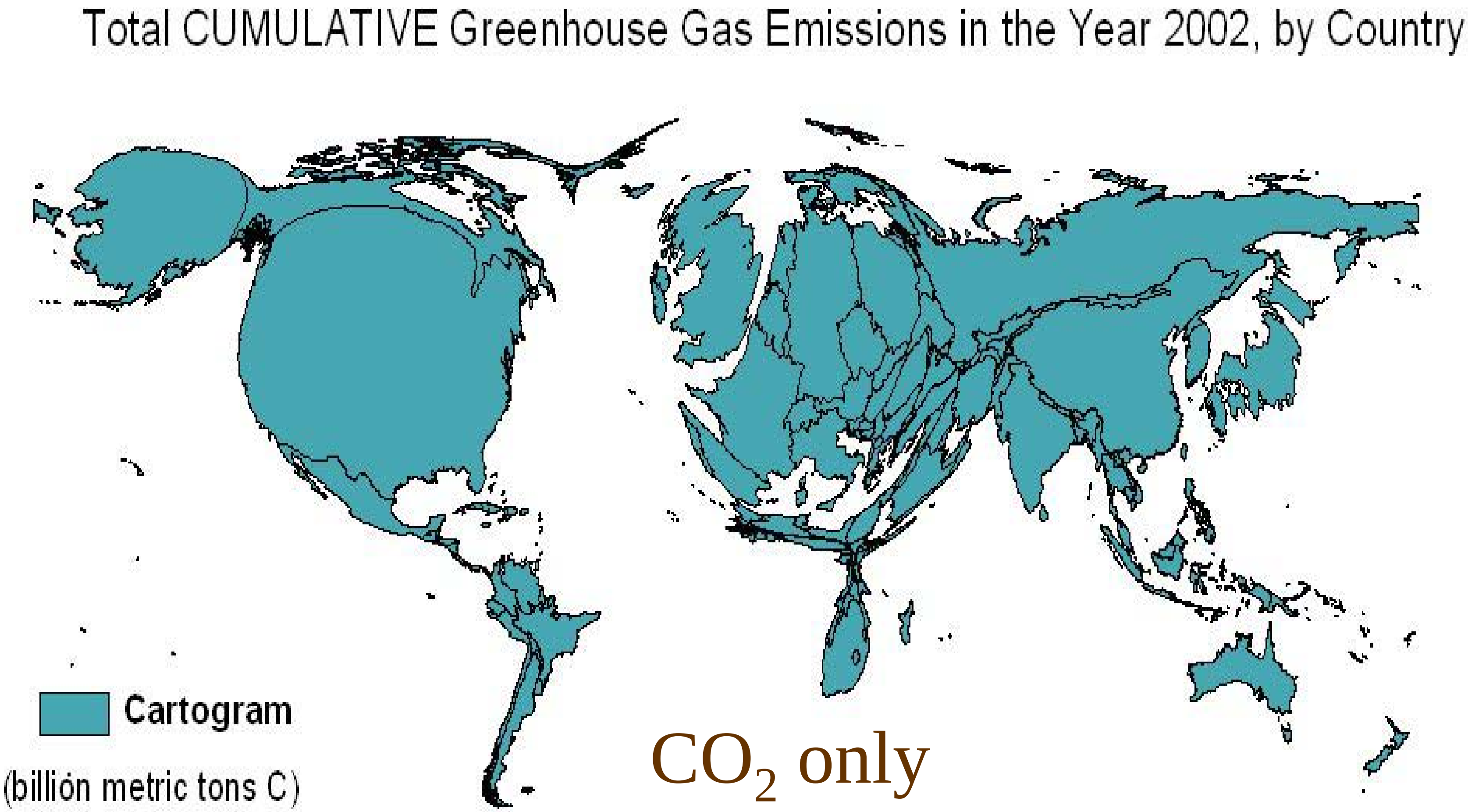
No matter what the feasibility of paying off all past debts, the basic point remains the same. Since the present economic status of most countries has been achieved partly by incurring natural debts, it seems only fair to allocate responsibility for whatever needs to be done by using indices that reflect an expectation that nations should pay back the debt in the same proportion as it was borrowed.

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



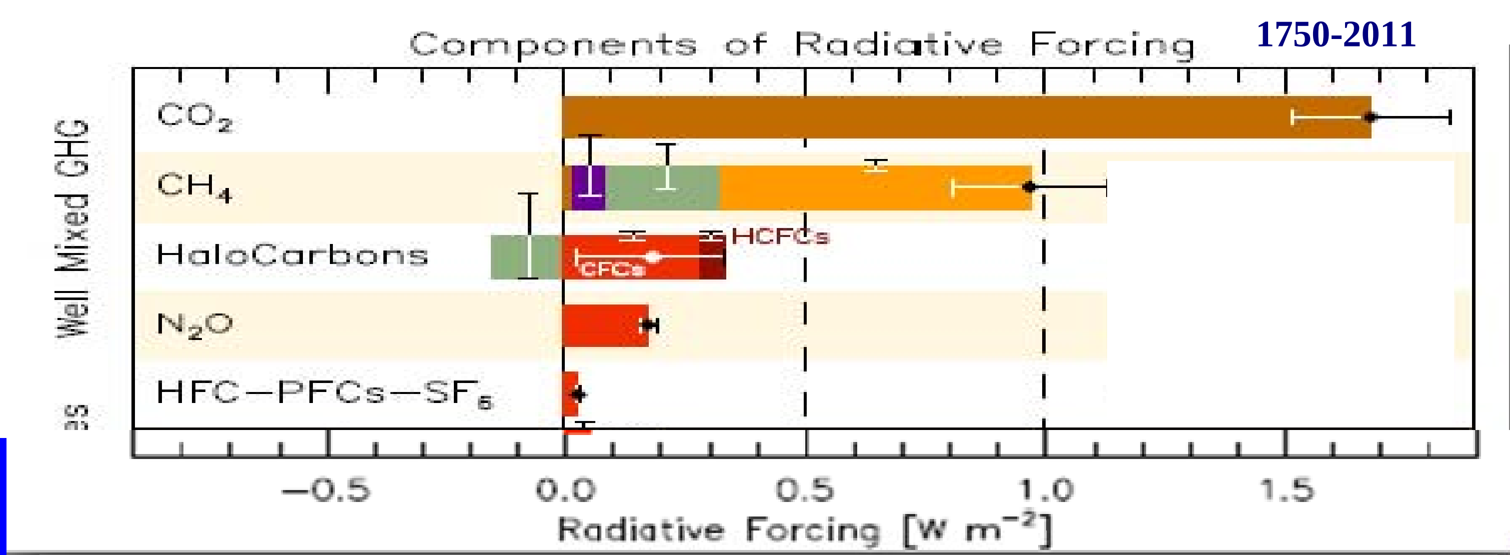
Patz JA, Gibbs HK, Foley JA, Rogers JV, Smith KR, 2007, **Climate change and global health: Quantifying a growing ethical crisis**, EcoHealth 4(4): 397–405, 2007.

year



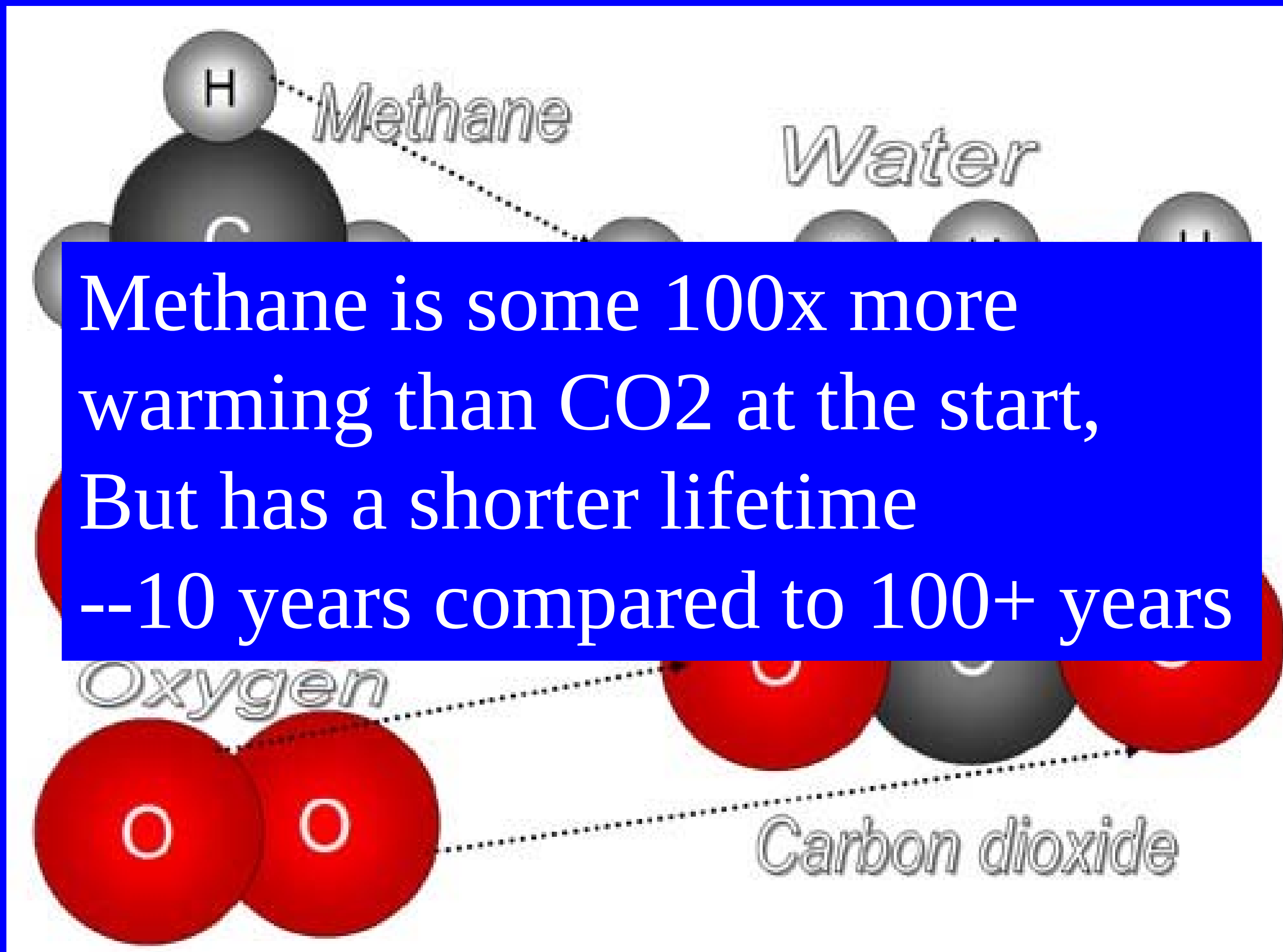
CO_2 only

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.

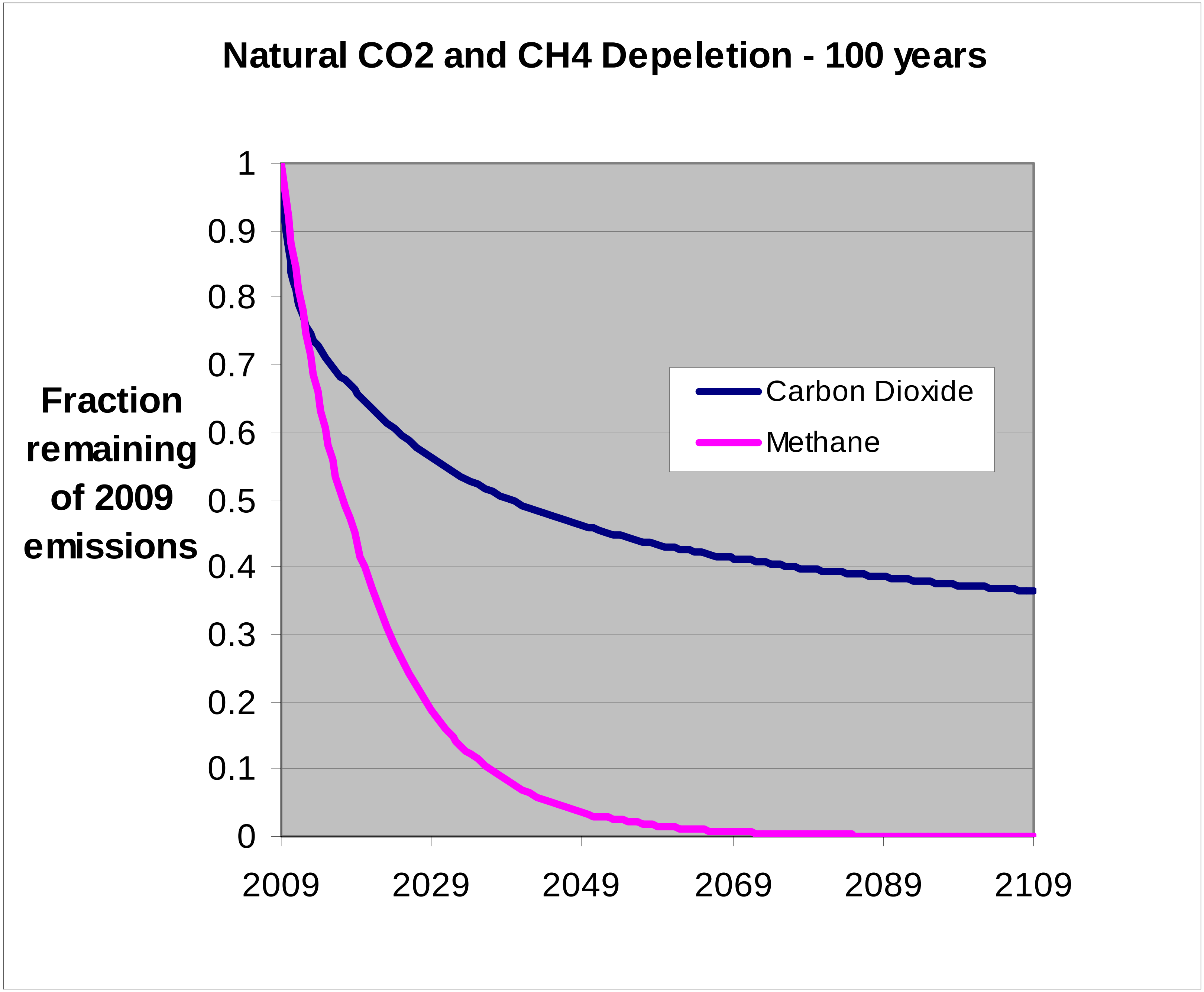

Components of Radiative Forcing
1750-2011
Well Mixed GHG
CO_2
CH_4
HaloCarbons
HCFCs
CFCs
N_2O
HFC–PFCs–SF_6
−0.5
0.0
0.5
1.0
1.5
Radiative Forcing [W m^{-2}]

WG1, AR5

The Methane Story: CH_4



Methane is some 100x more warming than CO2 at the start,
But has a shorter lifetime
--10 years compared to 100+ years


Natural CO2 and CH4 Depeletion - 100 years
Fraction remaining of 2009 emissions
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
2009
2029
2049
2069
2089
2109
Carbon Dioxide
Methane

Joint CO_2 and CH_4 accountability for global warming

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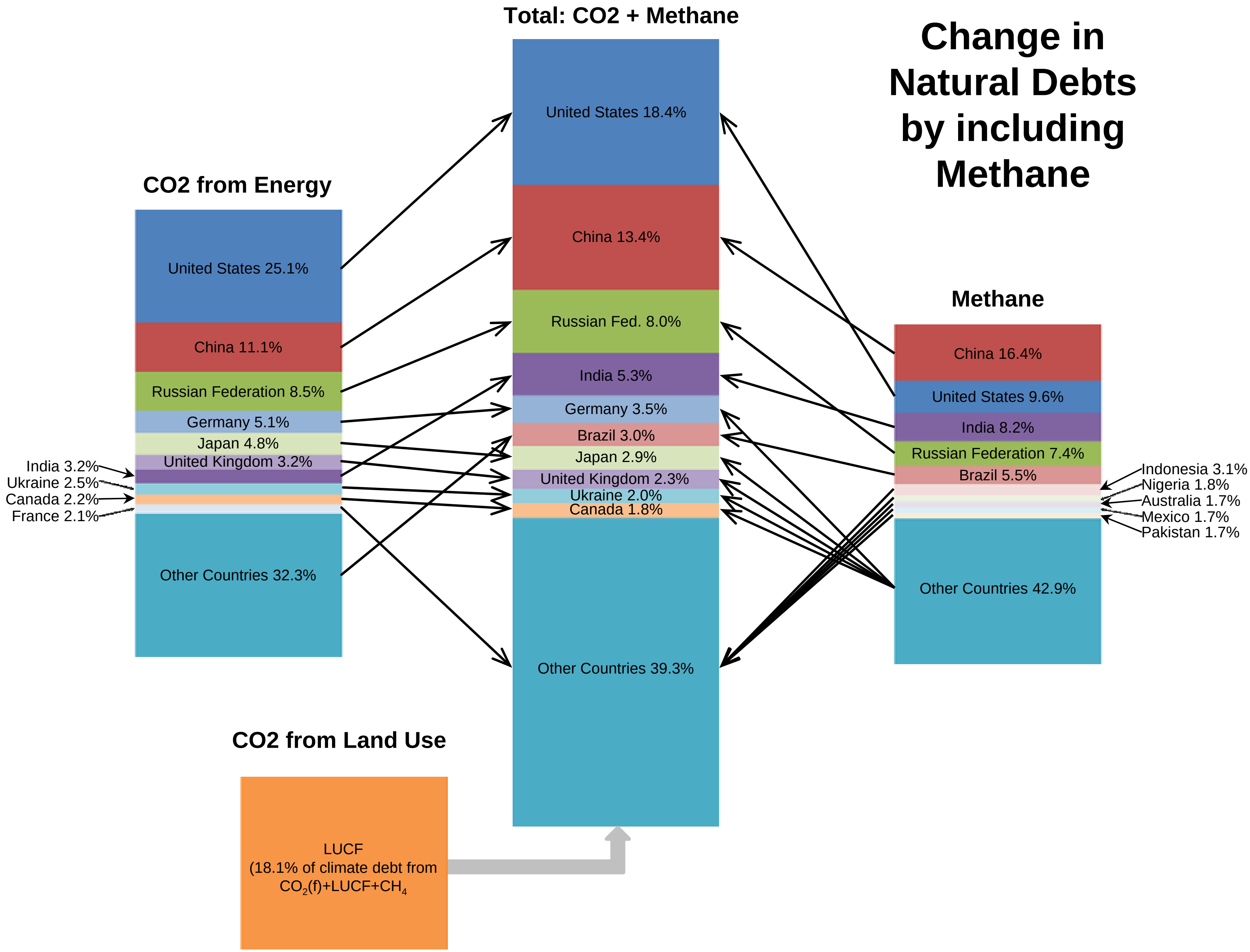
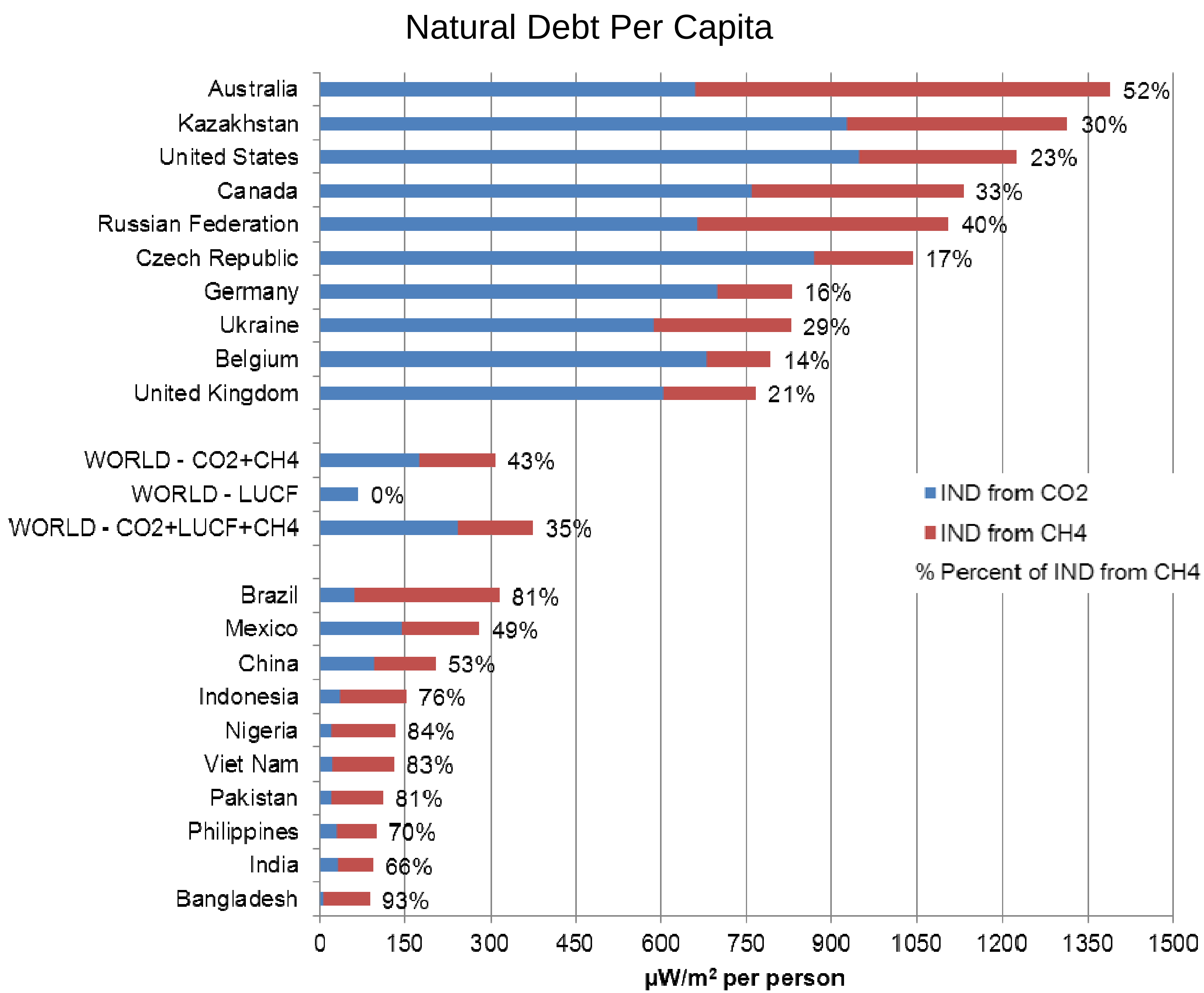
Proceedings of the (US) National Academy of Sciences, July 2013



Change in Natural Debts by including Methane
Total: CO2 + Methane
United States 18.4%
China 13.4%
Russian Fed. 8.0%
India 5.3%
Germany 3.5%
Brazil 3.0%
Japan 2.9%
United Kingdom 2.3%
Ukraine 2.0%
Canada 1.8%
Other Countries 39.3%
CO2 from Energy
United States 25.1%
China 11.1%
Russian Federation 8.5%
Germany 5.1%
Japan 4.8%
United Kingdom 3.2%
India 3.2%
Ukraine 2.5%
Canada 2.2%
France 2.1%
Other Countries 32.3%
Methane
China 16.4%
United States 9.6%
India 8.2%
Russian Federation 7.4%
Brazil 5.5%
Indonesia 3.1%
Nigeria 1.8%
Australia 1.7%
Mexico 1.7%
Pakistan 1.7%
Other Countries 42.9%
CO2 from Land Use
LUCF
(18.1% of climate debt from CO_2(f)+LUCF+CH_4


Natural Debt Per Capita
Australia
Kazakhstan
United States
Canada
Russian Federation
Czech Republic
Germany
Ukraine
Belgium
United Kingdom
WORLD - CO2+CH4
WORLD - LUCF
WORLD - CO2+LUCF+CH4
Brazil
Mexico
China
Indonesia
Nigeria
Viet Nam
Pakistan
Philippines
India
Bangladesh
52%
30%
23%
33%
40%
17%
16%
29%
14%
21%
43%
0%
35%
81%
49%
53%
76%
84%
83%
81%
70%
66%
93%
IND from CO2
IND from CH4
% Percent of IND from CH4
0
150
300
450
600
750
900
1050
1200
1350
1500
μW/m² per person

Multiple Benefits of Reducing Methane

Methane is the chief cause of widespread ozone pollution which damages human health, crops, and ecosystems

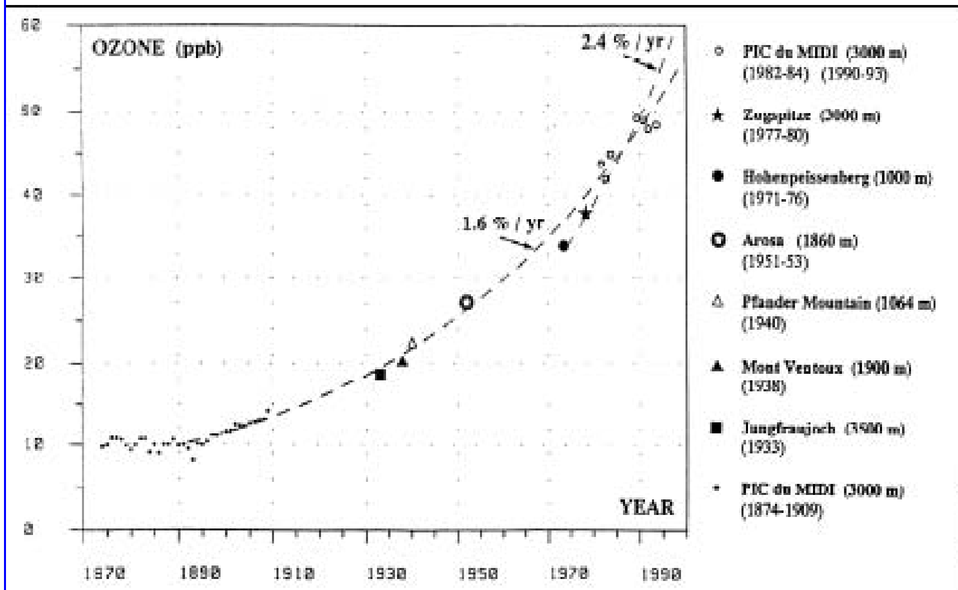
Reducing ~20% of anthropogenic methane emissions will:

- **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

Background Ozone is Growing …

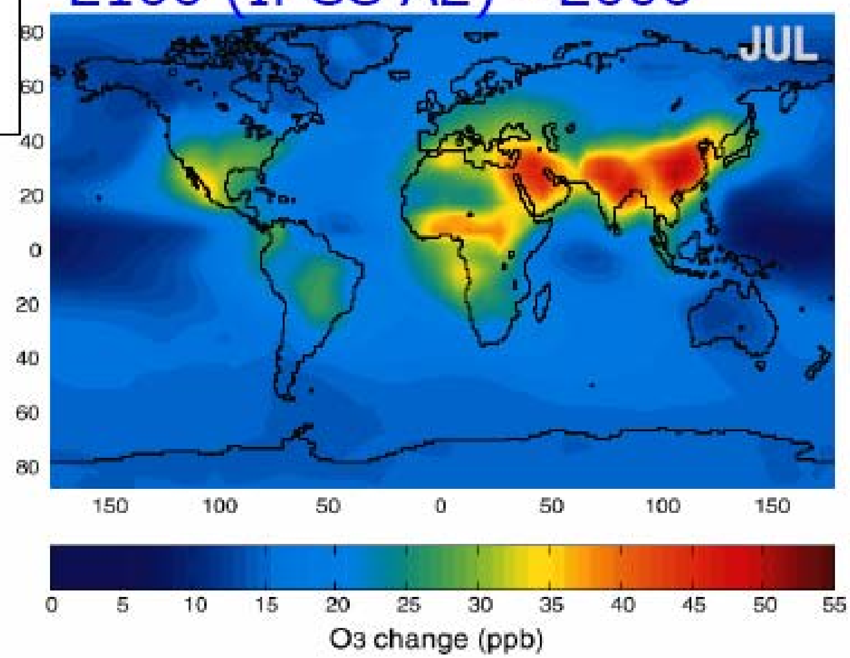
… and Will Continue to Grow!



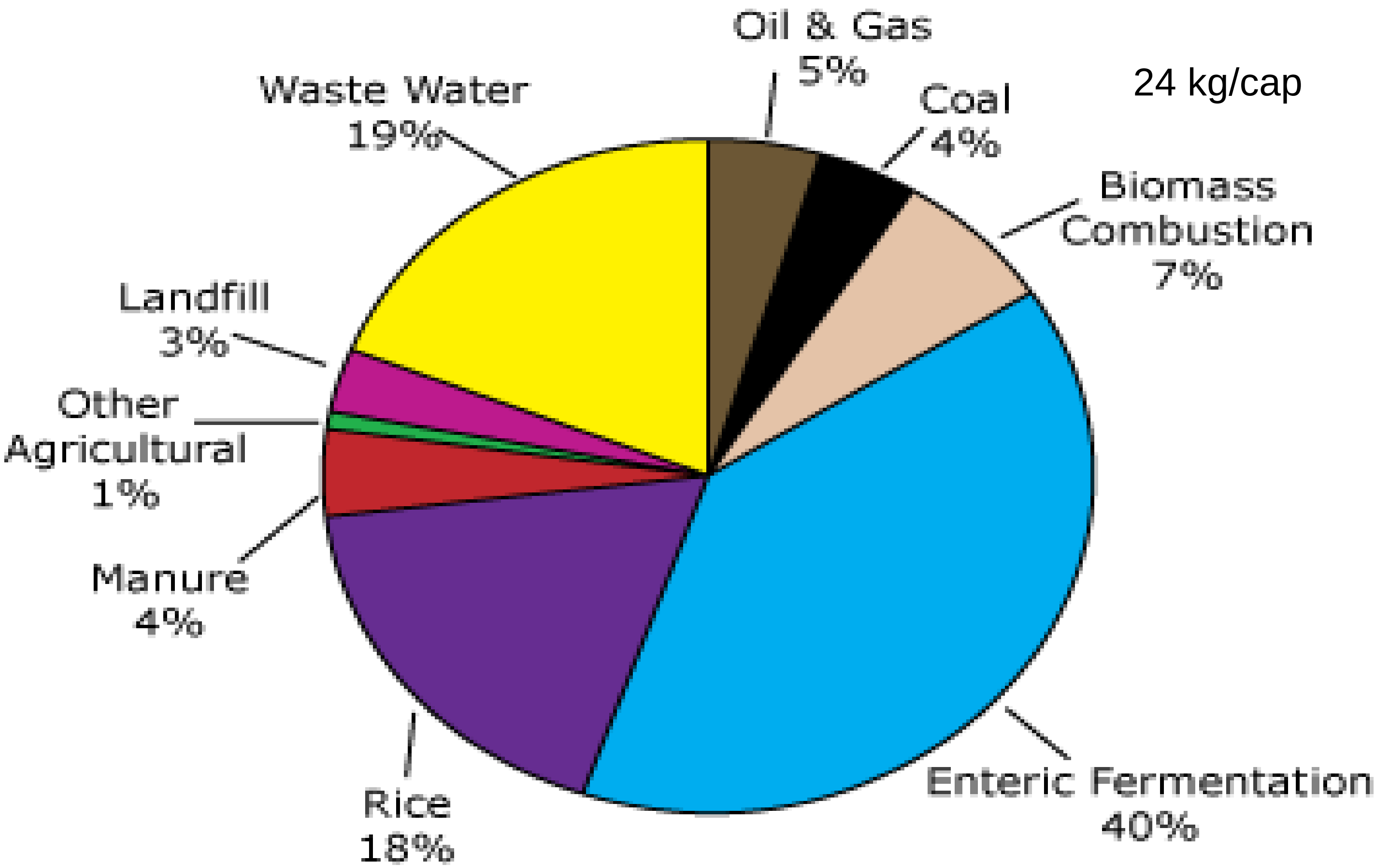
Ozone trend at European mountain sites, 1870-1990 (Marenco et al., 1994).

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



Methane Emissions from India in 2005
26.1 Mt (9% of world)



24 kg/cap

http://www.epa.gov/nonco2/econ-inv/international.html

Methane Conclusions

- Methane holds a unique niche in climate change
  - High warming and large emissions: 2nd largest total impact after CO_2
  - Relatively short-lived, but long-enough to be globally mixed – can be treated under existing frameworks
  - ~Two-thirds of its emissions are amenable to control measures using existing technology and policy tools, much at low cost
  - Interventions commonly target methane alone, unlike those for black carbon
- Adding in shorter-lived climate-altering pollutants such as methane shifts the political landscape
  - More relative accountability for LDCs, but also
  - Controls in LDCs wield greater leverage for making an impact – opportunities are greater and response to them faster than in rich countries
  - More co-benefits – methane and all other SLCAPs have health impacts

What is possibly the largest economic impact of climate change as well as one of the major threats to health?

- Storms, floods, droughts, wildfires?
- Malaria, dengue, meningitis?
- Heat waves?
- Malnutrition?

Climate Vulnerability Monitor 2012, DARA

Estimates climate change impacts to 2030, US$ Billions

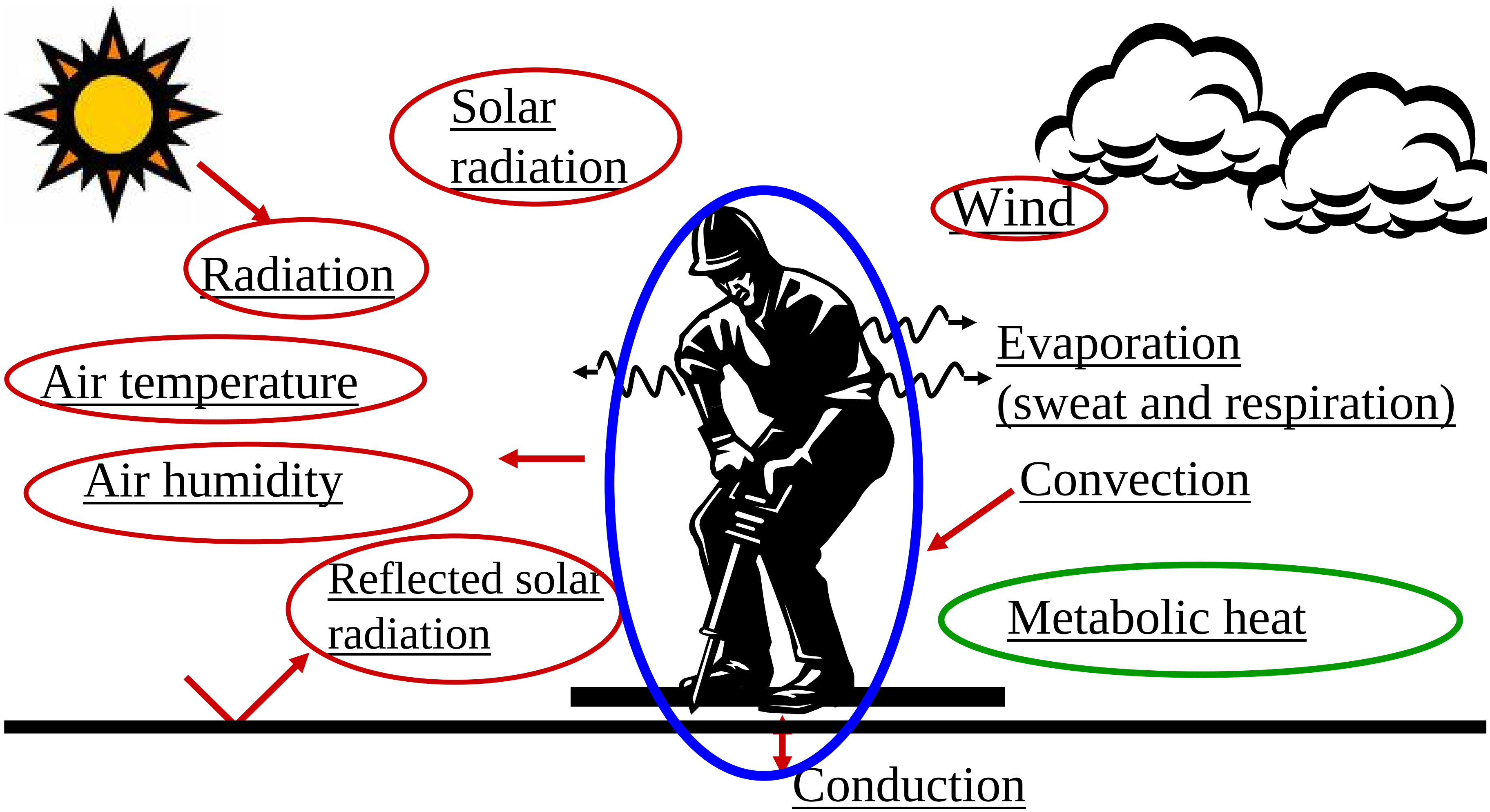
Impact component	Total global net cost; in brackets, % of total climate		Net cost in 2030 in specific country types		
	2010	**2030**	**Developing, low GHG emitters**	**Developing, high GHG emitters**	**Developed**
Total climate change costs	609 (100%)	4345 (100%)	1730(100%)	2292 (100%)	179 (100%)
Labor Productivity loss due to increased workplace heat	**311** (51%)	**2436** (56%)	1035(60%)	1364 (60%)	48 (27%)
Clinical Health impacts costs	23 (3.7%)	106 (2.4%)	84 (4.9%)	21 (0.9%)	0.002 (0.001%)

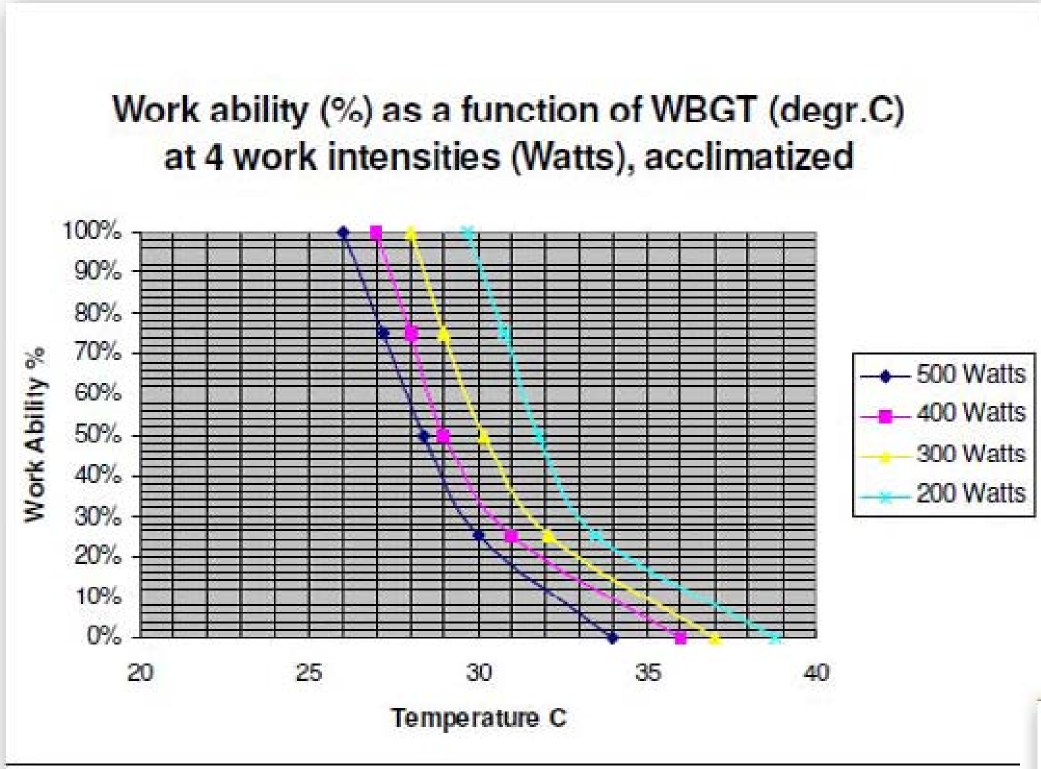
DARA Report, 2012

- Fractional increases in global temperature can translate into tens of additional hot days with each passing decade.
- <u>(Loss of) labour productivity is estimated to result in the largest cost to the world economy of any effects analysed</u>
- Trillions of US$ by 2030
- Not peer-reviewed and only one report, but indicates potential scale of the issue

Heat exchange of worker performing physical work in hot weather

Heat stress = Environmental + metabolic heat loads - heat loss





Wet Bulb Globe Temperature =

Function of
•temperature,
•humidity,
•wind speed, and
•radiative energy, e.g., sunlight

Effects of heat exposure

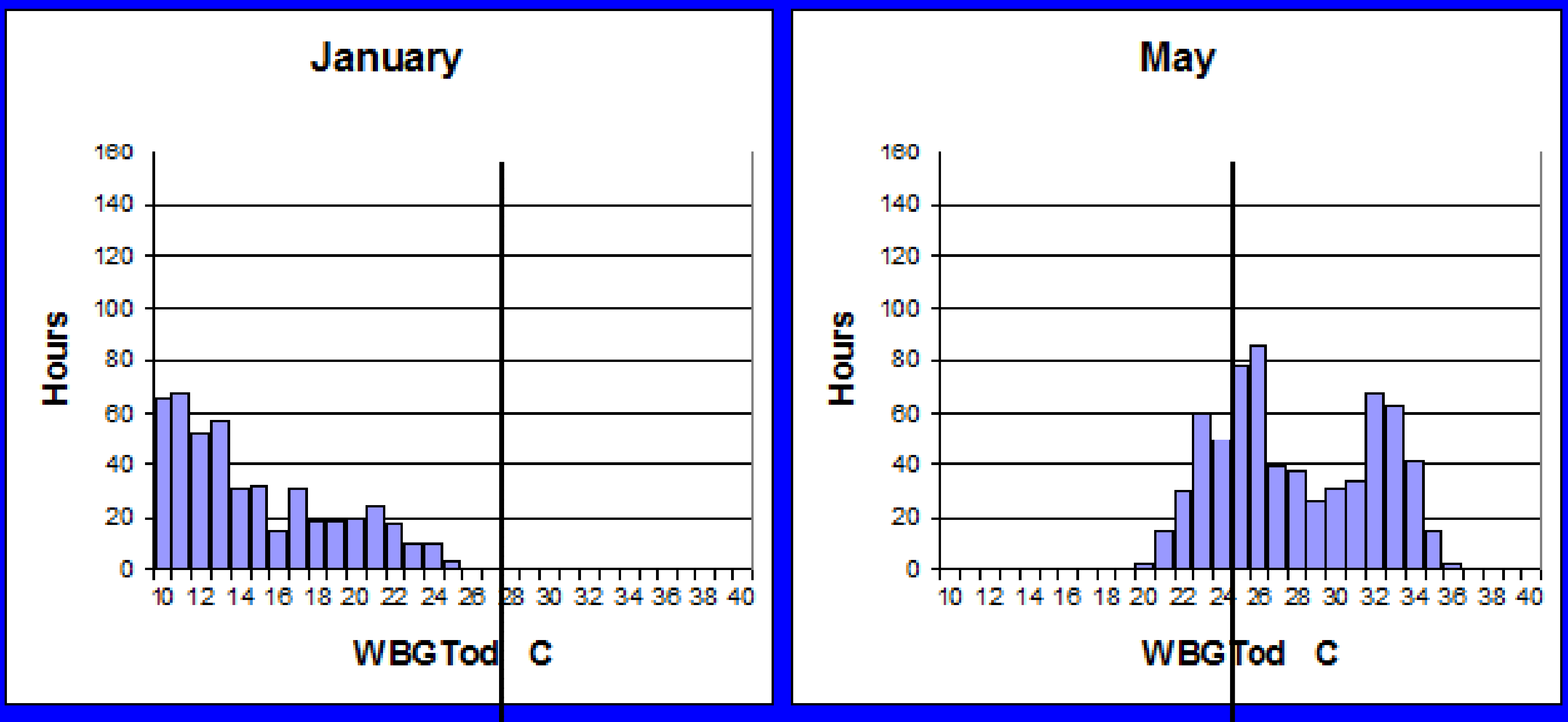
- **Sweating, dehydration, salt loss**
- **Loss of ability to work intensively**
- **Loss of perceptual motor performance**
- **Increased accident risk**

- **Increased body temperature (>38 °C)**
- **Heat stroke**
- **Unconsciousness**
- **Death**

- Basic physics and human physiology from exposure chamber studies
- The science is 60 years old – US military research in the 1950s and much since
- **Refers to healthy workers – not the most vulnerable**

Hourly heat exposure situation:

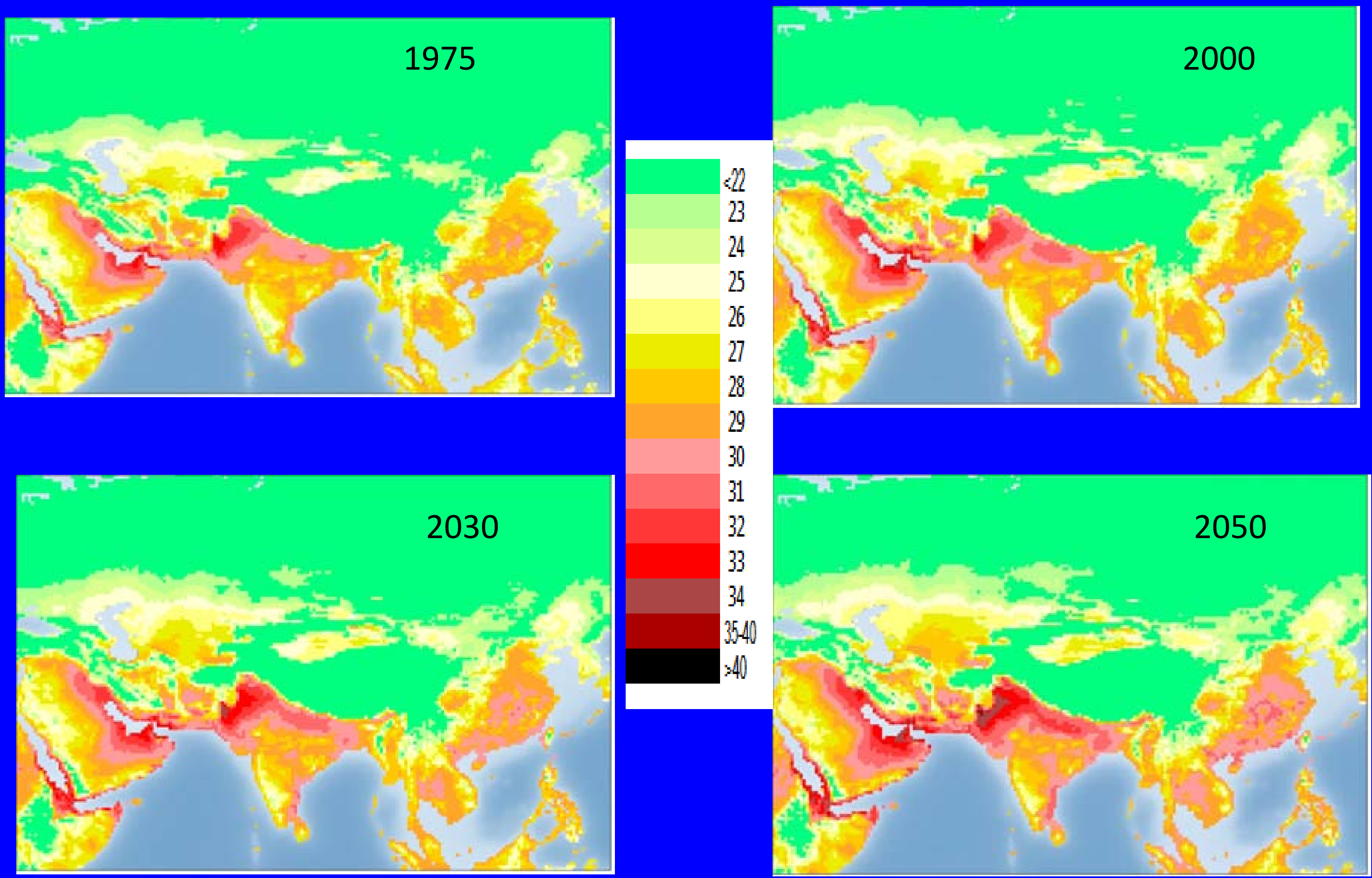
Heat index (WBGT) outdoors in Delhi, 1999. Hours each month at each WBGT level, January + May (coolest and hottest months). **WBGT = 26 ºC cut-off point for work capacityimpact risk**



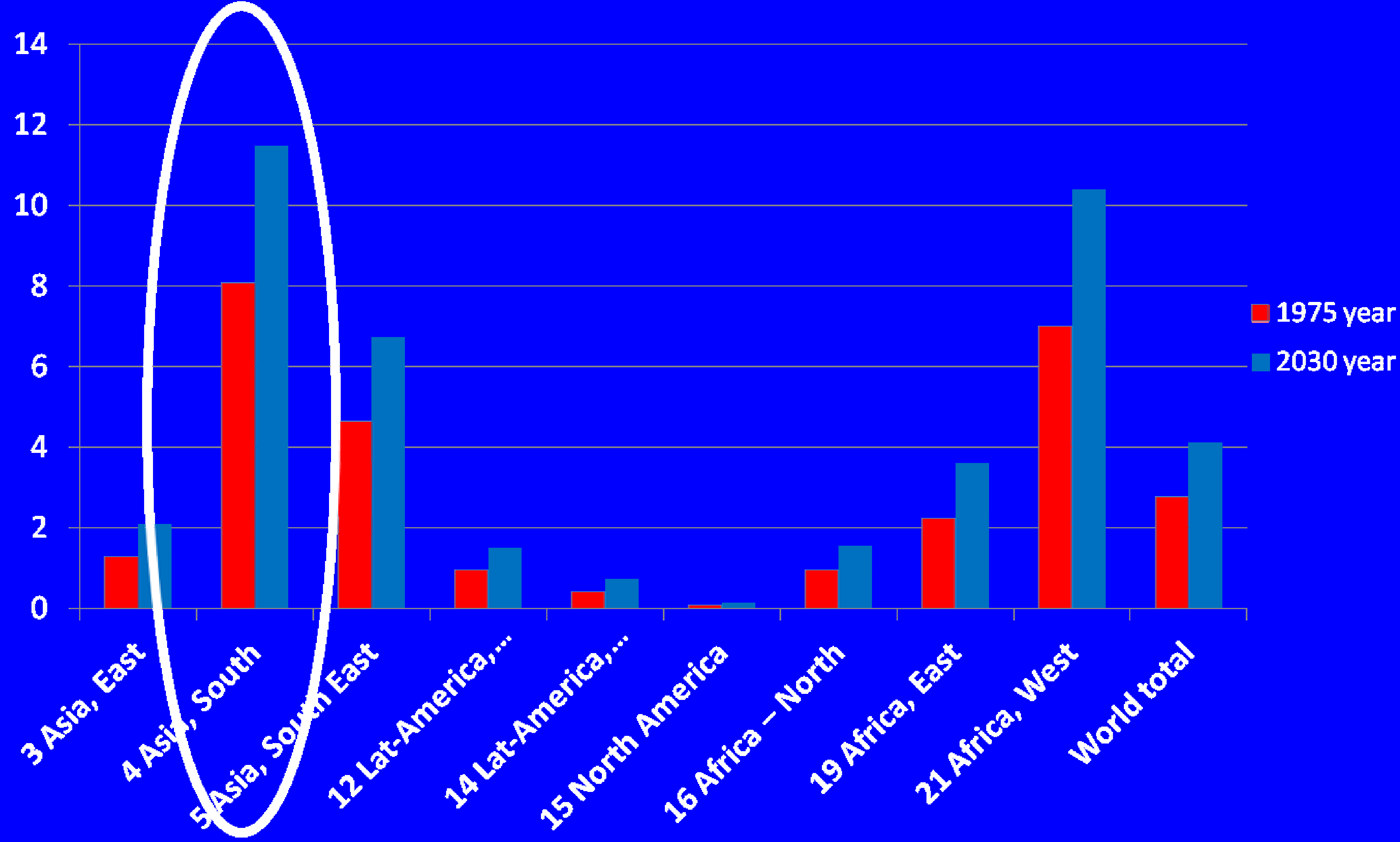
Hourly WBGT data for Summer 2013
Residential complex, Chennai

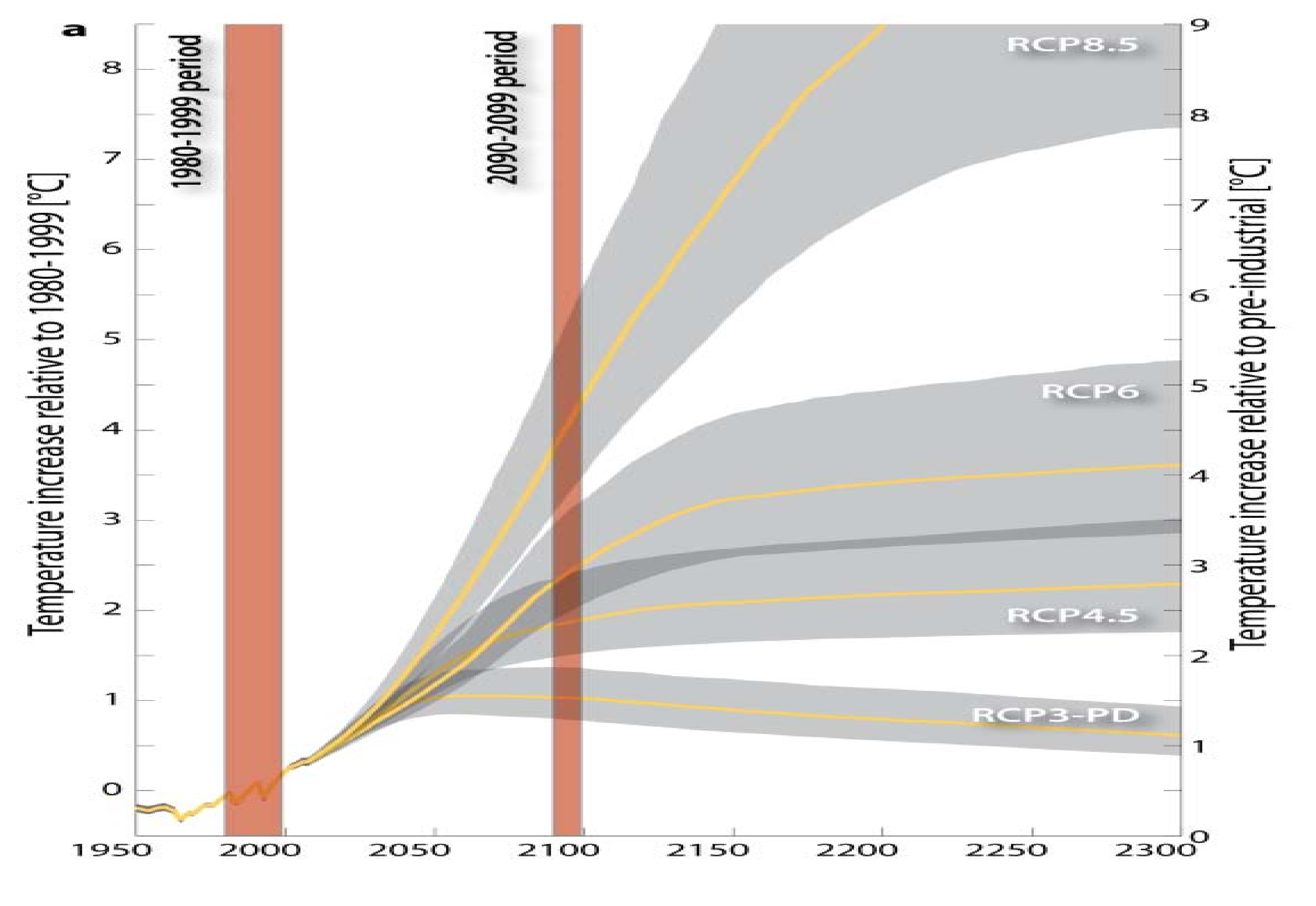
Date	Location	Work Category	WBGT (^0C)										Ambient temp(^0C)
			8:00-9:00	9:00-10.00	10:00-11:00	11:00-12:00	12:00-13:00	13:00-14.00	14:00-15:00	15:00-16:00	16:00-17:00	17:00-18:00	
21/05/2013	Ironing Room -G-Block	Heavy 500W	-	-	-	35.3	34.5	34.4	34.5	34.0	34.7	34.4	34.5
22/05/2013			34.2	34.3	34.7	35.1	35.7	36.0	35.0	35.4	35.7	35.1	35.1
23/05/2013			32.6	33.2	33.1	34.3	34.0	33.8	33.8	33.7	33.9	34.1	33.6
24/05/2013			34.3	34.0	34.7	34.8	35.4	34.6	35.8	35.7	35.3	34.8	34.9
25/05/2013			30.5	30.3	30.2	30.7	30.7	31.3	31.6	31.6	32.1	33.2	31.2
21/05/2013	Ironing Room -C-Block	Heavy 500W	-	-	-	34.1	34.3	33.9	32.7	32.7	33.0	33.6	33.5
22/05/2013			32.4	32.8	34.2	34.8	35.2	34.6	34.5	34.8	34.8	34.6	34.2
23/05/2013			31.5	32.8	32.5	32.8	33.2	34.5	34.6	34.6	35.0	35.5	33.7
24/05/2013			32.7	33.5	34.4	34.4	35.2	34.9	34.5	35.6	35.4	35.2	34.6
25/05/2013			31.1	30.9	32.3	32.8	33.3	33.5	34.1	34.6	35.5	35.5	33.3
21/05/2013	Ironing Room -D2-Block	Heavy 500W	-	-	-	34.2	34.0	33.2	33.6	34.4	34.8	34.8	34.1
22/05/2013			32.4	33.8	34.1	34.9	35.7	34.5	35.5	36.3	35.9	35.7	34.9
23/05/2013			31.5	34.6	34.5	34.7	35.6	35.2	35.1	36.4	35.8	36.7	35.0
24/05/2013			32.5	32.3	32.3	32.2	32.1	32.1	32.5	32.9	33.6	33.7	32.6
25/05/2013			30.4	30.4	30.7	35.1	33.0	31.6	31.7	31.6	34.8	34.6	32.7

July afternoon WBGT in 1975 and 2000 (based on recordings); 2030 and 2050 (based on models)



Work capacity loss (% of daylight hours) in 2030 based on regional climate change (average of 3 models), population in 2030 and estimated workforce distribution in 2030





***Draft* IPCC Fifth Assessment**

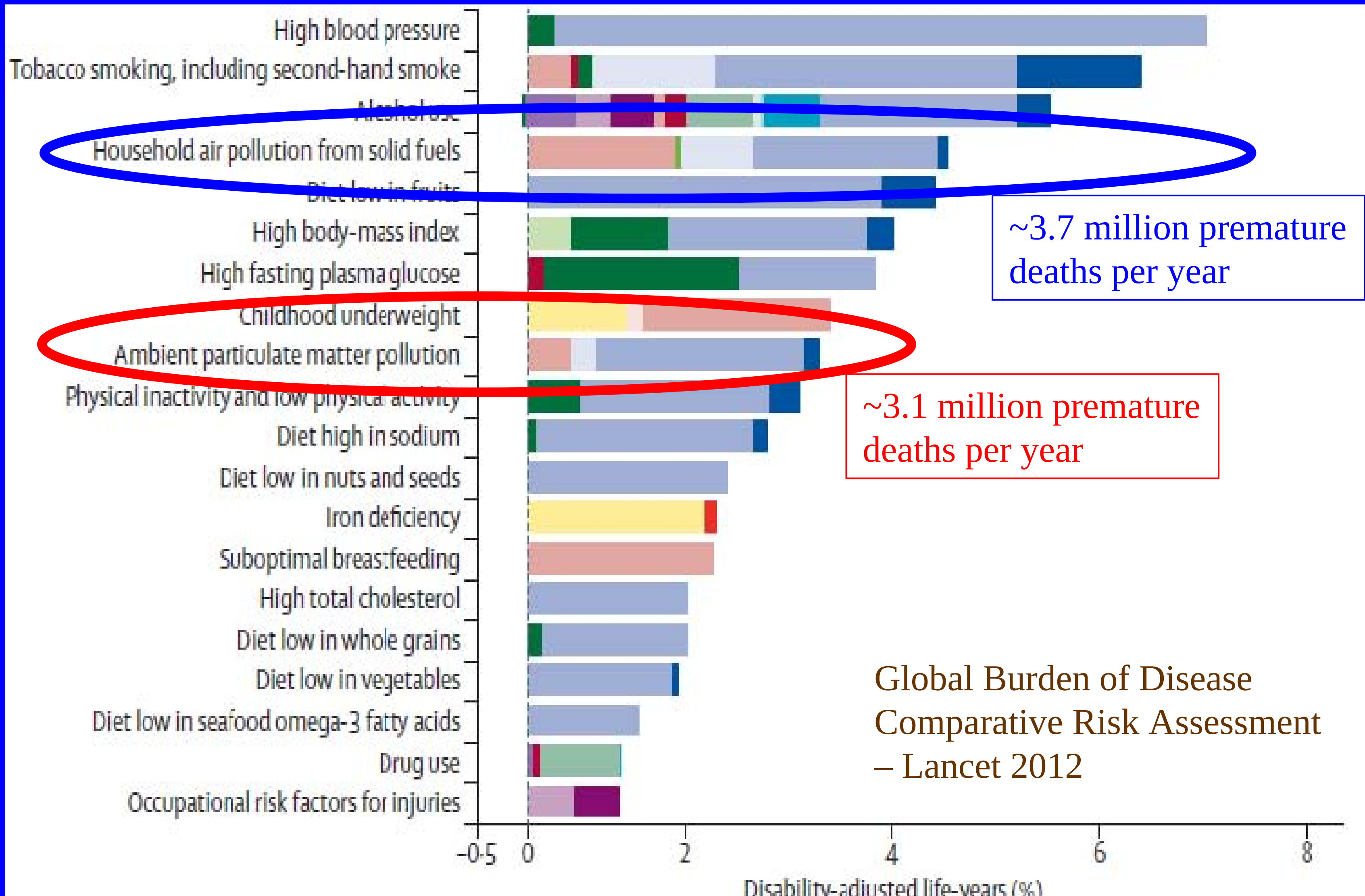
Publications and presentations available at my website. Easiest to just google "Kirk R. Smith"

Thank you

Ranking of Carbon Emissions:
The Pharmaceutical Index

- Carbon dioxide is noxious if fossil or forest derived, but benign if from renewable sources
- Products of incomplete combustion (PIC) such as carbon monoxide and hydrocarbons are like CO_2 on caffeine – several times worse
- Methane from any source (fossil, biologic, or incomplete combustion) is like CO_2 on steroids – dozens of times worse.
- Black carbon in particles from incomplete combustion is like CO_2 on crack cocaine– hundreds of times worse.

Top 20 Risk Factors for Health in 2010

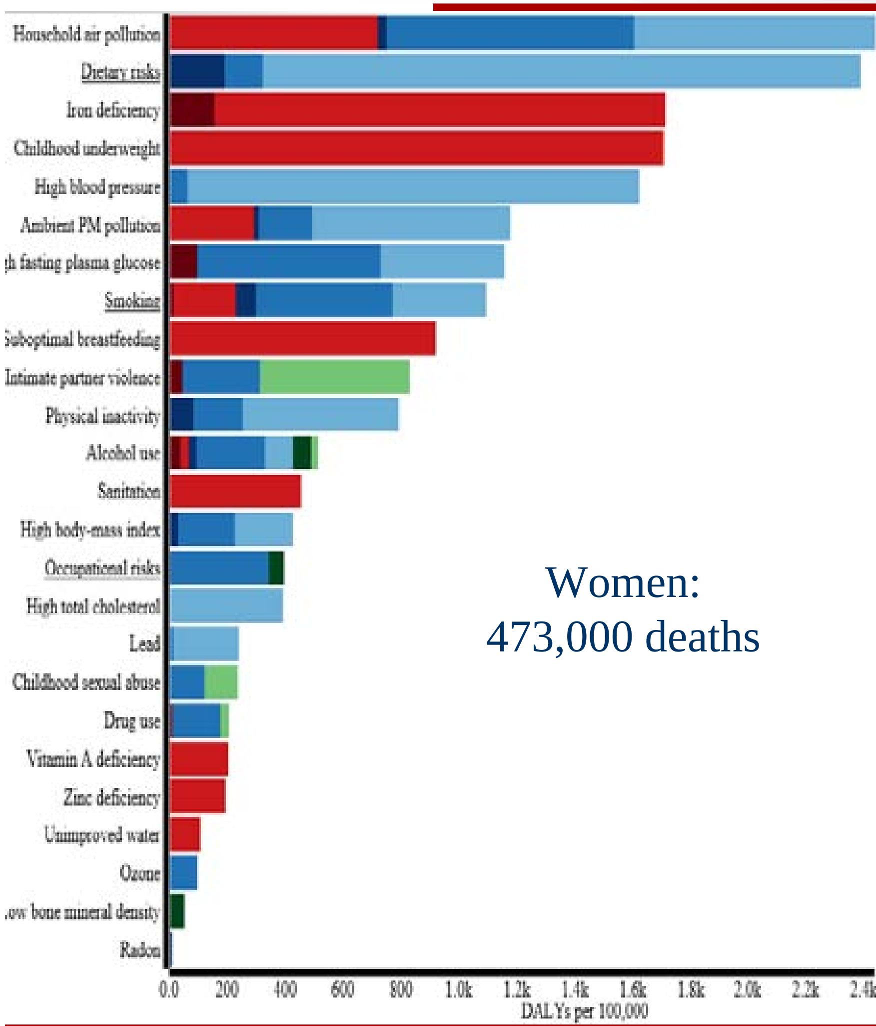


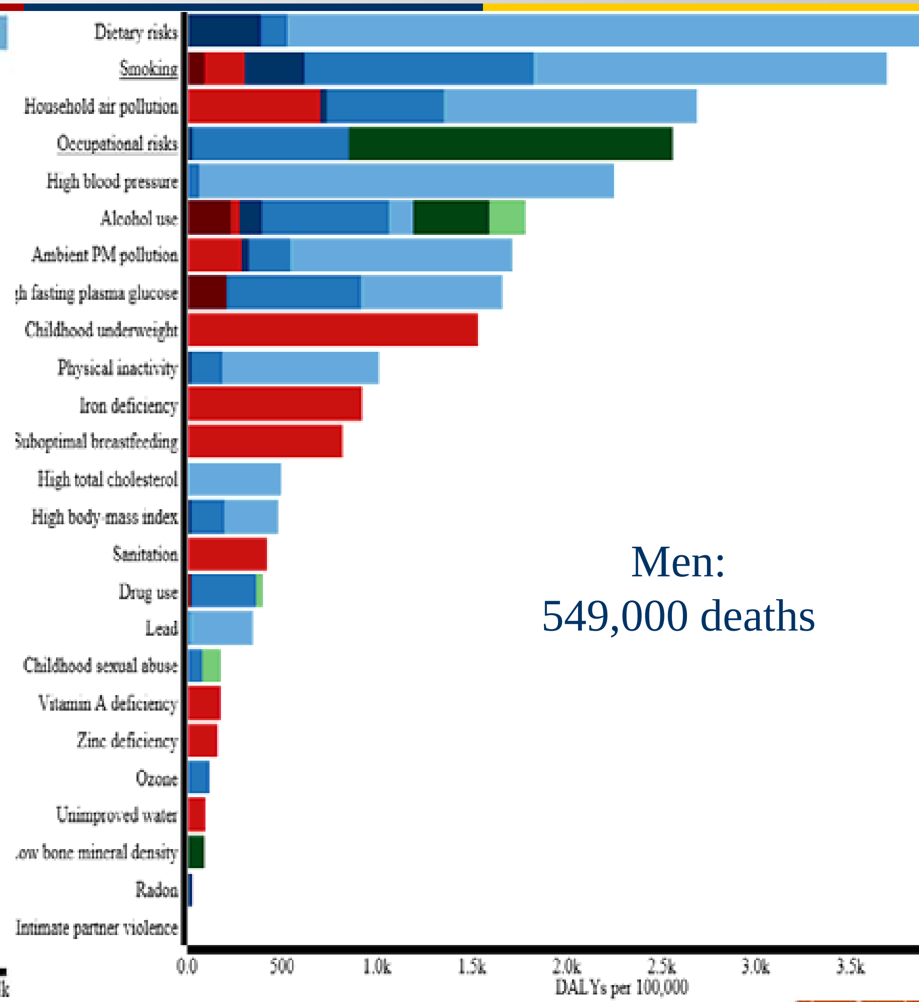
Department of Environmental Health Engineering

World Health Organization
Collaborating Centre for
Occupational & Environmental Health

Indian Council of Medical Research
Centre for Advanced Research
On Environmental Health

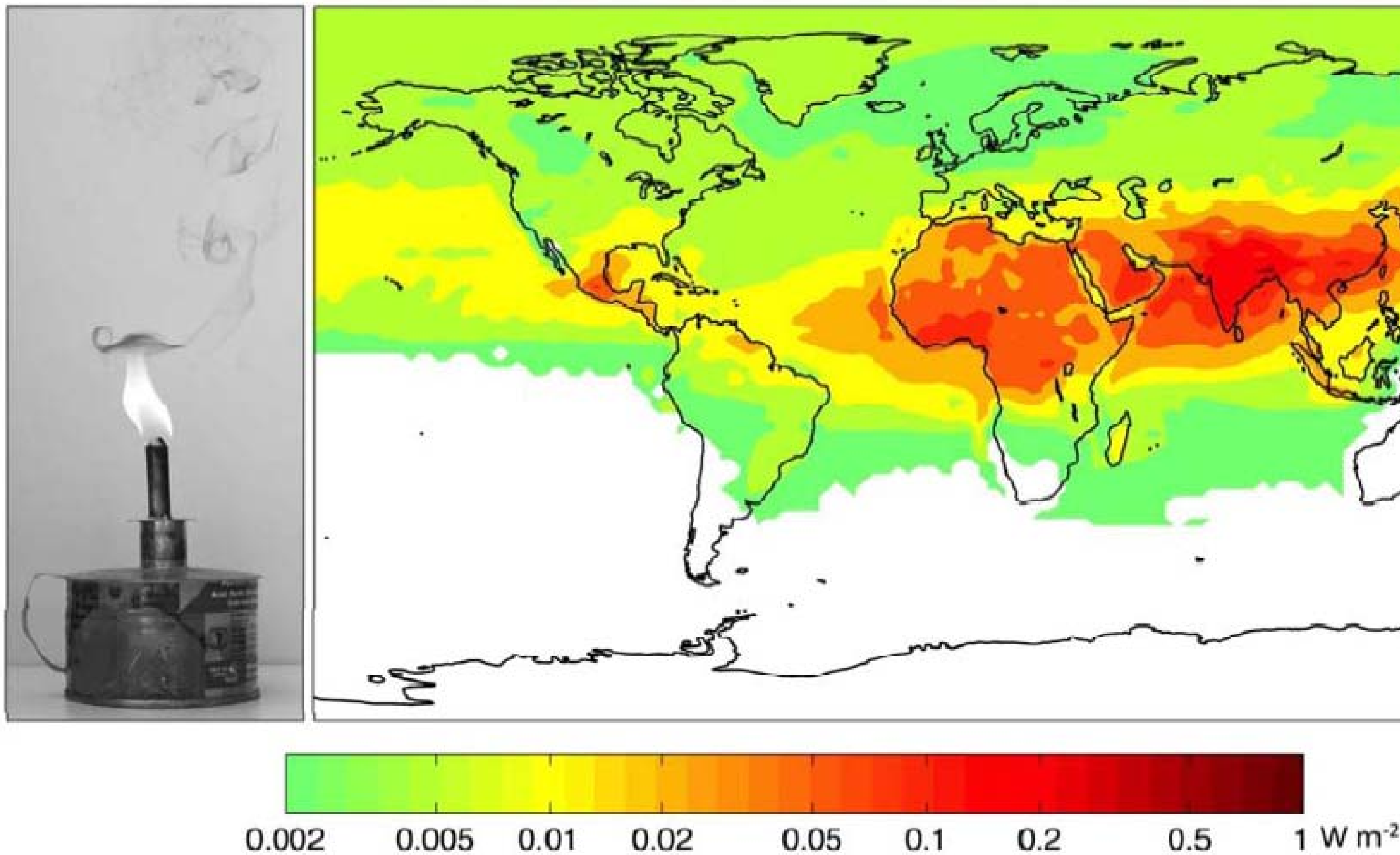
Top 20 causes of ill-health in India (GBD 2010)
Total: ~1,000,000 premature deaths annually



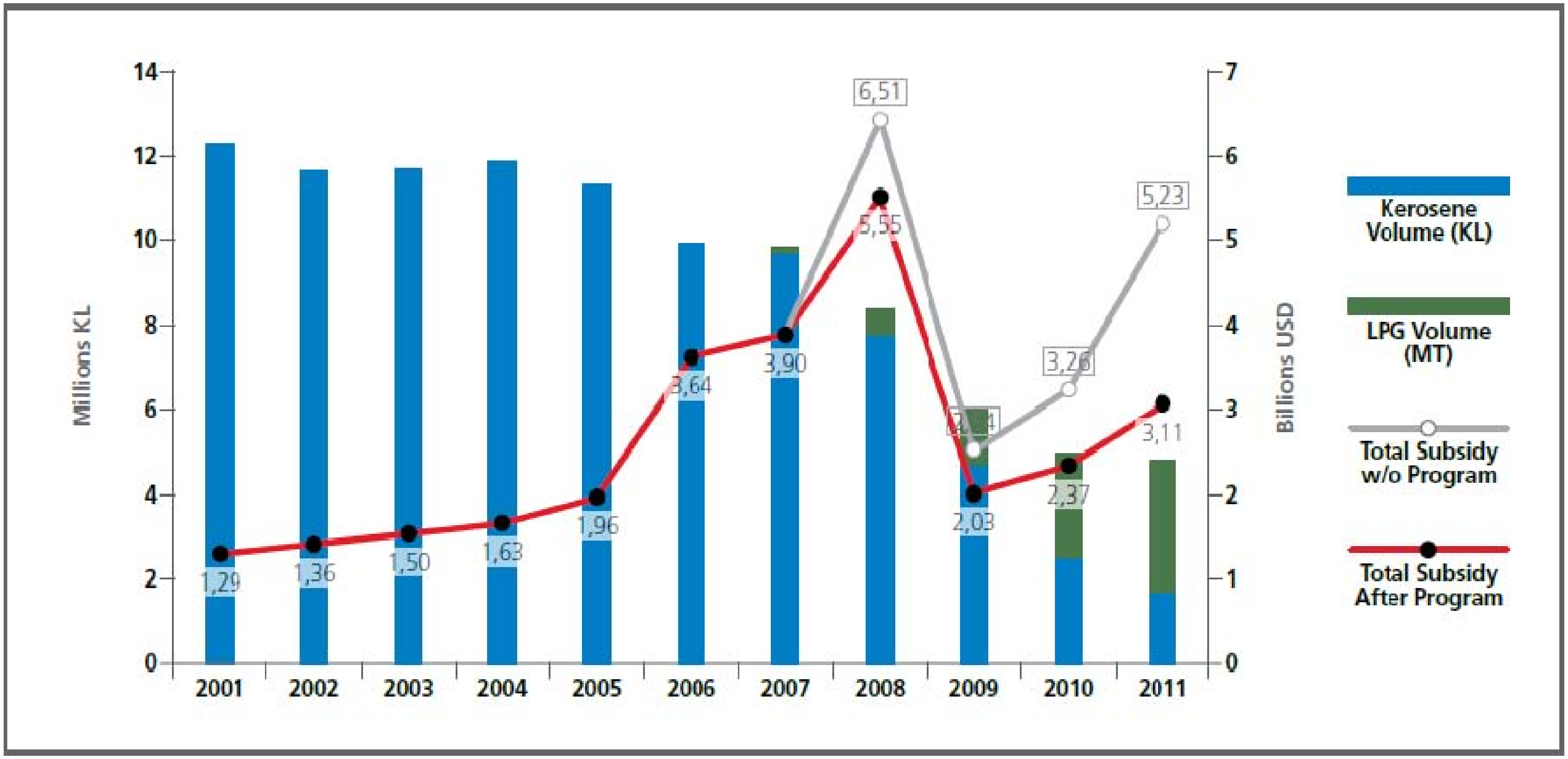


Global Warming Impact of Kerosene Lamps

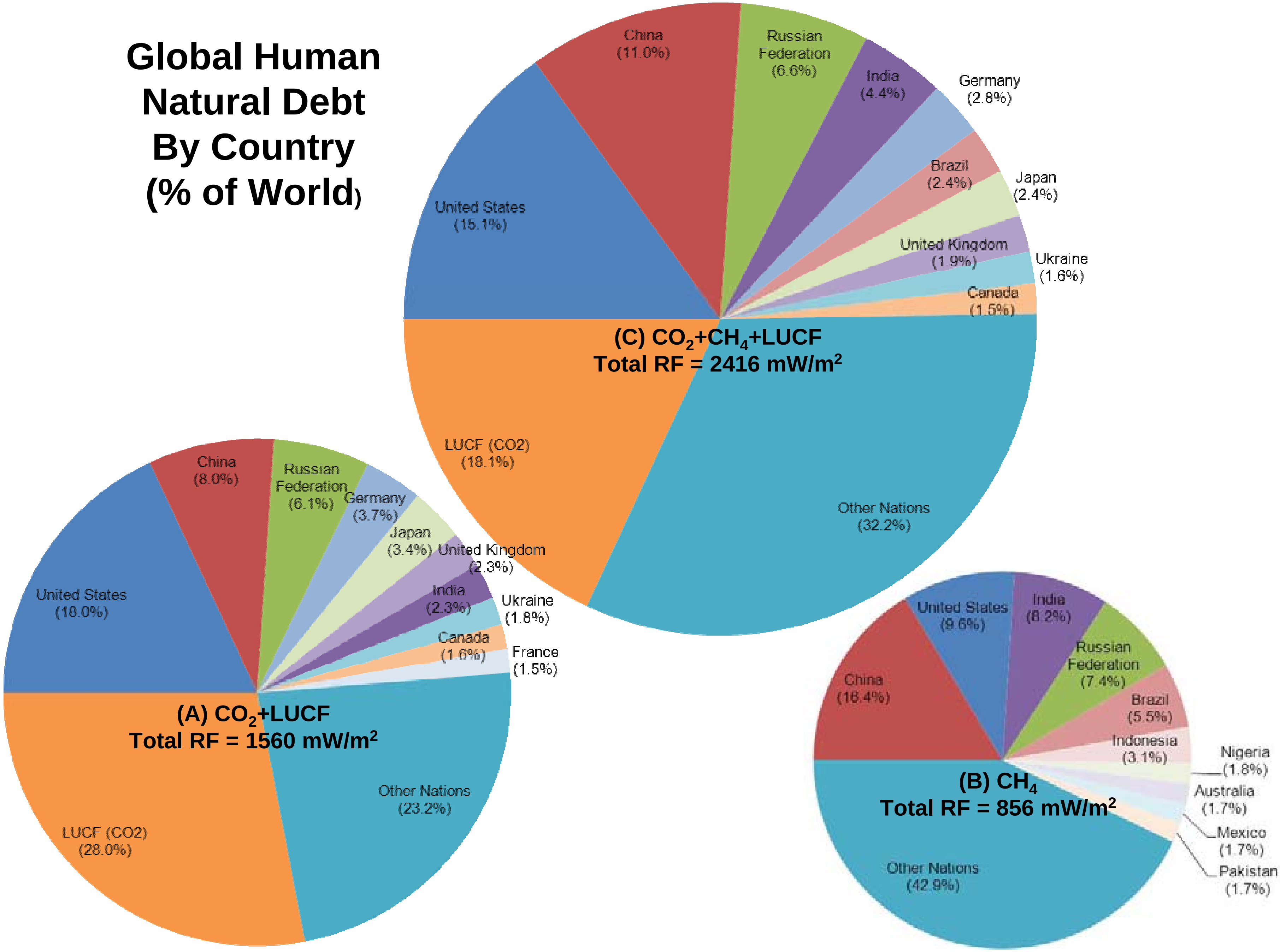
Lam et al., 2012, *Environ Sci and Tech*



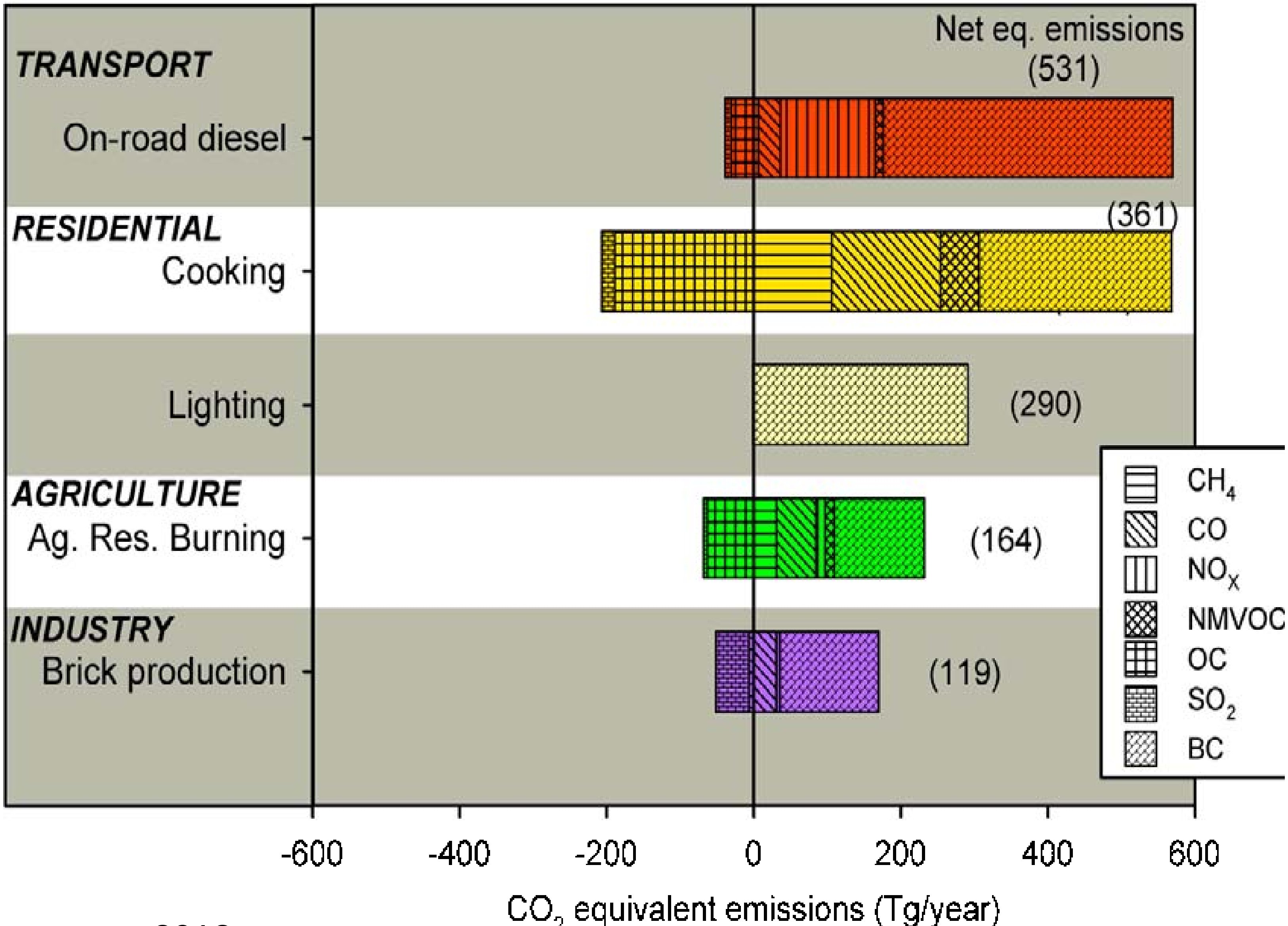
Kerosene to LPG in Indonesia



Pertamina, 2012


Global Human Natural Debt By Country (% of World)
China (11.0%)
Russian Federation (6.6%)
India (4.4%)
Germany (2.8%)
Brazil (2.4%)
Japan (2.4%)
United States (15.1%)
United Kingdom (1.9%)
Ukraine (1.6%)
Canada (1.5%)
(C) CO_2+CH_4+LUCF
Total RF = 2416 mW/m^2
LUCF (CO2) (18.1%)
Other Nations (32.2%)
China (8.0%)
Russian Federation (6.1%)
Germany (3.7%)
Japan (3.4%)
United Kingdom (2.3%)
United States (18.0%)
India (2.3%)
Ukraine (1.8%)
Canada (1.6%)
France (1.5%)
(A) CO_2+LUCF
Total RF = 1560 mW/m^2
Other Nations (23.2%)
LUCF (CO2) (28.0%)
United States (9.6%)
India (8.2%)
Russian Federation (7.4%)
China (16.4%)
Brazil (5.5%)
Indonesia (3.1%)
Nigeria (1.8%)
(B) CH_4
Total RF = 856 mW/m^2
Australia (1.7%)
Mexico (1.7%)
Pakistan (1.7%)
Other Nations (42.9%)

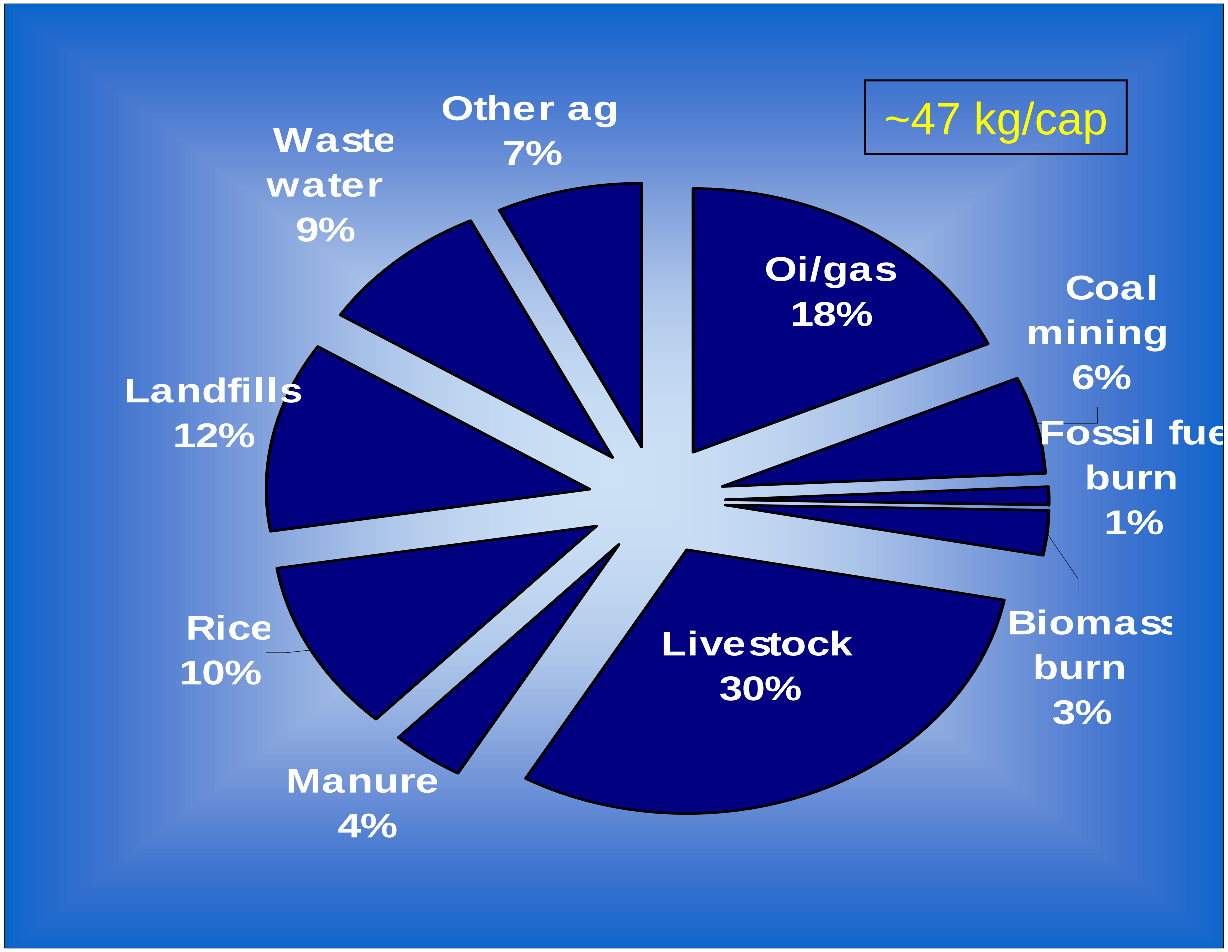
India’s CO2-Equivalent Emissions by Sector ~2009



Venkataraman, 2013

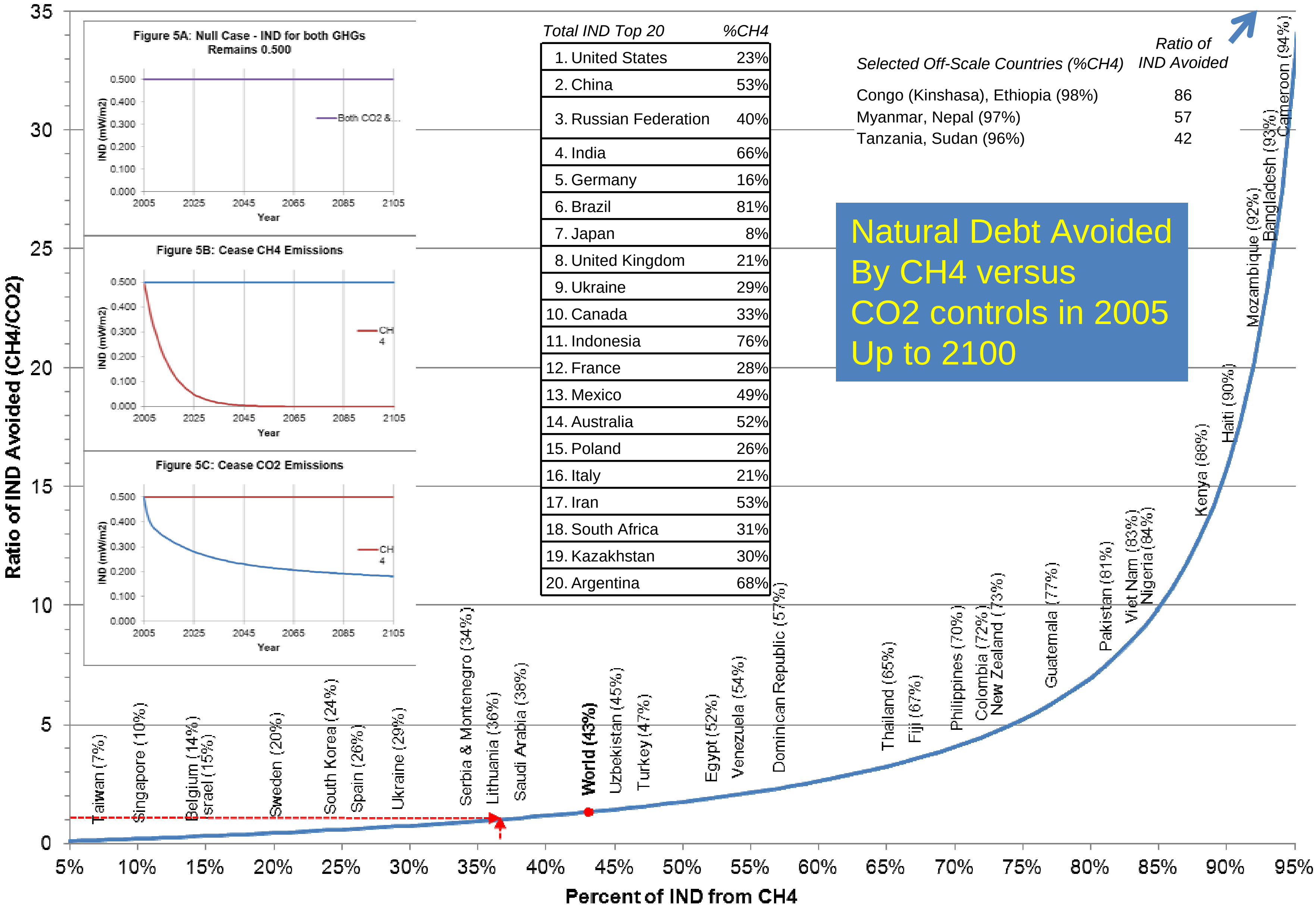
Global Anthropogenic Methane Emissions
Total ~ 300 million tons

–



Expected
to grow at
~1.5%
per year

USEPA,



Total IND Top 20	*%CH4*
1. United States	23%
2. China	53%
3. Russian Federation	40%
4. India	66%
5. Germany	16%
6. Brazil	81%
7. Japan	8%
8. United Kingdom	21%
9. Ukraine	29%
10. Canada	33%
11. Indonesia	76%
12. France	28%
13. Mexico	49%
14. Australia	52%
15. Poland	26%
16. Italy	21%
17. Iran	53%
18. South Africa	31%
19. Kazakhstan	30%
20. Argentina	68%

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Thank you