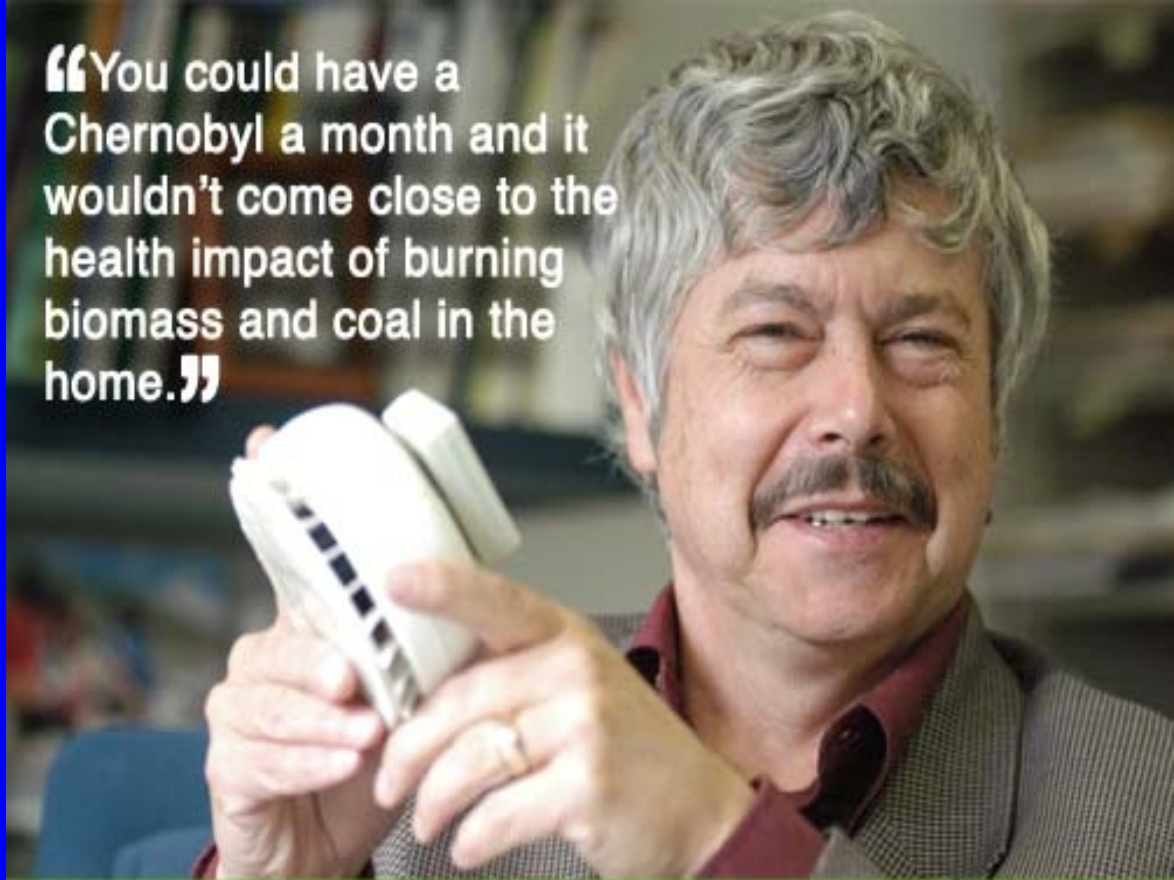


18th Annual Sewell Distinguished Lecture in Environmental Health Sciences

Columbia University

*Kirk R. Smith
Professor of Global
Environmental Health
University of California
Berkeley*

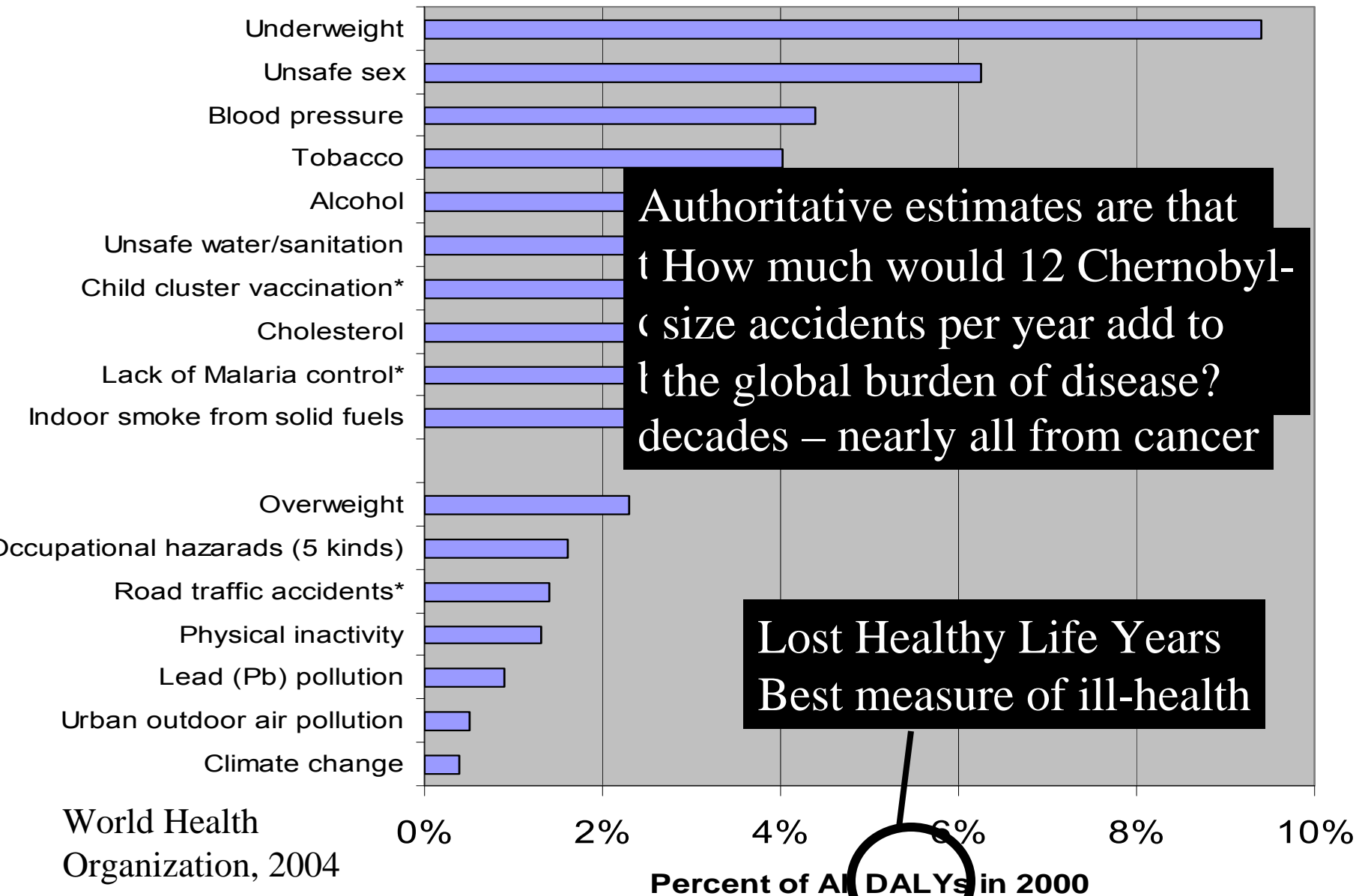
“You could have a Chernobyl a month and it wouldn't come close to the health impact of burning biomass and coal in the home.”



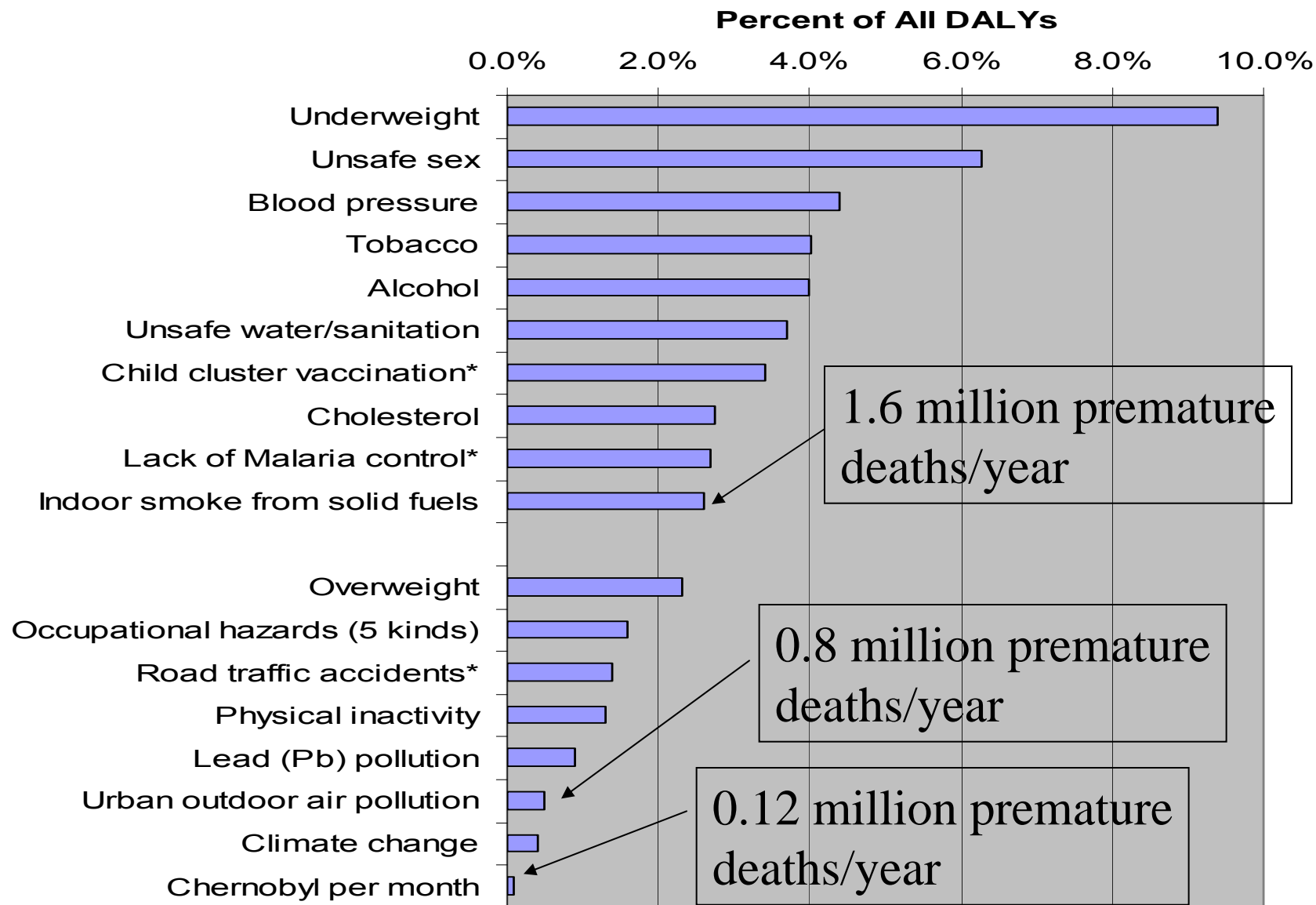
Dr. Kirk Smith holds a device used to measure air pollution in homes where people cook over wood, coal, cow dung, crops, and other biomass fuels. More than half the world's households cook with such fuels, with devastating effects on the environment and public health.

**Cooking and Climate:
The Unfinished Health Agenda
of Incomplete Combustion**

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



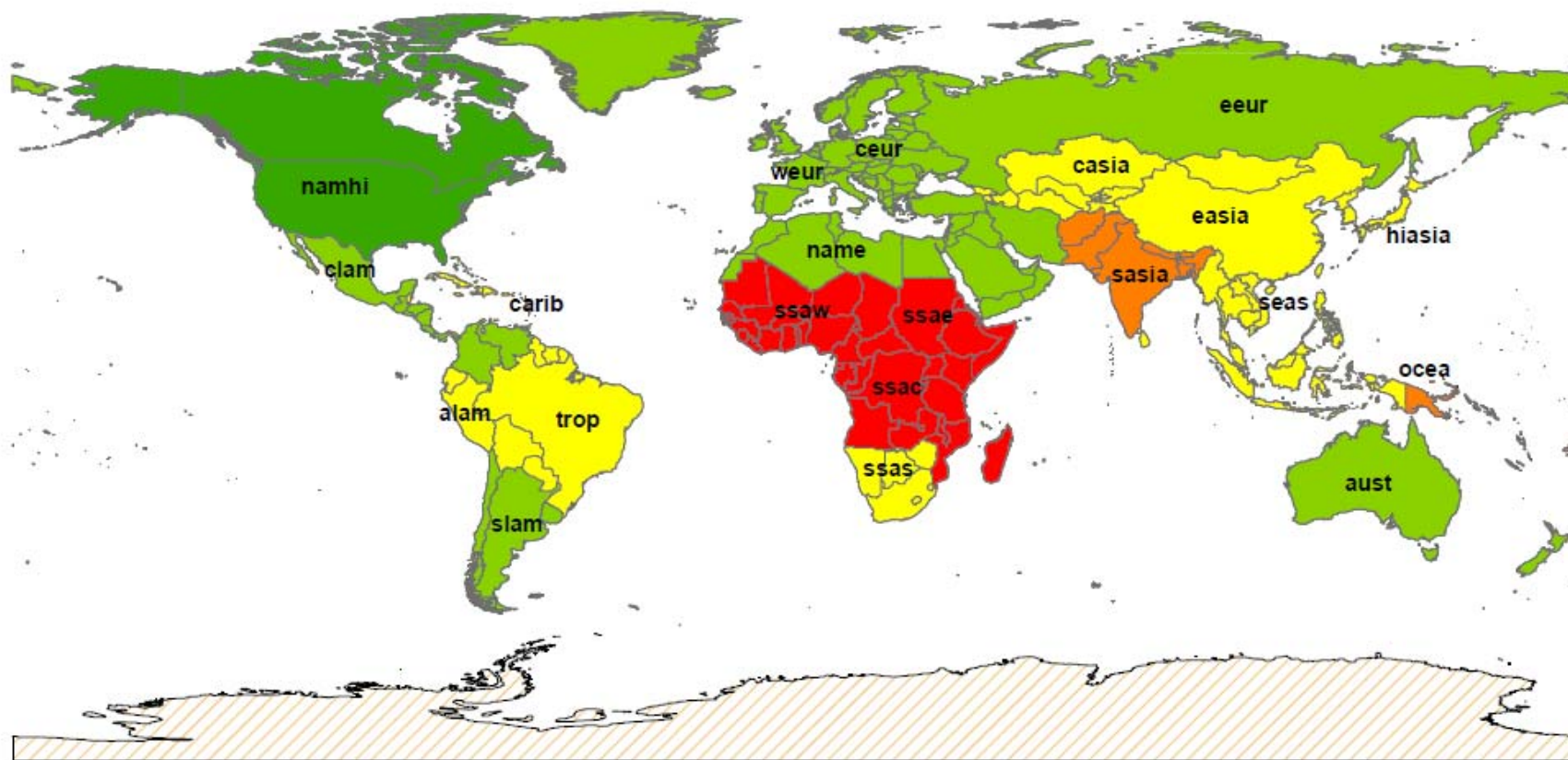
Global Burden of Disease from Top 10 Risk Factors plus selected other risk factors



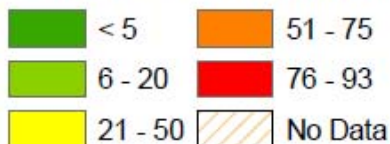
Oldest Pollution Source in Human History



Households Using Solid Cooking Fuels



% of HH Exposed to HAP



For 2005, CRA-10 preliminary

Mixed fuels



Woodsmoke is natural – how can it hurt you?

Or, since wood is mainly just carbon, hydrogen, and oxygen, doesn't it just change to CO_2 and H_2O when it is combined with oxygen (burned)?

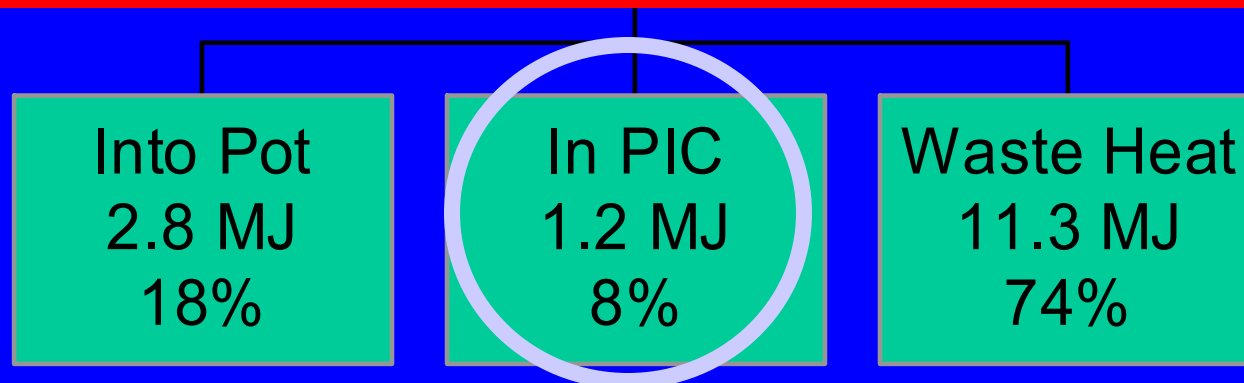


Reason: the combustion efficiency is far less than 100%

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.

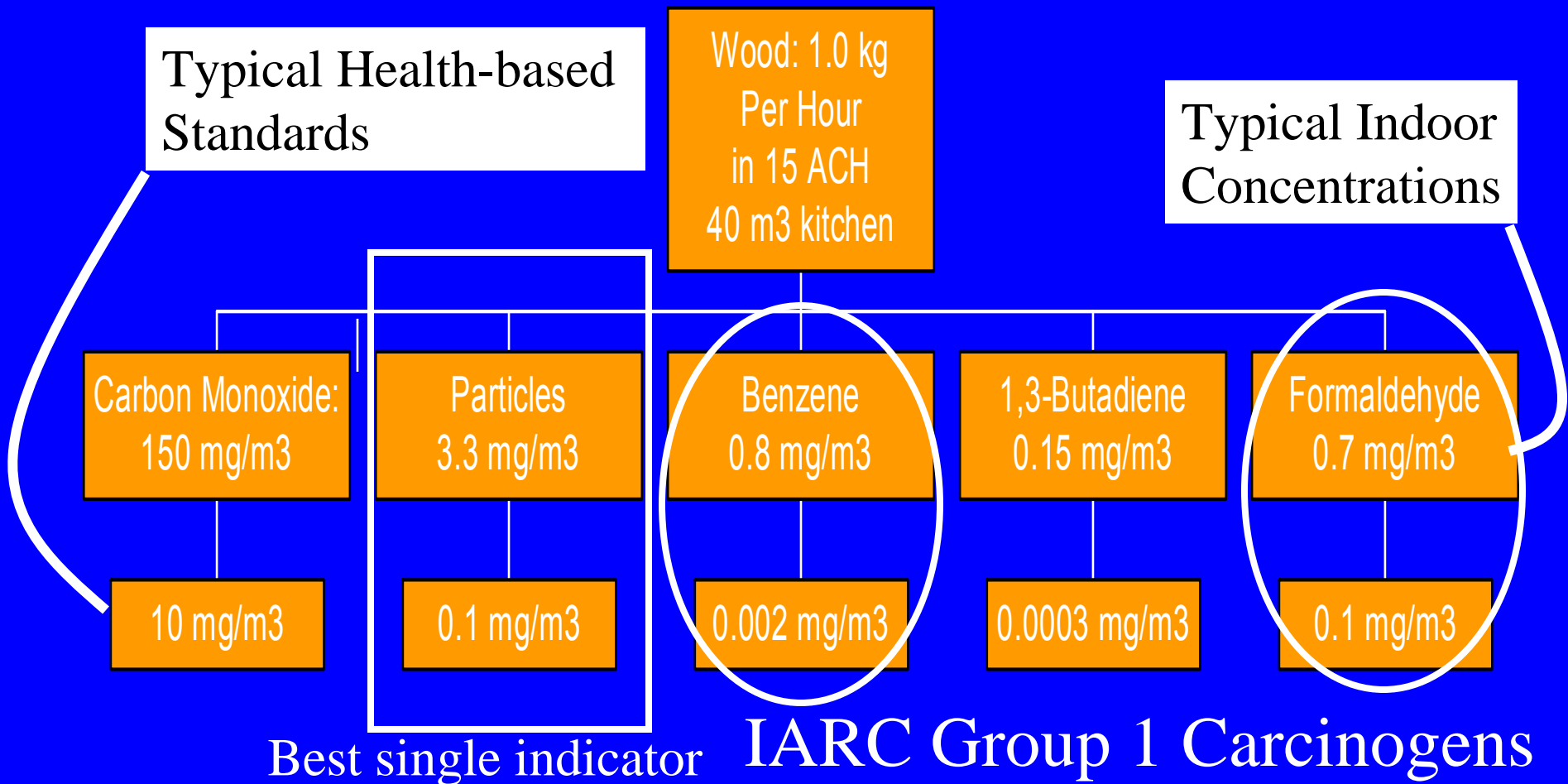
Source:
Smith,
et al.,
2000

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

- Small particles, CO, NO₂
- Hydrocarbons
 - 25+ saturated hydrocarbons such as *n-hexane*
 - 40+ unsaturated hydrocarbons such as *1,3 butadiene*
 - 28+ mono-aromatics such as *benzene & styrene*
 - 20+ polycyclic aromatics such as *benzo(α)pyrene*
- 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*

Source: Naeher et al,
J Inhal Tox, 2007

Health-Damaging Air Pollutants From Typical Woodfired Cookstove in India.



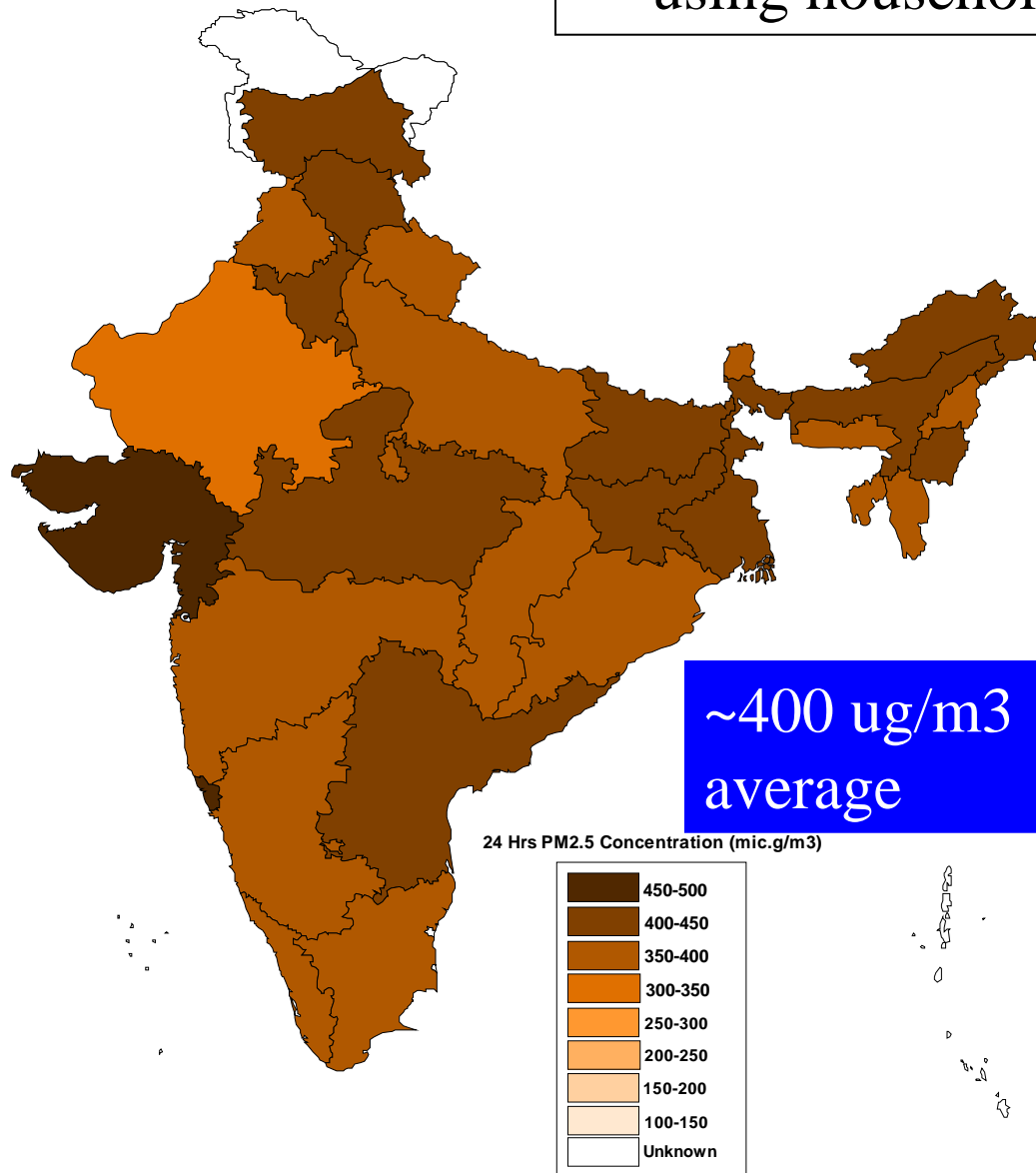
First person in human history to have her exposure measured doing the oldest task in human history

How much exposure?

Kheda District,
Gujarat, 1981



Estimated PM2.5 for solid fuel using households in India



USEPA Standard
15 ug/m3

WHO Guideline
10-35 ug/m3

Preliminary
result from
HAP CRA

Balakrishnan
et al.

Diseases for which we have
epidemiological studies - 2010

ALRI/
Pneumonia
(meningitis)

Low birth
weight

Stillbirth

Cognitive
Impairment

Birth defects?

Asthma?

Chronic
obstructive
lung disease

Interstitial lung
disease

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

Blindness
(cataracts, opacity)

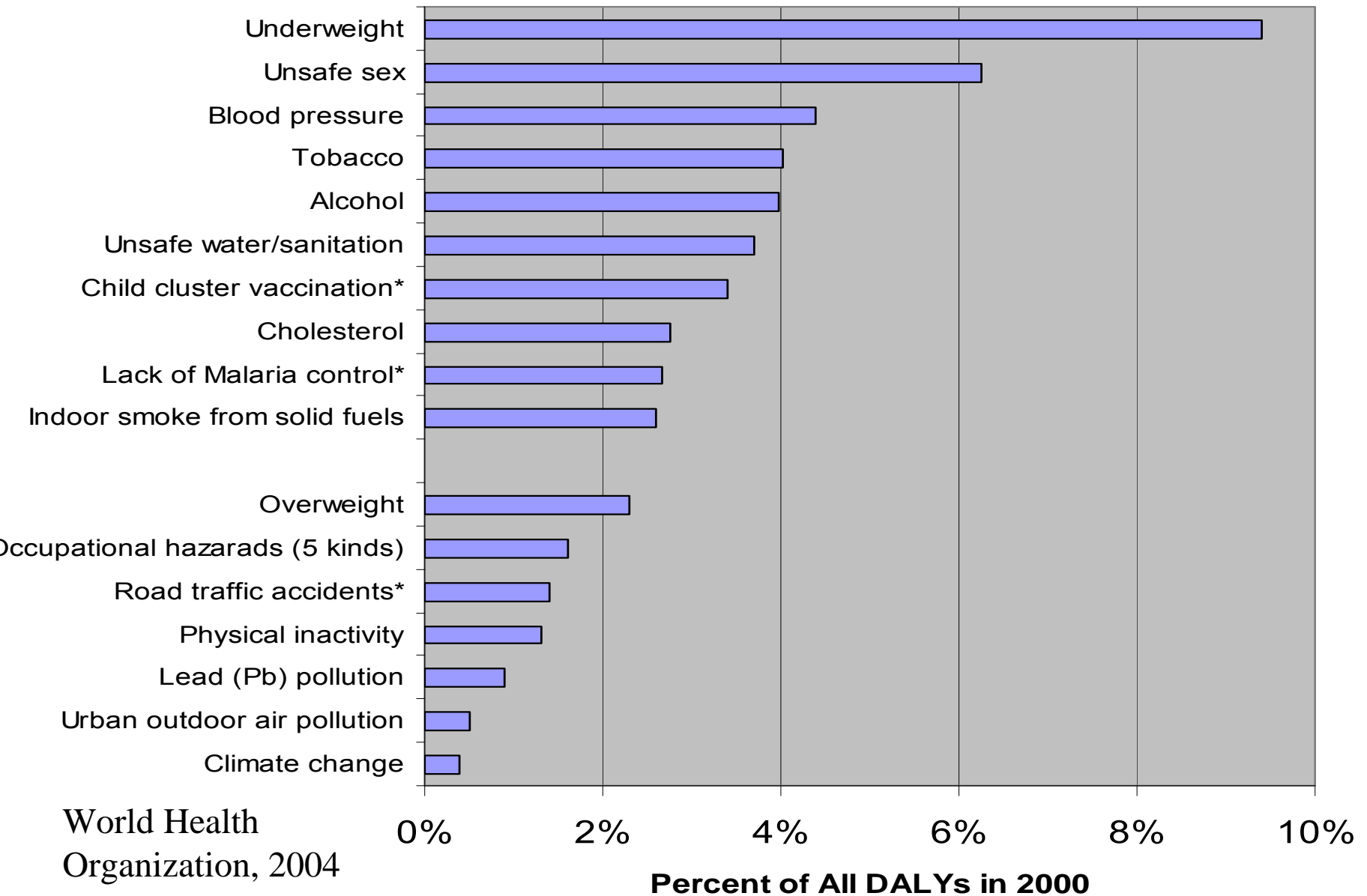
Tuberculosis

Heart disease?
Blood pressure
ST-segment

Burns, health and safety
impacts of fuel gathering?



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



Start Eudora - [In] 5 Microsoft Office ... 12 Microsoft Office... 5 Microsoft Office... Windows Media Player WHO Statistical Infor... Type to search 9:36 AM

RESPIRE – Randomised trial (n=518)

Impact on pneumonia up to 18 months of age



Traditional open 3-stone fire:
kitchen 48-hour $\text{PM}_{2.5}$ levels of
600 - 1200 $\mu\text{g}/\text{m}^3$



Chimney wood stove, locally made
and popular with households

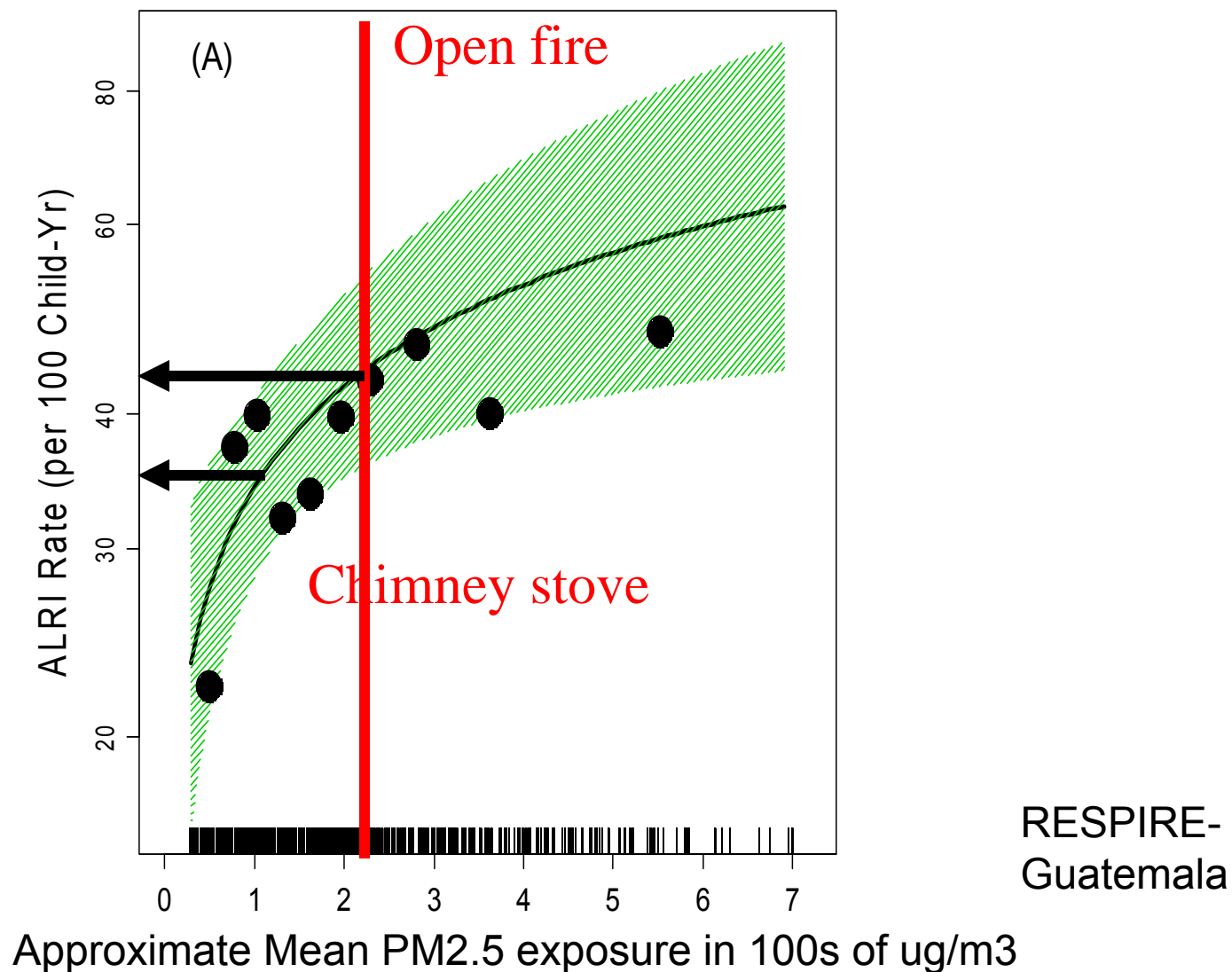
Highland Guatemala



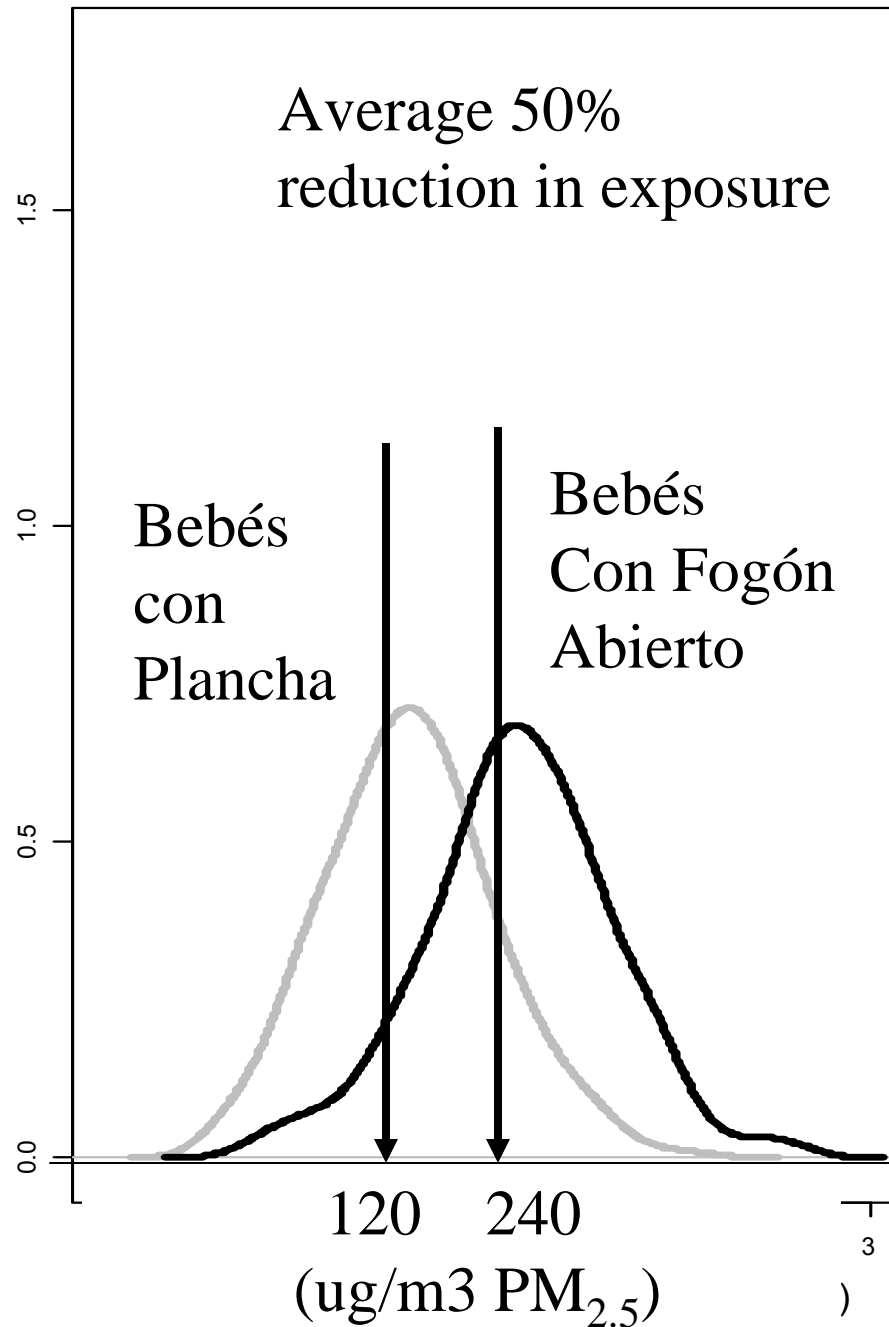
Tubito

Tubito

MD-diagnosed Acute Lower Respiratory Infection



(b)



Chimney stove did not protect all children

Effect of Plancha on PM2.5

Log Scale



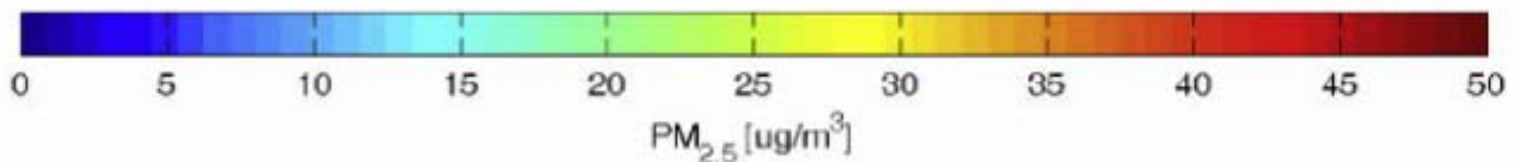
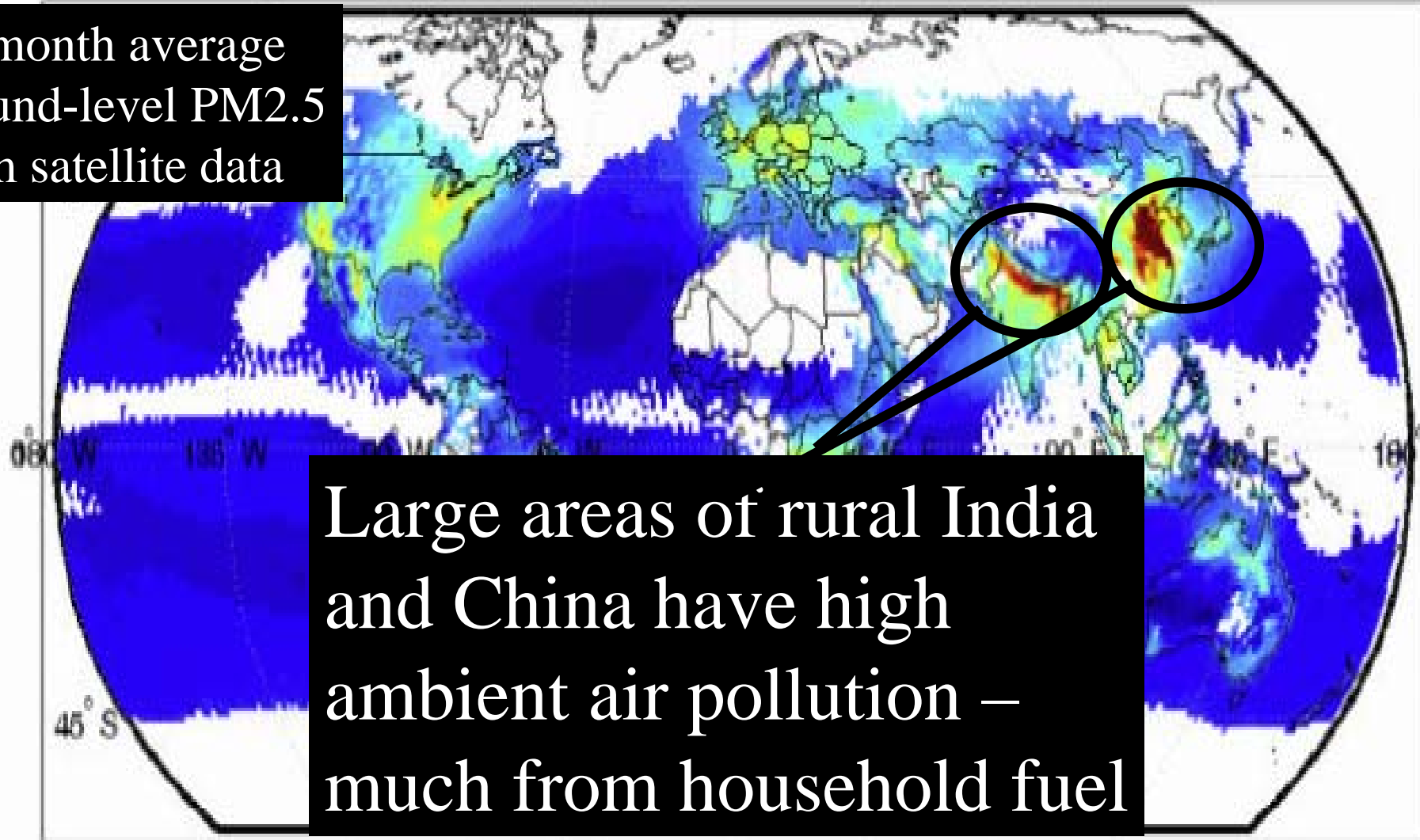
Reasons that child personal exposures did not lower as much as kitchen levels:

- Time-activity: the kids do not spend their entire day in the kitchen
- Household (or “neighborhood”) pollution: a chimney does not reduce smoke, but just shifts it outside into the household environment, where the difference between intervention and control households was less



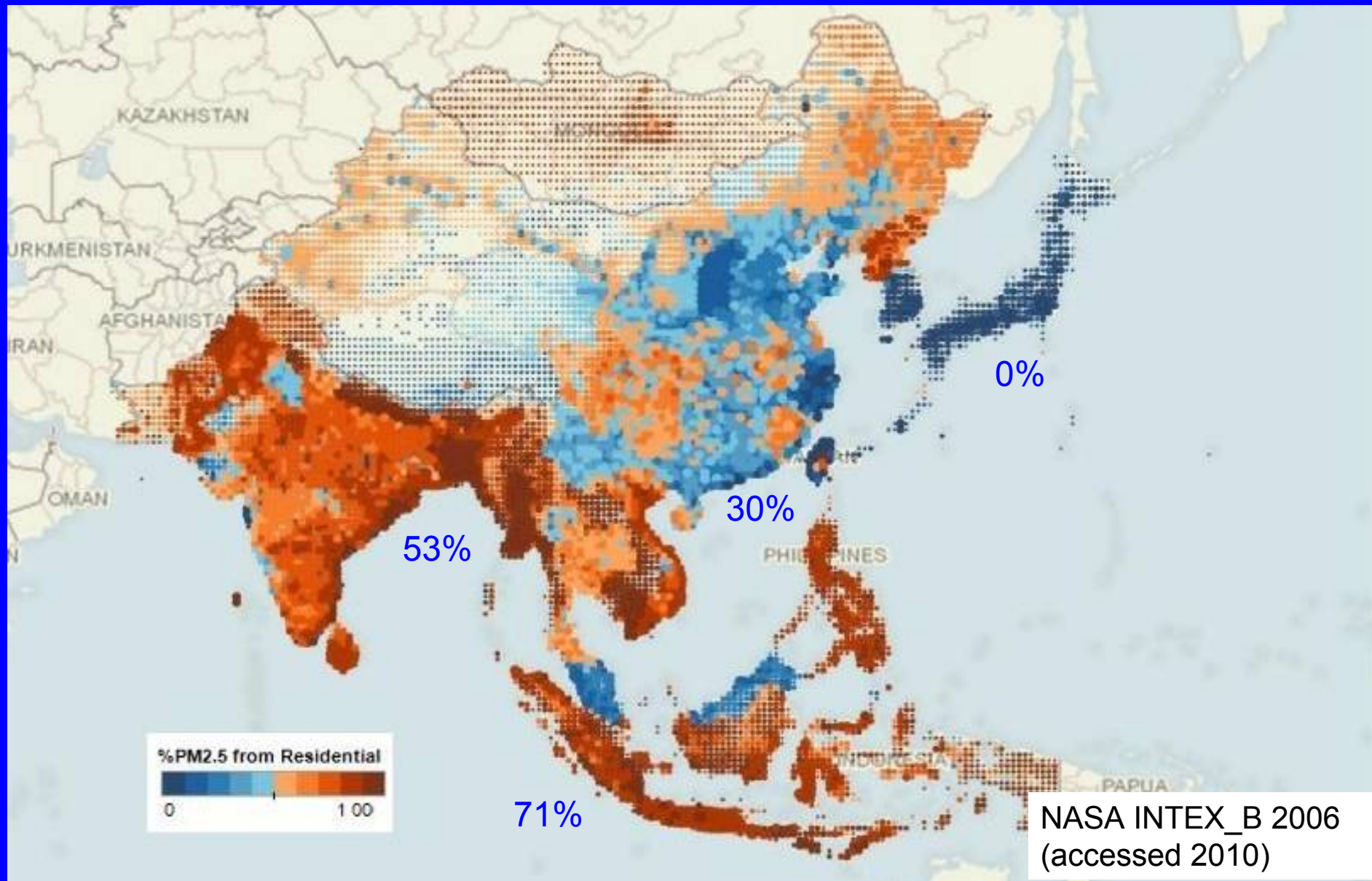
20-month average
ground-level PM_{2.5}
from satellite data

MODIS

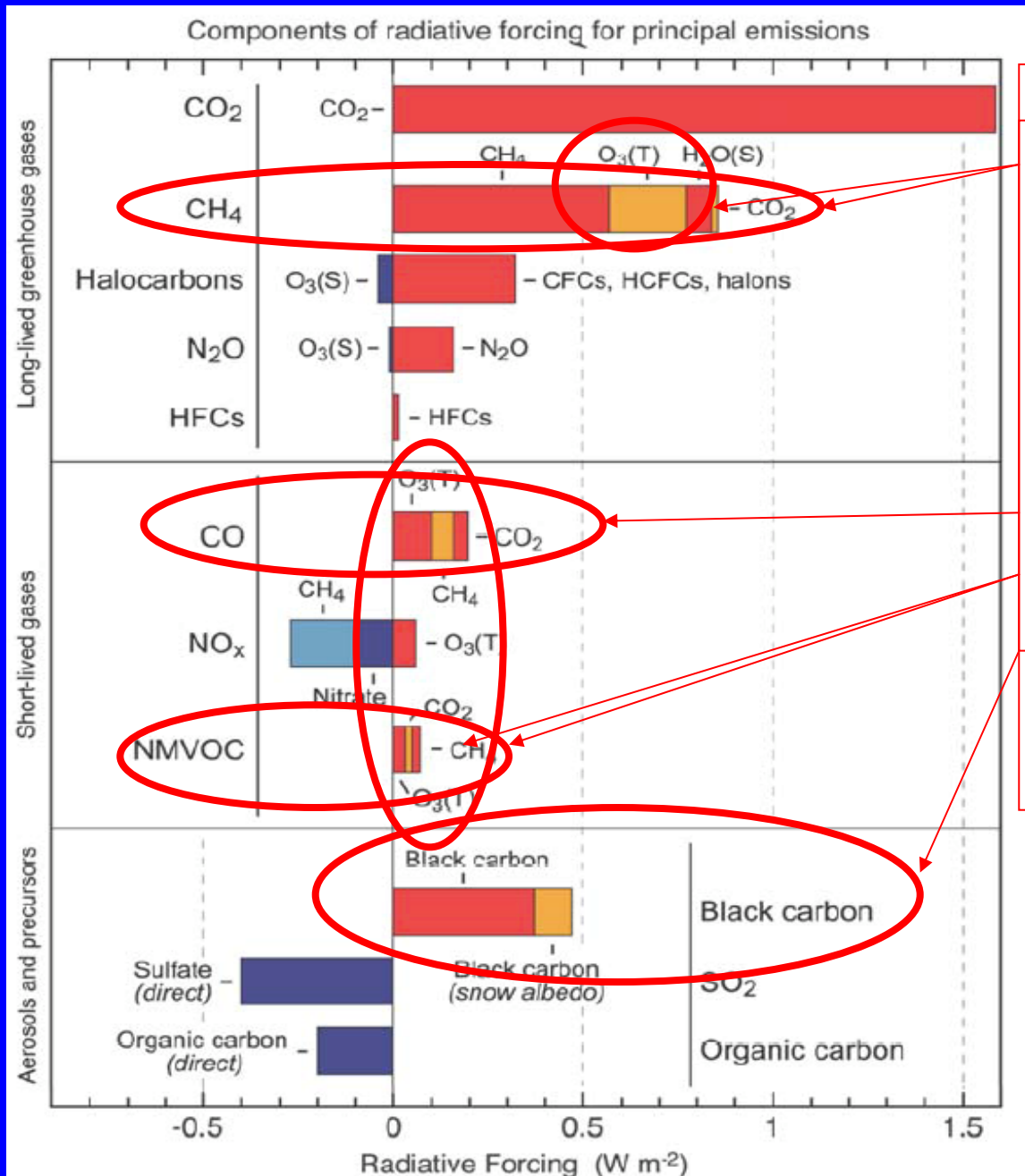


NASA INTEX_B Database

Percent PM_{2.5} emissions from households



Global warming in 2005 due to all human emissions since 1750



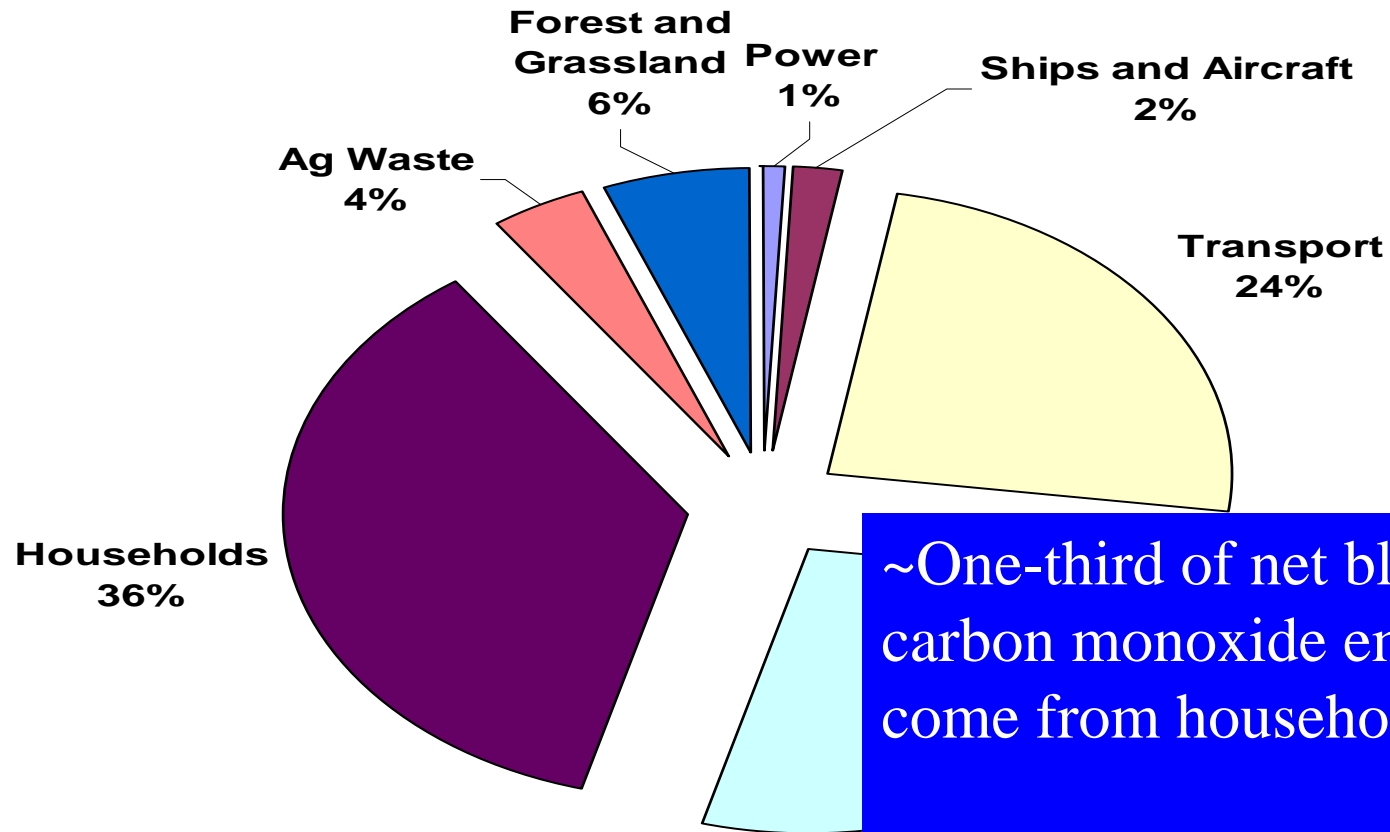
CO₂ is important for climate, but so are many other greenhouse gases create pollutants, including the ones a good proportion of both circled that, unlike CO₂, also their climate forcing and have significant health as well as climate impacts the secondary pollutant, tropospheric ozone

Household Fuels and Climate

- Climate impacts come from non-renewable biomass and coal, i.e., from net CO₂ emissions
- Poor combustion also leads to other emissions such as the relatively well-understood GHGs – methane and nitrous oxide – which are “Kyoto” GHGs
- In addition, a wide range of less well-understood short-lived GH-related emissions are emitted including
 - CO and black carbon – warming agents
 - Ozone precursors – warming But also cooling agents such as sulfates and organic carbon particles
- There are also indirect climate impacts of these pollutants including
 - Reducing carbon capture of forests by ozone damage
 - Darkening of snow/ice by black carbon

Controllable Global Warming from Black Carbon Emissions

Net of OC, Forcings from IPCC, 2007: 0.25 W/m^2
Inventory from T Bond Database, V 7.1.1 Feb 2009

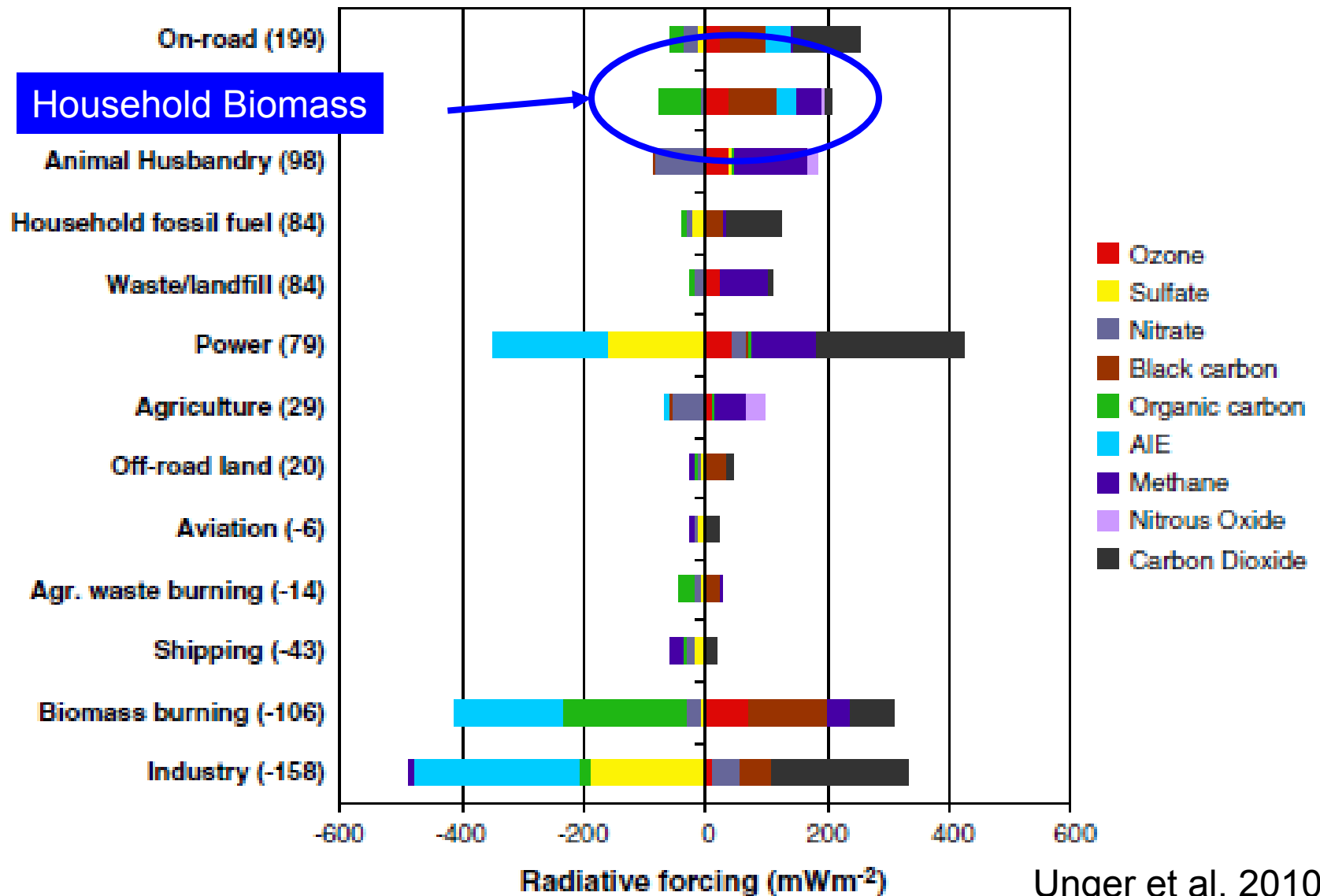


~One-third of net black carbon and carbon monoxide emissions globally come from household fuels

~One-sixth of ozone causing potential

~One-twentieth of methane

Climate Warming in 2020 Under Present Trends



Unger et al. 2010

Perfect Storm for Health Impacts

- Highly polluting activity
- Half of world households
- Several times a day
- Just when people are present
- Most vulnerable (women and young children) most likely to be there

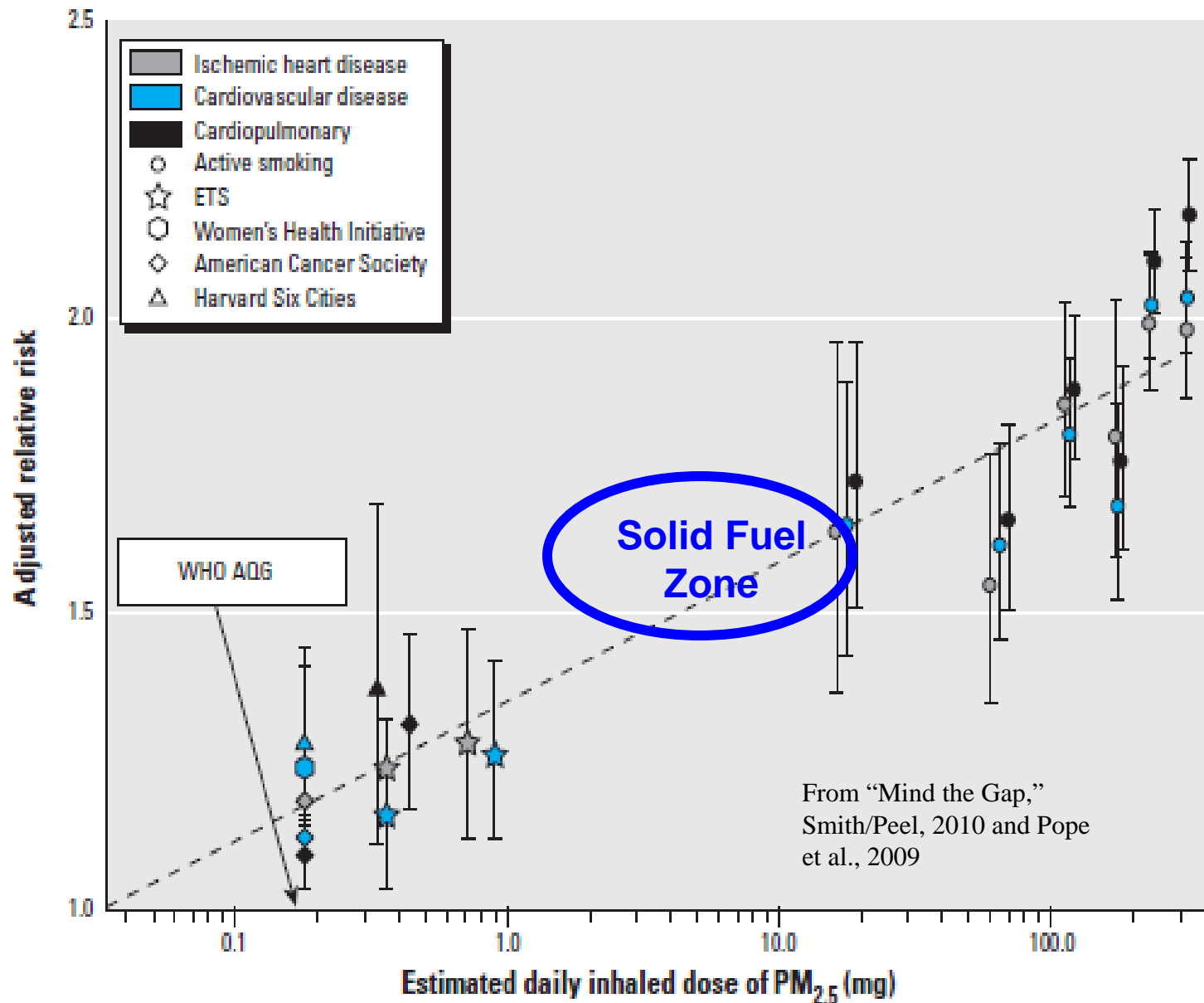
In other words, the Intake Fraction
is extremely large

IF is the fraction of material emitted
that is actually breathed in by someone

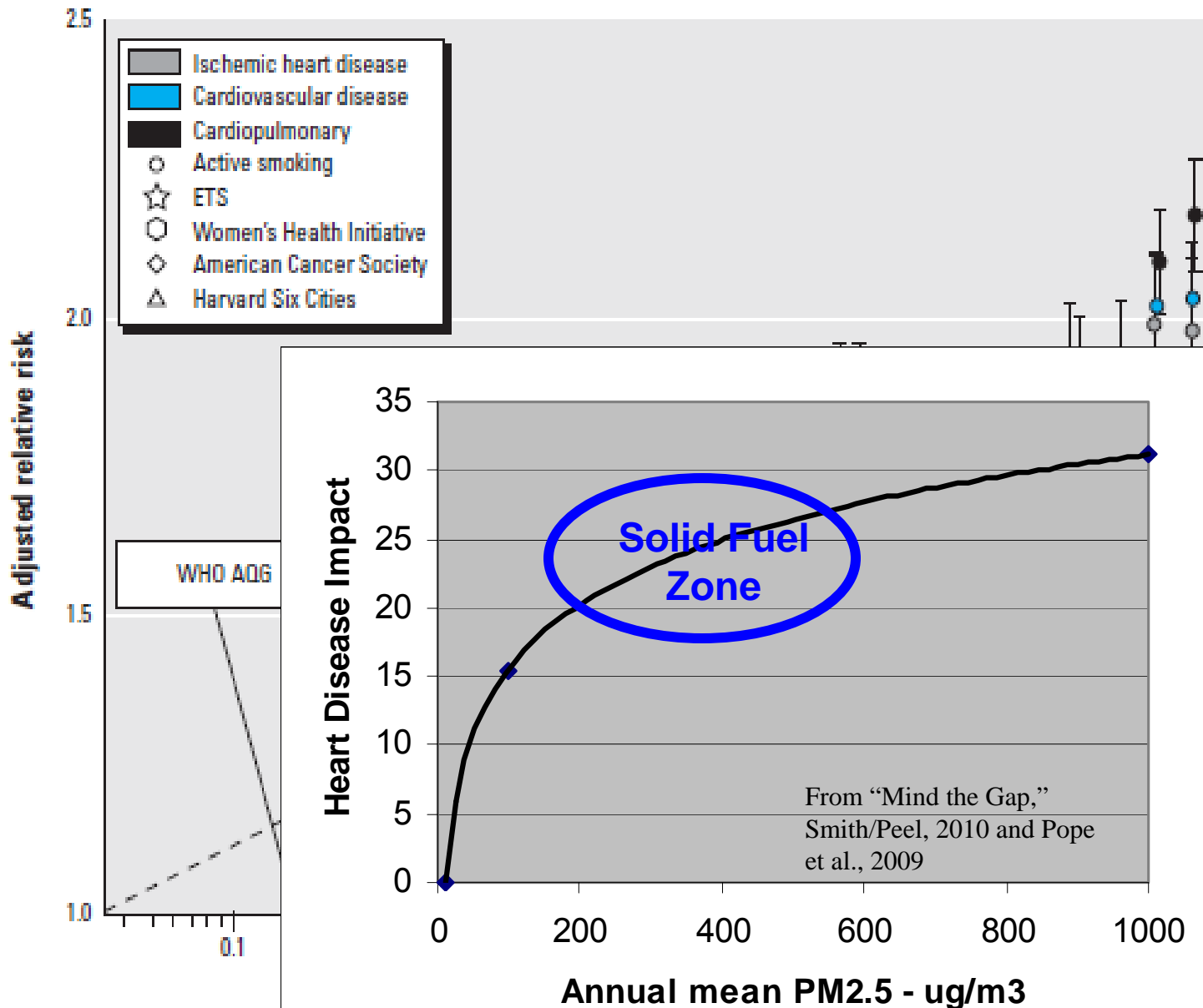


$IF = 1.0$

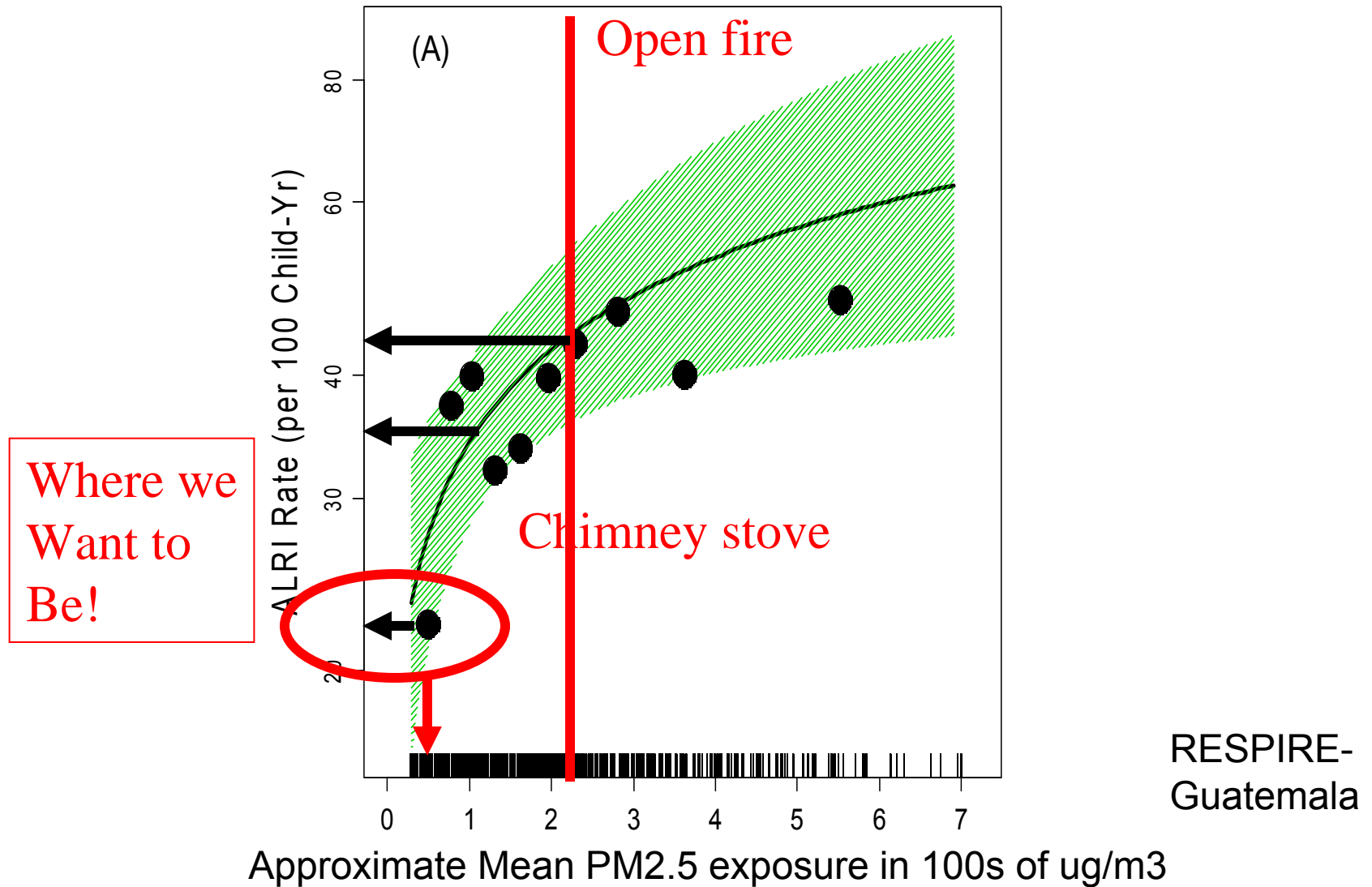
Heart Disease and Combustion Particle Doses



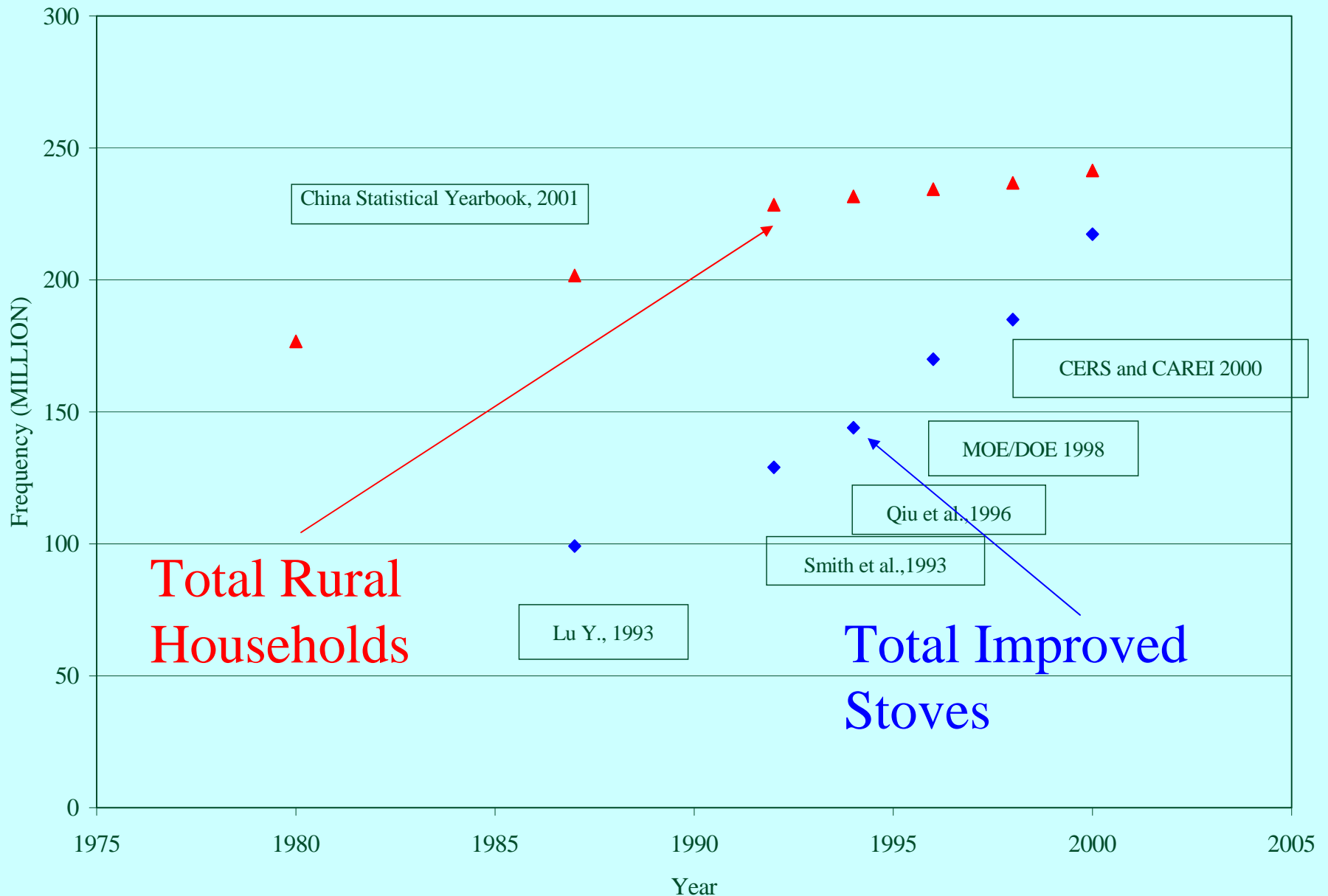
Heart Disease and Combustion Particle Doses



MD-diagnosed Acute Lower Respiratory Infection



China's National Improved Stove Program (NISP) 1981-1998

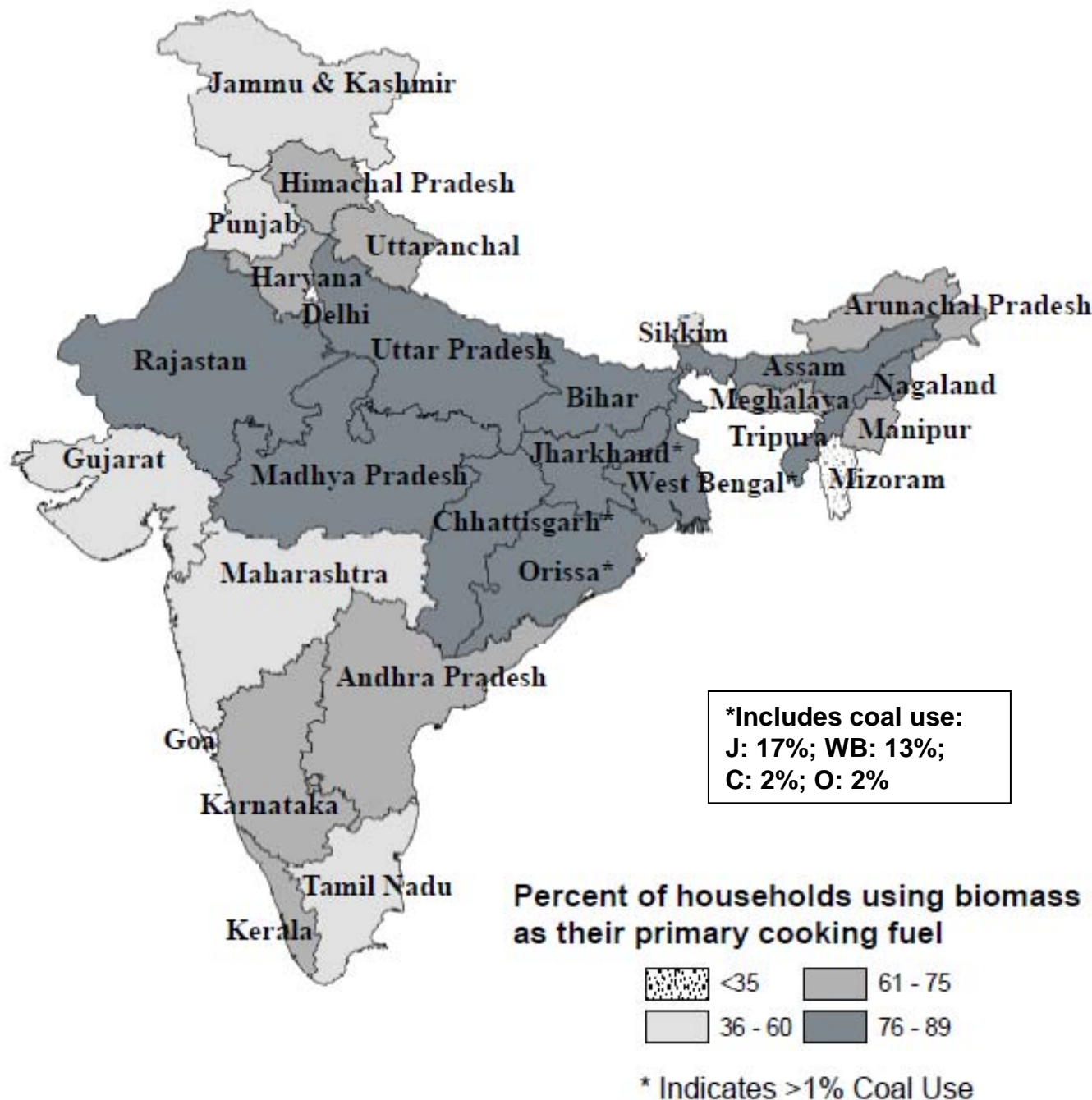


Improved Stove in Shanxi



India in 2005

71%
households
use solid fuel
for cooking



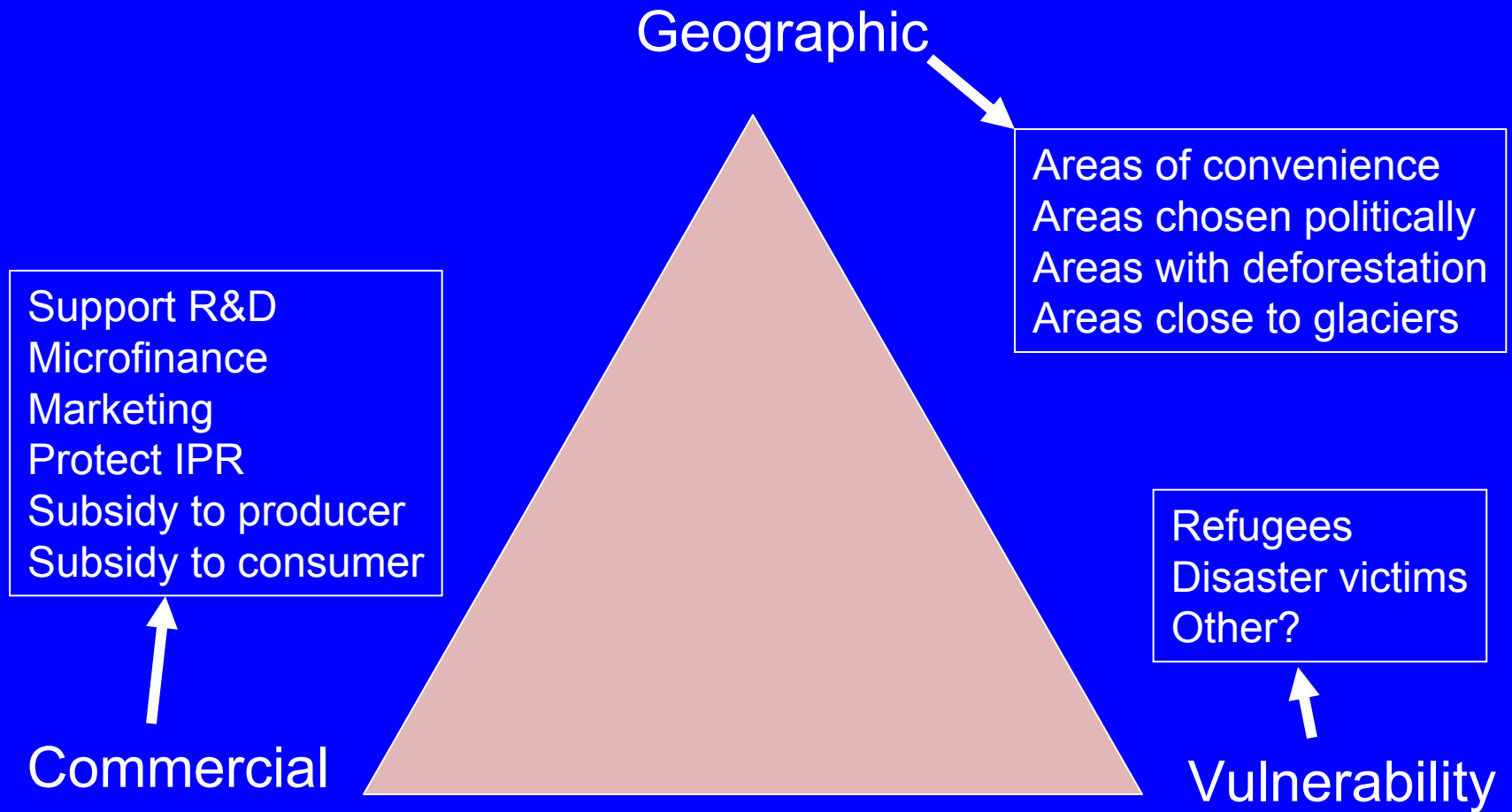
Venkataraman
et al. 2010





Only blower stoves are sufficiently clean
to mimic performance of gas
– where we need to be for health

Modes of Dissemination



Alternative Approaches Do Not Target the Vulnerable

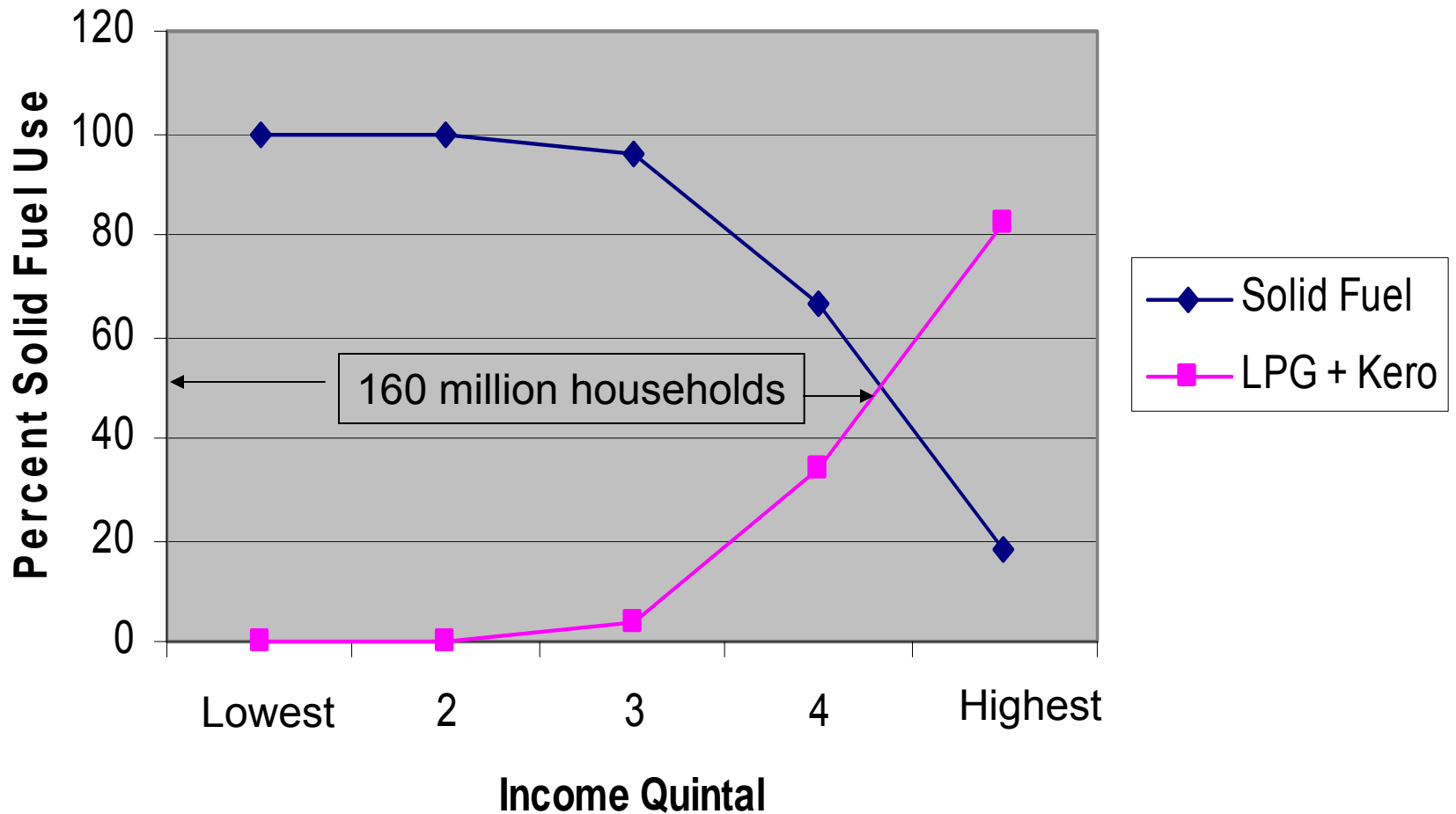
- **Geographic** targeting
com
vul
- **And**
crite
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vulnerab

In addition
to starting at
the top of the
income
pyramid,
therefore

with
most
ated
ty
rich,

Need to find ways
to start at the bottom!

Distribution of Household Cooking Fuel by Income in India



**Rural Housing
Program**

**Rajiv Gandhi
Scheme –
rural electrification**

**Vulnerable populations
in India now being reached
by national programs**

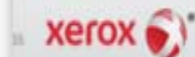
**Women's
Literacy
Program**

**Antenatal
Care
System**



ASHA
Worker
Contemplating
Advanced
Blower
Stove

Ready for
Xerox?



The New York Times

Wednesday, February 9, 2011 Last Update: 11:00 AM ET



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Environment

Toxic Tsunami threatening US health

By OUR CORRESPONDENT
Evidence indicates that a wave of toxic material will soon be affecting US populations. As many as half of all households to be exposed to hazards from new technology far exceeding safety standards. Thousands likely to die.

VIDEO

Cairo's Facebook Flat

In a communal apartment, young Egyptians are



Tony Gentile/Reuters

Prosecutors Seek Trial for Berlusconi

By RACHEL DONADIO 8:43 AM ET

Prosecutors filed a request on Wednesday to try Prime Minister Silvio Berlusconi of Italy on criminal charges related to prostitution and abuse of office.

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- Dowd: Forgive Me, for I Have Linked | Comments
- Bittman: Is 'Eat Real Food' Unthinkable?
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• Brian Jacques, Writer of Redwall Series, Dies at 71



• Forgive Me, Father, for I Have Linked



MARKETS »

At 11:03 AM ET

S.&P. 500	Dow	Nasdaq
1,322.93	12,241.36	2,796.29
-1.64	+8.21	-0.76
-0.12%	+0.07%	-0.03%

THE NEW
DealB%

It will wash across the countryside exposing half the United States population to a toxic soup containing

- Dozens of poisonous organic chemicals known to be mutagens, immune system suppressants, severe irritants, blood poisons, inflammation agents, central nervous system depressants, cilia toxins, endocrine disrupters, or neurotoxins.
- Several other chemicals firmly established as human carcinogens.
- Other toxic inorganic chemicals known to cause asphyxiation, stillbirth, infant death, heart disease, and severe acute and chronic lung disease.

The Toxic Tsunami

- It will be the result of a process that pours this toxic soup directly into half of all US homes every day; all year; every year.
- It will expose families to toxic levels much higher than those of people living on top of toxic waste dumps, working in most heavy industries, or residing in the dirtiest cities
- These toxic levels will be tens or hundreds of times the levels set by international and national organizations to protect health
- Insidiously, it will target women and young children in these households

Why would it happen?

- Because a technology will be widely promoted that takes perfectly safe natural material and converts 10% of it to toxins in the course of functioning. Sometimes as much as 20%
- The efficiency of the process is extremely low, leading to little human benefit per unit toxin created as well as waste of the natural resource.
- Instead of carefully disposing of this toxic material in safe places, this industry will spread the toxic soup by air right into neighborhoods where people live.
- All this, in spite of there being well-known alternative technologies available producing very little toxin.

What might be the health consequences if this happens?

- A vast epidemic of a respiratory illness that kills faster than SARS or Avian Flu – initiation to death in 2 days in some cases.
- So fast, that trying to apply medical care is often hopeless.
- Estimates are that soon it would be killing at least 1000 children a week, 50,000 a year
- In addition, thousands of children will be severely burned each year because of this technology, many will die

What else?

- Thousands of women would have their breath taken from them as their lung function is slowly eaten away by exposure to the toxins
- Thus, at tragically young ages they will become unable to breathe normally or do common tasks.
- Alarmingly, once a woman is affected, there is no known medical therapy to reverse the process.
- More than 500 per week, 25 thousand per year, would soon start to die prematurely because their lungs would finally give out.

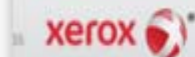
Anything else?

- Although some effects are known, so little study has been done of this threat that we are unsure of even all the types of health impacts there would be, let alone their scale
- There are strong indications, however, that the burden on households would include many other insidious diseases, such as
 - Significant exacerbation of heart disease, the most important cause of death in the country
 - A major negative impact on babies' health and survival through reductions in growth before birth
 - Increases in several types of cancer, including lung and throat
 - Damage to the eyesight of tens of thousands
 - A significant increase in tuberculosis, one of the most important and intransigent of the re-emerging infectious diseases
- Based on animal experiments, we can also expect
 - Reduction in child cognitive capacity (learning ability or IQ)
 - Several types of birth defects

What should the response be?

- **Fu In fact, nothing will happen er ne — no one will notice**
- A major effort coordinated by the National Guard to protect the country?
- Emergency legislation in Congress to provide funds for cleaner technologies?
- New laws and regulations to make sure it never happens again?

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The New York Times

Wednesday, February 9, 2011 Last Update: 11:00 AM ET



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Strikes Add to Egypt Unrest as U.S. Makes Demands

By DAVID D. KIRKPATRICK
4 minutes ago

As reports filtered in of strikes and unrest spreading on Wednesday, the government seemed to dig in deeper.

- The Lede: Latest Protest Updates [Live Blog](#)
- Allies Press U.S. to Go Slow

VIDEO

Cairo's Facebook Flat

In a communal apartment, young Egyptians are



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-1.64	+8.21	-0.76
-0.12%	+0.07%	-0.03%

THE NEW
DealB%

Everything stated about the Toxic Tsunami is true, as best we know, except for three aspects:

1. It is already happening
2. In half the world's households, but not US households
3. No industry is responsible – but poverty and complacency

A sin of omission, not commission

But still killing 1.5 million women and children



Wood is the fuel that

- Heats you twice as Thoreau said?
 - Once when you chop it and
 - Once when you burn it
- Or four times?
 - The fever from respiratory infection and
 - Global warming
- Better combustion will get rid of the second pair

Thank You

Publications and
presentations available at
my website:

Just Google “Kirk R.
Smith”

