Overview

- Air pollution and global health
  - Household
  - Outdoor
- Development transitions
- Challenges and opportunities

Global Burden of Disease Estimates

- Quantify causes of death and disability
  - DALY = Yrs of Life Lost + Yrs of Life with Disability
- Important for prioritization
  - Current status
  - Trends
- Identification of modifiable risk factors

10 Leading Causes of Global Mortality and Disease Burden 2004

Mortality

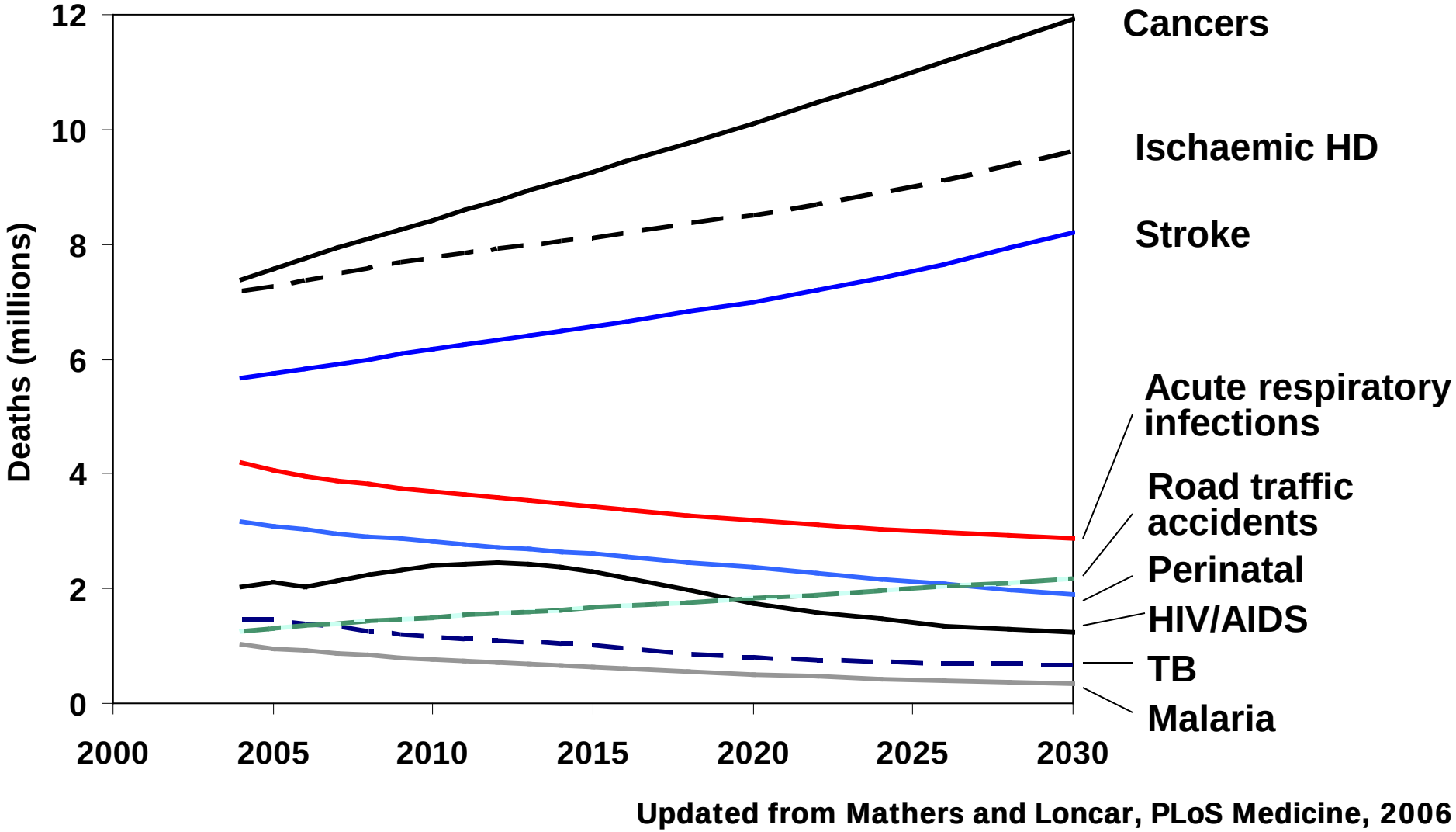
		%
1.	Ischaemic heart disease	12.2
2.	Cerebrovascular disease	9.7
3.	Lower respiratory infections	7.1
4.	COPD	5.1
5.	Diarrhoeal diseases	3.7
6.	HIV/AIDS	3.5
7.	Tuberculosis	2.5
8.	Trachea, bronchus, lung cancers	2.3
9.	Road traffic accidents	2.2
10.	Prematurity, low birth weight	2.0

DALYs

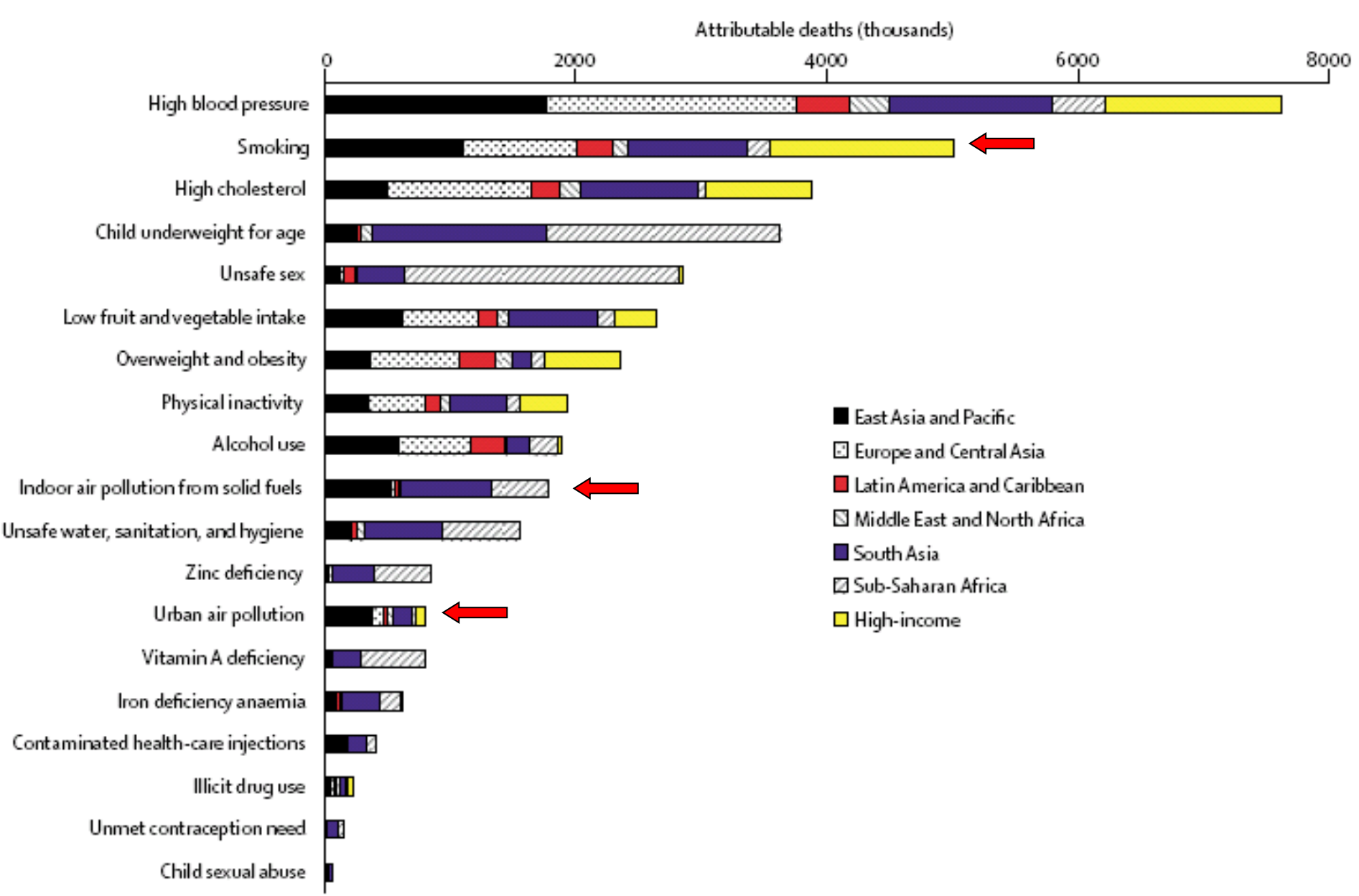
		%
1.	Lower respiratory infections	6.2
2.	Diarrhoeal diseases	4.8
3.	Depression	4.3
4.	Ischaemic heart disease	4.1
5.	HIV/AIDS	3.8
6.	Cerebrovascular disease	3.1
7.	Prematurity, low birth weight	2.9
8.	Birth asphyxia, birth trauma	2.7
9.	Road traffic accidents	2.7
10.	Neonatal infections and other	2.7

Source WHO, 2008

Global projections for selected causes, 2004 to 2030



Source WHO, 2008



Lopez et al, Lancet, 2006

Household Solid Fuel Combustion

~2 million premature deaths /year* worldwide due to indoor air pollution from solid fuel use.

2.7% of the global burden of disease

***Acute respiratory infections in children, chronic lung disease and lung cancer in women……(not including TB, blindness/cataracts, pregnancy outcomes, IHD)**

% Households Using Solid Fuels, 2005

% of HH Exposed to HAP

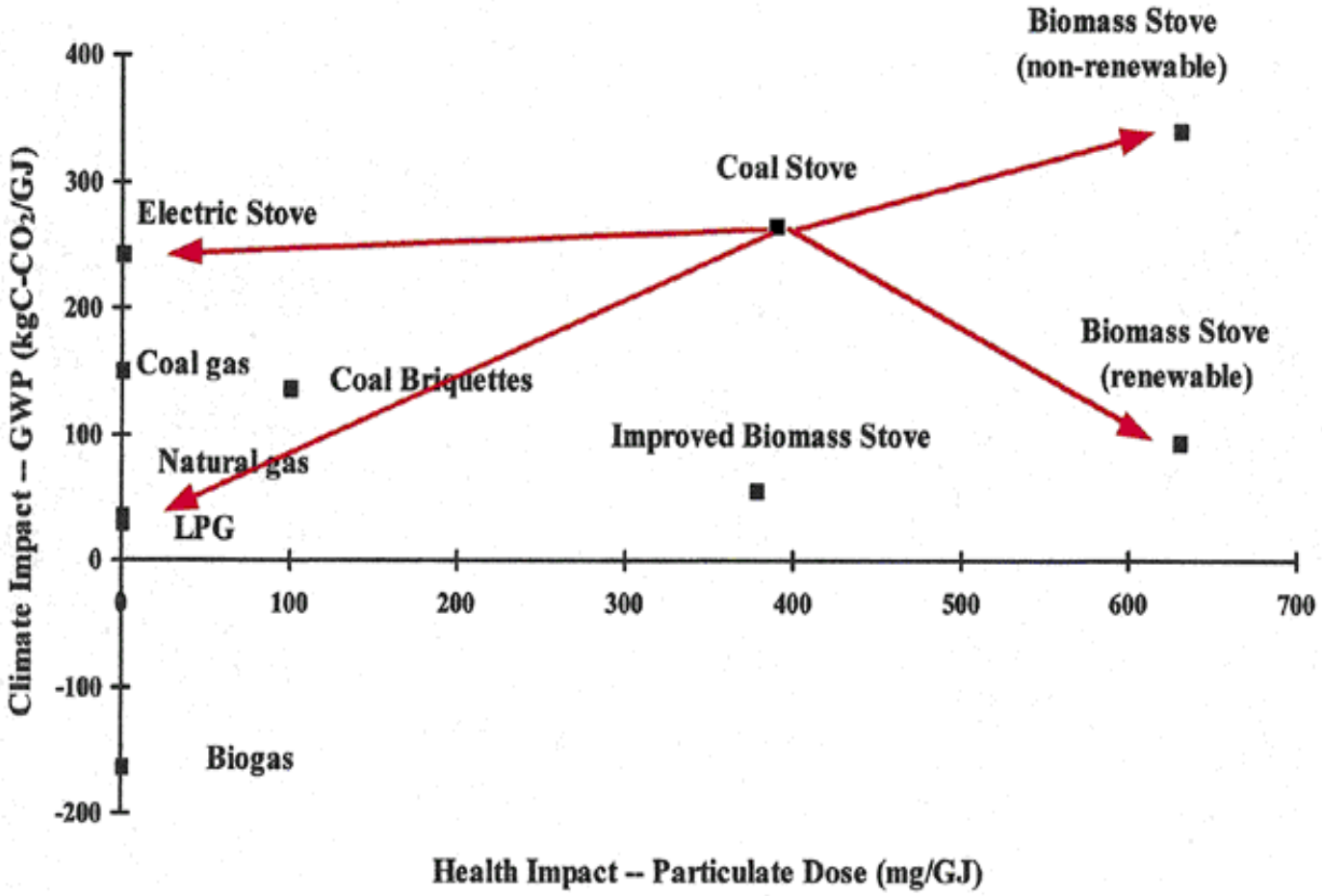
< 5	51 - 75
6 - 20	76 - 93
21 - 50	No Data

- ~half of world cooks with solid fuels
  - wood, coal, dung, crop residues, charcoal
- Women, young children

Map courtesy of Heather Adair-Rohani, 2010

Solutions

- Health impacts have substantial costs...interventions are cost effective
- Clean fuels
  - Most effective in reducing indoor air pollution
- Improved Stoves
  - Faster, cheaper, easier to implement in many regions
- Major opportunities for climate co-benefits ($)



The global warming potential (GWP: kg C as CO_2) and particulate dose (PD: mg) per unit energy (GJ) delivered for various household cooking options - for equivalence in energy service terms (i.e., cooking). Arrows indicate how shifts from coal stoves to other options change both types of emissions for the same energy service output.

Wang X and Smith KR. Secondary Benefits of Greenhouse Gas Control: Health Impacts in China Environ. Sci. Technol., 33 (18), 3056 -3061, 1999.

Improved Stove Interventions

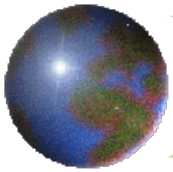
- China: 180 million stoves (1980-2000)
  - Decentralized program
  - Centralized stove production / local modifications
- India: 33 million stoves (1983-2000)
- Smaller programs
  - Africa: 5 million
  - Latin America

Improved Stove Interventions

- Some successful/some not
- Key factors:
  - participation of local women
  - social marketing
  - local design choices
  - financing (subsidies vs market economy)
- Residual emissions still high
- Sustainability
  - Repair/maintenance
- Outdoor air / global impacts

Co-benefits of interventions

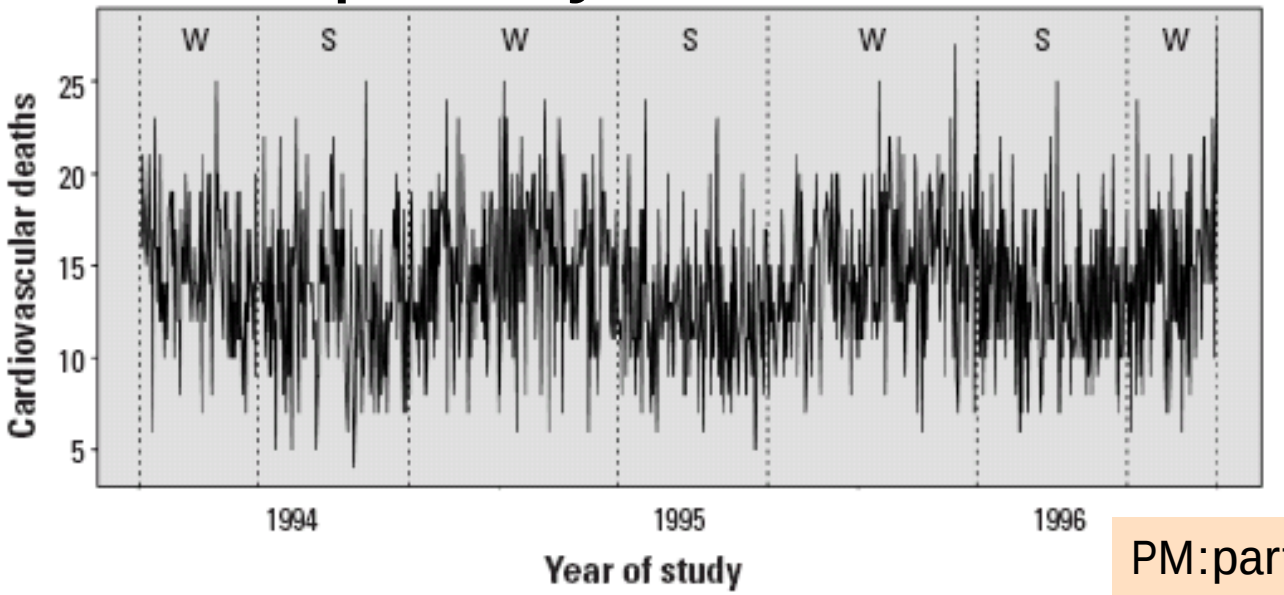
- Reduced Greenhouse Gas emissions
- Improved quality of life (simplifying household chores, better hygiene, easier cleaning)
- Reduced fuel demand, economic and time-saving benefits to the household
  - women spend ~12 hrs per week to gather biomass
- Increased sustainability of local natural resources



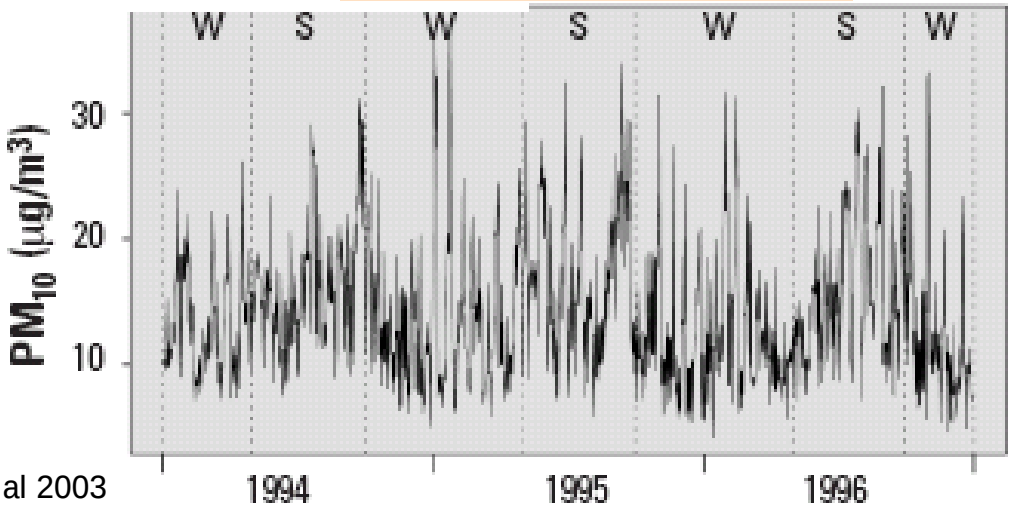
- Questions?

Outdoor (urban) air pollution

on days with worse air quality, more people die...especially from cardiovascular disease

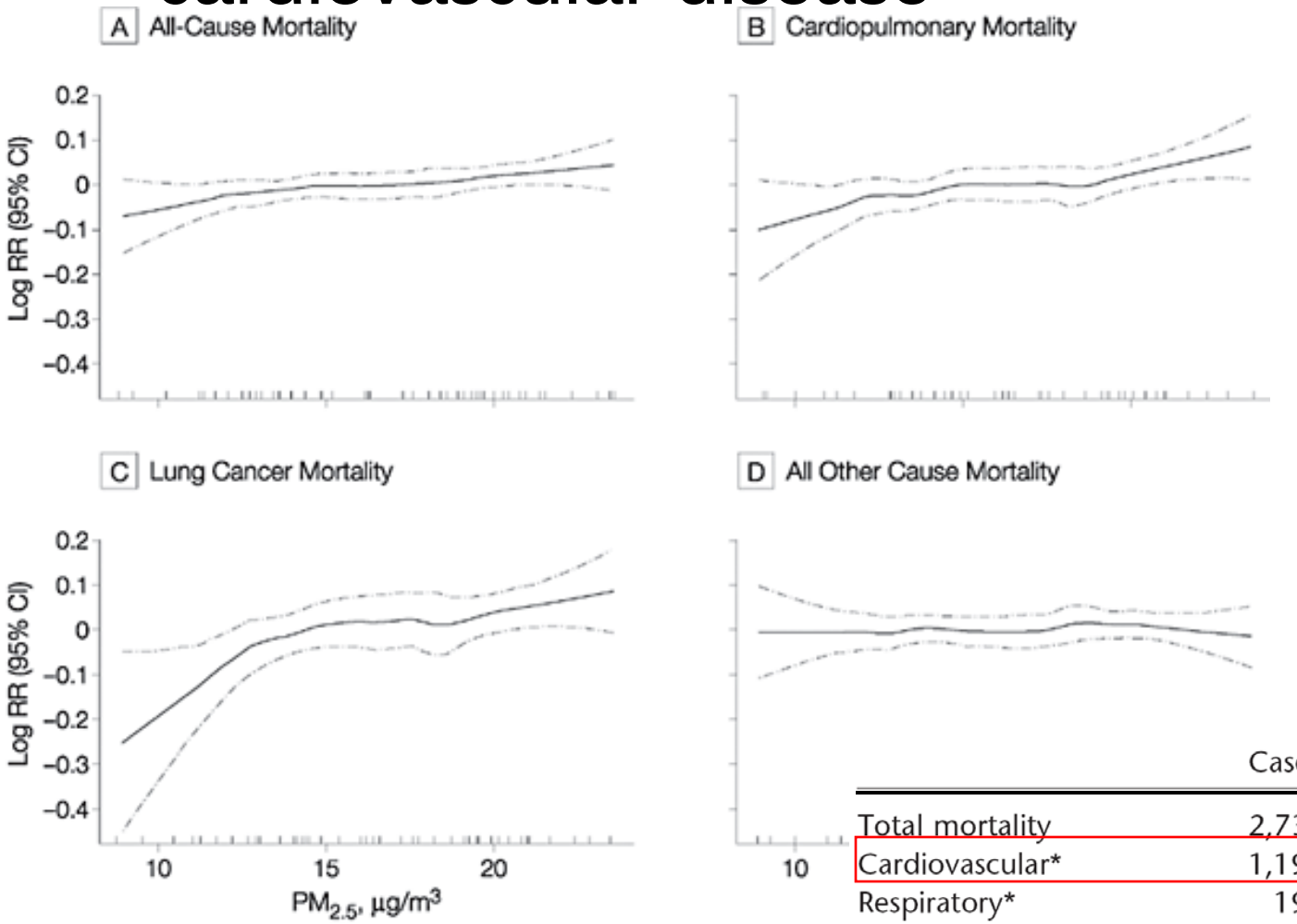


PM:particulate matter



Vedal et al 2003

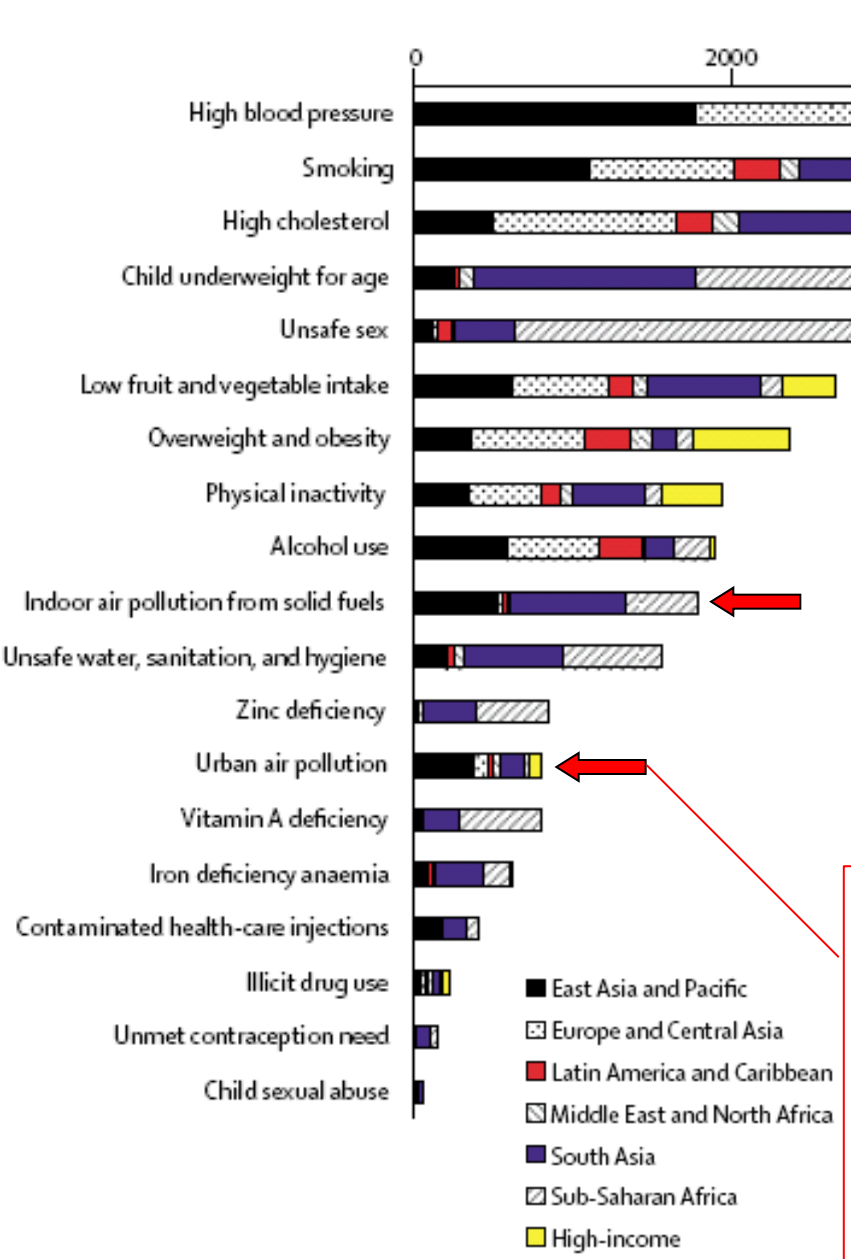
in more polluted cities, people die earlier than in less polluted cities...from cardiovascular disease

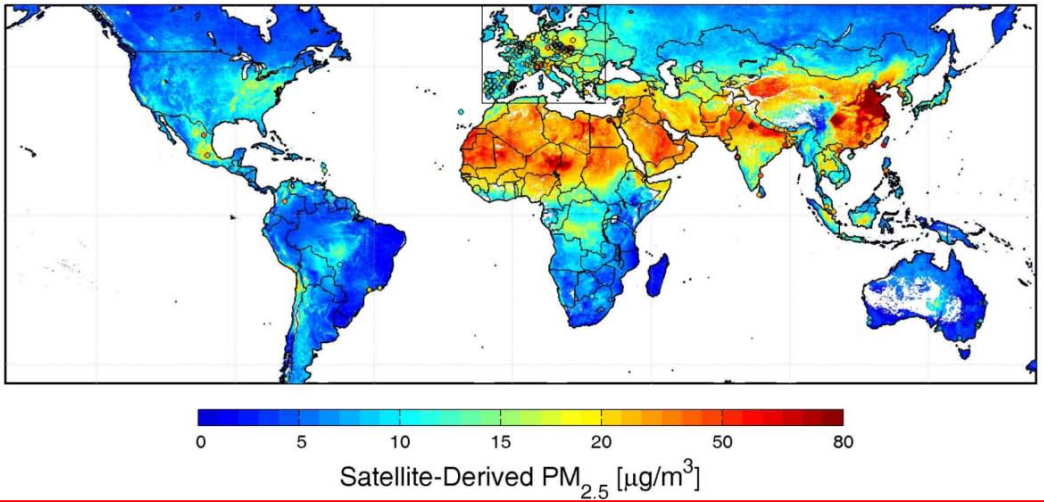


Pope et al, 2002

	Cases	Risk per 10 µg/m³ increase
Total mortality	2,732	1.16 (1.07–1.26)
Cardiovascular*	1,196	1.28 (1.13–1.44)
Respiratory*	195	1.08 (0.79–1.49)
Lung cancer*	226	1.27 (0.96–1.69)
Other	1,115	1.02 (0.90–1.17)

Laden et al., 2006



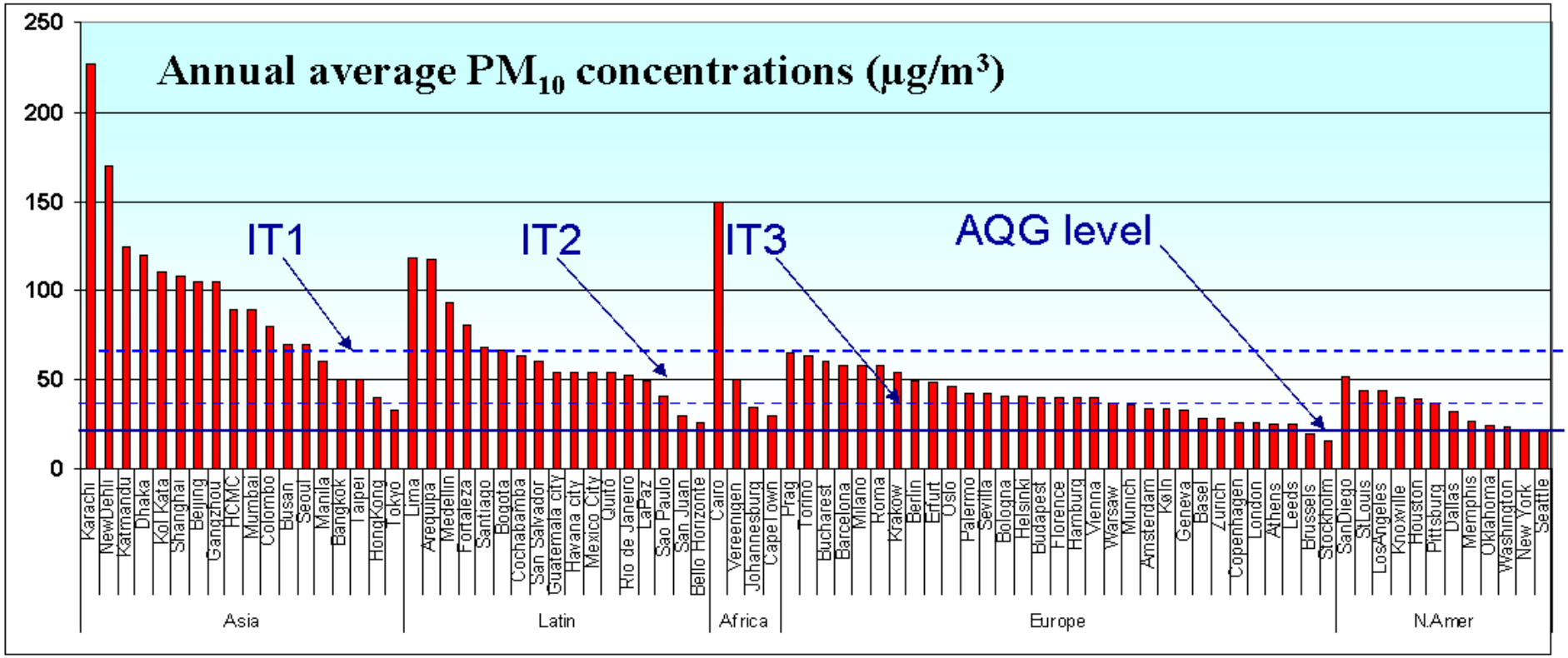


- Urban (2002) outdoor air pollution
  - 800,000 deaths
  - 6.4 million lost life-years*
- 2/3 in rapidly urbanizing **Asia**

***adult cardiopulmonary mortality, lung cancer** (not including childhood ARI, birth outcomes)

Lopez et al, Lancet, 2006; van Donkelaar et al, 2010

Global Air Quality and WHO Guidelines



Delhi (8): 17M

Shanghai (16): 14M

Seoul (3): 20M

Tokyo (1): 34M

Mex (6): 18M

Cairo (11): 16M

LA (12): 15M

NYC (2): 20M

Source: Michal Krzyzanowski (WHO), 2006; Demographia Urban Areas Database, 2007

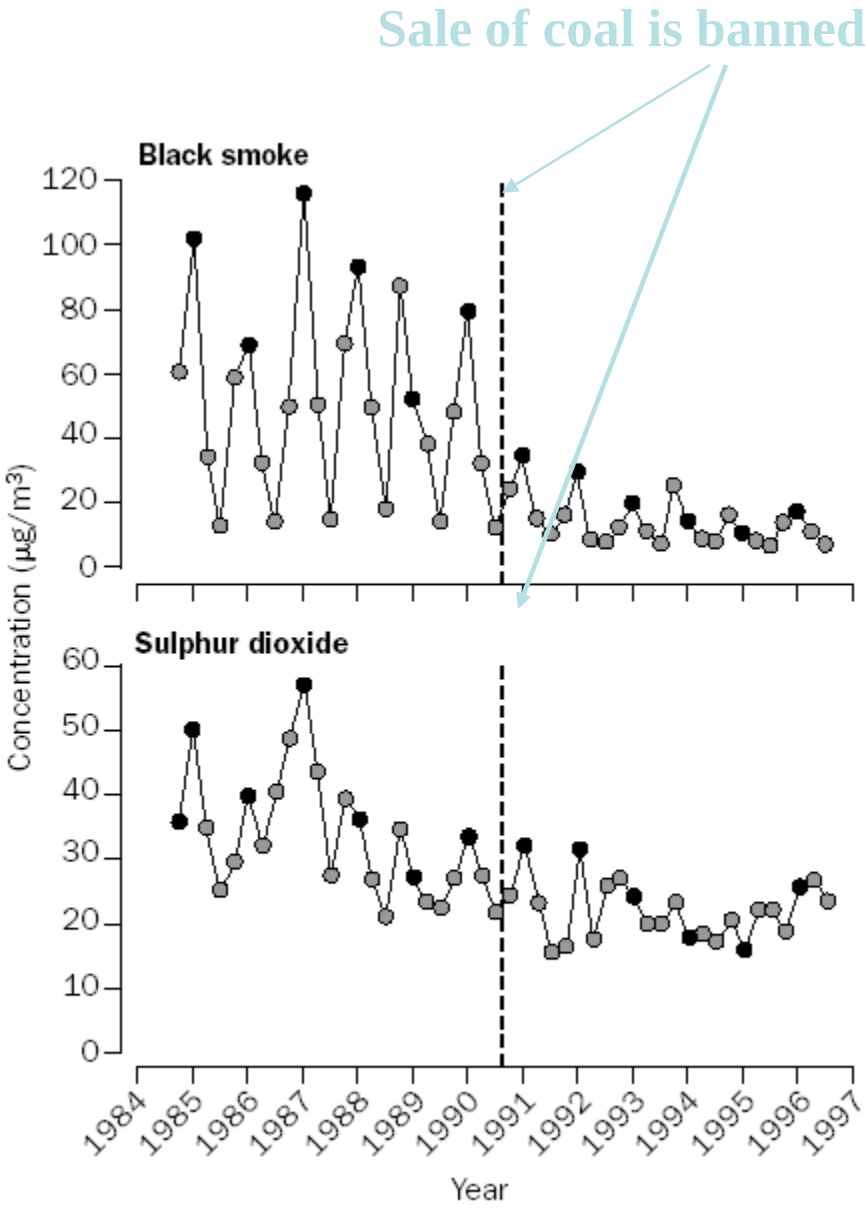
Solutions: Early air quality management

- Emission reductions
- Tall stacks
- Smoke control
- Centralized heating
- Zoning / **move sources**

Dublin, Ireland

False Creek, Vancouver, in 1939 (noon)

2010 annual average $PM_{2.5}$ = 6 µg/m³



Effect of Air-Pollution Control on Death Rates in Dublin, Ireland

5.7 % decrease in total non-trauma deaths

15.5% decrease in respiratory deaths

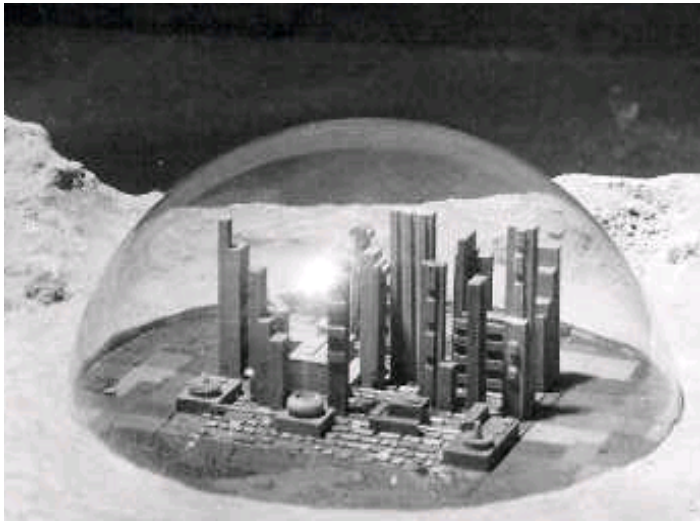
10.3% decrease in cardiovascular deaths

controlling for temperature, humidity, day of week, respiratory epidemics, death rates in the rest of Ireland

Clancy L, Goodman P, Sinclair H, Dockery D. Effect of air-pollution control on death rates in Dublin, Ireland: an intervention study. *Lancet* 2002; 360: 1210–14

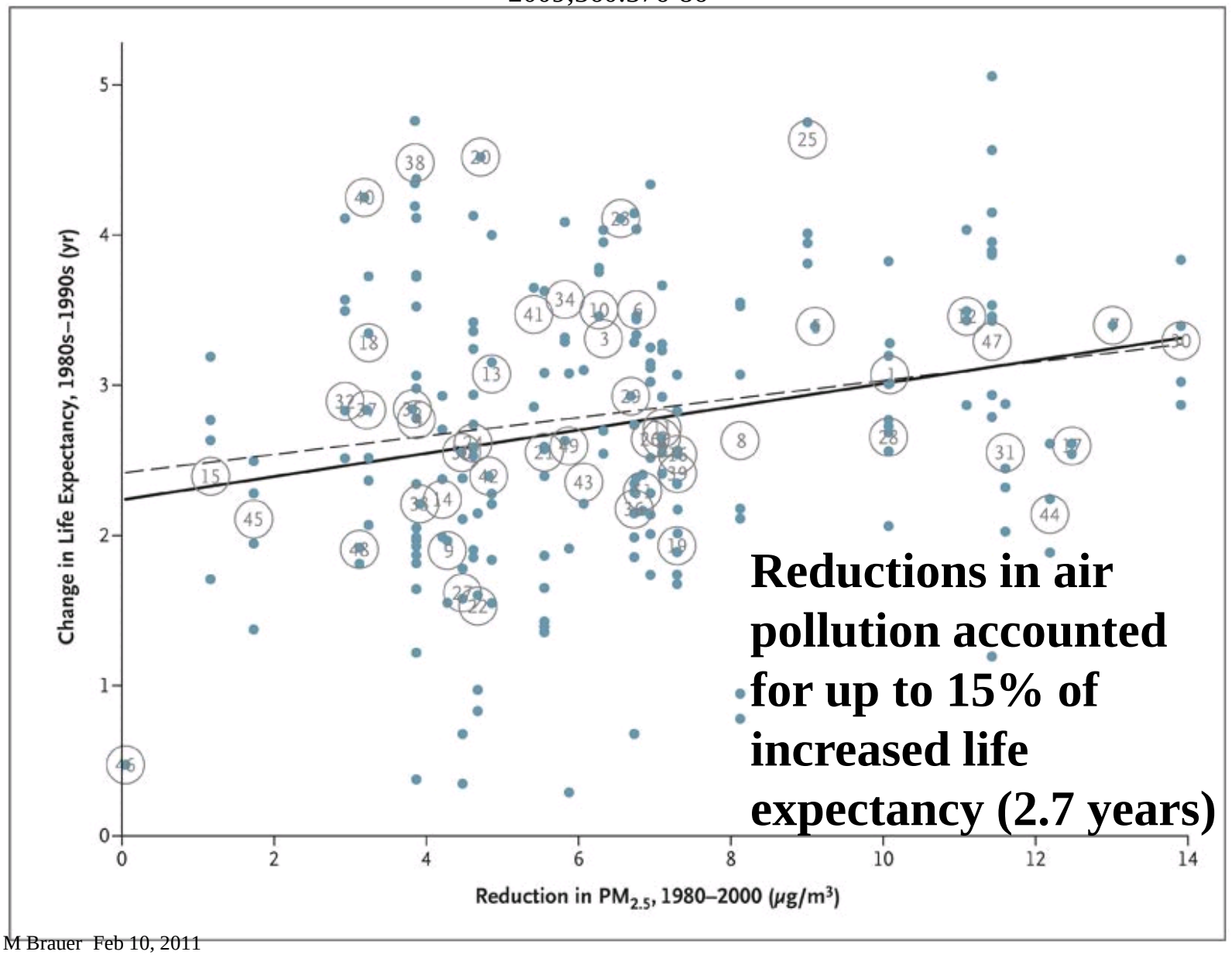
"Modern" air quality management (1980s-1990s)

- Urban airshed approach: emphasis on overall emissions reductions
  - Little attention to land use
  - Regional air quality
  - Ozone, Acid rain
- Focus on motor vehicles as a proportion of total emissions
  - Engine technology
    - Catalytic converters, fuel injection
    - Inspection and maintenance programs
    - Fuel quality
- Point source emissions controls
    - Scrubbers, catalysts, improved efficiency

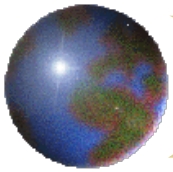


The NEW ENGLAND JOURNAL of MEDICINE

Fine-Particulate Air Pollution and Life Expectancy in the United States. *Arden Pope, III, Ph.D., Majid Ezzati, Ph.D., and Douglas W. Dockery, Sc.D* N Engl J Med 2009;360:376-86

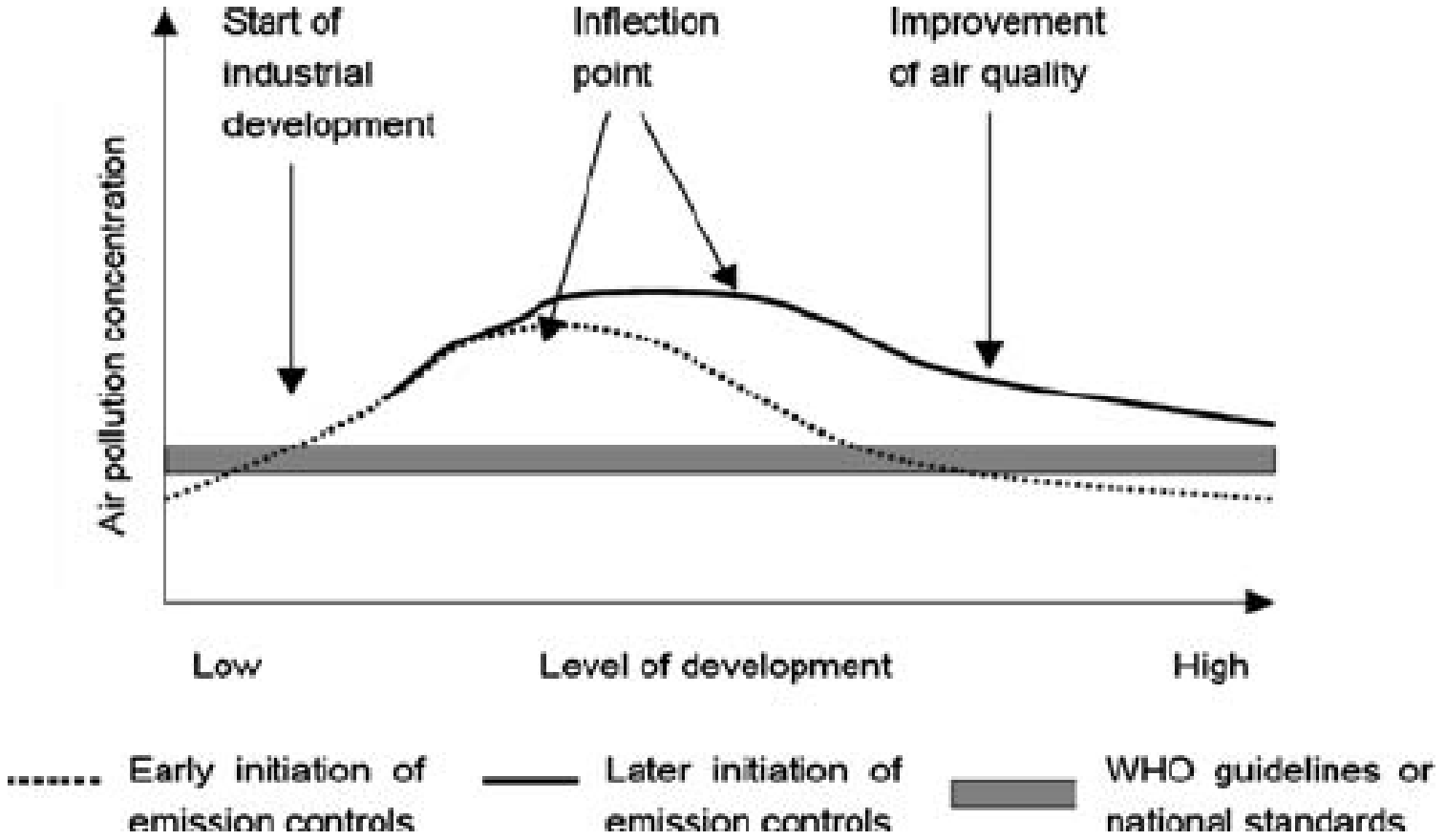


Reductions in air pollution accounted for up to 15% of increased life expectancy (2.7 years)

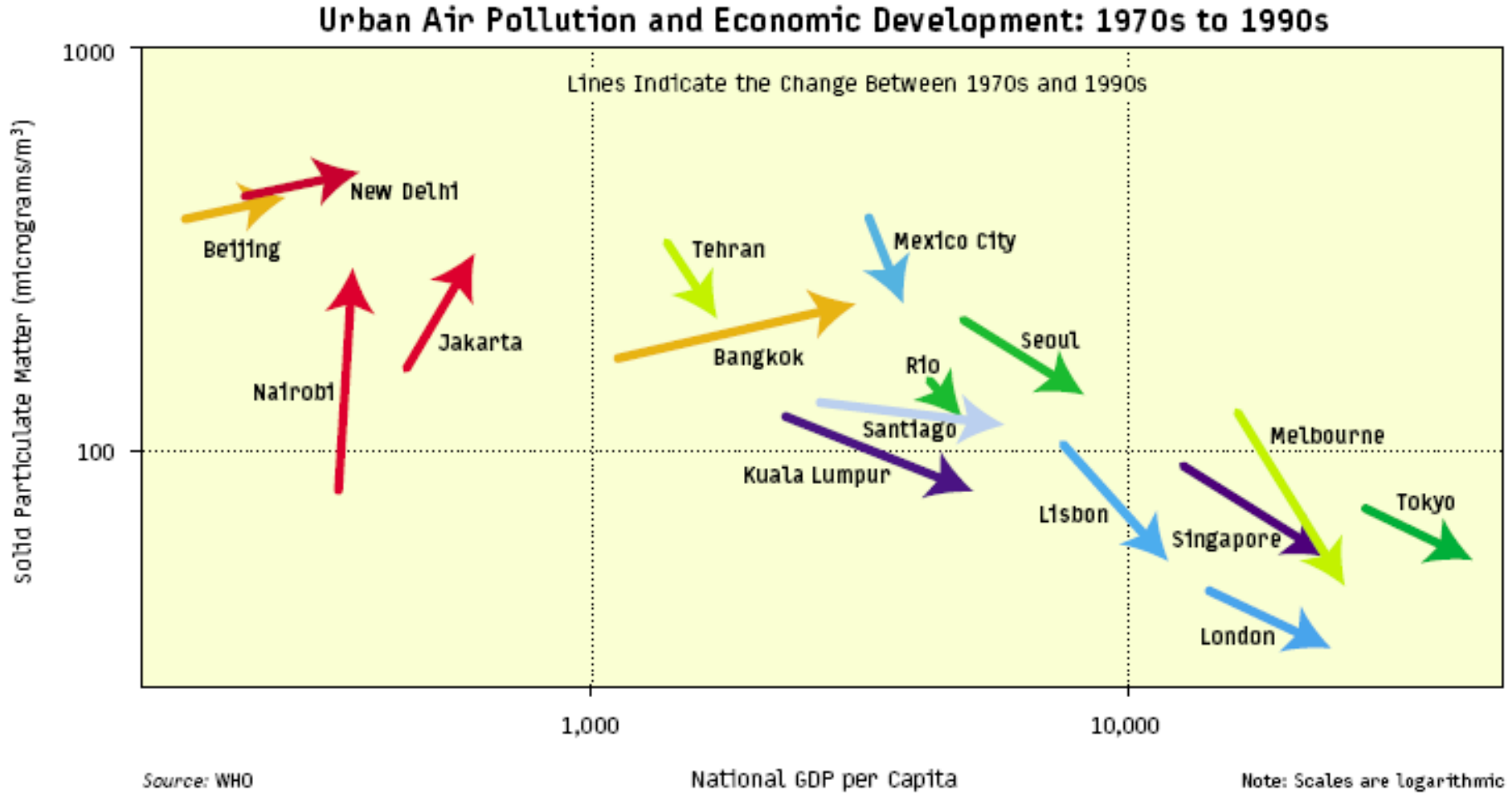


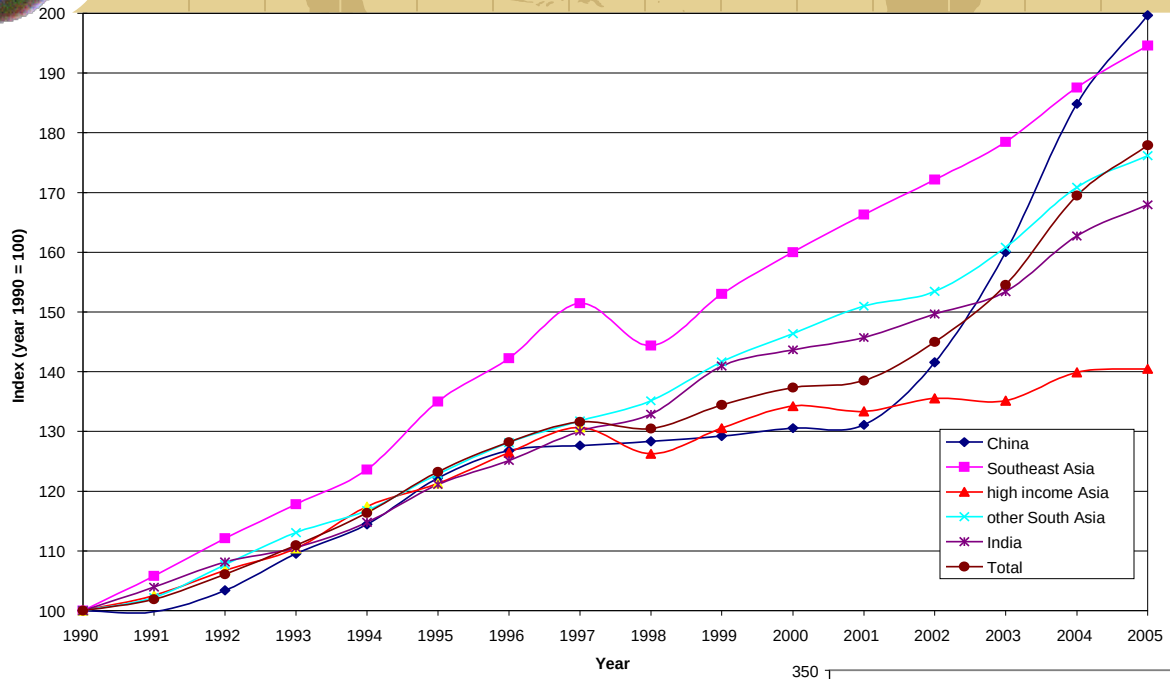
- Questions?

Environmental Kuznets Curve: Urban Air Pollution and Development



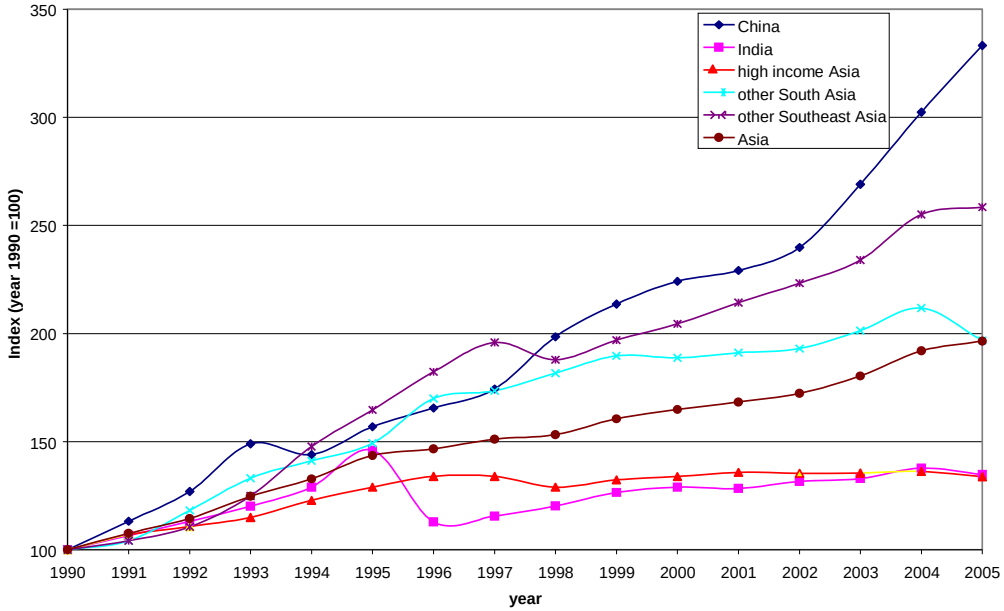
Air quality and development



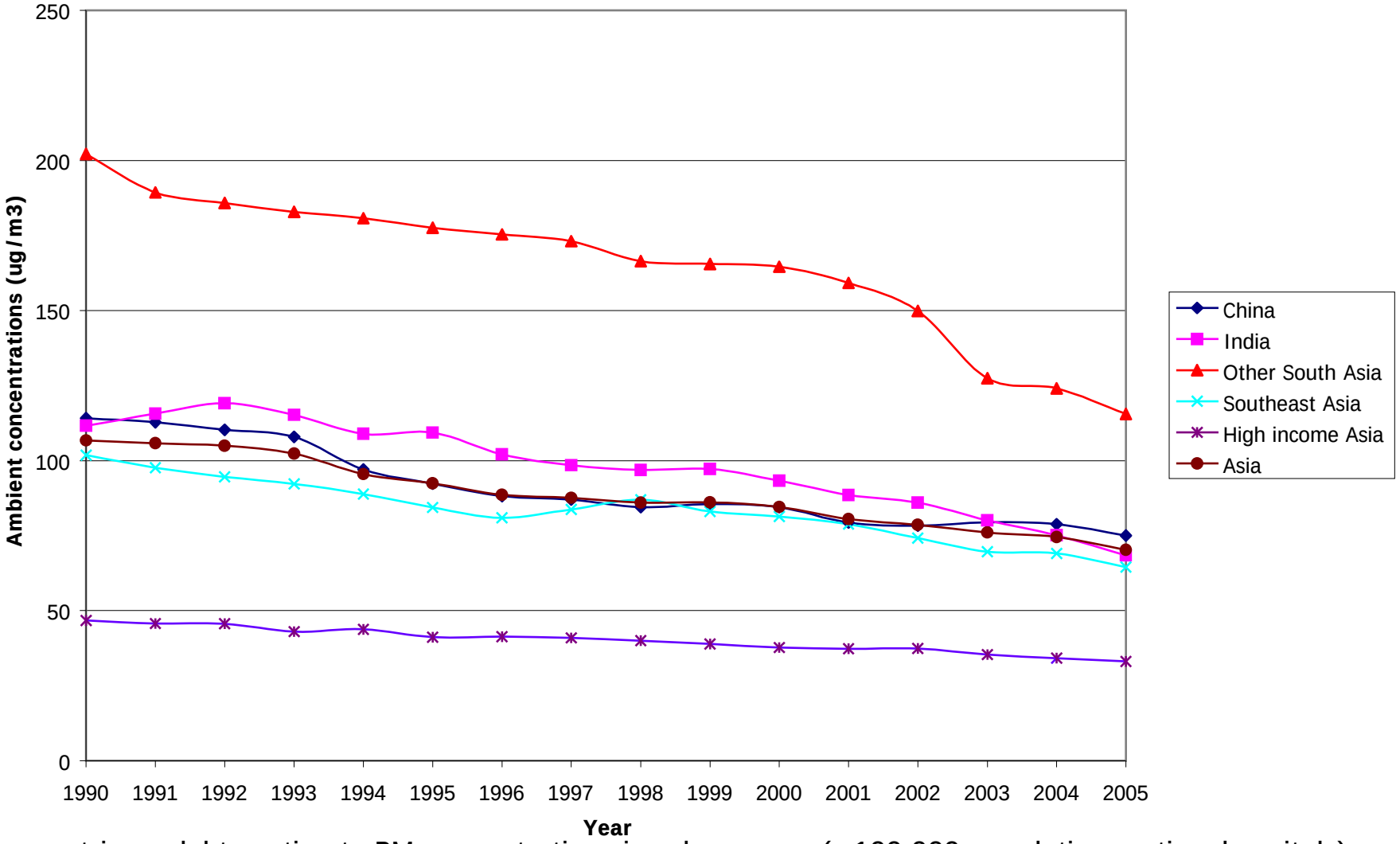


Trends in primary energy Consumption (1990-2005)

Trends in transportation fuel consumption (1990-2005)



Trends in urban ambient PM_{10} in Asia (1990-2005, GMAP model)*

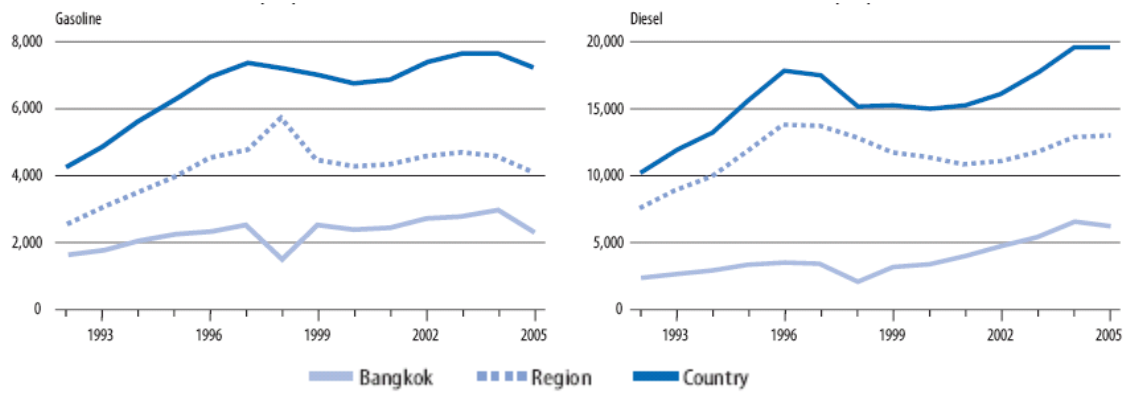


*Econometric model to estimate PM concentrations in urban areas (>100,000 population, national capitols)

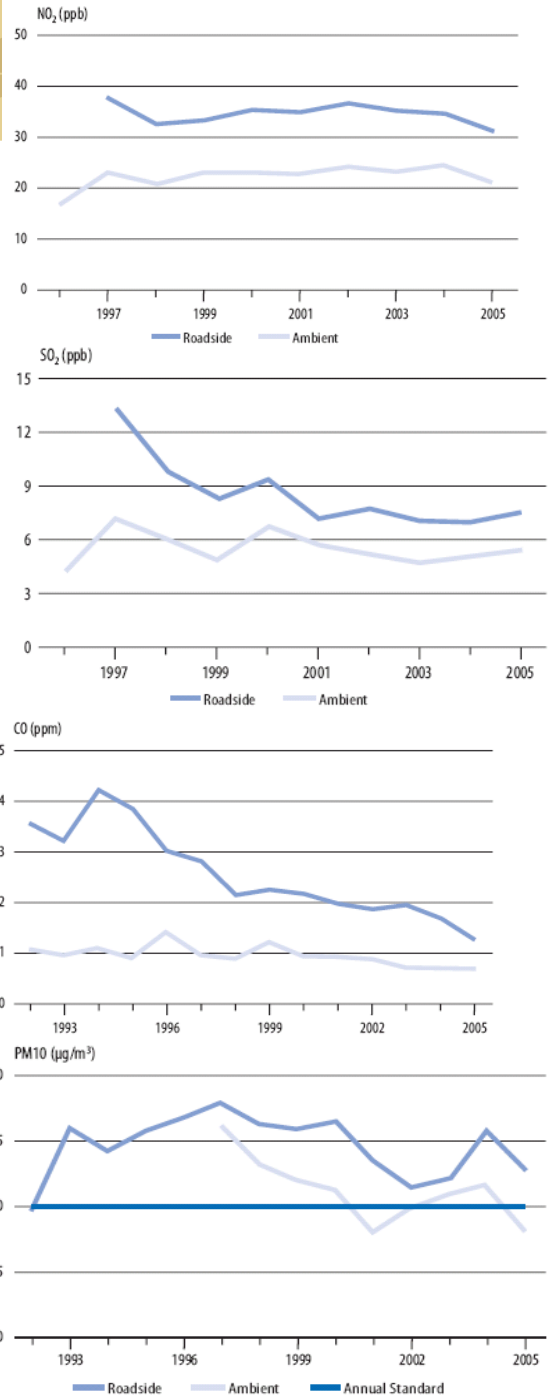
(roadside) Air Quality

Bangkok

Fuel consumption

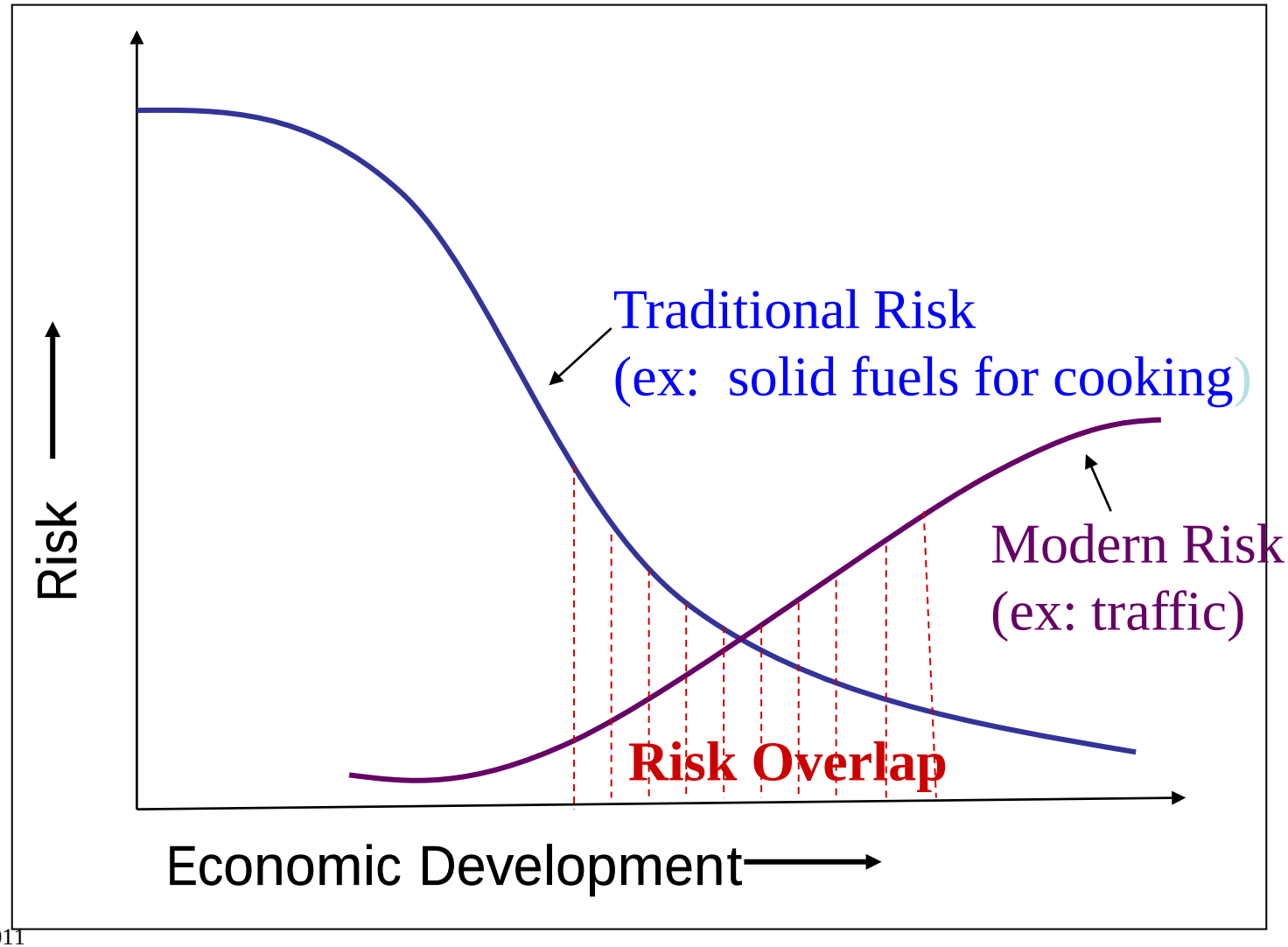


- 1993: catalytic converters
- shift from 2-stroke to 4-stroke engines
- Roadside inspections
- Vehicle inspection and maintenance program
- 1996: Removal of lead from gasoline
- 1996: Reduction of diesel (and fuel oil) sulfur
- 2003: CNG for transport sector

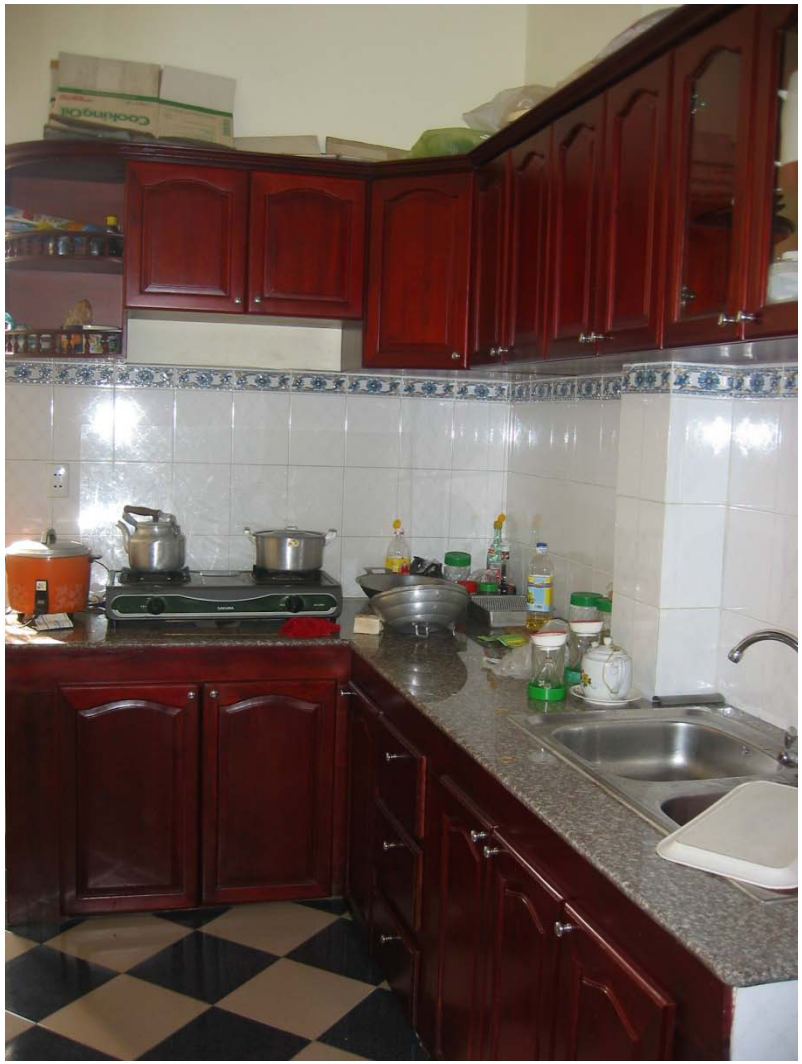


Source: CAI Asia

Environmental Risk Transition



Ho Chi Minh City, 2006



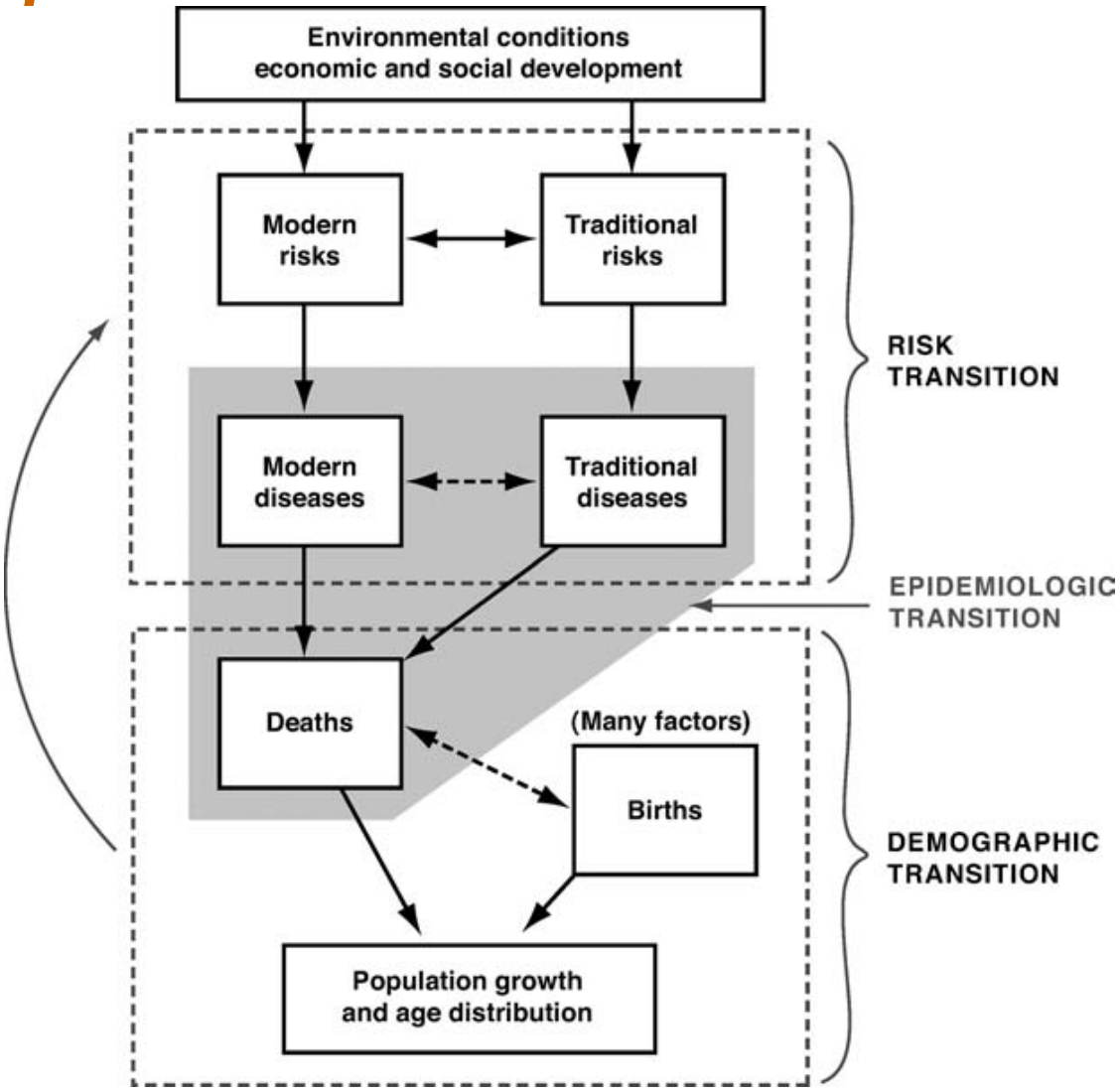
LOW SES; higher and more variable exposures

Delhi, 2010: Photos courtesy of Andy Grieshop, UBC; Joshua Apte, UC-Berkeley

Accra, 2010: Photos courtesy of Kathie Dionisio, Harvard University

Importance of SES; neighborhood (biomass) sources ~ traffic

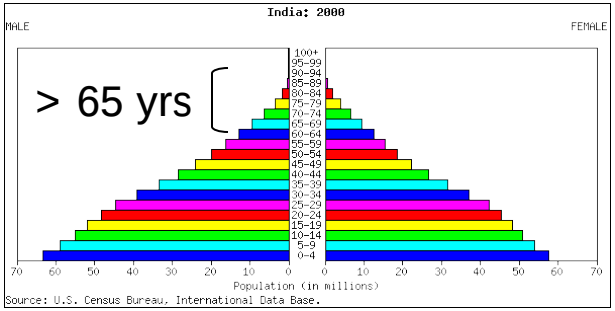
Development Transitions



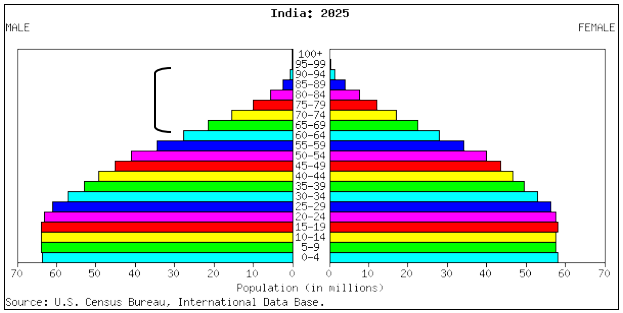
Source: Smith and Ezzati 2005

Demographic transition

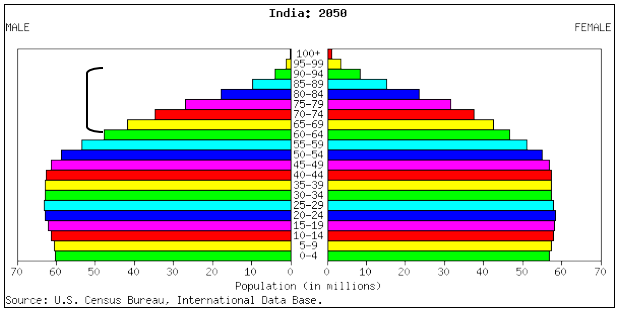
India 2000



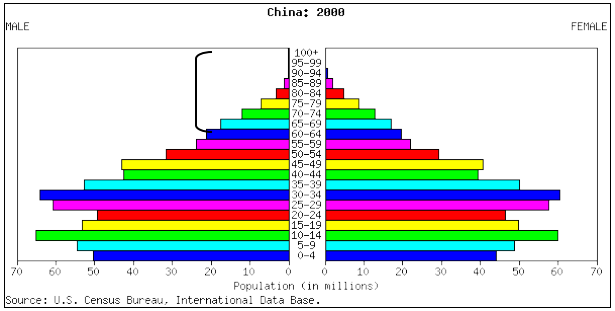
2025



2050



China 2000



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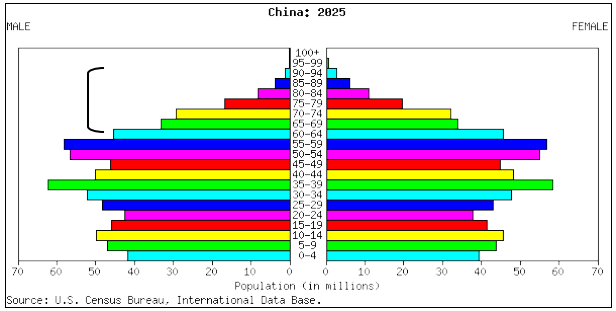

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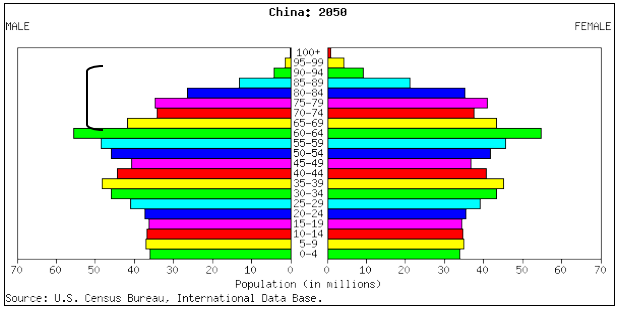
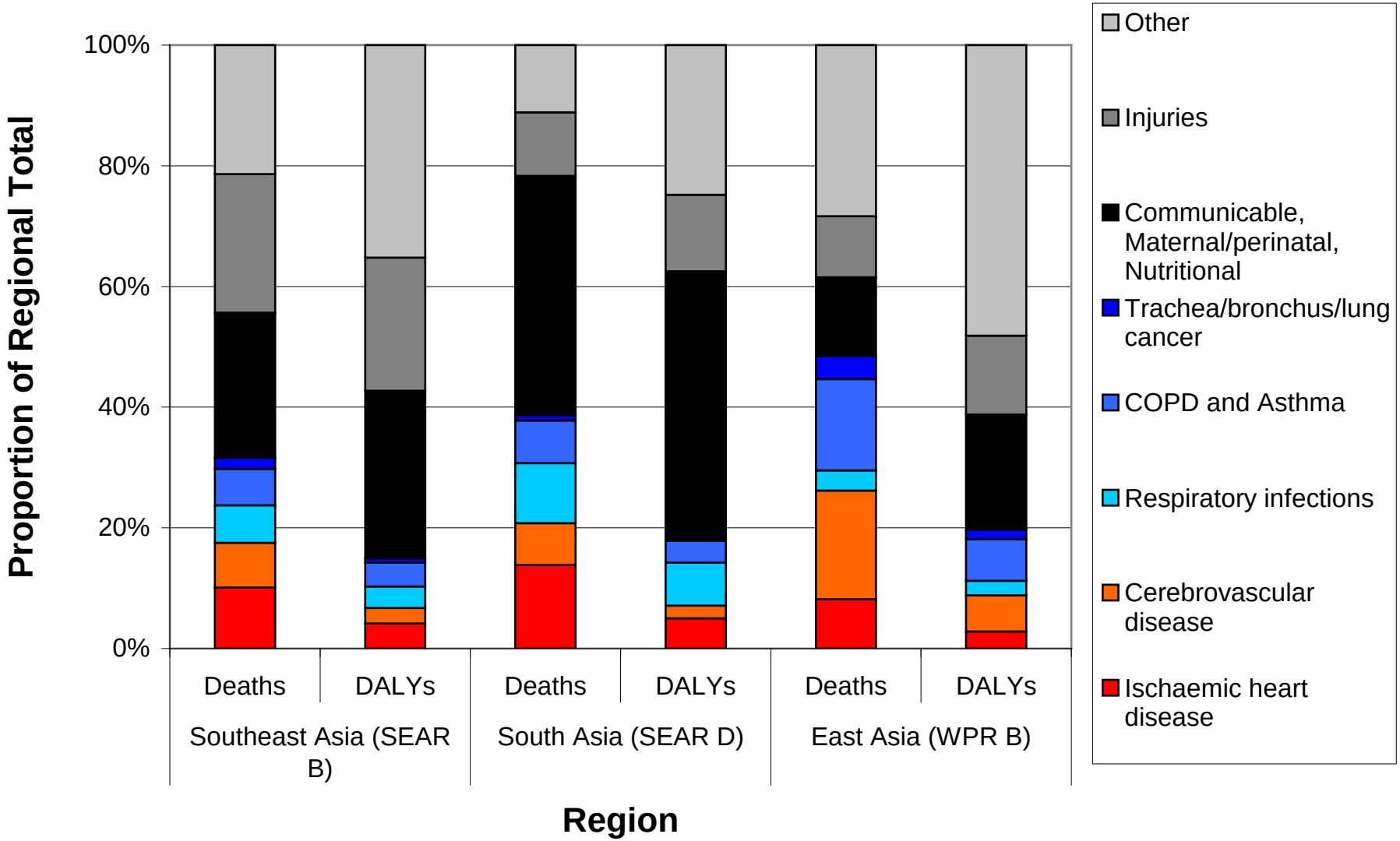


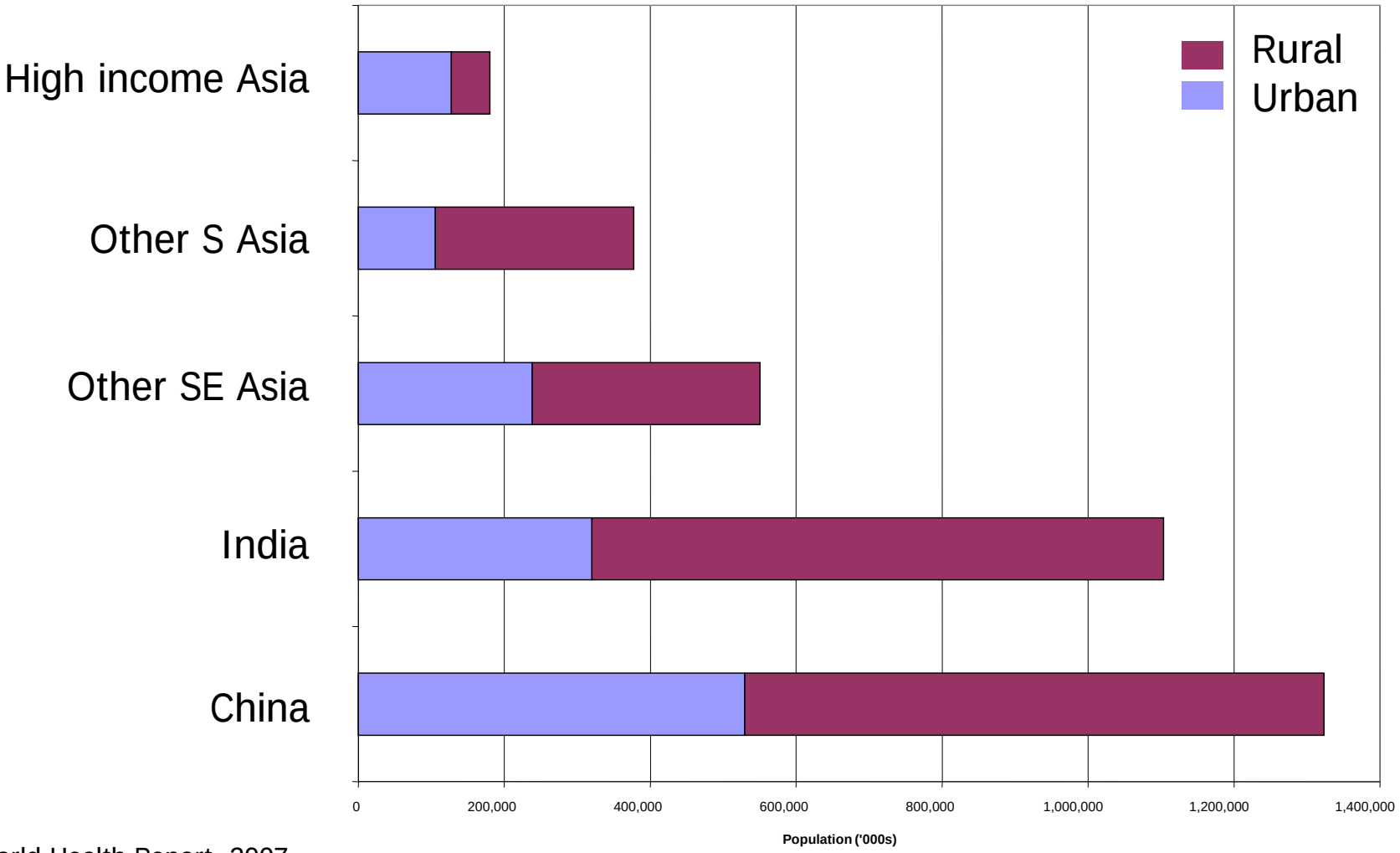
Asian Deaths and Disability-Adjusted Life Years (DALYs), 2004



Source: WHO 2008

M Brauer Feb 10, 2011

Urbanization opportunities and challenges



Source: World Health Report, 2007

Take home messages

- Air pollution has substantial impacts on global health
  - Household
    - partial progress...GHG emissions as significant driver?
  - Outdoor air
    - With development, increasing size of susceptible, potentially exposed population
    - Impacts likely to increase even if concentrations decrease

- Complex exposures as development progresses
- Given widespread exposures, interventions can be very (cost) effective
- Quantifying causes and risk factors to set priorities (targets move w/development)