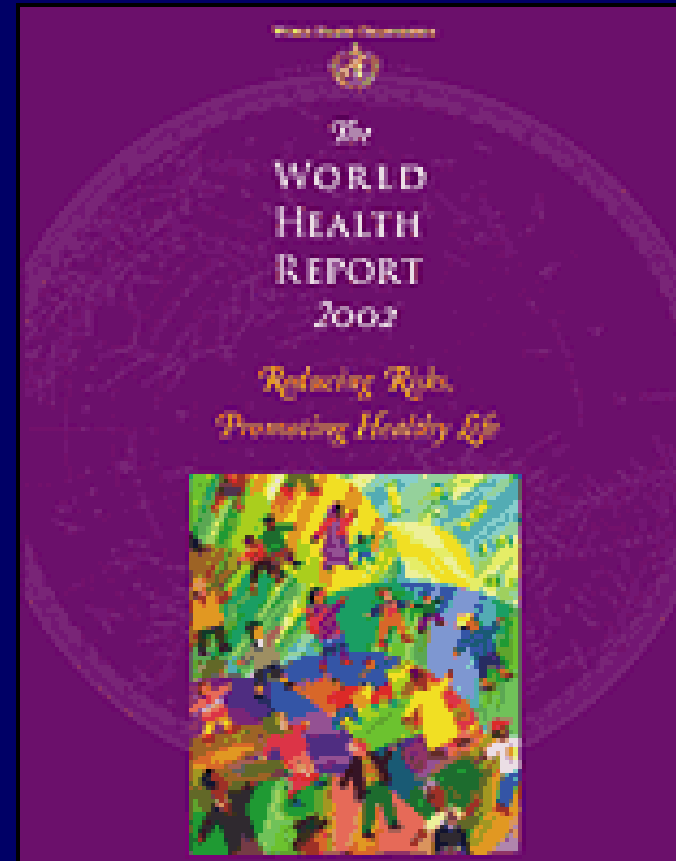
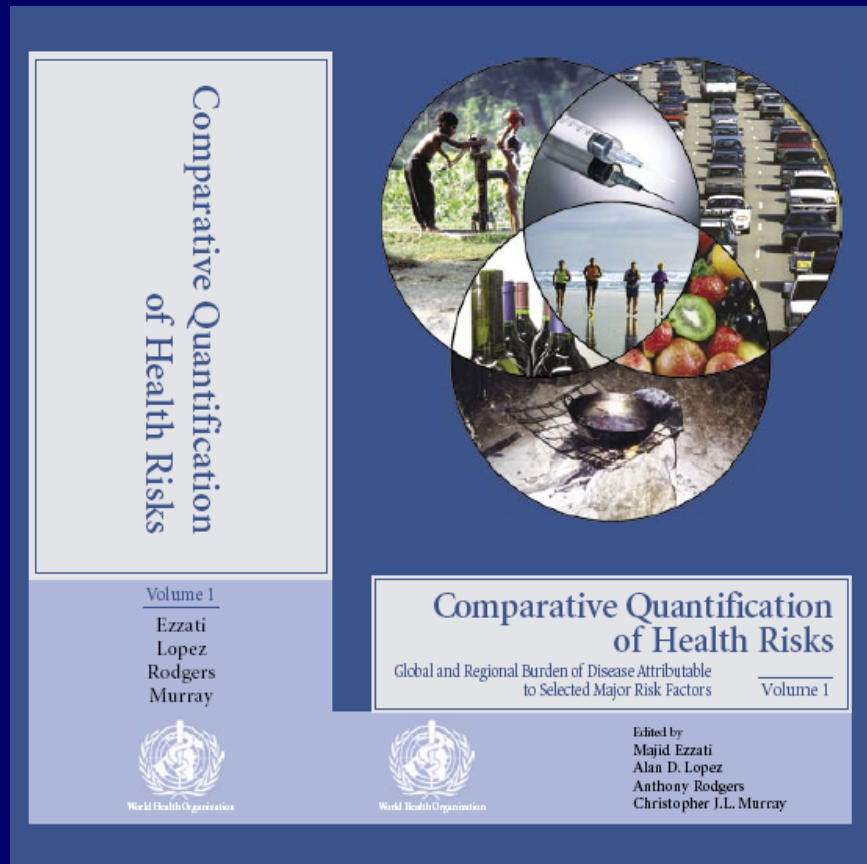


The Global Burden of Disease Due to Urban Air Pollution: Estimates and Uncertainties

Aaron Cohen
Health Effects Institute

CRA project and WHR 2002



www.who.int/whr
www.thelancet.com

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California Health Dept

World Bank

Brigham Young

PAHO

Johns Hopkins

UC Berkeley

The Global Burden of Disease Due to Urban Air Pollution: Estimates and Uncertainties

- **The Global Burden of Disease Comparative Risk Assessment**
- **Estimating the Global Burden of Disease Due to Urban Air Pollution**
- **Magnitude and distribution of the attributable burden**
- **Major sources of uncertainty**
- **Estimating the avoidable burden**

Risk factors in CRA

Child & maternal under-nutrition

Childhood and maternal underweight
Iron deficiency
Vitamin A deficiency
Zinc deficiency

Other nutrition-related risks & inactivity

High blood pressure
High cholesterol
Overweight and obesity
Inadequate fruit and vegetable intake
Physical inactivity

Addictive substances

Smoking and oral tobacco
Alcohol
Illicit drugs

Sexual and reproductive health risks

Unsafe sex
Non-use and ineffective use of contraception

Environmental risks

Unsafe water, sanitation, and hygiene
Urban air pollution
Indoor smoke from solid fuels
Lead exposure
Climate change

Occupational risks

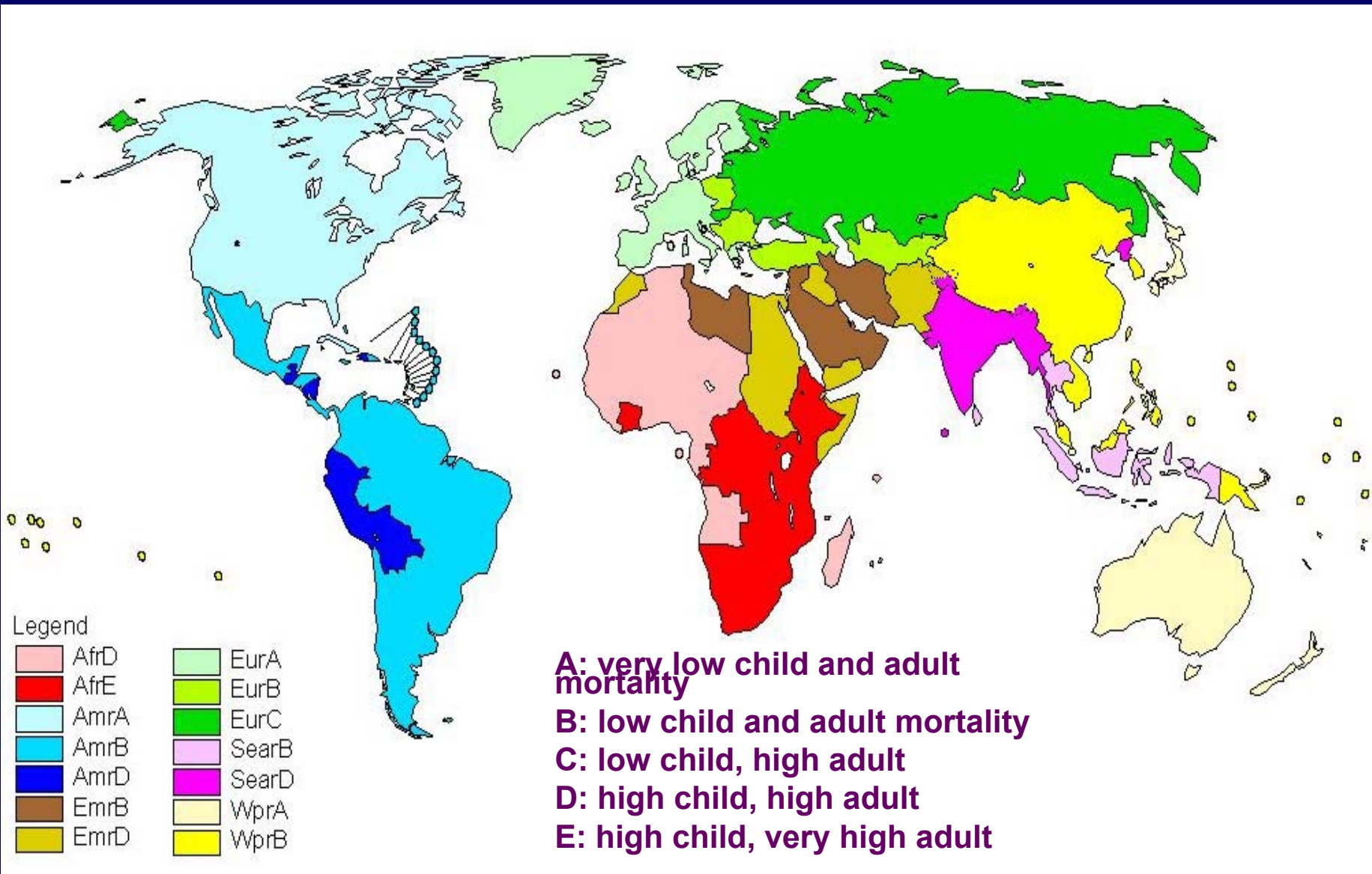
Risk factors for injury
Carcinogens
Airborne particulates
Ergonomic stressors
Noise

Other selected risks to health

Contaminated health care injections
Child sexual abuse

Distributions of risks by poverty

14 WHO mortality sub-regions



Basic CRA framework and goals

Risk factor levels

- current distribution
- counterfactual distribution(s)

Risk factor-disease relationships

- risk accumulation
- risk reversal

Disease burden

Attributable burden in 2000
Avoidable burden in 2010 & 2020

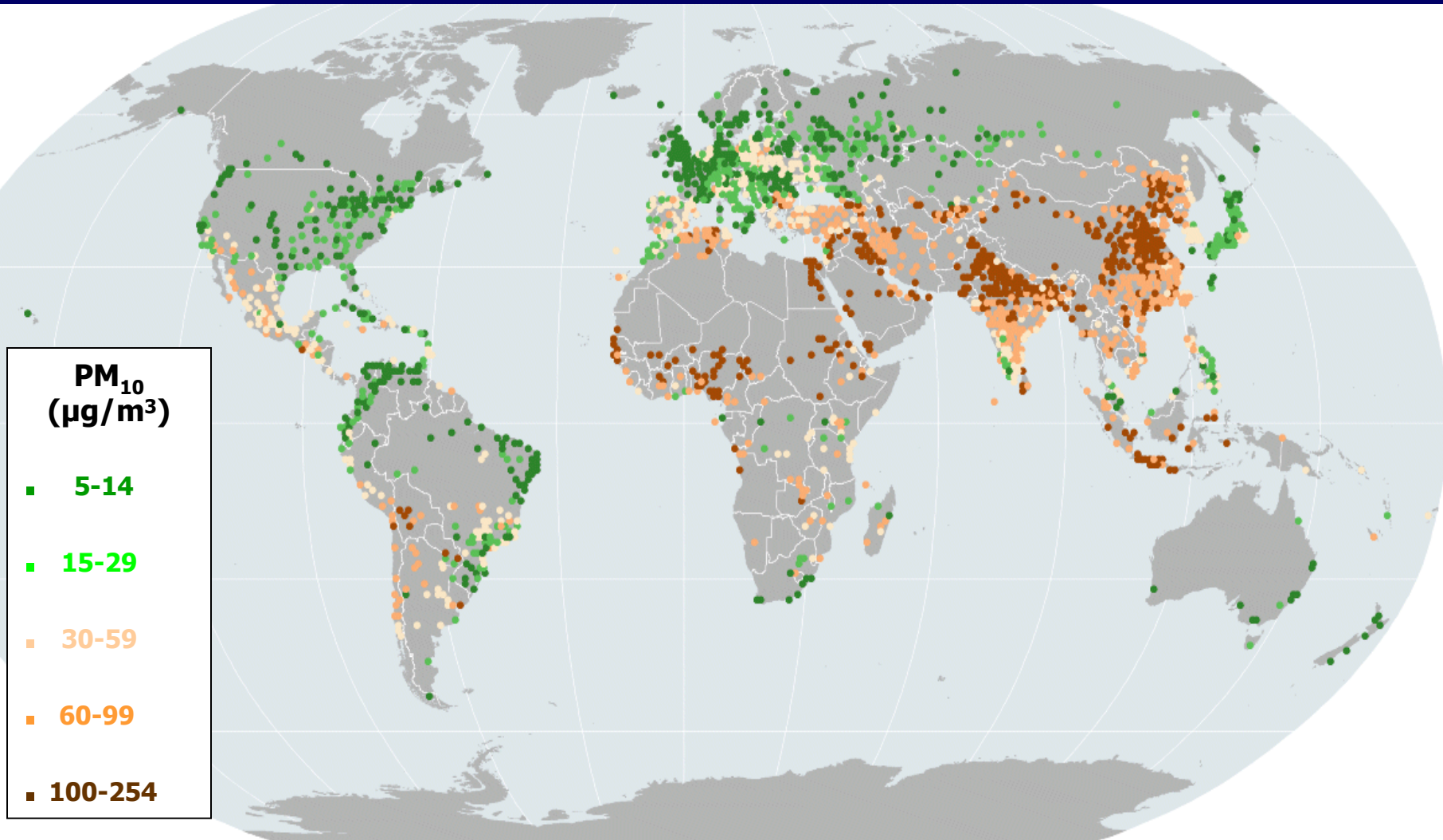
Mortality and Burden of Disease

- **Mortality = Numbers of Deaths**
- **Burden = Disability Adjusted Life Year *or* DALY**
- **DALY = YLL + YLD**
 - *years of life lost because of premature death (YLLs)*
 - *years of life lived with disability (YLDs)*
 - **one DALY = one lost year of healthy life**

Applying the CRA Methods to Urban Air Pollution

- **Choice of indicator pollutant and estimation of ambient concentrations**
- **Choice of risk factor-disease relationships**
- **Calculation of disease burden**

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



American Cancer Society II Cohort

500,000 adults followed 1982 – 1998

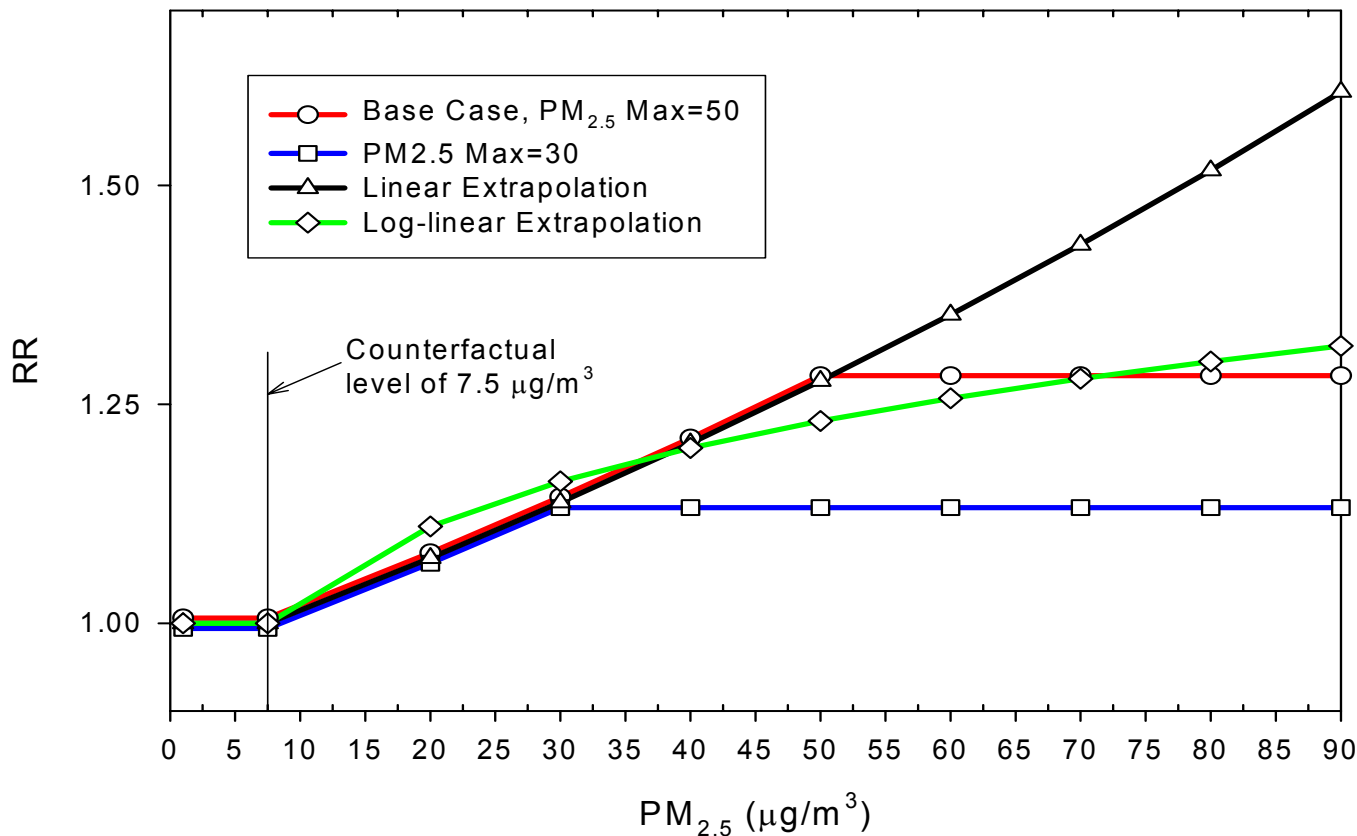
(Pope et al JAMA 2002)

RR per 10μg/m³ PM_{2.5} 1979-83		
	RR	95% CI
Cardiopulmonary	1.06	1.02-1.10
Lung Cancer	1.08	1.01-1.16

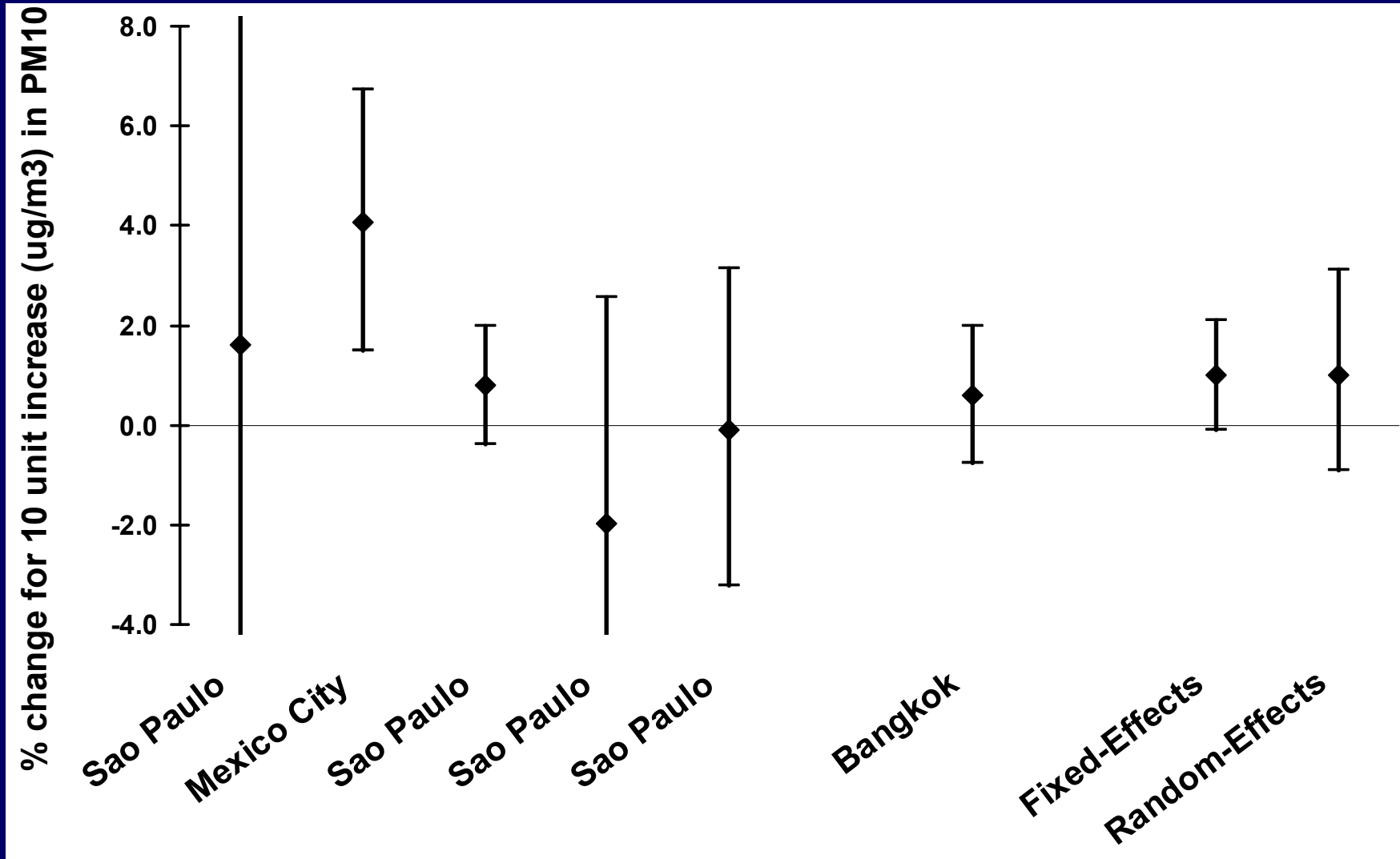
Random effects Cox proportional hazards model controlling for age, sex, race, smoking, education, marital status, body mass, alcohol, occupational exposure and diet

Alternative Scenarios for Burden of Disease Estimation for Urban Air Pollution

Alternative concentration-response curves for cardiopulmonary deaths



Percent change in mean daily number of child and infant deaths



Estimation of attributable deaths and DALYs

1. Calculate region specific relative risk

$$RR_{2.5} = \exp [CR * (X - 7.5)]$$

where CR is slope of the C-R function (β coefficient) and X is regional population weighted mean PM.

2. Calculate Attributable Fraction (AF)

$$AF = P(RR-1) / [P(RR-1)+1]$$

where P is proportion exposed, i.e. proportion living in cities

3. Calculate attributable deaths and DALYs

(AF * regional totals)

Estimated Burden of Urban Air Pollution Worldwide

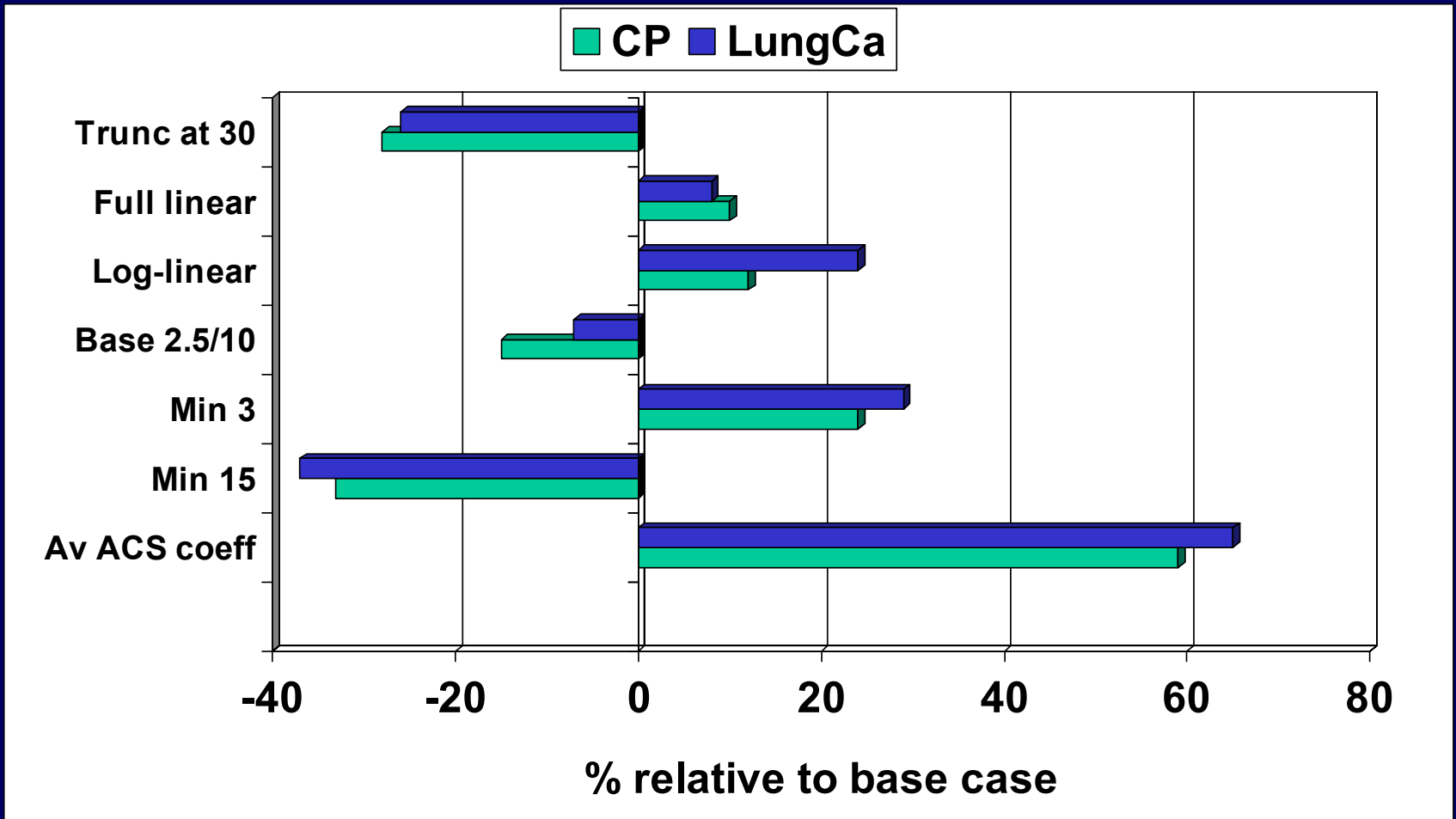
(95% confidence intervals)

	AF (%)	Deaths (thousands)	YLL (thousands)
CPD	4 (1, 6)	712 (245, 1107)	4,666 (1,695, 7700)
Lung Ca	5 (1, 9)	62 (10, 114)	572 (92, 1,063)
ARI (< 5yr.)	1 (-1, 3)	26 (-24, 66)	862 (-799, 2,228)
All-cause (from time-series studies)	1 (NA)	378 (NA)	(NA)

Excess Deaths from Selected Environmental Factors

Environmental Risks	Global Estimate	Asian Estimate (S ,SE Asia + W Pacific)	Asia as a percent of Global
Unsafe Water	1,730,000	730,000	42%
Urban Outdoor Air	799,000	487,000	65%
Indoor Air	1,619,000	1,025,000	63%
Lead	234,000	88,000	37%

Sensitivity of Attributable Mortality Estimates



Uncertainties that we did not quantify

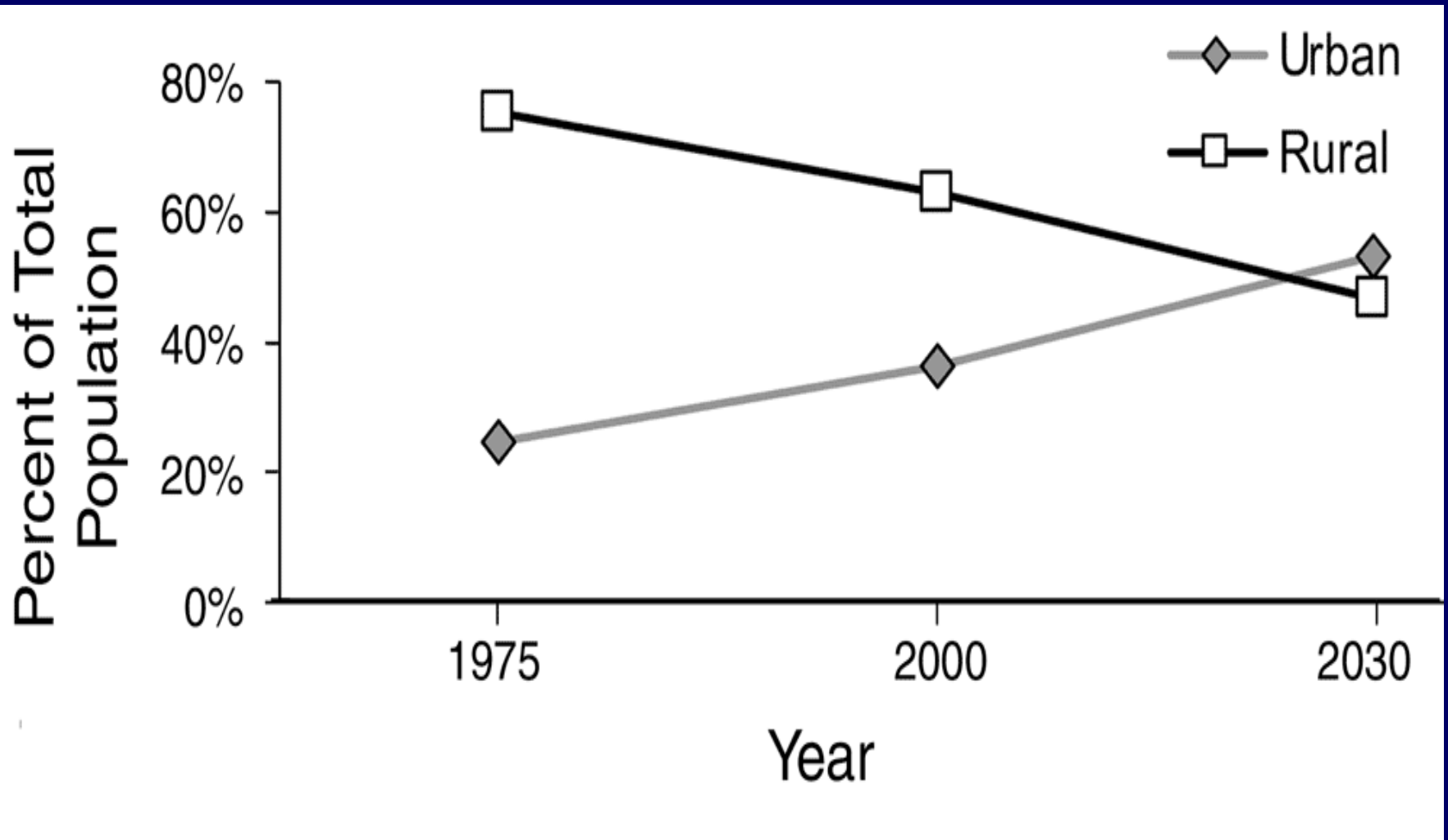
- **Burden due to pollutants other than PM, e.g., ozone**
- **Effects of exposure at finer spatial scales e.g., due to proximity to vehicular traffic**
- **Relative toxicity of PM from different sources**
- **Burden in cities with populations <100 K and rural areas**
- **Contribution of other potentially important health outcomes, e.g., LBW, infectious disease**

What will determine the attributable and avoidable burden in the future?

- ✓ **Number of people in cities**
- ✓ **Sources of air pollution**
- ✓ **Emissions**
- ✓ **Air quality**
- ✓ **Susceptibility**

An Increasingly Urban Population

(data from UN/UN Centre for Human Settlements 1995-2002)



UK SO₂ Emissions and Electricity Generation 1970-1995

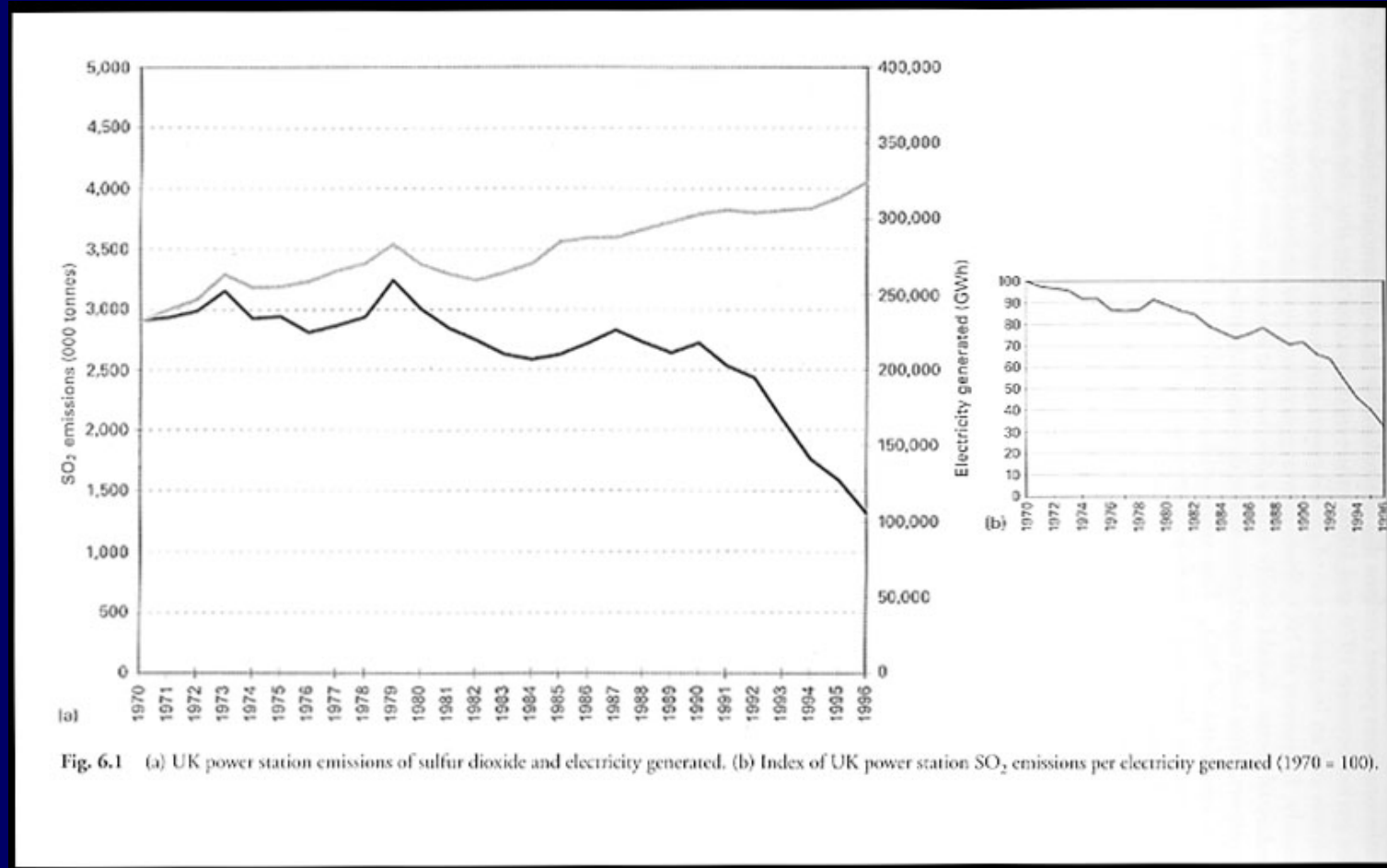
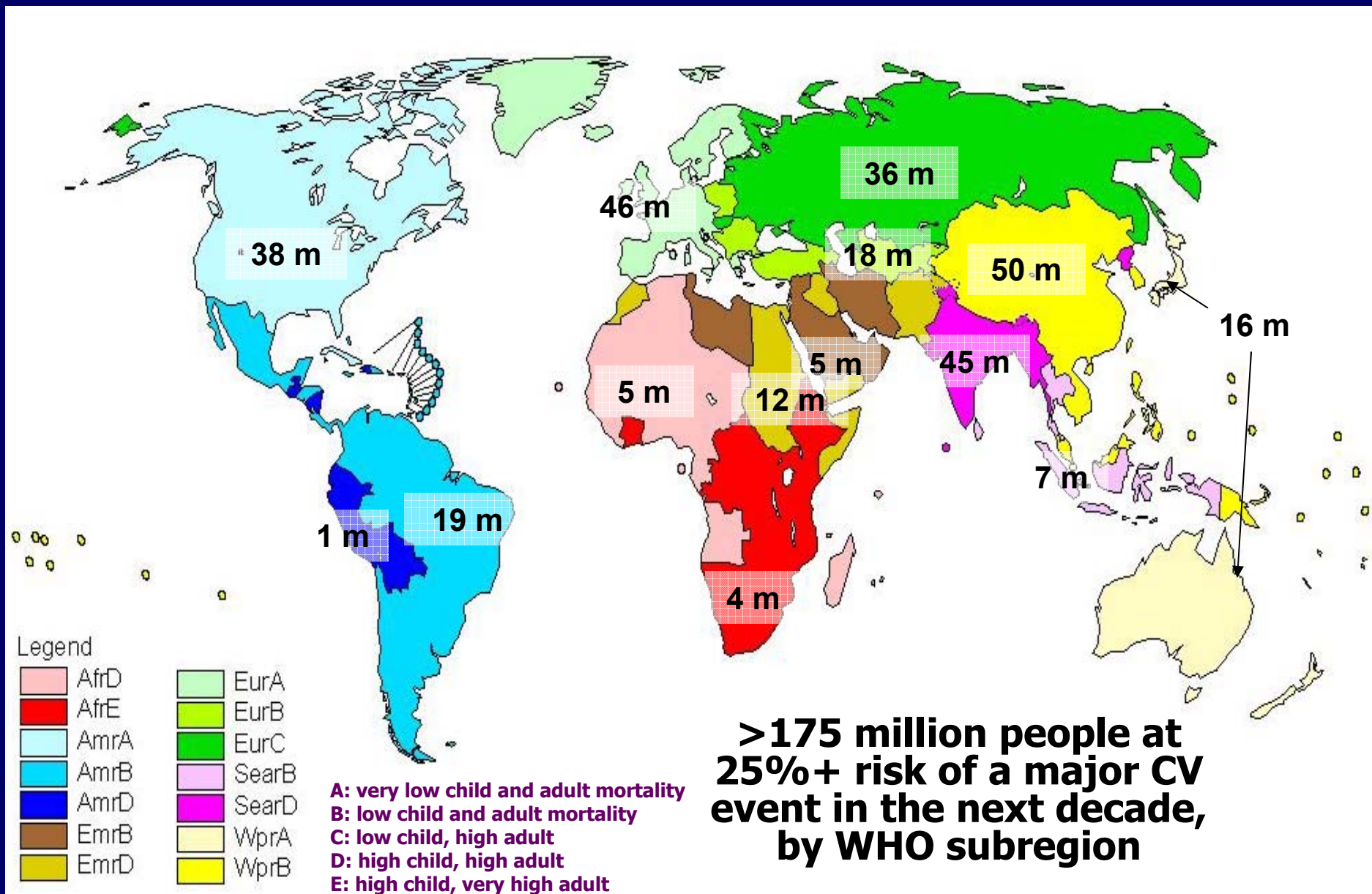


Fig. 6.1 (a) UK power station emissions of sulfur dioxide and electricity generated. (b) Index of UK power station SO₂ emissions per electricity generated (1970 = 100).

Number of people at high CV risk 2000 - 2010

(A Rogers 2005)



Thank You

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