

## Quantifying the Health Effects of Air Pollutants in Asian Cities

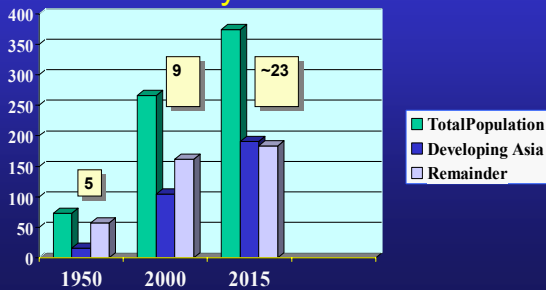
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*Better Air Quality, 2004;  
 Agra, India*

## Quantifying Health Effects

- Review changes in populations
- Review estimates from emission sources
- Discuss some methodological issues
- Define environmental health indicators and burden of disease indicators
- Discuss recent approaches and new agendas
- Conclusions and what we can expect

## Population in Millions for All World Megacities (over 10 million) by Year



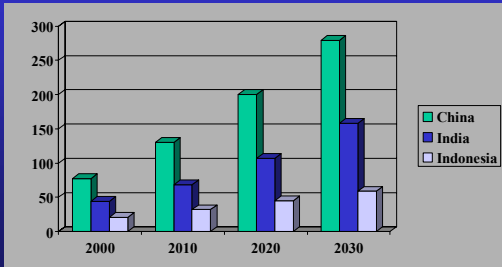
## PM10 emissions from domestic fuel usage by income class in Delhi and Mumbai

Domestic fuel usage(tons/year) in city by income class<sup>a</sup>

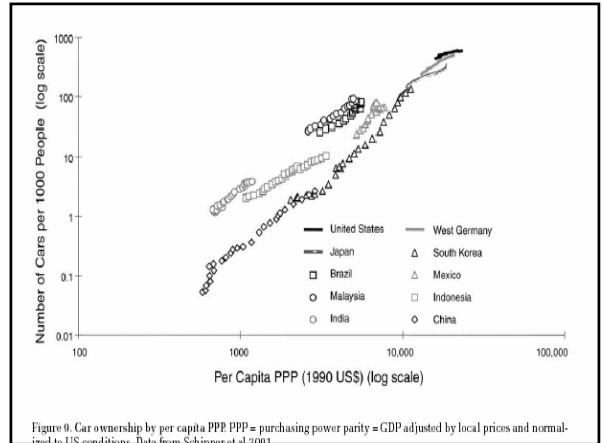
Fuel	Delhi			Mumbai		
	Low income	Middle income	High income	Low income	Middle income	High income
Biomass	3100-4500	300-550	N.A.	4000-6000	800-1400	N.A.
Coal	50-150	35-65	N.A.	70-200	45-85	N.A.
Kerosene	40-80	60-90	10-20	60-100	80-120	15-25
LPG	10-20	10-20	15-25	15-25	15-25	20-35
Total	3200-4750	400-700	25-45	4200-6300	1200-1650	35-60

<sup>a</sup>Ranges capture 1 S.D. around mean of distribution. Total emissions for Delhi=3900-6000 and for Mumbai=5500-8000 tons/year (from Kandlikar and

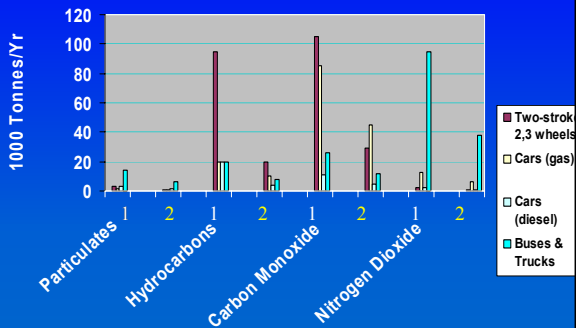
## Transport Oil Consumption Projections, 2000-2030 (10<sup>6</sup> tonnes oil equivalent)



Source: Internat. Energy Agency, 2002 and Walsh, 2001



## Emission Estimates by Vehicular Categories for Delhi (1) and Mumbai (2) (1000 tonnes/year)



## Environmental Health Indicators

By definition *environmental health indicators* provide measures that link environmental hazards to health effects.

\**Exposure-side indicators* imply degree of health risk

\**Health-side indicators* imply outcome attributable effects

Both assume contribution of pollutant to health

## Methodological Approaches to Environmental Issues

Study Approaches	Comments
– Biologic/Cellular Studies	<i>Requires laboratory infrastructure, and mechanistic hypotheses</i>
– Toxicological Studies	<i>Whole animal studies, generally carried out at higher exposure levels, relevance to humans</i>
– Human Controlled Exposure Studies	<i>Ethical considerations of exposure levels, generally small sample sizes</i>
Epidemiological Studies	<i>Relevant to the population of interest</i>

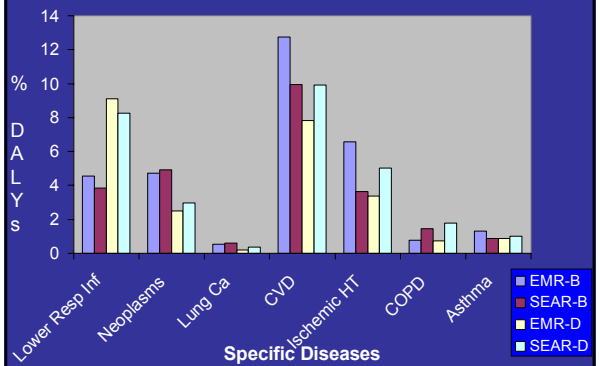
## Population Studies: Approaches

Epidemiological Methods	Comments
<u>Time series studies</u>	<i>Relatively inexpensive using administrative records</i>
<u>Cross Sectional Studies</u>	<i>Prevalence estimates</i>
<u>Case-Control Studies</u>	<i>Assessing exposure risk in diseased subjects</i>
<u>Case-Cross over Studies</u>	<i>Using subject as own control</i>
<u>Cohort Studies</u>	<i>Assessing risk of disease in exposed groups</i>
<u>Intervention Studies</u>	<i>Assessing effects of changing exposures</i>

## WHO Regions by Low (B) and High (D) Child and Adult Mortality Regions/Countries

EMR-B	EMR-D	SEAR-B	SEAR-D
Bahrain	Afghanistan	Indonesia	Bangladesh
Cyprus	Djibouti	Sri Lanka	Bhutan
Iran, Jordan	Egypt	Thailand	N.Korea
Iraq, Kuwait	Morocco		India
U. Arab Emir			Maldives
Lebanon	Pakistan		Myanmar
Libya, Oman	Somalia		Nepal
Saudi Arabia	Sudan		
Syria	Yemen		
Tunisia			

## Percent DALYs for Specific Diseases by Regions Divided by High and Low Mortality Rates



## Health Effects Institute PAPA Program

**Partnership with CAI-ASIA to understand the health effects of air pollution in Asia, now and in the future**

Supported by US AID, Foundations, industry, ADB, others

**Four - year program to assess the state of air pollution and health across Asian cities**

Initial review of what is known today about health effects in Asian cities published April 2004

A second **comprehensive assessment** in four years

Initiate a **series of epidemiological studies** in representative Asian cities to estimate local impacts, inform extrapolation throughout the region

**Build capacity** of local scientists

**Overall Goal:**

Inform key Asian regulatory & policy decisions

## Health Effects of Outdoor Air Pollution in Developing Countries of Asia: A Literature Review

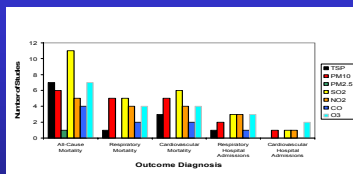
Systematic identification of peer-reviewed Asian studies 1980-2003



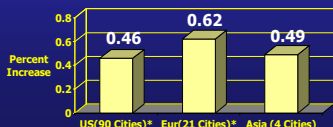
- Focus on studies of daily changes in air pollution and health
- Conduct first regional "meta analysis" to quantify risks
- Identify knowledge gaps/research needs
- Put results in context of broader air pollution & health science
- Available at [www.healtheffects.org](http://www.healtheffects.org)

## Meta-Analysis of Asian Studies of Daily Mortality/Hospital Admissions

- 28 recent daily time series studies examined in depth
- Studies find effects of air pollution on rate of death, illness
  - ~0.5% increase per 10  $\mu\text{g}/\text{m}^3$  of  $\text{PM}_{10}$
  - High levels of air pollution in Asian cities ( $>100 \mu\text{g}/\text{m}^3$ ), imply a substantial public health impact
- **Limitations**
  - Small number of cities
  - Not geographically representative (poorest, most polluted countries under-represented)



Percent Increase in Mortality per 10 micrograms  $\text{PM}_{10}$



## PAPA: New Research in Asian Cities

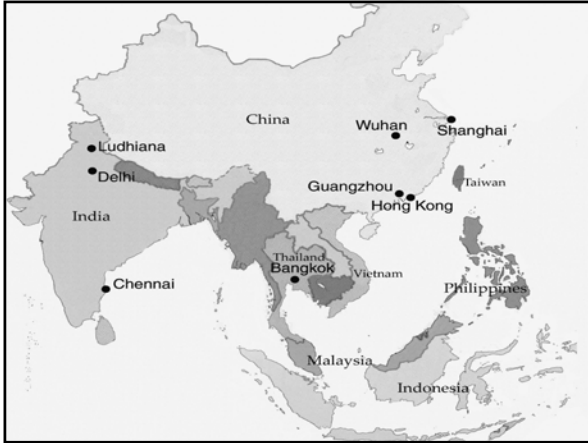
Coordinated time-series studies (7 Cities)

Strong teams, quality data

Common protocol for a coordinated analysis

Pilot study of long-term exposure and cardio respiratory mortality in the elderly in Guangzhou

Additional studies possible in 2005 in countries with less experience in conducting air pollution health studies or with data challenges: (for example) Ho Chi Minh City, Jakarta, Manila



### ***PAPA: New Research in Asian Cities***

- **Where data are limited for time series, other possible study designs/research questions are being considered**
  - Case-control and Panel studies
  - Exposure Studies
  - Source Apportionment
- **Capacity building through design and conduct of new research - not just workshops**
  - Asia led & staffed investigator teams
  - Strong linkages to local health, regulatory officials to ensure data access & maintain policy relevance
  - Regular interaction with international experts
  - Coordinated study design enhances communication/builds regular collaboration among Asian investigators
  - Website to facilitate education, communication

### **Conclusions**

- Changing economic conditions will result in welcomed increased standards of living.
- This will result in increase fossil fuel usage.
- More pollution will result in more chronic diseases.
- With almost 50% of the world population living in these cities even if the attributable risk burden is small a large number of people will be affected.

### **Conclusions (cont.)**

The only way to avoid these excesses is to persuade these countries to demand the use of best available technologies, rather than have these countries experience unregulated development and the 50 year lag it took the US and Western Europe to get to the stage of control they currently enjoy.

Clearly, part of the effort underway at present is to develop the database in these megacities that can be used to help local authorities set regulations that can protect or lessen the burden of chronic cardiopulmonary diseases.

## Acknowledgements

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