Evidence to drive decisions: Building an Air Quality Management System

Dan Greenbaum
Health Effects Institute
Delhi
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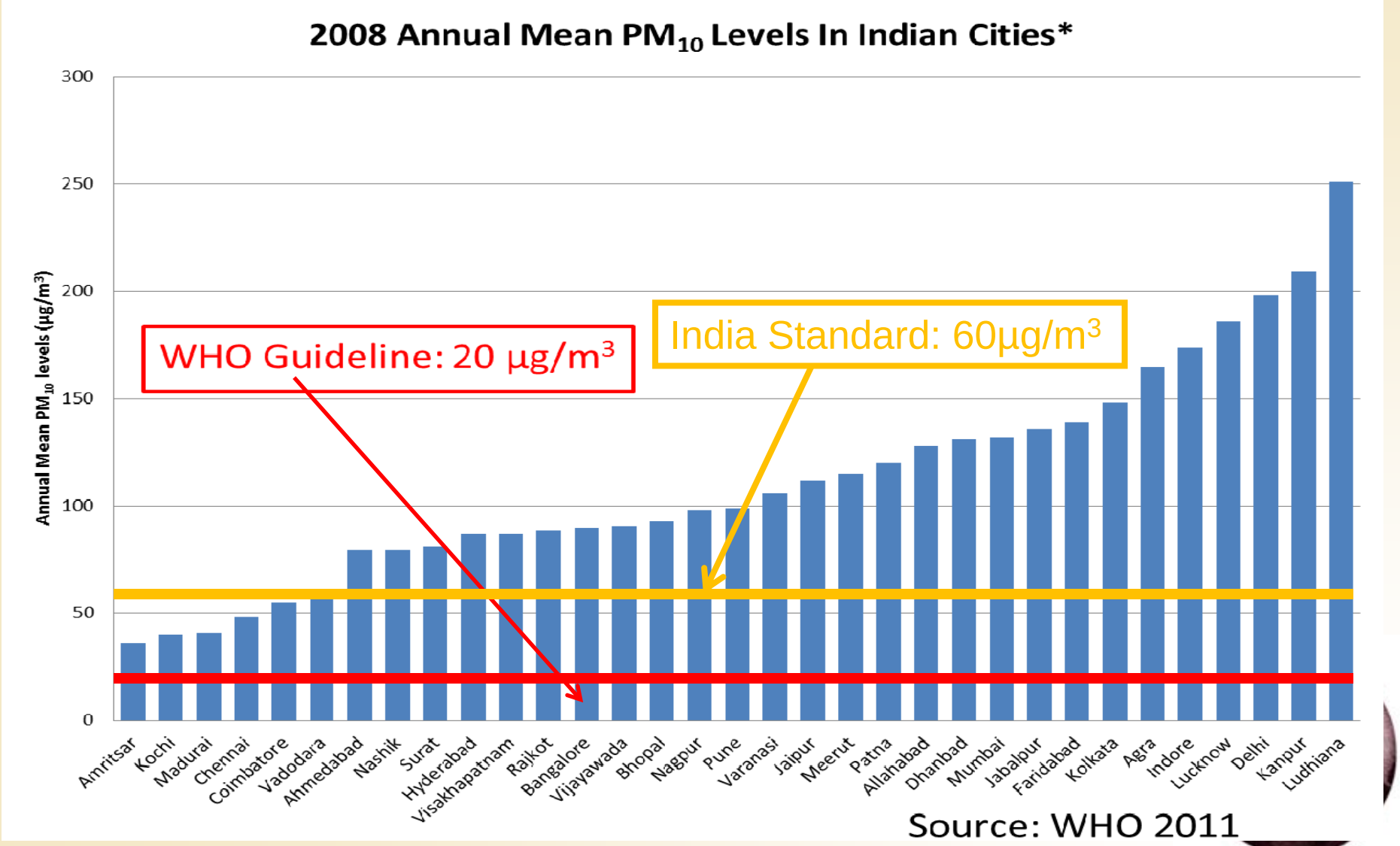
Building an Air Quality Management System

- Significant air pollution challenge
- Multiple sources
- But, many cost-effective solutions available
- What are the elements of comprehensive air quality management system?

India: Many Cities Substantially Exceed WHO and Indian Air Quality Guidelines



Many Sources of PM in India

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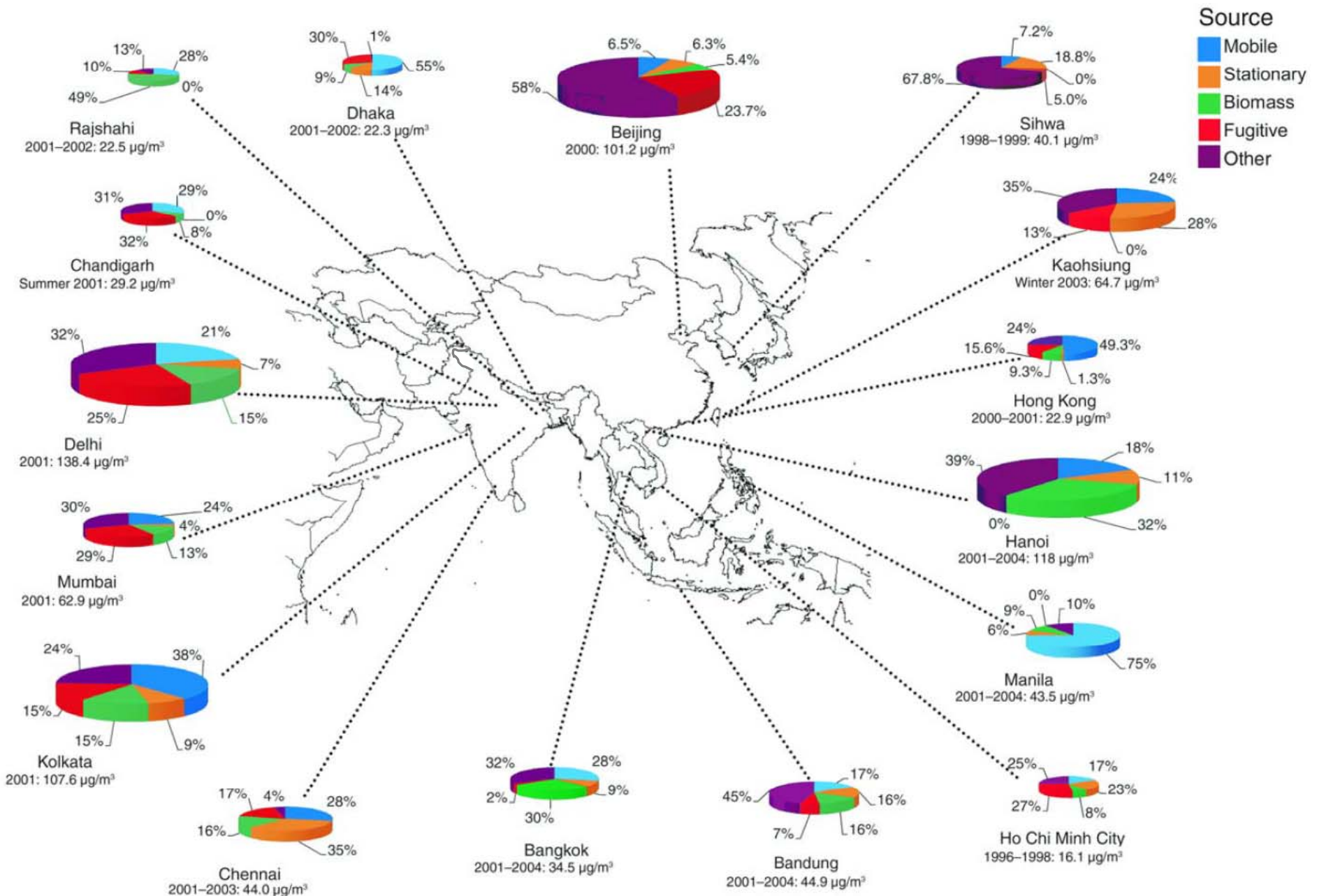
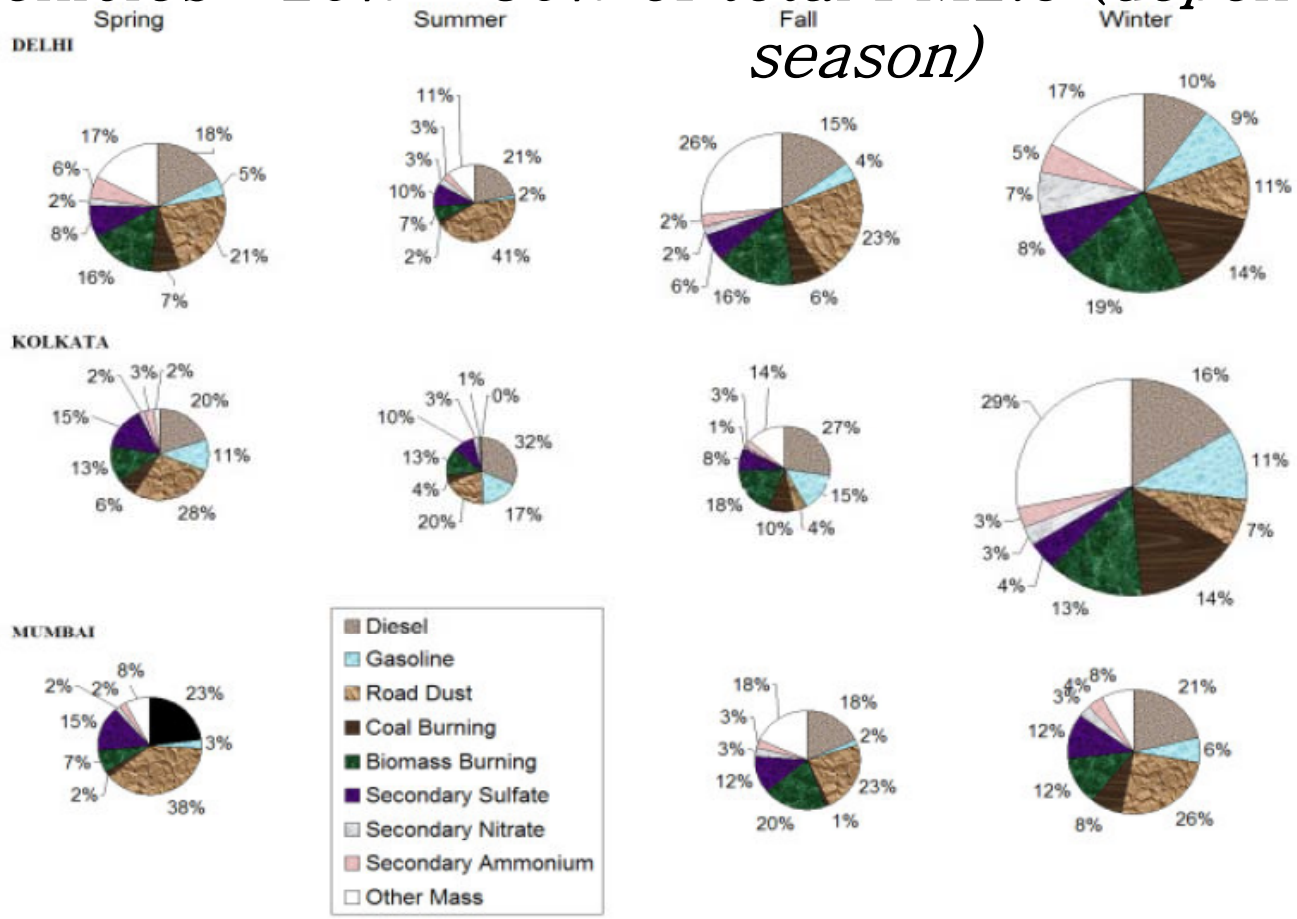
Asia PM 2.5 Source Apportionment: Vehicles ~20% - 35%



Source: Chowdhury, HEI

Seasonality of Sources in India

Vehicles ~20% – 30% of total PM2.5 (depending on city and season)



- Fossil fuel and biomass combustion dominates:
  - Fossil Fuel
  - Del: 25-33%
  - Kol: 37-53%
  - Mum: 21-35%
  - Biomass
  - Del: 7-19%
  - Kol: 13-18%
  - Mum: 7-20%
- Dust dominates during Spring and Summer
  - Long range transport and dust from local construction
- Biomass and coal are high in winter
  - Heating
  - Poor mixing and atmospheric inversion

Road Dust an additional 10% – 30%

Source: Adapted from Chowdhury et al. (2007).

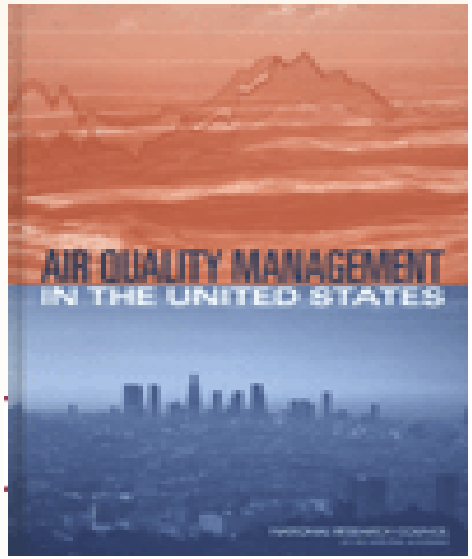
The Basics of Air Quality Management

(U.S. National Academy of Sciences Report)

Assessing Status
Measuring Progress
-AQ Monitoring
-Health Effects

Setting Standards
and Objectives
-Ambient AQ Standards
-Critical Ecosystem Loads

Designing and
Implementing
Control Strategies
-Identifying key sources
-Controlling Emissions
-Anticipating Growth



Air Quality Management in the United States
http://books.nap.edu/catalog/10728.html

India has already set PM and Ozone Ambient Air Quality Standards (in µg/m^3)

Pollutant	WHO AQG (Interim Targets)	US EPA	EU*	China GB3095-1996	China Newly Revised** *(adopted by 2016)*	India (Revised 2009)
PM10 Annual	**20** (70-50-30)	---	40	100	70	60
PM10 Daily	**50** (150-100-75)	150	50	150	150	100
PM2.5 Annual	**10** (35-25-15)	**12**	**25**	**na**	**35**	**40**
PM2.5 Daily	**25** (75-50-37.5)	35	---	na	75	60
Ozone 8-hour	**100**	**~150 (75 ppb) ~120-140* (60-70ppb)**	**100*** **	**na (*1 hr. avg. of 200*)**	**160**	**100**

* **Evaluation Underway**

*** **target value, not limit value**

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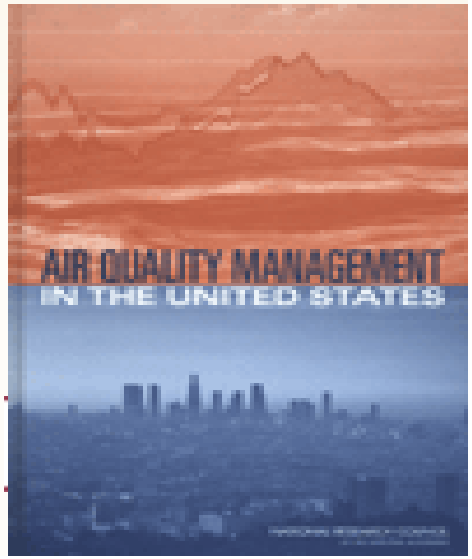

Many Sources of PM in India..
…require comprehensive strategy

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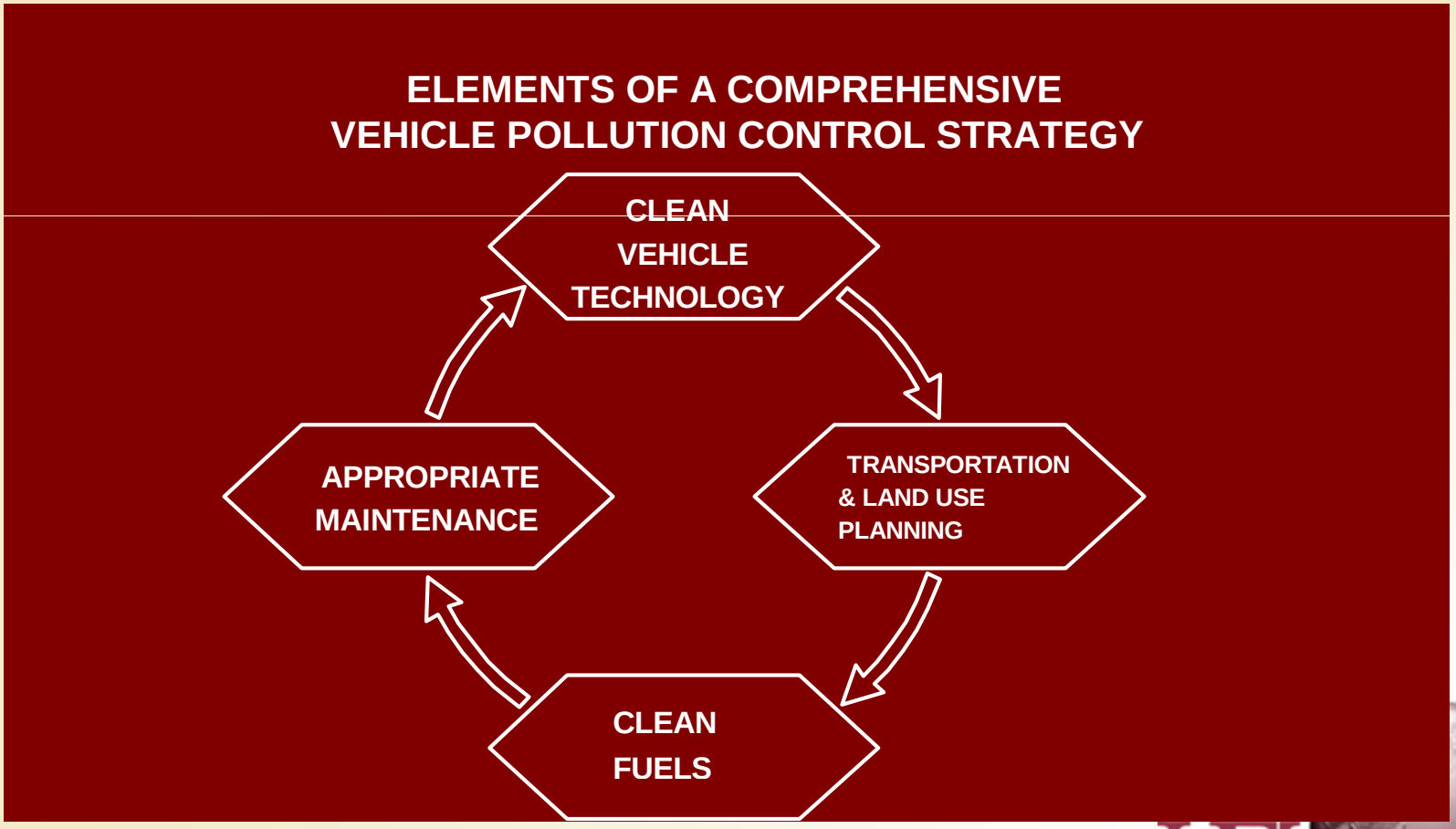
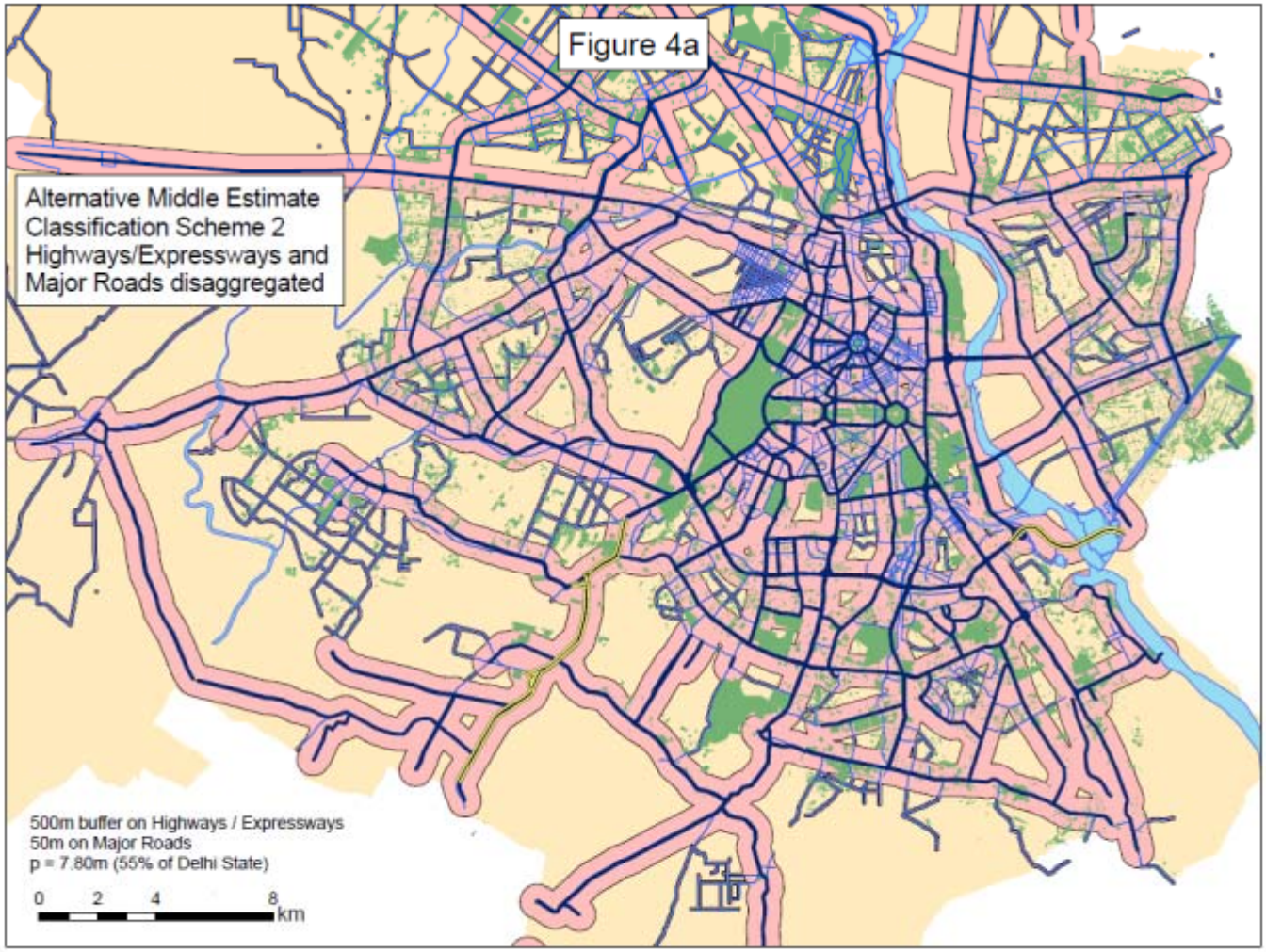
Mobile Sources:
Cars, Trucks, Buses, Three-Wheelers

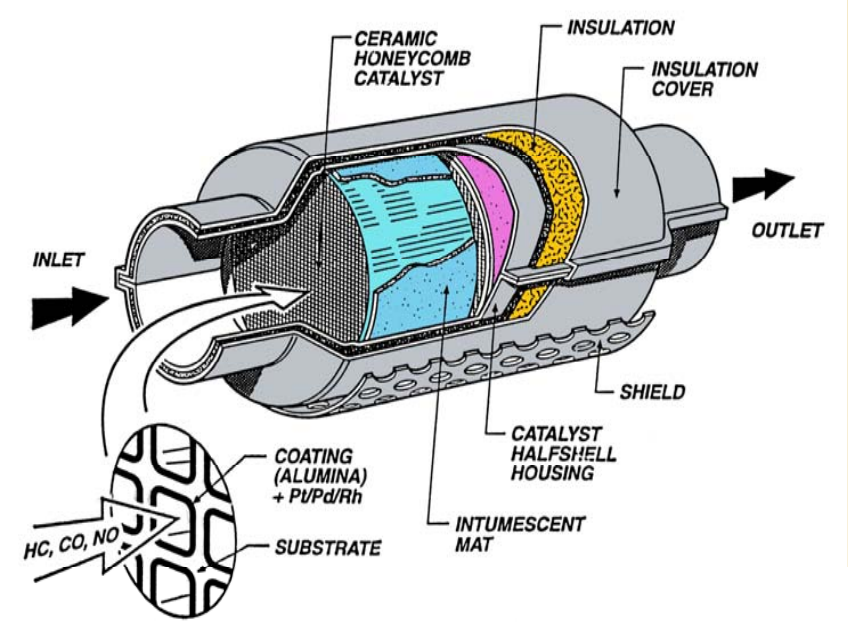


Source: Michael Walsh

The Traffic Impact Area in Delhi:

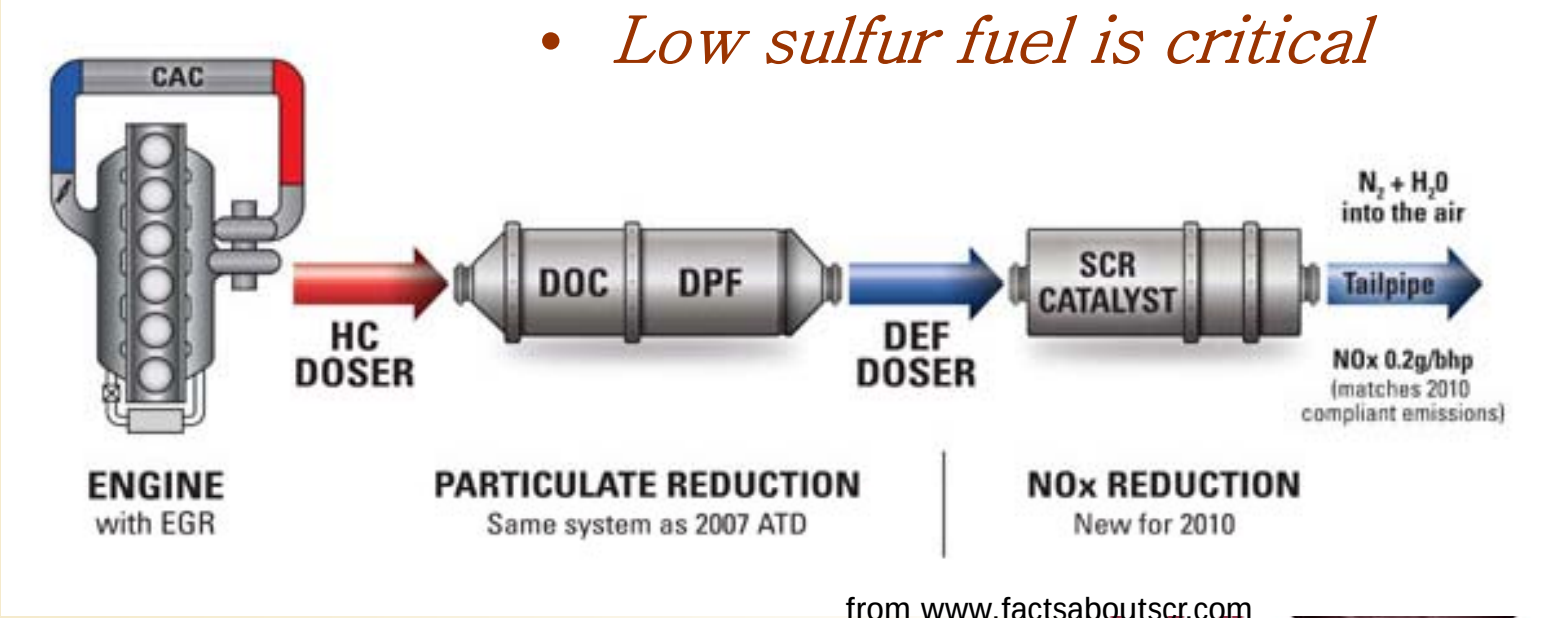
*HEI Analysis: **55% of the Population** within 500 meters of a Freeway; 50 meters of a Major Road*





Technology Now Exists To Dramatically Clean Up New Vehicles

- India has made progress
  - Bharat Stage 4/3
- But much cleaner, more cost-effective technologies now available (Euro 5, 6)
- *Low sulfur fuel is critical*



from www.factsaboutscr.com

Source: Michael Walsh

Stationary Sources:
e.g. Electric Power, Brick Kilns

- Substantial contributors to exposure
- Cost-effective technologies and cleaner fuels available
- Requires:
  - Clear Rules (level playing field)
  - Staff to inspect, enforce

Sources:
Household Cooking

- Substantial contributor to ***both*** indoor and outdoor exposure
- Contributes to both health effects and short-lived climate change forcing (black carbon)
- Improved technology and fuels available
  - Requires resources and education

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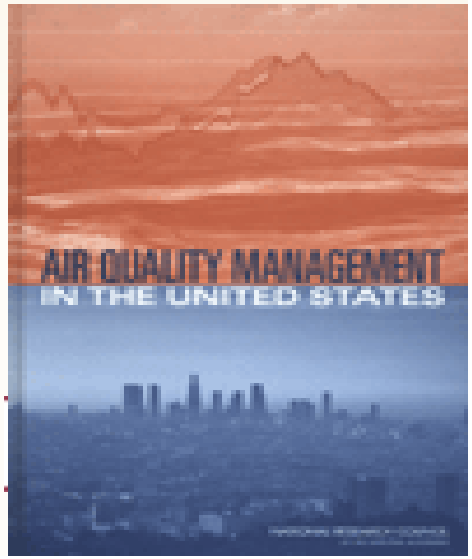
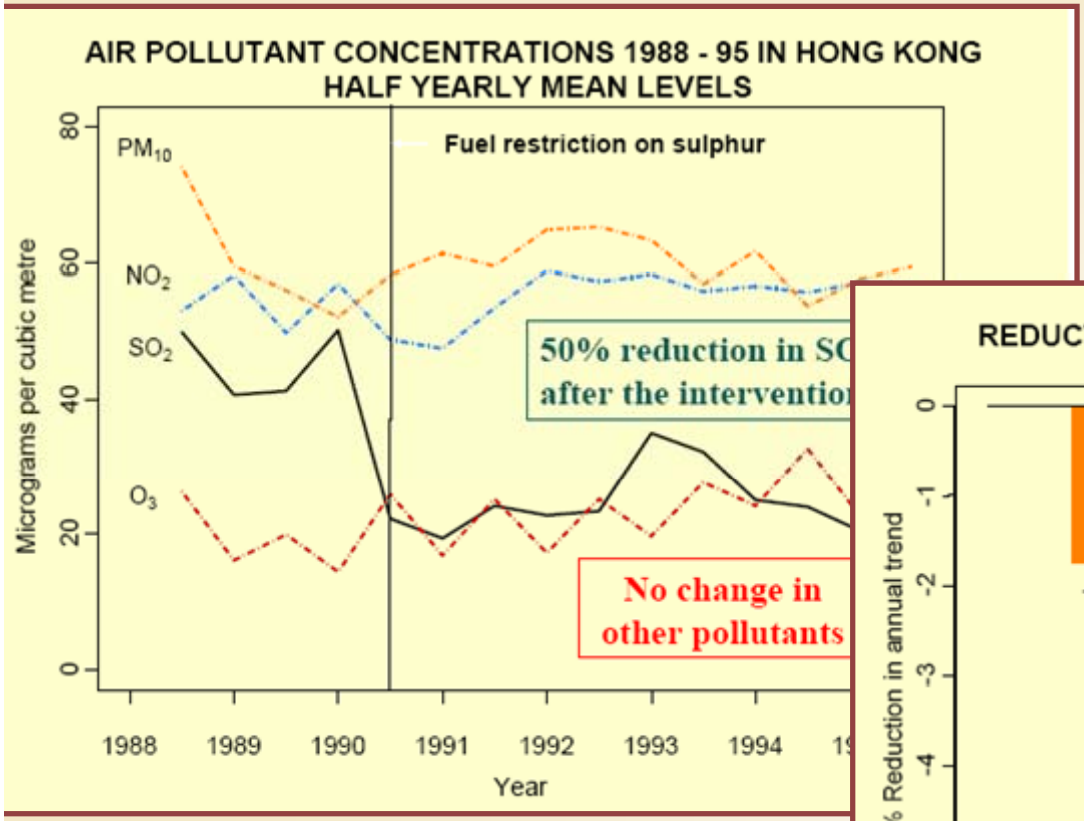
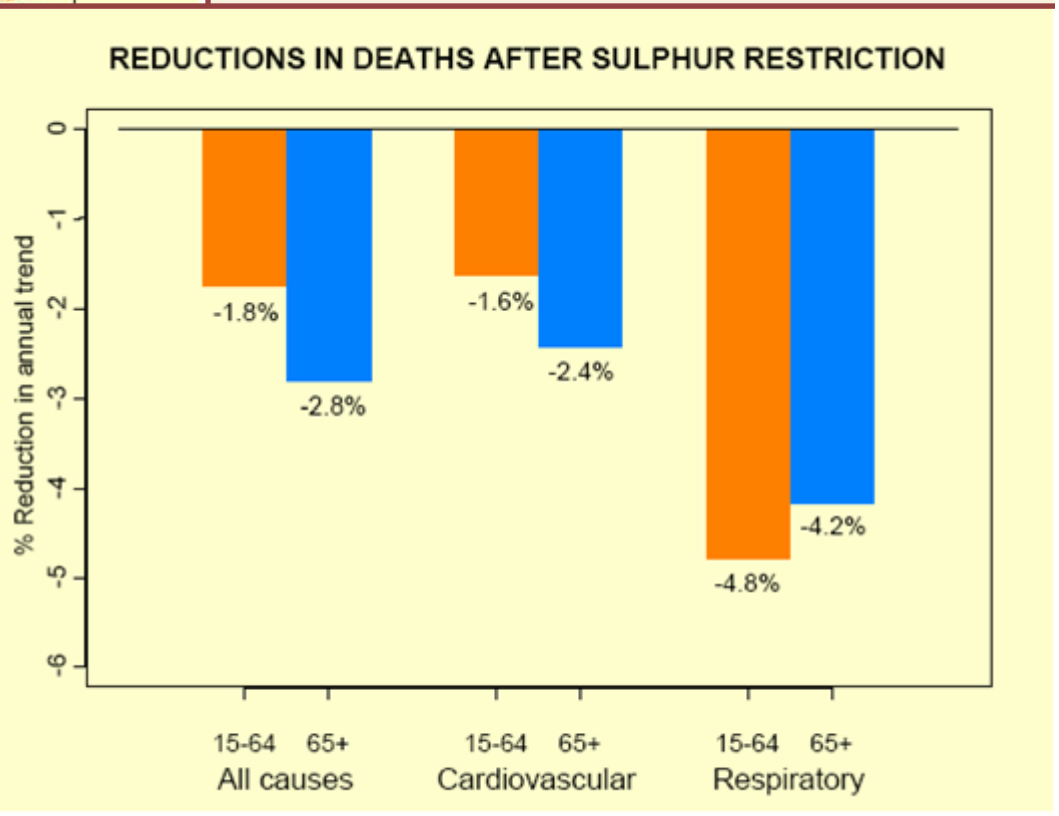


Action can have Results: When Hong Kong Fuel Sulfur (and SO_2) Went Down in 1990, Health Improved

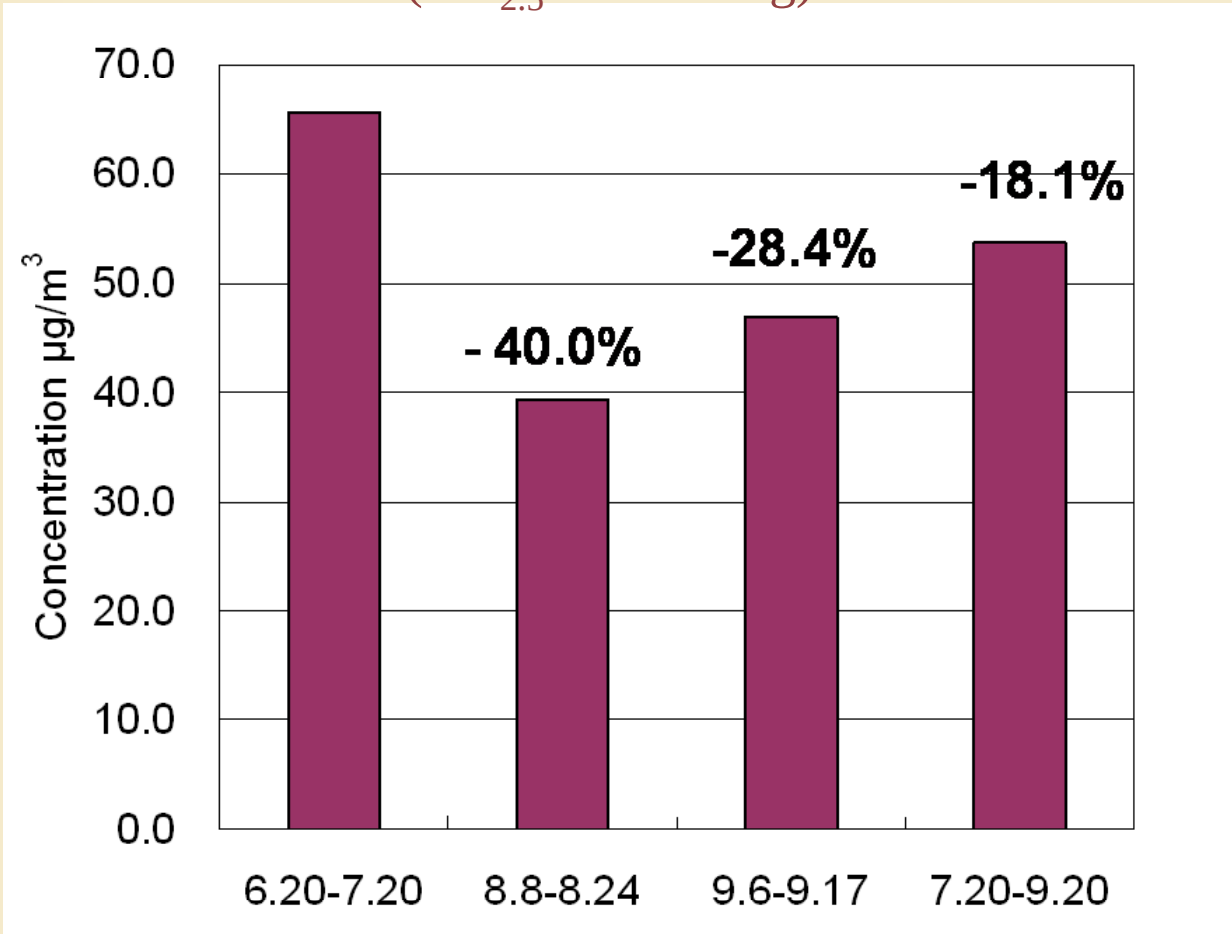




Action can have Results

When action was taken during Beijing Olympics, air pollution went down…

($PM_{2.5}$ Monitoring)



Instruments for $PM_{2.5}$:R&P and TEOM1400

Source: Hao, 2008

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…and heart health improved

- HEI-funded study with PKU and Rutgers University tested air and heart health
- Before, during, and after Olympics
- New report (2012): when air pollution improved measures of heart inflammation and health improved

JAMA Journal of the American Medical Association

Association Between Changes in Air Pollution Levels During the Beijing Olympics and Biomarkers of Inflammation and Thrombosis in Healthy Young Adults

David Q. Rich, ScD
Howard M. Kipen, MD, MPH
Wei Huang, ScD
Guangfa Wang, MD
Yuedan Wang, PhD
Ping Zhu, MD
Pamela Ohman-Strickland, PhD
Min Hu, PhD
Claire Philipp, MD
Scott R. Diehl, PhD
Shou-En Lu, PhD
Jian Tong, MS
Jicheng Gong, PhD
Duncan Thomas, PhD
Tong Zhu, PhD
Junfeng (Jim) Zhang, PhD

Context Air pollution is a risk factor for cardiovascular diseases (CVD), but the underlying biological mechanisms are not well understood.

Objective To determine whether markers related to CVD pathophysiological pathways (biomarkers for systemic inflammation and thrombosis, heart rate, and blood pressure) are sensitive to changes in air pollution.

Design, Setting, and Participants Using a quasi-experimental opportunity offered by greatly restricted air pollution emissions during the Beijing Olympics, we measured pollutants daily and the outcomes listed below in 125 healthy young adults before, during, and after the 2008 Olympics (June 2-October 30). We used linear mixed-effects models to estimate the improvement in outcome levels during the Olympics and the anticipated reversal of outcome levels after pollution controls ended to determine whether changes in outcome levels were associated with changes in pollutant concentrations.

Main Outcome Measures C-reactive protein (CRP), fibrinogen, von Willebrand factor, soluble CD40 ligand (sCD40L), soluble P-selectin (sCD62P) concentrations; white blood cell count (WBC); heart rate; and blood pressure.

Results Concentrations of particulate and gaseous pollutants decreased substantially (−13% to −60%) from the pre-Olympic period to the during-Olympic period. Using 2-sided tests conducted at the .003 level, we observed statistically significant improvements in sCD62P levels by −34.0% (95% CI, −38.4% to −29.2%; $P<.001$) from a pre-Olympic mean of 6.29 ng/mL to a during-Olympic mean of 4.16 ng/mL and von Willebrand factor by −13.1% (95% CI, −18.6% to −7.5%; $P<.001$) from 106.4% to 92.6%. After adjustments for multiple comparisons, changes in the other outcomes were not statistically significant. In the post-Olympic period when pollutant concentrations increased, most outcomes approximated pre-Olympic levels, but only sCD62P and systolic blood pressure were significantly worsened from the during-Olympic period. The fraction of above-detection-limit values for CRP (percentage ≥0.3 mg/L) was reduced from 55% in the pre-Olympic period to 46% in the during-Olympic period and reduced further to 36% in the post-Olympic period. Interquartile range increases in pollutant concentrations were consistently associated with statistically significant increases in fibrinogen, von Willebrand factor, heart rate, sCD62P, and sCD40L concentrations.

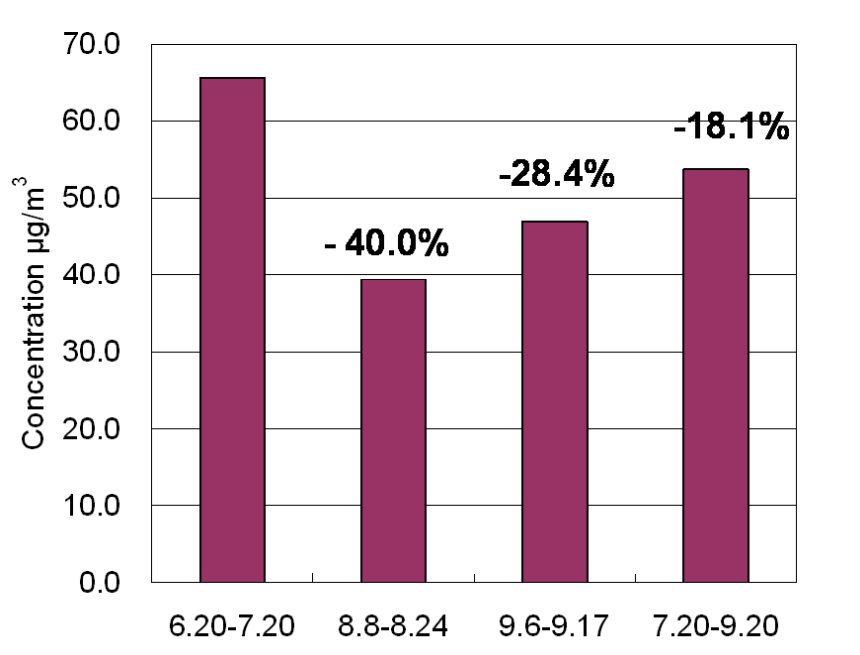
Conclusions Changes in air pollution levels during the Beijing Olympics were associated with acute changes in biomarkers of inflammation and thrombosis and measures of cardiovascular physiology in healthy young persons. These findings are of uncertain clinical significance.

JAMA. 2012;307(19):2068-2078 www.jama.com

AIR POLLUTION IS A RISK FACtor for cardiovascular diseases (CVD), but the mechanisms by which air pollution leads to CVD is not well understood.[1-3] Hypothesized mechanisms with associated biomarkers include systemic inflammation (fibrinogen, C-reactive protein [CRP], white blood cell [WBC] count) and thrombosis or endothelial dysfunction (platelet activation markers P-selectin [sCD62P] and soluble CD40 ligand [sCD40L] as well as the adhesive endothelial glycopro-

Although progress can be made…

- …sustained progress requires broader knowledge and communication of public health impact
  - Air pollution improved during the Beijing Olympics, but rose again shortly after
  - And in Delhi, air pollution dropped after the CNG conversions – but has now risen to much higher levels…
- Continued setting of standards, implementation, and enforcement all require support
- The new GBD can help further support and inform action



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Thank You

Dan Greenbaum
dgreenbaum@healtheffects.org