Evaluating the Effectiveness of Air Quality Interventions:

HEI's Research Program on Accountability

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EPA workshop: Assessing Public Health Impacts
of Risk Management Decisions
RTP, January 22, 2008

Why accountability?

In North America and Western Europe, air quality has improved substantially over the past decades

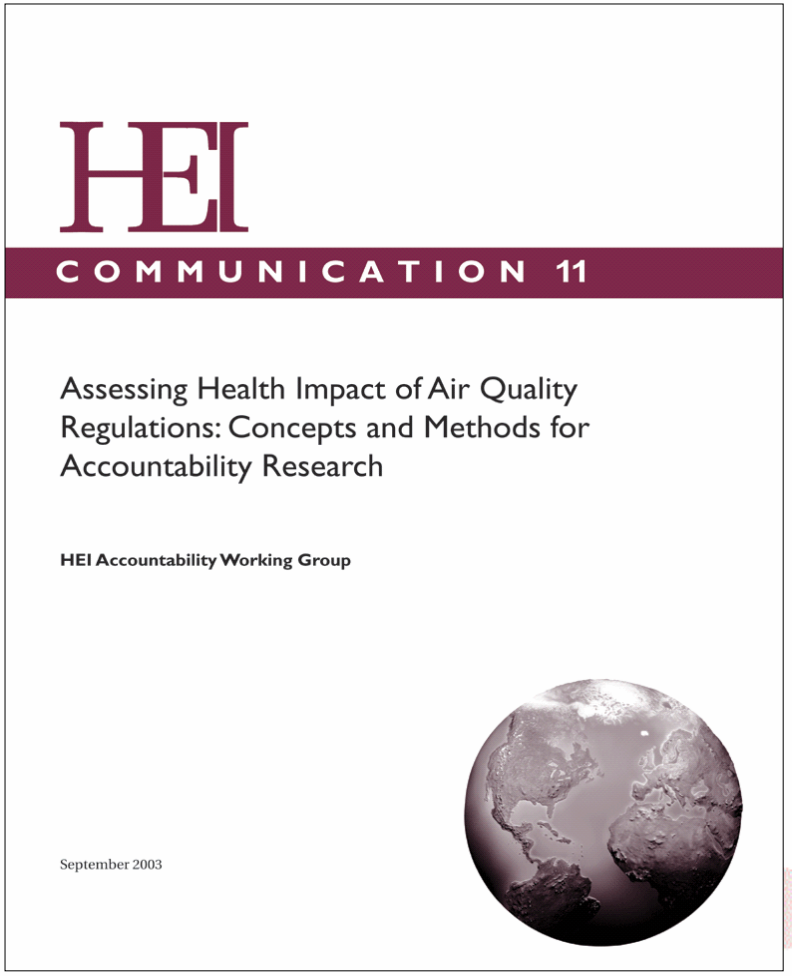
Further improvements are becoming more costly

Need to ensure that current and future regulations are achieving the intended public health benefits

Important to measure indicators along entire chain from regulatory action → emissions → air quality → exposure → human health

HEI Communication 11: Concepts and methods for accountability research

- Multi-authored monograph published September 2003
- Assessment of the task
- Conceptual framework for future research
- Research directions



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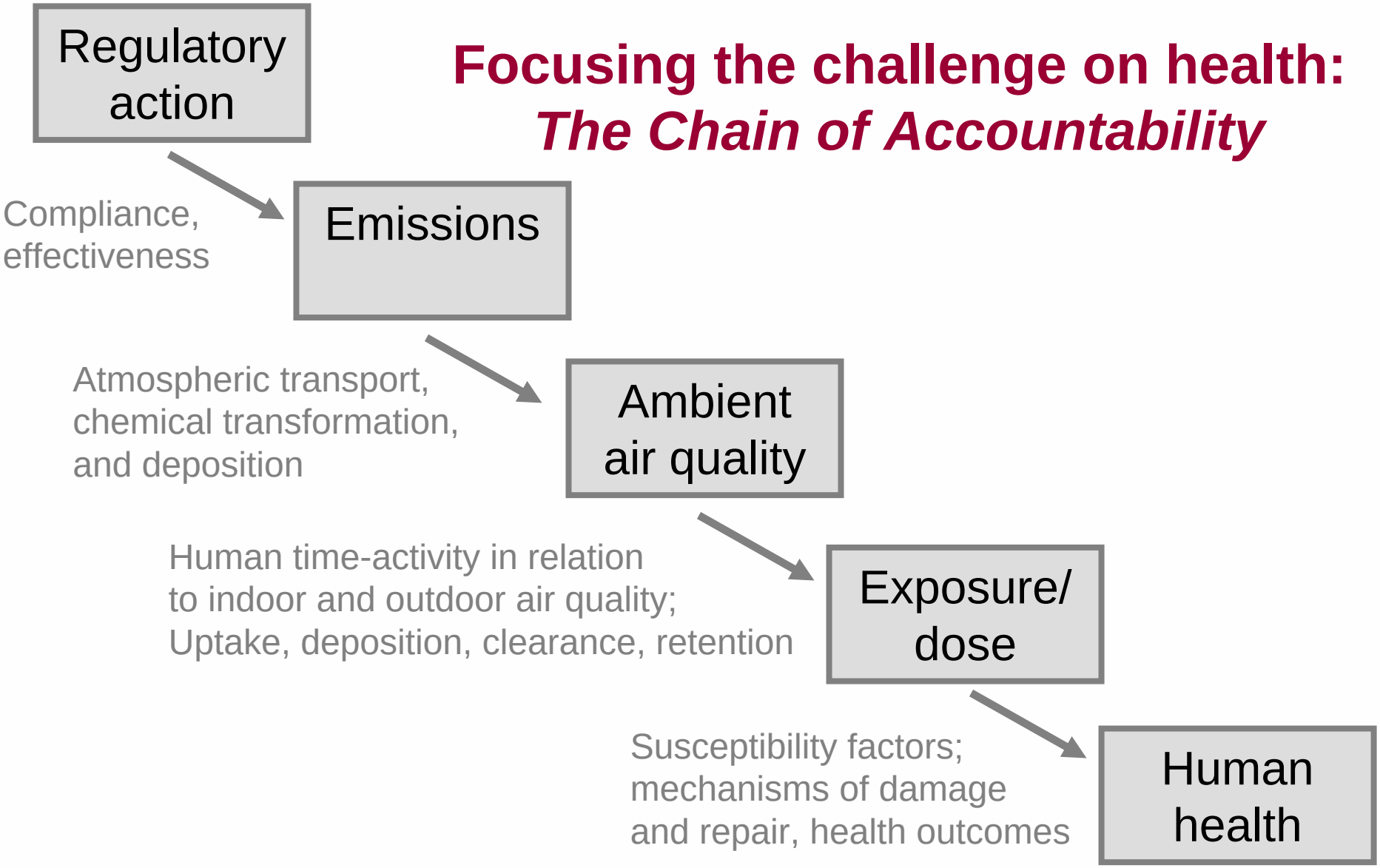
Focusing the challenge on health: *The Chain of Accountability*



Chain of Accountability. *HEI Communication 11, 2003*

Some issues and questions:

- How do emissions, exposures and health effects respond to different types of interventions?
  - Step-change vs. gradual change in AQ

- Methodologic issues
  - Which designs?
    - Large-scale, periodic monitoring to track population exposure versus smaller scale studies of specific subpopulations
  - Which health outcomes?
  - How to obtain adequate pre-intervention baseline data
  - Compare model-based predictions with actual outcome

Some issues and questions (cont'd)

- How to pursue unique opportunities (intentional, unintentional) that come up relatively quickly
  - Opportunities at national, regional, local levels
  - Identify and publicize opportunities
- How can accountability studies provide stronger tests of causal relations and contribute to scientific research on health effects of specific sources?

HEI studies:
Shorter-term interventions

Traffic reduction

1. Atlanta 1996 Olympic Games (completed and under review)
2. Congestion charging zone in London (completed and under review)
3. Low emission zone in London (completed and under review)

Targeting fuels & combustion

4. Cleaner wood stoves in Montana
5. Coal ban in Irish cities
6. Reducing sulfur in fuel in Hong Kong

Multiple sources

7. Reducing traffic and industrial sources in Beijing in association with 2008 Olympic Games

HEI studies:
Actions and events over the longer term

8. Regulations requiring decreased SO_2 emissions from powers plants in the eastern United States (Title IV of the 1990 Clean Air Act Amendments)

9. Changes in eastern Germany after the reunification, such as switching from brown coal to natural gas and increased use of catalytic converters and diesel engines (completed and under review)

1996 Olympics (Atlanta)

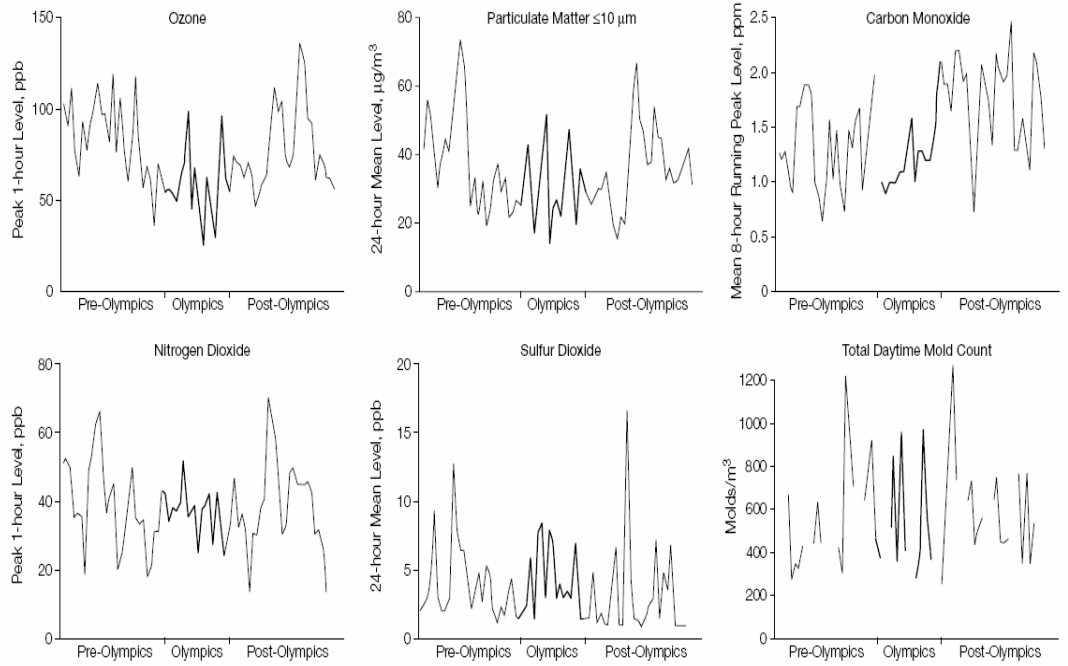
PI: Jennifer Peel, Colorado State University (study completed and under review)

- measures to reduce traffic in downtown Atlanta during period of the Olympics
- earlier study showed a decrease in ozone and childhood asthma (Friedman et al, JAMA 2001)
- focus on emergency department visits and arrhythmic events in patients with ICDs
- comparing before, during and after Olympics; also the same periods in previous and subsequent years
- investigating geographical subsets of the Atlanta metropolitan area

Atlanta Olympics –

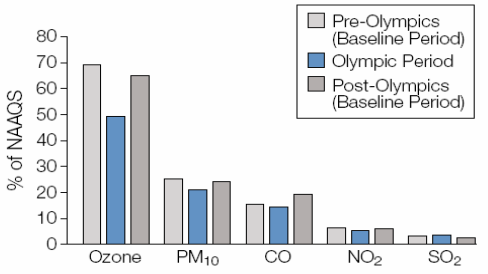
Michael Friedman et al, JAMA 285 (2001) 897-905

Figure 2. Daily Time Series of Individual Air Pollutant Levels and Mold Counts During the 1996 Summer Olympic Games and Baseline Period



Broken line indicates incomplete data (eg, mold counts were available weekdays only).

Figure 3. Mean Levels of Major Pollutants Before, During, and After the 1996 Summer Olympic Games as a Percentage of the National Ambient Air Quality Standard (NAAQS)



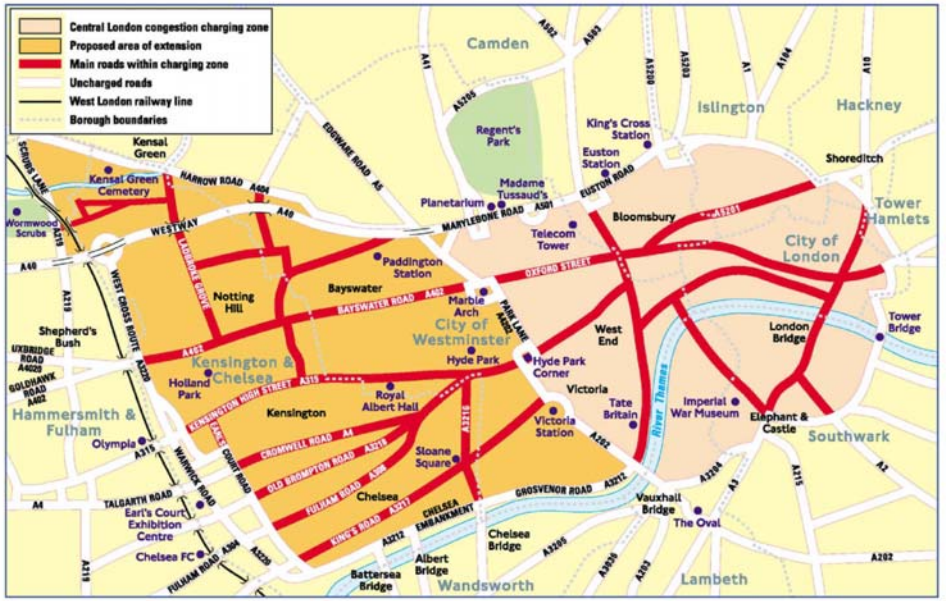
National Ambient Air Quality Standard at time of study: ozone 1-hour peak average, 120 ppb; particulate matter of 10 µm or smaller (PM_{10}) 24-hour average, 150 µg/m³; carbon monoxide (CO) 8-hour average, 9 ppm; nitrogen dioxide (NO_2) 1-hour peak average, 600 ppb; sulfur dioxide (SO_2) 24-hour average, 140 ppb.[35]

Significant reduction in asthma acute care events (-41%), peak daily ozone levels (-28%), and morning traffic (-22%)

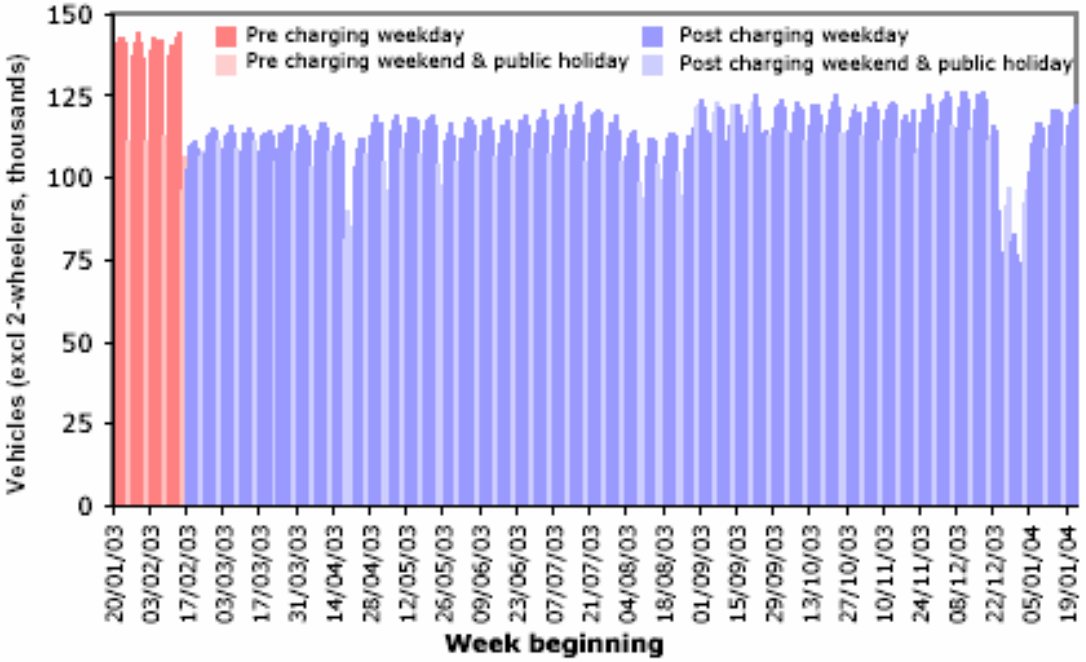
Congestion charging scheme (London)

PI: Frank Kelly, King's College London (study completed and under review)

- implemented in February 2003 to reduce traffic congestion in London's inner city (charge was £5/day, now £8)
  - concomitant increase in public transportation
  - show that traffic reduction has led to pollution reduction
  - also looking at potential changes in pollutant composition
- oxidative properties of PM collected on filters before and after implementation (*in vitro*)
- if pollution reduction evident, follow up with health study:
  - mortality & hospital admissions
  - respiratory and cardiovascular conditions in children and elderly obtained from primary care records

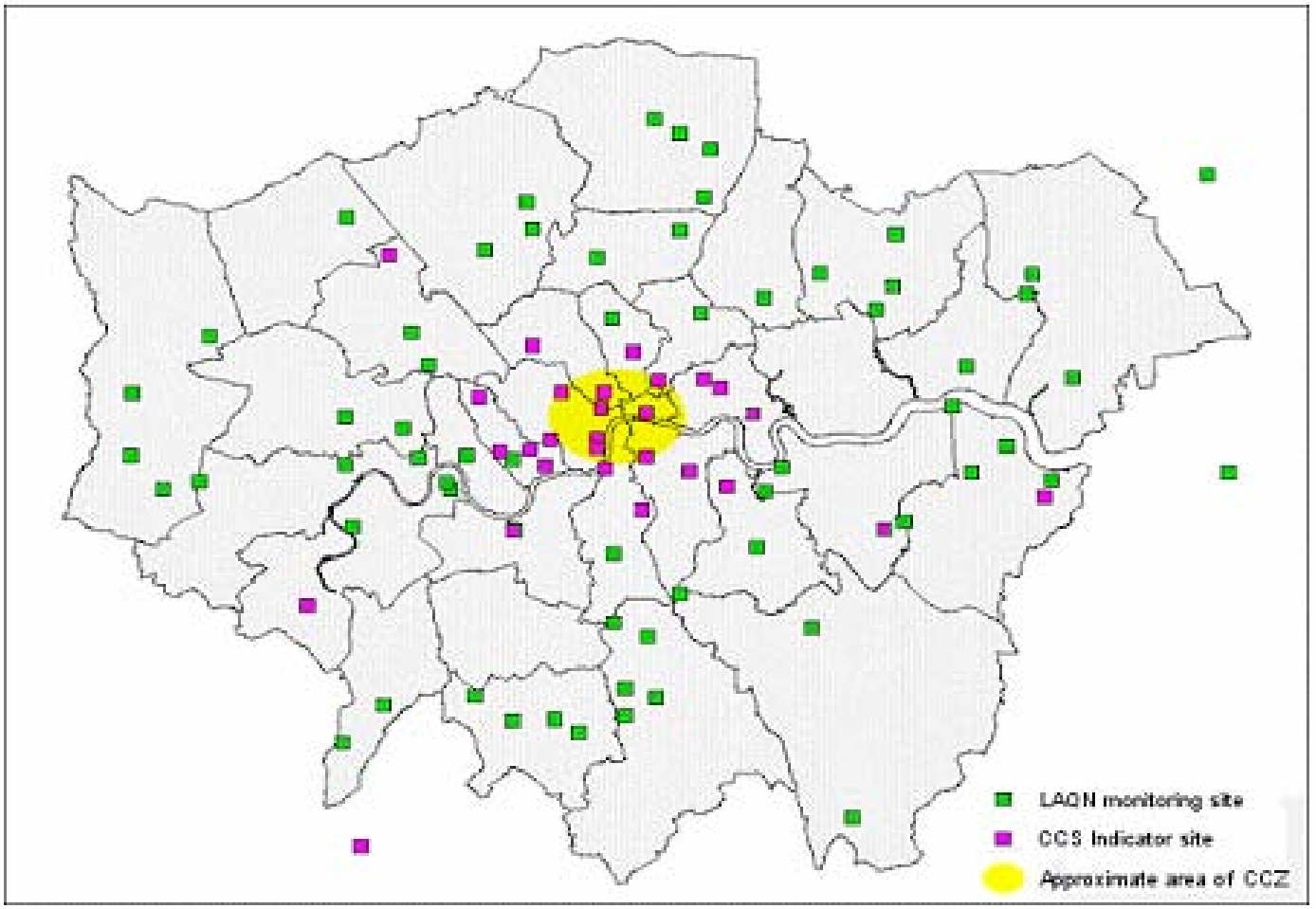


London inner city: original CCZ and western extension



Changes in traffic entering the CCZ during charging hours on a representative selection of major entry points. *Source: Transport for London.*

Greater London air quality monitoring network

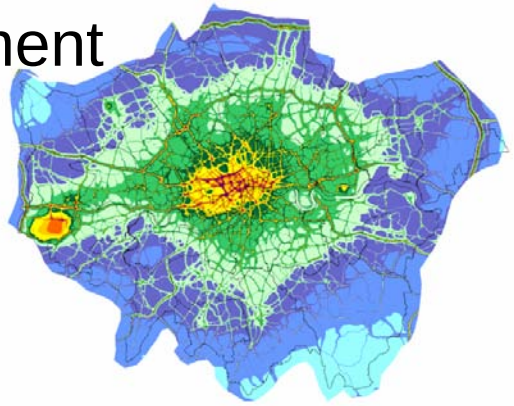


Location of long-term continuous pollution monitoring sites within Greater London

Low emission zone (London)

PI: Frank Kelly, King's College London (baseline study completed and under review)

- reduce pollution levels by excluding high emitters, several stages starting February 4, 2008 through 2012
- affects much larger area (Greater London)
- prospective study: baseline assessment
  - pollution levels
  - collect filters for oxidative properties
  - obtain access to primary care data
- improved monitoring network
  - in collaboration with Transport for London
- post-intervention study to be decided



NO_2 scenario

visit www.cclondon.com for more information on the CCS and LEZ

LEZ implementation plan

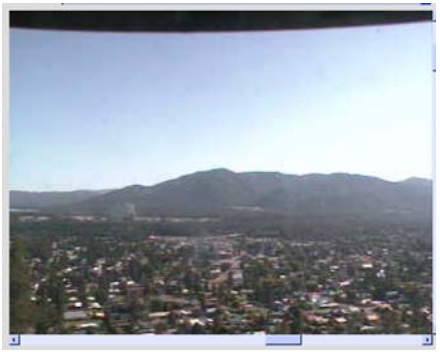
Heavier HGV > 12 tonnes	February 2008 January 2012	Euro III for PM Euro IV for PM
Lighter HGV 3.5 – 12 tonnes	July 2008 January 2012	Euro III for PM Euro IV for PM
Buses and coaches > 8 seats and > 5 tonnes	July 2008 January 2012	Euro III for PM Euro IV for PM
Heavier LGV 1.205 – 3.5 tonnes	October 2010	Euro III for PM
Minibuses > 8 seats and < 5 tonnes	October 2010	Euro III for PM
Private cars	No plans (yet)	

HGV = heavy goods vehicles; LGV = light goods vehicles

Cleaner wood stoves (Montana)

PI: Curtis Noonan, University of Montana

- community intervention project by Montana DEQ & others
- change-out of 1200 uncertified wood stoves during two winters (2005 and 2006)
- assess $PM_{2.5}$ levels outdoors, in schools, and in homes before, during and after wood stove replacement



Libby, Montana web cam
(June 26, 2007)

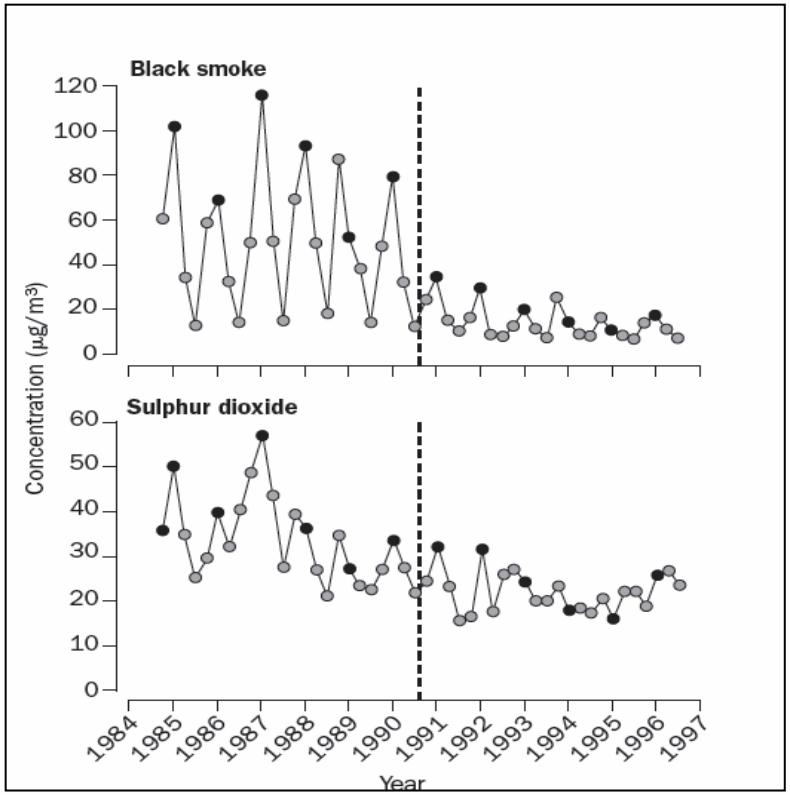
- relate air quality to children's respiratory symptoms, infections, and illness-related school absences

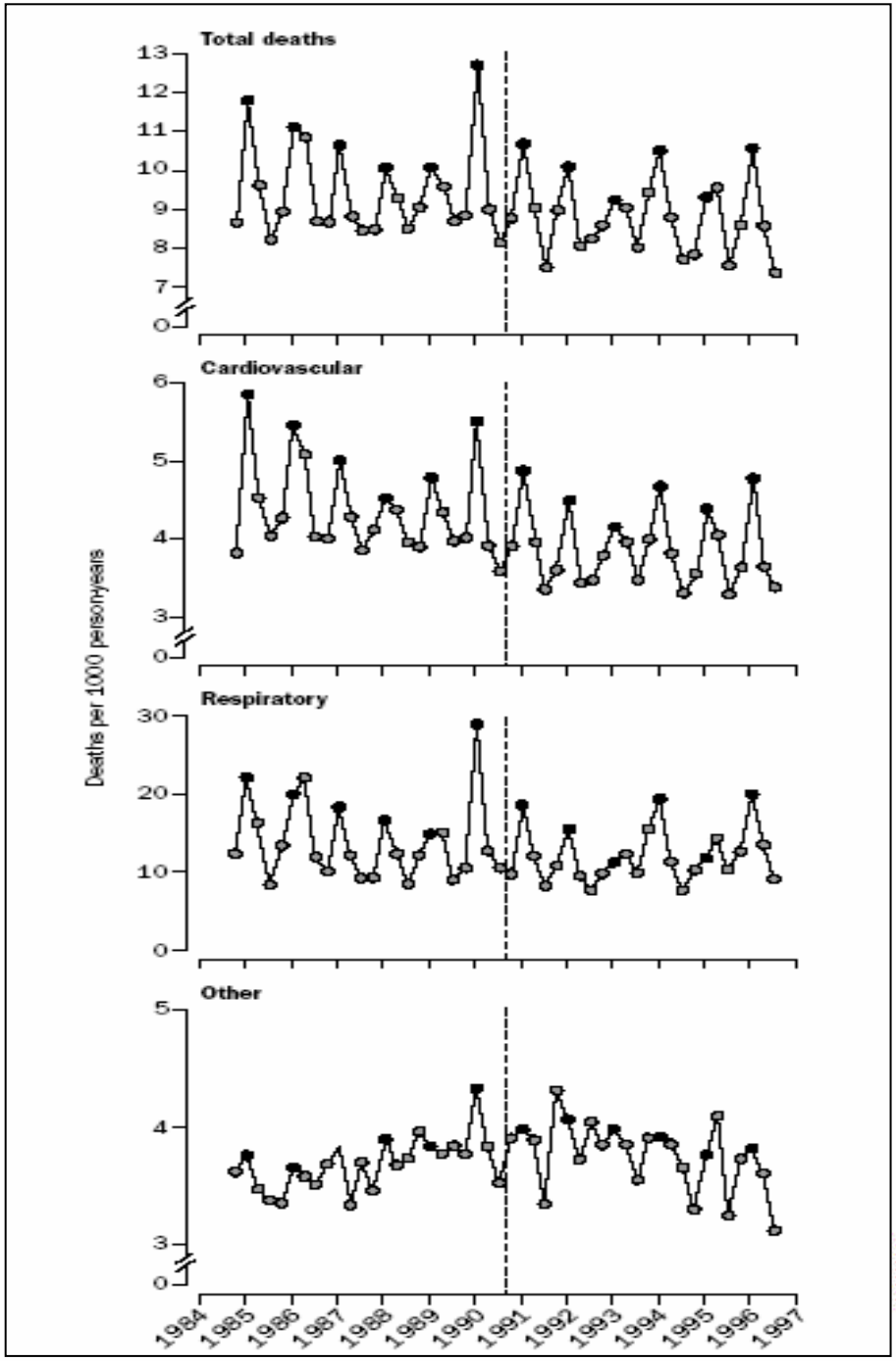
Coal ban in Irish Cities

PI: Douglas Dockery, Harvard School of Public Health

- based on earlier study showing reduction in black smoke and mortality after a 1990 coal ban in Dublin (Clancy et al, Lancet 2002)
- include 11 other cities: Cork (1995 ban) and 10 other major cities (1998 ban)
- quantify the effect of the ban on coal sales on black smoke and sulfur oxide levels
- total and cause-specific mortality, and cardiovascular and respiratory hospital admissions

Dublin 1990 coal ban (Clancy et al 2002)





Fuel sulfur content (Hong Kong)

PI: Chit-Ming Wong, University of Hong Kong

AFP/Philippe Lopez

- effect of 1990 regulation to reduce sulfur in fuel on AQ in Hong Kong
  - affecting both power plants and vehicles
  - shown to reduce SO_2 and mortality (Hedley et al, Lancet 2002)
- develop methodologies for assessing change in life expectancy and years of life gained
- focus on PM composition
- relation between short-term and long-term benefits

Hong Kong fuel sulfur content (Hedley et al 2002)

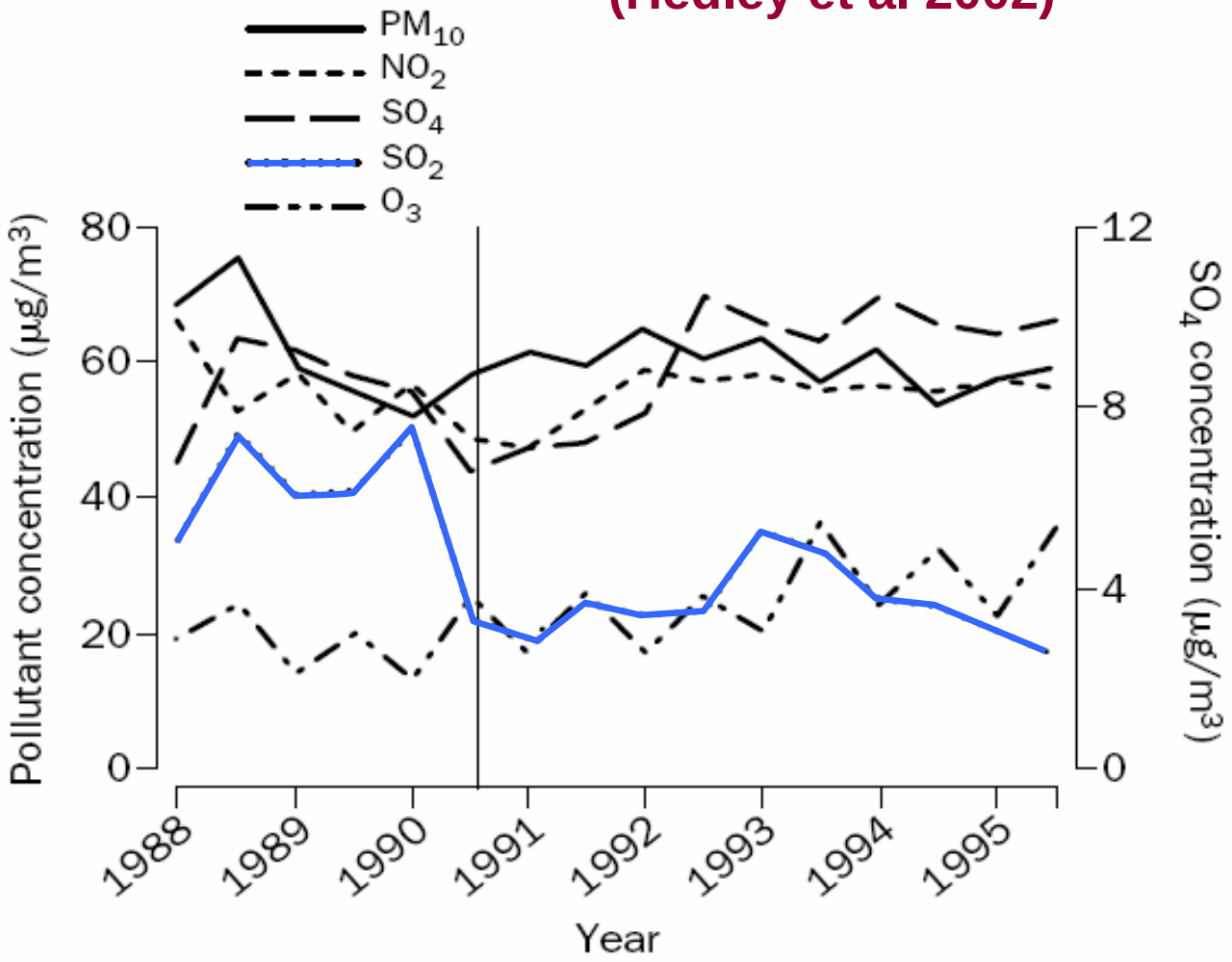


Figure 1: **Average of pollutant concentrations at five monitoring stations**

Vertical line represents date of introduction of fuel regulation.

2008 Olympics (Beijing)

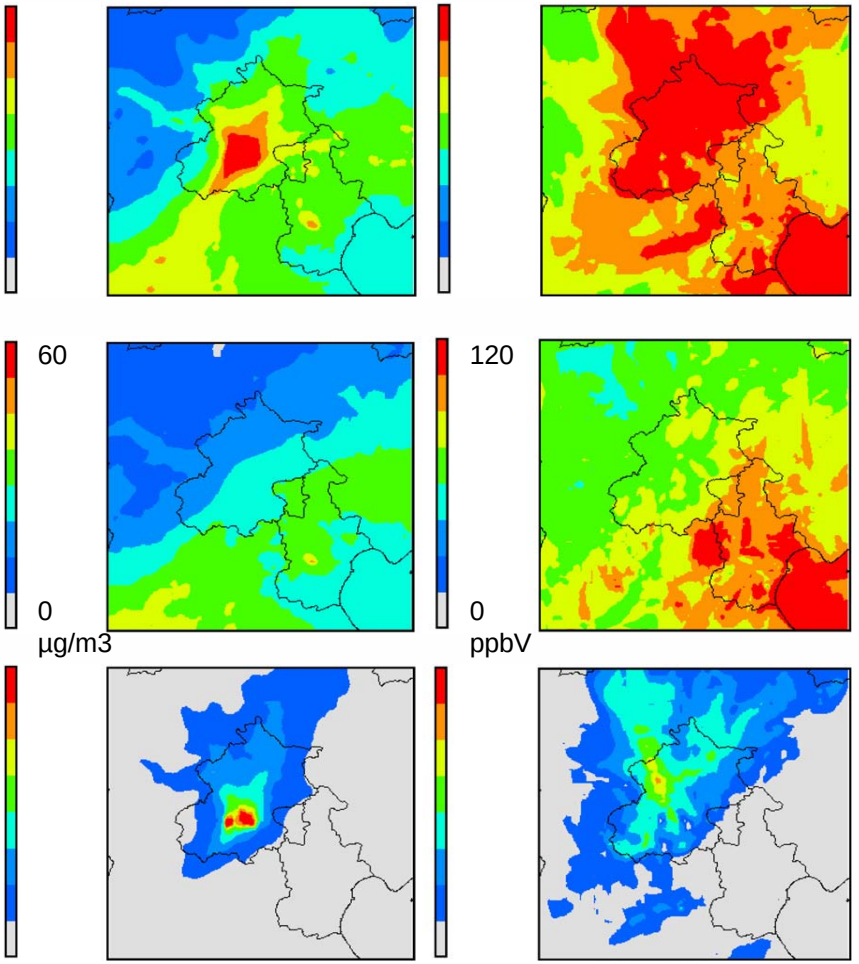
PI: Jim Zhang, University of Medicine and Dentistry of New Jersey

- reduce emissions from traffic and industrial sources in period leading up to and during Olympics
  - changes already started, targeting industry in Beijing area
  - two-tiered approach during the Olympics:
    - (1) keep highly emitting vehicles off the road and restrict operation of high emitting industries (July 25 – September 17)
    - (2) restrict additional vehicles and factories during actual competition (August 8–24)
- follow medical students before, during, and after Olympics to measure blood coagulation and systemic inflammation

Modeled Air Quality in Beijing –

David Streets et al, Atmospheric Environment 41 (2007) 480-492

CMAQ model simulations of $PM_{2.5}$ and ozone concentrations for Beijing, July 2001



All sources

Sources outside Beijing

Beijing sources alone

$PM_{2.5}$ (monthly average)

Ozone (max hourly)

In the news….

IOC chief says bad air could disrupt Beijing Games (AFP – Nov 2, 2007)
CHICAGO – International Olympic Committee chief Jacques Rogge said Friday that poor air quality in Beijing could disrupt events in next year's Games. "We will not hesitate to delay or postpone events if the air quality could harm athletes," Rogge said.

Rogge confident about air quality for Olympics (China Daily – Nov 5, 2007)
BEIJING – IOC President Jacques Rogge is confident that Beijing will ensure the air quality for the 2008 Olympic Games.

Beijing rules out car restrictions during Olympics (AFP – Nov 5, 2007)
BEIJING – Olympic host city Beijing has ruled out any limits on the number of private cars allowed on the Chinese capital's notoriously congested and polluted streets, state media reported Tuesday.

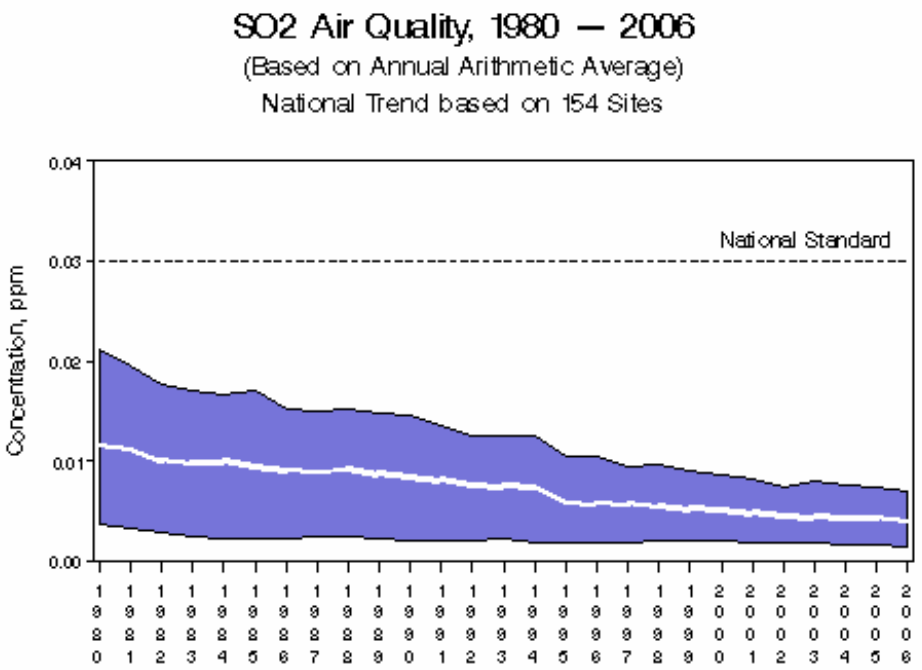
Henin might not defend her Olympic gold in Beijing because of asthma problems (The Canadian Press – Nov 5, 2007)
MADRID, Spain – Justine Henin might not defend her Olympic gold medal in Beijing because of concern the city's air pollution will trigger her asthma.

SO_2 from power plants (eastern US)

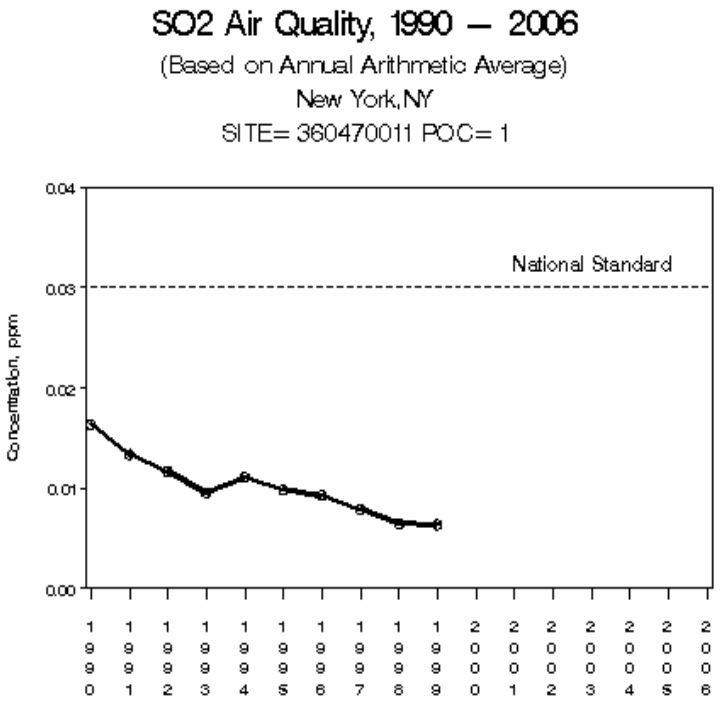
PI: Richard Morgenstern, Resources for the Future

- reduction of SO_2 emissions from power plants under Title IV of the 1990 Clean Air Act Amendments
  - two phases, targeting largest, dirtiest plants first
- source-by-source analysis to determine where and when reductions occurred
  - using EPA emissions inventories and transaction data
- source-receptor models to establish relationship between emissions reduction and air quality improvement
  - estimate pollution levels in absence of policies
- study on health effects to be finalized

SO_2 air quality trends (EPA)



1980 to 2006 : 66% decrease in National Average



New York, NY

source: http://www.epa.gov/air/airtrends/sulfur.html

German reunification

PI: Annette Peters, GSF-National Research Center for Environment and Health (study completed and under review)

- conversion from brown coal to natural gas in homes, factories, and power plants
- conversion of cars with two-cycle engines to cars equipped with catalytic converters

  - general increase in traffic, including diesel cars & trucks
- track daily cause-specific mortality in Erfurt at various lagged times with levels of pollutants of interest
- develop methods to track dynamic changes in health risks over time during interventions or source changes (1991–2002)

What's ahead:

Prepare a Program Summary describing HEI's accountability research program; manuscript to appear in J. Toxicol. & Environm. Health

Work with CDC EPHT Branch, US EPA and States to apply newly developed environmental public health tracking methods to accountability (workshop January 15/16, Baltimore MD)

Pursue new research and methods development on long-term and short-term impacts of domestic air quality actions on public health

HEI/CDC/EPA workshop on methodologic issues in Environmental Public Health Tracking of air pollution effects

- Build on work of CDC's EPHT program to develop indicators of air pollution-related health effects at the US state and local levels
- Bring together participants in CDC's EPHT program, US EPA's air quality programs, and US and international experts to address key methodologic issues in indicator development for public health applications
- Make recommendations to CDC regarding further development and application of indicators

EPHT workshop charge:

To develop recommendations for:

(1) approaches for using state analyses of state data to generate state and sub-state impact estimates for acute effects of air pollution;

(2) approaches for using external Concentration-Response function estimates from the scientific literature to generate local estimates for chronic and acute effects; and

(3) approaches to communicating the estimates and their limitations to stakeholders.

Thank you!

To find out more about HEI's research program
or to download the Accountability Monograph
(HEI Communication 11)
visit our website at *www.healtheffects.org*