

# **Evaluating the Effectiveness of Air Quality Interventions:**

## **HEI's Research Program on Accountability**

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# Why accountability?

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In the US 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

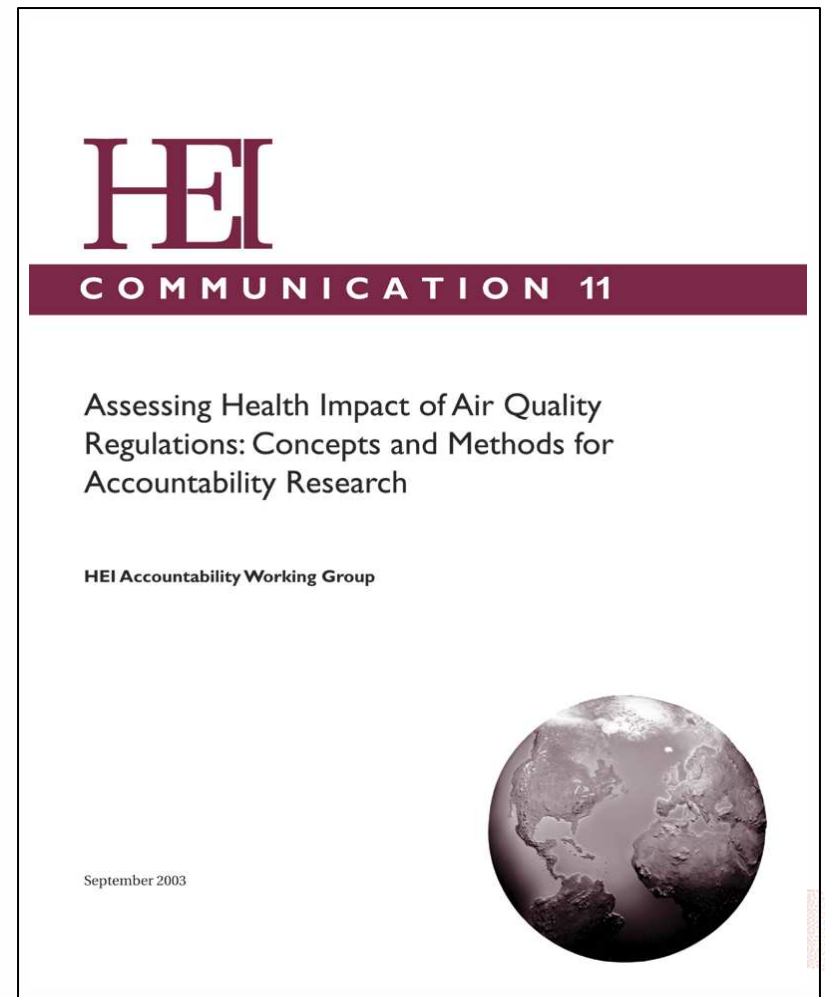


# HEI Communication 11: Concepts and methods for accountability research

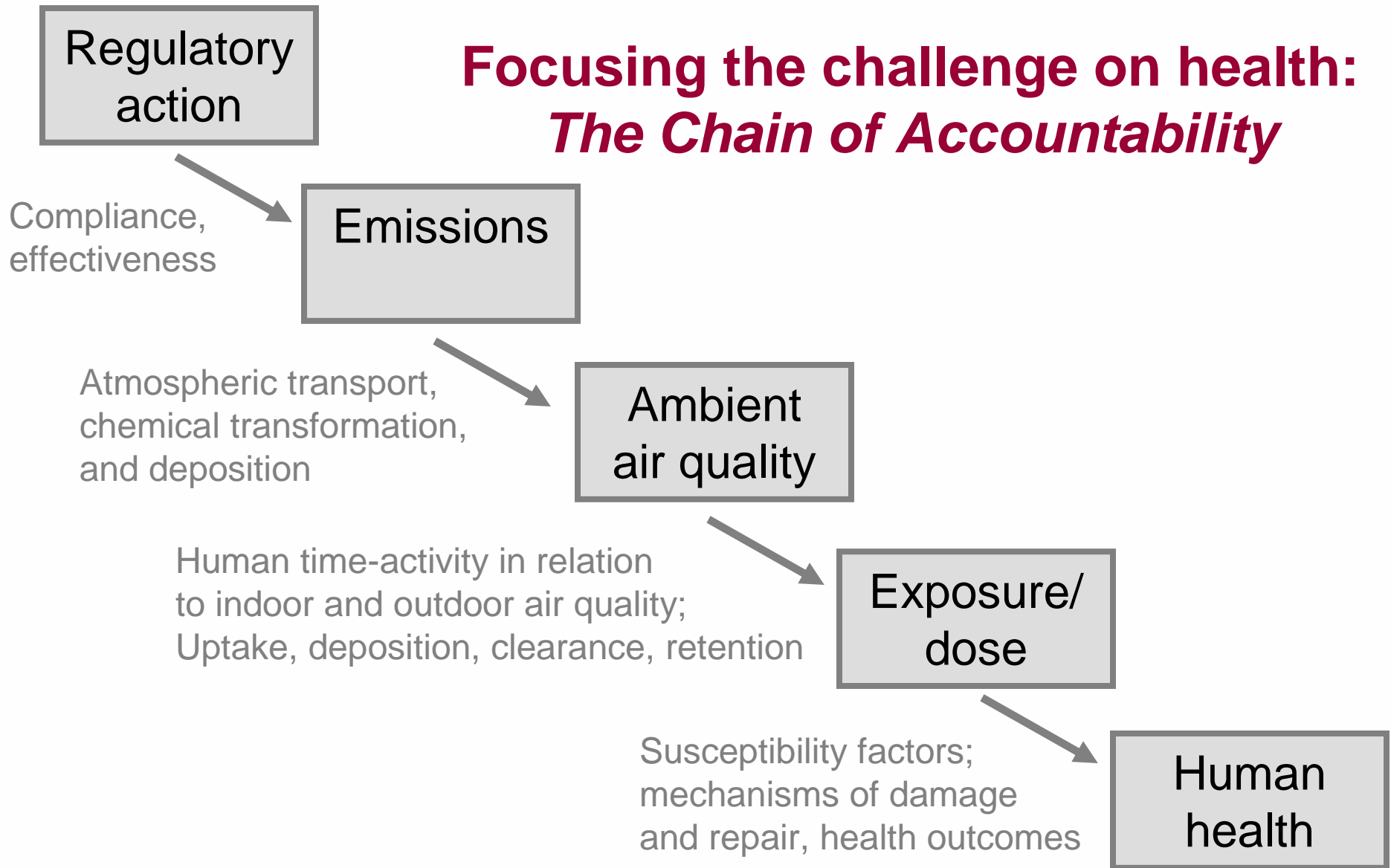
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- Multi-authored monograph published September 2003
- Assessment of the task
- Conceptual framework for future research
- Research directions

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



# HEI studies: Shorter-term interventions

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## Traffic reduction

1. Atlanta 1996 Olympic Games
2. Congestion charging zone in London
3. Low emission zone in London

## 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

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8. 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
9. Regulations requiring decreased SO<sub>2</sub> emissions from powers plants in the eastern United States (Title IV of the 1990 Clean Air Act Amendments)





# 1996 Olympics (Atlanta)

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PI: Jennifer Peel, Colorado State University

- based on earlier study showing a decrease in ozone and childhood asthma (Friedman et al, JAMA 2001)
- focus on emergency department visits and arrhythmic events in patients with implanted cardioverter defibrillators
- comparing before, during and after Olympics; also the same periods in previous and subsequent years
- investigating geographical subsets of the Atlanta metropolitan area



# Congestion charging scheme (London)

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PI: Frank Kelly, King's College London

- 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



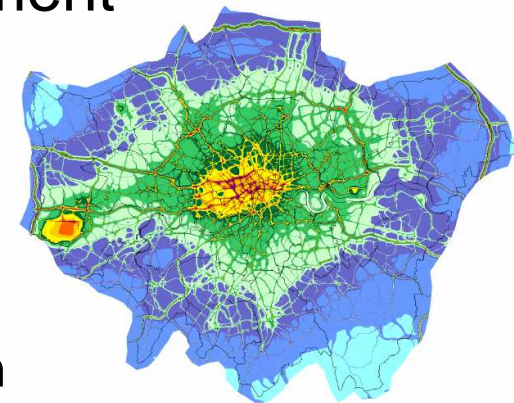




## Low emission zone (London)

PI: Frank Kelly, King's College London

- 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<sub>2</sub> scenario



visit [www.cclondon.com](http://www.cclondon.com) for more information on the CCS and LEZ

# Cleaner wood stoves (Montana)

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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<sub>2.5</sub> 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

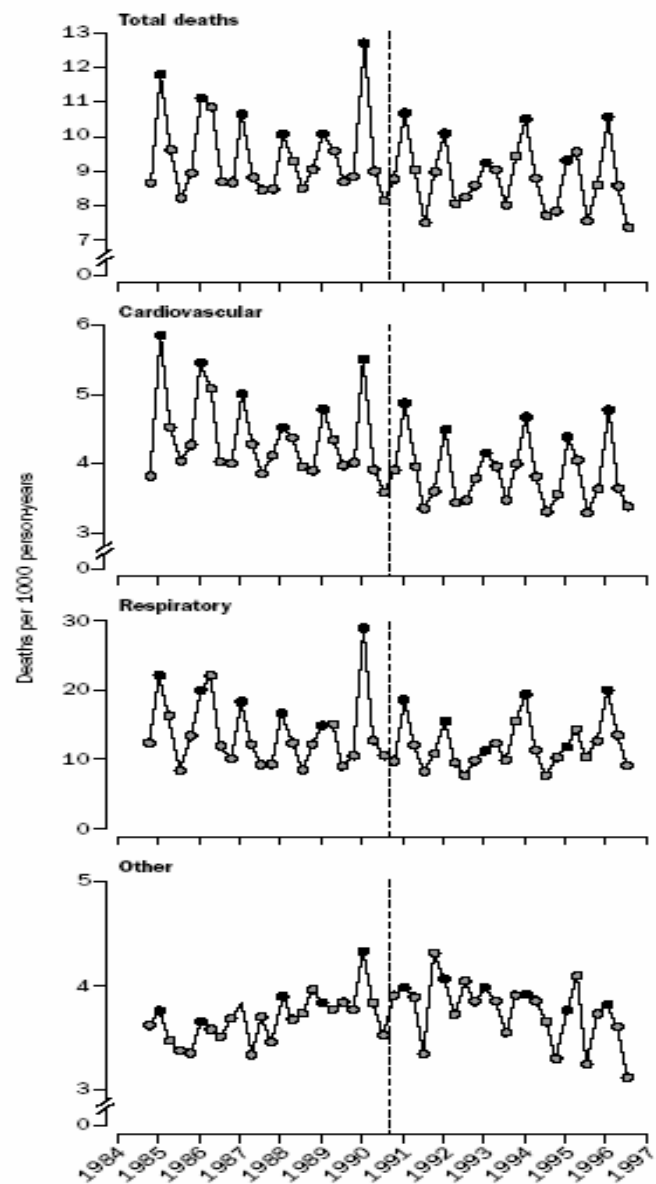
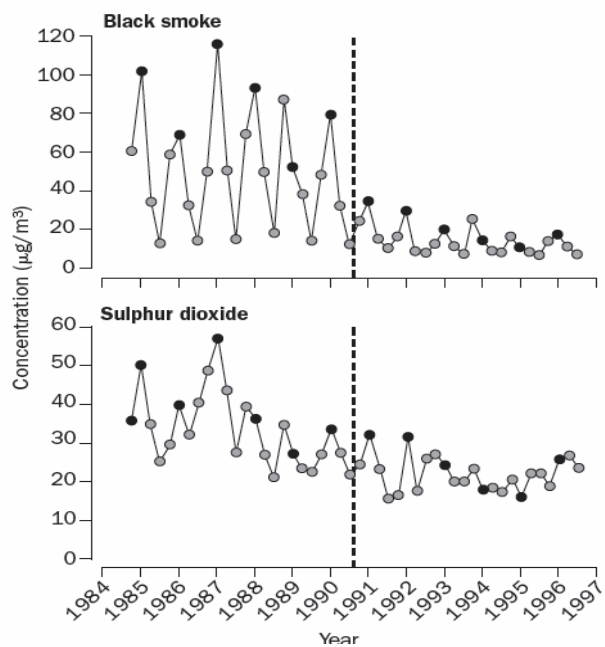
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PI: Douglas Dockery, Harvard School of Public Health

- 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)

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PI: Chit-Ming Wong, University of Hong Kong

- effect of 1990 regulation to reduce sulfur in fuel on AQ in Hong Kong
  - affecting both power plants and vehicles
  - shown to reduce SO<sub>2</sub> 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



AFP/Philippe Lopez



## Hong Kong fuel sulfur content (Hedley et al 2002)

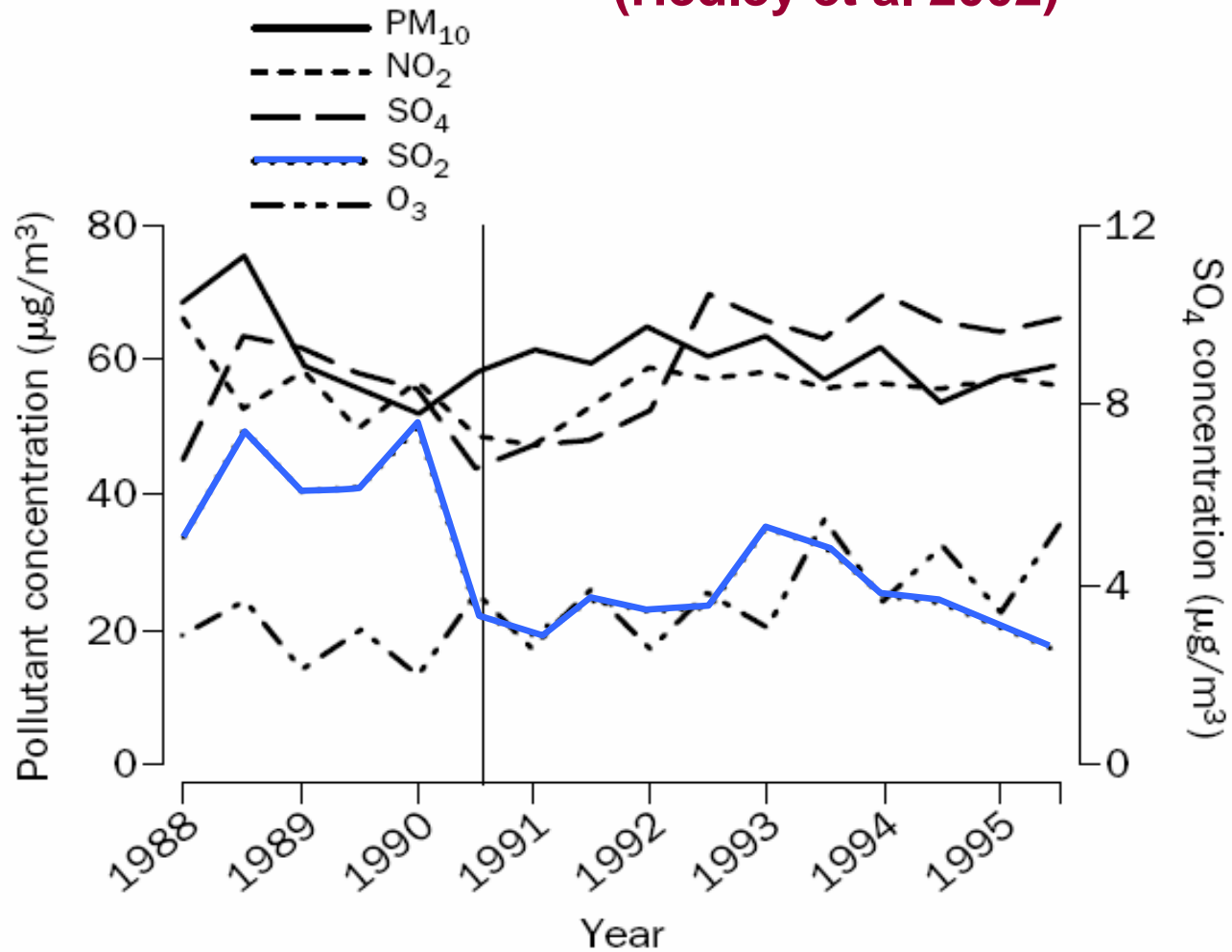


Figure 1: **Average of pollutant concentrations at five monitoring stations**

Vertical line represents date of introduction of fuel regulation.





## 2008 Olympics (Beijing)

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

- 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



# SO<sub>2</sub> from power plants (eastern US)

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PI: Richard Morgenstern, Resources for the Future

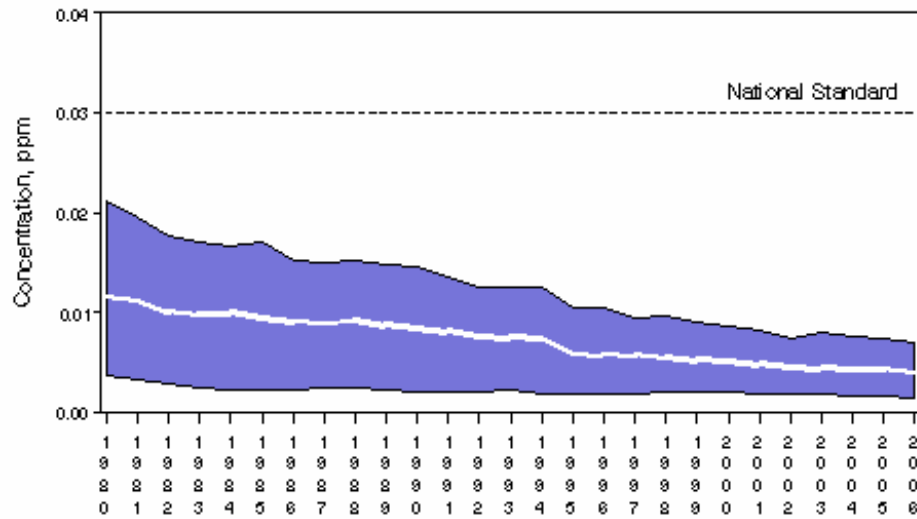
- reduction of SO<sub>2</sub> emissions from power plants under Title IV of the 1990 Clean Air Act Amendments
  - two phases, targeting largest, dirtiest plants first
- source-by-source analysis of to determine where and when reductions occurred
  - using EPA emissions inventories and transaction data
- 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





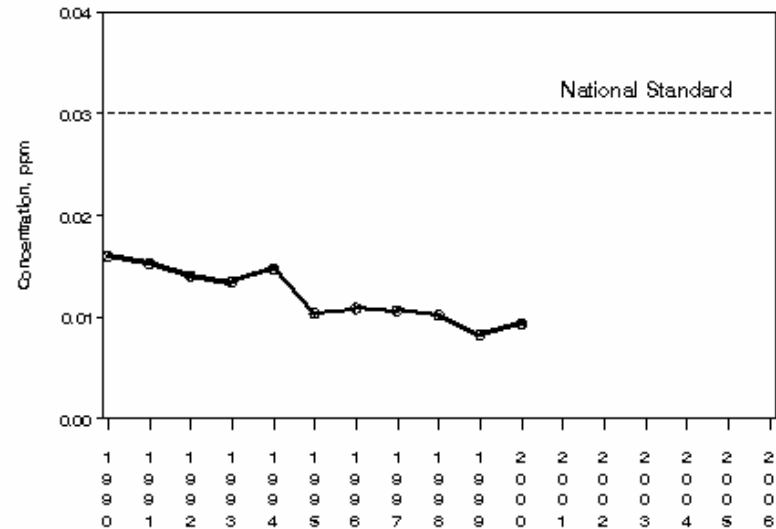
# SO<sub>2</sub> air quality trends (EPA)

**SO<sub>2</sub> Air Quality, 1980 — 2006**  
 (Based on Annual Arithmetic Average)  
 National Trend based on 154 Sites



1980 to 2006 : 66% decrease in National Average

**SO<sub>2</sub> Air Quality, 1990 — 2006**  
 (Based on Annual Arithmetic Average)  
 Pittsburgh, PA  
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Pittsburgh, PA

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



# German reunification

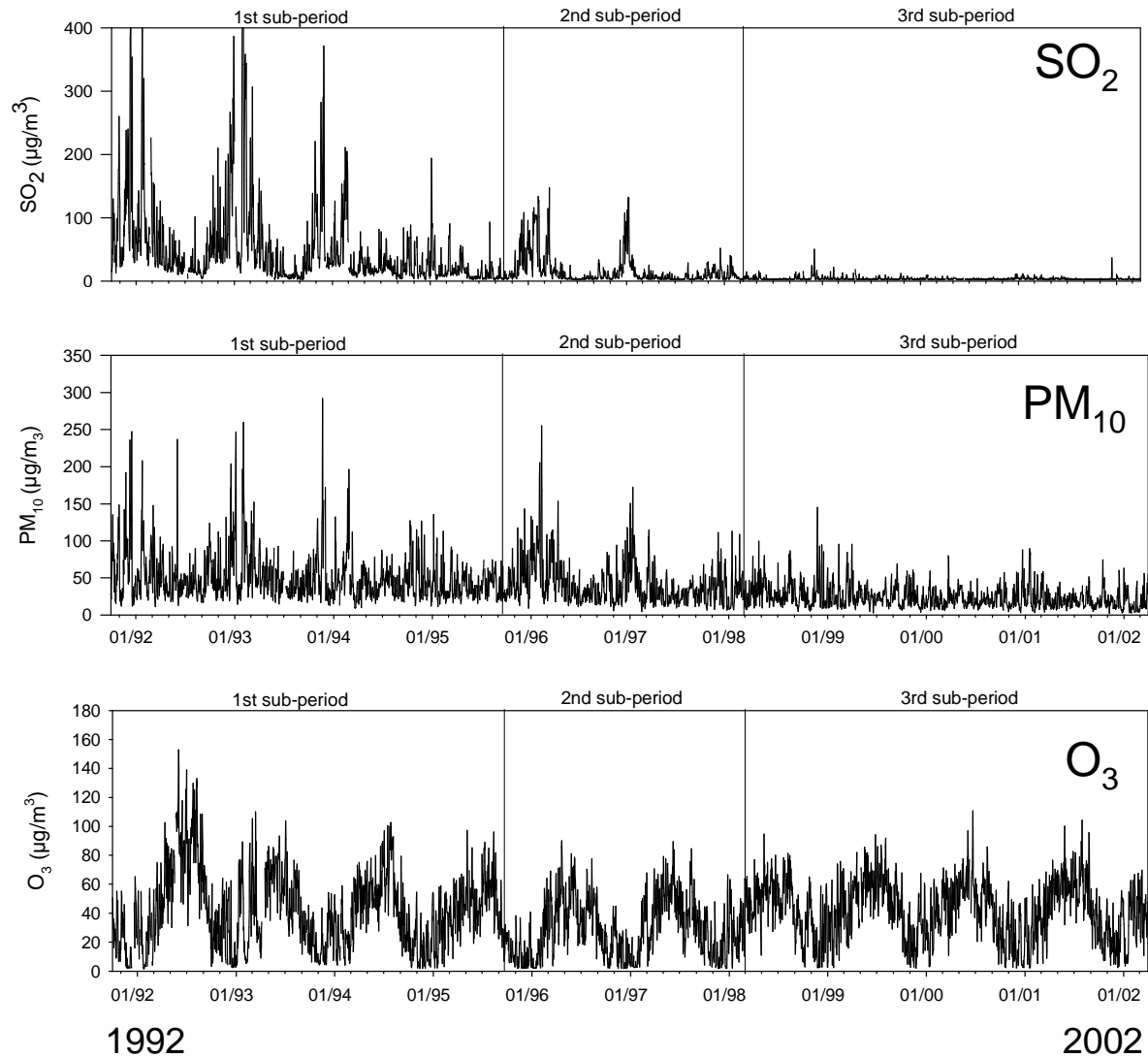
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PI: Annette Peters, GSF-National Research Center for Environment and Health (study completed and under review)

- 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)



# Time series of air pollutants in Erfurt (1992–2002) (Peters et al, in review)



## What's ahead:

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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

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

*Investigators who have identified a unique opportunity to study accountability should contact HEI*



# 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](http://www.healtheffects.org)



# Some issues and questions:

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- Which types of interventions are effective at reducing emissions / exposure / health effects?
  - Evaluate step-change vs. gradual change in AQ
- Role of study design and data analysis; methods development
  - Large, periodical, random monitoring to track population exposure (including use of biomarkers) versus smaller scale studies of specific subpopulations
  - How to select appropriate health outcomes
  - How to obtain adequate pre-intervention baseline data
  - Compare model-based predictions with actual outcome
- How to pursue unique opportunities (intentional, unintentional) that come up relatively quickly
  - Opportunities at national, regional, local levels
  - Identify and publicize opportunities
- Do accountability studies provide unique opportunities to study health effects of specific sources? What about causality?

