

Innovations in Environmental Governance

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Agenda

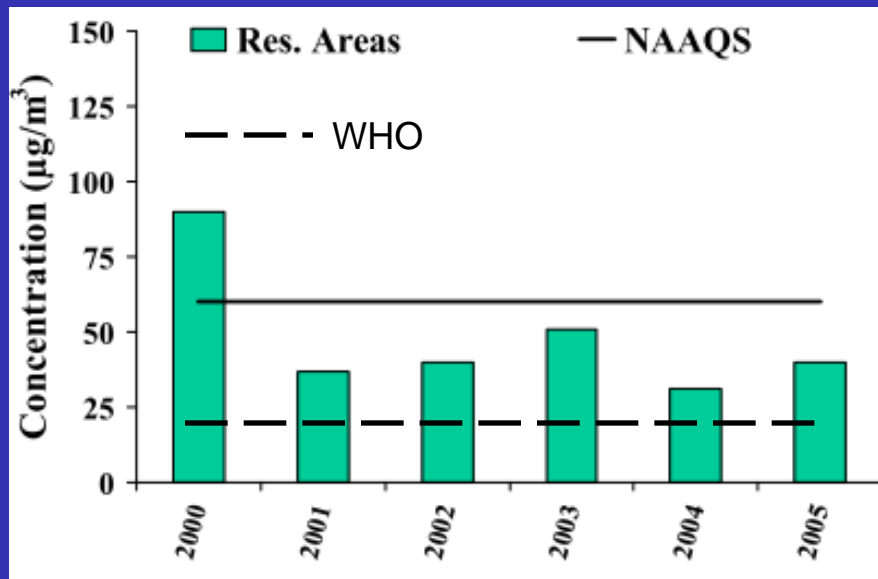
- 1 Why regulate? The case of Air Pollution
- 2 How to improve regulatory bite?
- 3 Improve Auditor Incentives: Environmental Audit Reform In Gujarat (with Duflo, Greenstone, Ryan)
- 4 Market Design: Emissions Trading Scheme in India (with Greenstone, Ryan, Sudarshan)

Air Pollution

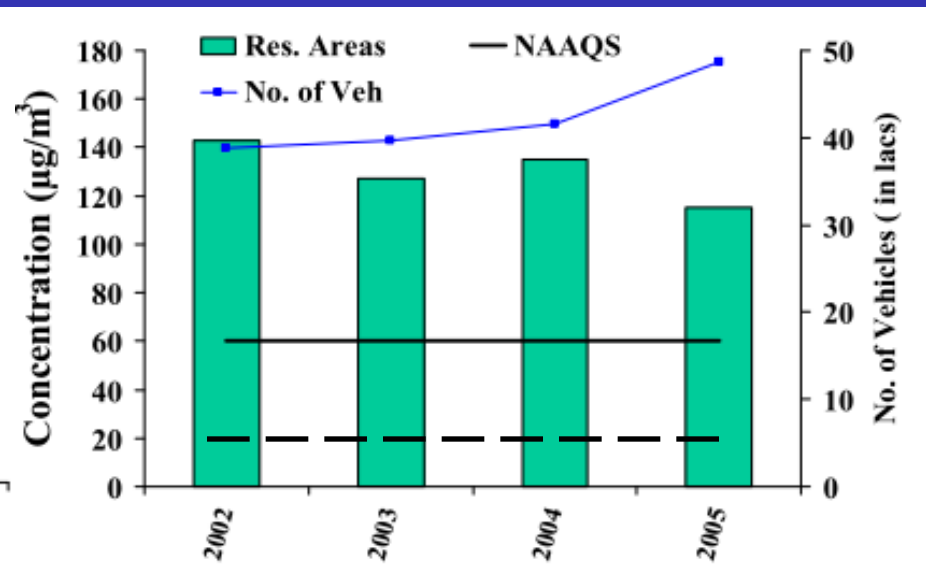
- Over the next 20 years, India's urban population is expected to rise to 50%
 - Over 60 cities of 1 million+
- Most large Indian cities violate NAAQS for RSPM ($60 \mu\text{m}/\text{m}^3$)
 - MoEF says air pollution caused 40,351 premature deaths in only 36 cities of India in 1995
- Weak evidence that economic growth will naturally lead to cleaner environment



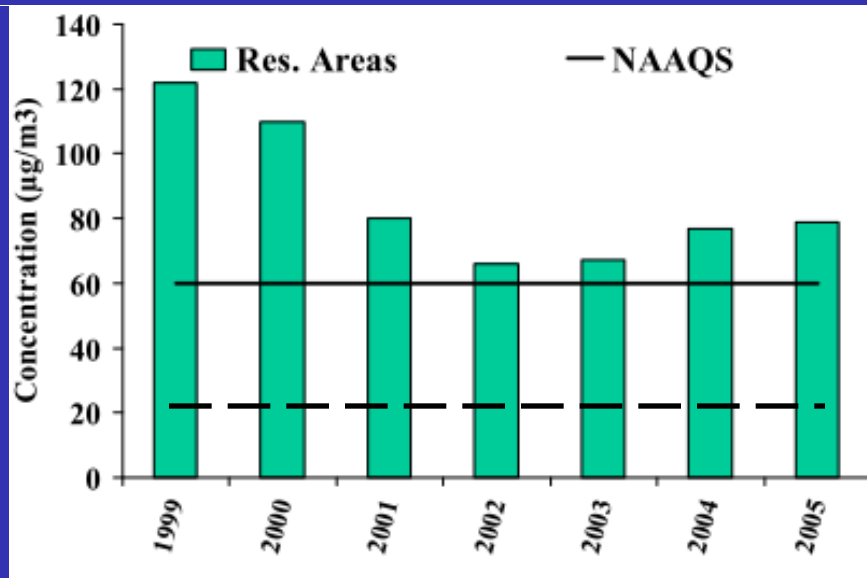
RSPM TRENDS: CHENNAI



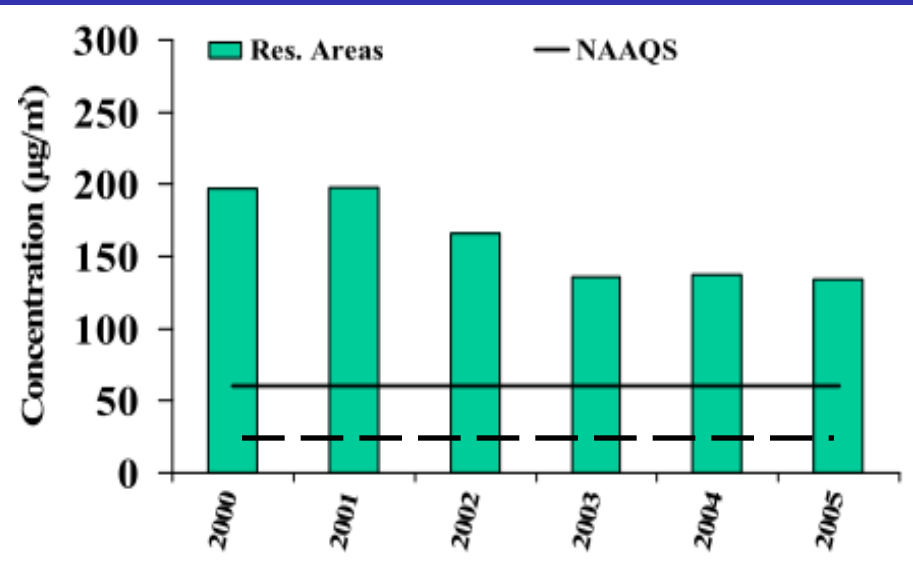
RSPM TRENDS: DELHI



RSPM TRENDS: MUMBAI



RSPM TRENDS: AHMEDABAD



Source: Central Pollution Control Board (2006)

Reducing harmful pollution

- The effectiveness of regulation is not clear
 - Environmental literature.
 - U.S. EPA inspections work (Hanna & Oliva, 2009).
 - Indian regulations mixed (Greenstone & Hanna, 2010).
 - Not purely a developing-country gap: traditional government action has been effective in other difficult settings (Olken 2007).
 - Growth literature.
 - Excessive labor and licensing regulation hurt growth in India (Besley and Burgess, 2004; Aghion et al. 2008).
 - Is environmental regulation more of the same?

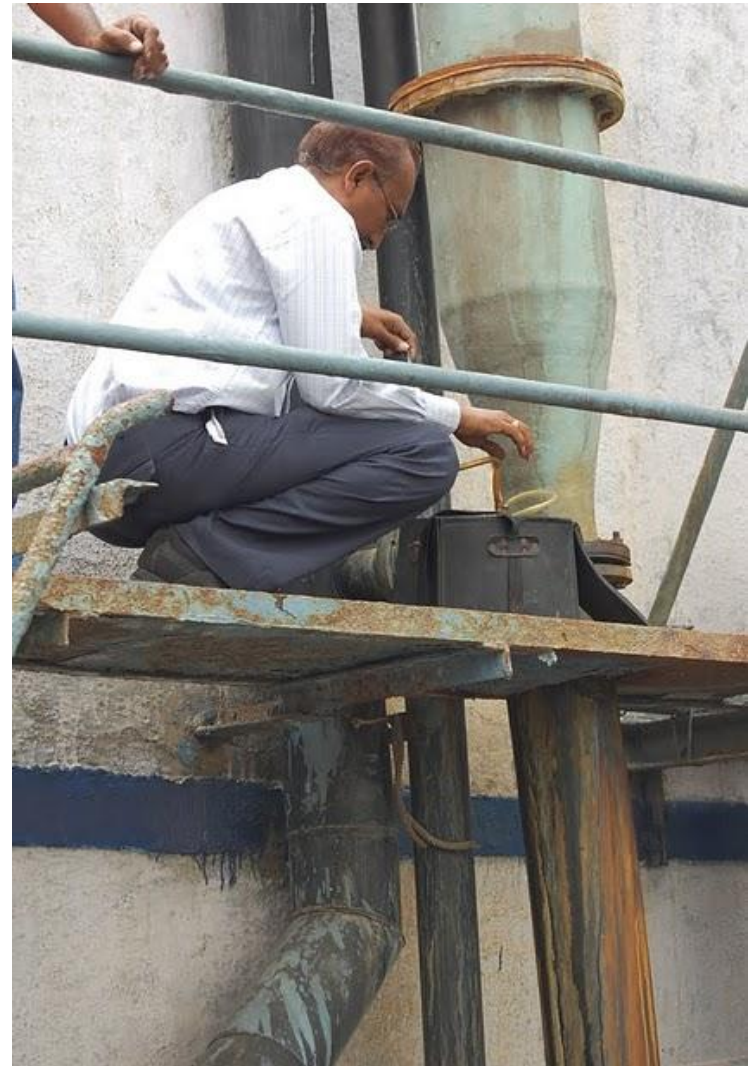
Study Context



- Indian environmental Regulation entirely traditional command-and-control.
 - Central Pollution Control Board (CPCB) sets strict guidance for industrial emissions.
 - State Pollution Control Board enforces standards, required to be at least as stringent as central guidance.
 - Intervention by court system, through public interest litigation (PIL), for egregious cases.
- Enforcement and Compliance Weak

Study interventions

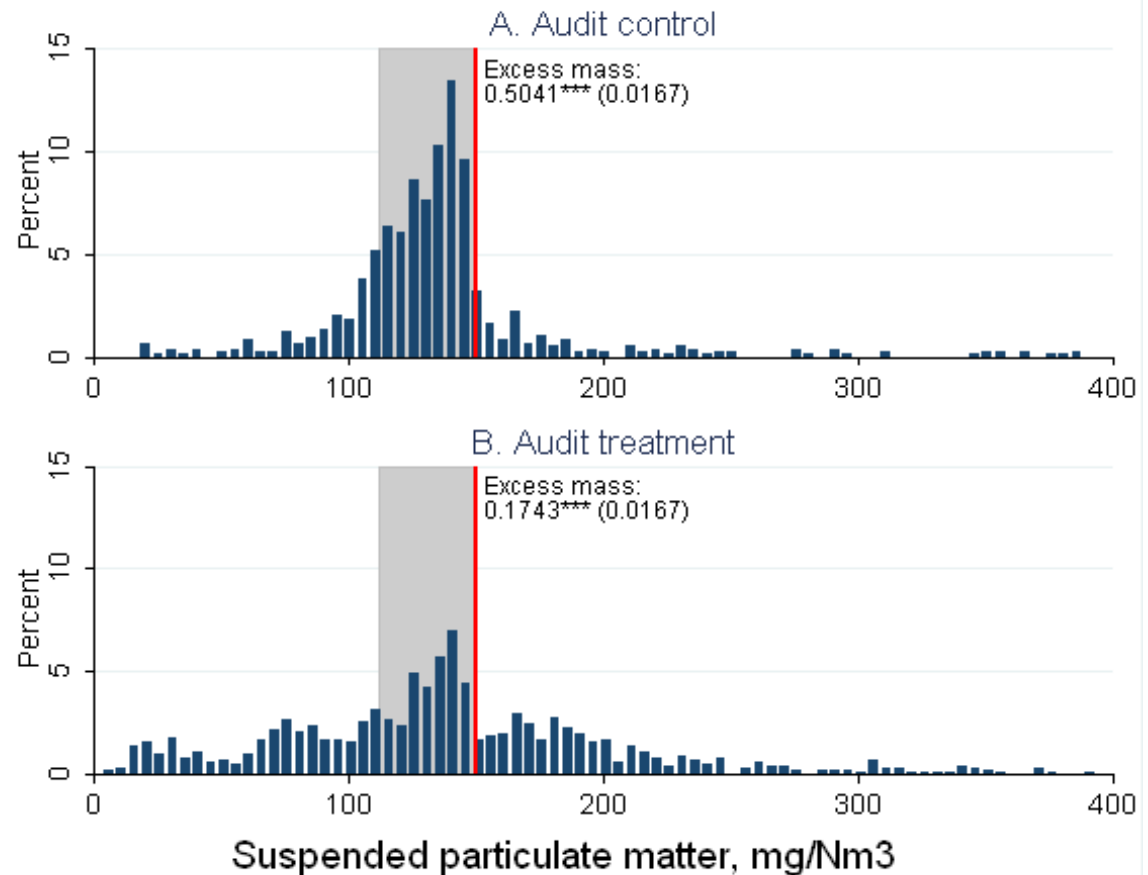
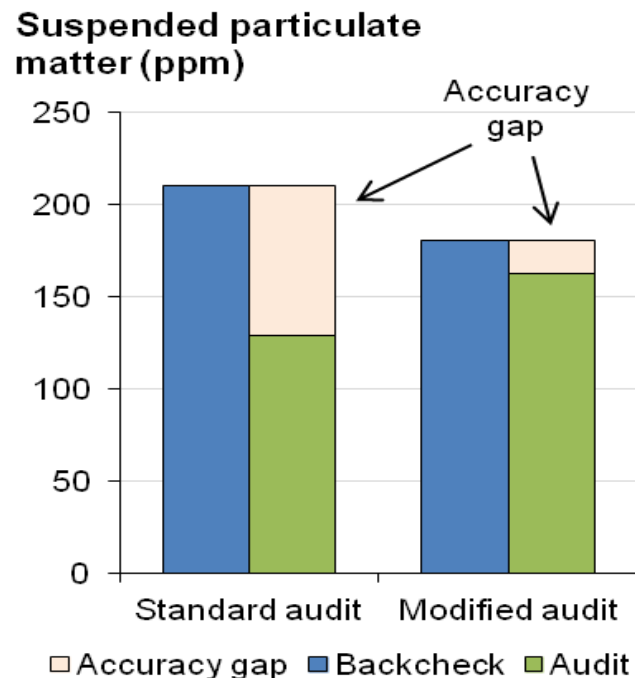
- Environmental audits by private auditors mandated by Gujarat High Court in 1996
- Innovation: Improve incentives for accurate reporting by making auditors independent
 - Auditors randomly assigned to firms, rather than being selected
 - Auditors paid from central pool, rather than by firm
 - Auditors back-checked on pollution readings
- Nearly 30 auditors auditing over 200 plants in this study for two years, 2009 and 2010
 - *Same* audit firms working at the same time in the control group
 - True pollutant value measured with back-checks after audits



Independent Auditors provide more accurate reports

Modified audits much closer to true pollution reading on average . . .

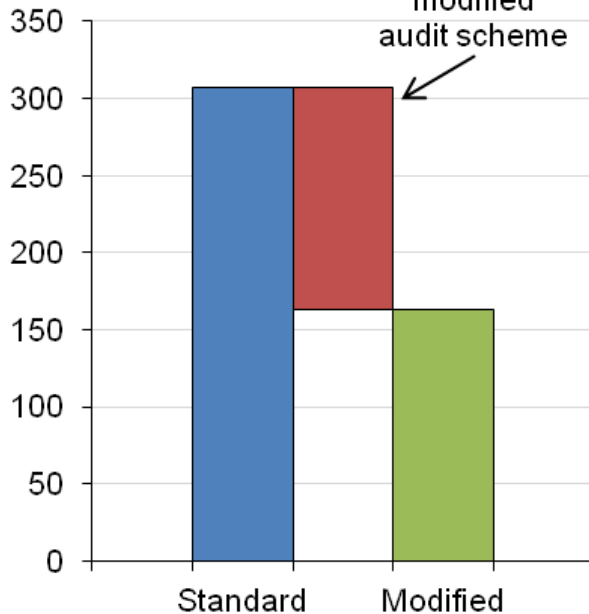
With much of this difference coming from far less clustering beneath the standard



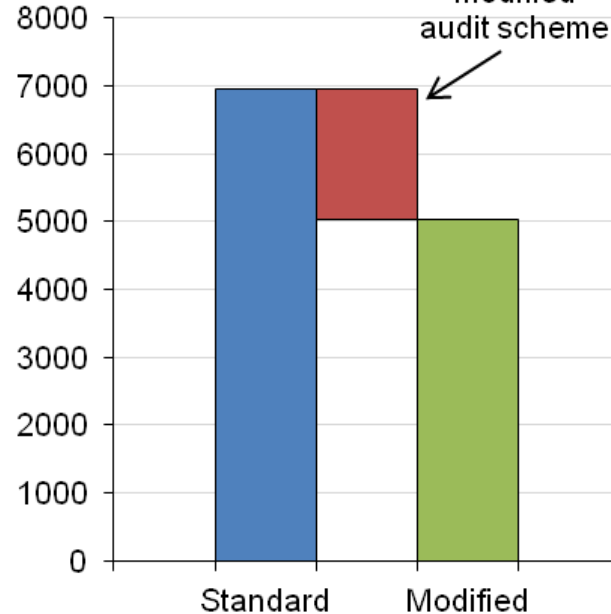
Firms respond by reducing Pollution

Pollutant Concentrations from Firms under Standard Scheme (Blue) and Modified Scheme

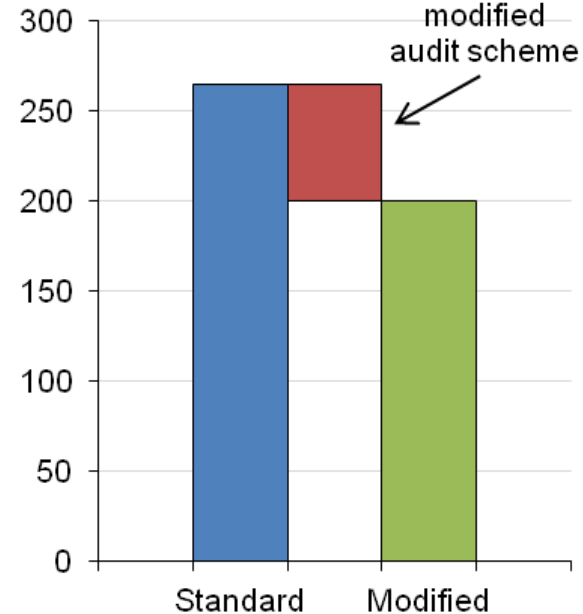
Biochemical oxygen demand (mg/L)



Total dissolved solids (mg/L)



Suspended particulate matter (ppm)



Second Innovation: How Does Market Based Regulation Help?

Regulating what Matters at level (area) that matters

- Emission caps on SPM restrict the mass of SPM emitted
- Total mass emitted directly affects health
- Concentration standards DO NOT constrain total mass

Transparent and Public Monitoring

- Use technology to monitor emissions in real time
- Data can be made public, violations instantly detected
- More stringent monitoring possible than manual inspections

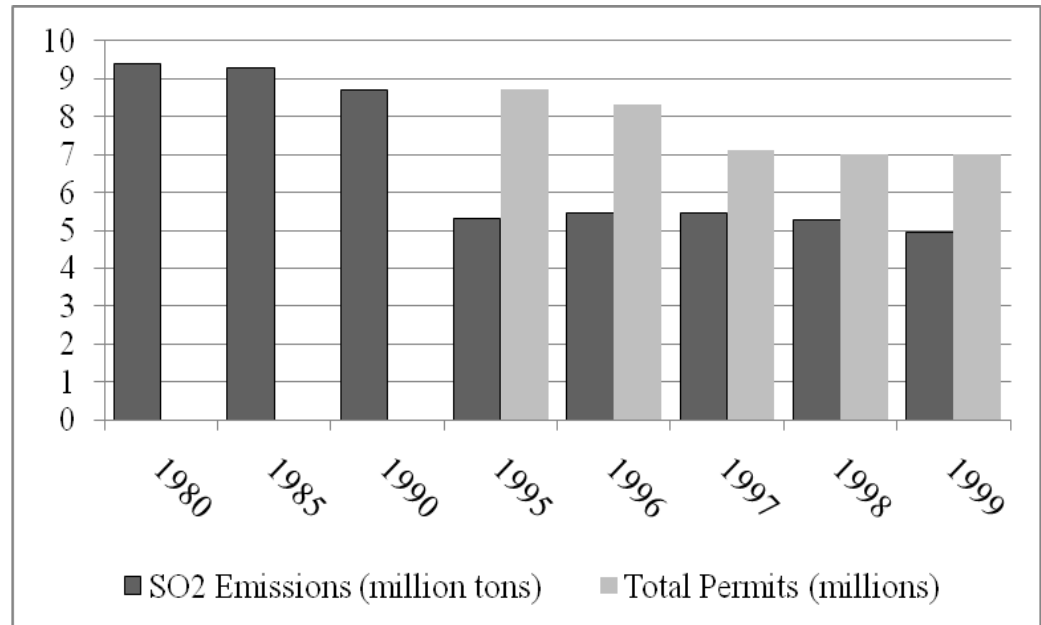
Reduced Compliance Costs

- Greater industry cooperation towards achieving environmental goals

Second Regulatory Innovation: Pilot Emissions Trading Scheme

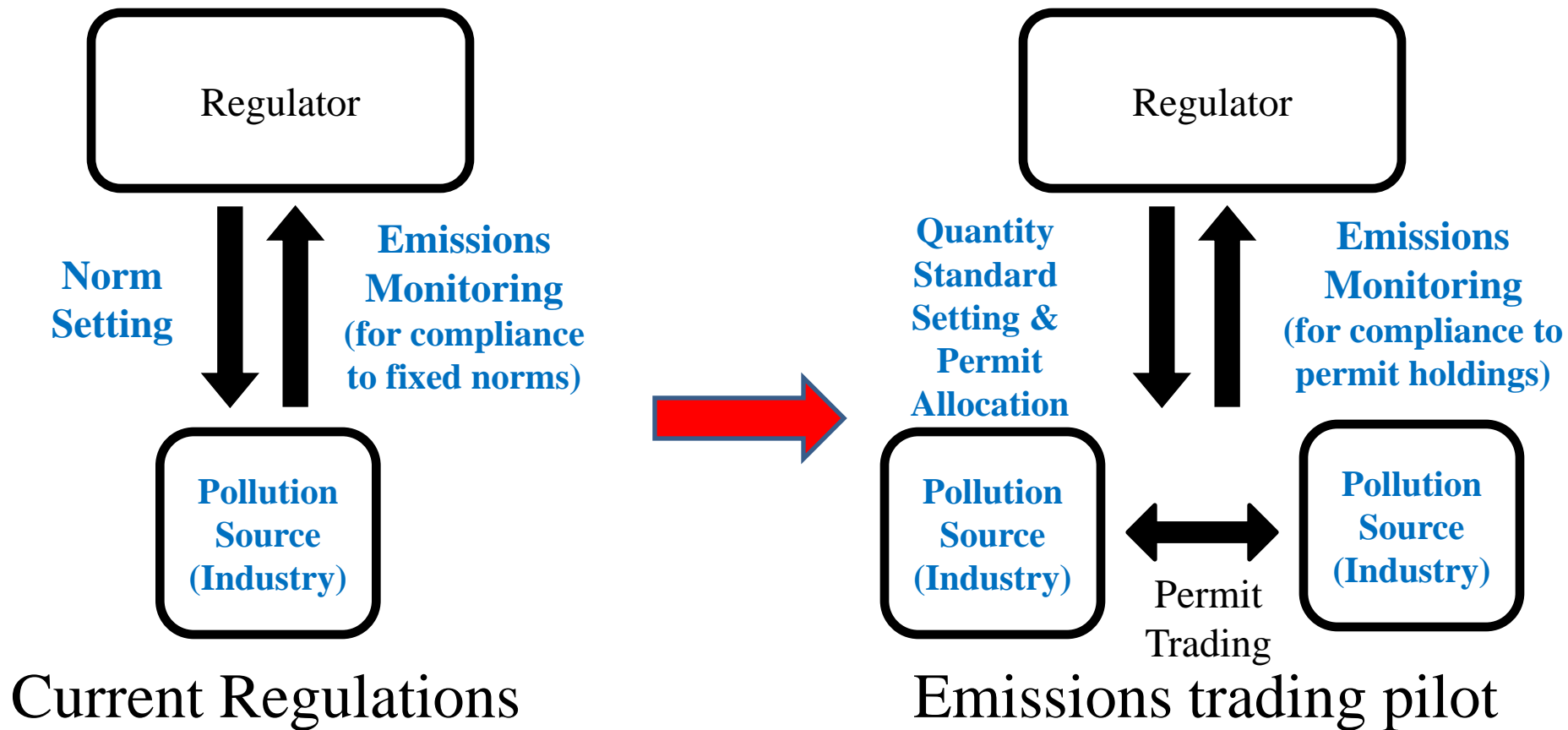
- Regulatory powers for ETS exist within the current legal framework.
- Proven track-record of success in addressing tough environmental problems (**Figure 1**)

Figure 1: Total Emissions in the U.S. Acid Rain Program, 1980—1999
The cap-and-trade scheme sharply reduced emissions in its first year, 1995



Source: EPA (2009c).

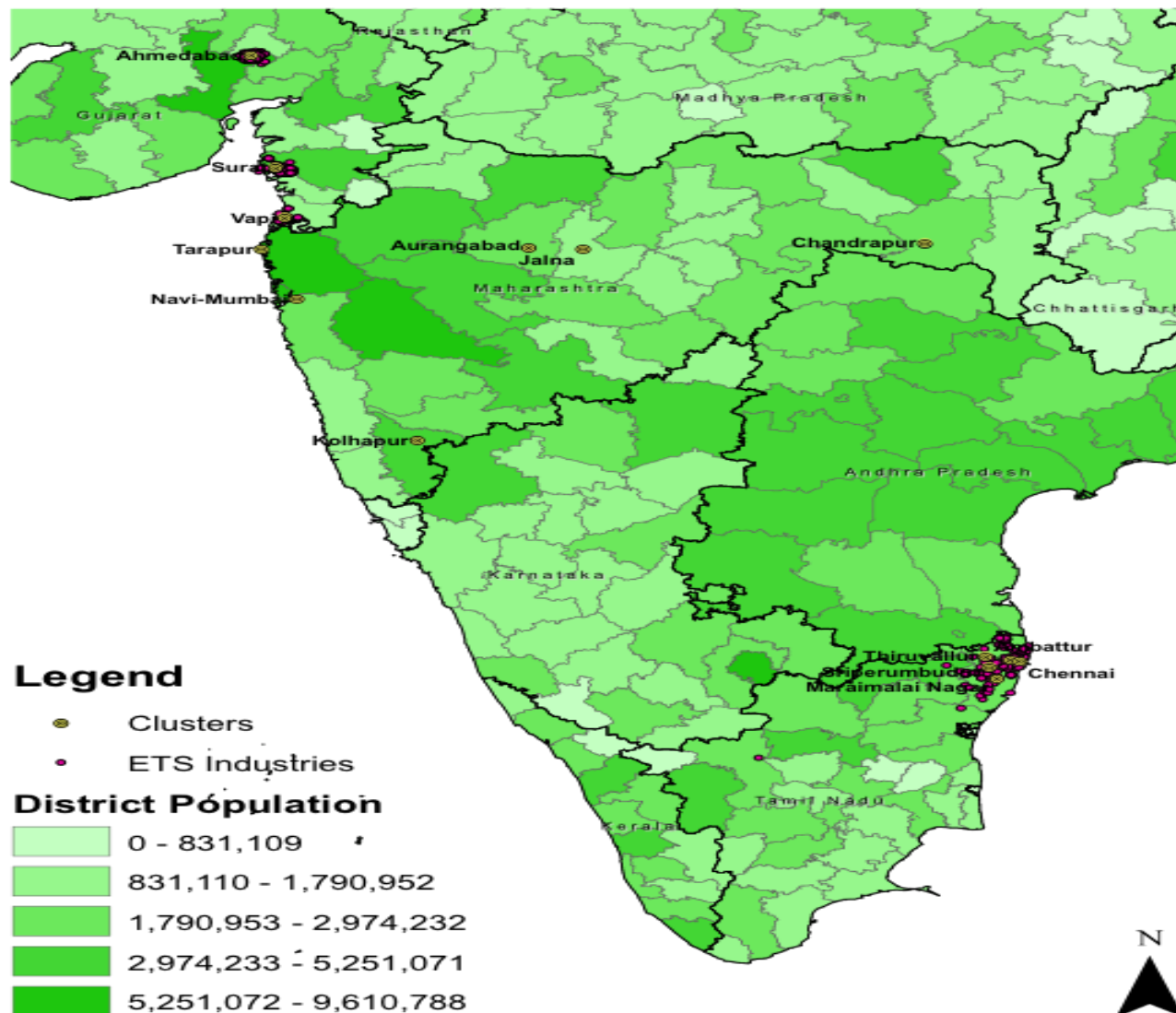
Emissions Trading Systems have Two Fundamental Advantages



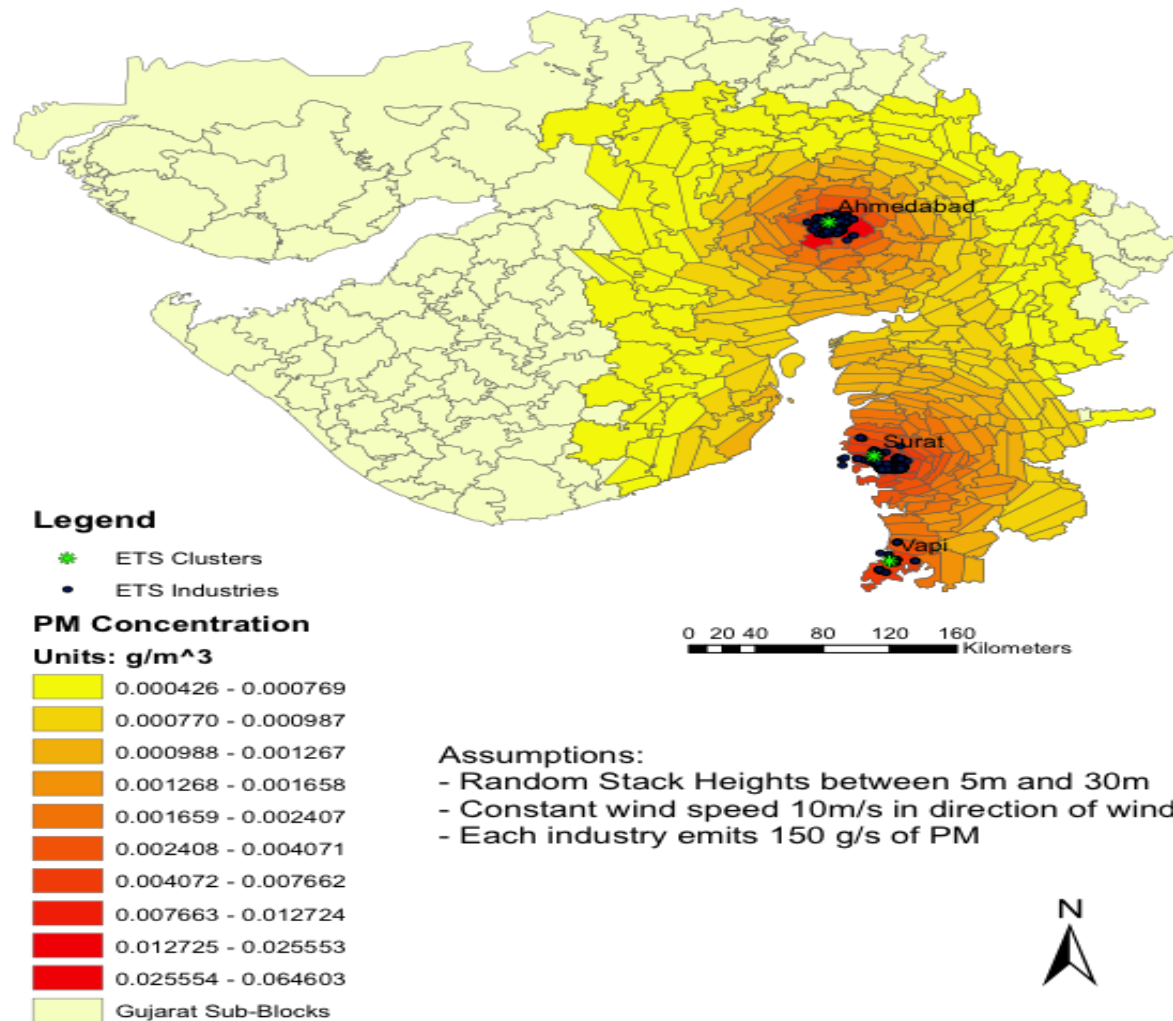
1. Area-wide cap limits total emissions
2. Ability to trade lower costs to industry

India ETS Industries Against Population by District

Sample

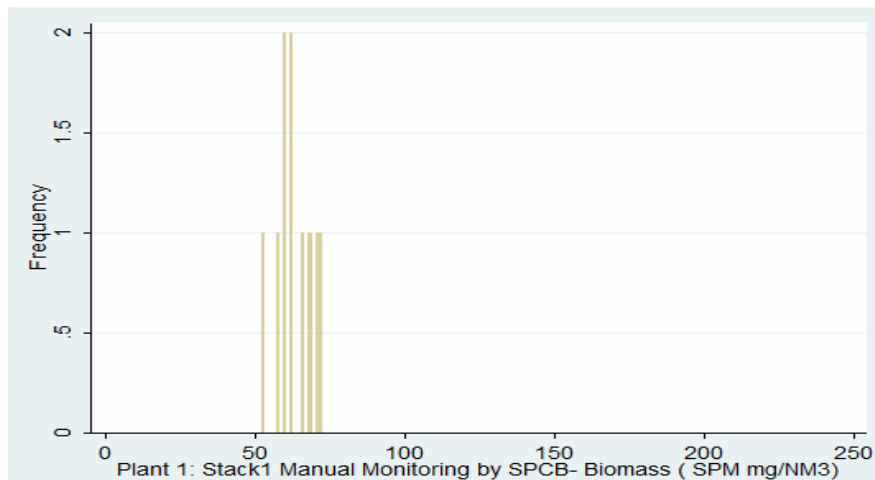


Gujarat Sub-Block Pollution Diffusion Map: PM Concentration from ETS Pilot (g/m³)

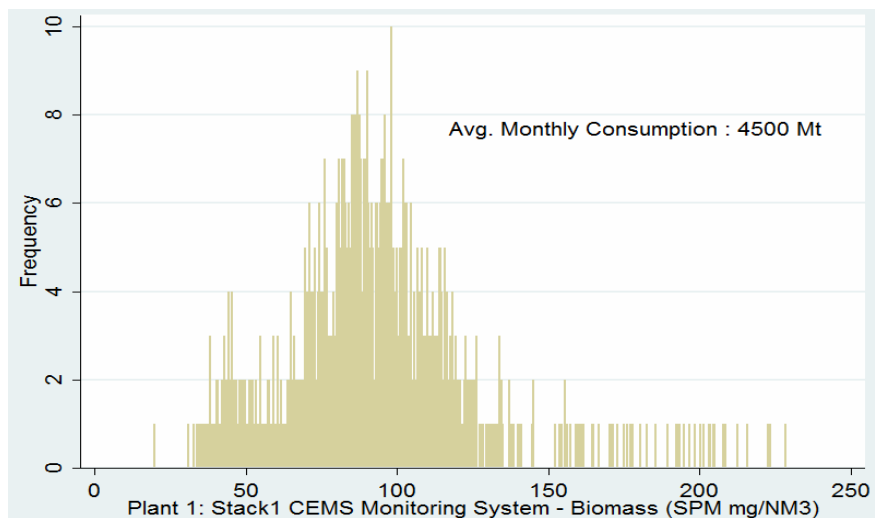


Empirical Evidence: Better Monitoring

Manual Monitoring



CEMS Monitoring



ETS Evaluation Design

Firms Divided into Research Groups (Random Assignment)					Research Question
Phase 1.a	CEMS		No CEMS		<i>Measure the effect of continuous emissions monitoring</i>
Phase 1.b	CEMS		CEMS		
Phase 2	Trading	No Trading	Trading	No Trading	<i>Measure the effect of market-based regulation</i>

Policy and Research Innovation Together

- Weak evidence for which environmental regulations work and difficult to identify which past approaches worked best
 - Areas with more stringent regulations are typically more polluted.
 - Hard to measure key economic parameters such as cost to industry.
 - Pilot regulatory experiments give an opportunity to test program before moving to greater scale
 - Possible adoption of independent audits in Gujarat and expansion in Maharashtra
 - ETS has great potential for a range of areas and pollutants
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