Non-Traditional Sources of Pollution in Indian Cities

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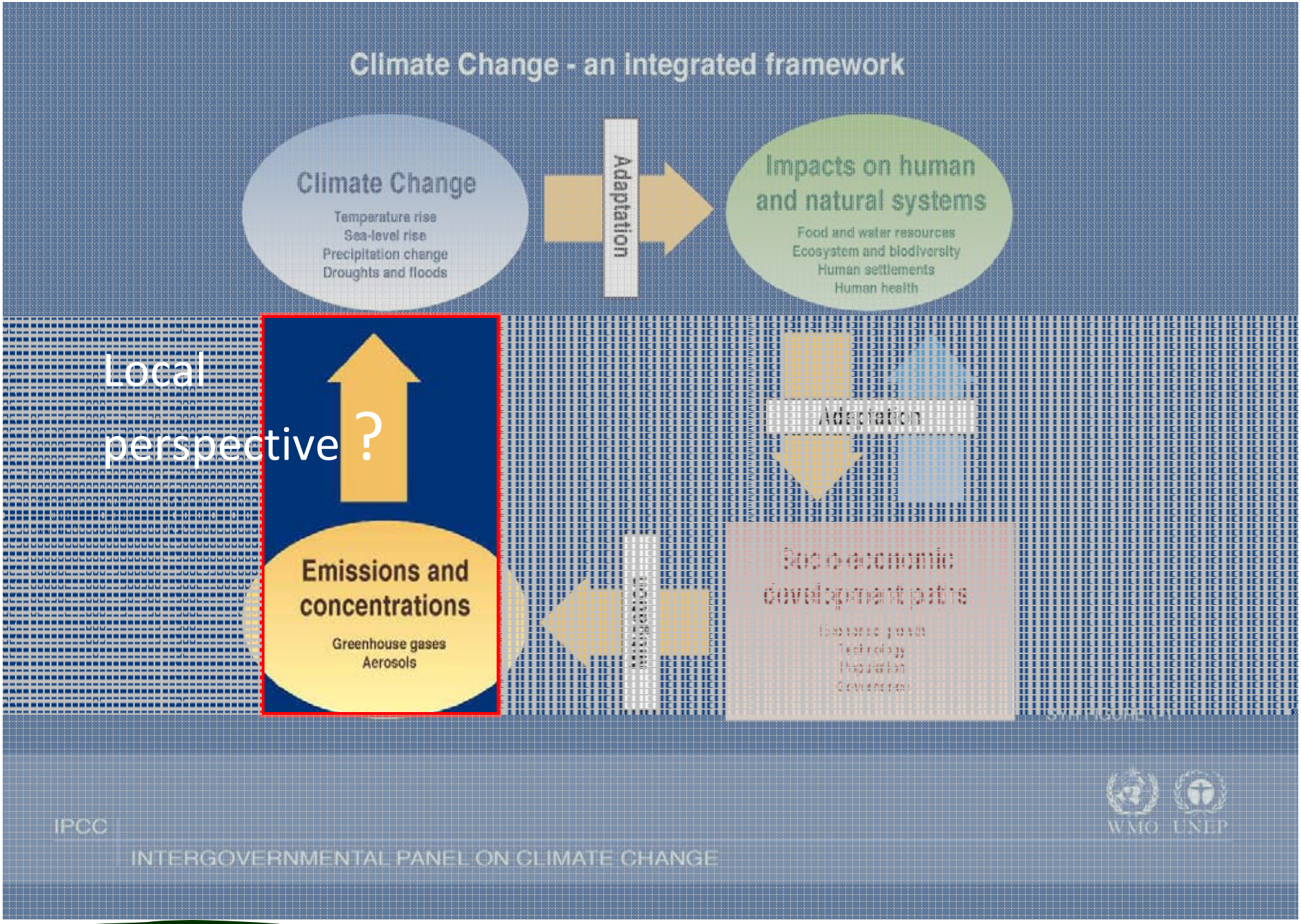
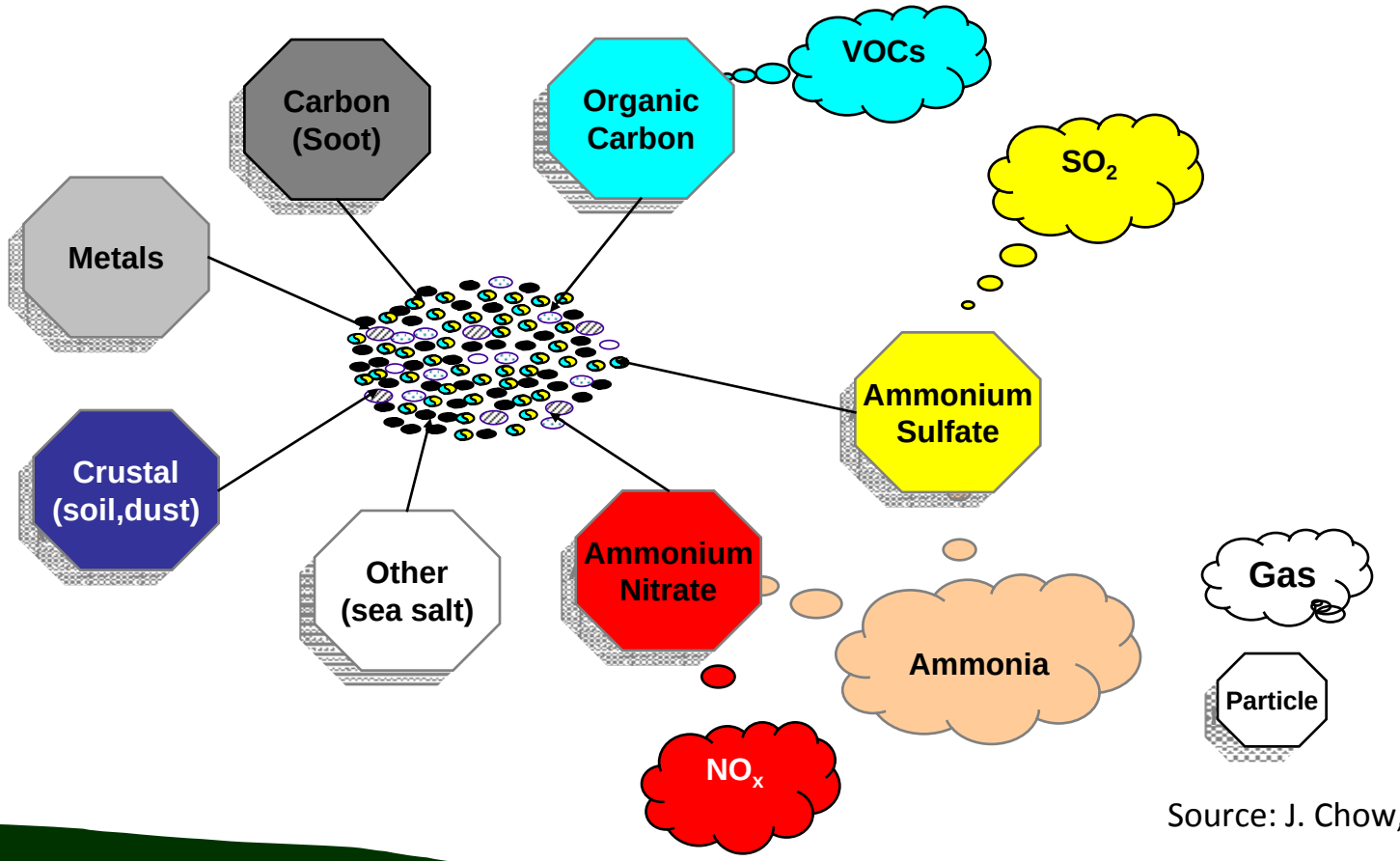

Climate Change - an integrated framework
Climate Change
Temperature rise
Sea-level rise
Precipitation change
Droughts and floods
Adaptation
Impacts on human and natural systems
Food and water resources
Ecosystem and biodiversity
Human settlements
Human health
Local perspective ?
Emissions and concentrations
Greenhouse gases
Aerosols
Mitigation
Socioeconomic development paths
IPCC
INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE
WMO UNEP

PM

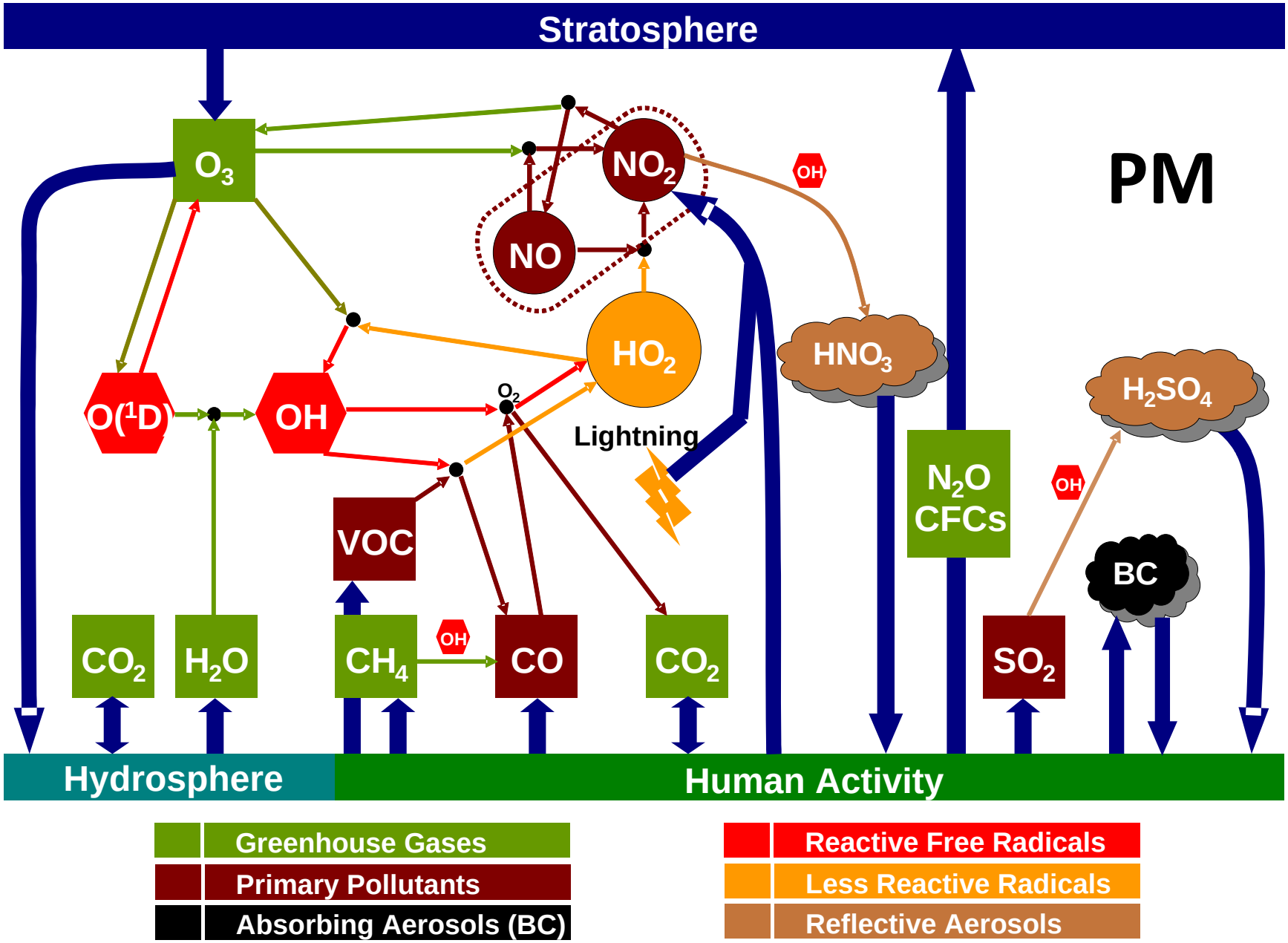
Chemical composition gives an indication of the sources

Primary Particles
(directly emitted)

Secondary Particles
(from precursor gases)

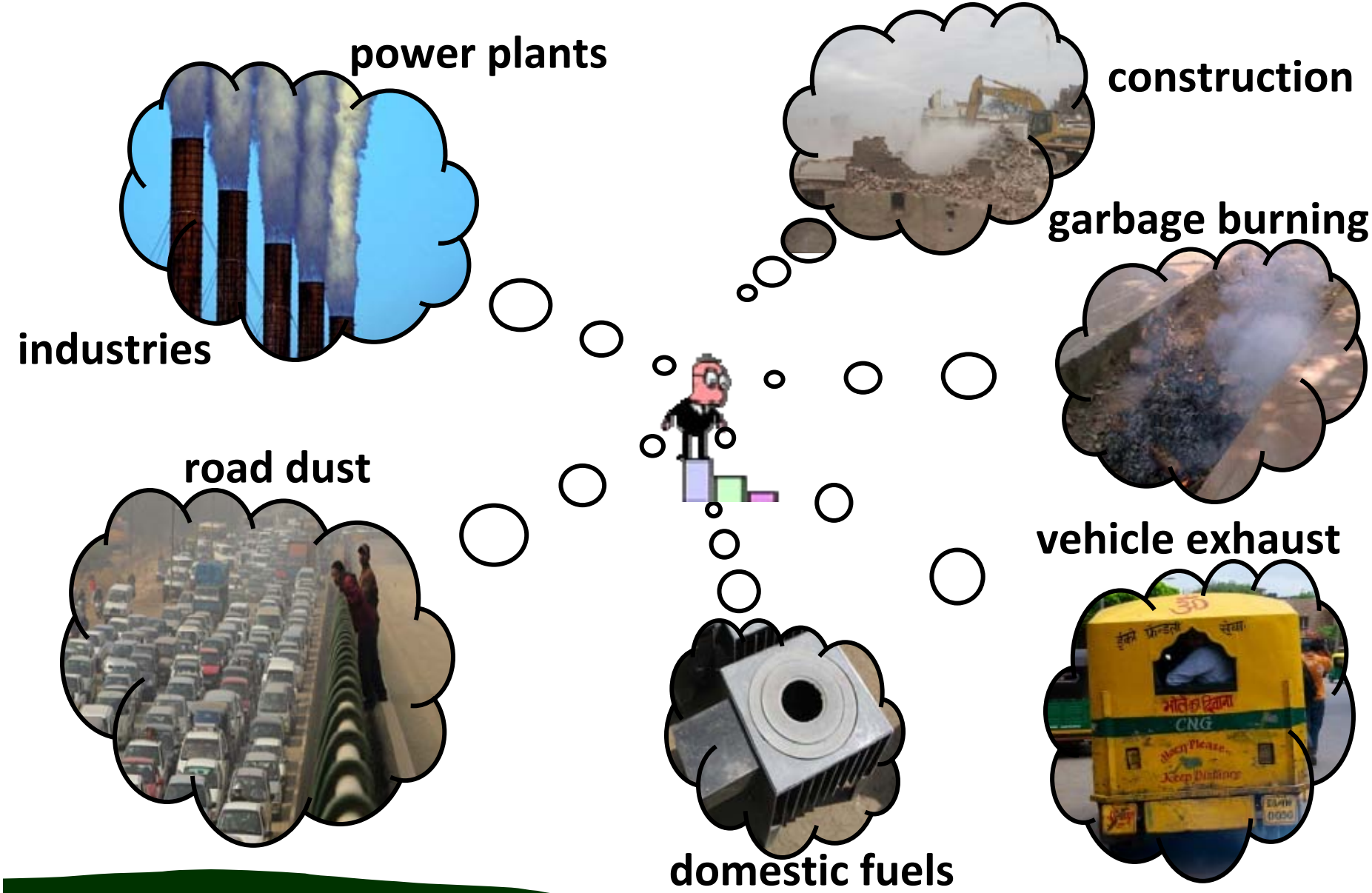


Source: J. Chow, DRI



Source: Riely, MIT

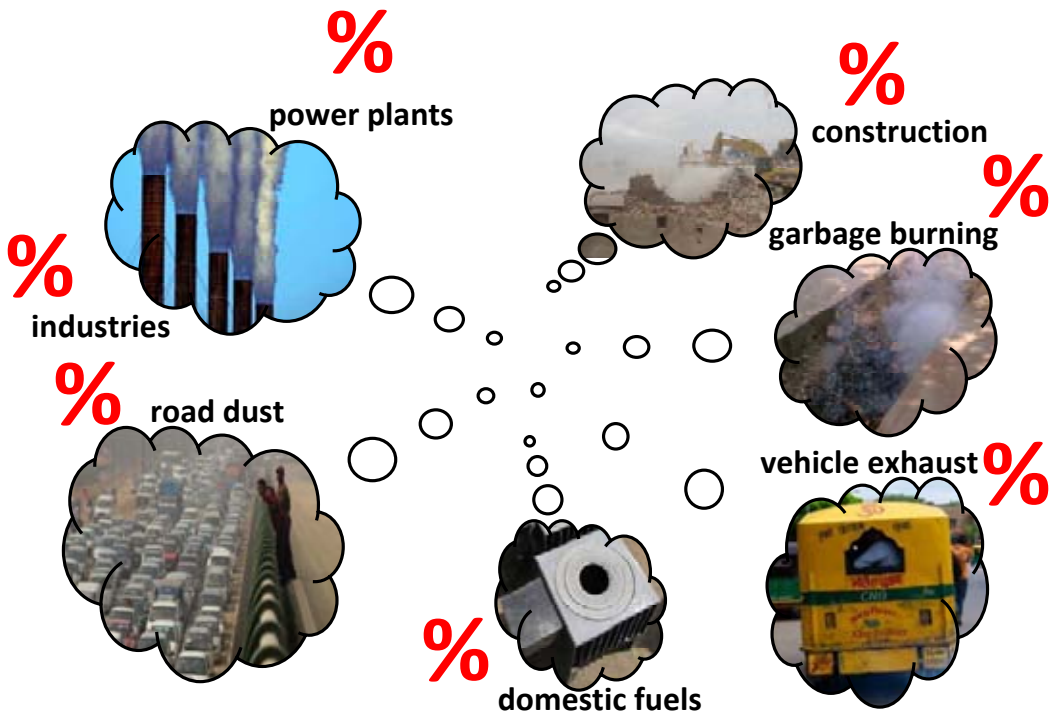
Traditional known sources



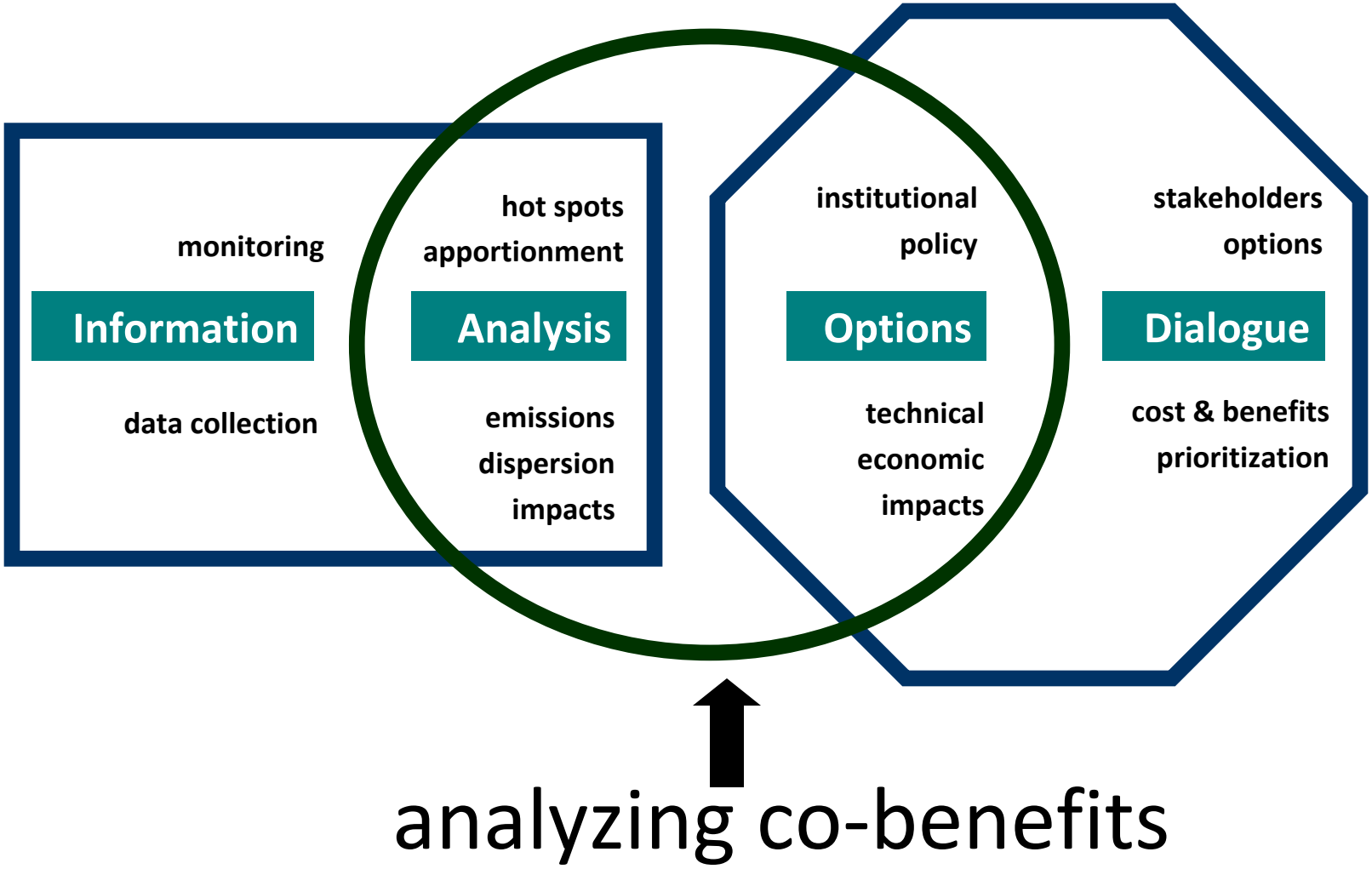
Results, using..

Monitoring data
Chemistry of the pollutants
Geographical knowledge
Meteorology
Modeling

Consolidated decisions

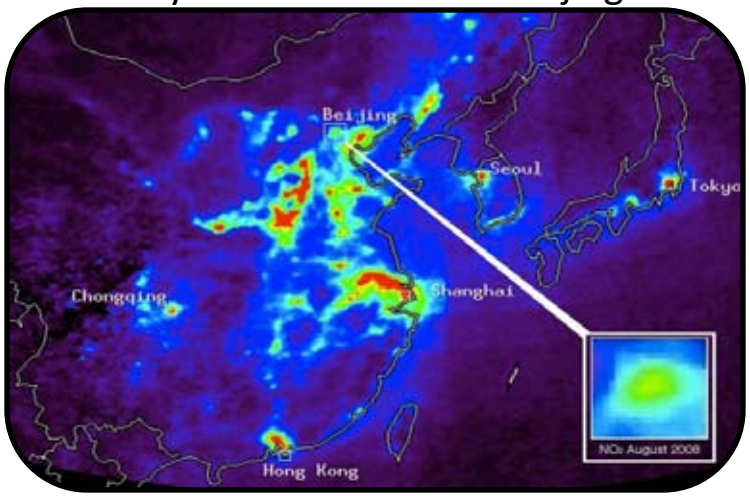


How are we addressing these gaps?



2008 Olympic Games – Beijing, China

Photo Diary of Air Pollution in Beijing



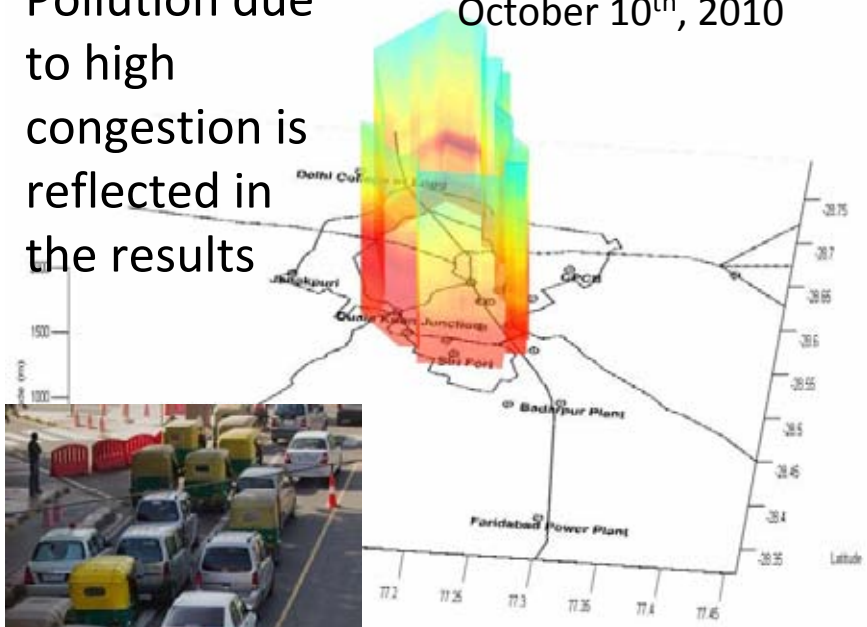
50% drop in the NOx concentrations, during the 2 months of Olympic interventions.

2010 CW Games - Delhi, India

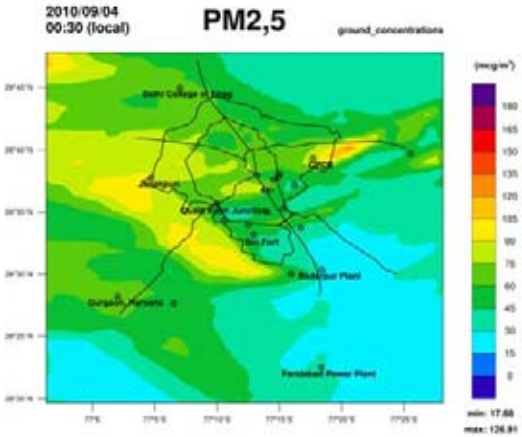
Mobile lidar monitoring provided spatial and temporal evolution of pollution during the games.

Pollution due to high congestion is reflected in the results

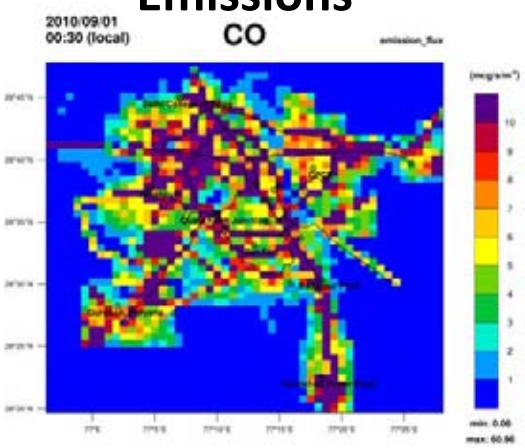
October 10th, 2010



Concentrations

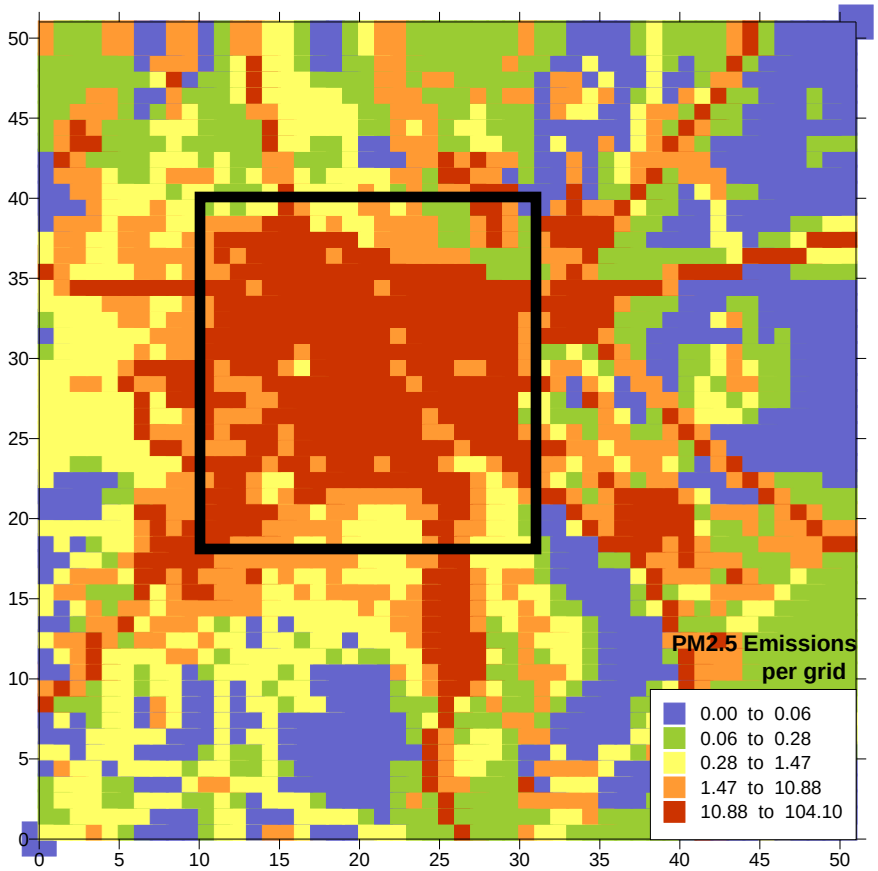


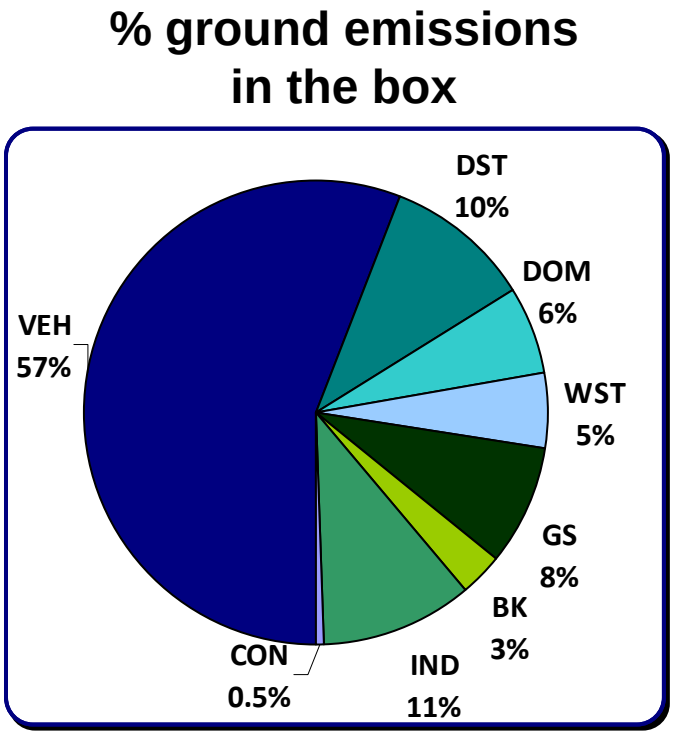
Emissions



Source: SIM-air Working Paper No.36

Gridded Vehicle $PM_{2.5}$ Emissions in Delhi, India

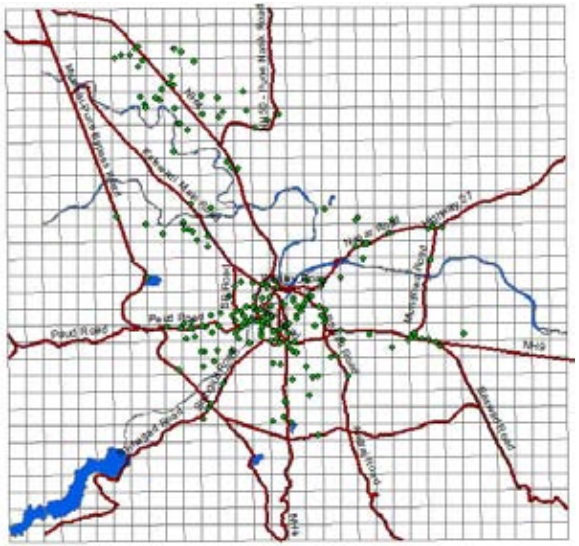




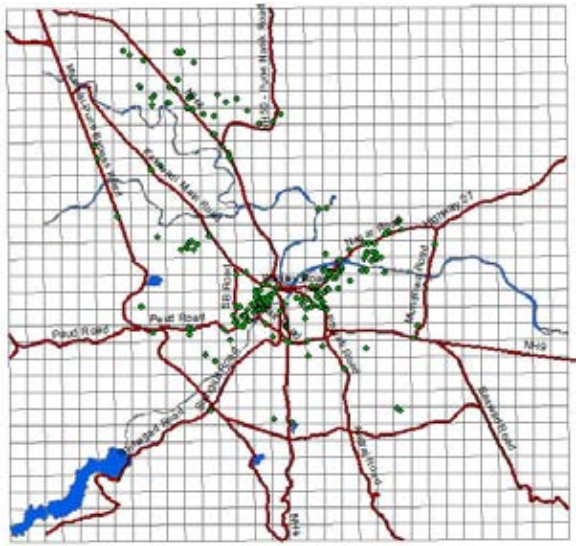
IND = industries; PP = power plants; DOM = domestic; VEH = transport; DST = road dust; WST = waste burning; CON = construction activities; BK = brick kilns; GS = generator sets

Source: SIM-air Working Paper No.36

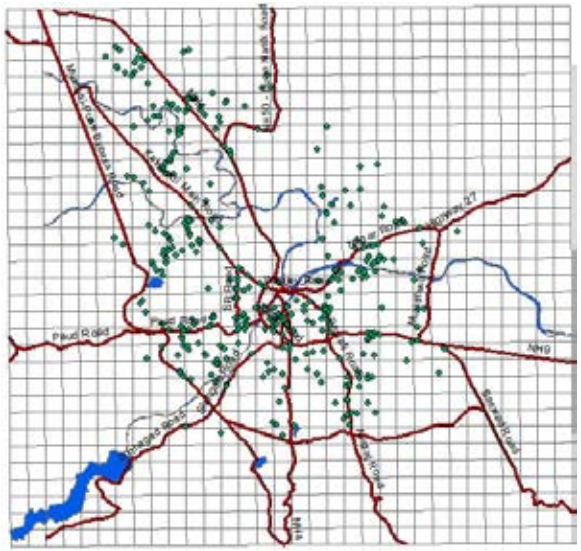
Generator Usage in Pune, India



Hospitals



Hotels

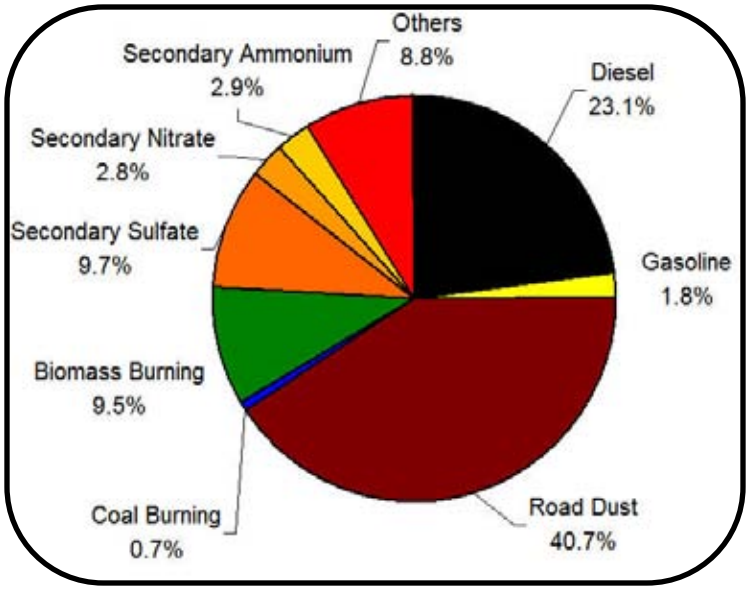


Apartments and Markets

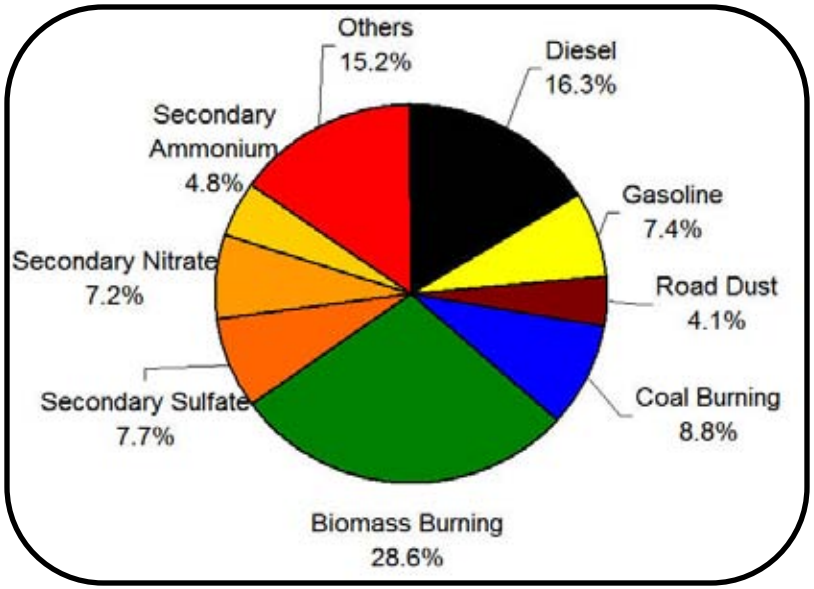
Other cities in India – Hyderabad, Chennai, Ahmedabad, Delhi, Surat, Indore, Rajkot, Kolkata, Bangalore

Source: SIM-air 6 City Study (2011)

Seasonal sources in Delhi, India



Summer



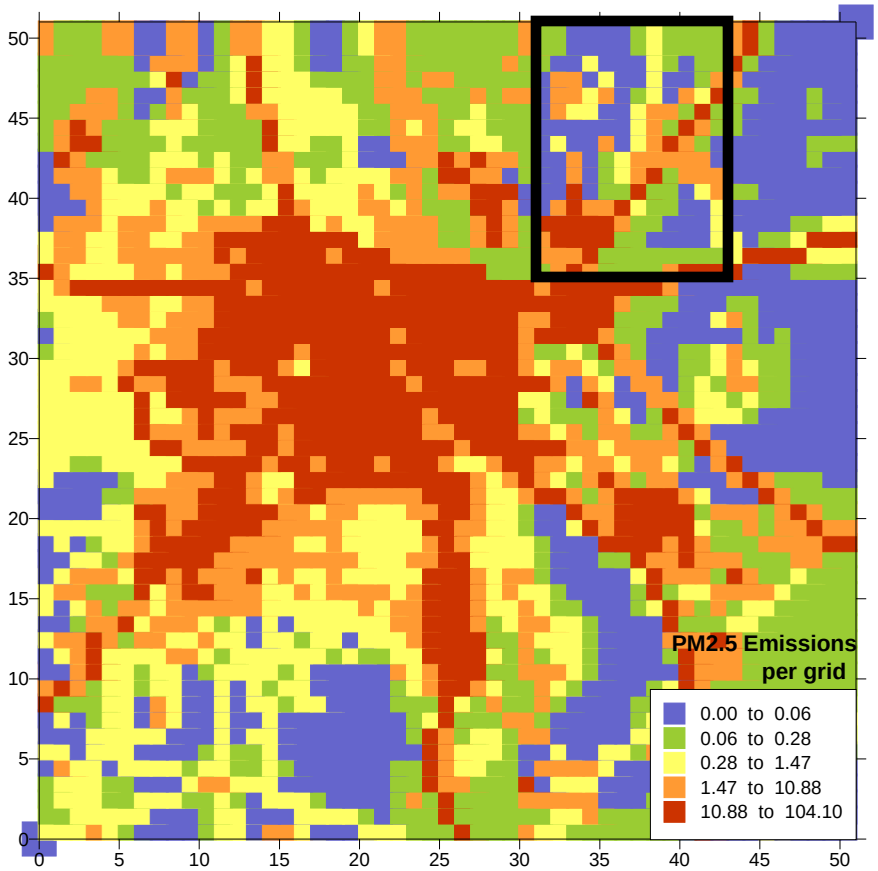
Winter

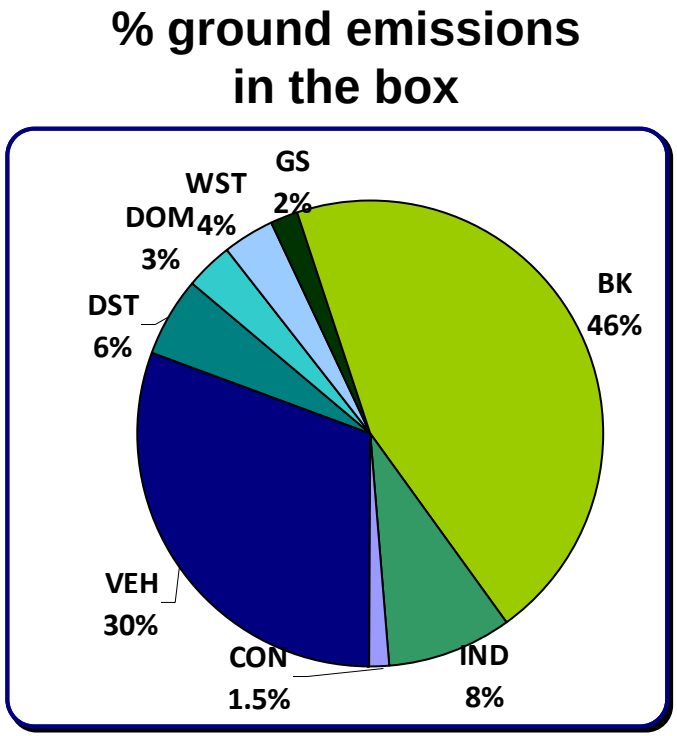
Study results from $PM_{2.5}$ Hydrocarbon analysis of measured samples from 2002.

Summer concentrations 40-80 $\mu g/m^3$ daily average
Winter concentrations 90-320 $\mu g/m^3$ daily average

Details @ www.urbanemissions.info/pmsa

Gridded Vehicle $PM_{2.5}$ Emissions in Delhi, India





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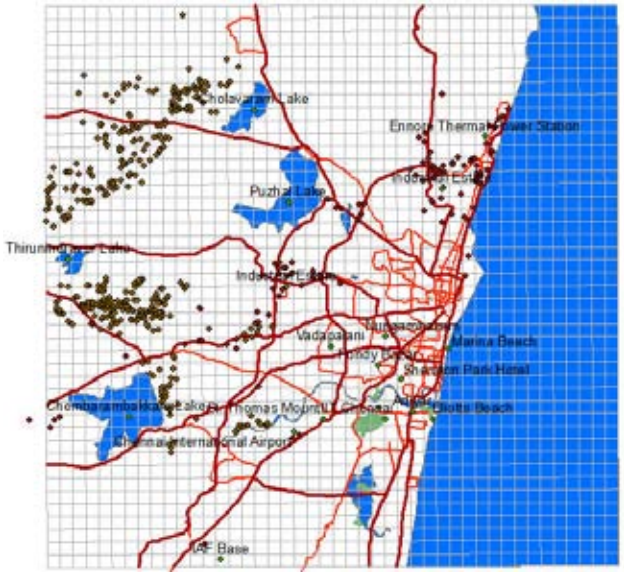
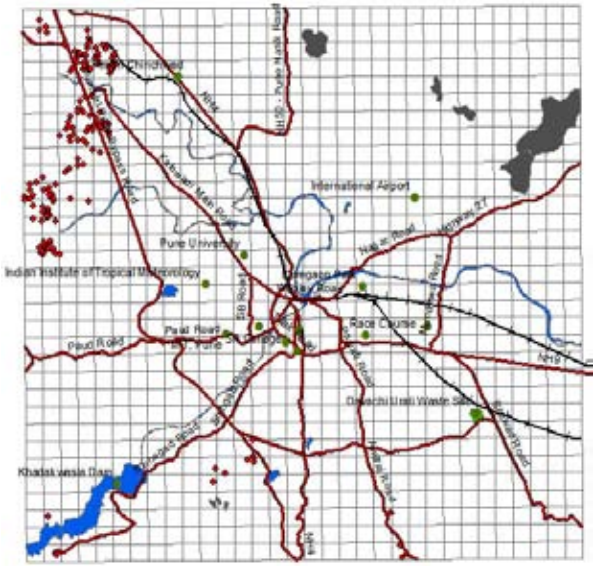
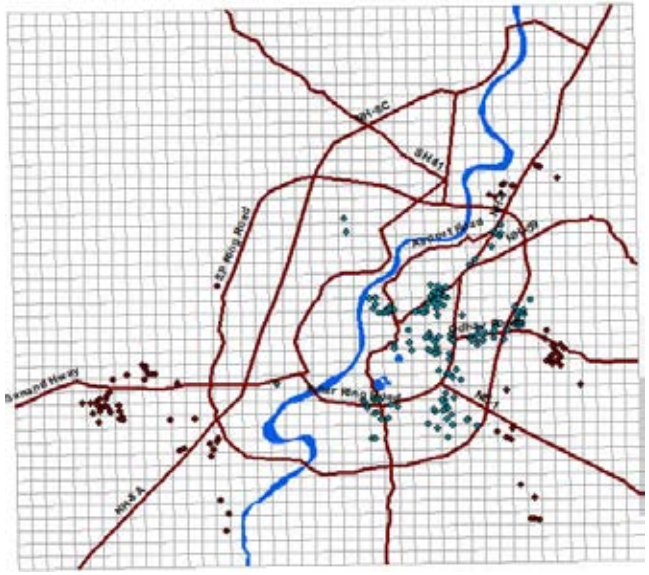
Brick kiln Industry in India



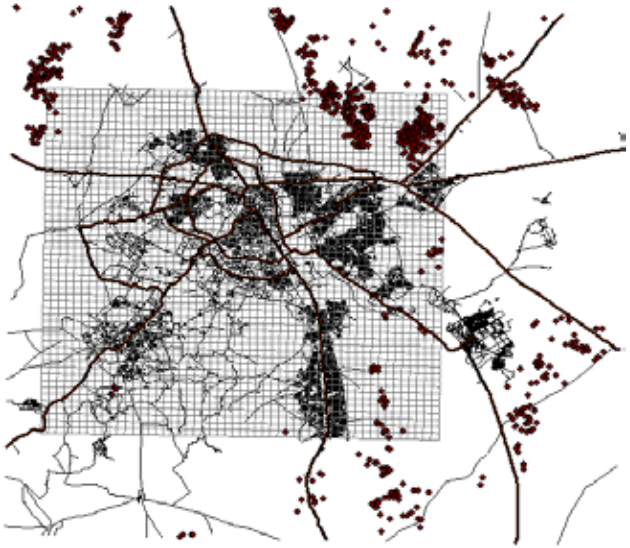
Chennai, ~550



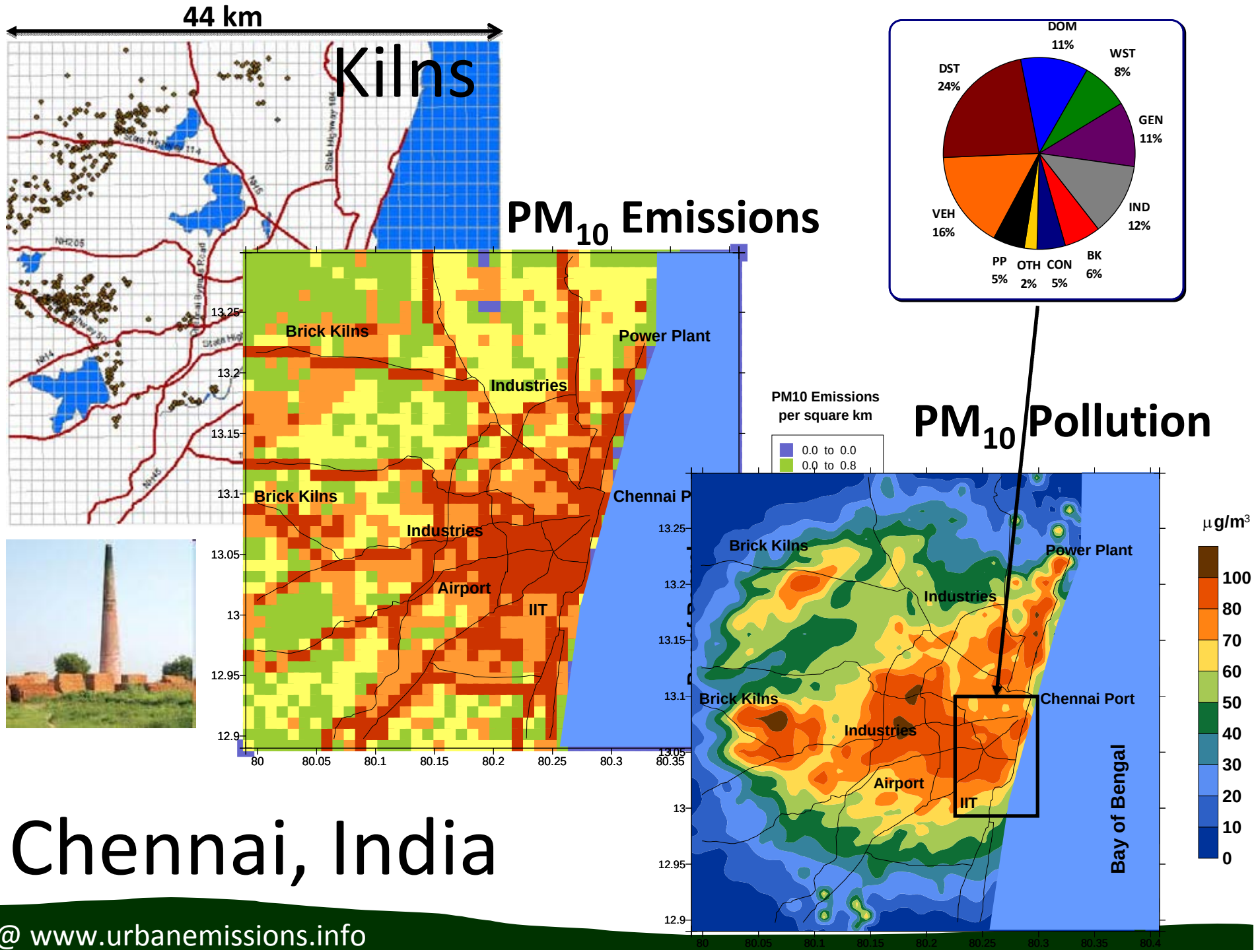
Pune, ~400



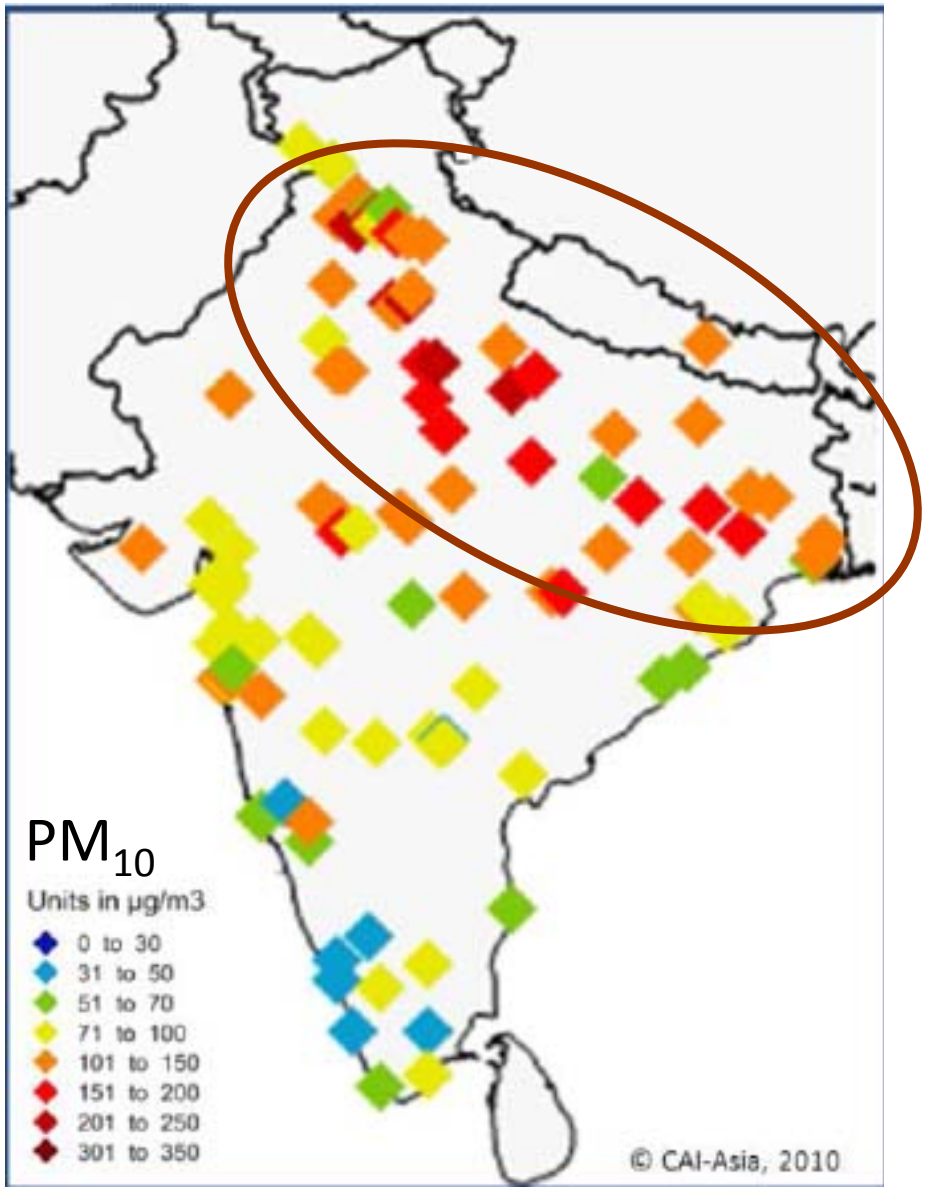
Ahmedabad, ~400



Delhi, ~800

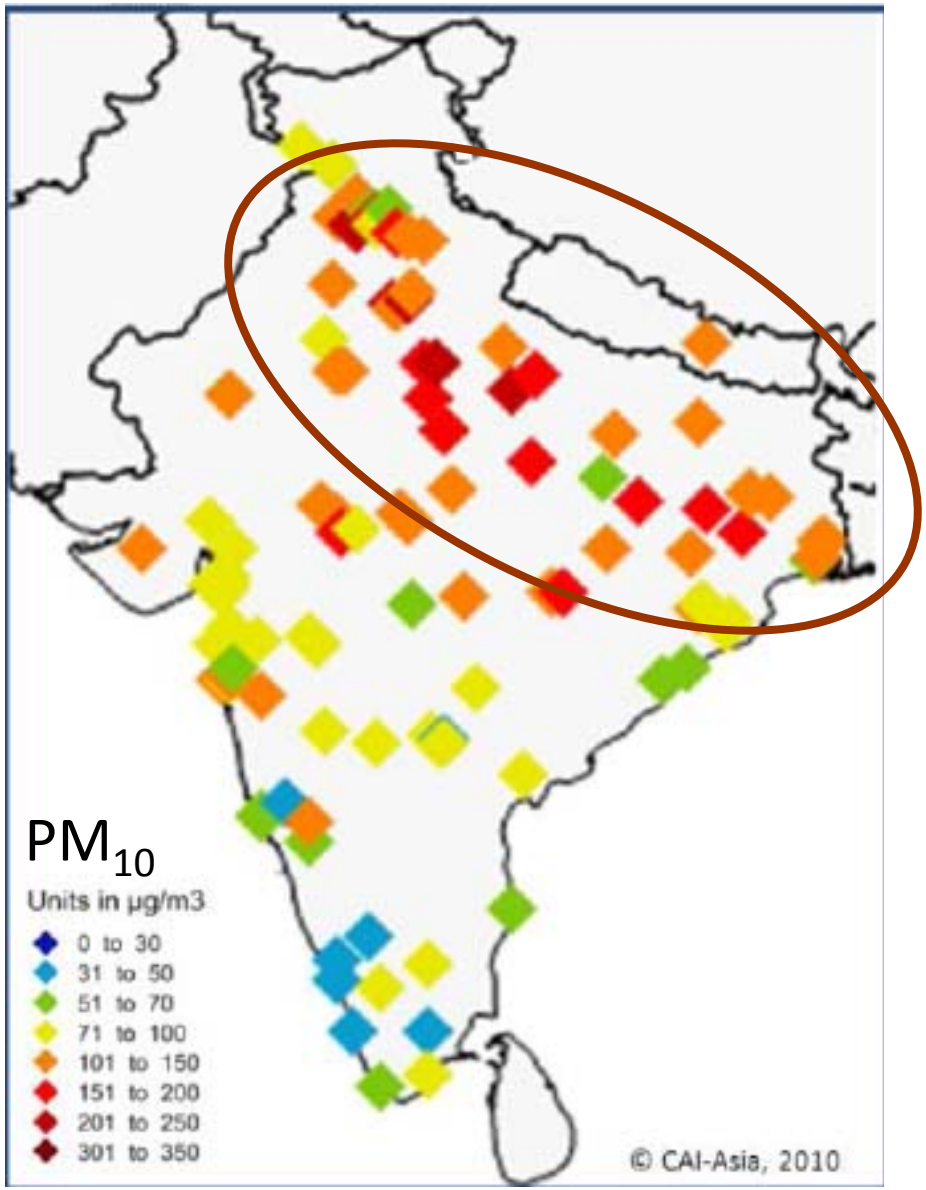


Chennai, India



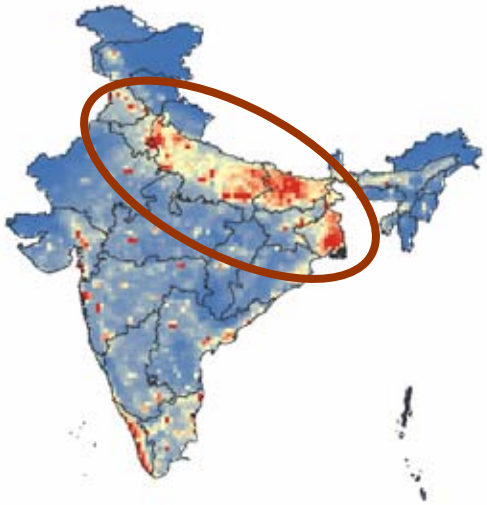
Indo-Gangetic Region

- Transport
- Rural Biomass Cooking
- Agricultural
- Industries
- Brick Kilns



Indo-Gangetic Region

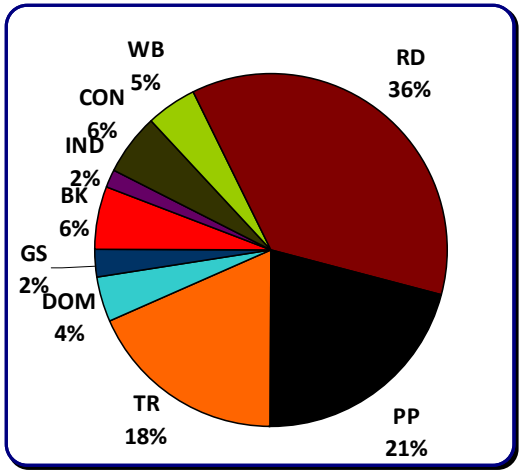
- Transport
- **Rural biomass cooking**
- Agricultural
- Industries
- **Brick kilns**



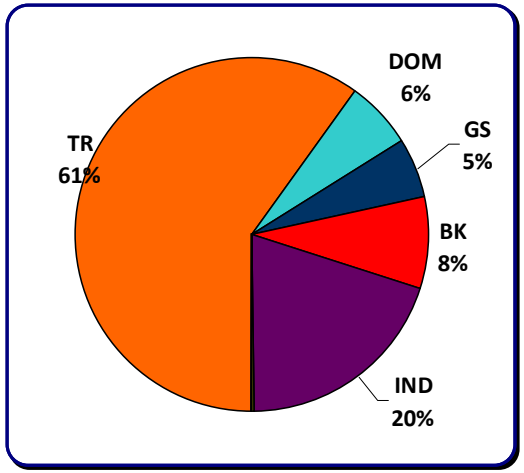
Coal Unloading
onto Conveyor Belt
North Chennai PP

Freight activity

Brick Kilns



2010 - PM10
~56,000 tons/yr

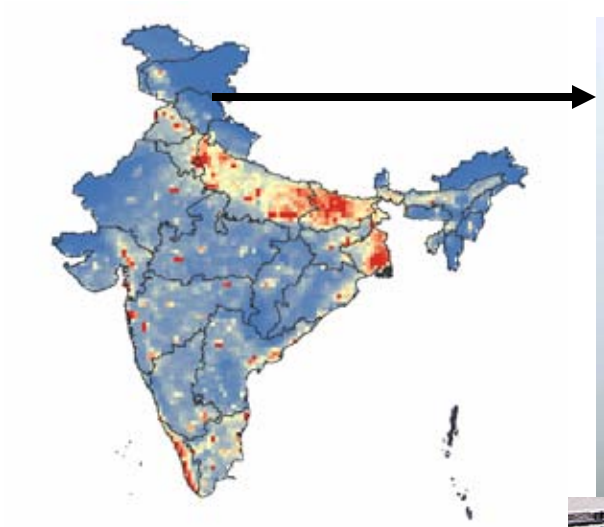


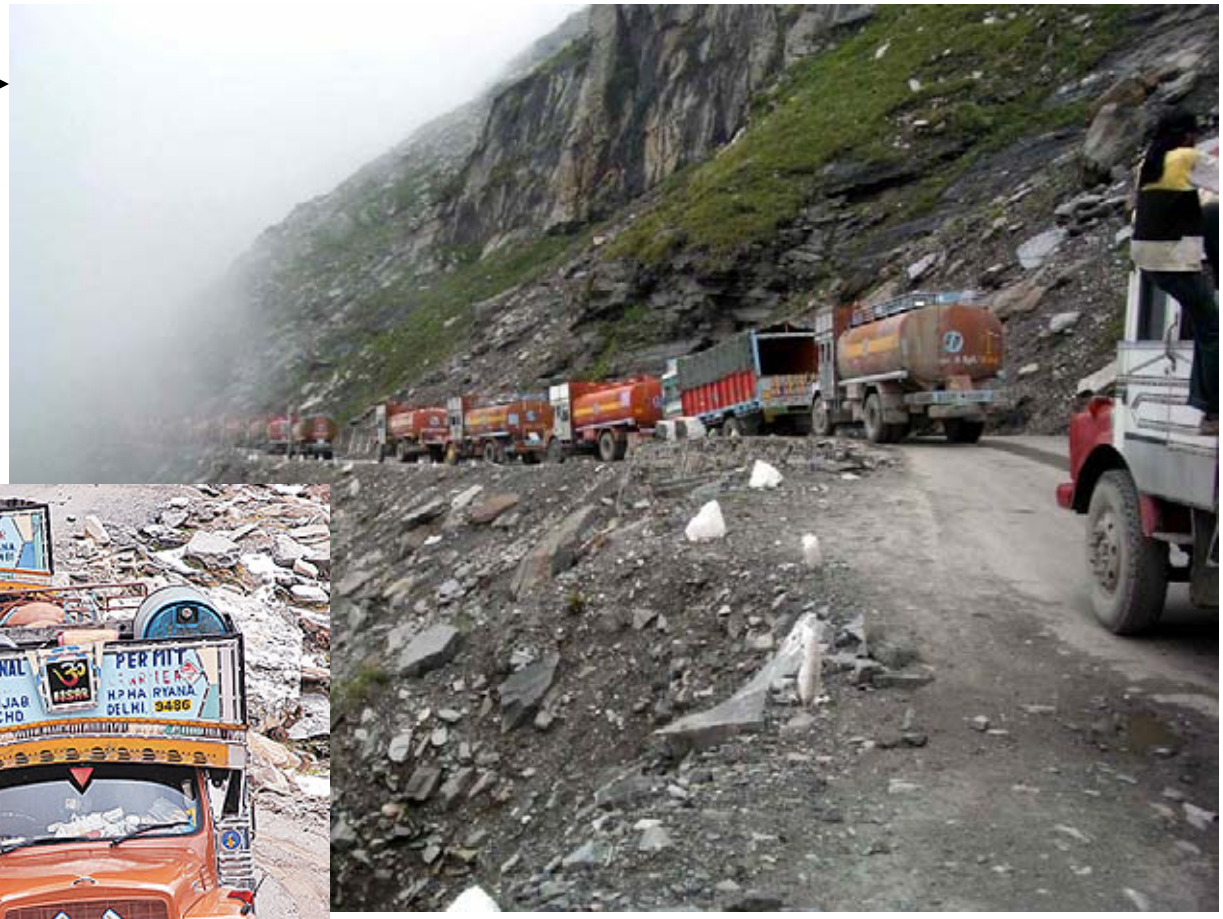
2010 - CO2
~25 mil tons/yr

Chennai, India

Source: SIM-air 6 City Study (2011)

Non-Urban: High Altitude Passes





Rohtang pass, Himachal Pradesh

Possible strategies for facilitating action for short-term (and rapid) gains in air pollution for the cities and support climate policy

- Brick kilns
  - emerging technologies and replacement material
- High altitude sources
  - freight movement and vehicle and road maintenance programs
- Freight movement and management
  - on road, rail, and ship
- Domestic sector
  - rural biomass cooking

Health Impacts in 6 Cities

Table 5.2: Estimated Mortality and Morbidity due to air pollution for 2010 (numbers rounded to nearest zero)

Mortality & Morbidity	Pune	Chennai	Indore	Ahmedabad	Surat	Rajkot
Domain size (km x km)	32 x 32	44 x 44	32 x 32	44 x 44	44 x 44	24 x 24
Study Domain Population (million)	6.5	8.5	3.3	7.8	5.0	1.4
Land-Sea Breeze	NO	YES	NO	NO	YES	NO
2010 PM_{10} emissions (tons/yr)	36,600	56,400	18,100	35,100	19,900	14,000
Premature Deaths	**3,600**	**3,950**	**1,800**	**4,950**	**1,250**	**300**
Mortality per ton of PM10	0.1	0.07	0.1	0.14	0.06	0.02
Adult Chronic Bronchitis	10,800	11,800	5,400	14,800	3,750	950
Child Acute Bronchitis	79,250	86,600	39,300	108,300	27,400	6,800
Respiratory Hospital Admission	5,000	5,460	2,500	6,800	1,700	450
Cardiac Hospital Admission	1,350	1,480	670	1,850	470	120
Emergency Room Visit	97,800	106,900	48,500	133,700	33,800	8,400
Asthma Attacks (million)	1.2	1.3	0.6	1.7	0.4	0.1
Restricted Activity Days (million)	10.4	11.3	5.1	14.2	3.6	0.9
Respiratory Symptom Days (million)	49.7	54.1	24.5	67.6	17.1	4.2

Source: SIM-air 6 City Study (2011)

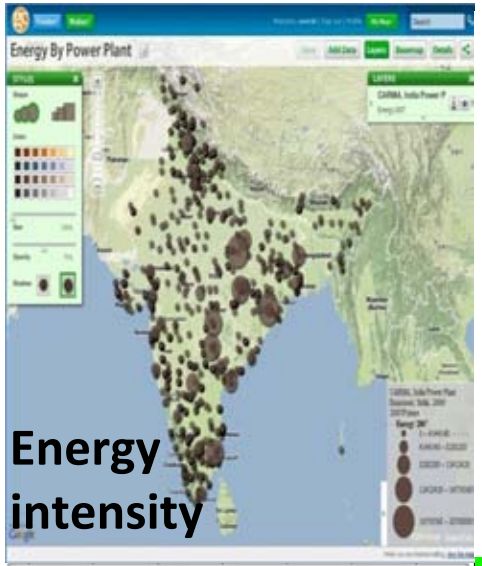
Co-Benefits in 6 Cities

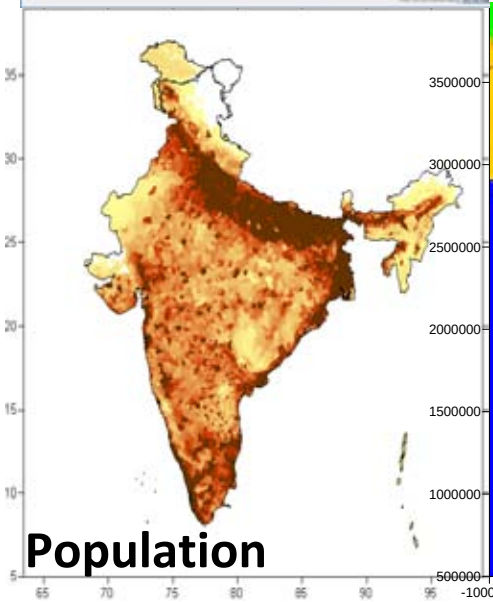
Table 6.14: Estimated combined benefits for emissions and health from the six interventions in 2020

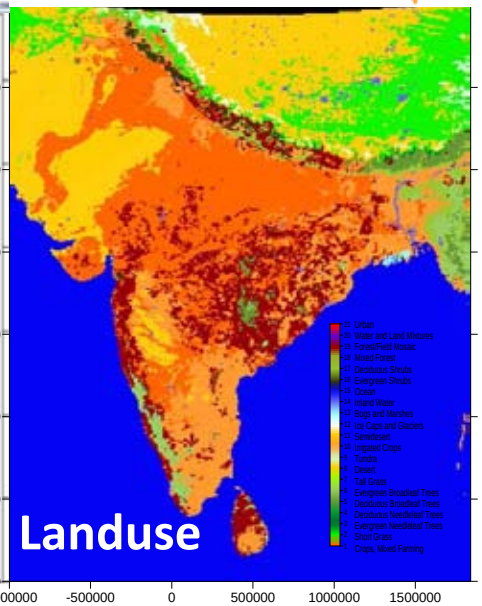
Mortality & Morbidity	Pune	Chennai	Indore	Ahmedabad	Surat	Rajkot
Domain size (km x km)	32 x 32	44 x 44	32 x 32	44 x 44	44 x 44	24 x 24
Study Domain Population (million)	7.6	10.5	4.3	10.3	6.2	1.9
Land-Sea Breeze	NO	YES	NO	NO	YES	NO
2020 PM_{10} emissions (tons/yr)	38,000	55,100	21,000	31,800	23,200	18,500
Estimated PM10 emissions reduced (tons/yr)	13,900	17,400	6,200	8,800	8,200	7,900
% compared to 2020	37%	31%	30%	27%	35%	42%
Premature deaths saved	1,700	1,270	630	1,390	590	290
% compared to 2020	39%	21%	25%	18%	29%	42%
Estimated CO2 emissions reduced (million tons/yr)	3.0	5.7	1.8	2.5	2.4	1.4

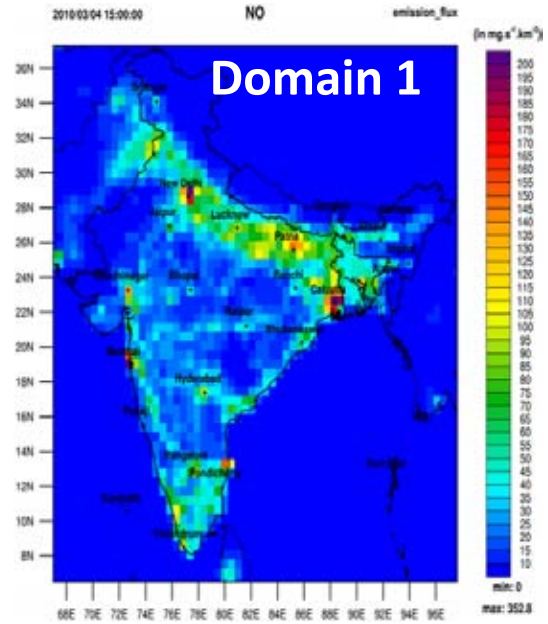
Source: SIM-air 6 City Study (2011)

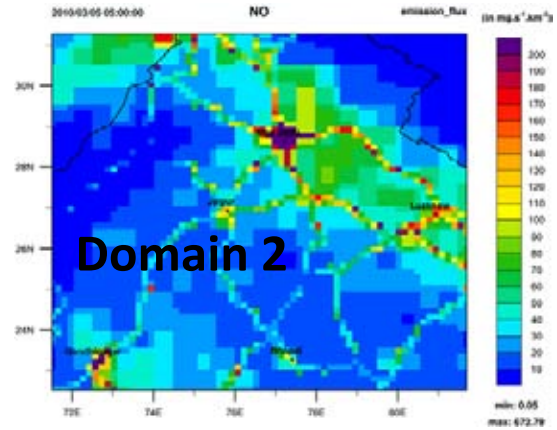
(2012) www.indiaairquality.info











Gridded Inventory

Thank you

Questions?

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September, 2011