managing air pollution from thermal power plants and brick kilns in India

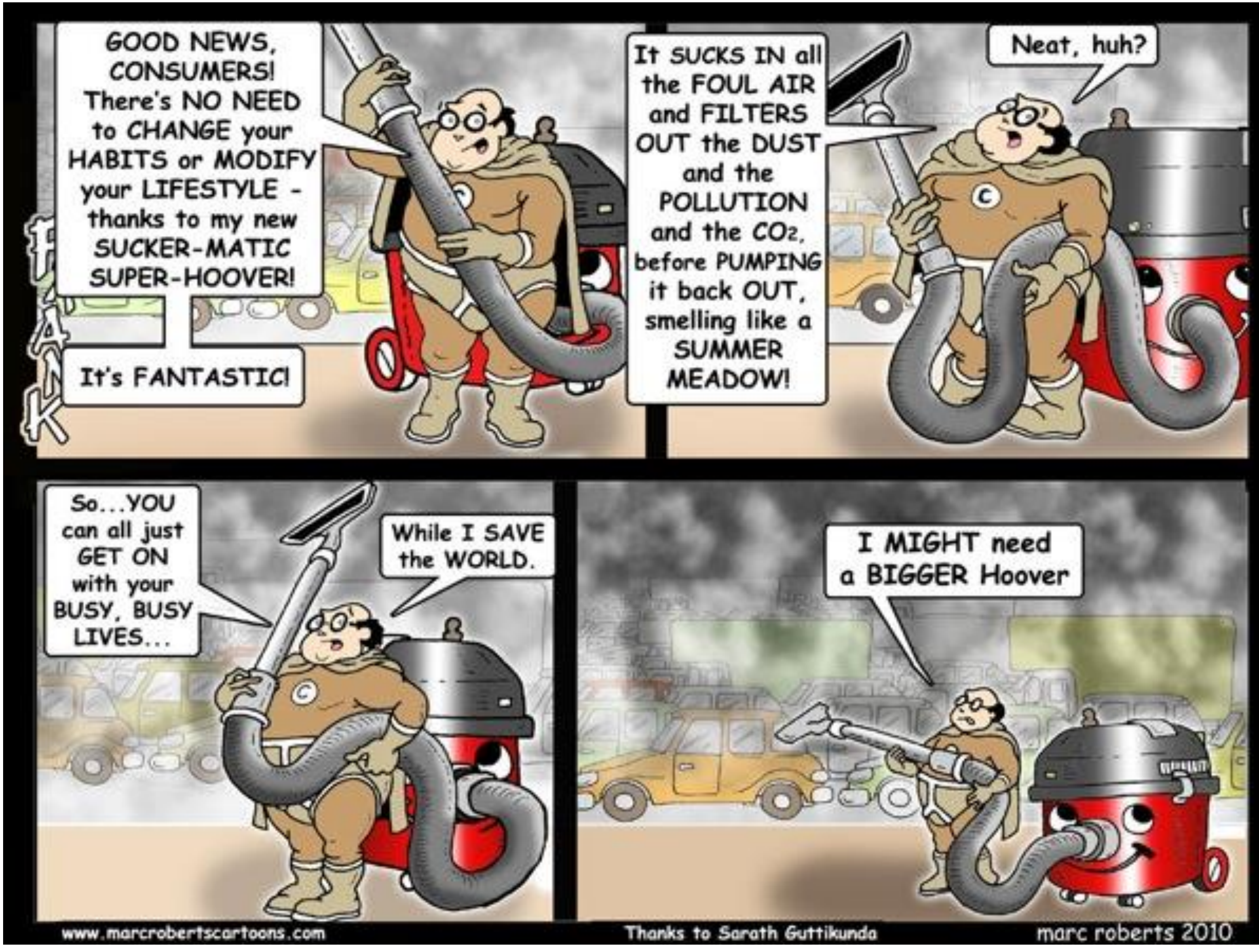
Dr. Sarath Guttikunda

URBANEMISSIONS.info

giant vacuum cleaner?

each costs 2.5 crores (0.5 million USD)

giant vacuum cleaner?



http://www.indiaairquality.info

INDIA air quality .info

Forecasts ▾ Emissions ▾ Blog Resources ▾ About

Emissions – Household Cooking & Heating

The global burden of disease assessments, listed outdoor air pollution among the top 10 health risks in India. The study estimated 695,000

India Air Quality Forecasts – District Avg. Hourly Time Series

Air pollution has emerged as a top-10 risk factor for human health in India

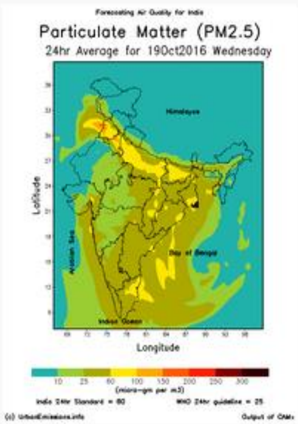
Emissions – Road Transport

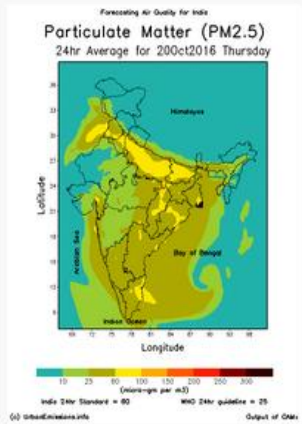
The road transport emissions vary both in space and time. The modeling domain considered for this exercise is very diverse (covering 640 districts, 36

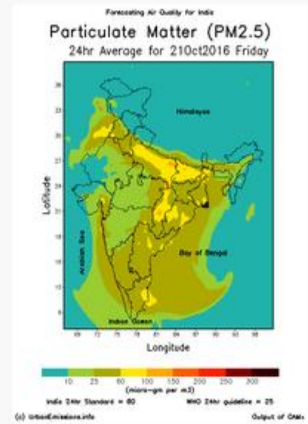
indiaairquality.info

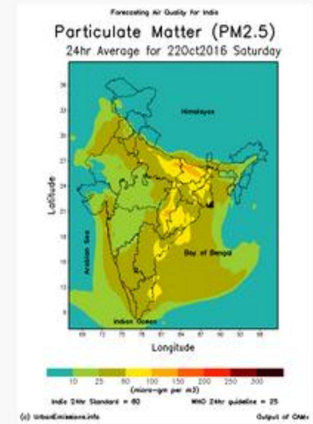
http://www.indiaairquality.info

Particulate Matter (less than 2.5 micron-m) (PM2.5)







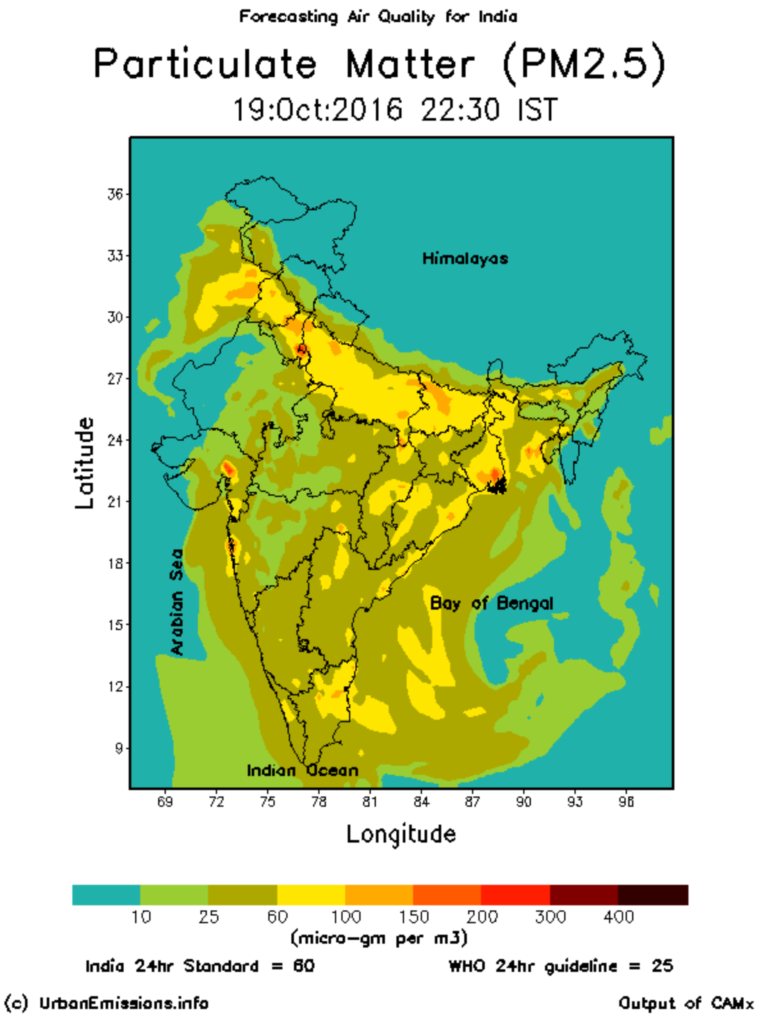


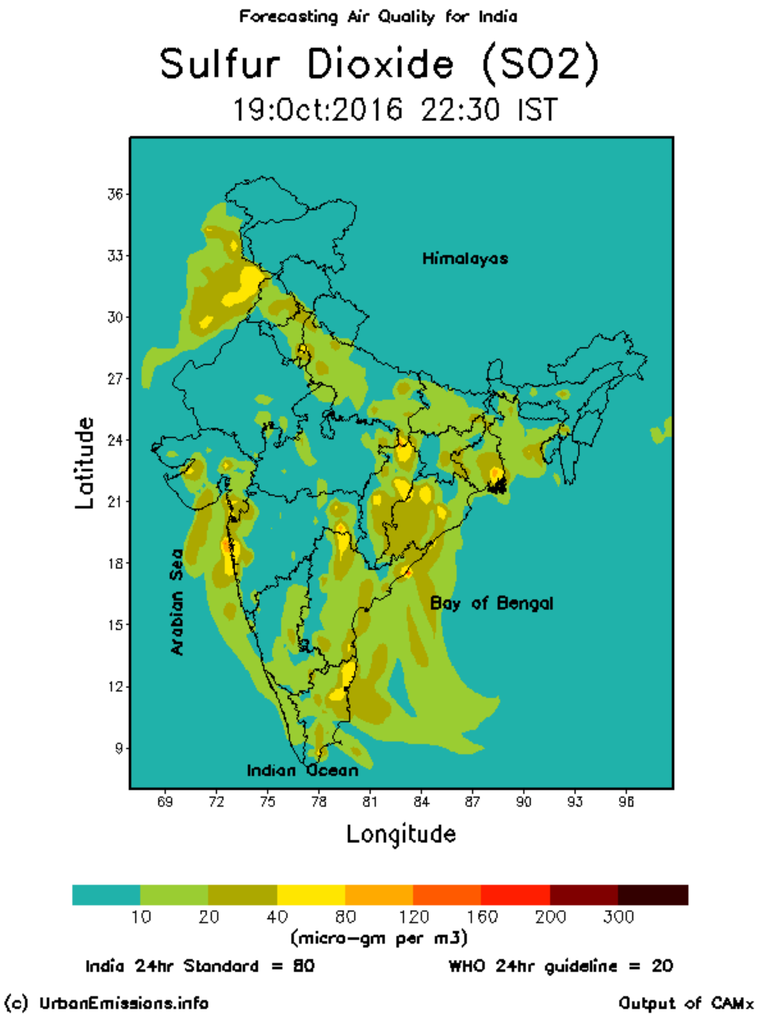
Particulate Matter (less than 10 micron-m) (PM10)

72-hr Animations

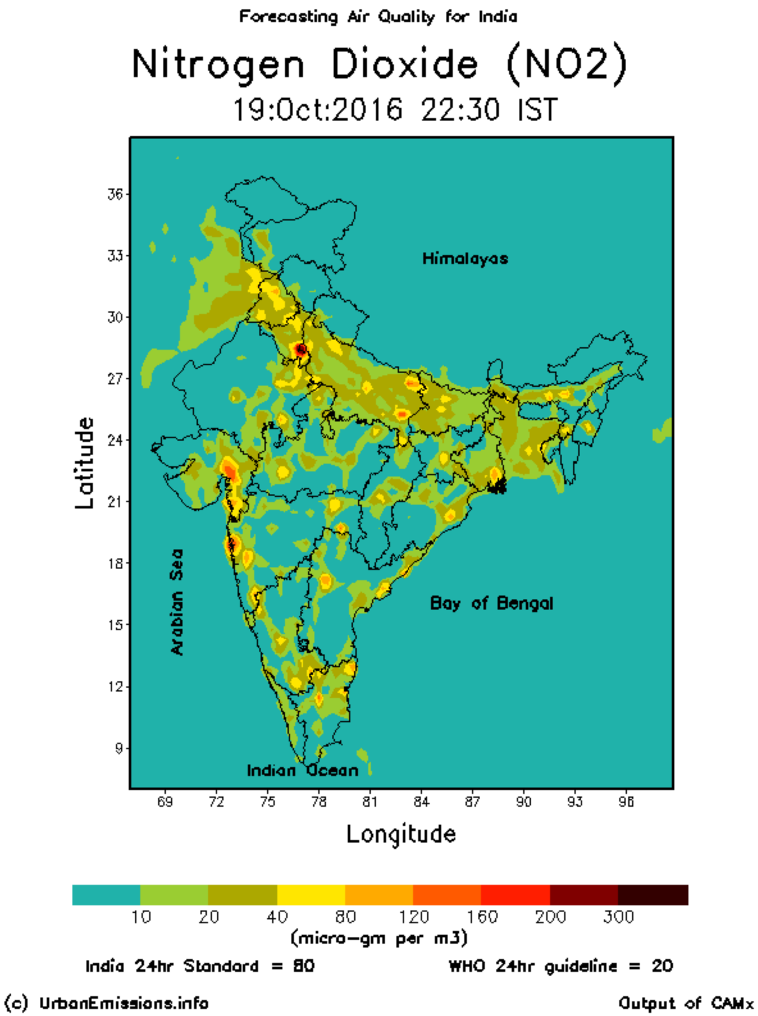
$PM_{2.5}$	PM_{10}	SO_2	CO	NO	NO_2	O_3
Particulate Matter	Particulate Matter	Sulfur Dioxide	Carbon Monoxide	Nitric Oxide	Nitrogen Dioxide	Ozone

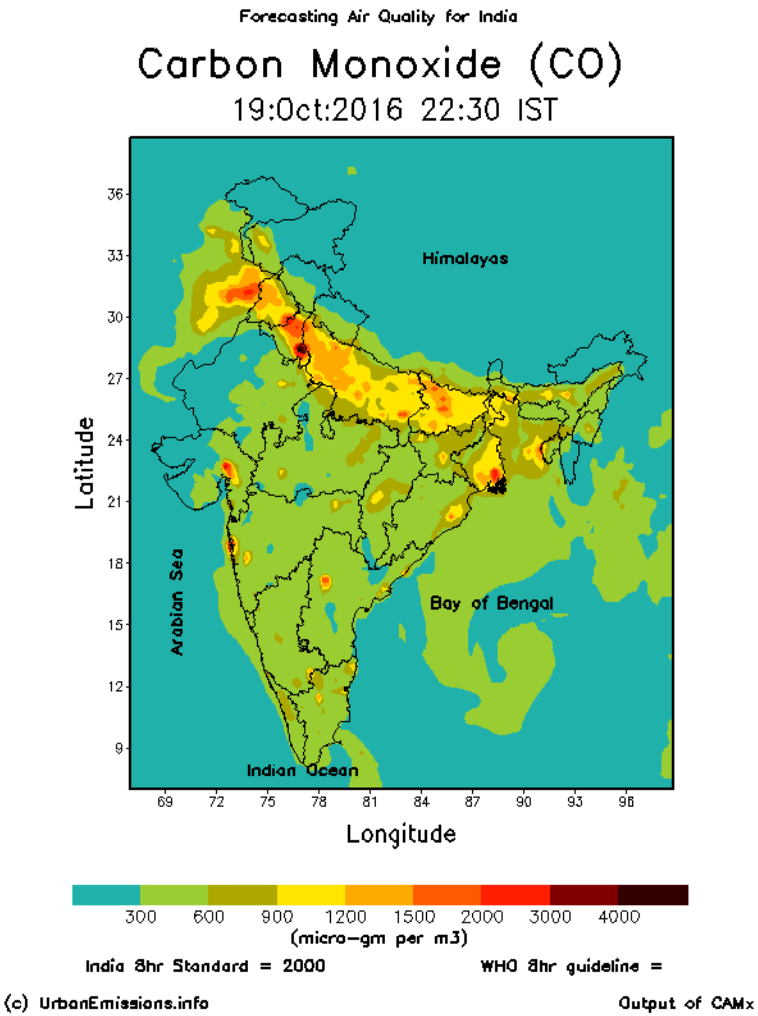
http://www.indiaairquality.info



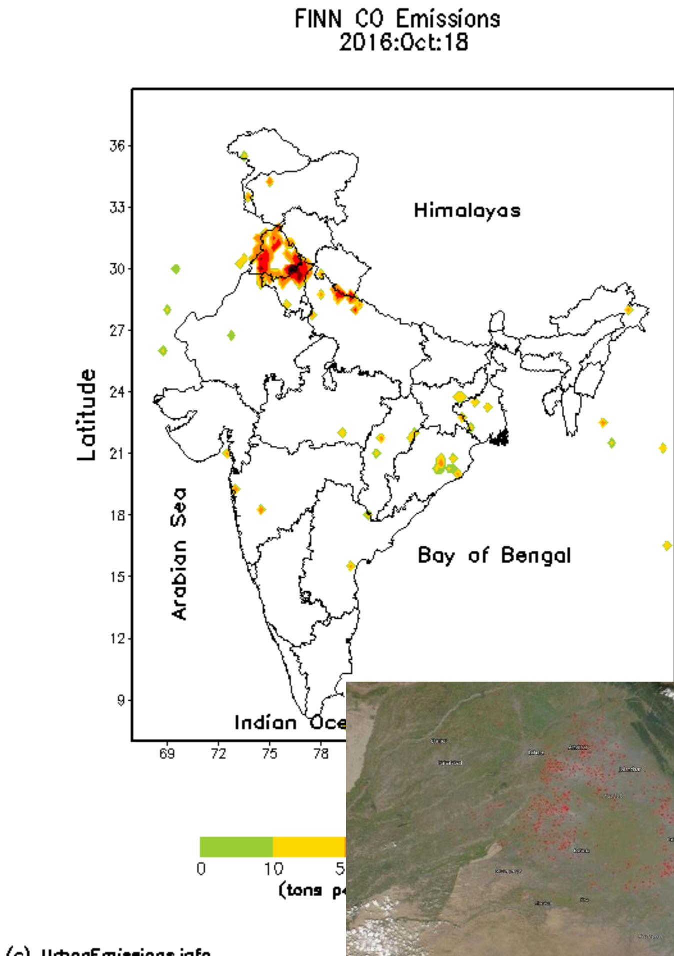


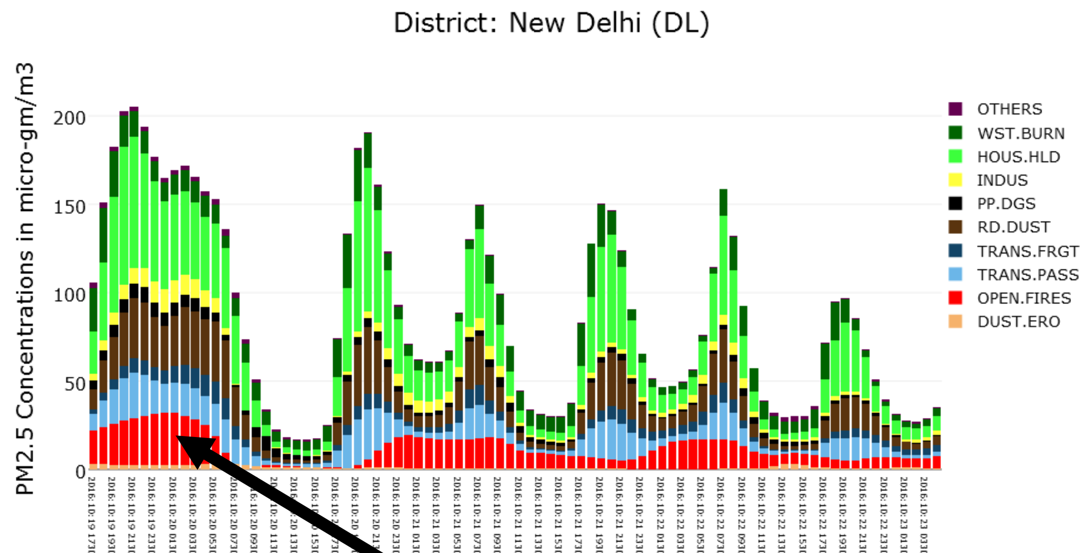
http://www.indiaairquality.info

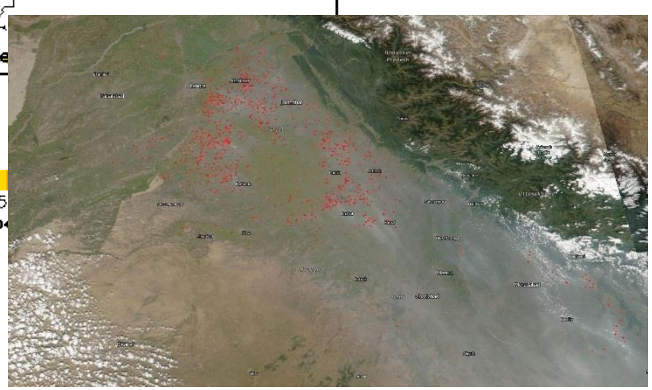




http://www.indiaairquality.info







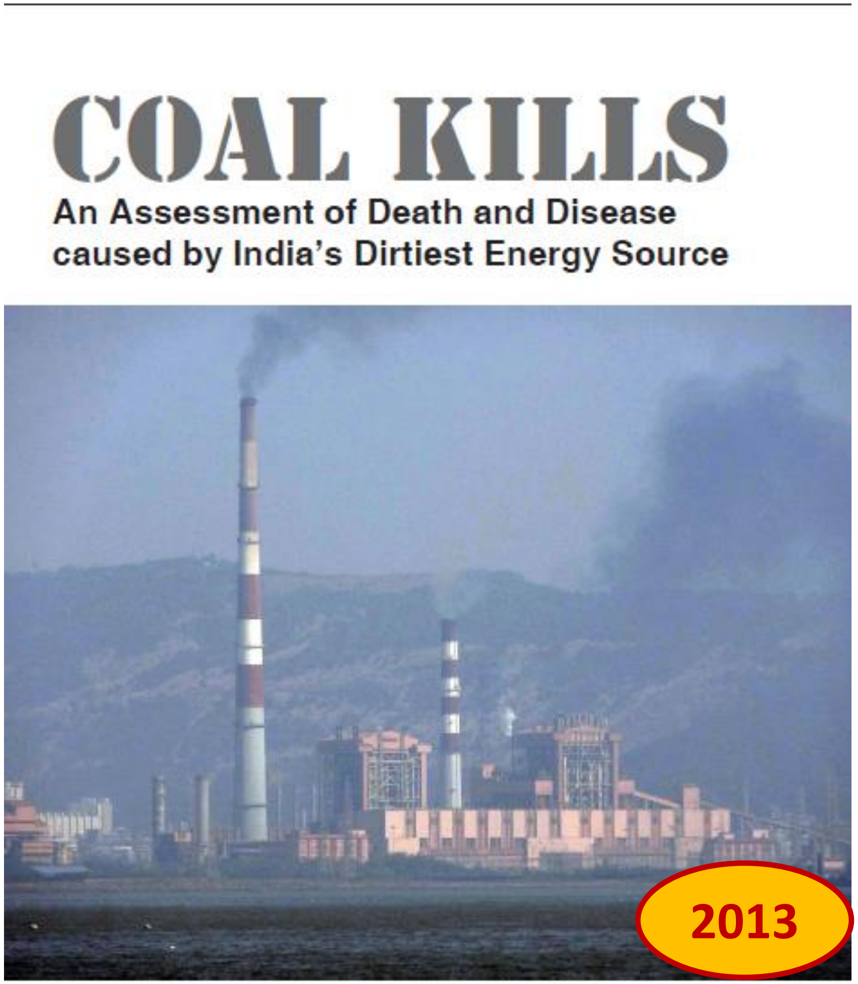
10% contribution from the open fires

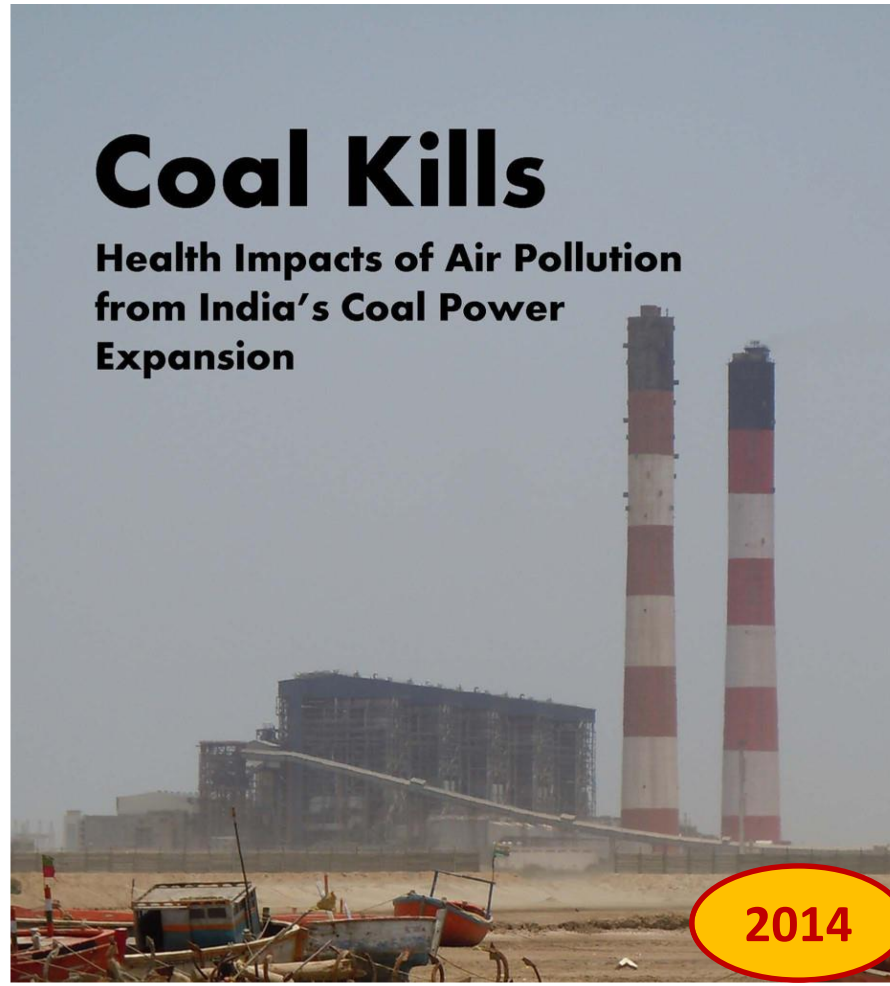
satairquality@twitter

emissions from FINN@NCAR

http://www.indiaairquality.info

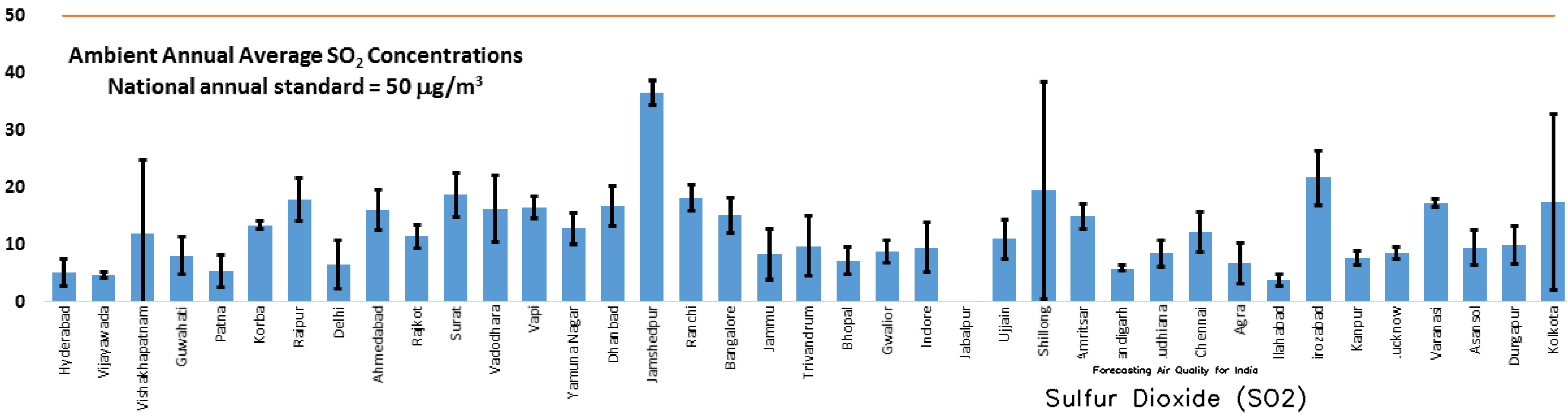
Coal-fired thermal power plants



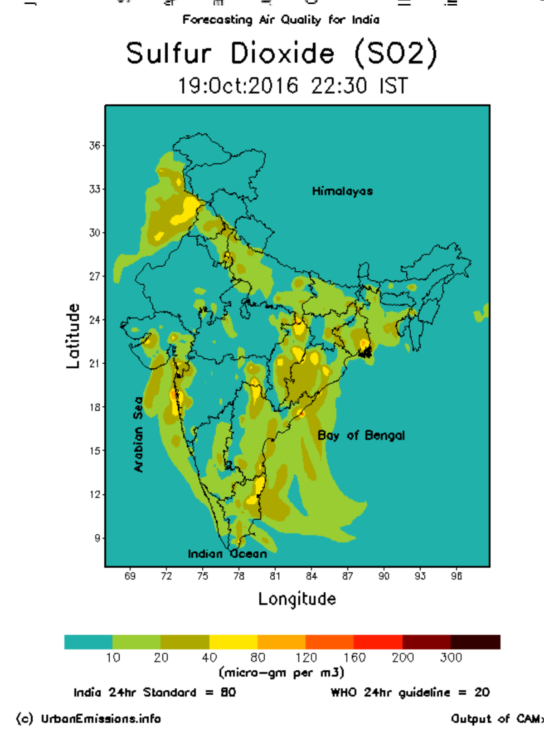


Conservation
ACTION TRUST

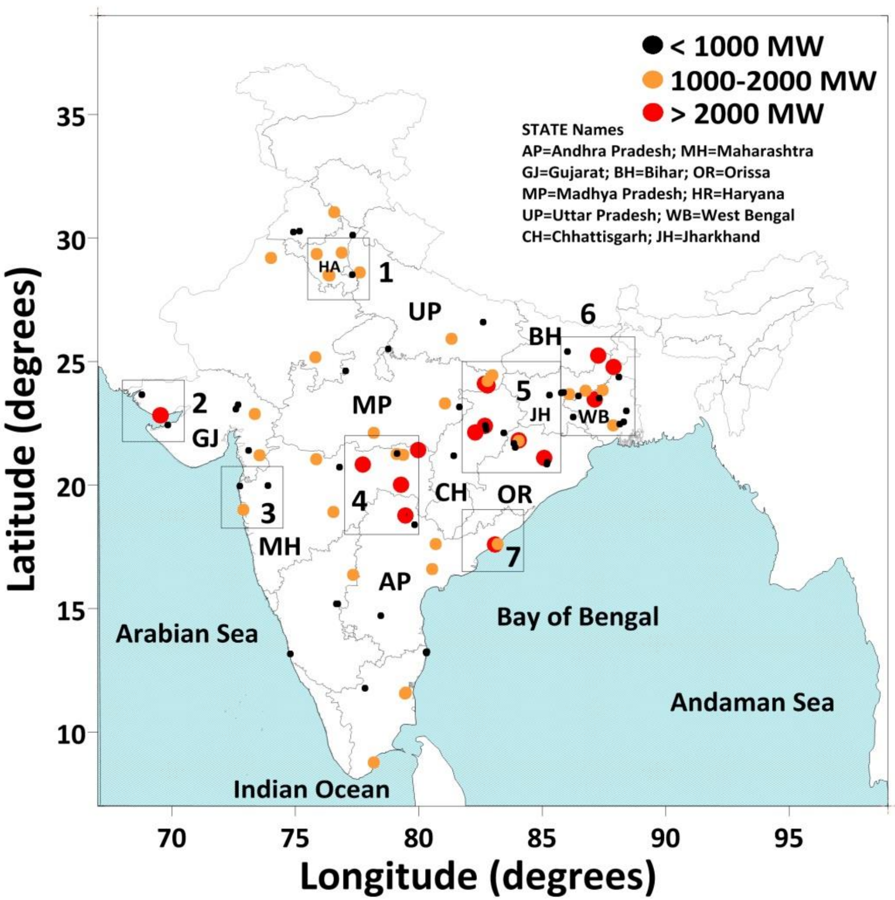
Monitoring Data from the NAMP Stations

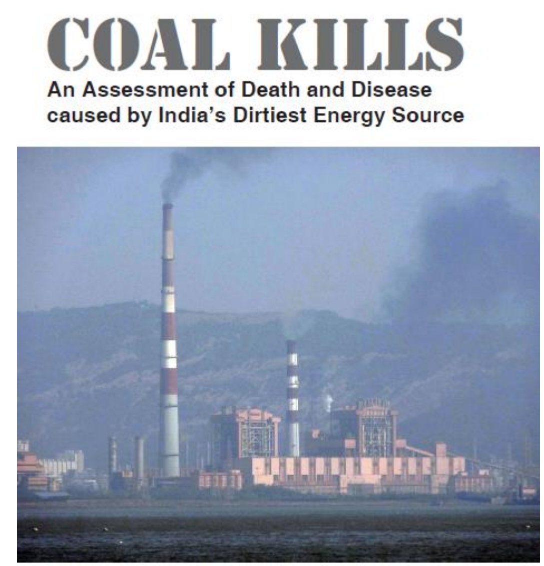


SO_2



Coal-fired thermal power plants





2011-12

Operational 111 plants

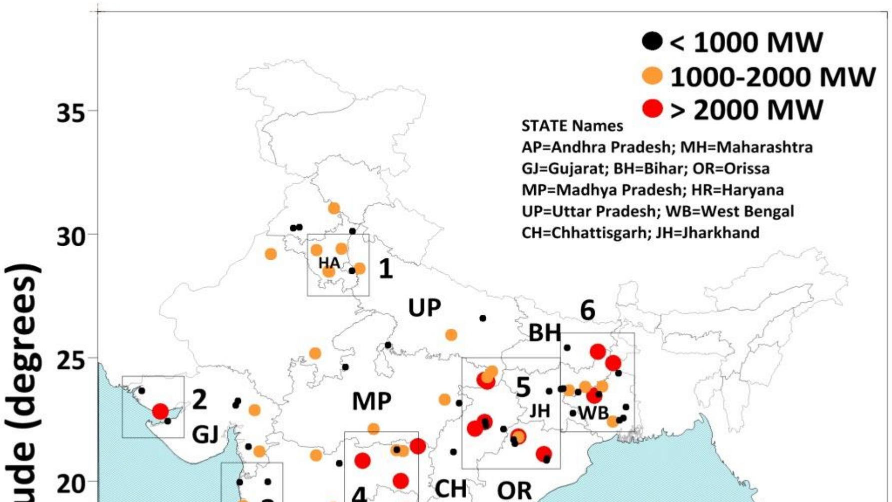
Conservation ACTION TRUST

80,000 to 115,000 premature deaths

GBD study estimate - 695,000 deaths from all sources in 2010

Atmospheric Environment (2014)

Coal-fired thermal power plants



पत्र सूचना कार्यालय, भारत सरकार

Press Information Bureau, Government of India

A- A+

Printer friendly Page   Email this page

Ministry of Health and Family Welfare 13-August, 2013 14:59 IST

Health Hazards from Emission in Coal-Fired Power Plants

Government is aware of the report titled " Coal kills- An assessment of death and disease caused by India's dirtiest energy source" which was jointly published by Conservation Action Trust (a non-profit organization), Urban emission (air pollution research firm) and Greenpeace India in Dec 2012. The report shows that in 2011-2012, emission from Indian coal plants resulted in 80,000 to 1,15,000 premature deaths and more than 20 million asthma cases from exposure to air pollution. The study quantified additional health impacts such as large number of cases of heart attacks, emergency room visits, hospital admission and lost workdays caused by coal based emissions. The study estimates that monetary cost associated with these health impacts exceeds Rs. 16,000 to 23,000 crores per year.

Central Electricity Authority (CEA) has informed that Ministry of Power has constituted a Standing Committee on occupational health and safety of workers of thermal power plants. The committee has members from various stake holders.

COAL KILLS

An Assessment of Death and Disease caused by India's Dirtiest Energy Source

Conservation ACTION TRUST

2011-12

Operational 111 plants

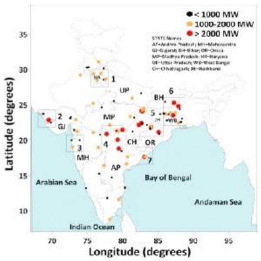
80,000 to 115,000 premature deaths

GBD study estimate - 695,000 deaths from all sources in 2010

Atmospheric Environment (2014)

Emissions & pollution modeling

Emissions



Inputs
Geographical information
Pollutant emission rates
Stack characteristics

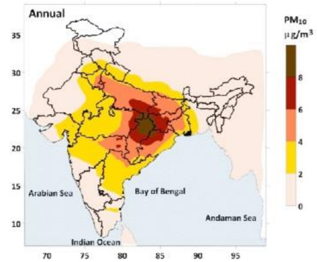
+

Dispersion

Model
CAMx Eulerian dispersion model with plume rise function for stack emissions

Inputs
Emissions
3D meteorological data from NCEP reanalysis

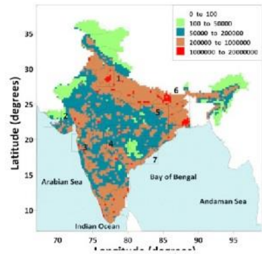
Concentrations



Model outputs
Concentration maps of primary and secondary PM
% contributions to total ambient pollution
Monthly and seasonal variations
Cluster contributions for 7 select sub-regions
Forward trajectory analysis for select clusters

+

Population

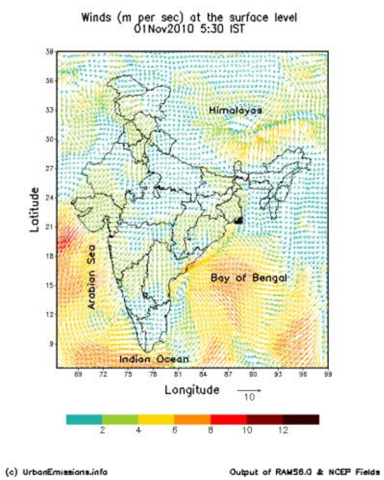


Source
Population data at 30 second resolution (SEDAC/GRUMP)

Health Impacts

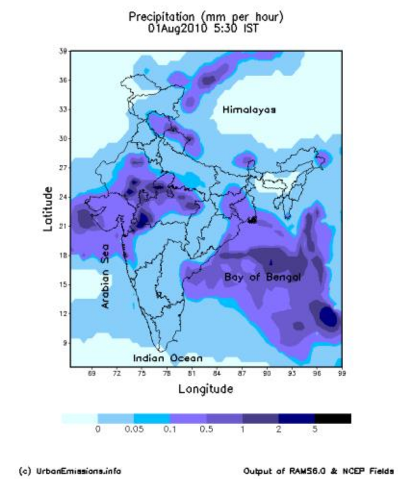
Inputs
Relative risk assessments for mortality and morbidity based on epidemiological studies

Endpoints
Premature mortality due to cardiovascular and respiratory ailments
Asthma attacks
Productivity days lost
Total health costs

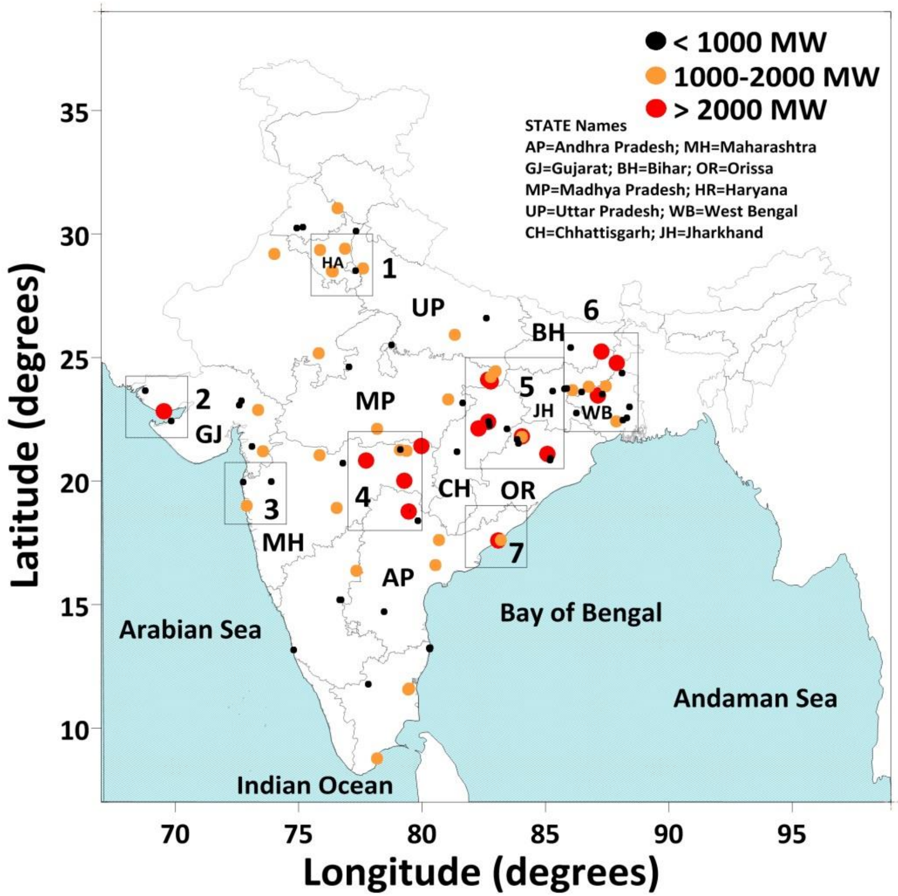


4 key messages

Published in Atmospheric Environment (2014)



1 limited number of plants

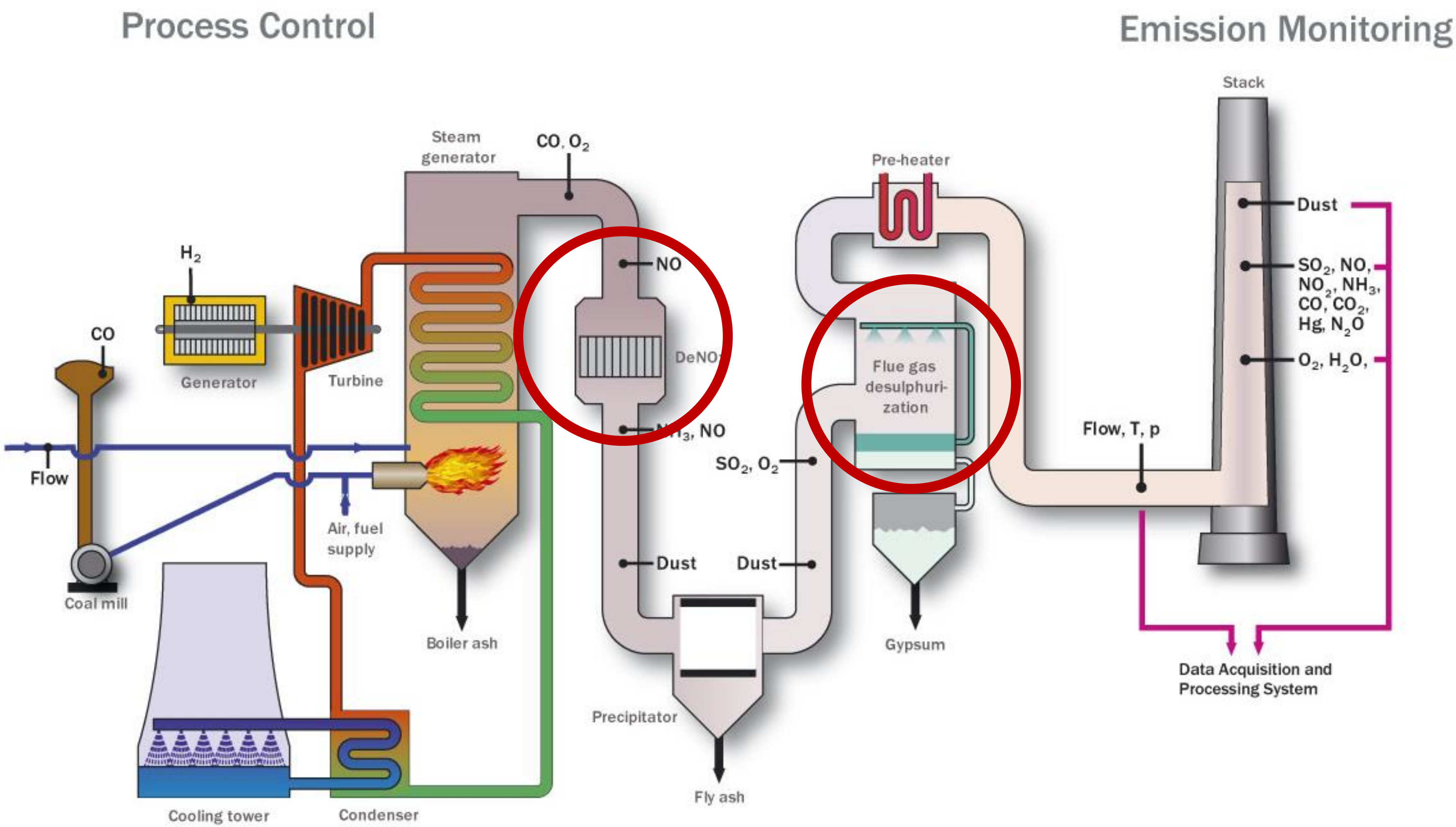


Health impacts are high and we need to deal with only limited number of point sources

VERY doable !!

Atmospheric Environment (2014)

2 new generation coal-fired boilers



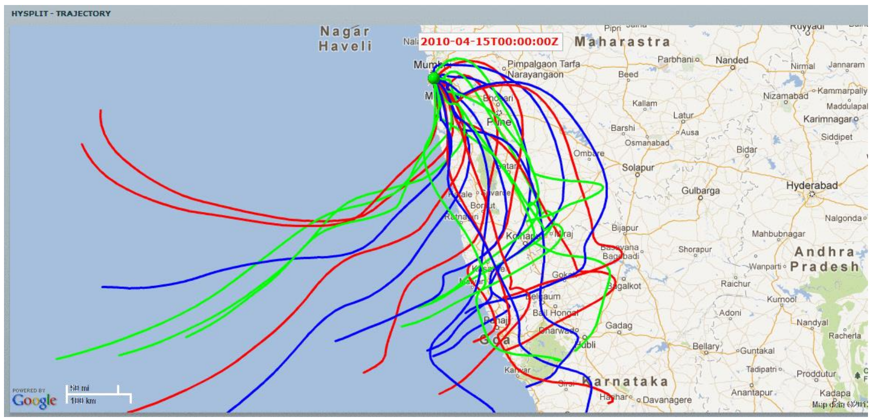
3 mix of old technologies

Table 1
Summary of annual coal consumption at the power plants in India in 2010–11.

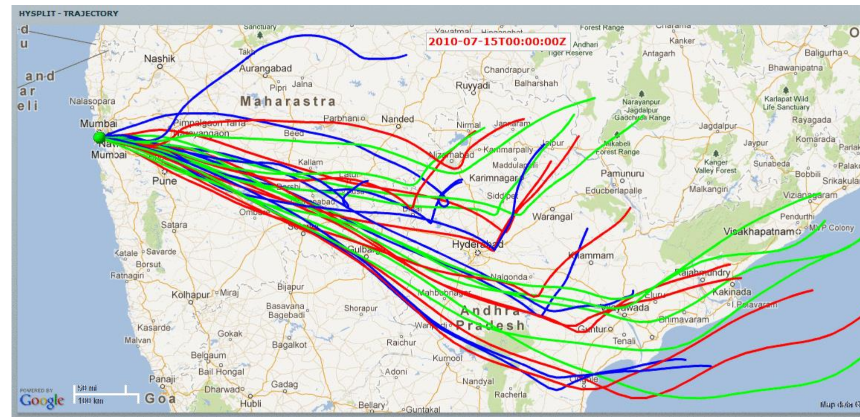
State	Number of plants	MW	Coal million tons	kg coal/kWh 2006–07	% Installed units <210 MW
Andhra Pradesh	8	10,523	47.4	0.72	65%
Bihar	3	2870	10.2	0.94	77%
Chhattisgarh	8	9480	44.5	0.72	39%
Delhi	2	840	4.8	0.77	100%
Gujarat	11	14,710	55.9	0.65	69%
Haryana	5	5860	23.9	0.70	35%
Jharkhand	6	4548	12.0	0.75	86%
Karnataka	5	3680	14.6	0.69	64%
Madhya Pradesh	4	6703	33.1	0.79	79%
Maharashtra	13	17,560	71.5	0.73	51%
Orissa	8	8943	40.7	0.73	76%
Punjab	3	2620	13.2	0.66	82%
Rajasthan	4	3490	13.2	0.67	44%
Tamilnadu	8	6210	25.8	0.72	95%
Uttar Pradesh	11	11,997	56.0	0.80	86%
West Bengal	12	10,695	36.1	0.69	75%
Total	**111**	**120,727**	**503**	**0.73 ± 0.10**	**70%**

4 archaic EIA procedures
Mumbai Cluster (State: Maharashtra)

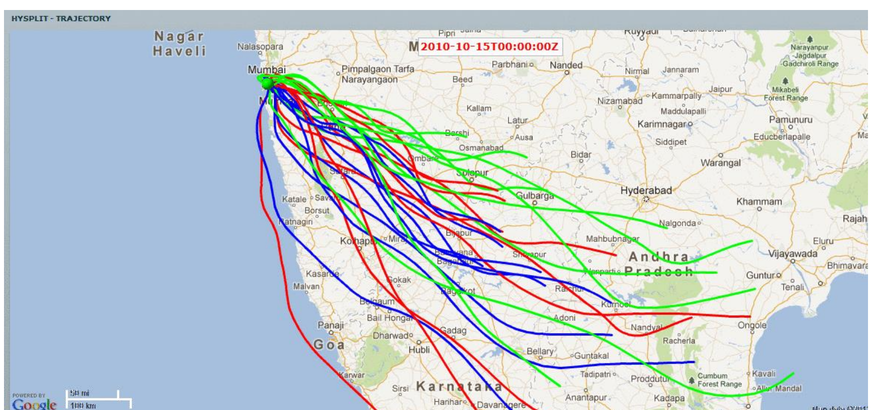
April, 2010



July, 2010



October, 2010



The 24 lines are trajectory lines started at every hour of the day. These are trajectories for one day of each month and indicative of the flow of emissions from power plant clusters and do not represent the strength of the emissions or dispersed pollution. All the trajectories are started at 275m above ground level.

Atmospheric Environment (2014)

Coal-fired thermal power plants

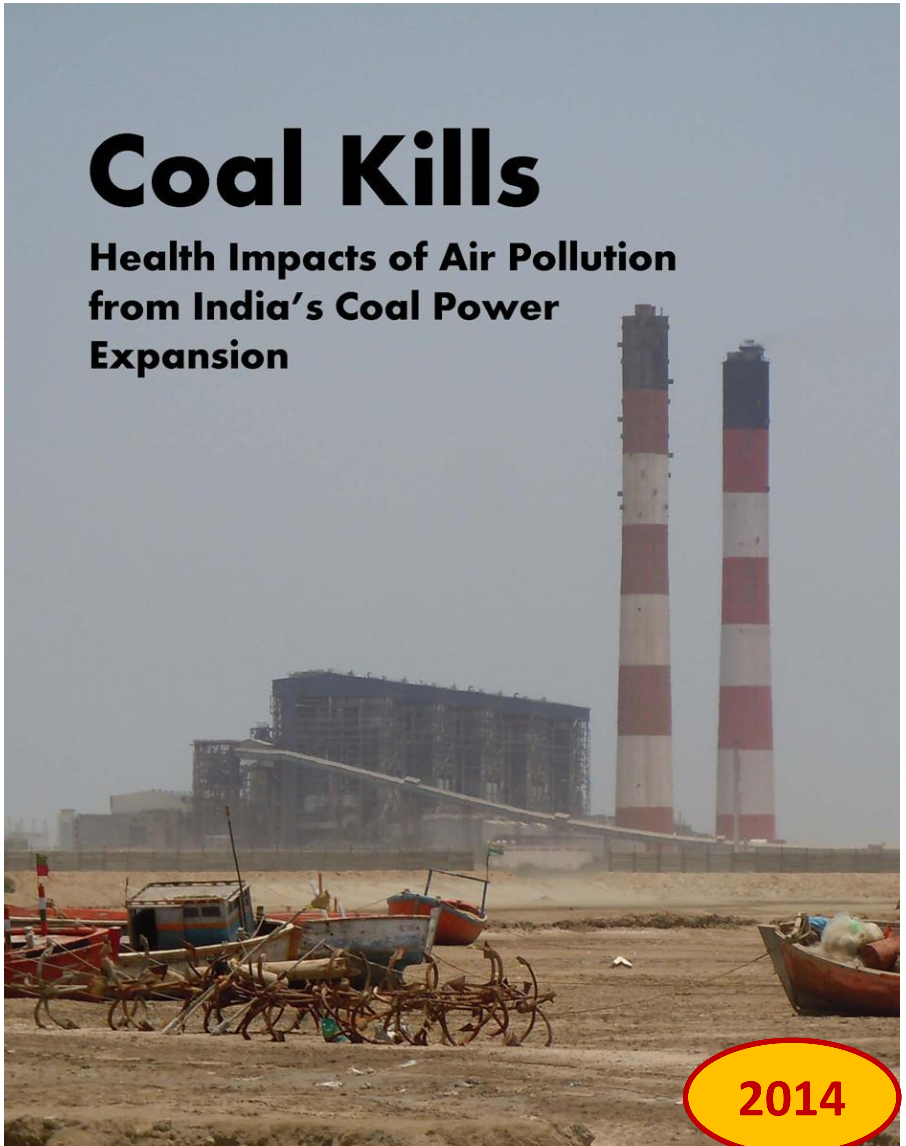
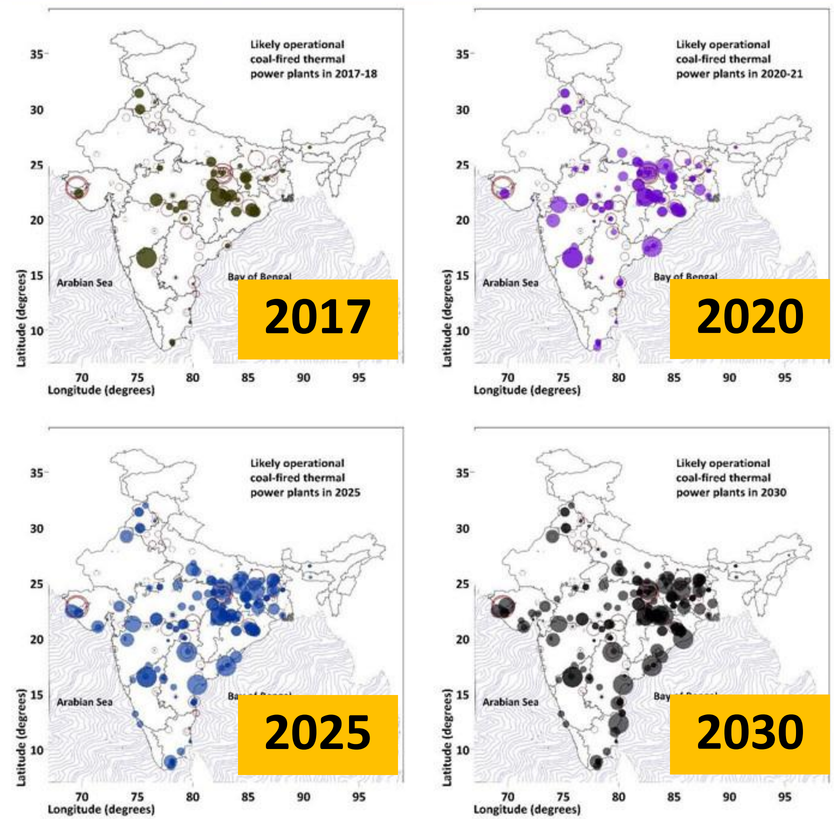


Figure 8: Proposed locations of the coal-fired TPPs in India through 2030. The brown circles represent the TPPs operational in 2014 (details in Figure 6) and the second colour in each map represents all the new plants and expansions expected after 2014 and likely to be operational in the representative year. The largest circle is 4620MW. Note that many of these circles are overlapping due their close proximity to other TPPs



Conservation ACTION TRUST

Coal-fired thermal power plants

FGD

Country	PM	SO_2	NO_2	Mercury
India [a]	350mg/Nm³ for 210MW 150mg/Nm³ for >210MW	No	None	None
China [b]	30mg/Nm³ (proposed all) 20mg/Nm³ for key regions key regions	100mg/Nm³ f w 200mg	100mg/N	None
Australia [c]	1997-2005 2005	None	800mg 500mg/	In base
European Union [c]	Pre-2003 100mg/Nm³ f 50mg/Nm³ f Post 2003 50mg/Nm³ fo 30mg/Nm³ for >	00MW r >500MW for <100MW m³ for >100MW	Pre-2003 600mg/Nm³ for <500MW 500mg/Nm³ for >500MW Post 2003 400mg/Nm³ for <100MW 200mg/Nm³ for >100MW	In discussion

30

100

100

0.03

50%
drop

draft standards proposed in April, 2015

new emission standards ratified in December, 2015

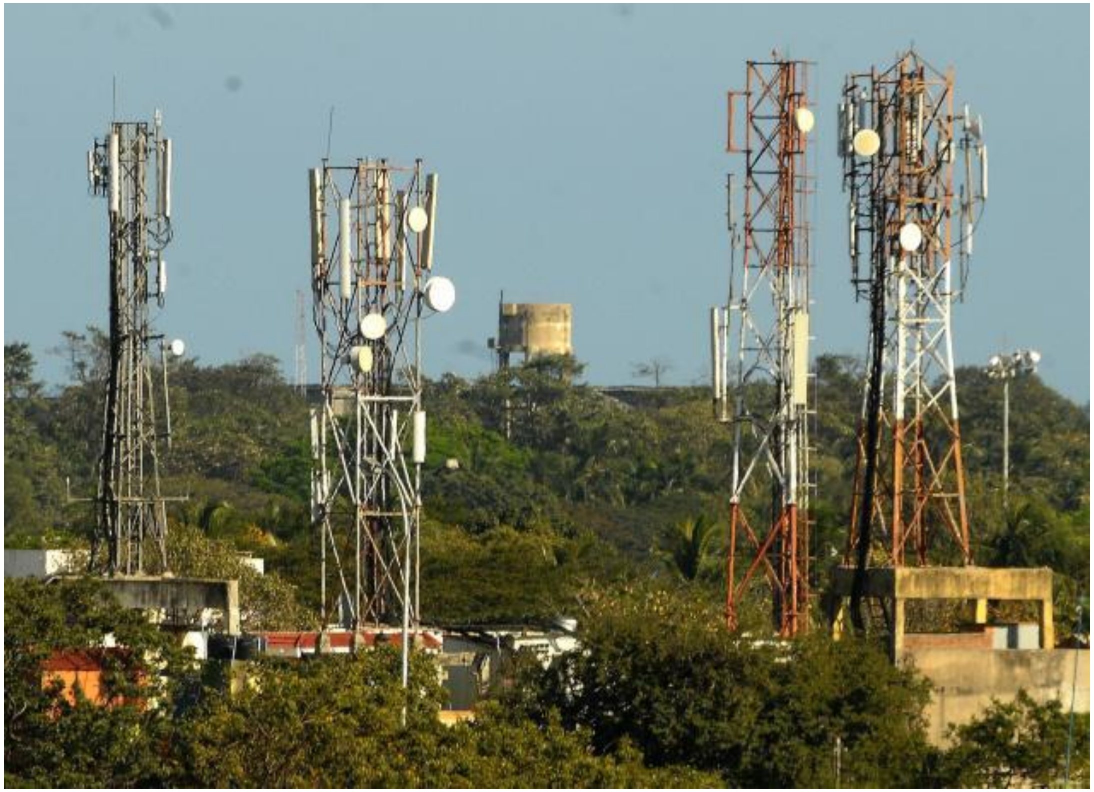
Coal-fired thermal power plants

Growth of Installed Capacity in India[1][3]

Installed Capacity as on	Thermal (MW)				Nuclear (MW)	Renewable (MW)			Total (MW)	% Growth (on yearly basis)
	Coal	Gas	Diesel	Sub-Total Thermal		Hydel	Other Renewable	Sub-Total Renewable		
31-Dec-1947	756	-	98	854	-	508	-	508	1,362	-
31-Dec-1950	1,004	-	149	1,153	-	560	-	560	1,713	8.59%
31-Mar-1956	1,597	-	228	1,825	-	1,061	-	1,061	2,886	13.04%
31-Mar-1961	2,436	-	300	2,736	-	1,917	-	1,917	4,653	12.25%
31-Mar-1966	4,417	137	352	4,903	-	4,124	-	4,124	9,027	18.80%
31-Mar-1974	8,652	165	241	9,058	640	6,966	-	6,966	16,664	10.58%
31-Mar-1979	14,875	168	164	15,207	640	10,833	-	10,833	26,680	12.02%
31-Mar-1985	26,311	542	177	27,030	1,095	14,460	-	14,460	42,585	9.94%
31-Mar-1990	41,236	2,343	165	43,764	1,565	18,307	-	18,307	63,636	9.89%
31-Mar-1997	54,154	6,562	294	61,010	2,225	21,658	902	22,560	85,795	4.94%
31-Mar-2002	62,131	11,163	1,135	74,429	2,720	26,269	1,628	27,897	105,046	4.49%
31-Mar-2007	71,121	13,692	1,202	86,015	3,900	34,654	7,760	42,414	132,329	5.19%
31-Mar-2012	112,022	18,381	1,200	131,603	4,780	38,990	24,503	63,493	199,877	9.00%
31 Mar 2015	169,118	23,062	1,200	188,898	5,780	41,267	35,777	77,044	271,722	11.98%
31 Mar 2016	185,172	24,508	993	210,675	5,780	42,783	42,727	85,510	301,965	11.13%

https://en.wikipedia.org/wiki/Electricity_sector_in_India

Telecom towers



TRAI green report

40% power from grid
60% from diesel

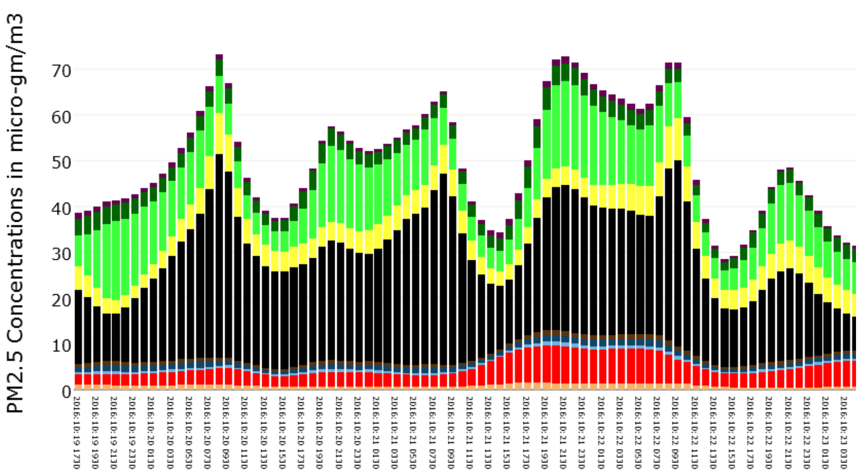
estimates 2 billion litres of annual diesel consumption

total number of mobile connections in 2016

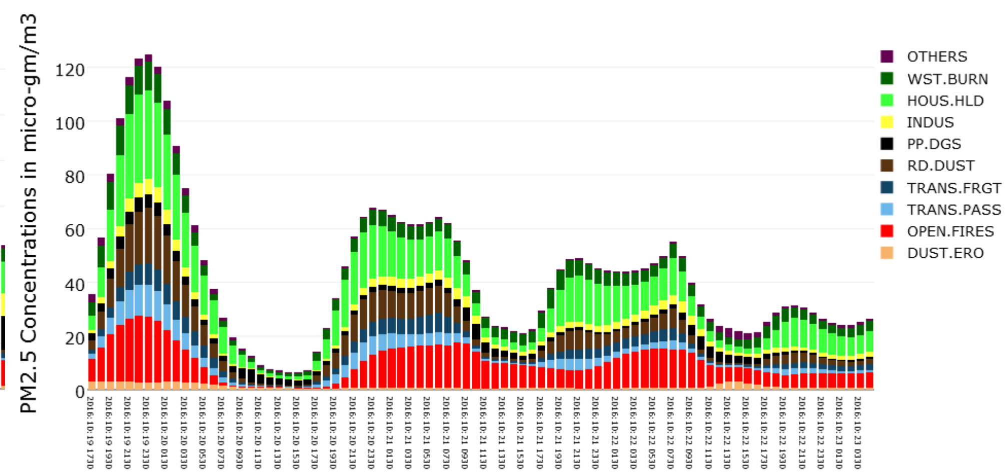
950 million

Contributions of PP-GS

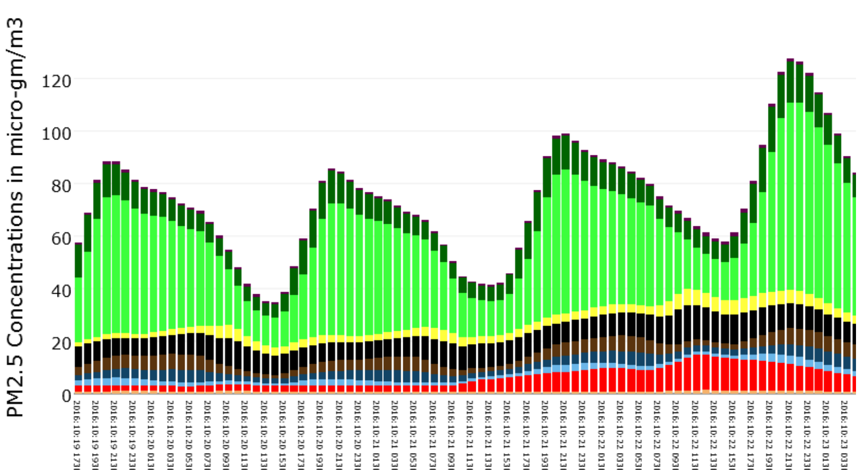
District: Korba (CG)



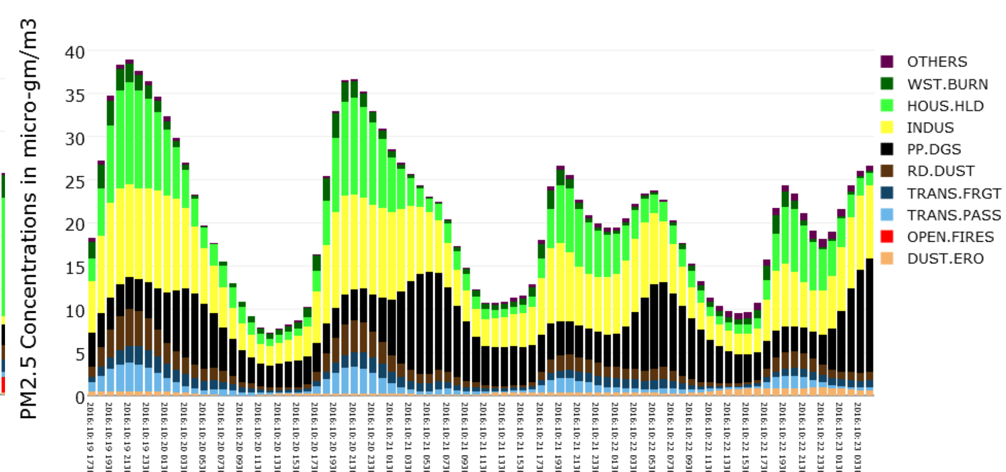
District: Jhajjar (HR)



District: Patna (BH)



District: Ahmadabad (GJ)

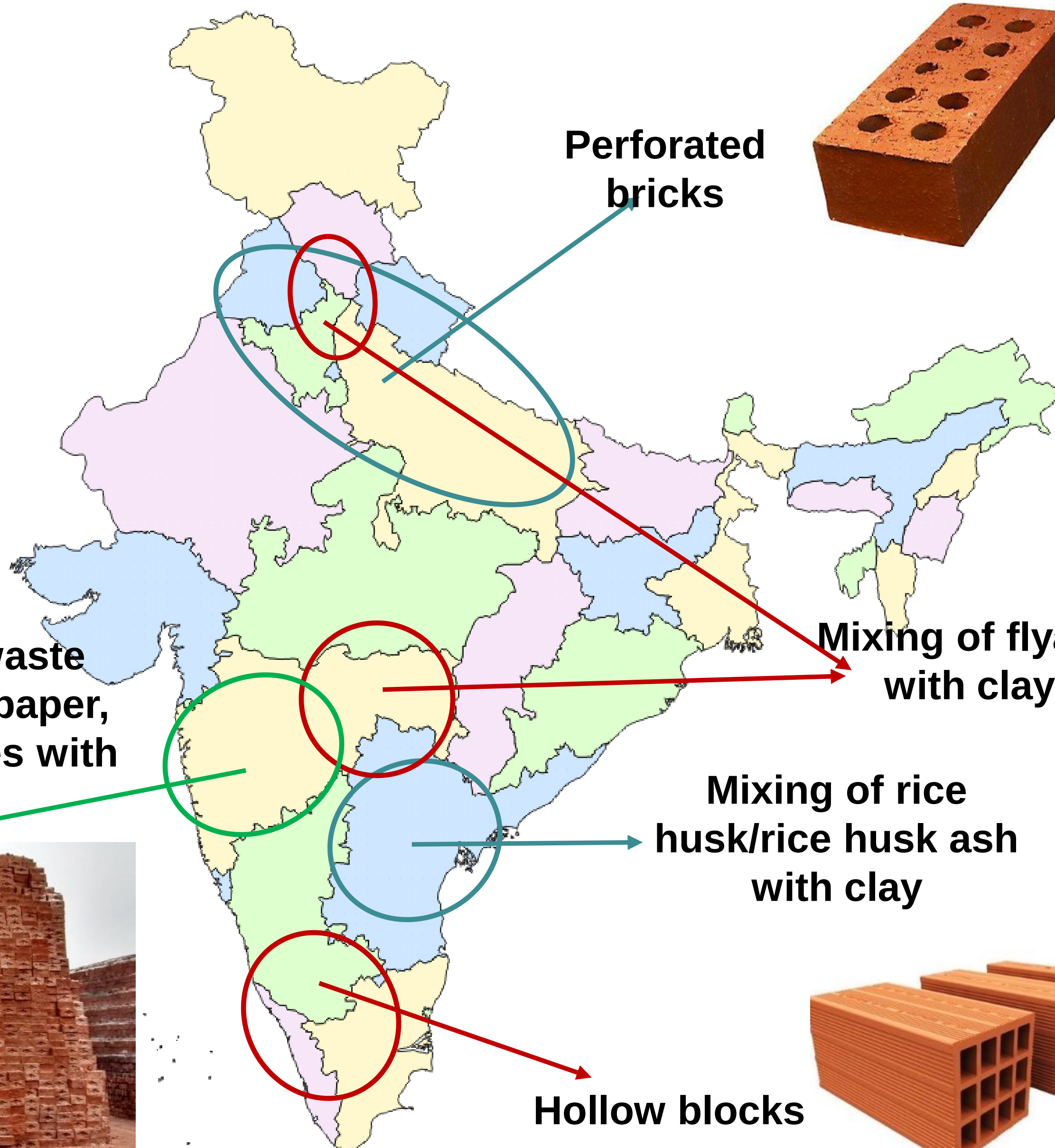


Ash Utilization

stop these from getting blown into the inhabited areas nearby. "All the units of the plant have dry ash extraction and transportation systems. The ash utilization at NTPC, Badarpur is more than 113%—way more than the industry standard," the official said.

http://timesofindia.indiatimes.com/city/delhi/NTPC-says-Badarpur-plant-doesnt-pollute/articleshow/46402507.cms

Resource Efficiencies



Perforated bricks

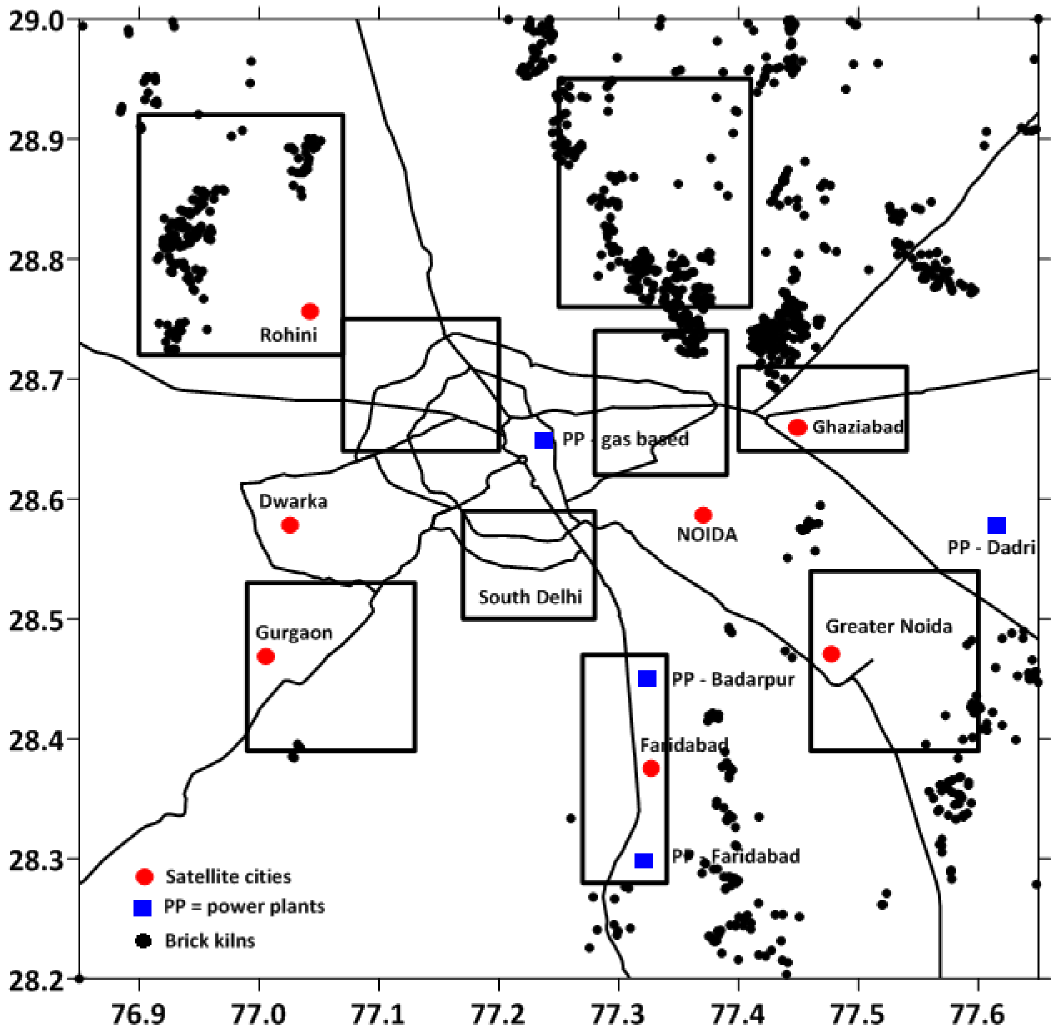
Mixing of flyash with clay

Mixing of waste from sugar, paper, etc. industries with clay

Mixing of rice husk/rice husk ash with clay

Hollow blocks

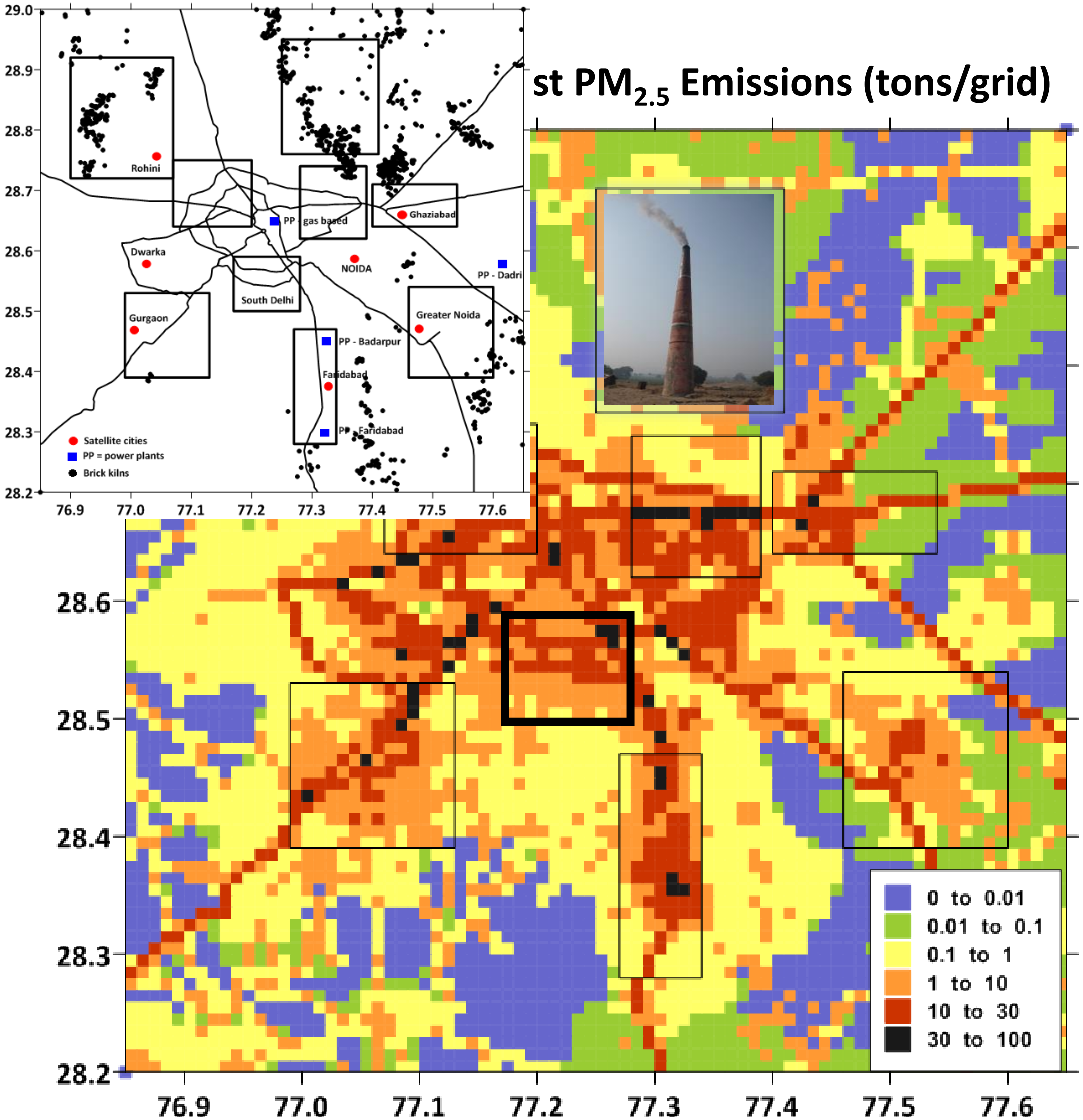
This is still an Urban problem



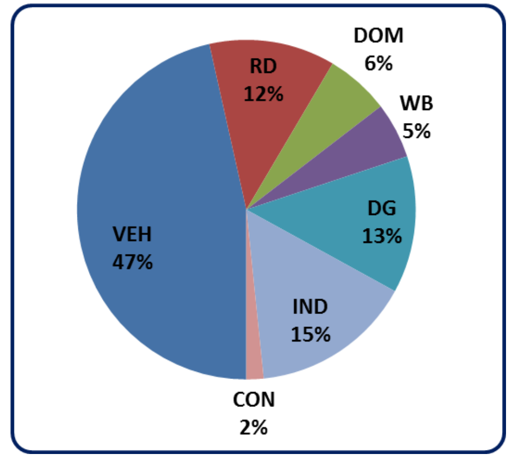
moved but not cleaned

Guttikunda et al. (2013) "Emissions inventory and health impact analysis for Delhi, India" @ Atmospheric Environment

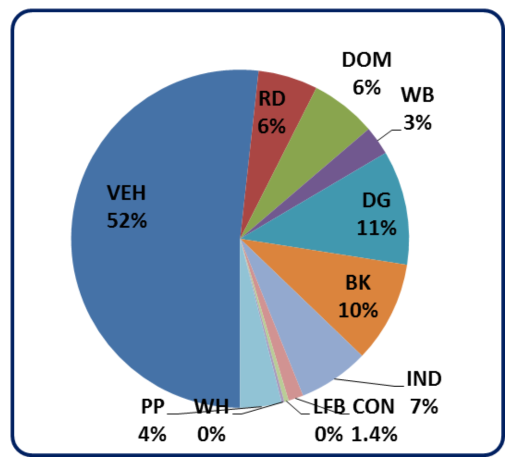
% ground based emissions in south Delhi



Emissions



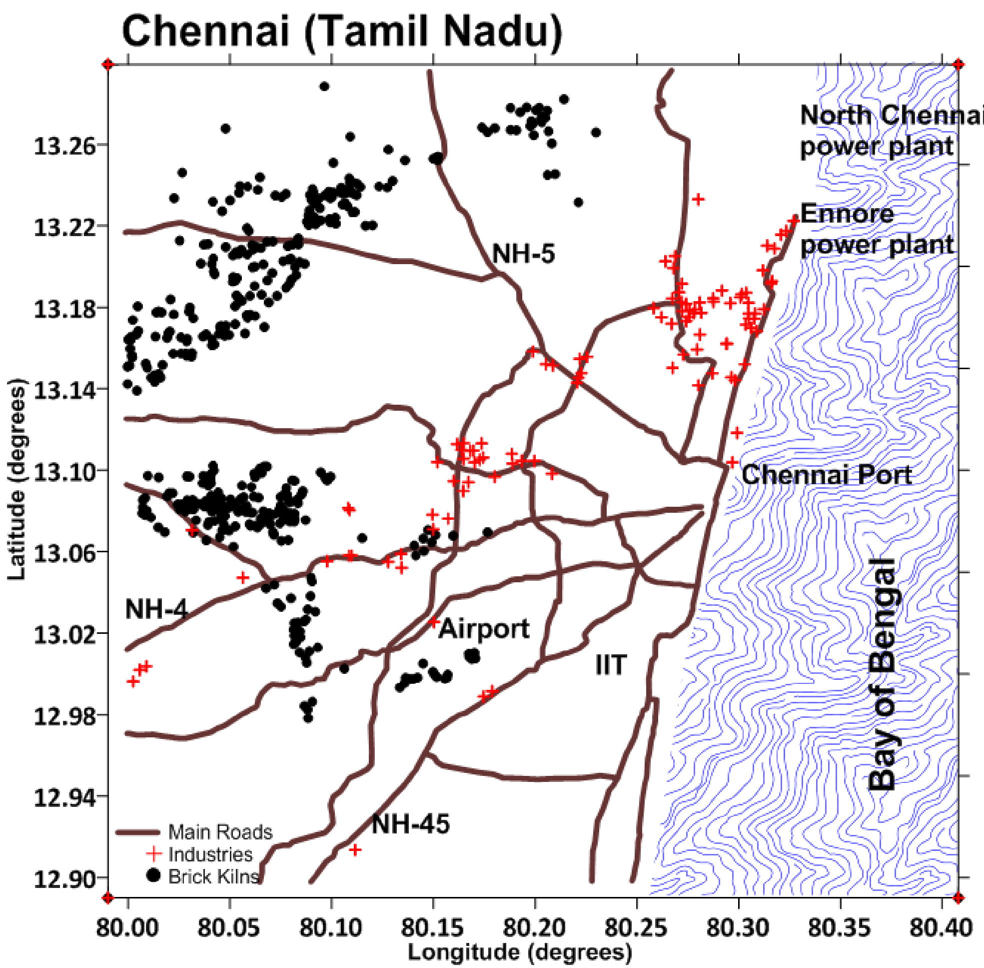
Concentrations



IND = industries; PP = power plants; DOM = domestic; TR = transport; RD = road dust;
WB = waste burning; CON = construction activities; BK = brick kilns; DG = diesel generator sets; LFB = landfill burning

Guttikunda et al. (2013) “Emissions inventory and health impact analysis for Delhi, India” @ Atmospheric Environment

This is still an Urban problem



moved but not cleaned

Guttikunda et al. (2015) "Characterizing emissions in Chennai and Visakhapatnam, India" @ Air Quality Atmosphere & Health

Brick Production Cycle

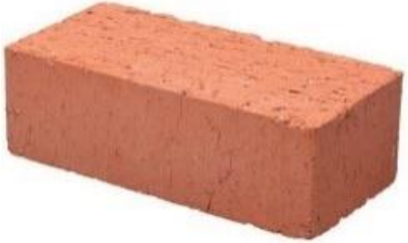
hand moulding

open sun drying

brick firing

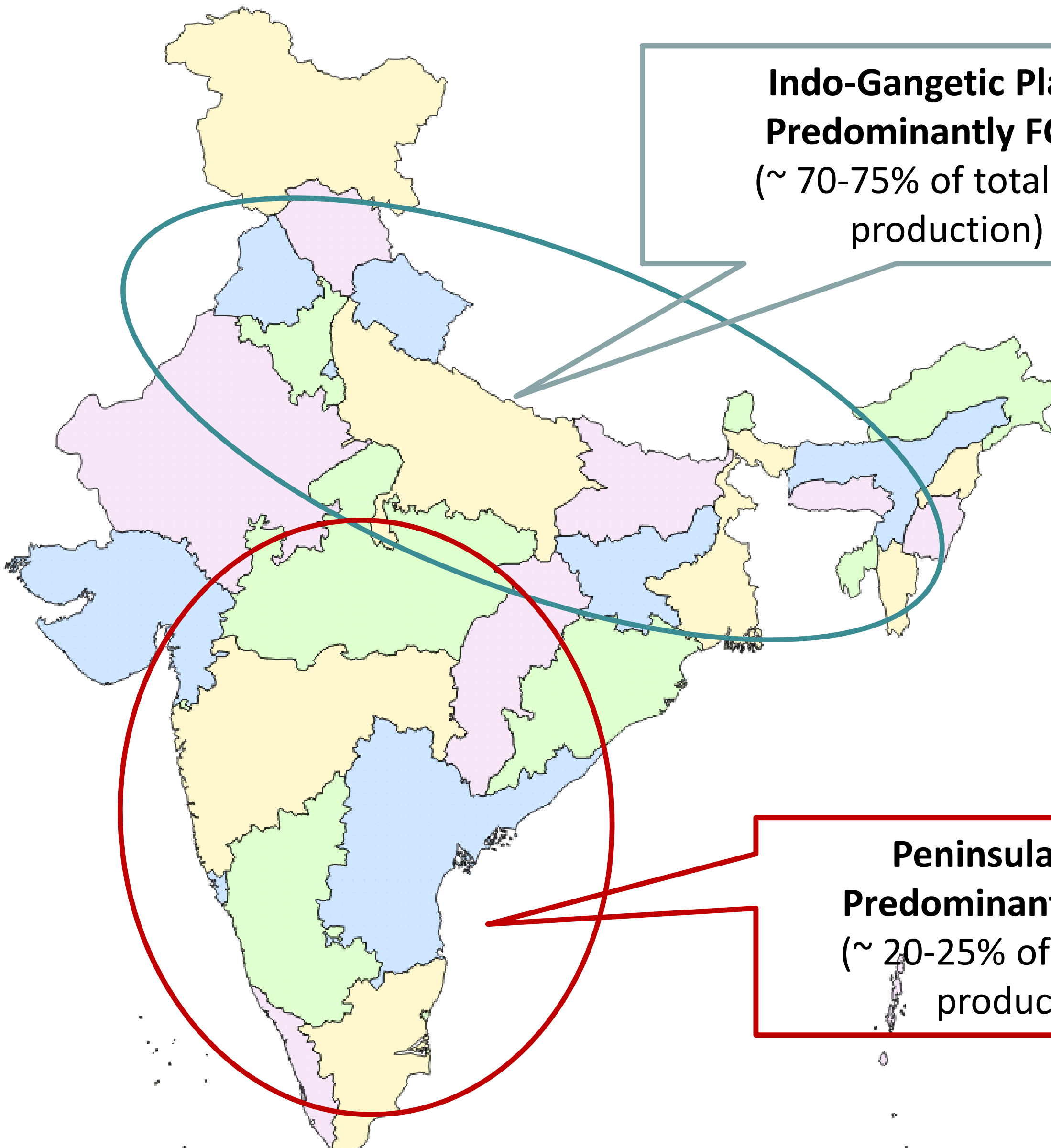
~ 20-25% production through Clamps

~ 70-75% production through FCBTK



final product: Solid bricks

Brick Production Cycle



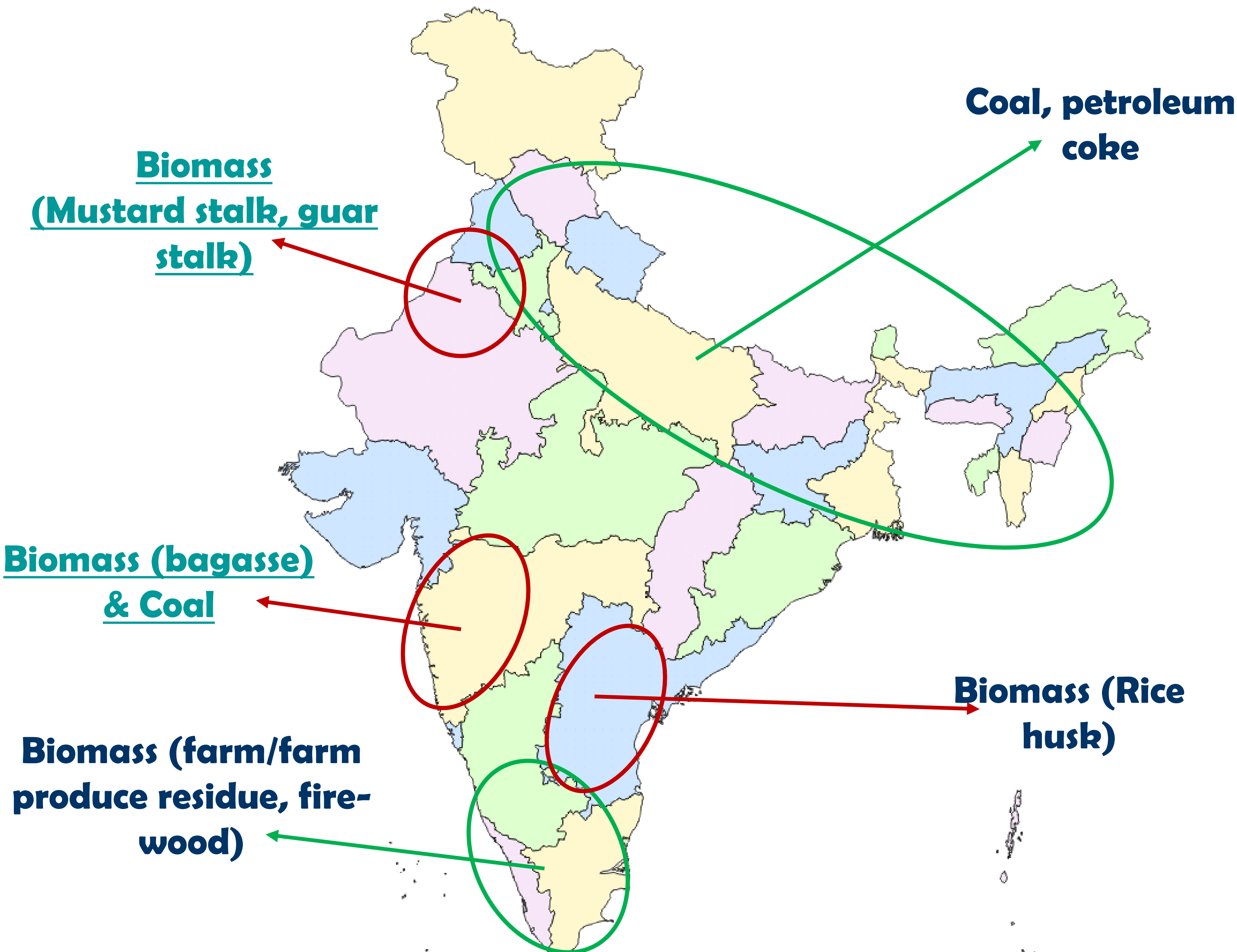
Indo-Gangetic Plains: Predominantly FCBTK
(~ 70-75% of total brick production)

Peninsular India: Predominantly Clamps
(~ 20-25% of total brick production)

What is burning at the kilns?

Workers pushing a mixture of agri-waste and powdered coal at a kiln outside Delhi, India

fuels utilized in brick kilns



What else is burning at the kilns?

A worker soaks dry cow dung in a mixture of kerosene and gasoline at a kiln near Amritsar, India.

Source: Charles W. Schmidt (2013), Environ Health Perspect; DOI:10.1289/ehp.121-A242

What else is burning at the kilns?

Workers cut firewood to light a brick kiln in Kabul, Afghanistan.

Source: Charles W. Schmidt (2013), Environ Health Perspect; DOI:10.1289/ehp.121-A242

What else is burning at the kilns?

A boy transports a discarded tire, to use in a kiln near Dhaka, Bangladesh

Source: Charles W. Schmidt (2013), Environ Health Perspect; DOI:10.1289/ehp.121-A242

What else is burning at the kilns?

Workers pour coal into the fire of a Bull's trench kiln outside Kabul, Afghanistan

Source: Charles W. Schmidt (2013), Environ Health Perspect; DOI:10.1289/ehp.121-A242

What else is burning at the kilns?

A worker removes sand from a batch of fired bricks in Amritsar, India

Source: Charles W. Schmidt (2013), Environ Health Perspect; DOI:10.1289/ehp.121-A242

Brick Kiln Technologies

Traditional Technologies

Bulls Trench Kiln

Down-draught Kiln

Clamp

Alternate Technologies

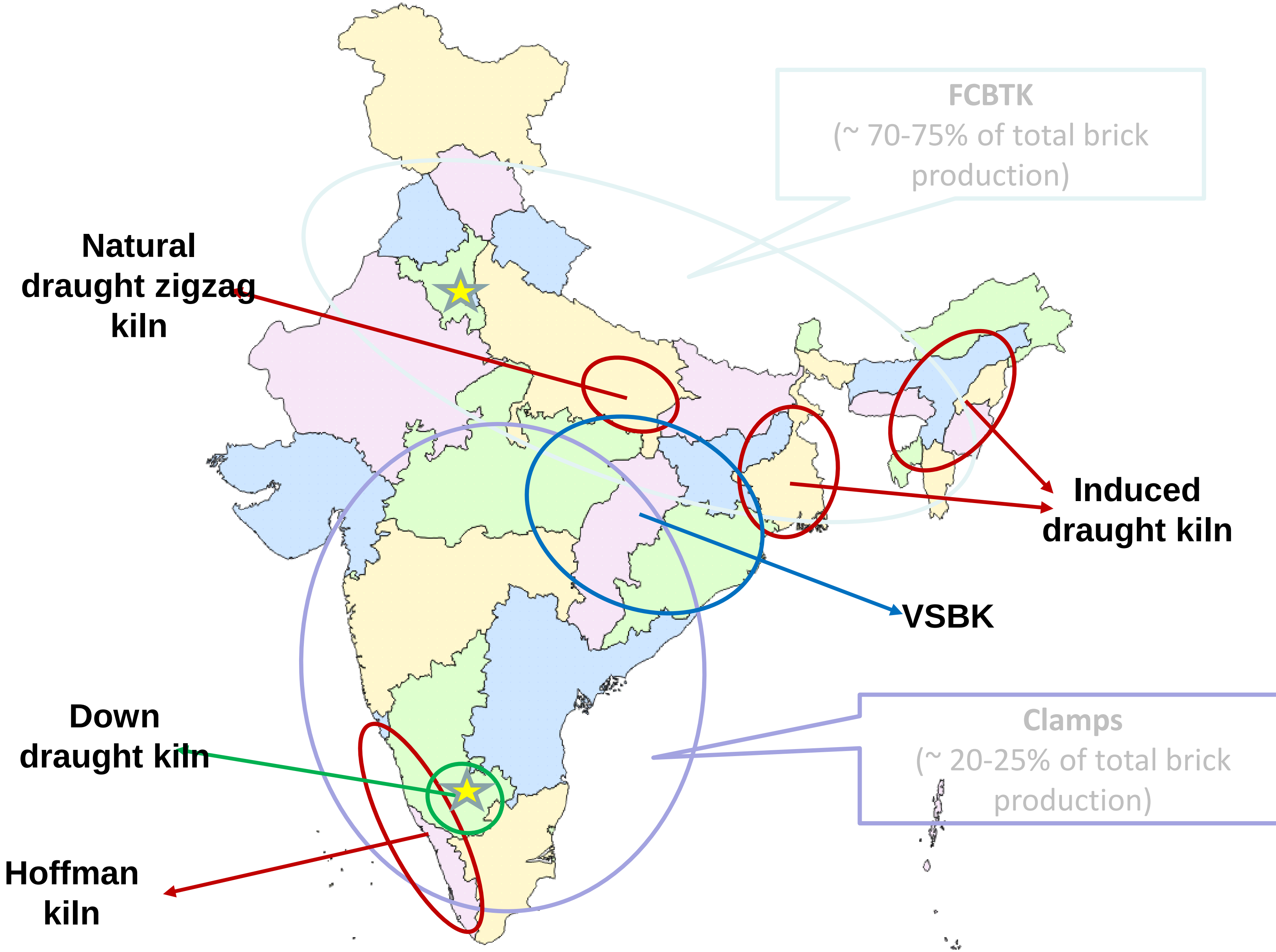
Zigzag Kiln

Hoffman Kiln

Vertical Shaft Kiln

Tunnel Kiln

Brick Kiln Technologies



At source solutions

Table 1 Comparison of technical and operational benefits and constraints of current and alternative brick manufacturing technologies available in Bangladesh

Technology	Fuel consumed per 100,000 bricks	Average tons of CO_2 produced per 100,000 bricks	Average reduction in PM emissions compared to FCBTK (%)
FCBTK	20–22 t coal	50	
Zigzag[a]	16–20 t coal	40	40
Hoffmann[b]	15,000–17,000 m^3 NG	30	90
Hoffmann[c]	12–14 t coal	30	60
VSBK[d]	10–12 t coal	25	60

The table is a summary of information presented in World Bank 2007

FCBTK fixed chimney bull trench kiln, *NG* natural gas, *VSBK* vertical shaft brick kiln

[a] Some zigzag pilot kilns are in operation, listed as poor to medium performance. Any improvement in the efficiency of operations can lead to further reductions in coal consumption

[b] Manufacturing period for Hoffmann kilns is round the year, compared to the six month operations for the other kilns; thus increasing the land and raw material requirements; Link to natural gas grid and continuous supply is a major constraint

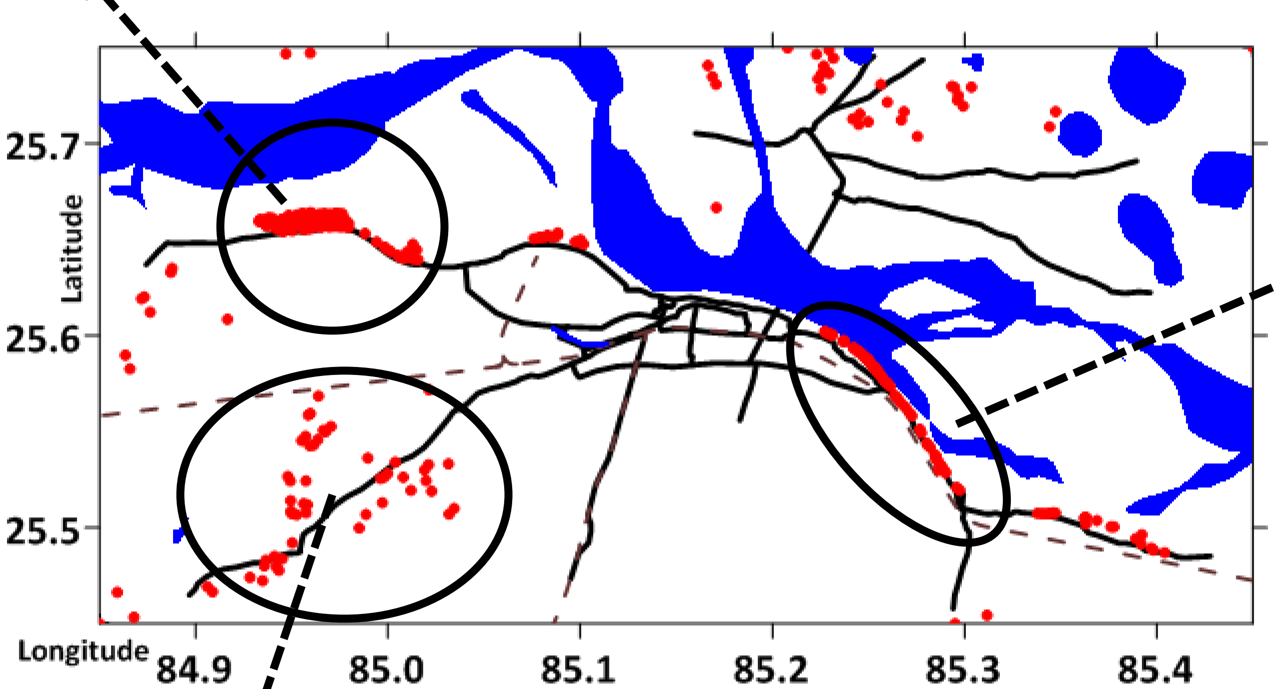
[c] Initial investments are higher for Hoffmann kilns

[d] Operational models are available in India and Kathmandu (CAI-Asia 2008)

Guttikunda et al. (2013) “Analysis of Dhaka’s brick kiln emissions” @ Air Quality Atmosphere and Health

Patna, India

100 stacks



75 stacks

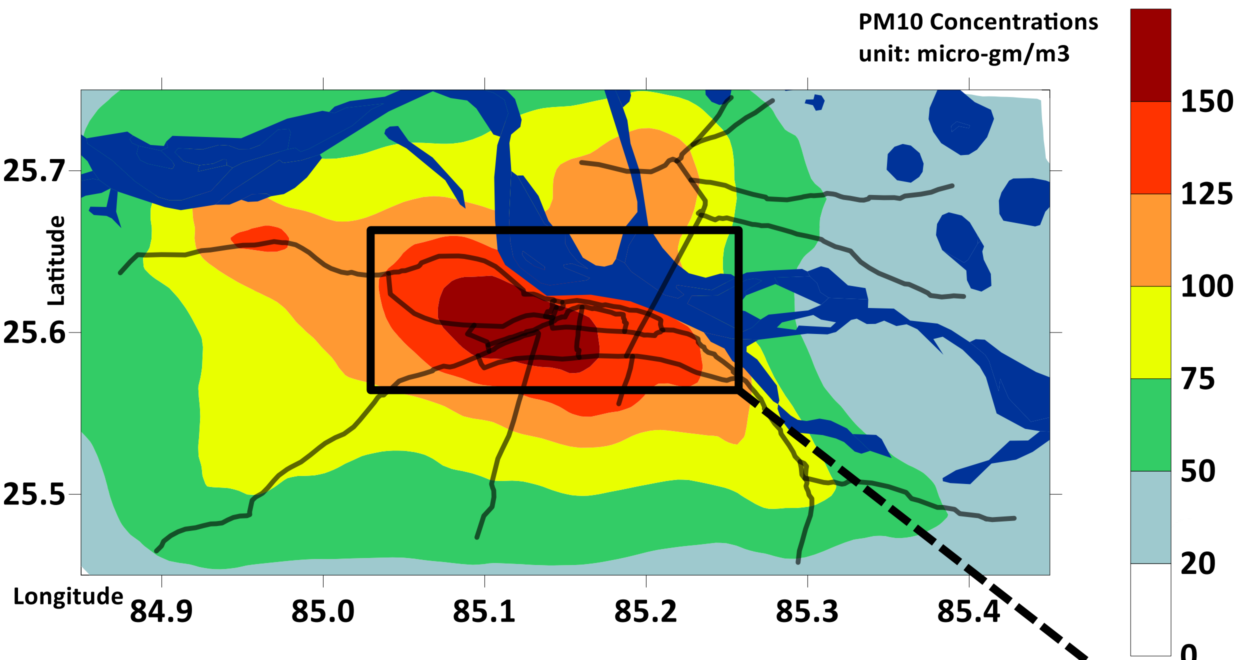
Major roads (black lines), rail lines (hash lines), water ways, and brick kilns (red dots)

50 stacks

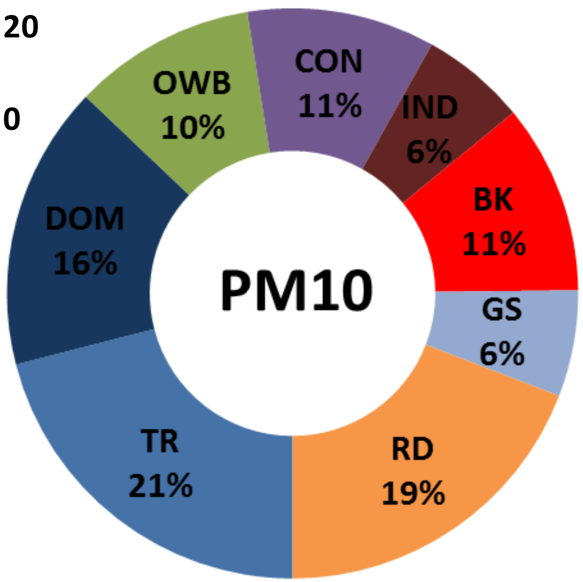
SHAKTI SUSTAINABLE ENERGY FOUNDATION

Guttikunda et al. (2014) "Characterizing air pollution in Patna, India" @ http://www.urbanemissions.info

Patna, India



Sectoral contributions in the select region for ambient PM_{10} (2012)



TR = transport (including road, rail, and air); RD = road dust; DOM = domestic (including household and kiosks); GS = generator sets; OWB = open waste burning; IND = manufacturing industries (other than brick kilns); BK = brick kilns; CON = construction activities

SHAKTI SUSTAINABLE ENERGY FOUNDATION

Guttikunda et al. (2014) “Characterizing air pollution in Patna, India” @ http://www.urbanemissions.info

Health impact shares

GBD assessments estimate 530,000 premature deaths (2015) in India due to outdoor air pollution

National share of impacts from brick kiln emissions is ????

At urban scale, this can be 5-15%

http://www.indiaairquality.info

Thank you

More @

URBANEMISSIONS.info