Out of Sight:
How coal burning advances India's Air Pollution Crisis

CLEAN AIR NATION

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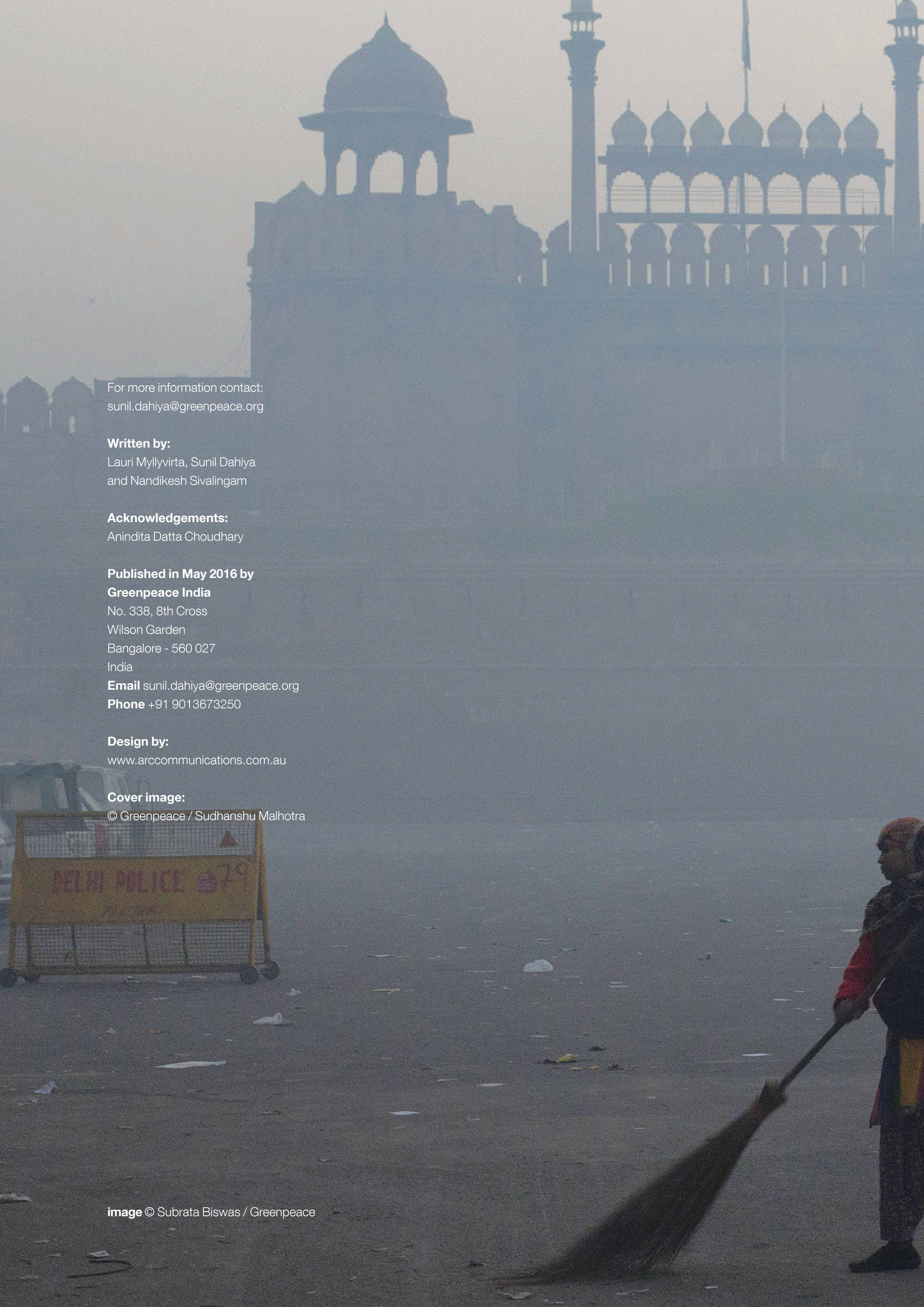

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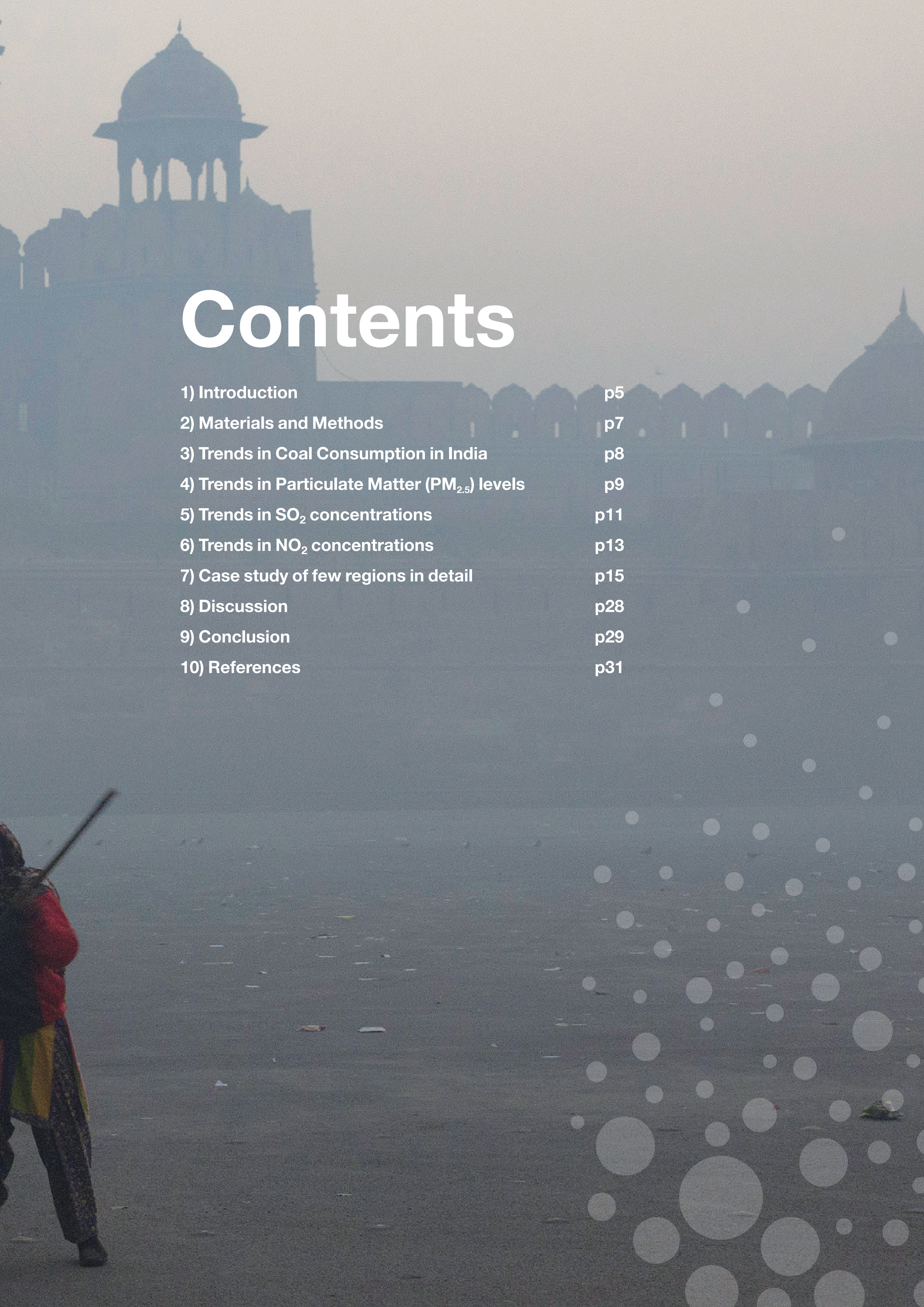


Contents

Summary

While the debate about air pollution in India continues to focus on visible pollution sources inside cities, rapid growth in coal-based thermal power generation, largely out of sight of urban Indians, is one of the key drivers of the crisis. This report exposes the largest air pollution emission hotspots and largest sources of SO_2 and NO_2 emission growth in India from 2009 to 2015 by analysing satellite data. The analysis shows respective increase of 13% and 31% for $PM_{2.5}$ and SO_2 levels from 2009-2015. Earlier research on regional trends has identified a 20% increase in NO_2 levels using the same data.[1] Identification of hot spots clearly indicates that large industrial clusters are the dominant sources of SO_2 and NO_2 emission growth, with huge capacities of new coal-fired thermal power plants (TPPs) as the main driver. The secondary particulates formed from aerosols like SO_2 and NO_X are key cause of the recent increase in $PM_{2.5}$ levels, which is causing damage to human health and creating potentially a health emergency situation in India. Many researches on air pollution as well the recent IIT Kanpur study on Delhi's air pollution has highlighted thermal power plants being the biggest source of SO_2 and NO_x emission growth in India. The case study in the report establishes clear links between increase in coal consumption and air pollution levels in specific hotspots like Singrauli, Korba – Raigarh, Angul, Chandrapur, Mundra and NCR.

This study emphasises on the urgent need to comply with the thermal power plant emission standards announced in December 2015 in order to solve the air pollution crisis faced by Delhi and many other parts of the country. The study also highlights the big sources of pollution over the larger geographical area where attention is urgently required to come up with a comprehensive and systematic National Action Plan on air pollution with time bound actions.

Introduction

High levels of toxic air pollution are a problem plaguing all of north India for several years now. In 2013, air pollution caused 1,800 deaths each day in India, up from 1,300 in 2000.[2] Over this period, air pollution levels increased dramatically across India which can be attributed to various factors such as massive fossil fuel consumption, industrial growth, increase in number of vehicles and rapid expansion in construction activities along with biomass burning at household level and in the agricultural fields. In a recent assessment done by Central Pollution Control Board (CPCB) based on the data generated by the National Ambient Air Quality Index showed that most of the cities in North India like Agra, Delhi, Faridabad, Gaya, Kanpur, Lucknow, Muzaffarpur, Patna, Varanasi, Jaipur and Jodhpur are heavily polluted.[3] The important thing to note about air pollution is the fact that it moves across long distances making it difficult to solve the issue in isolation by concentrating only on specific cities and sources[4].

If we consider the last decade fossil fuel burning can be clearly seen as one of the major drivers for increasing air pollution levels across India. Among fossil fuels, especially the use of coal doubled from 2005 to 2014 and oil consumption increased by 50%.[5] The current installed electricity generation capacity in India stands at 289 GW as on 29th February 2016.[6] Out of the total installed capacity 176 GW is coal based electricity generation in 2016 as compared to 68 GW in 2005.[7] Also, Coal production in India in 2014- 2015 stood at 612 MT and India was third largest producer of coal following China and USA.[8]

While there were some improvements in emission performance of vehicles, meaning that the rate of air pollutant emissions increased less than of total fuel use, there was little or no improvement in SO_2 and NO_x emission controls used in coal-burning facilities, implying that emissions from coal-burning increased equal to the rate of coal consumption.

Among the pollutants released by thermal power plants, SO_2 and NO_x are the key ingredients. These particles also contribute to the toxic particle haze covering north India.[9,10,11] If the country's air pollution crisis is to be addressed effectively, tackling the runaway increase in these emissions (SO_2 and NO_x) is of key importance. Boys et al., 2014[12] found that $PM_{2.5}$ increase in South Asia from 1999-2012 were largely explained by the increase in inorganic secondary particles, which are dominantly formed from SO_2 and NO_x in the atmosphere. Investigating further Lu et al., 2013[13] found that coal-based thermal power plant clusters were responsible for more than 75% of total SO_2 emissions in all 23 Indian states they analysed, and for more than 90% in 16 Indian states.

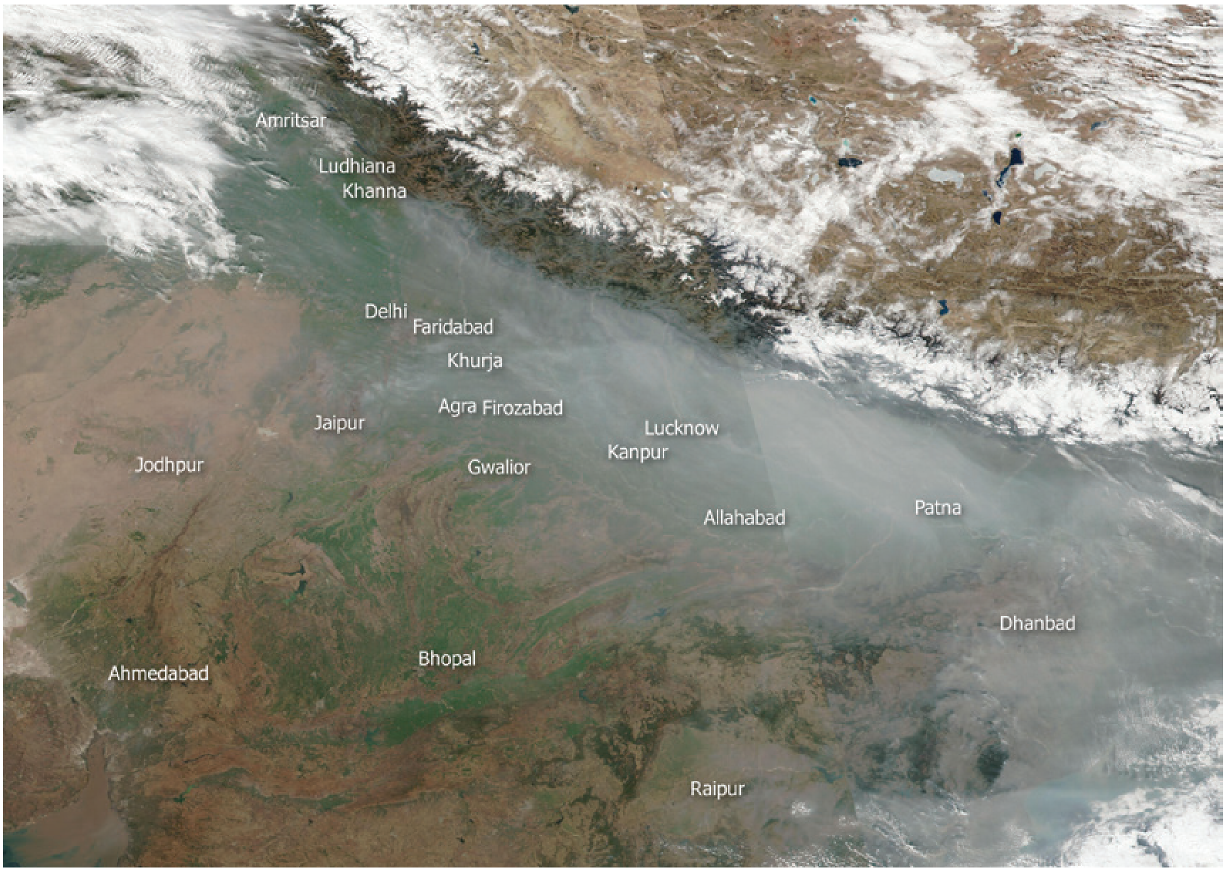


Figure 1: Satellite view of the North India smog on 28th January 2016 (MODIS Terra imagery via NASA WorldView) showing polluted cities in Indo- Gangatic Plain (IGP)

From the above studies it's clear that a major source of $PM_{2.5}$ in North India is secondary particles such as those formed from SO_2 and NO_x and emissions from thermal power plants are the major contributors for these particulates. This report attempts to understand the increase in the emissions of SO_2 and NO_2 and to identify the correlation between such increases and major coal consuming hot-spots in the country.

Materials and methods

Average annual SO_2 and NO_2 column amounts were calculated for each year starting from 2009 to 2015 from daily NASA OMI data (OMSO2e v003 and OMNO2d data products) obtained through the Giovanni portal.[14] Power plant locations, capacity and year of commissioning were taken from the Global Coal Plant Tracker database,[15] March 2016 version which includes data through 2015. For each grid cell, a linear regression model was fitted through the annual time series to obtain annual linear trend in pollutant levels, and grid cells with p-value below 5% were used for analysis.

To detect trends in SO_2 and NO_2 levels at each of the power plant locations, average pollutant levels were calculated within a 60-kilometer radius around the power plant. This distance was adopted from an earlier piece of research done on the same data by Lu et al., 2013.

To control against annual variation in background pollutant levels, the average pollution levels within a radius of 250km, and not within 60km of any coal-fired power plant, were used as comparison.

To assess the development of total SO_2 and NO_2 emissions by state, the pollutant measurements in all grid cells over each state were summed up by year.

The $PM_{2.5}$ data from Boys et al., 2014 was used by extending it to 2015 by scaling the 2012-2014 data with average aerosol optical depth in 2012-2015. The results for $PM_{2.5}$ were validated against ground measurements obtained from the National Air Quality Index (NAQI) system. Full-year time series are still sparse but the correspondence between satellite based and ground data gave R^2 value of 0.85 highlighting the depiction of most of ground based data through satellite measurements (Figure 2).

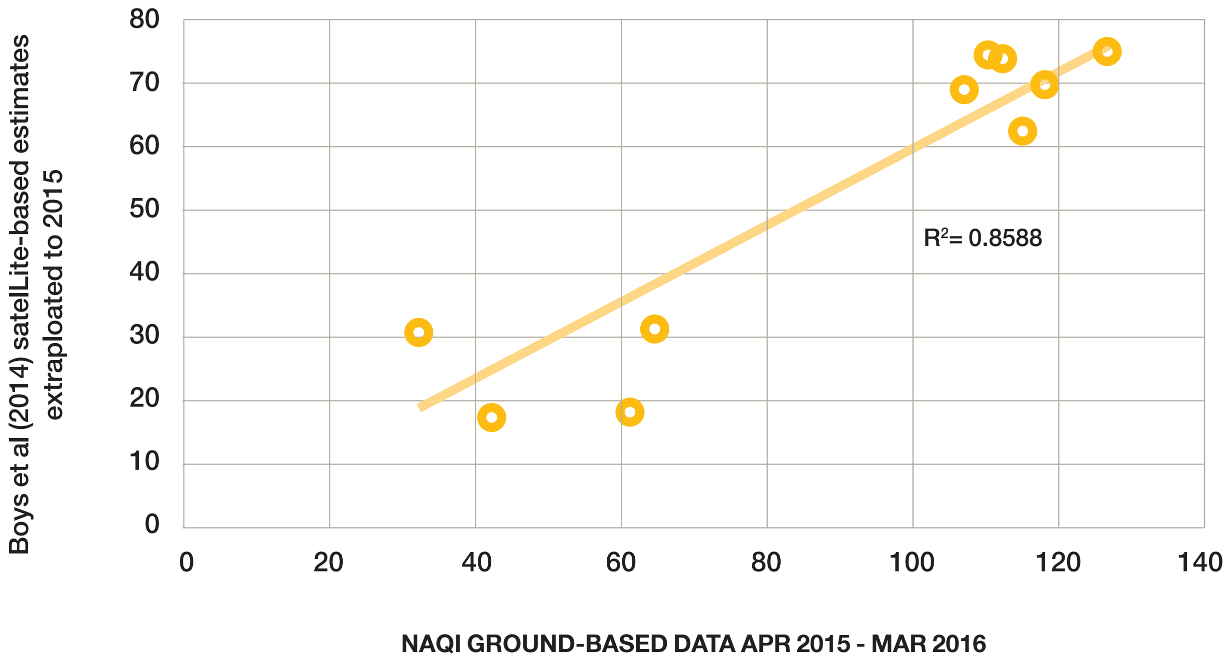


Figure 2: Sateliite-based $PM_{2.5}$ estimates vs. ground measurements

Trends in Coal Consumption in India

The fossil fuel consumption in India has grown drastically over the last decade and most of this has come from expansion in the coal consumption increasing from 184 Mtoe (Million Ton Oil equivalent) in 2005 to 360 Mtoe in 2014 (Figure 3).[16] Most of the coal consumption has come from the increase in domestic coal mining with a noticeable increase in the imports over recent years from countries such as Indonesia, Australia and South Africa. The Indian coal has relatively low heating value and high ash content making the specific coal consumption high and releasing more pollutants into the atmosphere. Out of the total coal consumption in India, major share of approximately 65% is consumed by the power utilities and nearly 6% by the captive power units (Table 1).[17]

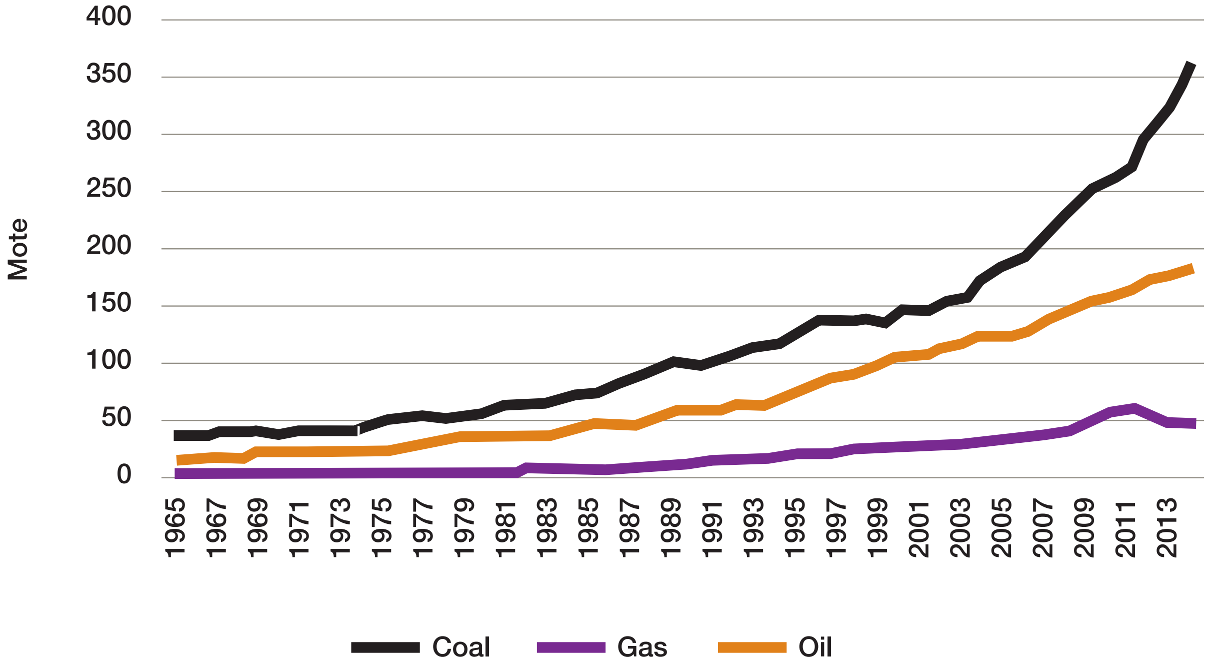


Figure 3: Fossil fuel consumption in India

Table 1: Sector wise breakup of Coal Supply over past years

		Sector	2011-2012	2012-2013	2013-2014
I.		**COKING COAL**			
	1	Steel/ Coke Oven & Cokeries (indigenous)	15.53	16.9	23.13
	2	Steel (Import)	31.8	35.56	37.19
		Sub Total	**47.33**	**52.46**	**60.32**
II.		**NON COKING COAL**			
	3	Power (utilities)	412.44	457.43	482.33
	4	Power (Captive)	46.51	55.05	42.41
	5	Cement	22.57	22.39	23.85
	6	Sponge Iron/CDI	21.69	20.9	15.12
	7	BBK & Others, including Fertilizer	88.19	107.95	115.66
		Sub Total	**591.4**	**662.94**	**679.37**
		Total Raw Coal	**638.73**	**713.39**	**739.69**

Trends in Particulate Matter ($PM_{2.5}$) levels

The increase in $PM_{2.5}$ for cities in North India is shown in figure 4 below. The satellite image (Figure 5) clearly shows the $PM_{2.5}$ levels between 2009 and 2015 and the incremental difference during the same period (2009 - 2015) at the national level. Assessment of the data shows an increment of 13% in $PM_{2.5}$ between the years. During the same period $PM_{2.5}$ levels in China reduced by 17% due to the implementation of time bound action plan to curb pollution, of which reducing emissions from thermal power plants was a major component.

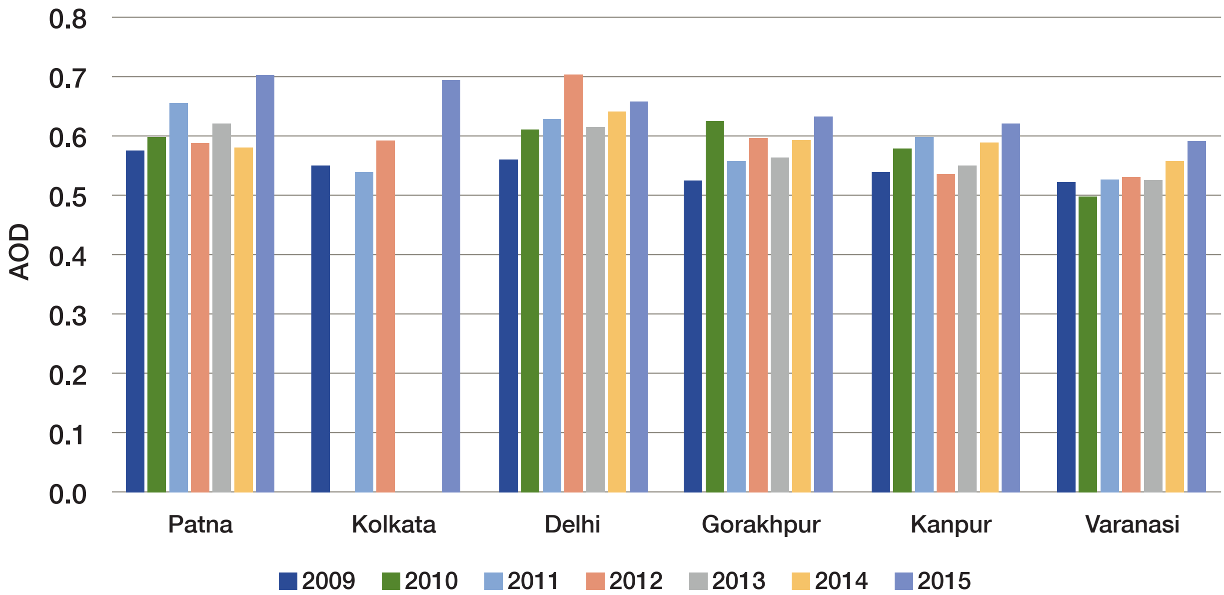
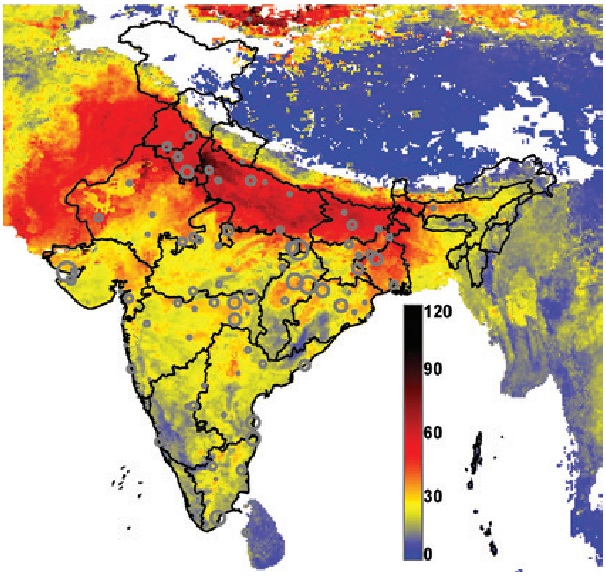
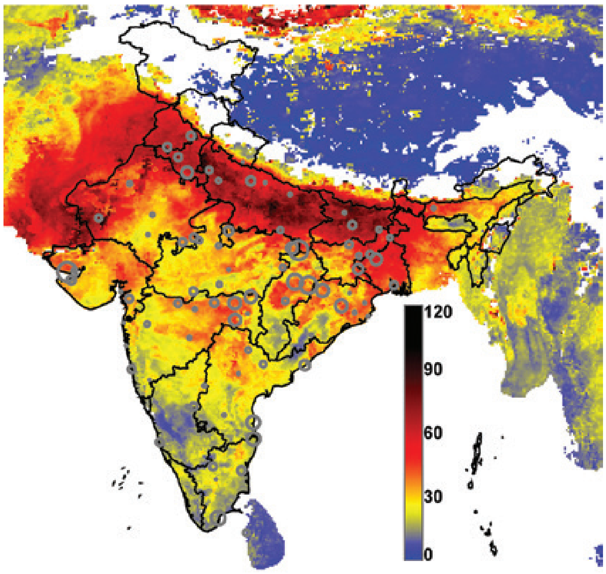


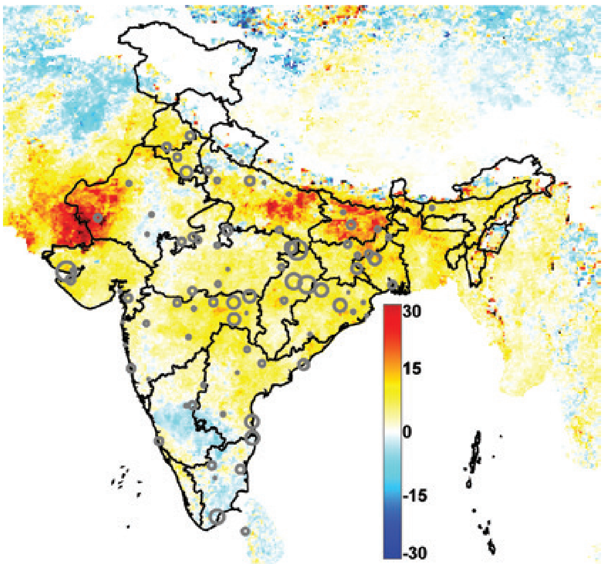
Figure 4: Satellite-based pollution levels in most polluted Indian cities in 2009-2015



Average $PM_{2.5}$ levels in 2009-2010



Average $PM_{2.5}$ levels in 2014-2015



Change in average $PM_{2.5}$ levels in 2009-2015

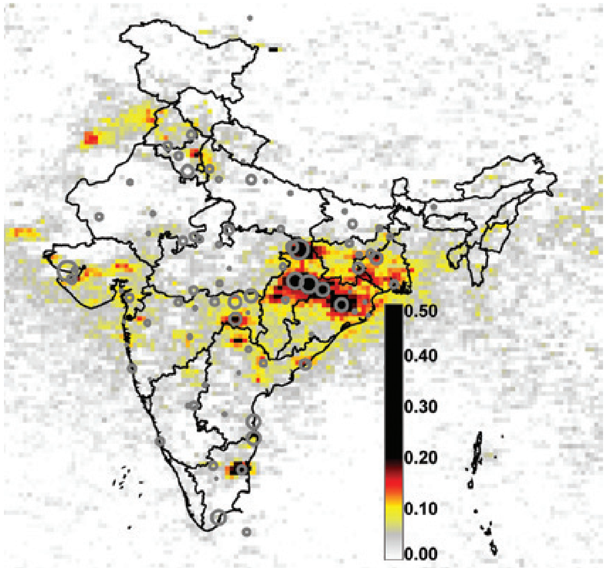
Figure 5: Particulate Matter ($PM_{2.5}$) change through AOD data

Trends in SO_2 concentrations

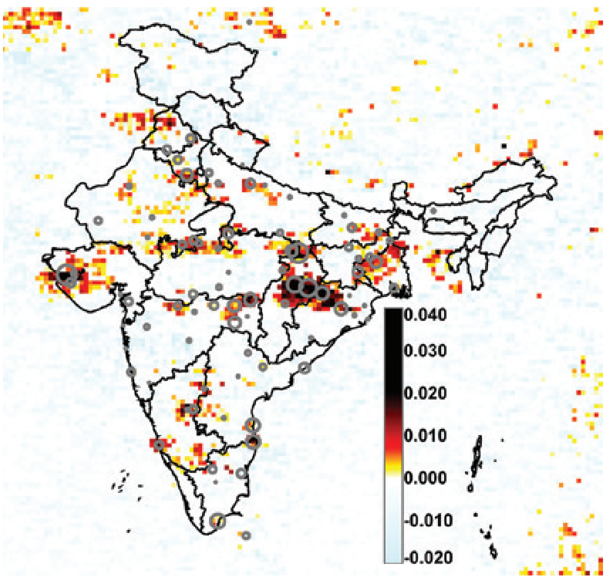
Measurements of average SO_2 levels in India reveal easily identifiable pollutant emission hotspots in coal thermal power plant clusters and steel industry complexes. Furthermore, an analysis of the time series of measurements from 2009 to 2015 (satellite data) shows a very dramatic increase in the SO_2 emissions from these industrial clusters (Figure 6).

Analysis of satellite measurements of pollution data reveals the largest pollution sources in India and the breakneck increase in power plant and industrial pollution that has contributed to worsening air quality across India.

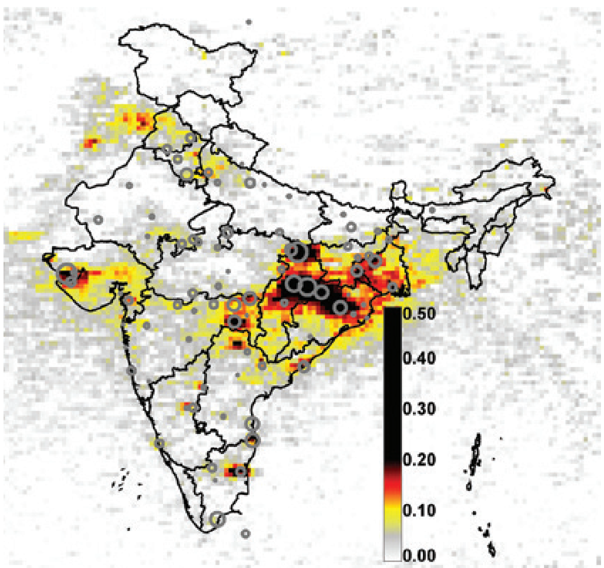
The difference in SO_2 emissions for the years 2009 and 2015 are shown below (Figure 7). The states of Odisha, Chhattisgarh, Maharashtra, Gujarat and Madhya Pradesh shows very high columnar depth of SO_2, at the same time the incremental concentration was highest in Chhattisgarh, Odisha, Gujarat, Uttar Pradesh and Rajasthan (Figure 8).



Average SO_2 level in 2009-2010



Average change in SO_2 levels from 2009-2015



Average SO_2 level in 2014-2015

Figure 6: Trends in SO_2 concentrations

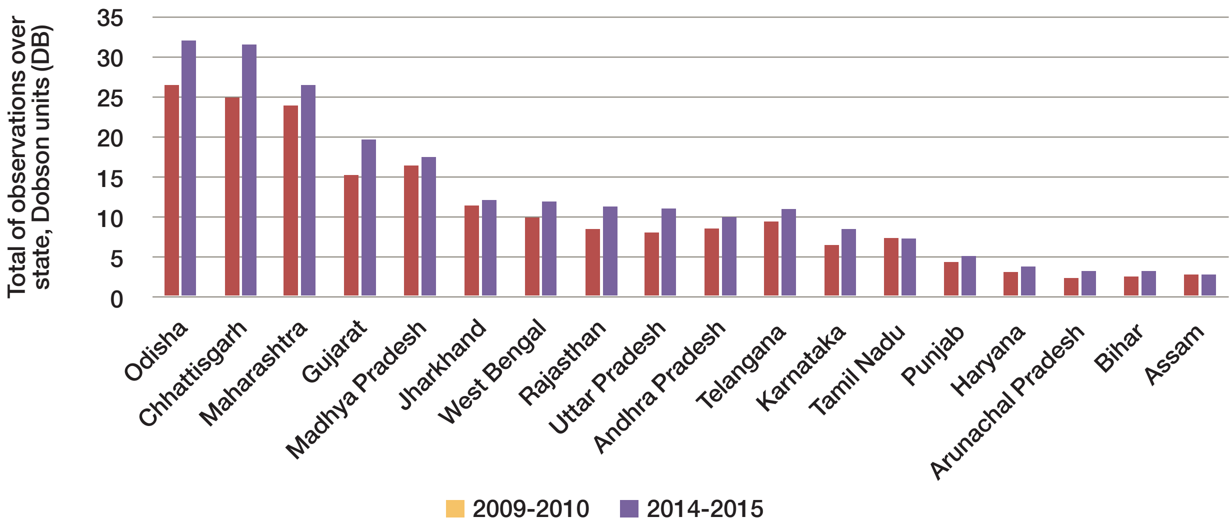


Figure 7: SO_2 amount in 2009-2010 and in 2014-15

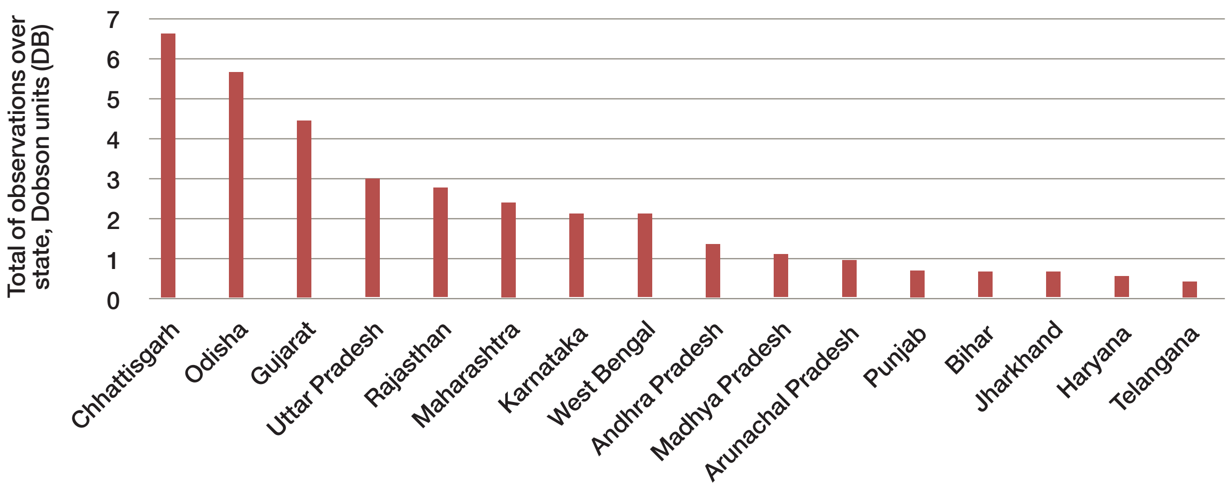
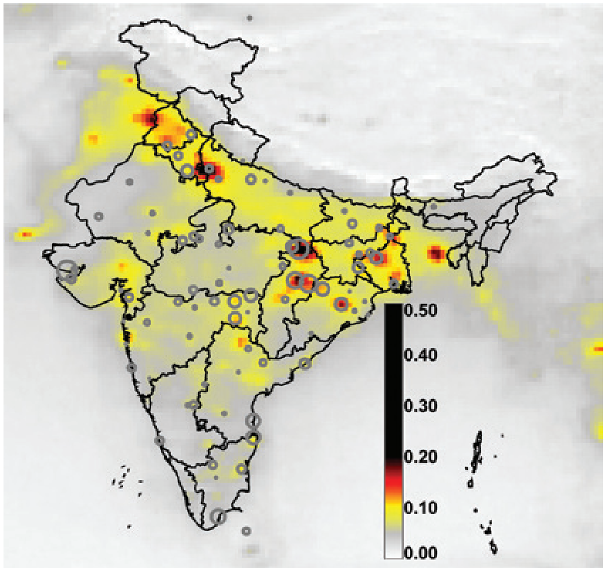


Figure 8: SO_2 increase 2009 to 2015

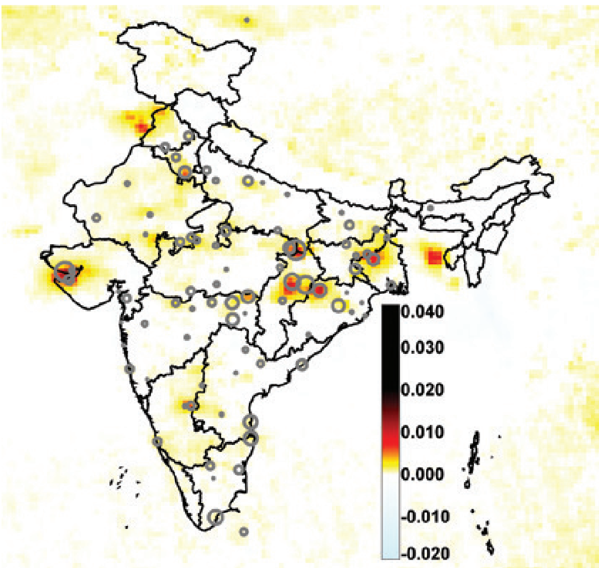
Trends in NO_2 concentrations

Measurements of average NO_2 levels in India reveal easily identifiable pollutant emission hotspots in coal thermal power plant clusters and steel industry complexes. The time series analysis of measurements from 2009 to 2015 (satellite data) shows a very dramatic increase in the NO_2 emissions from these industrial clusters (Figure 9).

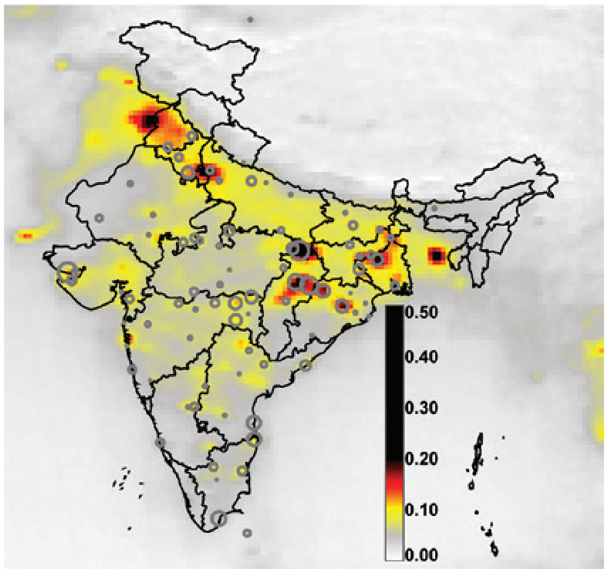
The difference in NO_2 emissions for the years 2009 and 2015 are shown below (Figure 10). The states of Uttar Pradesh, Rajasthan, Madhya Pradesh and Maharashtra shows very high columnar depth of NO_2, at the same time the incremental concentration was highest in Chhattisgarh, Madhya Pradesh, Karnataka and Rajasthan (Figure 11).



Average NO_2 level in 2009-2010



Average change in NO_2 levels from 2009-2015



Average NO_2 level in 2014-2015

Figure 9: Trends in NO_2 concentrations

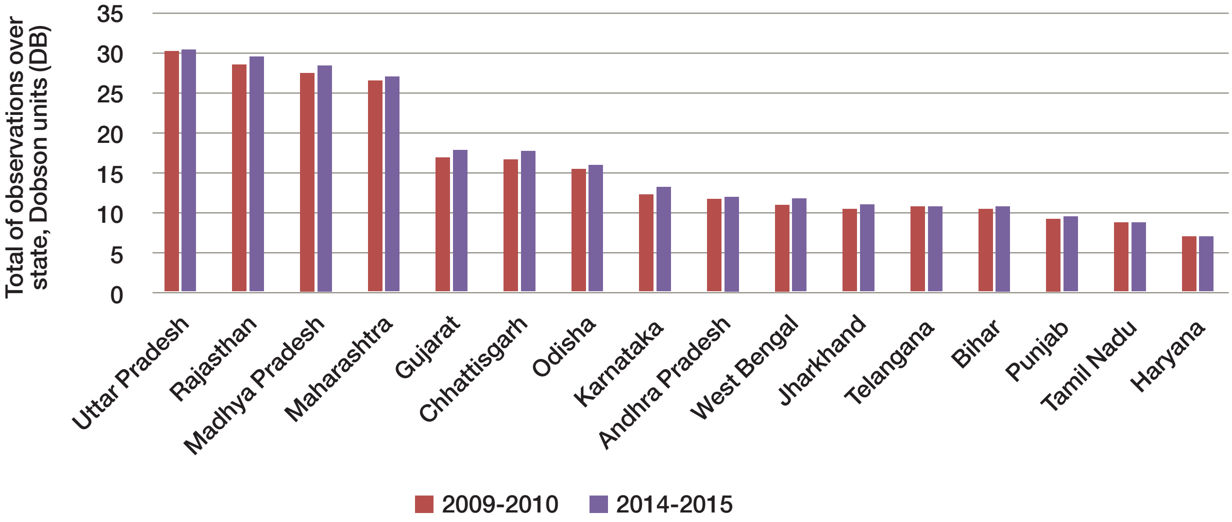


Figure 10: NO_2 amount in 2009-2010 and in 2014-15

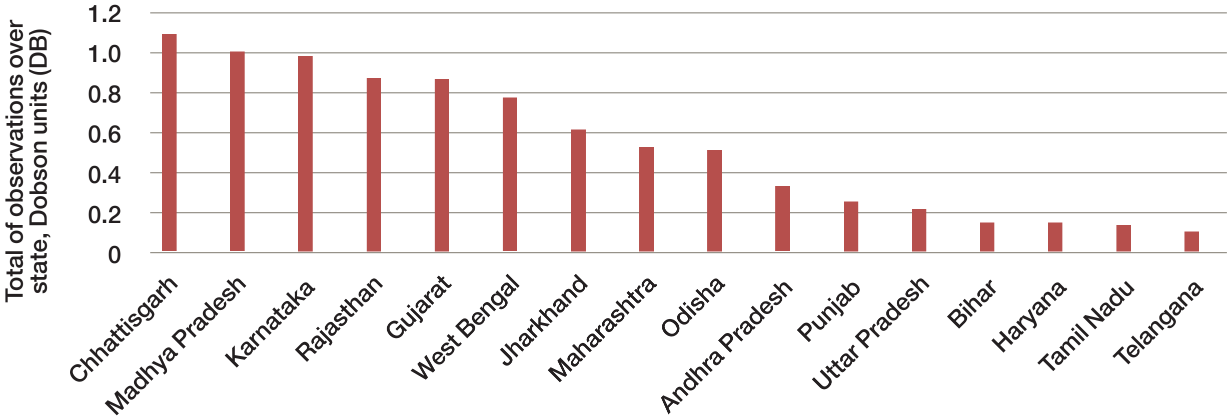


Figure 11: NO_2 increase 2009 to 2015

Case study of few regions in detail

Delhi and region around it

A modelling study carried out by two Indian researchers at IIT Delhi found that 60-90% of PM_{10} in Delhi is due to emissions outside the megacity, so it's imperative to understand pollution sources at the regional level to find solutions to the rising problem.[18] Furthermore, a significant fraction of the particle pollution in Delhi are so-called secondary particles that are formed from pollutants such as SO_2, NO_x and ammonia in the atmosphere, rather than emitted directly, so focusing only on particulate matter (PM) emissions leaving aside SO_2 and NO_2 does not give an accurate picture of the sources of pollution.

Industrial sources are responsible for nearly 90% of SO_2, 52% of NO_x and 11% of $PM_{2.5}$ emissions load in Delhi, most of these pollutants are emitted from the power plants; the sulfate and nitrate particles formed from SO_2 and NO_x pollution, respectively, are key contributors to the total $PM_{2.5}$ pollution. In comparison, the most often cited emissions from vehicles, is responsible for approximately 1% of SO_2, 36% of NO_x and 20% of $PM_{2.5}$ emissions load from the city. This excludes emissions from sources outside the city boundary.[19]

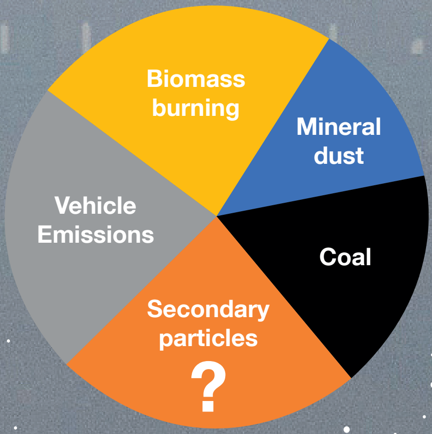
There are 16 coal-fired units (2,824MW) within 50 kilometres from the center of New Delhi, and 114 units (26,874 MW) within 500km.[20] Depending on wind direction and other atmospheric conditions, these power plants and other large coal-burning industries can make a very significant contribution to Delhi's air pollution. Even more alarmingly, nine more coal-fired units (5,530MW) are under construction and 36 units (28,040MW) are in pipeline within the 500km radius of the capital. If realized, these plants could more than double the coal-fired generating capacity and associated air pollution emissions within the region.

A team of researchers led by Dr. Zohir Chowdhury analyzed the chemical composition of the wintertime $PM_{2.5}$ pollution in Delhi, and found out that 1/6th was soot and dust from coal burning, and 1/4th was secondary particulates[21] formed from SO_2, NO_x, ammonia and other "precursor" emissions through chemical reactions in the atmosphere. Most of these secondary particles are linked to SO_2 and NO_x emissions from coal. In total, based on Dr. Chowdhury's results, it is likely that at least ¼ the of the $PM_{2.5}$ pollution in Delhi is linked to coal (Figure 12).

Figure 12: Where Does Delhi's wintertime pollution come from.
(Chowdhary et al., 2007)

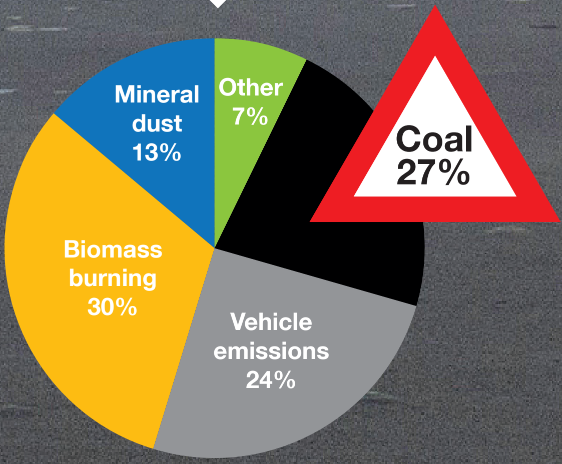
Where does Delhi's wintertime pollution come from?

A team of researchers analyzed the chemical composition of the pollution blackening Delhi's skies (and Delhiites' lungs) and this is what they found out:



"Secondary particles" are tiny, toxic particles generated in the atmosphere from SO_2, NO_x and ammonia emissions. Coal burning is the largest source of SO_2 and NO_x in the regions around Delhi.

When we break these particles up to the sources of SO_2, NO_x and ammonia emissions, here's what it looks like:



The data analysis (Figure15) reveals the Indira Gandhi STPP as the largest source of SO_2 emission increases in 2009-2015 (Figure 13), while the Indira Gandhi STPP and Rajpura TPP stand out as the largest sources of NO_2 emission increase. While Delhi's own NO_2 emissions are visible in the satellite data, the increase in emissions in recent years has clearly come predominantly from the surrounding regions, with very less from within the city itself.

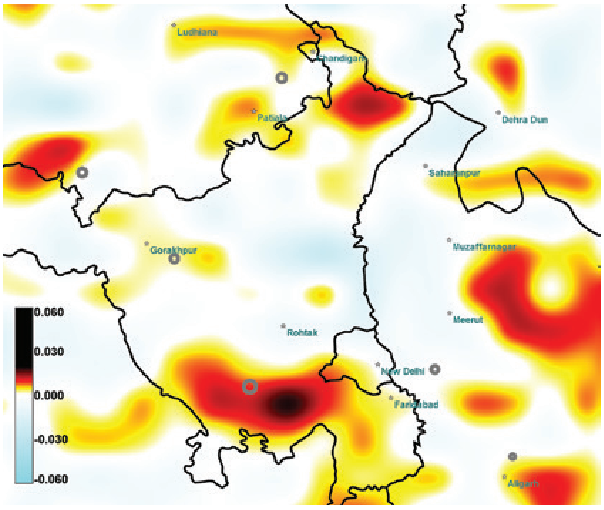


Figure 13: Change in average SO_2 levels in 2009-2015 over Delhi and surrounding areas

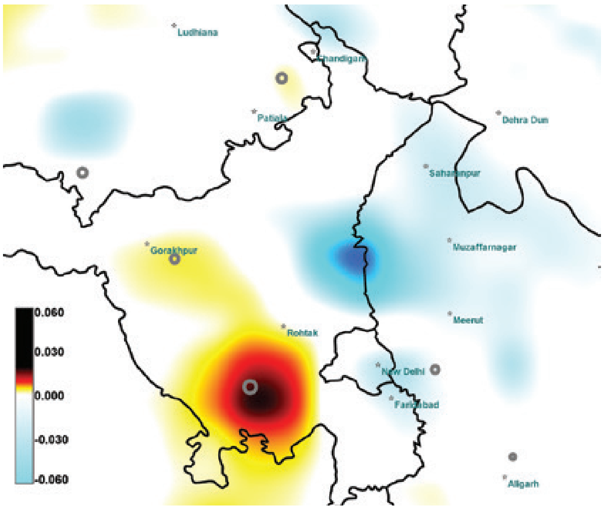


Figure 14: Change in average NO_2 levels in 2009-2015 over Delhi and surrounding areas

Table 2: Summary Table for Delhi, Haryana and Punjab

S.No.		Delhi	Haryana	Punjab
1	Total Installed coal based TPP capacity during 2009-2015 (MW)	0	4020	2020
2	Planned Capacity addition (MW)	0	800	2640
3	SO_2 columnar depth, Total (increment over 2009-2015) (Db)	64%	20%	16%
4	NO_2 columnar depth, Total (increment over 2009-2015) (Db)	-1%	2%	3%
5	$PM_{2.5}$ (AOD) levels Total (increment over 2009-2015) (Db)	16%	14%	24%

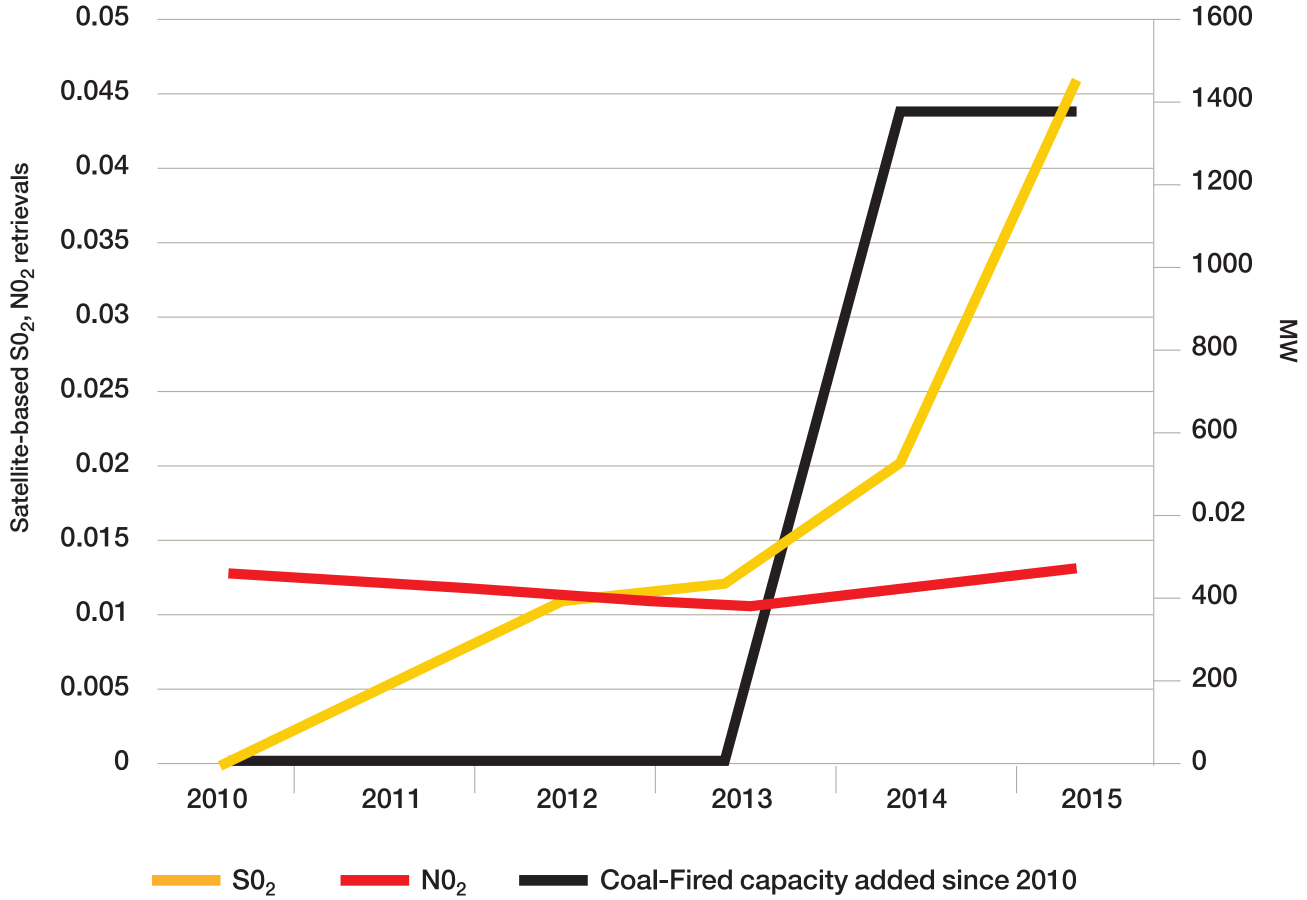


Figure 15: Development of coal-fired capacity and pollution levels: Rajpura TPP

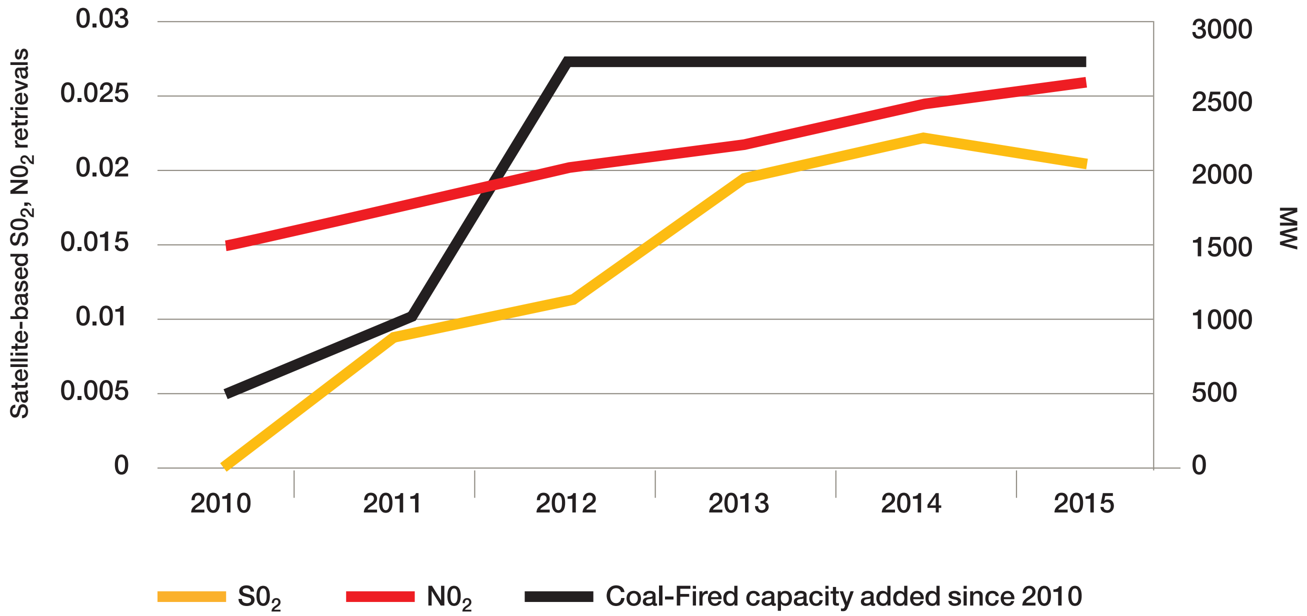
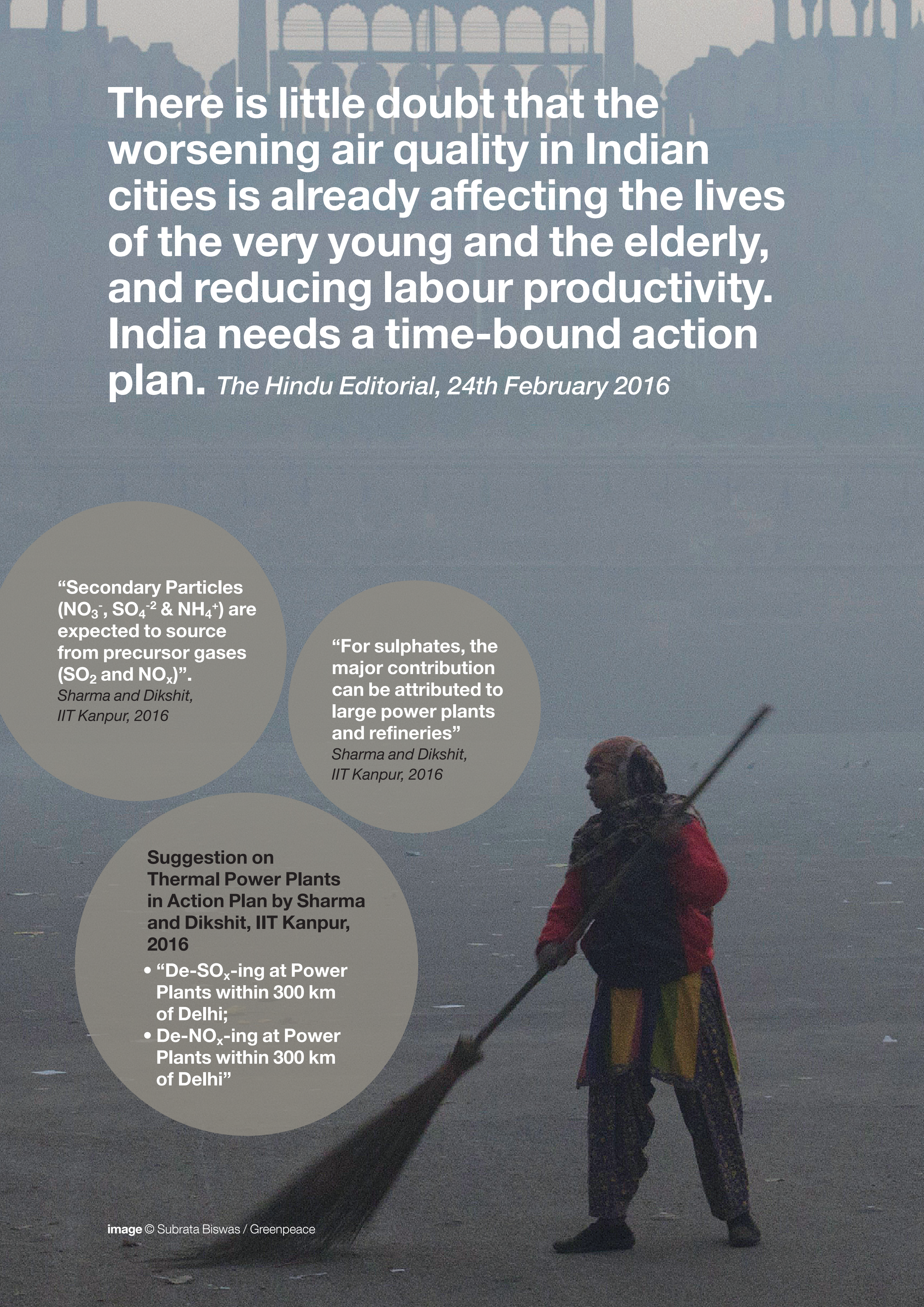


Figure 16: Development of coal-fired capacity and pollution levels: Indira Gandhi STPP

The time series data shows very sharp increases in SO_2 and NO_2 levels right after the new generating capacity was commissioned, validating the link between the thermal power expansion and the emission levels detected from satellite data.

"A calculation assuming 90% reduction in SO_2 from these plants can reduce 72% of sulphates. This will effectively reduce PM_{10} and $PM_{2.5}$ concentration by about 62 μg/m^3 and 35 μg/m^3 respectively. Similarly 90% reduction in NO_x can reduce the nitrates by 45%. This will effectively reduce PM_{10} and $PM_{2.5}$ concentration by about 37 μg/m^3 and 23 μg/m^3 respectively. It implies that control of SO_2 and NO_x from power plant can reduce PM_{10} concentration approximately by 99 μg/m^3 and for $PM_{2.5}$ the reduction could be about 57 μg/m^3."

Sharma and Dikshit, IIT Kanpur, 2016



There is little doubt that the worsening air quality in Indian cities is already affecting the lives of the very young and the elderly, and reducing labour productivity. India needs a time-bound action plan. *The Hindu Editorial, 24th February 2016*

"Secondary Particles (NO_3^-, SO_4^{-2} & NH_4^+) are expected to source from precursor gases (SO_2 and NO_x)".
Sharma and Dikshit, IIT Kanpur, 2016

"For sulphates, the major contribution can be attributed to large power plants and refineries"
Sharma and Dikshit, IIT Kanpur, 2016

Suggestion on Thermal Power Plants in Action Plan by Sharma and Dikshit, IIT Kanpur, 2016

- **"De-SO_x-ing at Power Plants within 300 km of Delhi;**
- **De-NO_x-ing at Power Plants within 300 km of Delhi"**

image © Subrata Biswas / Greenpeace

Other SO_2 and NO_2 hotspots

The major increase in SO_2 and NO_2 level have come from states outside of Delhi where thermal power generation saw a spike in the last five years proving that emissions from thermal power contribute significantly to the emissions of these pollutants. From satellite imagery is also clear that these states also have had high increase in $PM_{2.5}$ levels during the same period. The detailed data from the satellite imagery along with incremental coal capacity in few regions are given below (Figure 17 - Figure 26). In Gujarat, both the coal-fired power generating capacity expansion and the expansion of the Jamnagar petrochemical complex contribute to the increases in pollutant levels.

Table 3: Summary table for Madhya Pradesh, Chhattisgarh, Odisha, Jharkhand and West Bengal

S.No.		Madhya Pradesh	Chhattisgarh	Odisha	Jharkhand	West Bengal
1	Total Installed coal based TPP capacity during 2009-2015 (MW)	11170	12511	7409	4473	4800
2	Planned Capacity addition (MW)	12060	12390	19940	13520	4220
3	SO_2 columnar depth, Total (increment over 2009-2015) (Db)	7%	27%	22%	6%	21%
4	NO_2 columnar depth, Total (increment over 2009-2015) (Db)	4%	7%	3%	6%	7%
5	$PM_{2.5}$ (AOD) levels Total (increment over 2009-2015) (Db)	13%	19%	27%	29%	18%

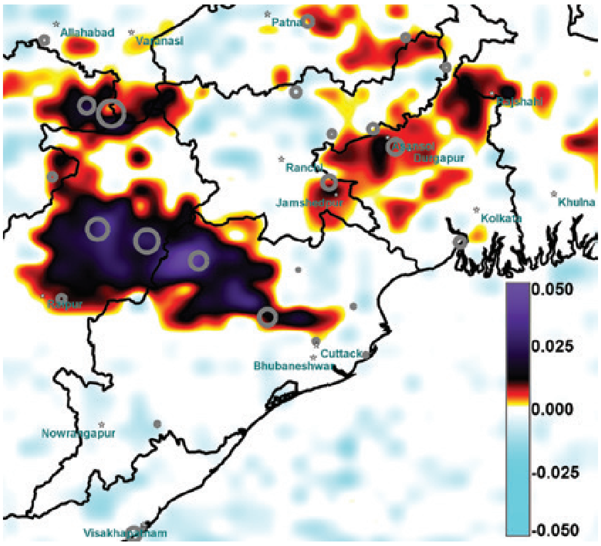


Figure 17: Change in average SO_2 levels in 2009-2015 Over Madhya Pradesh, Chhattisgarh, Odisha, Jharkhand and West Bengal

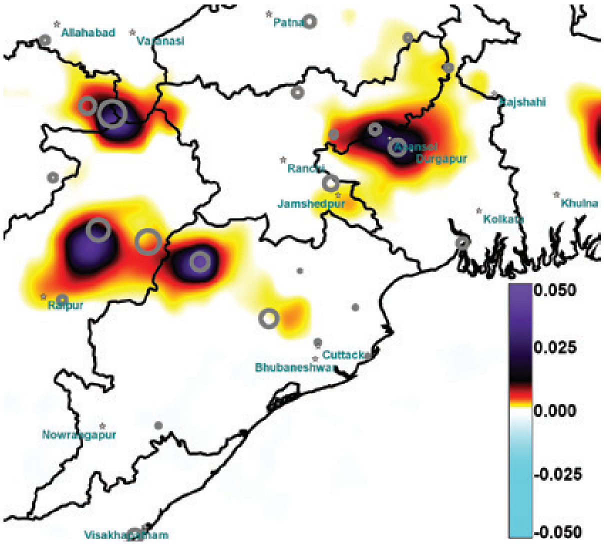


Figure 18: Change in average NO_2 levels in 2009-2015 Over Madhya Pradesh, Chhattisgarh, Odisha, Jharkhand and West Bengal

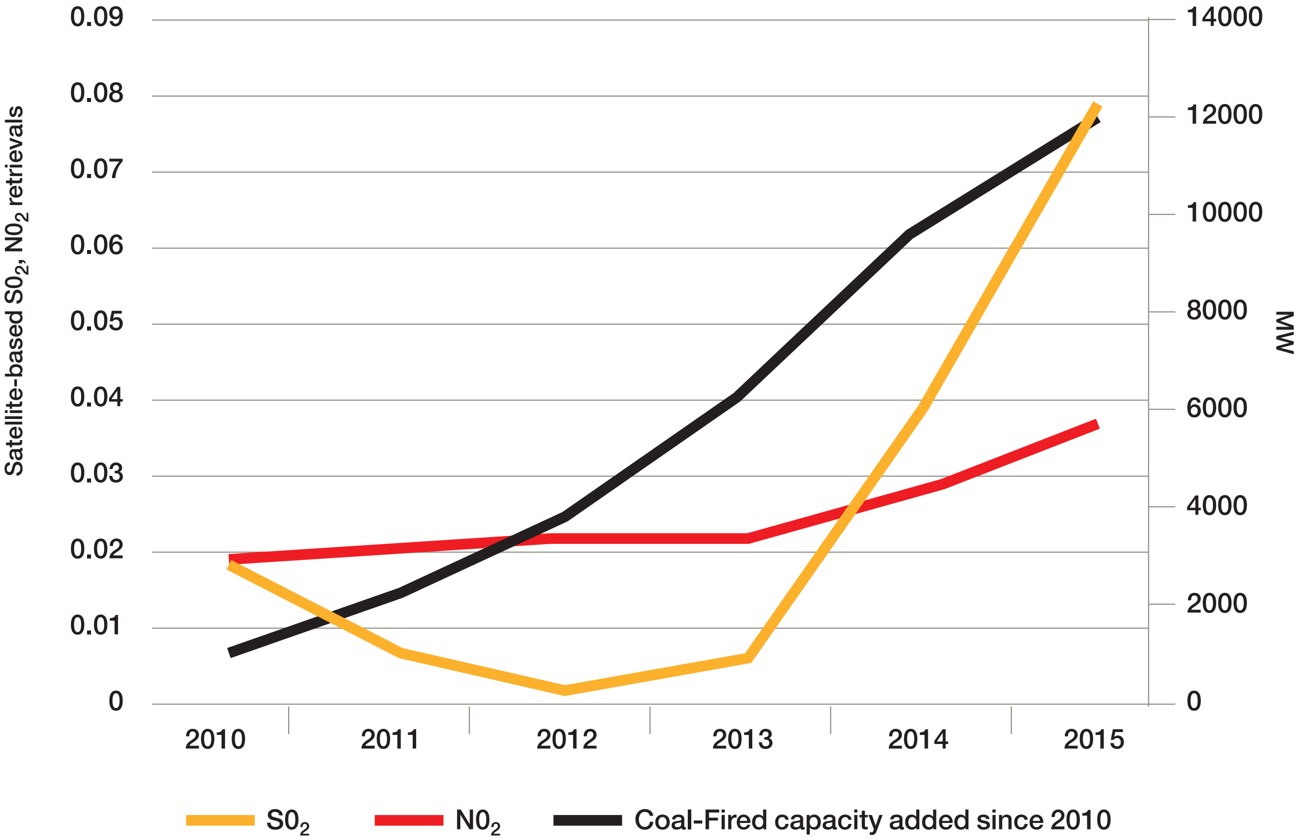


Figure 19: Development of coal-fired capacity and pollution levels: Singrauli

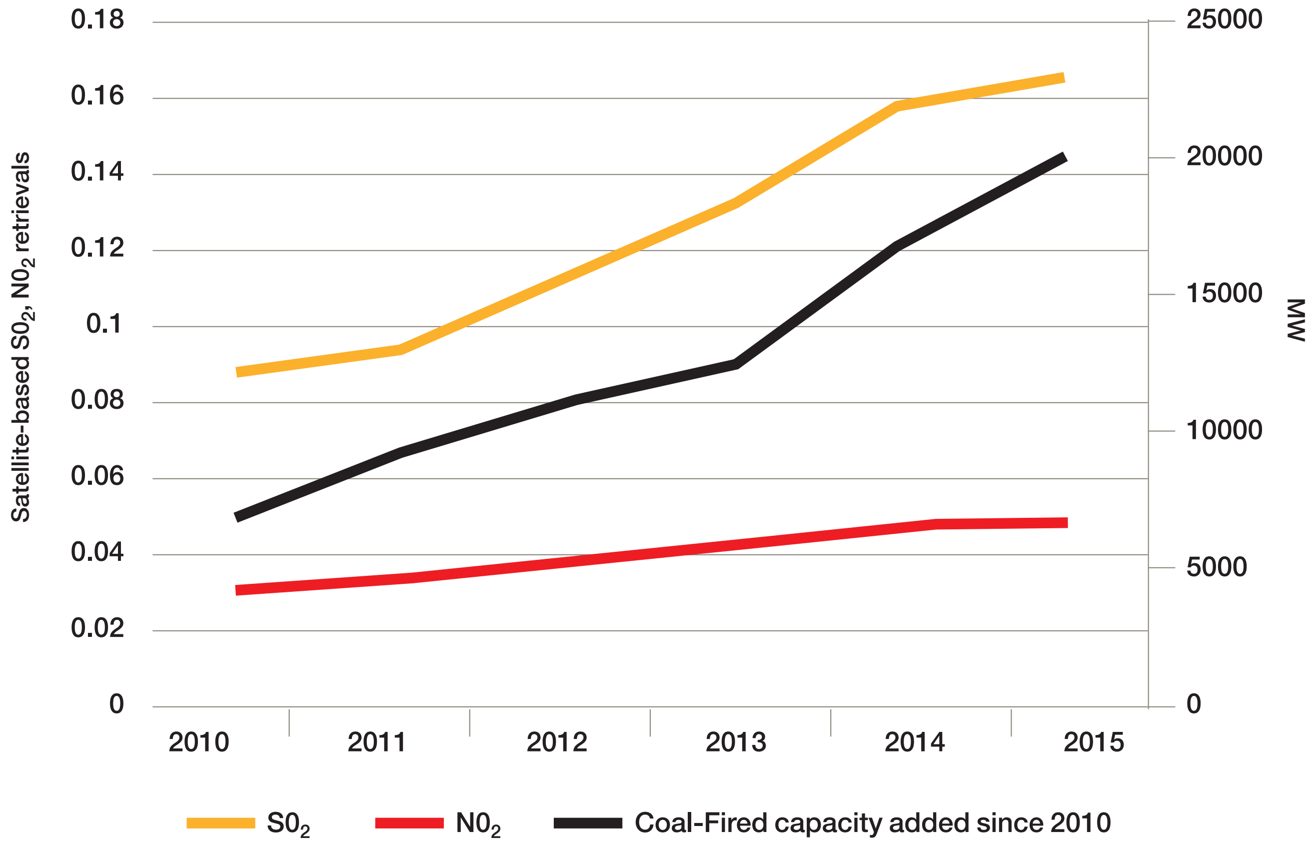


Figure 20: Development of coal-fired capacity and pollution levels: Korba

Table 4: Summary Table for Maharashtra

S.No.		Maharashtra
1	Total Installed coal based TPP capacity during 2009-2015 (MW)	14240
2	Planned Capacity addition (MW)	8680
3	SO_2 columnar depth, Total (increment over 2009-2015) (Db)	10%
4	NO_2 columnar depth, Total (increment over 2009-2015) (Db)	2%
5	$PM_{2.5}$ (AOD) levels Total (increment over 2009-2015) (Db)	14%

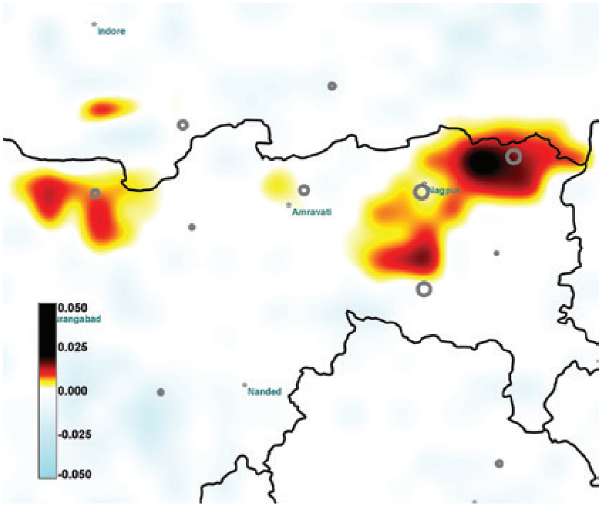


Figure 21: Change in average SO_2 levels in 2009-2015 around Chandrapur, Maharashtra

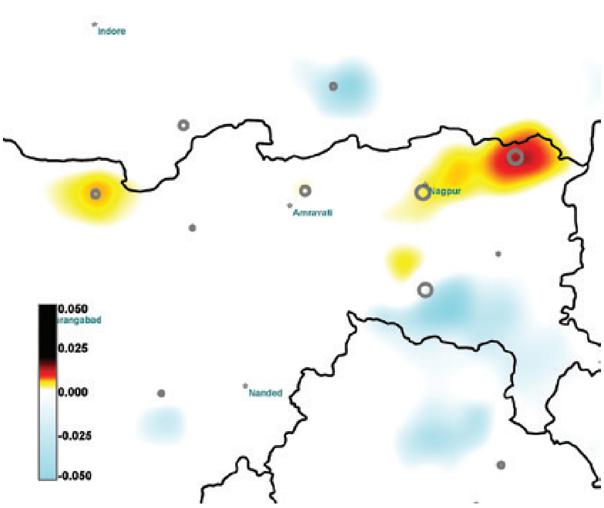


Figure 22: Change in average NO_2 levels in 2009-2015 around Chandrapur, Maharashtra

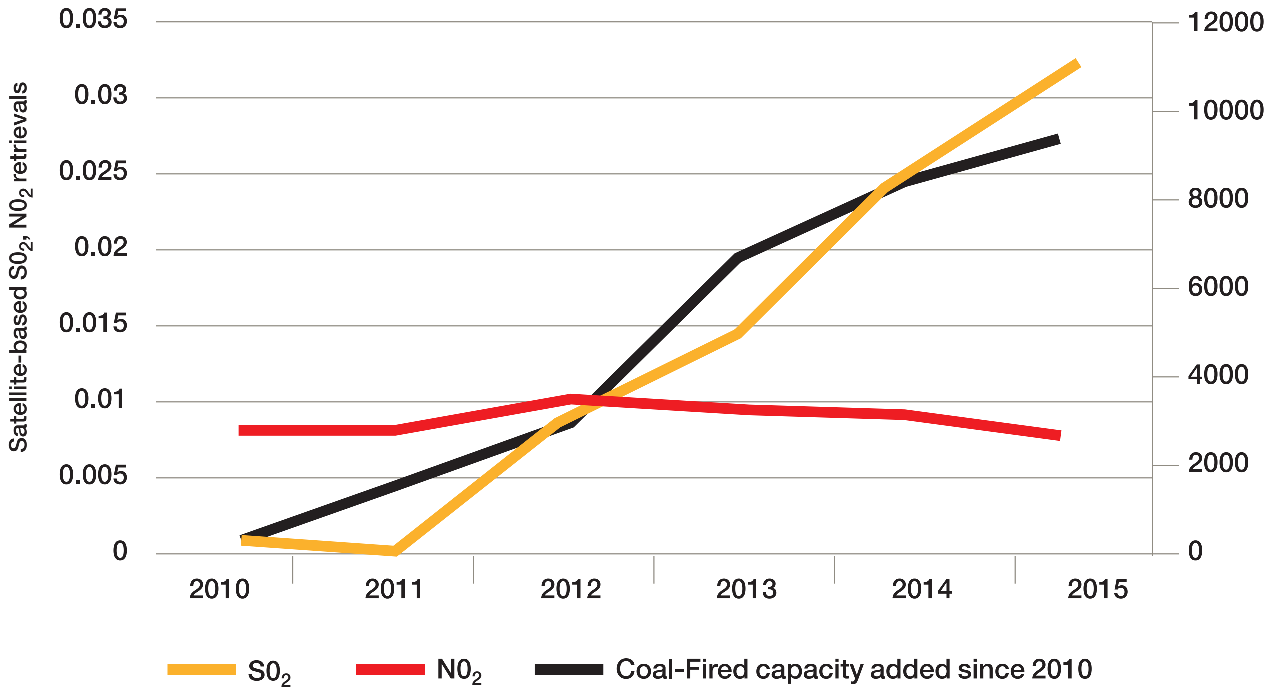


Figure 23: Development of coal-fired capacity and pollution levels: Chandrapur

Table 5: Summary Table for Gujarat

S.No.		Gujarat
1	Total Installed coal based TPP capacity during 2009-2015 (MW)	11460
2	Planned Capacity addition in (MW)	8440
3	SO_2 columnar depth, Total (increment over 2009-2015) (Db)	30%
4	NO_2 columnar depth, Total (increment over 2009-2015) (Db)	5%
5	$PM_{2.5}$ (AOD) levels Total (increment over 2009-2015) (Db)	17%

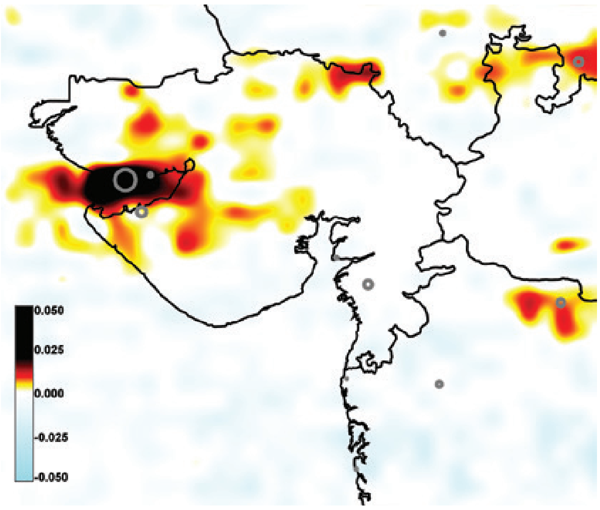


Figure 24: Change in average SO_2 levels in 2009-2015

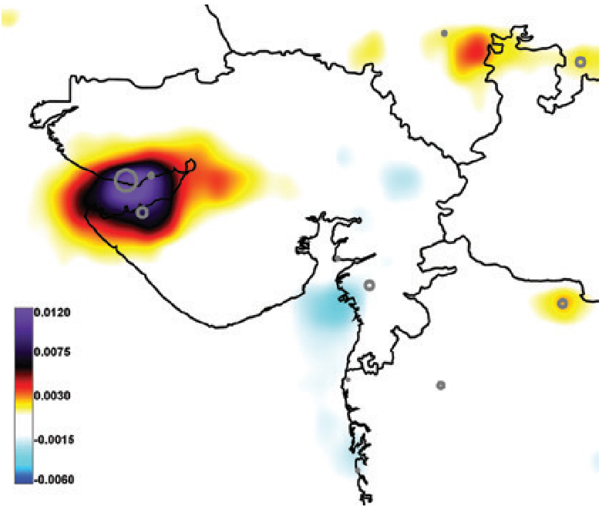


Figure 25: Change in average NO_2 levels in 2009-2015

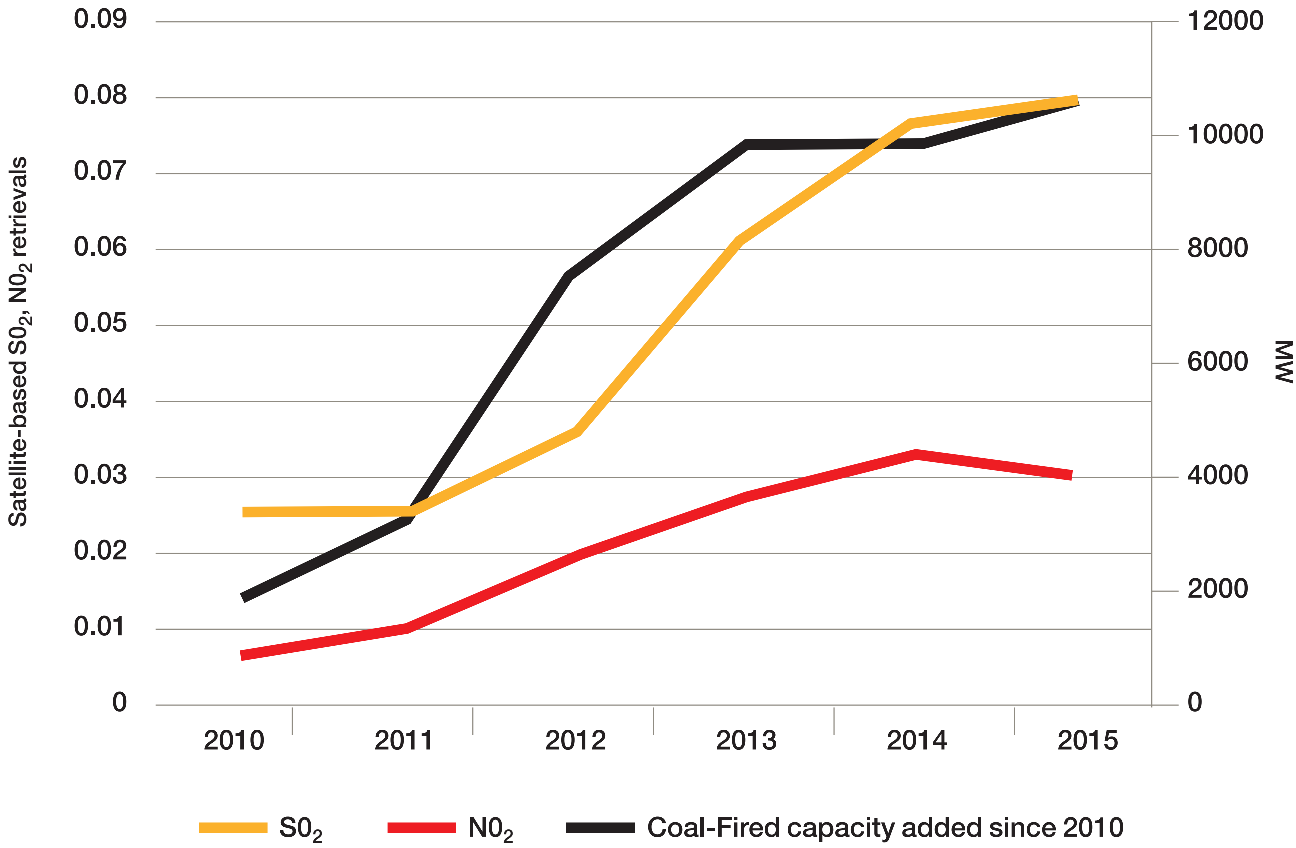


Figure 26: Development of coal-fired capacity and pollution levels: Mundra

Discussion

Various researchers suggest that a major portion of the PM emission in the country comes from the industrial sector, especially from coal based thermal power plants. A significant share of India's total PM emission is also contributed by secondary particles formed by SO_2 and NO_2 emitted from thermal power plants.

Study from Behara and Sharma (2010) on Kanpur city estimated approximately 34% contribution of secondary particles (inorganic aerosols) to the total $PM_{2.5}$ concentration levels and a recent IIT Kanpur report (2016) done on Delhi & NCR has found that secondary particle contributes to approximately 30% of total $PM_{2.5}$ concentration over the region. This establishes the close relationship between the overall $PM_{2.5}$ concentration and secondary particles.

Major contributors to the secondary particulate formation are precursor gases such as SO_2, NO_x and Ammonia. An estimated 75 - 90% of sulphates[22] and 50% nitrates[23] are formed from SO_2 and NO_x emissions originating from the stacks of thermal power plants. Analysis of satellite based imagery done by Greenpeace shows the SO_2 and NO_2 hotspots in the country and it overlaps with the high coal consuming regions clearly proving the following:

1) SO_2 and NO_2 emissions are very high within the regions where coal burning is high eg: Singrauli (UP & MP), Korba (Chhattisgarh), Raigarh (Chhattisgarh), Angul (Odisha), Mundra (Gujarat), Chandrapur (Maharashtra), Bellary (Karnataka) and Chennai and Neyveli (Tamil Nadu) regions and

2) There is a significant increase in emissions of SO_2 and NO_2 with the capacity addition of thermal power in clusters like Mundra, Raigarh, Korba, Angul, SIngrauli and Bellary.

Indian government notified the revised emission standards for thermal power plants in December 2015. The ambitious standard requires the power producers to comply within two years from the date of notification. The notifications puts a cap on SO_2 and NO_x for the first time in India and have stricter emission limits for particulate matter along with new norms for water consumption by the thermal power plants. Currently only about 10% of the thermal power plants have desulphurisation devices.[24] This makes the implementation of the new notified standard a huge task for both the industry and the government. To ensure compliance within the stipulated timeframe would require systematic and time bound action from all stakeholders, especially from the industry.

Government has also taken steps to implement continuous real time emission monitoring system for 17 polluting industries[25] and a direct alert system to the ministry when a particular industry is violating the emission norms. The government also has plans to introduce a Bill in the parliament to provide legal validity for this data for it to be submitted in the court of law.

Conclusion

From the analysis and the discussion above its very apparent that thermal power plant emissions play a very significant role in the increase of $PM_{2.5}$ levels across the country through secondary particulate formation from SO_2 and NO_2. While there are many initiatives taken at the level of individual cities, it's clear that initiatives need to be taken at a regional level in order to solve the air pollution crisis.

The recent IIT Kanpur study clearly mentions that to achieve a significant reduction in the particulate matter concentration in the NCR region, emissions from thermal power plants within a radius of 300km from Delhi needs to be curbed along with other sources. It's clear from the analysis that the existing thermal power plants contribute to high levels of SO_2 and NO_2 emissions deteriorating the overall air quality with the existing installed capacity. Further adding more capacity in the same regions can only worsen the pollution crisis (Figure 27).

China has successfully reduced SO_2 and NO_x emissions by 50% and 30%, respectively, from 2010 to 2015[26], by requiring power plant and industrial plant operators to install emission control devices and by enforcing new emission standards, while reducing total coal consumption. The result has been dramatic reductions in $PM_{2.5}$ pollution levels across eastern China in the past two years, even though pollution levels remain hazardous. Air pollution crisis peaked in China in 2013, which lead to the state taking stronger measures to curb air pollution by way of National Action Plan, 2013. The Air Pollution Action Plan was enacted with putting caps of coal consumption limiting new coal power addition in three key air pollution regions. The coal consumption cap was also set by sectors wherein for power sector it was capped at 1.86 billion tonnes[27].

Way Forward:

- **Set a deadline for meeting the national air quality standards e.g. 5-year interim targets for reducing pollution levels in each state and city that doesn't currently comply**
- **Create a regional action plan covering the extremely highly polluted areas from Punjab to West Bengal, addressing all major air pollution emitting sectors.**
- **Set targets for reducing interstate pollution, including compliance plan for meeting the new thermal power plant emission standards, 2015, as soon as possible**
- **Regularly monitor power sector progress in complying with the new emission standards, including reporting on timeline for ordering and installing pollution control devices.**
- **Update the regulatory framework for enforcing power plant emission standards, including substantial automatic fines for every violation of emission limits, as are used in China and the U.S.**
- **Make it mandatory for the industries and thermal power plants to display real time air emission data available on public platforms**

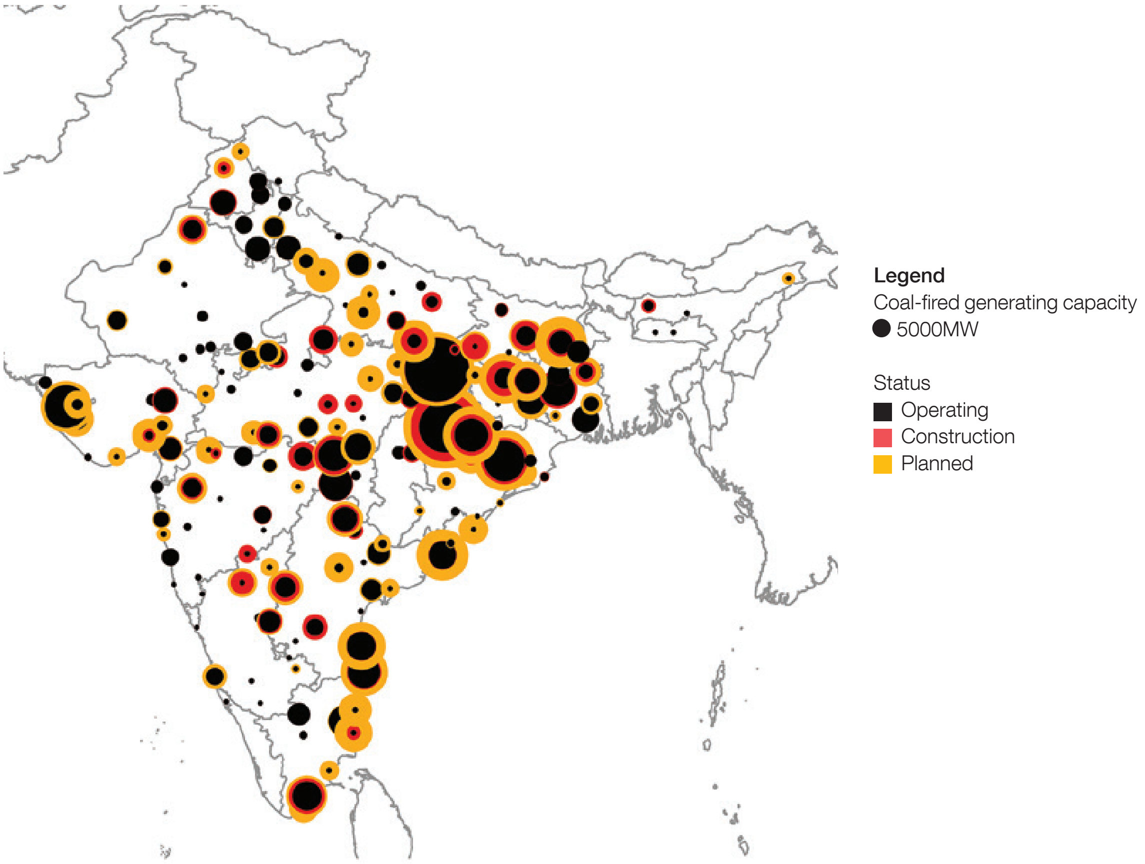


Figure 27: Coal-fired power plants in India

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ग्रीनपीस

Greenpeace is a global organisation that uses non-violent direct action to tackle the most crucial threats to our planet's biodiversity and environment. Greenpeace is a non-profit organisation, present in 40 countries across Europe, The Americas, Asia and the Pacific.

It speaks for 2.8 million supporters worldwide, and inspires many millions more to take action every day. To maintain its independence, Greenpeace does not accept donations from governments or corporations but relies on contributions from individual supporters and foundation grants.

Greenpeace has been campaigning against environmental degradation since 1971 when a small boat of volunteers and journalists sailed into Amchitka, an area north of Alaska, where the US Government was conducting underground nuclear tests.This tradition of 'bearing witness' in a non-violent manner continues today, and ships are an important part of all its campaign work.

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