

Is Delhi's air quality improving?

Summary/Key Message

- Air pollution levels in Delhi did not drop by 25% over the past years as claimed by various governments and institutions.
- The data from all real time air quality monitoring stations collectively shows a significant reduction in PM10, but no noticeable reduction in levels of PM2.5 - the most dangerous type of air pollution. The dataset also showed an increase in NO2 levels over the period
- The data from five stations (Anand Vihar, Mandir Marg, Punjabi Bagh, R K Puram and Shadipur) showed no statistically significant reductions in PM2.5 levels over the period and showed stagnation.
- The introduction of dozens of new stations in the last 1-2 years has introduced a downward bias - calculating simple averages from all stations gives a false impression of rapid improvements.
- Satellite data shows no statistically significant reduction in PM2.5 levels over the period from 2013 to 2018 and only shows slight reductions in later part of 2018 compared to the past 3 years.
- Delhi and the two upwind states, Haryana and Punjab show an increase in coal consumption by 17.8% from FY 2015-16 to 2018-19, while total petroleum product consumption increased by 3.3 % over the same period, increasing emissions and complicating clean air efforts.

Introduction

Delhi, the capital city of India, for the past many years has been singled out as one of the most polluted cities across the globe and despite past efforts to improve air quality, it still features in the world's 10 most polluted cities list, although the position might vary based on source of data used and geographical coverage of area under study.

Various studies have been conducted to understand the sources, factors and geographical area contributing to these high levels of pollution in Delhi and adjoining areas of NCR. IIT Kanpur in 2016 in their [report](#) which included sources within 300 km radius of Delhi found out that almost one-third of pollution in PM levels can be attributed to emissions from outside Delhi. The same study also found out the source contribution to particulate matter pollution in Delhi NCR and found out the contribution of different source during winter and summer as follows:

Source	Average for six monitoring locations			
	% contribution (PM ₁₀)		% contribution (PM _{2.5})	
	Winter	Summer	Winter	Summer
Vehicles	19.7	6.4	25.1	8.5
Secondary particulates	24.6	10.15	29.9	14.9
Biomass burning	16.7	6.8	25.8	12.2
Industries	0.65	1.05	0.8	1.2
Coal and Fly Ash	12.1	37.2	4.8	25.95
Construction material	3.1	4.1	1.5	3.0
Soil and road dust	14.4	26.5	4.3	27.1
Solid Waste burning	8.75	7.75	7.75	7.2

Another [study](#) published in 2018 by researchers at Louisiana State University again looking at long range transport of pollutants from states beyond Delhi, attributed the contribution of different sources to PM2.5 levels in delhi as:

Sector	Energy	Industry	Residential	Onroad	Offroad	Agriculture	Open burning	Windblown dust	SOA
PM2.5	15.7	33.4	37.9	1.3	0.3	6.5	0.05	2.1	2.8

Indian Institute of Tropical Meteorology (IITM) along with Central Pollution Control Board (CPCB) and other institutions carried out an [emission inventory study for Delhi](#) with a 70x65 km domain and found out percentage sectoral contribution to the emission load in the city as follows:

Sector	Transport	Industry	Power	Residential	Windblown dust	Others
PM _{2.5}	39	22	3	6	18	12
PM ₁₀	16	16	5	3	51	9

It is evident from the studies mentioned above that the source contribution to air pollution in Delhi varies based on the study area chosen as well as on the categorisation of the sources, i.e., Some studies include secondary particulates in the industry, energy or power plants and some will mention it separately. But one fact that remains true across all studies is that air pollution in Delhi is a complex phenomenon and is governed by meteorology, sources within Delhi and several hundred kilometers away from Delhi, and major sources contributing to these hazardous pollution levels are Transport, Industry, Power generation and residential sector along with others.

Recently there have been multiple discussions about air quality improvements in Delhi and some reports also mentioned that [Delhi has shown a 25% decrease in air pollution levels between 2016-2018 compared to the 2012-2014](#). There have also been various critiques of the claim which [demanded more transparency on how the figured for air quality were arrived](#) and others highlighting the [quality of data as an issue](#) while carrying out such analysis. But, the confusion is still not over whether the claims are right or wrong and this remains to be a complicated issue for researchers, civil society and policy makers.

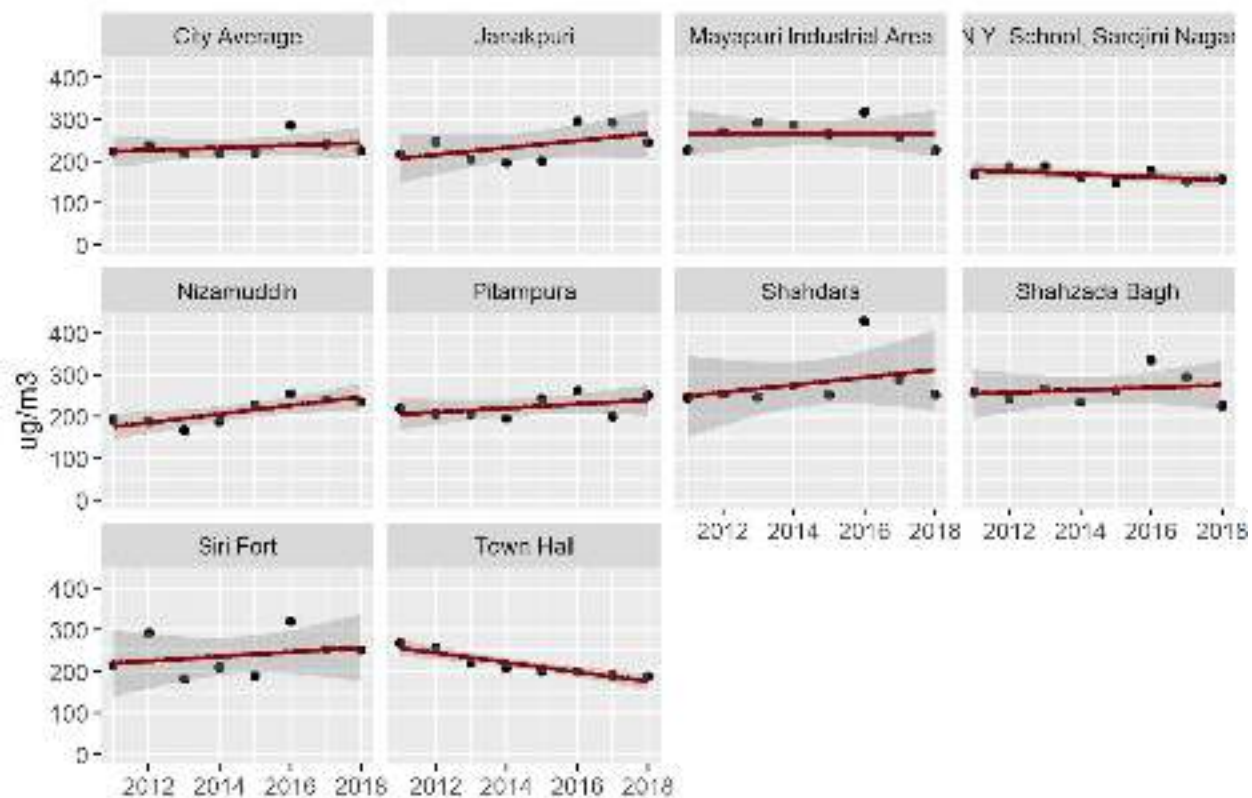
In the current piece for the first time we tried to look at the available data from CPCB as well as at the satellite data to find a concrete answer to the question, “Weather Delhi has reduced air pollution levels over past years or not?”

Data and Analysis

To find the answer to the question we first looked at the data from [National Ambient Air Quality Monitoring Programme \(NAMP\)](#) stations provided by CPCB as annual average levels for the 10 stations operating in Delhi with consistent data availability of 80-100 days annually since 2011.

Average annual PM10 concentrations in Delhi

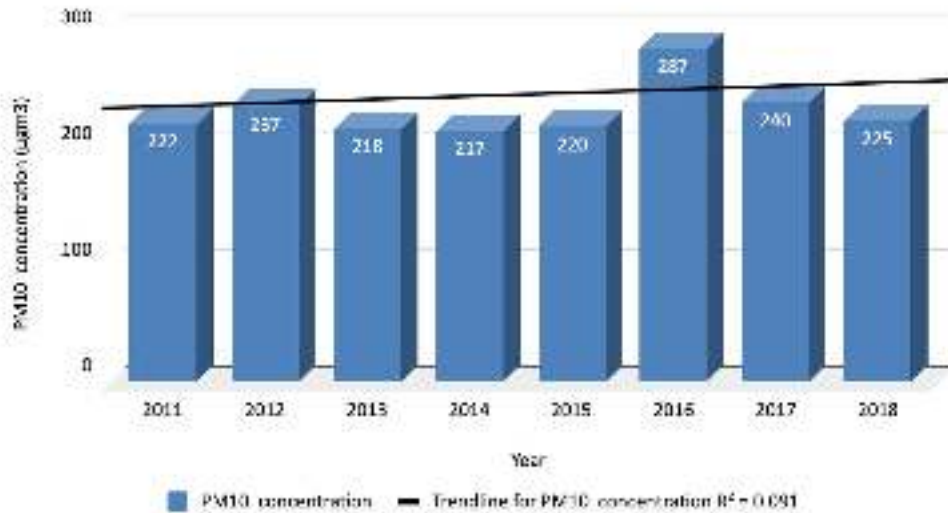
Measured at NAMP manual stations



NAMP Stations	Data Availability Days								PM10 Average (annual, micrograms/m3)							
	2011	2012	2013	2014	2015	2016	2017	2018	2011	2012	2013	2014	2015	2016	2017	2018
N.Y. School, Sarojini Nagar	96	96	96	90	94	88	96	94	168	186	186	161	149	177	152	156
Janakpuri	72	68	74	73	78	98	92	113	216	246	202	197	199	296	292	243
Mayapuri Industrial Area	96	96	80	96	95	88	92	94	225	268	292	287	265	318	257	225
Nizamuddin	72	76	75	77	78	92	89	99	192	187	165	188	225	253	240	234
Pitampura	75	77	74	76	78	88	93	118	217	206	206	195	241	260	199	250
Shahdara	76	78	80	74	76	103	102	102	244	253	246	272	252	427	289	252
Shahzada Bagh	71	77	77	72	70	100	90	104	258	243	265	234	261	334	292	225
Siri Fort	71	78	73	68	72	93	90	106	214	291	181	209	189	320	252	250
Town Hall	96	96	96	90	92	88	96	89	268	256	219	206	200	200	191	187
City Average	81	82	81	80	81	93	93	102	222	237	218	217	220	287	240	225

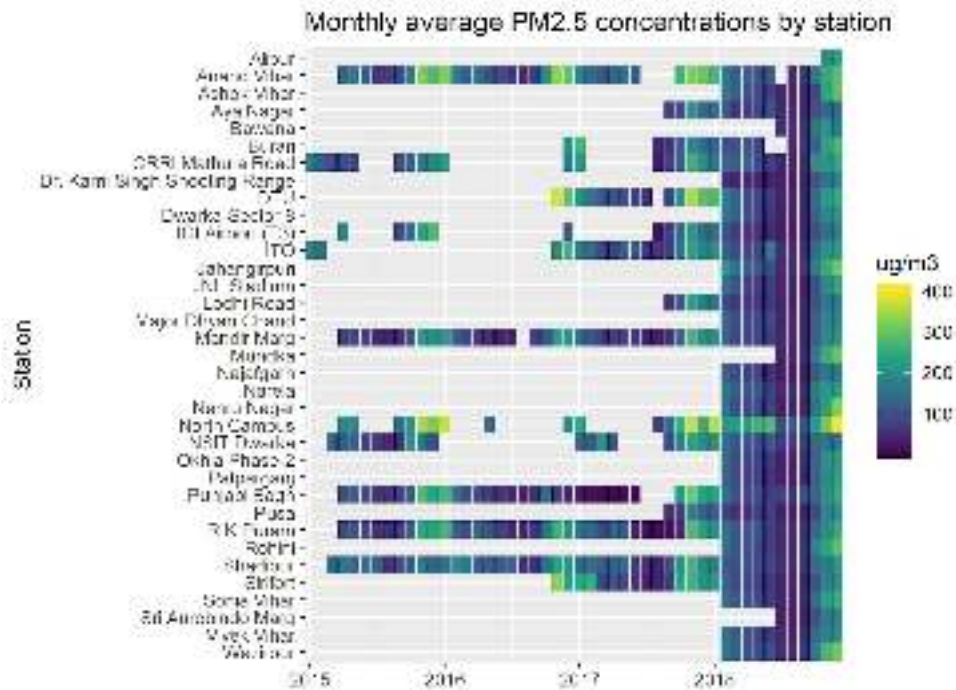
The data does not show any significant improvements in air quality for years between 2011-2018 except year 2016, which was extremely bad and showed the highest annual average of PM10 during the period at 287 $\mu\text{g}/\text{m}^3$. The annual average PM10 at these stations was recorded between 220 to 237 $\mu\text{g}/\text{m}^3$ between 2011-2015 and 225 $\mu\text{g}/\text{m}^3$ in 2018.

PM10 concentration in Delhi since 2011 (NAMP stations)

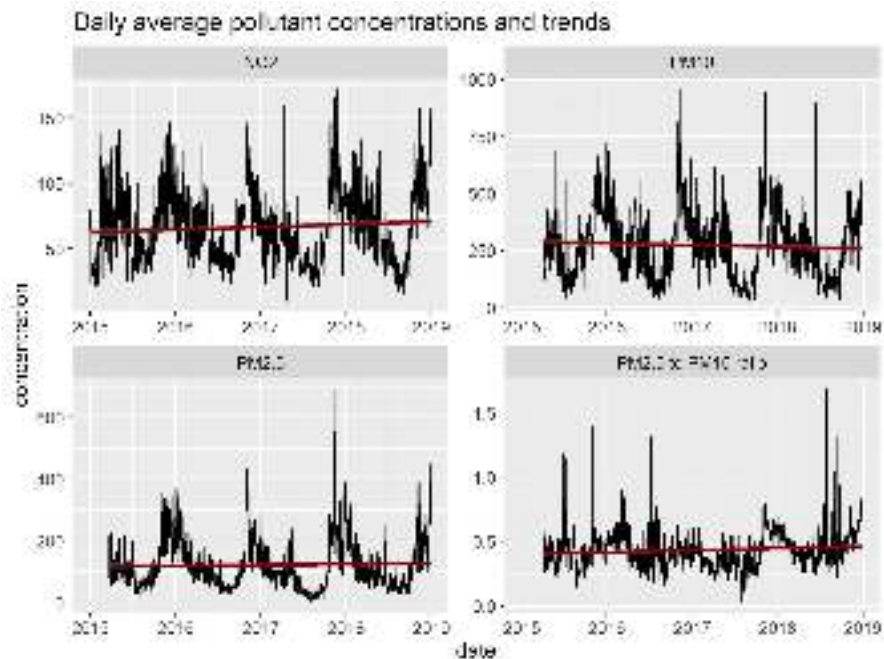


This made the situation a bit more complicated where one assessment used by the Government showed 25% improvements in air quality in Delhi over past years and other dataset which was made available by the national pollution watchdog CPCB showed the trend to be stagnant or even going upwards over the same period.

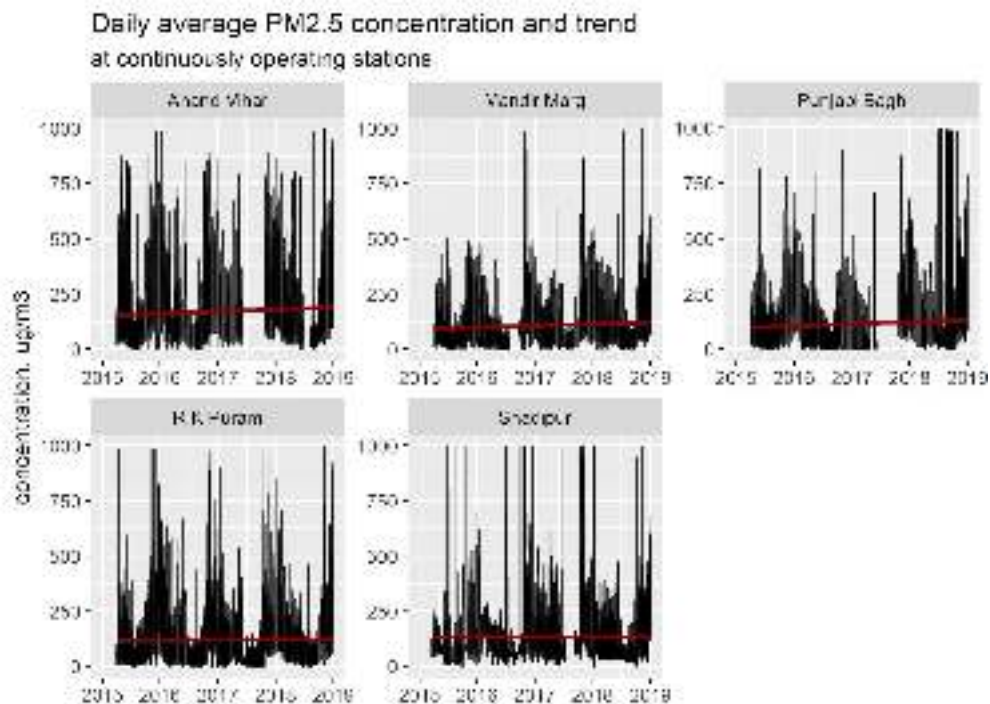
We then looked at other datasets which were available from the continuous ambient air quality monitoring stations run by CPCB and **Delhi Pollution Control Committee (DPCC)** over the past years (2013-2019) to resolve the confusion. The availability of real time data has increased dramatically from only 5-6 real time ambient air quality monitoring station in Delhi till 2016-2017, the number of such stations has increased to 38 as of October 2019.



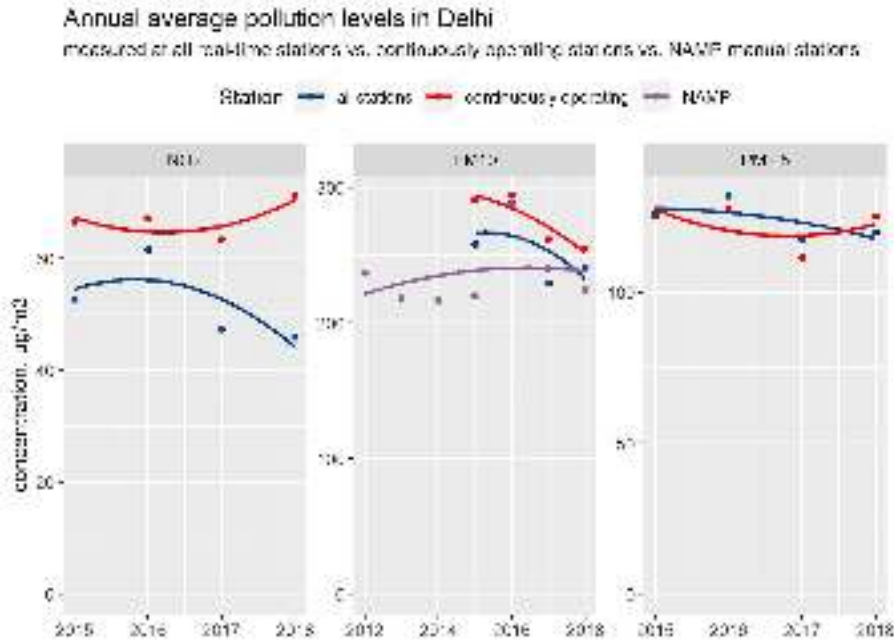
The data from these real time air quality monitoring stations shows a significant reduction in PM10, but no (statistically significant) reduction in PM2.5 levels. The dataset also showed an increase in NO2 levels over the period.



While looking at data from the real time air quality monitoring stations we also tried to look at a subset of this dataset where only the data from stations which provided consistent data for all years since 2013 was analysed. These stations included in the subset were Anand Vihar, Mandir Marg, Punjabi Bagh, R K Puram and Shadipur. **The data from these five stations showed no statistically significant reductions in PM2.5 levels over the period and showed stagnation.**

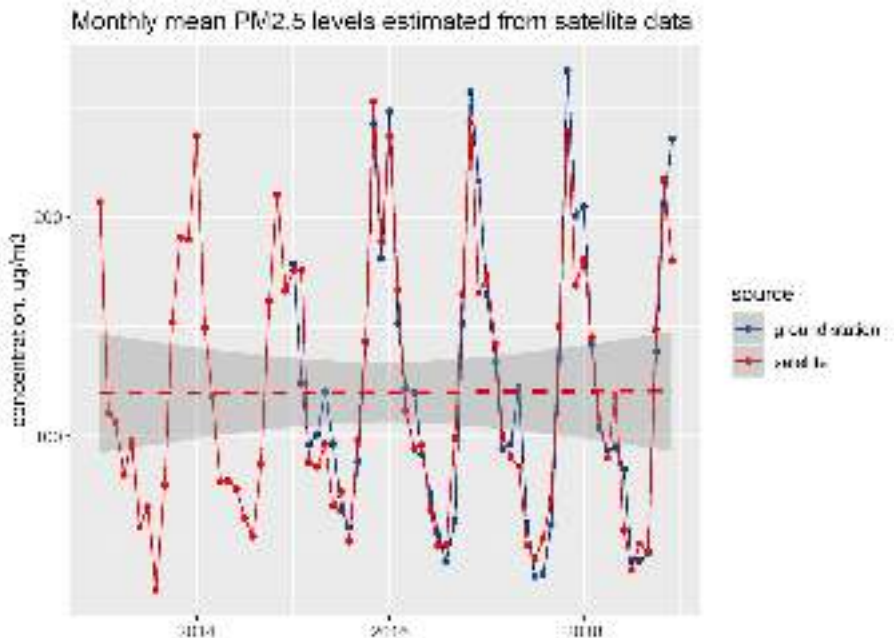


This signifies that **the introduction of dozens of new stations in the last 1-2 years has introduced a downward bias** - calculating simple averages from all stations gives a false impression of rapid improvements.



Note: The Continuous operating stations here means the 5 stations with consistent data since 2015.

As the ground data availability, consistency and quality have been questioned and debated on multiple occasions over the past years, we thought of looking at satellite data to find any correlation between the two. We analysed PM2.5 levels based on aerosol measurements from satellites (MODIS Terra and Aqua Aerosol Optical Depth) and the assessment shows no statistically significant reduction in PM2.5 levels over the period from 2013 to 2018 and slight reductions in later part of 2018 compared to the past 3 years.



Conclusion and Discussion

Delhi show slight improvements in reducing PM10 levels over past years but didn't see noticeable improvement in PM2.5. Looking at different datasets differently can give use contradicting messages of air quality improvement or deterioration.

The coarse particles (PM10) are associated with biomass burning, windblown dust and crop burning etc., while secondary particles are from industrial SO₂ and NO_x emissions as well as vehicle tailpipe particle emissions are predominantly finer PM_{2.5}. NO₂ is predominantly released from fossil fuel burning in the transport, energy and industry sector.

The trends in PM₁₀, PM_{2.5} and NO₂ levels indicate that emissions from biomass burning are falling while emissions from fossil fuel burning are stagnant. This also shows in the ratio of PM_{2.5} to PM₁₀ which is increasing over the past years due to slightly higher reduction in PM₁₀ contrary to PM_{2.5}. The fact is also substantiated by the **increase in coal consumption in Delhi and the two upwind states, Haryana and Punjab by 17.8% from FY 2015-16 to 2018-19, while total petroleum product consumption increased by 3.3 % over the same period.**

There has been no meaningful action taken to reduce thermal power plant or industrial emissions as 31 out of 33 coal fired electricity generation units still does not have Flue Gas Desulphurization (FGD) installed at their facilities which were supposed to be installed by December 2017 initially and by December 2019 as per the second timeline given by Ministry of Power and MOEF&CC as submission to Supreme Court in an ongoing case.

Very little progress has been made on improving public transport and reducing the number of vehicles as well as vehicle emissions standards in past years. Even those little steps which have been implemented across these sectors were introduced towards second half or late 2018, which means that slight improvements in air quality from these actions might be seen in pollution levels for 2019.

Actions taken on Ground:

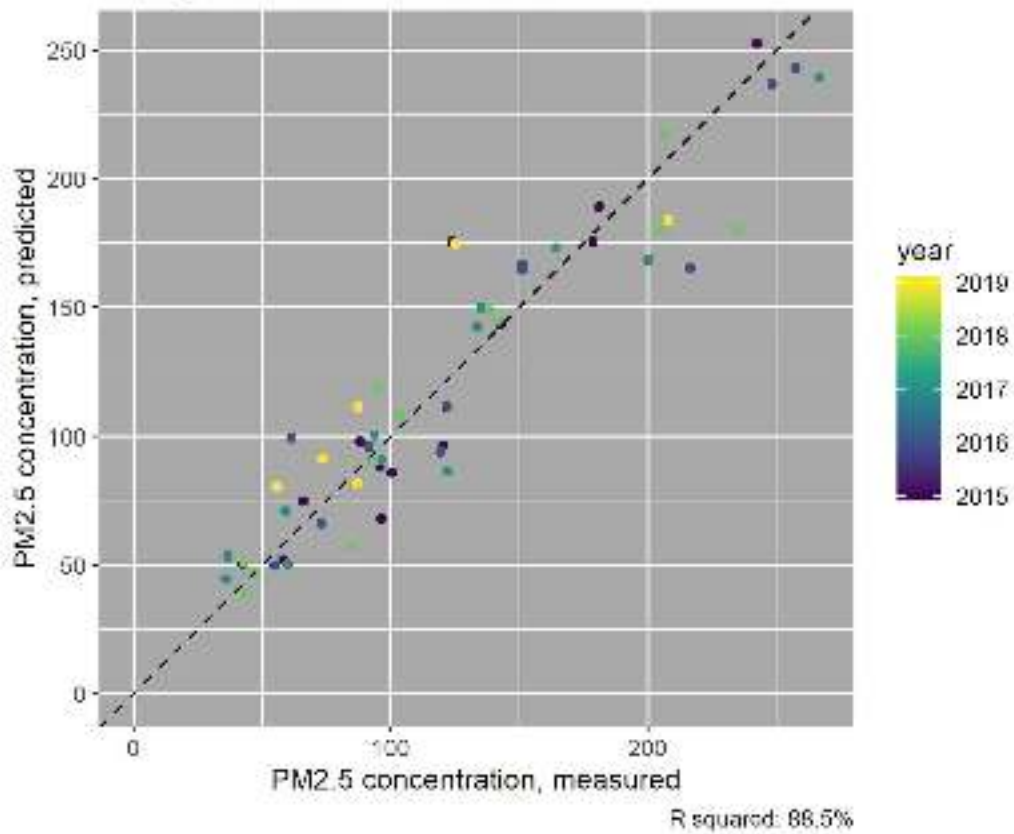
- Coal Power Plants being shut down in Delhi- Badarpur power plant was shutdown in October 2018.
- Pet Coke banned in Delhi NCR- November 2017
- Availability of BS VI fuel in Delhi NCR- April 2019
- Restricting truck entry into Delhi through introduction of by-pass roads- May/November 2018
- Stubble Burning Ban- 2016
- Graded Response Action Plan, Hot-Spot approach to be adopted this winter (2019)- 2018/2019
- Conversion of Industries to PNG- Approved by cabinet in September 2019

Moving forward we will have to use the data on air quality in a more consistent and comprehensive way. The National Clean Air Program aims to reduce PM 2.5 levels by 30% of 2017 levels by 2024. When there is a policy clearly defining the base year to which air quality improvements should be compared to, it's a futile and confusing exercise to compare air quality situations with other dates or series of years. Quite often these comparisons are made not to improve the effectiveness of actions taken to fight air pollution but rather to create a false narrative among the public. Given that Delhi and the Indo-Gangetic Plain are equally polluted by very similar sources throughout the year, any improvement in air quality should reflect at a regional level and be measured against the annual and 24 hours average of the base year of 2017.

Annexure

Performance of satellite-based predictions

Monthly mean PM2.5 concentrations



Model is based on MODIS Terra and Aqua Aerosol Optical Depth; monthly average meteorological parameters from NASA MERRA-2 model: boundary layer height, near-surface temperature and precipitation rate; and sum of Fire Radiative Power of all open fires detected from the VIIRS instrument within 400km of Delhi.