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Final Report February 6, 2018
People's Science Institute

The European Climate Foundation (ECF) was pleased to grant an amount of US $14,130 for a proposal submitted to an initiative of the ECF, Global Strategic Communications Council (GSCC), by the People's Science Institute (PSI), for carrying out air quality monitoring in Singrauli and Delhi in collaboration with Hazards Centre (HC). The project period was for 7 months, from 01/07/2017 to 31/01/2018. This is the final report of the project, due at the end of January 2018, that gives an overview of the progress and the data on air quality collected during the project October 2017 to January 2018.

Part I – Sonbhadra

Installation of 14 ATMOS sensor-based monitoring devices, provided by UrbanSciences, was carried out across Sonbhadra between 5th and 10th October, 2017. The team had members from Banwasi Seva Ashram (BSA), GSCC, and HC.

Locations

The villages where devices would be placed had earlier been planned by HC in association with PSI and BSA by classifying the zones in Sonbhadra district into 5 industrial clusters and taking villages in each cluster at three distances from the source of pollution in that cluster – those nearest located at <5 km, the middle distance village at 5-10 km, and the farthest village at >15 km: as given in Table 1. This clustering had been done as per a dispersion model for the area that had been prepared earlier on the basis of extensive monitoring over ten years by BSA and PSI, with assistance from HC. However, the actual locations changed.

Table 1: Clustering of proposed and actual device locations

Industrial cluster	Proposed	Distance	Actual	Distance
Bari-Dalla	Dalla	Nearest	Obra	Close
	Dahakudandi	Middle	Bari	Close
	Karail	Farthest	Dahakudandi	Medium
Hindalco	Murdhawa	Nearest	Murdhwa	Close
	Karhaiya	Middle	Jharo	Medium
			Govindpur	Medium
	Kewal	Farthest	Kewal	Far
Anpara	Kubri	Nearest	Anpara	Close
	Gulalidih	Middle	Bina-Basi	Close
			Chilkadaad	Close
	Jorba	Farthest	Faripaan	Far
Rihand	Dodahar-Bijpur	Nearest	Bijpur	Close
	Jarha	Middle	Jarha-Chetwa	Medium
	Satbahini	Farthest	Nadhira	Far
Vindhyachal/coal mines	Chilkadaad	Nearest	Merged with Anpara	
	Kohrawal	Middle		
	Faripan	Farthest		

The selection on the ground was influenced by several factors:

- Availability of regular supply of electricity
- Availability of net connectivity
- Availability of people in contact of BSA who would take care of the devices
- 'Visible' signs of pollution close to industries (especially during installation of the devices at Bari-Dalla and Anpara-Vindhyachal, which are heavily industrialised)

Details of where the monitoring devices were actually installed are given in Table 2. The sequence followed is as per the map of the region (given in Fig.1) in a sequence from North to South and West to East. Thus, they are arranged in the 4 clusters as given in Table 1 of: Bari-Dala (including the Obra TPP) in the north; Anpara (including Chilkadaad and Bina) in the west, Hindalco (including Murdhawa, Jharo, Govindpur, and Kewal) in the east; and Rihand (including Bijpur, Chetwa, Nadhira, and Faripaan) in the south. Thus, 7 devices were located very close to the stacks of the polluting industries, 4 were at intermediate distances, and 3 were at the farthest distance.

Table 2: Location of villages where ATMOS devices were installed

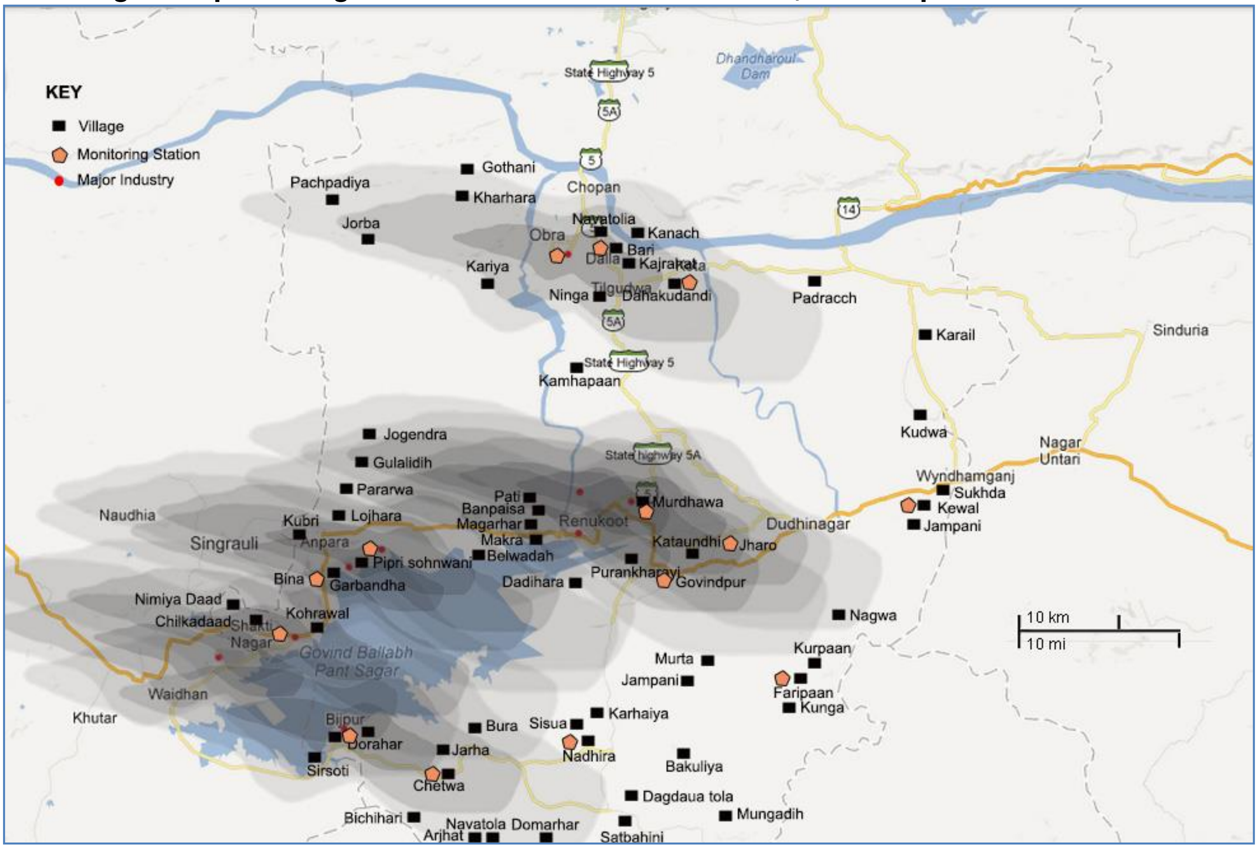
S.No.	Village/town	Location	Data out of 99 days
1	Obra (Mangwara)	• About 1km from Obra TPP • In front of house • At height of about 10 feet	83 days
2	Bari	• In front of house • At height of about 9 feet • Sources of smoke at evening time, 5.30-6.30 pm, wood burnt to prevent mosquitoes • Ban on stone crushing for past 2 months in Bari-Dala	66 days
3	Dahakudandi	• On front wall of house • Brick walls, mud floor • At height of about 9-10 feet	76 days
4	Chilkadaad	• Courtyard of house • At about 10 feet height • Cooking done using gas	63 days
5	Bina (Basi)	• On front of house, above main door • About 15 feet from ground • Faces the road where coal transport takes place from Bina, Kakri and other mines	No data
6	Anpara	• On first floor • About 6 feet height from floor • Facing courtyard of the house • Adjacent to Anpara TPP, less than 0.5km from the chimneys	54 days
7	Murdhawa	• On first floor • About 7-8 feet height • Near Birla Carbon, 2km from Hindalco	37 days
8	Jharo (Katauli)	• On wall of house • About 13-14 feet height	54 days
9	Govindpur	• Above the lab, on the first floor • At about 5 feet height	80 days
10	Kewal	• On the front of house • About 10 feet height • Facing village road, where tractors etc. ply	99 days
11	Bijpur	• On first floor of house • At height of about 8 feet • About 2km from Bijpur TPP	18 days
12	Chetwa (Jarha)	• In front of house • About 10-11 feet from ground • Not placed in courtyard to avoid cook stove	18 days
13	Nadhira	• First floor of house • About 8 feet high from ground	47 days
14	Faripaan	• On first floor of house • About 8 feet height • Potter next door fires his vessels weekly	No data

Note:

- *We have not been able to access data online from any device after 20/01/2018, perhaps because new SIMs are being installed.*
- *For Faripaan and Bina-Bassi, we have not been able to access any data.*
- *Data is not available sometimes due to problems of net connectivity and inability of the device to send data online from where it can be accessed through the online dashboard.*
- *In locations such as Bari-Dalla and Obra, the sensor got choked due to high levels of PM.*

The locations of the devices have been plotted in a map in Fig.1:

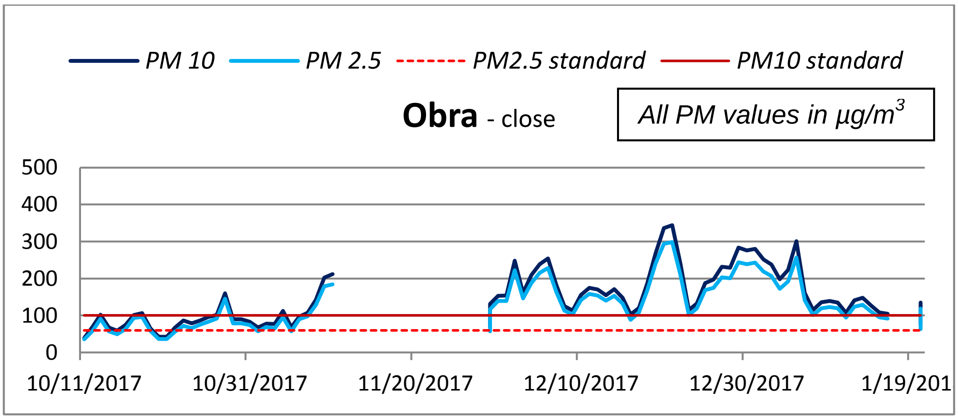
Fig.1: Map of villages where devices were installed, with dispersion model

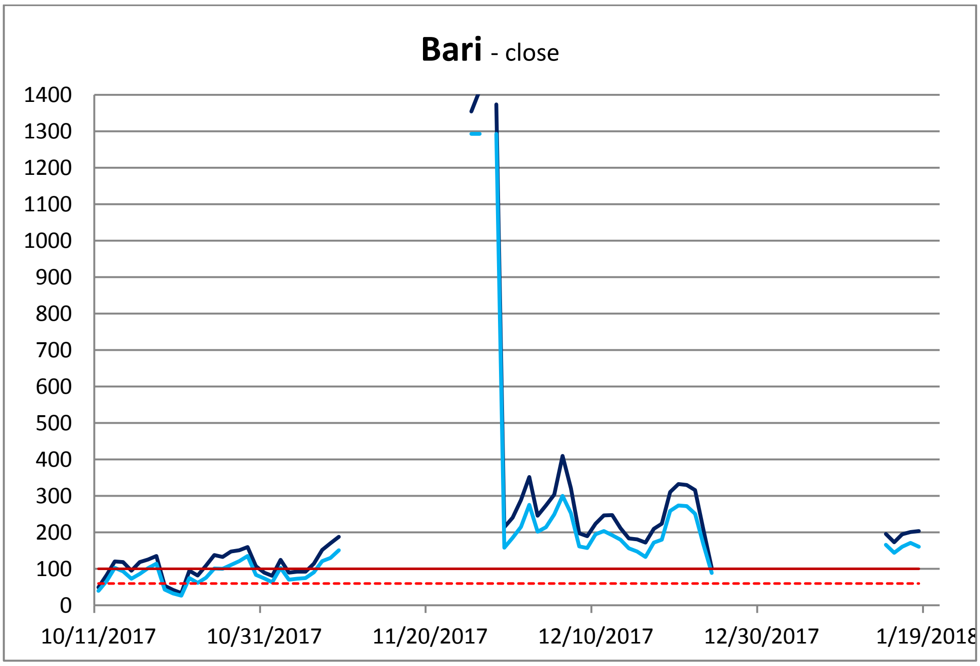


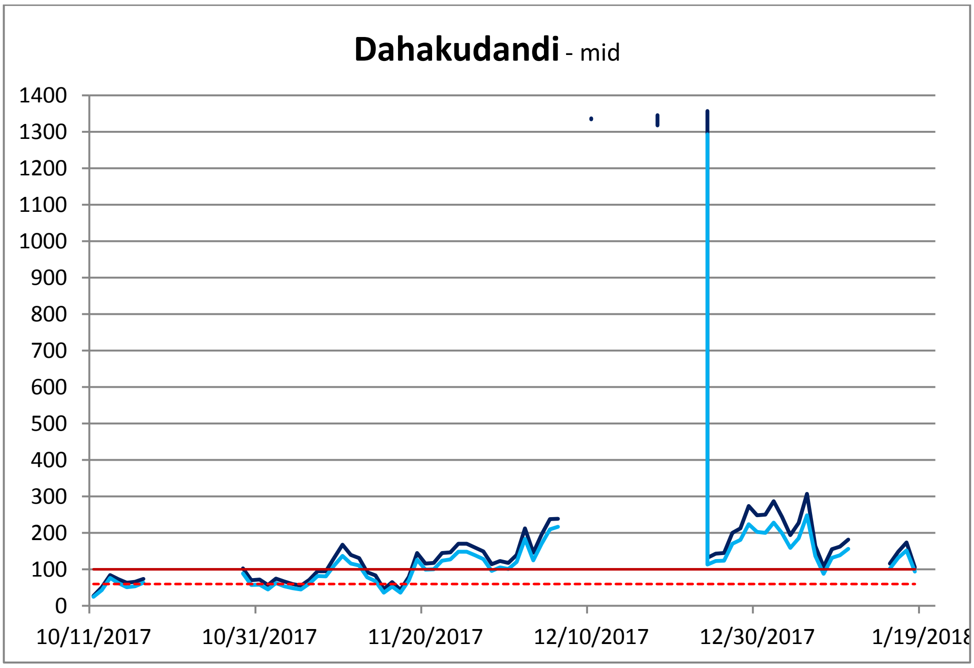
Daily Data

The following charts have plotted the daily data available from 11th October 2017 to 19th January 2018 from the devices that could be accessed. The sequence is the same as in Table 2, and the charts are on the same scale for ease in comparison. The hypothesis was that the devices near the major sources of pollution (the stacks of the different industries) would experience low pollution loads, particularly of fine particulates, as the stack plume would carry them along the mixing height level for some distance (about 5 km) until they began falling to the ground, and that the maximum concentrations would occur between 5 to 10 km from the stack after which they would steadily decrease. Earlier monitoring had also revealed that small particles could be carried as much as 30 km from the stack before descending to the ground depending upon mixing heights and wind speeds.

Only in the Hindalco and Rihand clusters could the devices be placed in the sequence necessary to test the hypothesis. We shall see later what the data has to say about the dispersion of pollutants, as well as the conditions at the different locations where the devices were actually installed. First, let us take the Bari-Dala cluster in the north, where there is a thermal power plant, two cement factories, and a large number of stone crushers.


PM 10
PM 2.5
PM2.5 standard
PM10 standard
Obra - close
All PM values in µg/m3
500
400
300
200
100
0
10/11/2017
10/31/2017
11/20/2017
12/10/2017
12/30/2017

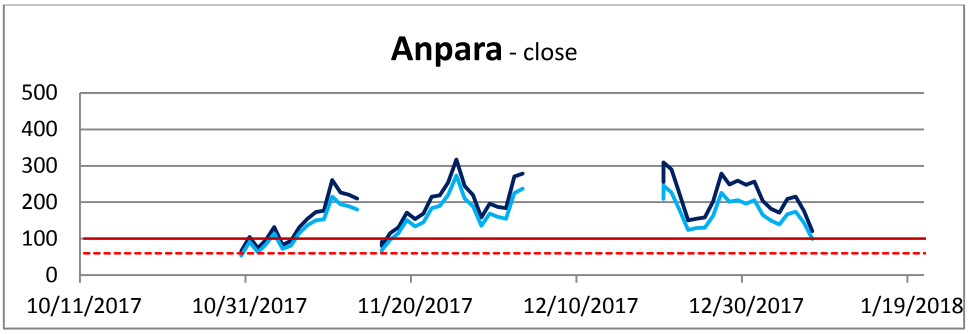

Bari - close
1400
1300
1200
1100
1000
900
800
700
600
500
400
300
200
100
0
10/11/2017
10/31/2017
11/20/2017
12/10/2017
12/30/2017

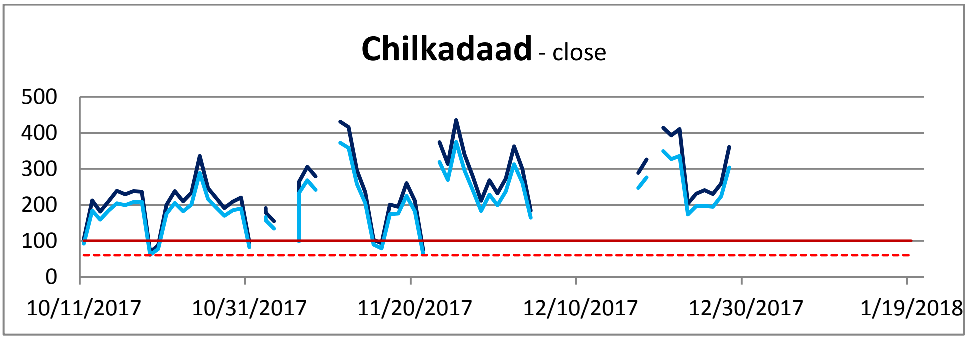

Dahakudandi - mid
1400
1300
1200
1100
1000
900
800
700
600
500
400
300
200
100
0
10/11/2017
10/31/2017
11/20/2017
12/10/2017
12/30/2017

What the charts above show are that while pollution concentrations in the region were low and near the permissible levels in October 2017, they rose in November and December at least two-fold and the increase persisted in January for the days for which data is available. There are two marked spikes around the 25th of November in Bari (close) and the 18th of December in Dahakudandi (mid) when the $PM_{2.5}$ levels rise to more than 20 times the permissible, and appear to stay there for a few days. However, since there is no data for the days preceding these events and they are unique for each location but not for the region, we would suggest they are anomalies probably caused by the dust coating over the optics of the device.

Further, since there are crucial gaps in the data and there was no device located far away downwind of Bari and Obra, it is not possible to verify the dispersion of pollutants. In any case, the presence of a very large number of stone crushers and the passage of a huge number of loaded trucks increases the concentration of dust particles in the locality at the ground level.

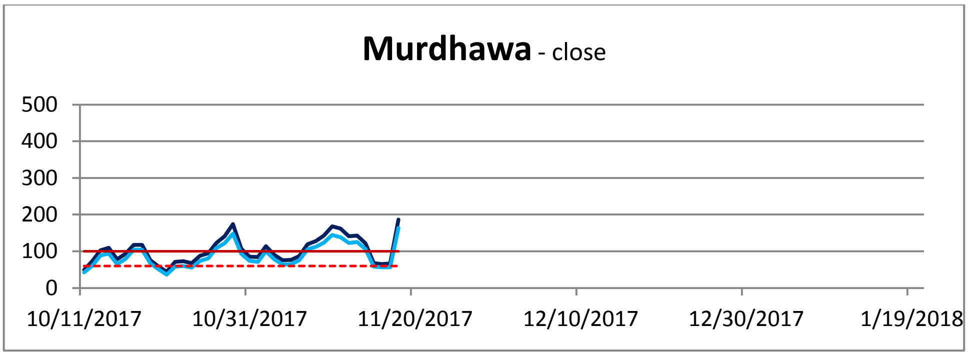
The charts for the Anpara-Vindhyachal cluster in the west, where there are three super-thermal power plants at Anpara, Shaktinagar and Vindhyachal as well as nearby coal mines, are given below. Two of the three devices were functional.

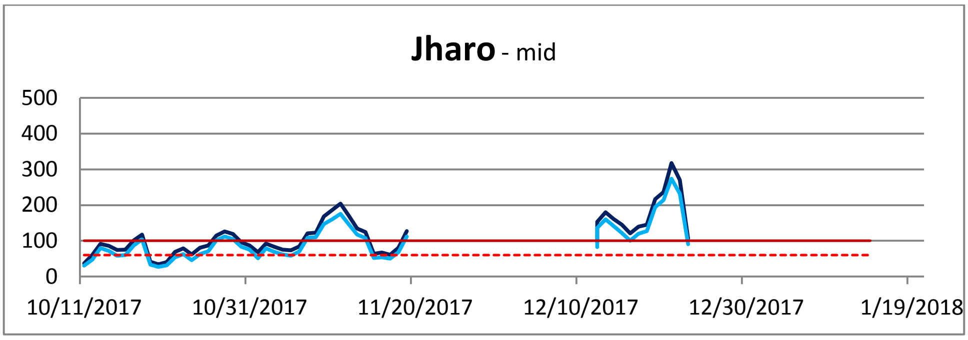


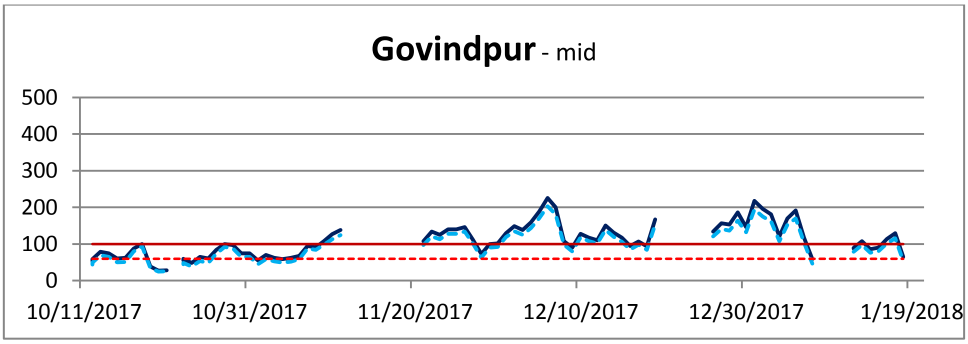


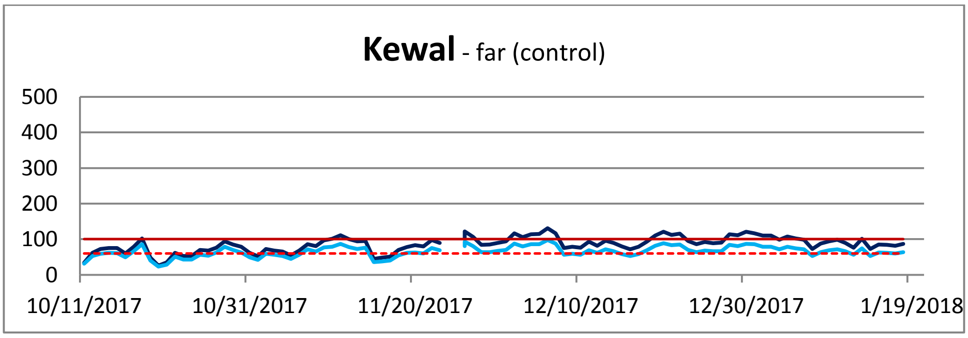
Both the working devices were located close to the super-thermal power plants and the third device at Bina did not function at all. $PM_{2.5}$ levels remained above the permissible limits throughout the entire period but rose periodically to between 5 to 6 times the permissible standard, especially at Chilkadaad. The massive movement of heavy trucks, the presence of several ash-ponds, and the large concentration of population in the region may also have contributed to local pollution loads.

Four devices were placed in the Hindalco cluster to the east, one being located at the town close to the main aluminium smelting industry and the carbon black factory with their captive thermal power plant. Two devices were in the middle region in villages near the road leading from the north to the south along the western side of the reservoir. The fourth device was placed over 25 km away, and was representative as a control to give the background levels.



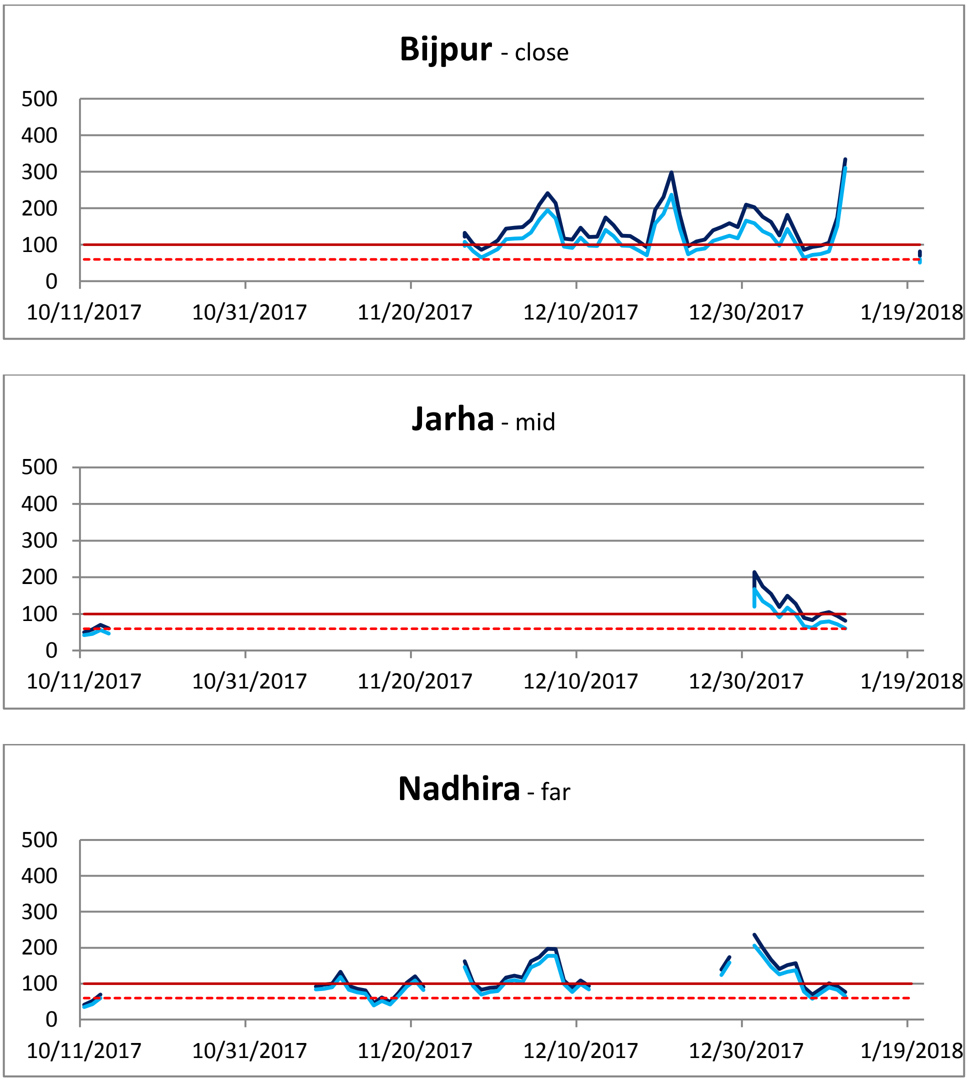




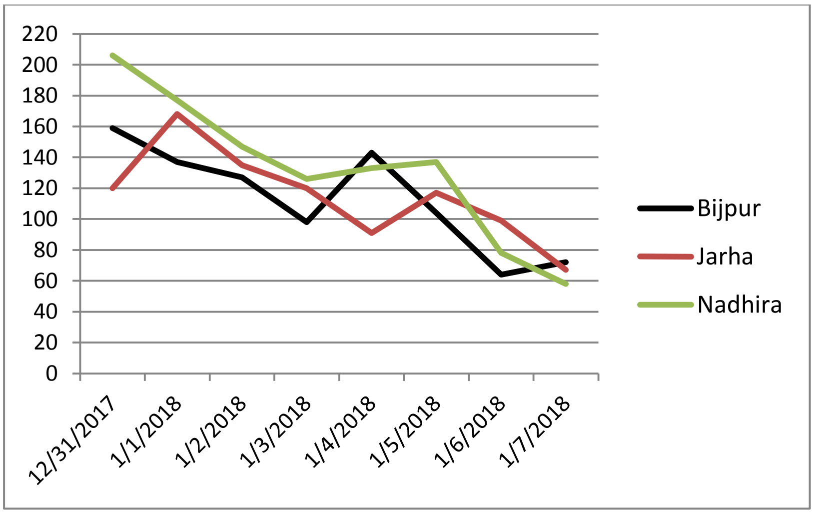


The data available shows that $PM_{2.5}$ levels were low in October, but rose significantly above the permissible levels in the November to January period. Unfortunately, it was only up to the first half of November that there was data available from all four locations to make any comparison possible, and this shows that during that period pollution levels at Jharo and Govindpur (with Jharo more directly downwind) was slightly lower than Murdhwa. But the surprising behavior was that of Kewal, supposed to be unpolluted, but here the $PM_{2.5}$ levels hovered above the permissible levels almost through the entire period of monitoring. It was also the location where the data was uploaded on to the dashboard almost continuously.

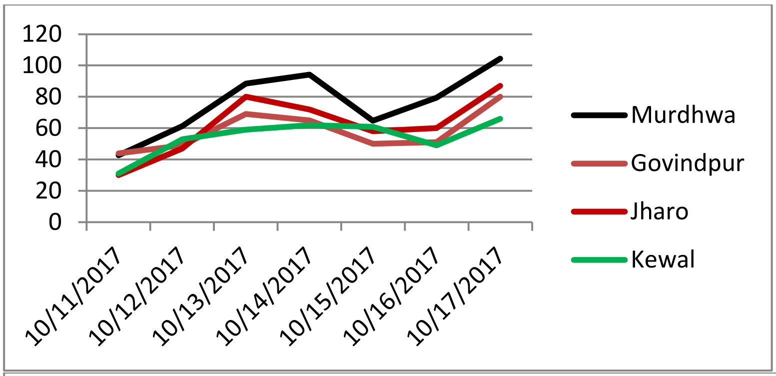
The charts for the three devices in the Rihand cluster in the south are given below, one located next to a thermal power plant, and the other two in the 5-10 km and 10-15 km belts.

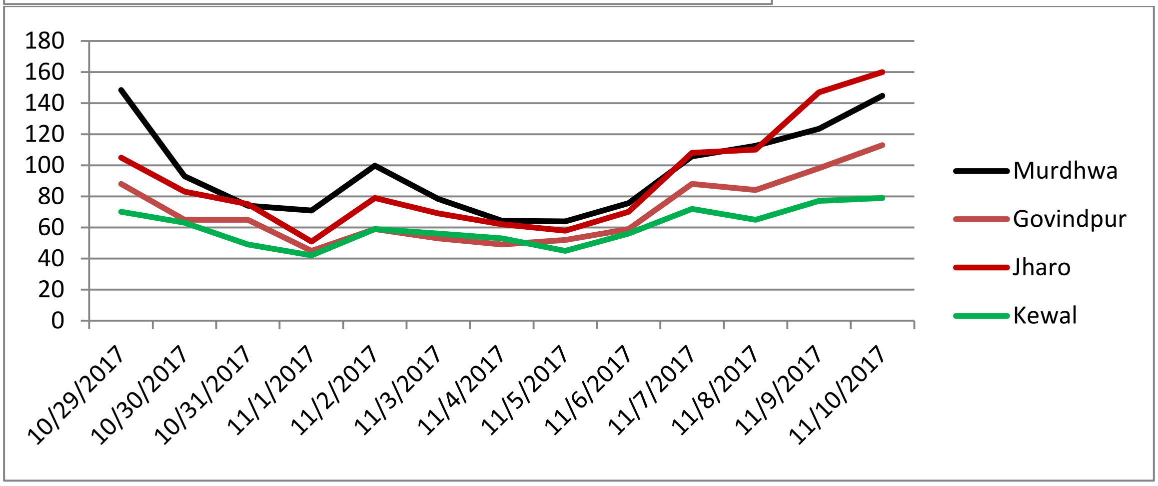


What is immediately clear from the above charts is that pollution levels, even far away from the thermal power plant, remain higher, sometimes as much as 2-3 times, than the standard permissible levels for much of December. For the four devices in the Hindalco cluster and the three devices in the Rihand cluster, at different distances from the source, there are three windows in time when the devices may be compared. The $PM_{2.5}$ levels are plotted below on the same scale:



PM2.5 levels in accordance with wind direction and plume behaviour



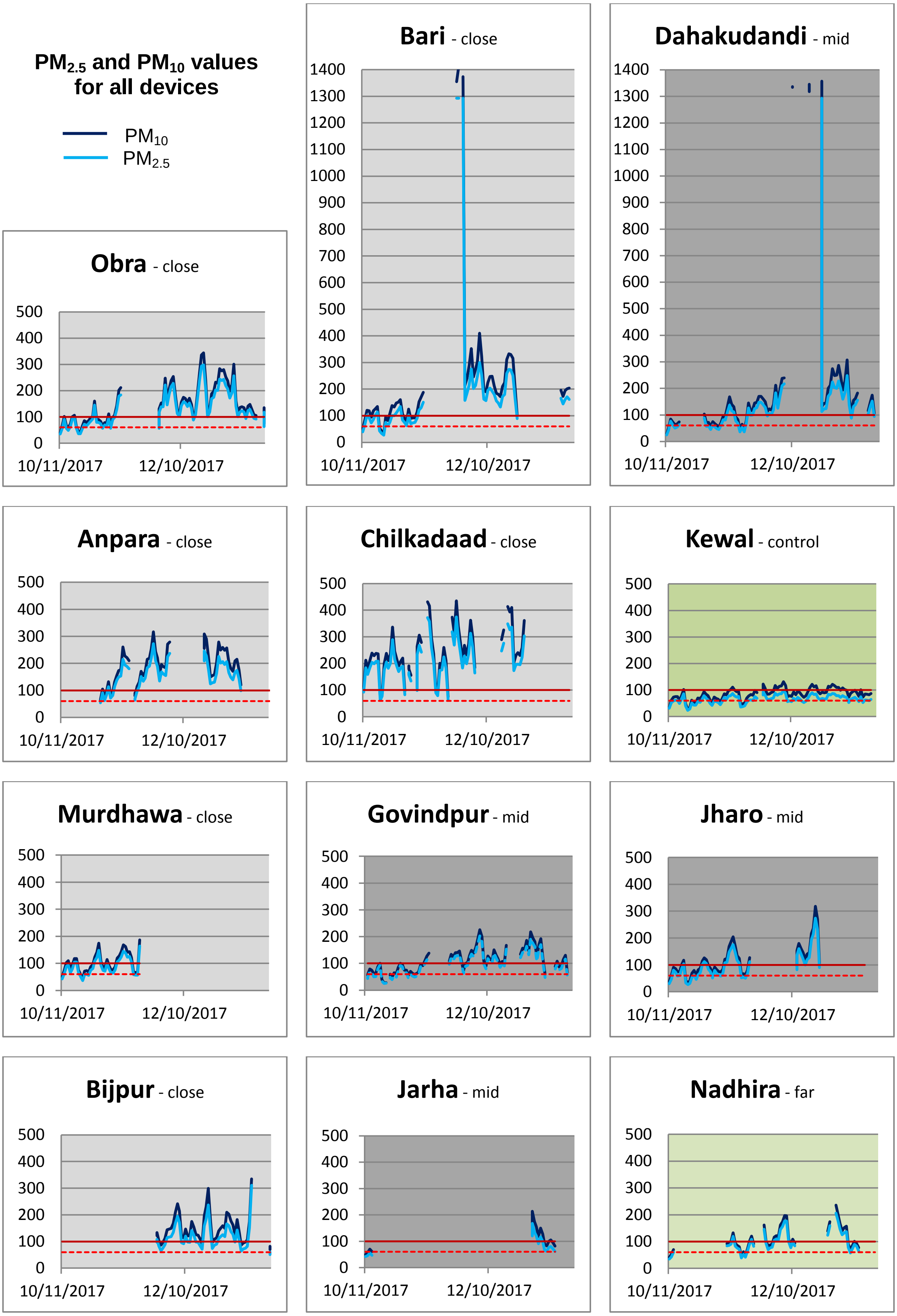


The first plot in this series shows that in early January the $PM_{2.5}$ levels at Bijpur (the source stack) are often lower than at the other two distant locations. But the levels at Nadhira, where it is expected that pollution levels should start decreasing, are often even higher than at the middle point, Jarha. In other words, small particles are being carried much further than expected. A similar pattern may be seen in the third plot of the first week of January, where the levels in in Govindpur and Jharo in the middle are a little lower than distant Kewal. In the second plot, the levels in Kewal occasionally match or surpass those in the middle. Table 3 summarises the data and supplements the above findings in these two clusters.

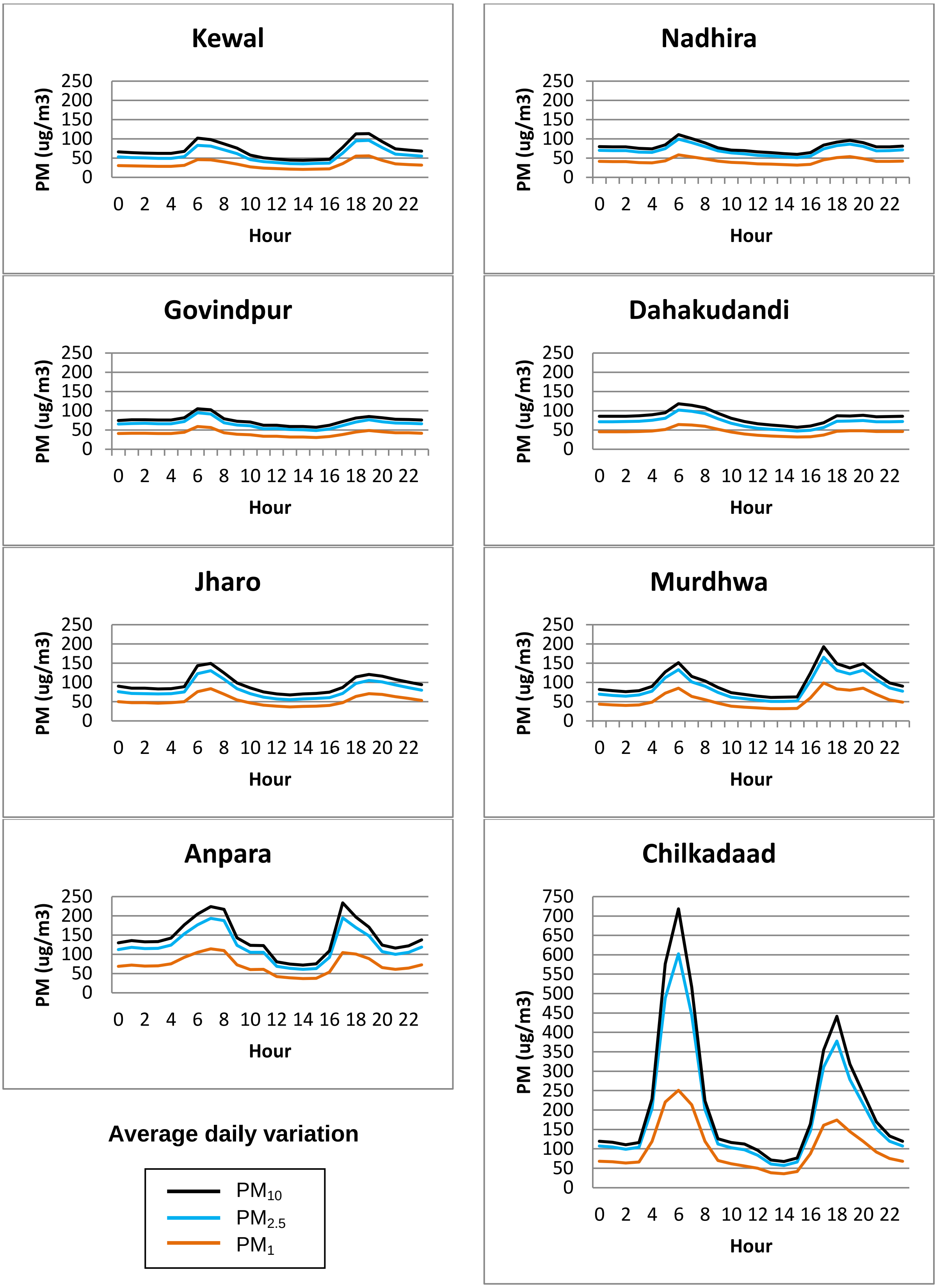
Table 3: $PM_{2.5}$ values for Singrauli locations in $\mu g/m^3$

Cluster	Station	Distance	Range		Av. $PM_{2.5}$	% $PM_{2.5}$/ PM_{10}
			Min	Max		
Obra-Dalla	Obra	close	35	298	130.1	88.1
	Bari	close	27	(1293)	228.9	85.7
	Dahakudandi	medium	25	(1293)	239.1	90.6
Anpara-Vindhyachal	Anpara	close	33	273	153.3	83.5
	Basi	close	No data			
	Chilkadaad	close	61	375	209.9	86.3
	Faripaan	far	No data			
Rihand	Bijpur	close	51	311	118.1	79.8
	Jarha-Chetwa	medium	42	168	89.2	78.1
	Nadhira	far	35	206	99.1	88.6
Hindalco	Murdhawa	close	37	164	88.1	86.1
	Govindpur	medium	25	203	97.0	89.3
	Jharo	medium	27	274	98.0	85.5
	Kewal	far	23	98	65.6	76.4

The charts below give a synoptic view of $PM_{2.5}$ and PM_{10} concentrations in all the clusters:



Given that the above comparisons are based on average daily data, the diurnal variations also need to be kept in mind as the exposures could be higher than the average. These are given in the following charts for 10 devices for which data was available. The levels given are for PM_1, $PM_{2.5}$, as well as PM_{10} given by the ATMOS devices.



Average daily variation

As may be seen from the above, the diurnal variation is low and consisting of mainly of a slightly higher peak in the morning hours at about 7 a.m. for the rural areas of Kewal, Nadhira, Govindpur, and Dahakudandi, and the average peak does not exceed the permissible levels. Two peaks in the morning at 7 a.m. and in the evening at 7 p.m. begin to be more pronounced at Jharo and Murdhwa, and the concentrations can reach 1.5 to 2 times the permissible levels. In Anpara the peaks go higher up to 2.5 to 3 times the standards, and in Chilkadaad they are the highest up to 7 to 10 times the standards.

Conclusions

In Singrauli region, the selection of locations on the ground was influenced by factors such as availability of electricity and net connectivity, as well as local persons to take care of the devices, and 'visible' signs of pollution.
Even then data uploaded on to the dashboard was irregular because of the absence of net connections, failure of at least two devices to function, and some problems with the device hardware.

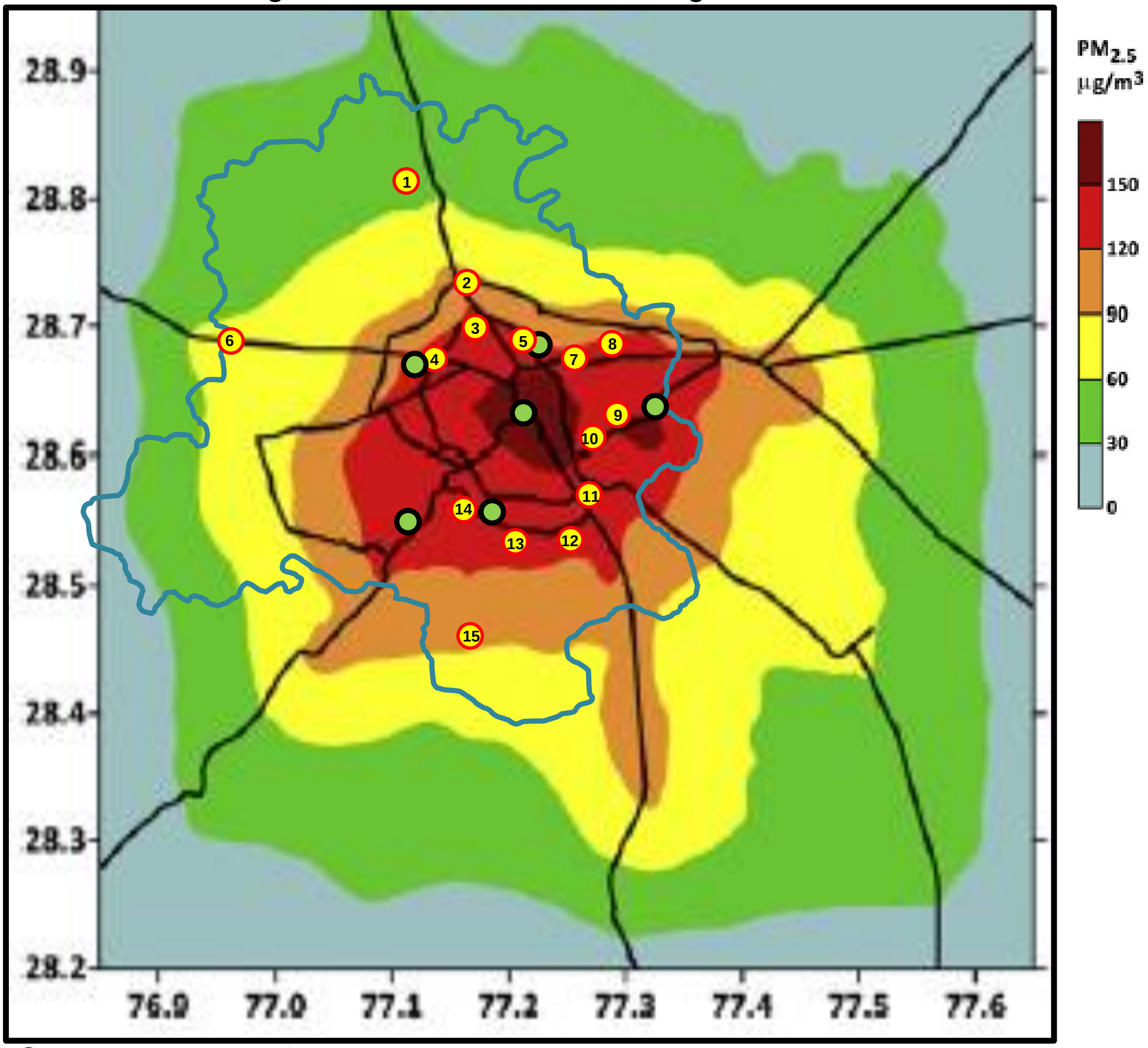
- In the northern Bari-Dala cluster, pollution concentrations were low and near the permissible levels in October 2017, then rose in November and December at least two-fold and the increase persisted in January 2018.
- Two marked spikes, in November for Bari and in December for Dahakudandi, when $PM_{2.5}$ levels rise to more than 20 times the permissible limits, could probably be disregarded as device malfunction.
- In the western Anpara-Vindhyachal cluster, $PM_{2.5}$ levels remained above permissible limits through the entire period but rose periodically to between 5 to 6 times the permissible standard, especially at Chilkadaad.
- In the eastern Hindalco cluster, $PM_{2.5}$ levels were low in October 2017, but rose significantly to about 2 to 3 times the permissible levels in the November 2017 to January 2018 period.
- In the southern Rihand cluster, pollution levels, even far away from the thermal power plant, remained high, sometimes as much as 2 to 3 times than the standard permissible levels for much of December 2018.
- The data in the Rihand and Hindalco clusters suggests that small particles are being carried much further than expected, and even 25 to 30 km away from the stacks in areas that would ordinarily be considered unpolluted.
- In addition, the diurnal variation in the clusters to the west and the east demonstrates peak concentrations in the morning at 7 a.m. and in the evening at 7 p.m. that can reach from 1.5 to 10 times the standards.

Part II – Delhi
Air Pollution Monitoring

Preparations for the monitoring in Delhi were begun in May 2017 and contact established with the Adviser to the Education Minister in the Delhi Government. But, in spite of numerous efforts, she was not able to give any confirmation. We then met the Chief Minister on 23rd October, he referred us to the Education Minister the next day, who was enthusiastic and arranged a meeting with the Environment Minister and his officials. These officials were indifferent, claiming that the low-cost devices were unreliable, the health study by the Kolkata National Cancer Institution was unscientific, and the Department should do the study itself. To date, however, the Department has not conducted a study, nor reverted back to us.

In the meantime, bearing in mind the deadlines for the project, the locations for installing the low-cost monitoring devices in Delhi were selected to monitor different levels of pollution (Fig.1), as per the model of 2010 of the group UrbanEmissions (www.urbanemissions.info), so that they lie along the eight arterial corridors that lead to Delhi and the major travel routes within Delhi (mainly the two Ring Roads). 15 devices measuring $PM_{2.5}$ and PM_{10} were purchased from Airveda in early October and installation began by 16th October at these locations wherever we could find an appropriate institution to host the device (Table 1).

Fig.1: DPCC & Airveda Monitoring Stations in Delhi



6 DPCC stations 15 Airveda stations

Locations

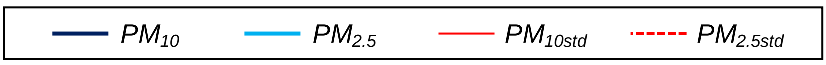
After extensive visits and discussions with local community groups and residents, locations were chosen where the devices could be installed and some person would be responsible for looking after the device and uploading the data on to the server. Table 1 gives the details of these locations, the period of monitoring, and the reasons for gaps in the data.

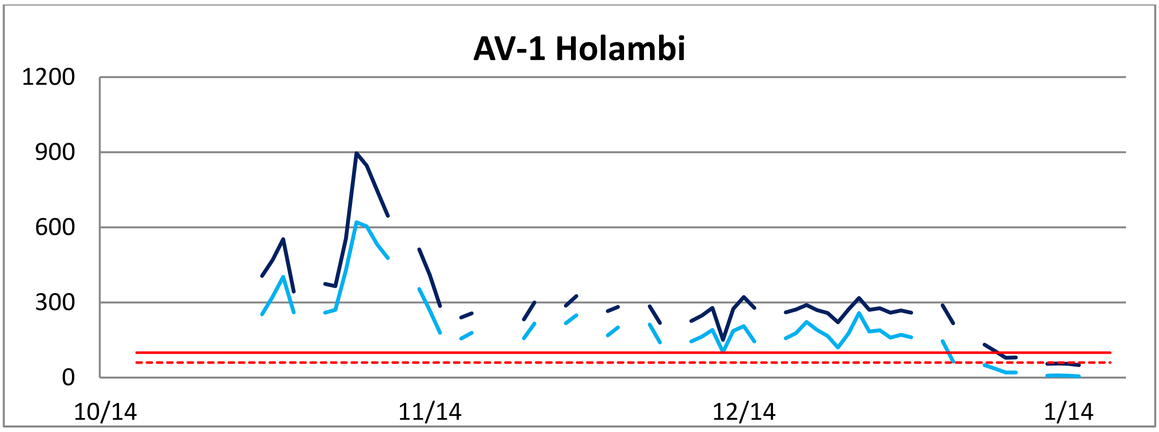
Table: Locations for installation of devices

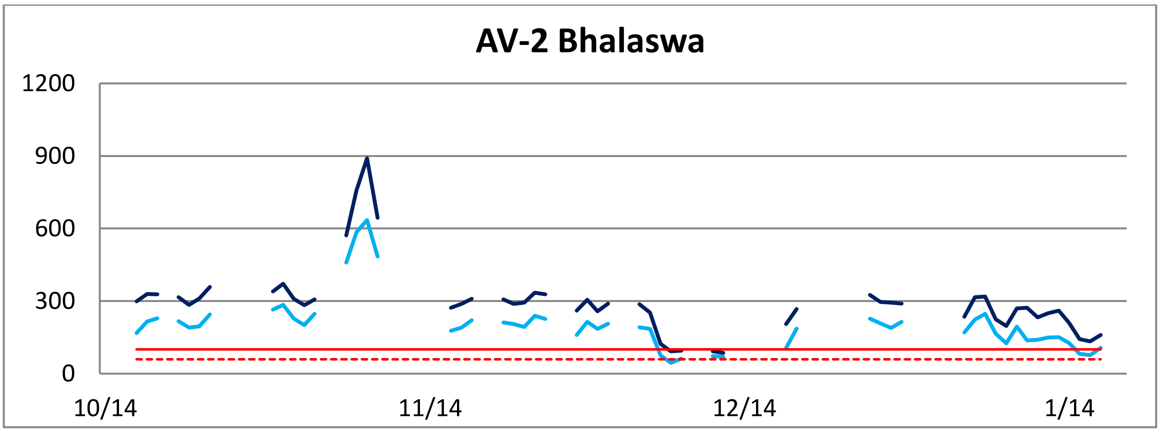
s.no	LOCATIONS	Period	Reasons for Installation	Gap in data
AV1	Holambi	17/10-28/11	Shop, within 200m of 1 MCD school	14 days, as local person busy and device problems
AV2	Bhalaswa	17/10-30/11	School	17 days, holidays and device stopped working
AV3	Wazirpur	17/10-30/11	Dargah, 500m of 1 school and 1 engineering college	15days, as responsible person out of station
AV4	Punjabi Bagh	27/10-30/11	School	4 days, because device not working
AV5	GTB Nagar	31/10-30/11	Next to tuition centre	4 days, because net connection down
AV6	Bahadurgarh	27/10-28/11	Residential area, within 500m of 1 school	12 days, as responsible person out of station
AV7	Seelampur	27/10-26/11	NGO office, where they teach children	7 days, because of delay in net recharge
AV8	Seemapuri	24/10-29/11	GRC office, within 200m of 2 private schools	16 days, as responsible person busy
AV9	Kalyanpuri	27/10-28/11	Bal Vikas Kendra	6 days, due to technical fault in device
AV10	Patparganj	16/10-29/11	Residential area, 200m of 1 MCD & 1 private school	2 days, as net not available
AV11	New Friends Colony	20/10-17/11	Residential area , within 500m of 2 schools	13 days , due to technical fault in device
AV12	Tughlakabad	20/10-29/11	Residential area, within 500m of 2 schools	2 days, as responsible person out of station
AV13	Saket	16/10-29/11	School	7 days, due to public holidays
AV14	Munirka	18/10-29/11	Residential area, opposite to 1 school	no gap
AV15	Ayanagar	16/10-29/11	Municipal Councillor’s office, opposite a school	2 days, because of no electricity

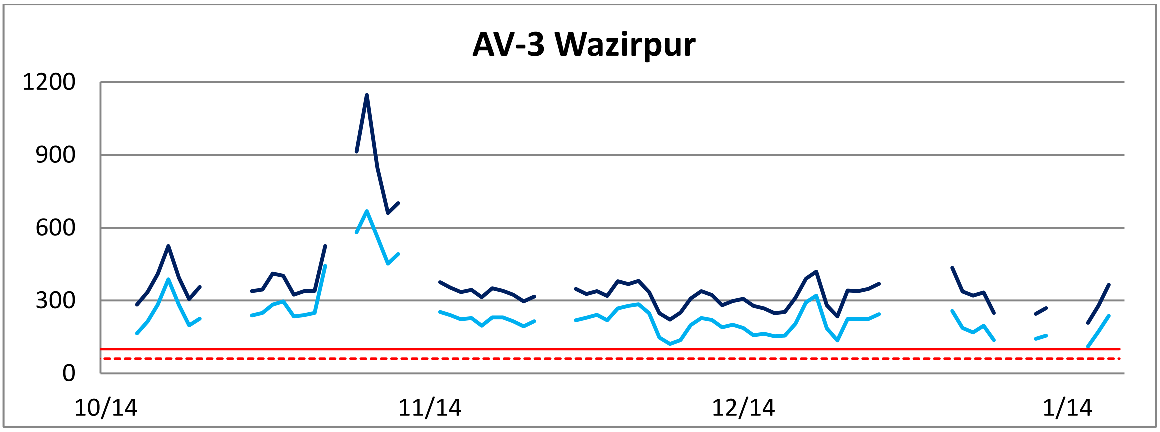
Daily data

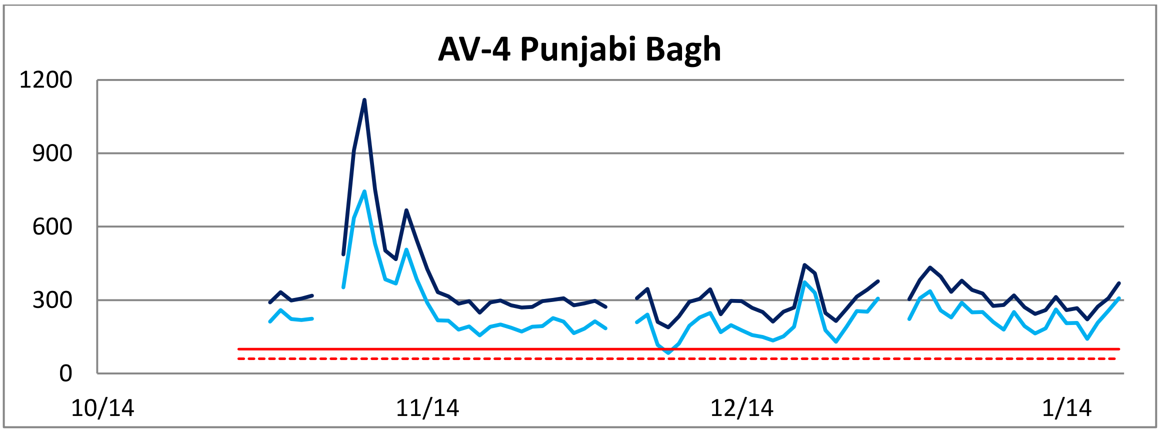
Airveda devices AV1-2 were located in the far north along the National Highway 1; AV3-5 were to the north along Inner Ring Road; AV6-10 were on highways leading to the west and east; and AV 11-15 were in the south mainly along Outer Ring Road. The $PM_{2.5}$ and PM_{10} levels from 14 October, 2017 to January 31, 2018 are given below (all PM values in µg/m^3):

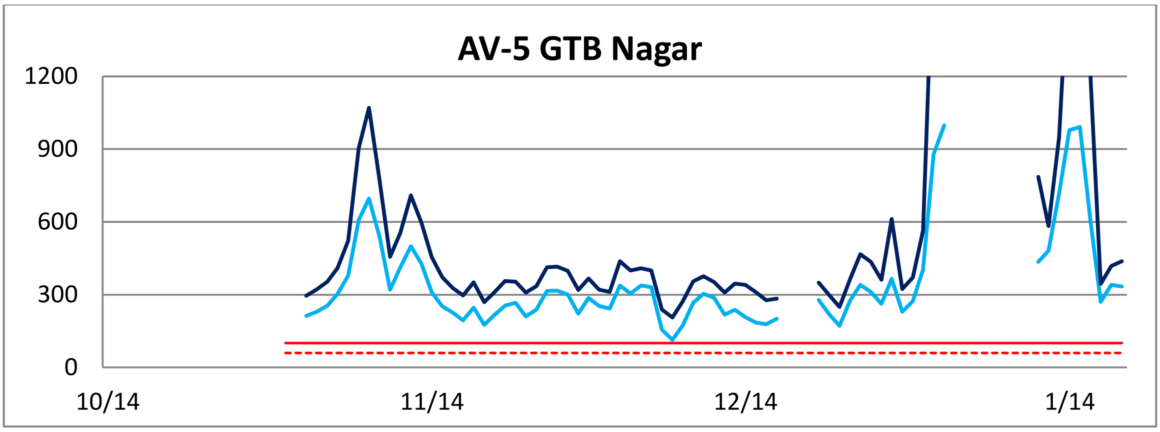


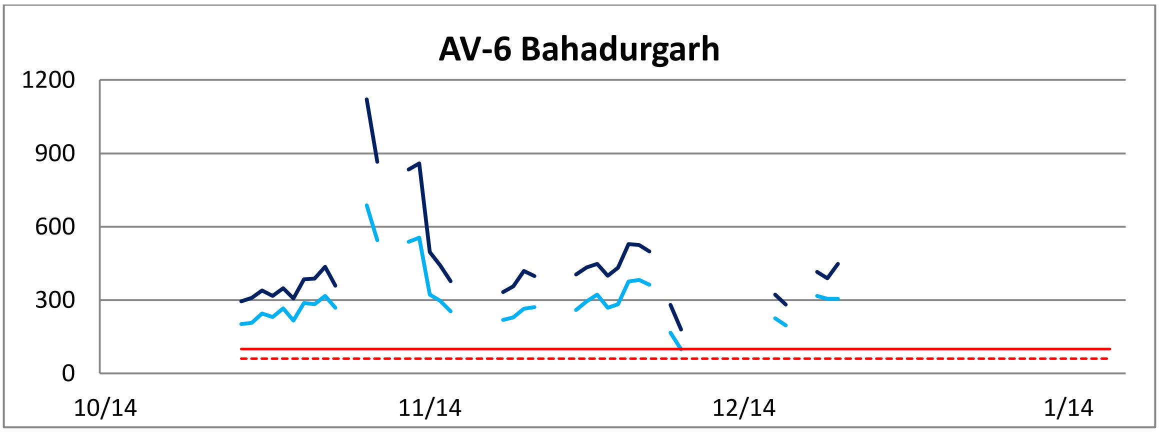

AV-1 Holambi
1200
900
600
300
0
10/14
11/14
12/14
1/14

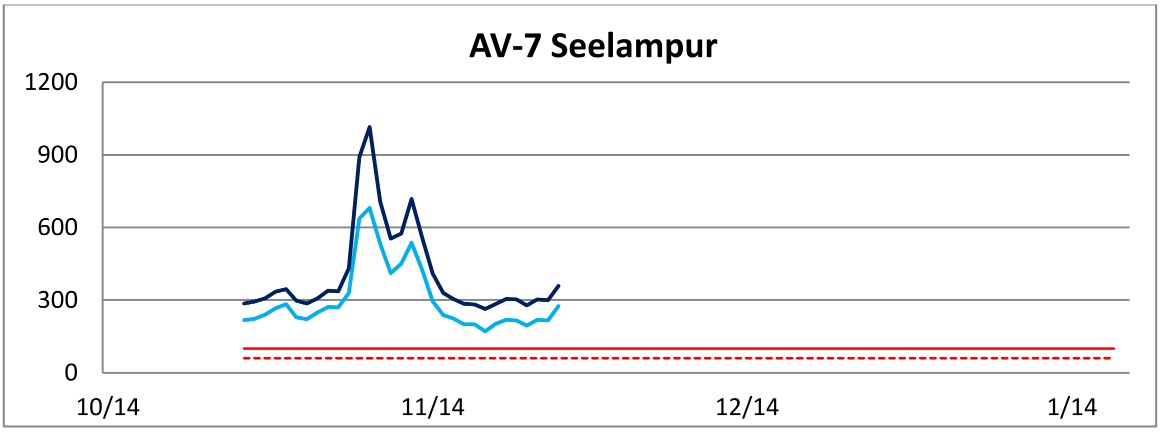

AV-2 Bhalaswa
1200
900
600
300
0
10/14
11/14
12/14
1/14

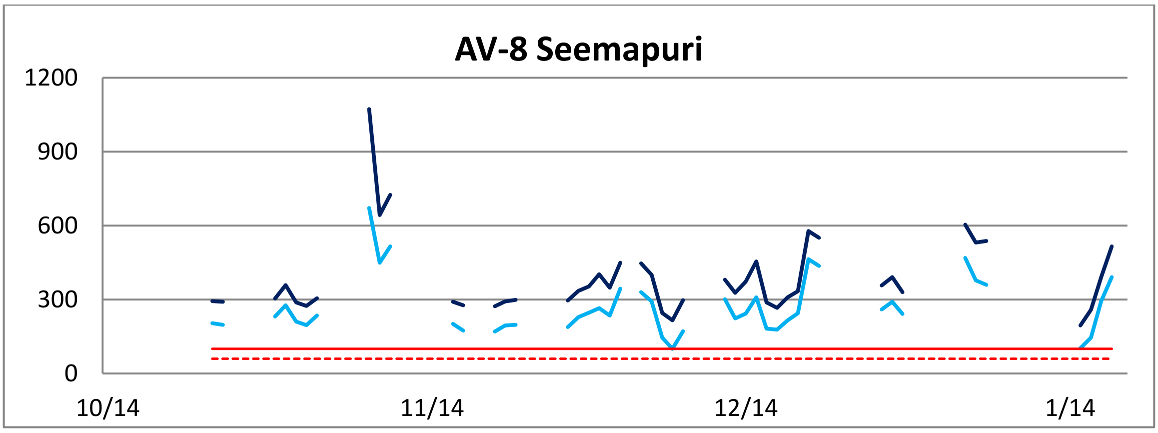

AV-3 Wazirpur
1200
900
600
300
0
10/14
11/14
12/14
1/14


AV-4 Punjabi Bagh
1200
900
600
300
0
10/14
11/14
12/14
1/14


AV-5 GTB Nagar
1200
900
600
300
0
10/14
11/14
12/14
1/14


AV-6 Bahadurgarh
1200
900
600
300
0
10/14
11/14
12/14
1/14


AV-7 Seelampur
1200
900
600
300
0
10/14
11/14
12/14
1/14


AV-8 Seemapuri
1200
900
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300
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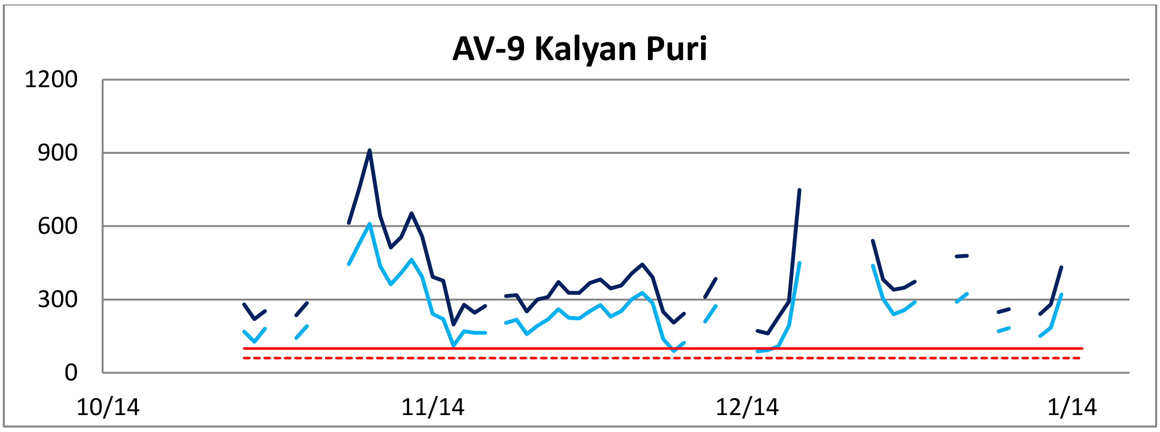
AV-9 Kalyan Puri
1200
900
600
300
0
10/14
11/14
12/14
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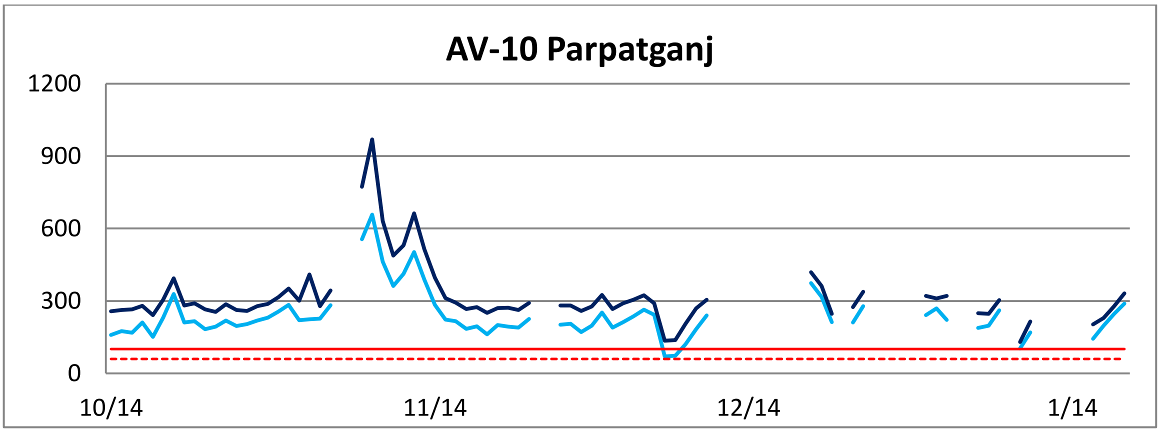
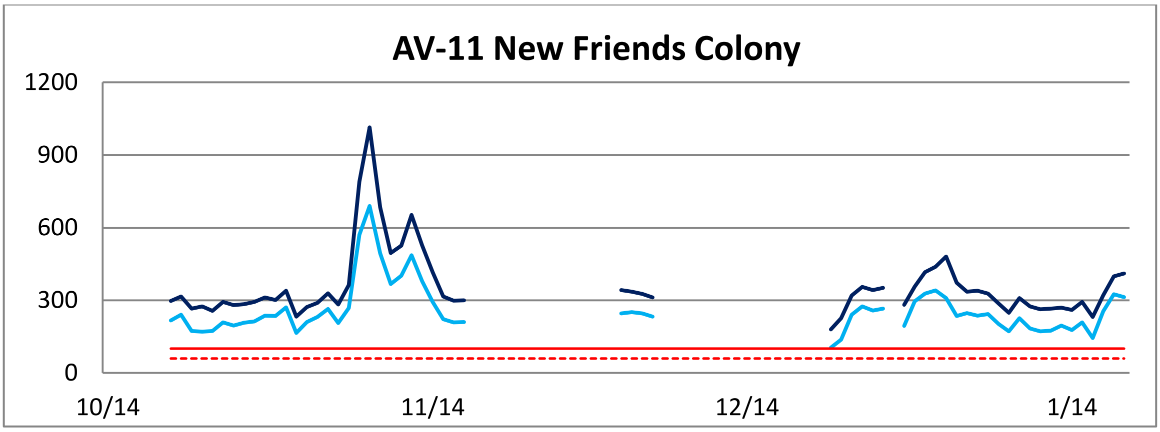
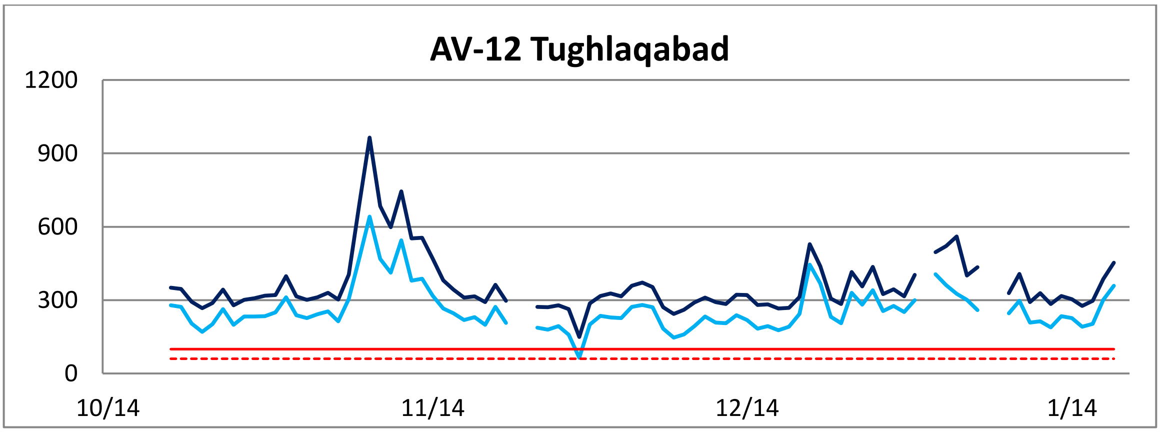
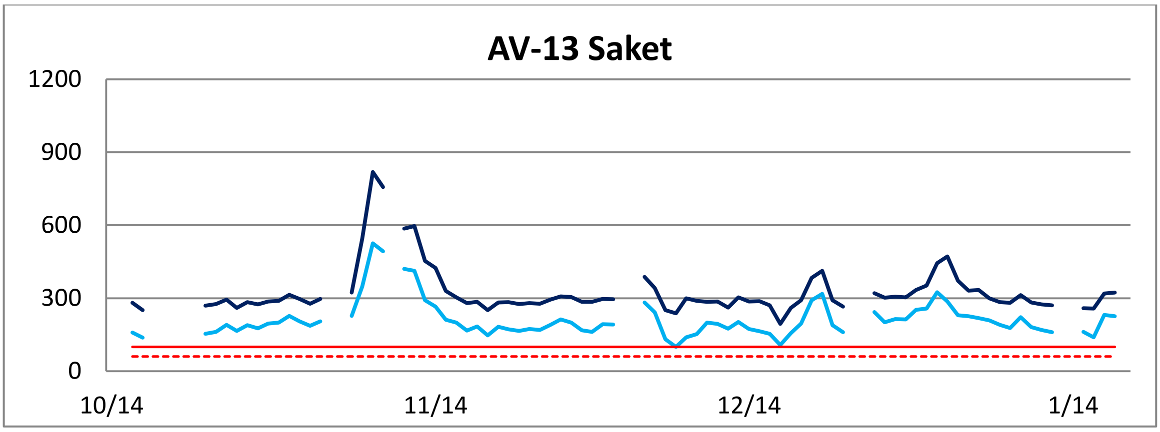
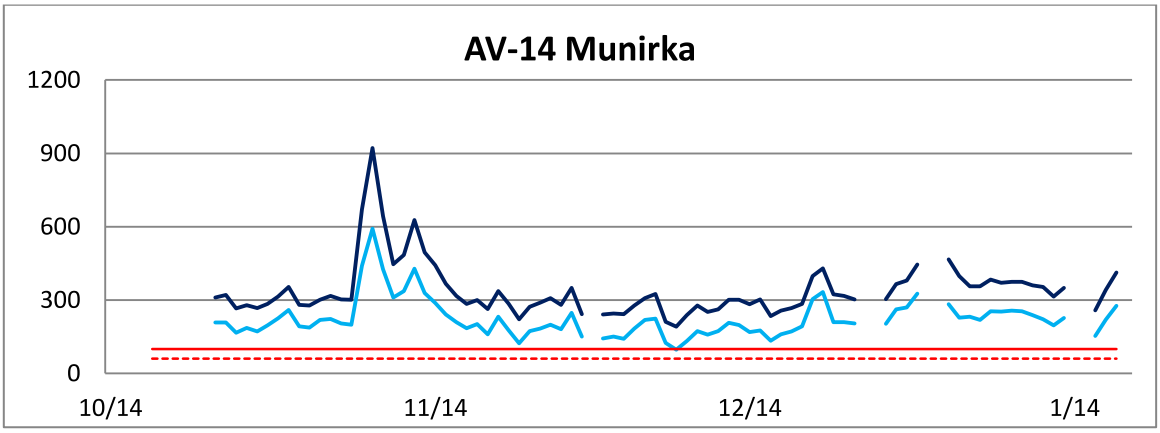
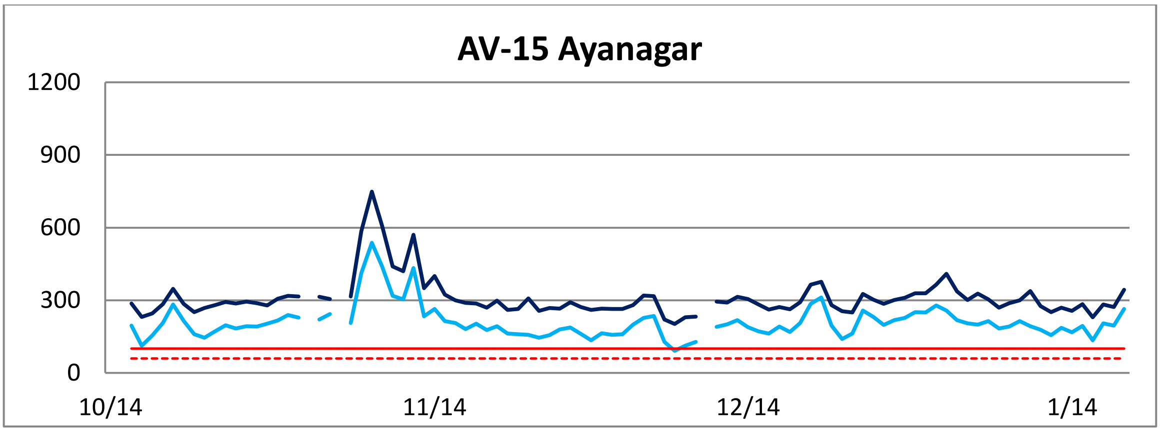

AV-10 Parpatganj
1200
900
600
300
0
10/14
11/14
12/14
1/14


AV-11 New Friends Colony
1200
900
600
300
0
10/14
11/14
12/14
1/14


AV-12 Tughlaqabad
1200
900
600
300
0
10/14
11/14
12/14
1/14

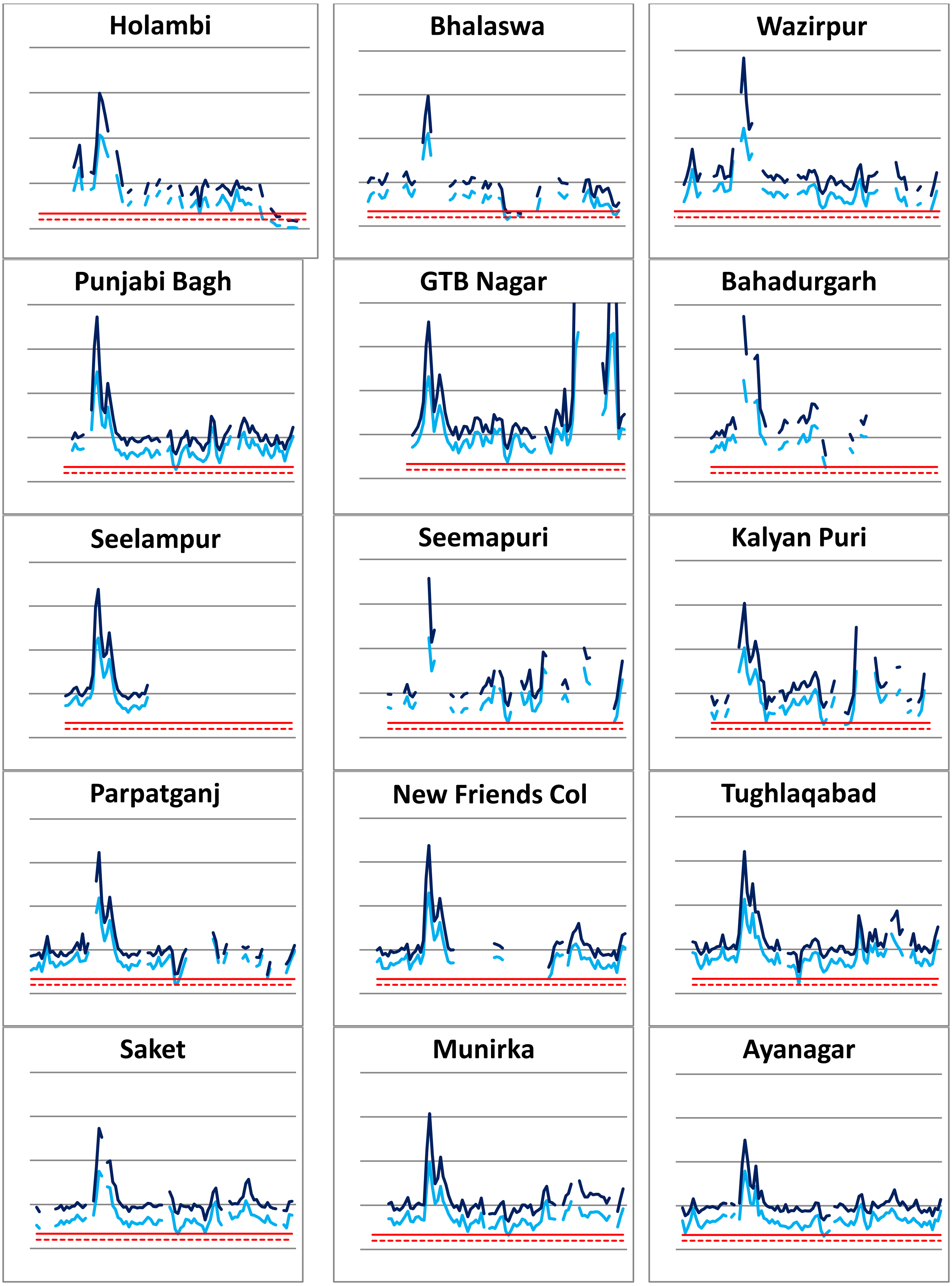




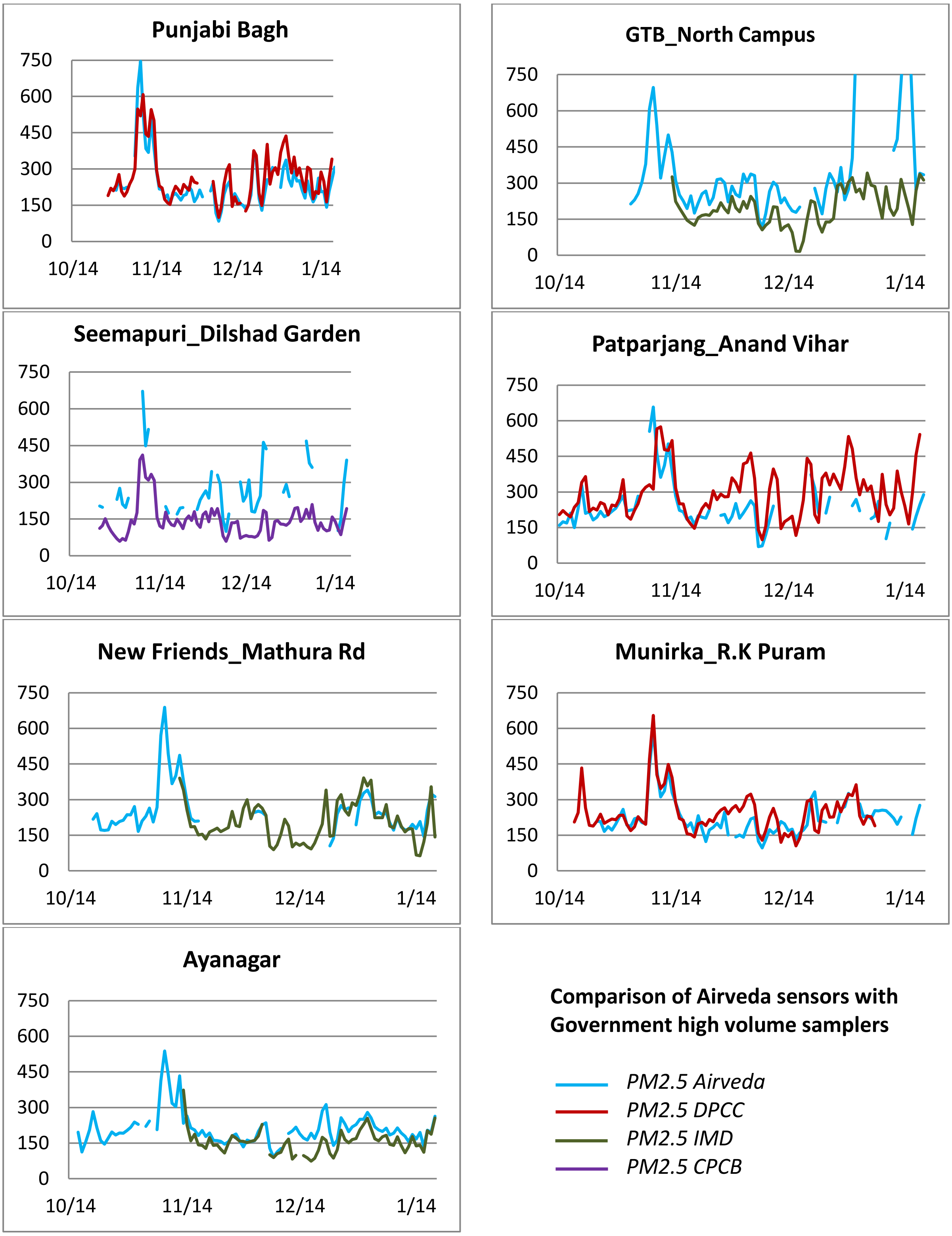


There have been gaps in the data because of the absence of the responsible person, or no access to the net, or malfunctions in the device – especially at Holambi and Bhalaswa in the far north, Bahadurgarh in the west, Seelampur and Seemapuri in the east, and New Friends Colony in the south. However, the remaining 9 devices yield sufficient data to build a picture of pollution levels across Delhi. Thus, all over Delhi, there was a spike in pollution levels to above 600 µg/m^3 for $PM_{2.5}$ (except Saket and Ayanagar in the south) on the 8th November 2017, and a smaller spike up to 500 µg/m^3 on 12th of the same month. These two spikes were much higher than even the one on Diwali on the 19th October. There is a much higher spike at the beginning of the year (going up over 2000 µg/m^3) at Guru Tegh Bahadur Nagar on the Ring Road in the north, but this may be treated as an anomaly. However, what is significant is that there is a base pollution load all the time all over Delhi of about 300 µg/m^3 for PM_{10}, and 200 µg/m^3 for $PM_{2.5}$, which is 3 times higher than the approved limits. This base load of pollution clearly has little to do with factors outside Delhi and must be traced to constantly polluting sources within Delhi – such as transport and construction.

The following assembly gives a bird's eye view of the behaviour of $PM_{2.5}$ (light blue) and PM_{10} (dark blue) in Delhi during the winter months, with PM_{10} values being uniformly higher than $PM_{2.5}$ and both being much higher than the stipulated limits (red lines, dotted for $PM_{2.5}$).



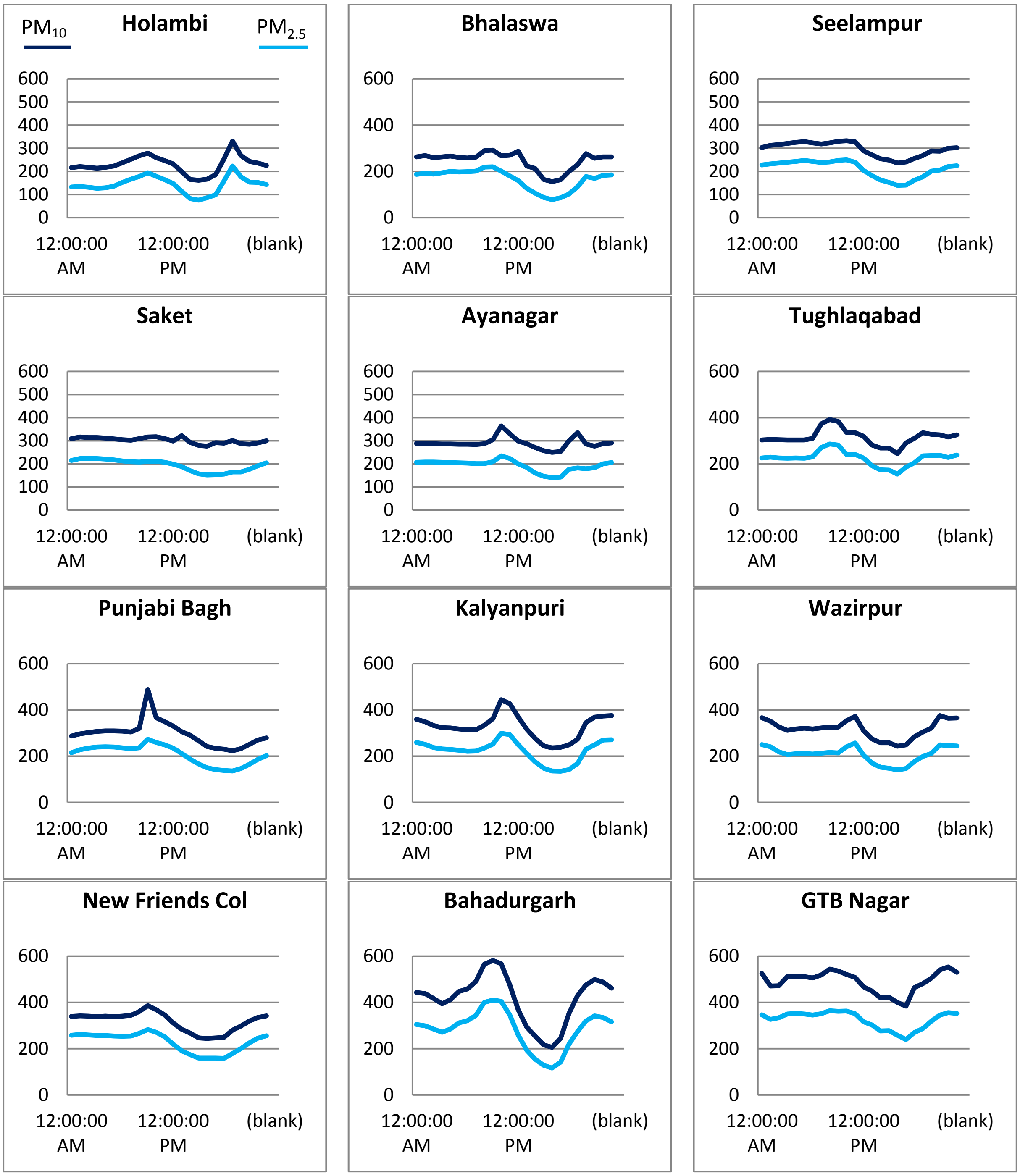
To check the validity of the data and the accuracy of the Airveda devices we have compared the $PM_{2.5}$ data with the nearest government monitor, and the results are given below.



Comparison of Airveda sensors with Government high volume samplers

While noting that sensors estimate the pollution levels at breathing height while high volume air samplers assess the pollution 5-6 metres above the ground, what is interesting is that the Airveda devices yield data that are lower than the DPCC monitors, about the same as the IMD ones, and higher than the CPCB monitors. But the patterns are more or less the same.

Apart from the average daily values pictured above, we have also computed the variations in the average 24 hours, and the charts are given below.

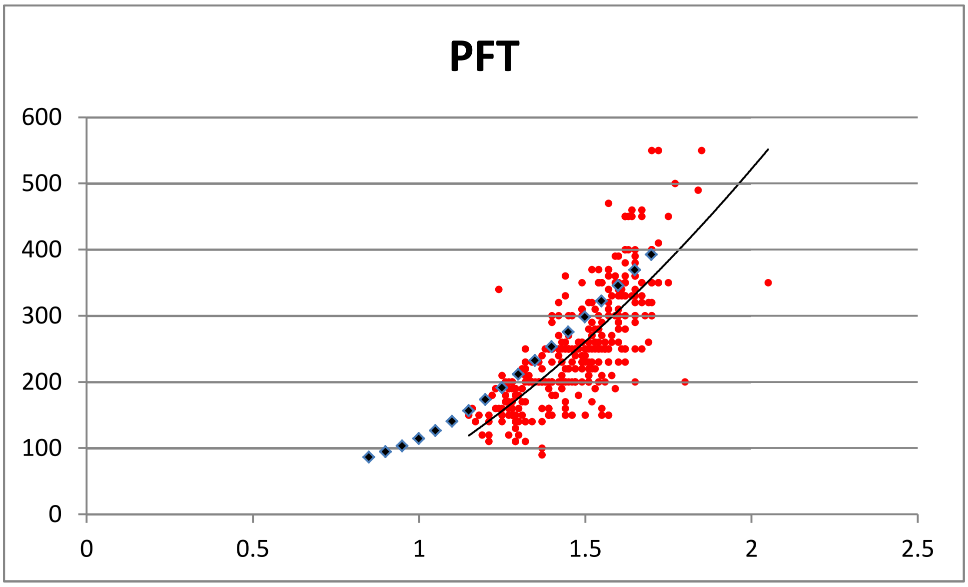


These charts reveal that across Delhi there is a spike in the morning hours between 8 to 10 a.m., a dip in the afternoons between 2 to 4 p.m., and another spike in the evening hours between 7 to 9 p.m. Thus, exposure to pollutants is the highest during the morning followed by the evening. The pollution loads are highest in places like Bahadurgarh and Punjabi Bagh in the west, GTB Nagar and Wazirpur in the north, Kalyanpuri in the east, and New Friends Colony in the south – all of them being characterised by heavy traffic on arterial roads. The lowest pollution is in Holambi and Bhalaswa in the far north at the periphery of the city. Saket, Tughlakabad, and Ayanagar in the south have slightly higher pollution but the peaks are slightly moderated.

Health Study

A health study was carried out with children wherever possible, and some adults, at 11 of the locations where devices had been placed. 470 individuals were studied and basic details of age, gender, class in school, distance to school, mode of transport, time spent on outdoor activities, and symptoms ascertained through a simple questionnaire. In addition, height, weight, and peak lung flow were measured using low-cost but effective devices. These individuals were then screened and only those aged below 20 years, and walking to school, were retained assuming that we were only interested in teenagers and below who lived in the neighbourhood of the pollution monitoring devices and, therefore, were exposed to the same concentrations. Thus 343 young people between the age of 8 and 19 formed the sample considered here.

A plot of the height in metres against the peak flow is given below.



The red dots represent the individuals in this sample of 343 young people, while the black line is the mean for the entire sample. The blue diamonds represent the normal values for a paediatric sample of children in the European Union. As may be seen from the chart, 80% of the peak flow values for the children in Delhi fall below the 'normal' level. This may partly be due to the demographic differences between the European Union and India, but one would not expect such a large difference in the city with the highest per capita income in the nation.

There are variations across the city too as seen in the chart annexed on the last page of this report. Assuming that the highest average peak flow the entire population of the sample achieves is a little over 300, then the areas which have a higher average peak flow and the children are, therefore, having lungs in somewhat better shape, are Saket, Okhla, and Badarpur. Holambi, Bhalaswa, Ayanagar, Punjabi Bagh, and Munirka seem to offer their children the next best atmosphere to breathe. But the air in the remaining parts of the city is definitely not good for our children.

Conclusions

There have been gaps in the data because of the absence of the responsible person, or no access to the net, or malfunctions in the device mainly in the far north and east, as also one location each in the south and west.

- The remaining 9 devices yield sufficient data to show that there is a base pollution load across Delhi of about 300 µg/m^3 for PM_{10} and 200 µg/m^3 for $PM_{2.5}$, which is 3 times higher than the approved limits and the source is located in Delhi.
- There was an overall spike in pollution levels to above 600 µg/m^3 for $PM_{2.5}$ on November 8, and a smaller spike up to 500 µg/m^3 on November 12, and both were much higher than the one on Diwali on October 19.
- A huge spike at Guru Tegh Bahadur Nagar on the Ring Road in the north at the beginning of the year went up to over 2000 µg/m^3, but this may be treated as an anomaly as it was an isolated incident.
- The diurnal behaviour reveals that across Delhi there is a spike in the morning hours between 8 to 10 a.m., a dip in the afternoons between 2 to 4 p.m., and another spike in the evening hours between 7 to 9 p.m.
- Thus, exposure to pollutants is the highest during the morning followed by the evening hours of peak traffic, and is highest at places characterised by heavy traffic on arterial roads.
- The lowest pollution is in the far north at the periphery of the city and moderate in some areas in the south.
- 80% of the peak flow values for the lungs of children in Delhi fall below the 'normal' level and, while this may partly be due to the weaker economic background of the children, it should not be expected in the richest city of India.
- Children's lungs are in somewhat better shape in the southern and northern peripheries of the city but the air in all parts of the city is definitely not good for our children.

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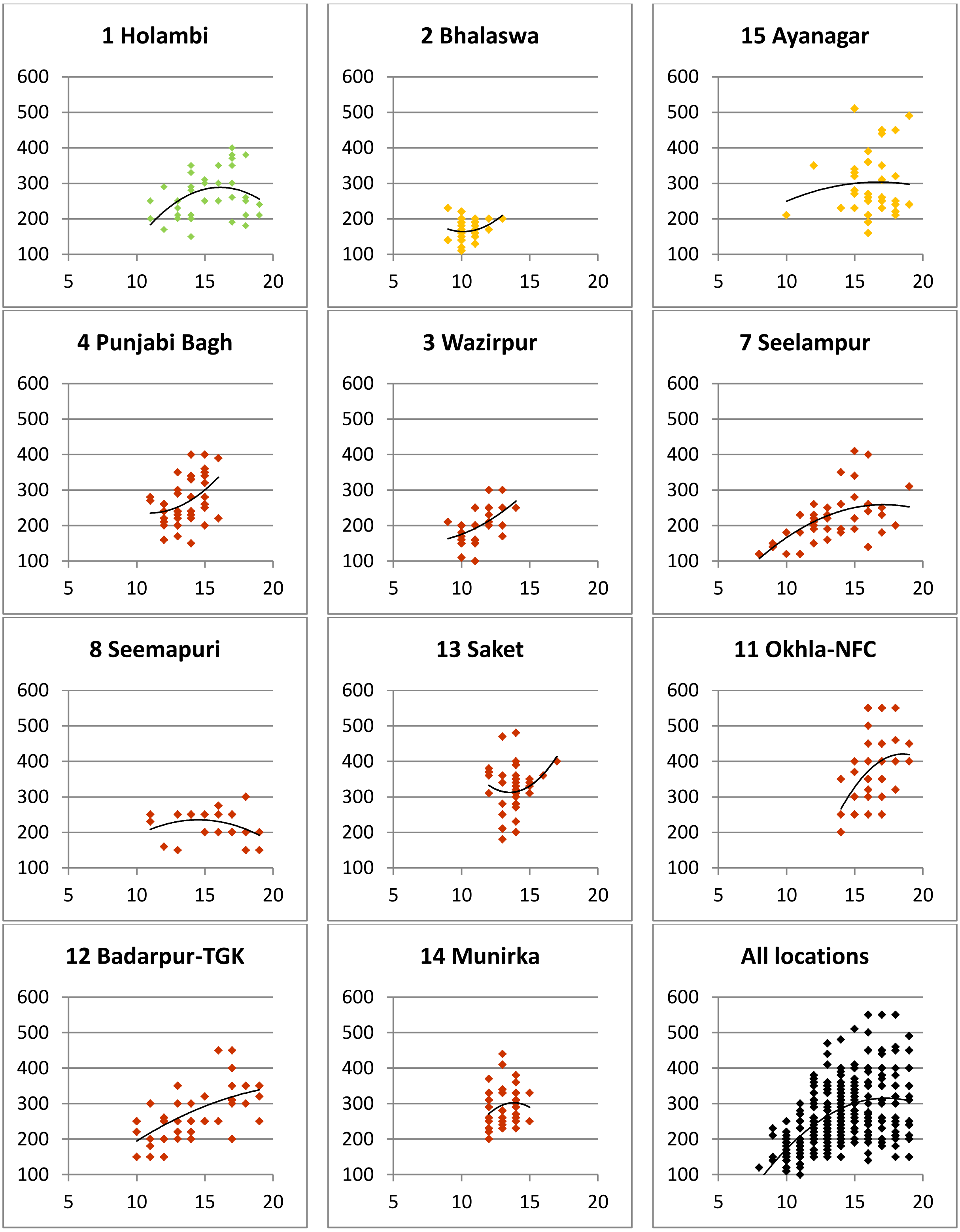
Peak flow plotted against age of children in different parts of Delhi



Explanation: the colour of the plots is dependent on how the dispersion model characterised the area in terms of pollution levels.
Green is for good; orange is for poor, and brown is for severe conditions.
The chart is arranged in decreasing order of air quality as per the dispersion model.