Delhi
Air Pollution Monitoring

February 2018

Prepared by
Hazards Centre

On behalf of
People's Science Institute

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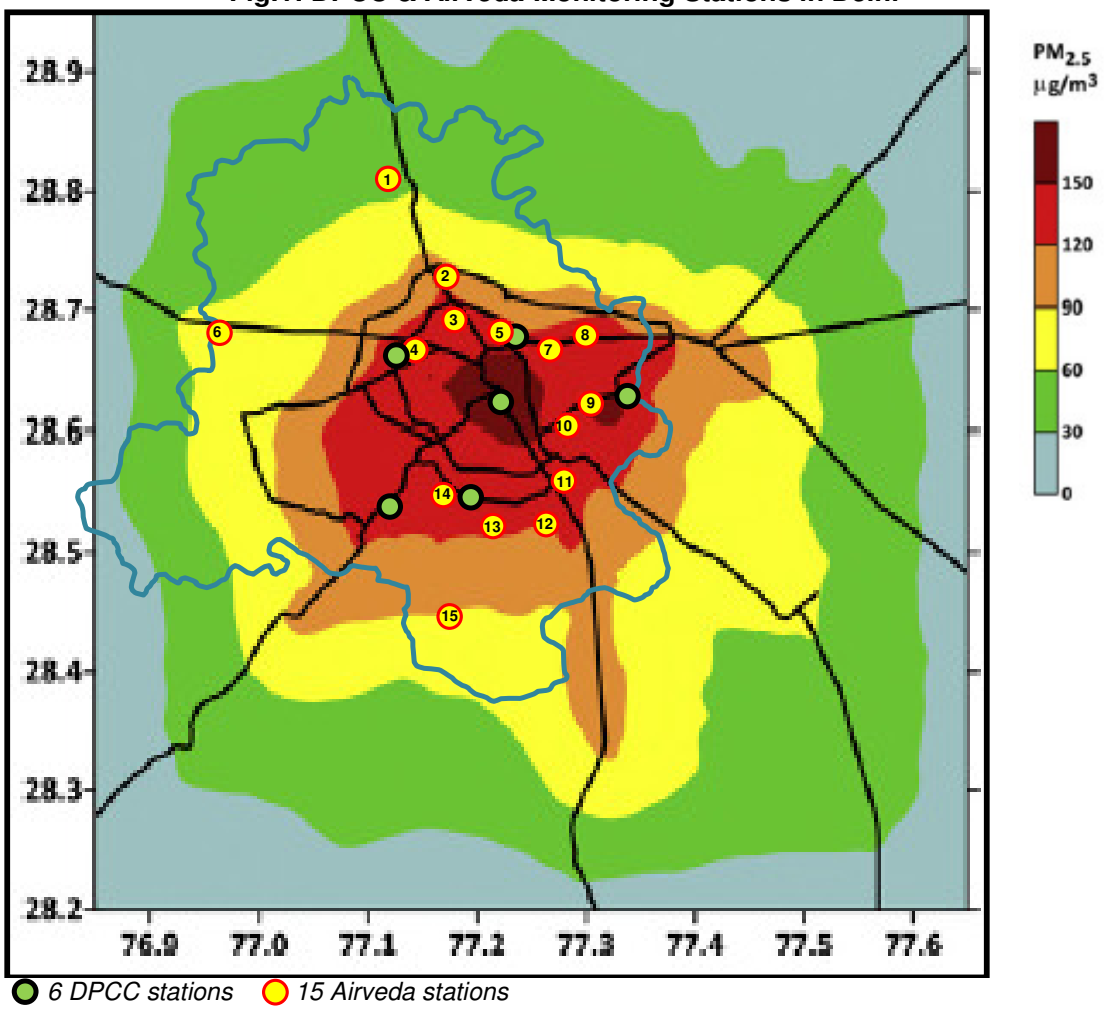
Air Pollution Monitoring

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



Locations

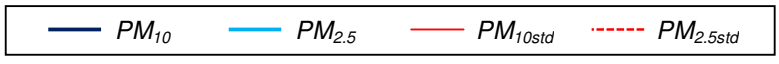
After extensive visits and discussions with local community groups and residents, locations were chosen where the devices could be installed and some person would be responsible for looking after the device and uploading the data on to the server. Table 1 gives the details of these locations, the period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

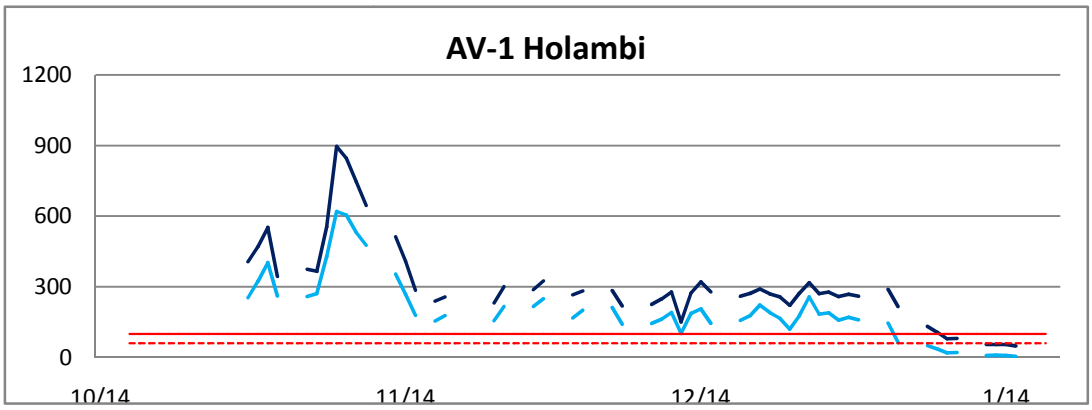
Table: Locations for installation of devices

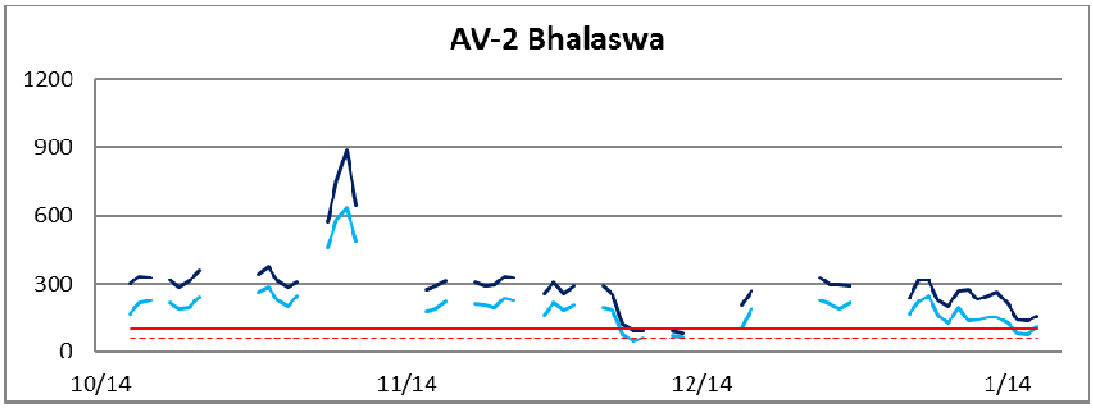
s.no	LOCATIONS	Period	Reasons for Installation	Gap in data
AV1	Holambi	17/10-28/11	Shop, within 200m of 1 MCD school	14 days, as local person busy and device problems
AV2	Bhalaswa	17/10-30/11	School	17 days, holidays and device stopped working
AV3	Wazirpur	17/10-30/11	Dargah, 500m of 1 school and 1 engineering 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

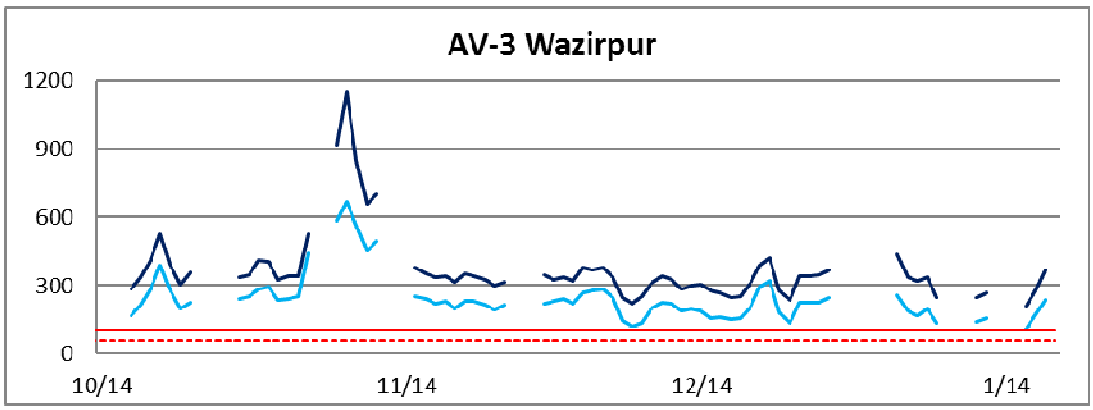
Daily data

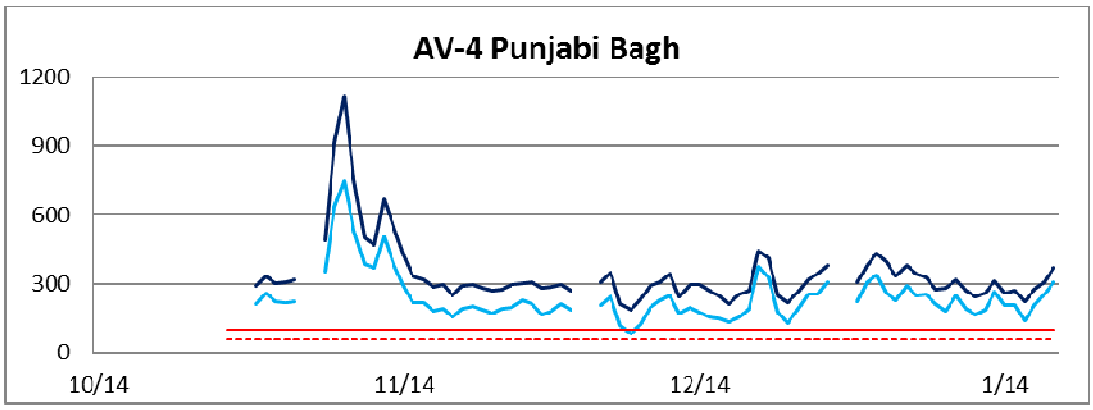
Airveda devices AV1-2 were located in the far north along the National Highway 1; AV3-5 were to the north along Inner Ring Road; AV6-10 were on highways leading to the west and east; and AV 11-15 were in the south mainly along Outer Ring Road. The $PM_{2.5}$ and PM_{10} levels from 14 October, 2017 to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

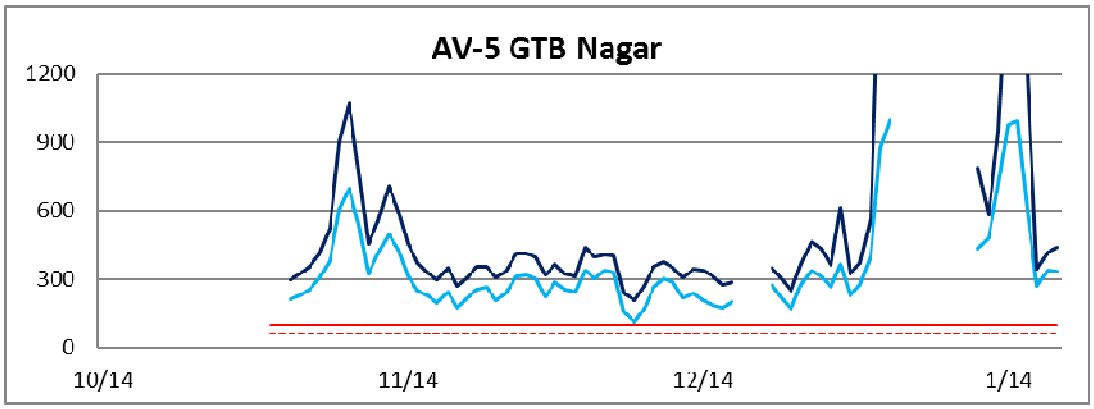


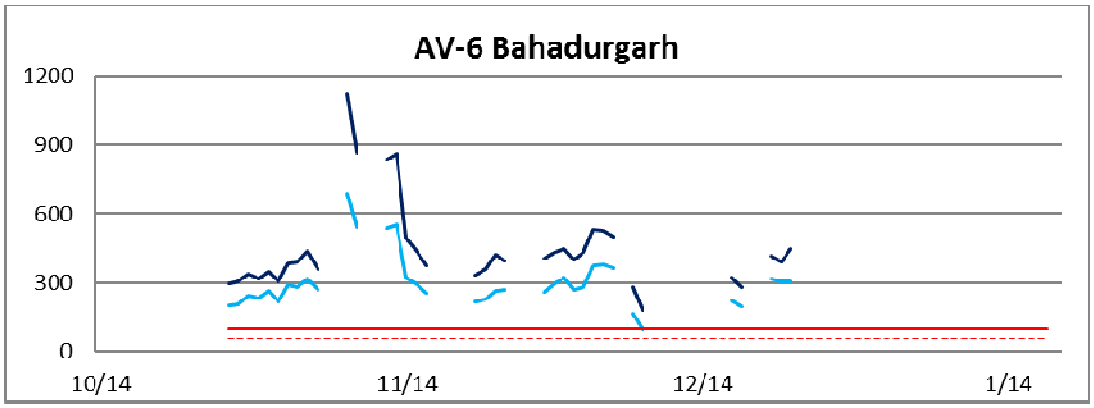

AV-1 Holambi
1200
900
600
300
0
10/14
11/14
12/14
1/14

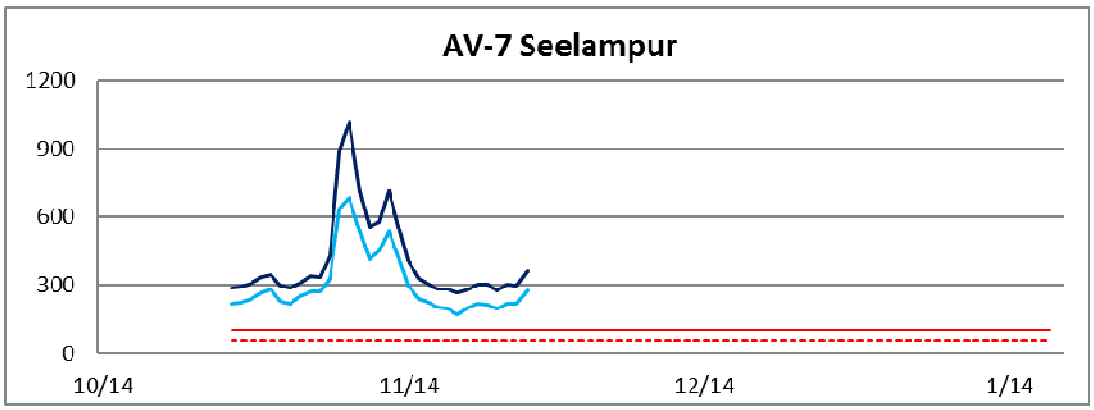

AV-2 Bhalaswa
1200
900
600
300
0
10/14
11/14
12/14
1/14

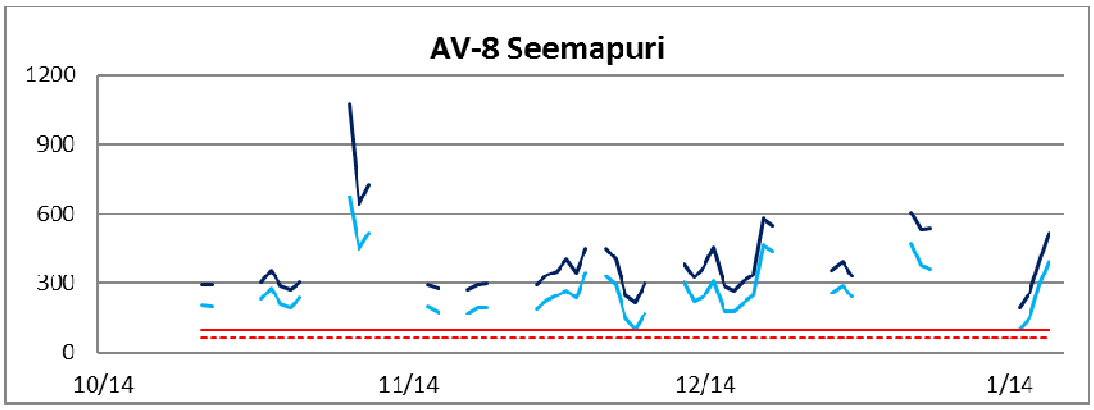

AV-3 Wazirpur
1200
900
600
300
0
10/14
11/14
12/14
1/14

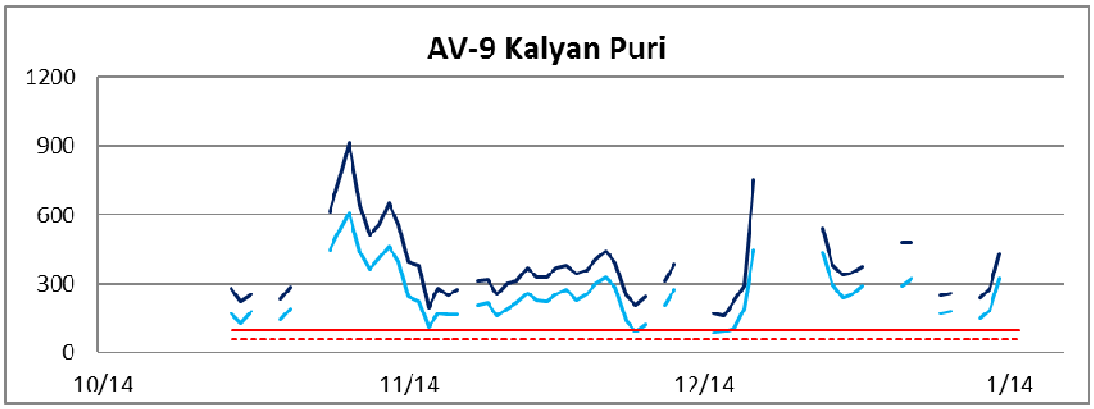

AV-4 Punjabi Bagh
1200
900
600
300
0
10/14
11/14
12/14
1/14

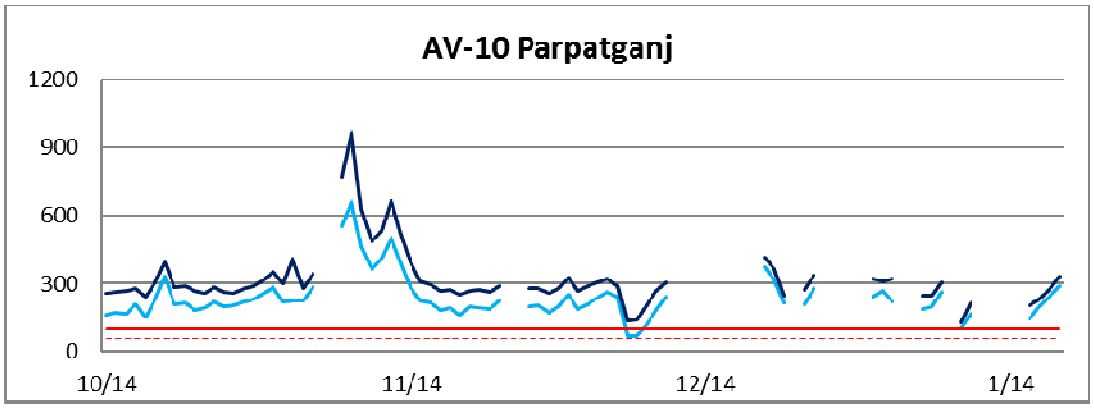

AV-5 GTB Nagar
1200
900
600
300
0
10/14
11/14
12/14
1/14

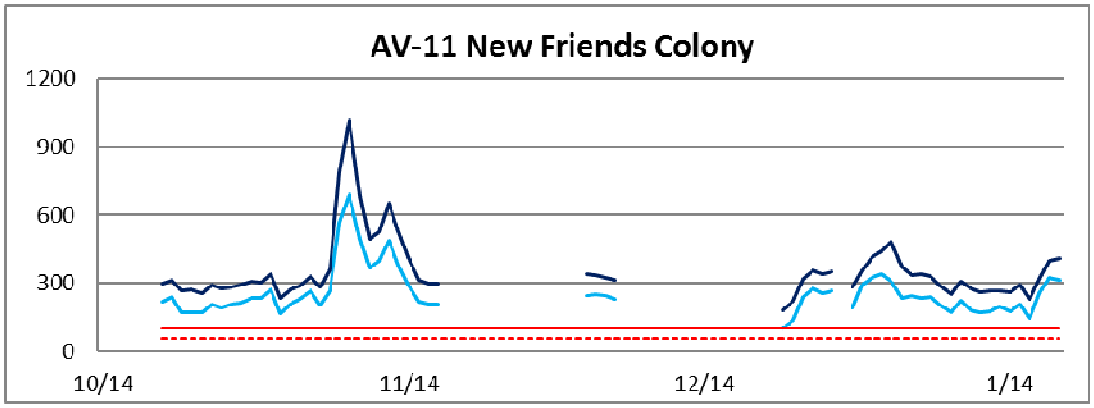

AV-6 Bahadurgarh
1200
900
600
300
0
10/14
11/14
12/14
1/14

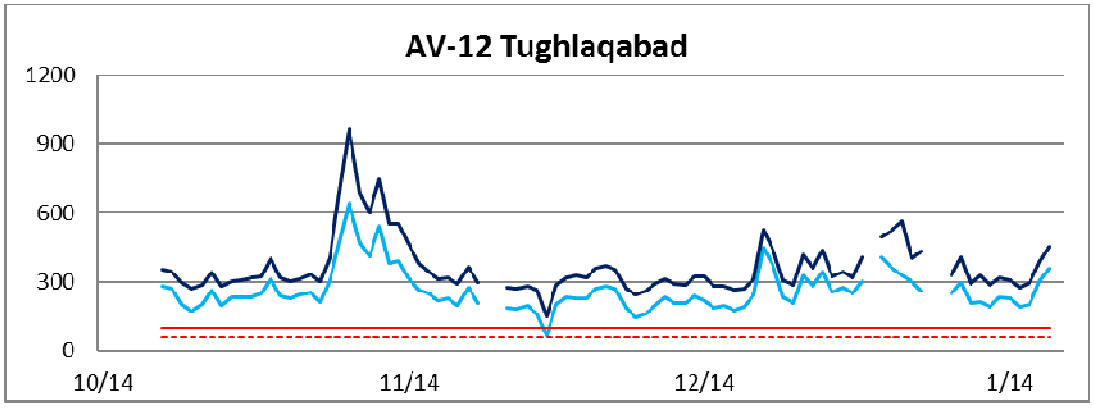

AV-7 Seelampur
1200
900
600
300
0
10/14
11/14
12/14
1/14

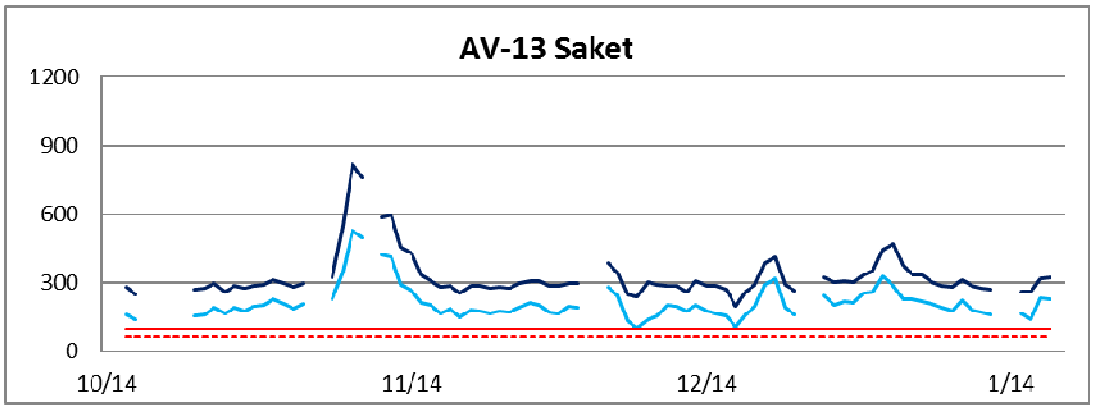

AV-8 Seemapuri
1200
900
600
300
0
10/14
11/14
12/14
1/14

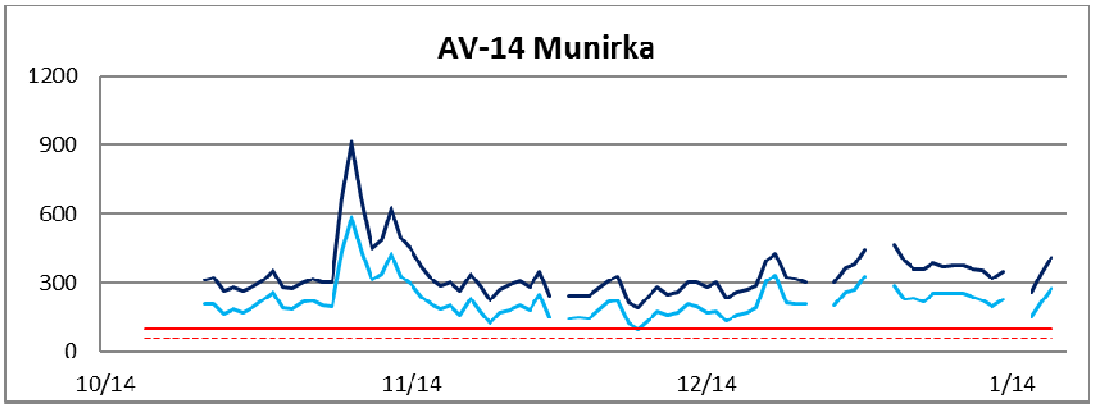

AV-9 Kalyan Puri
1200
900
600
300
0
10/14
11/14
12/14
1/14

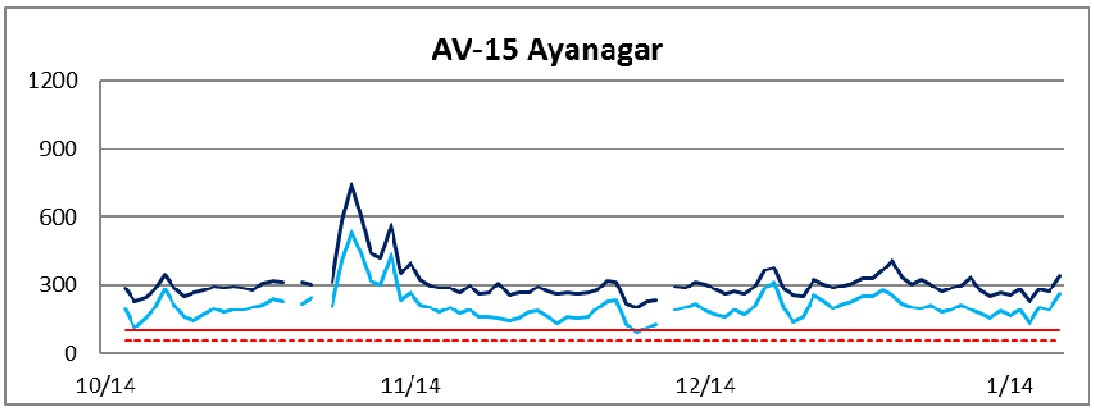

AV-10 Parpatganj
1200
900
600
300
0
10/14
11/14
12/14
1/14


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

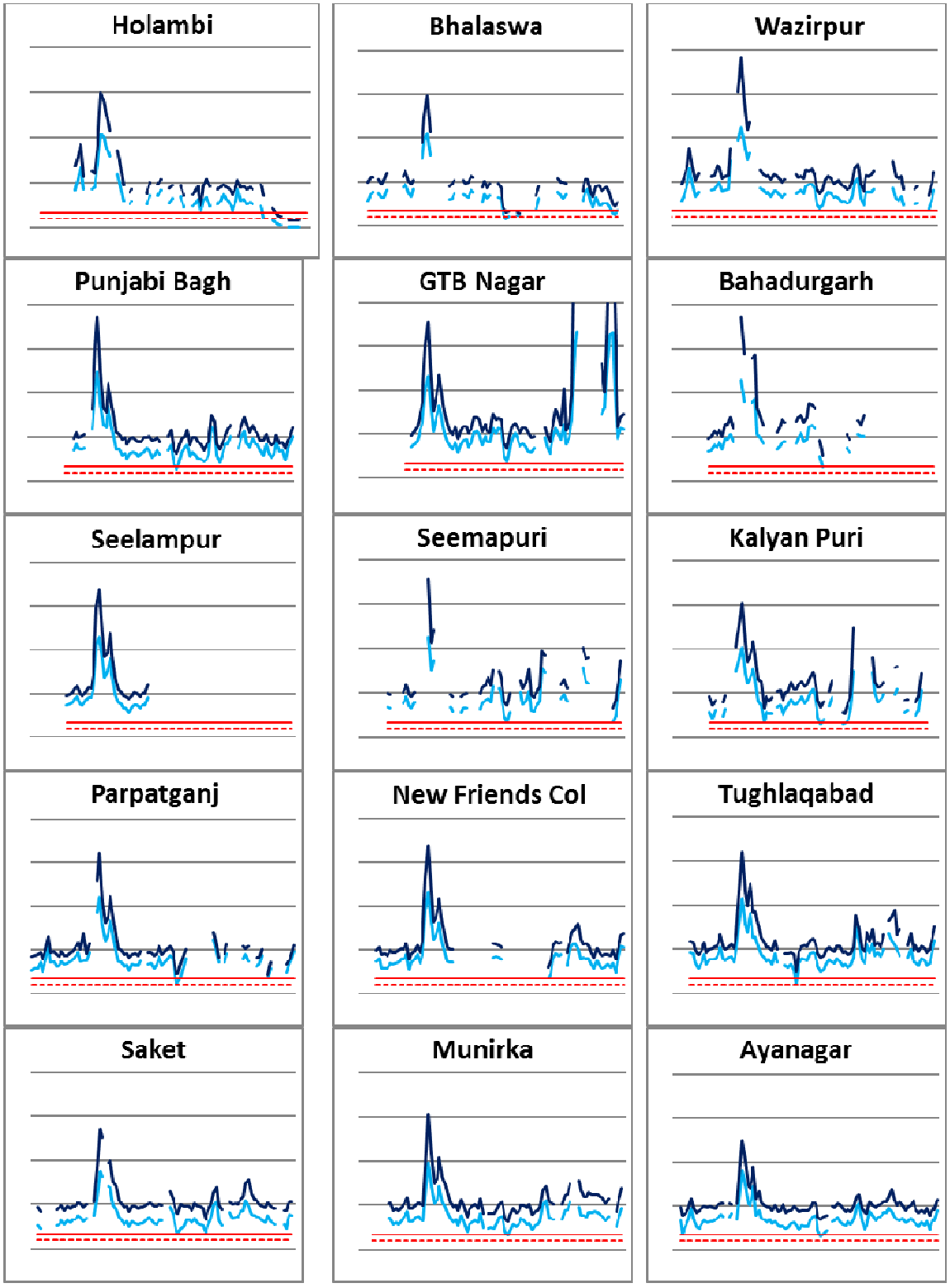




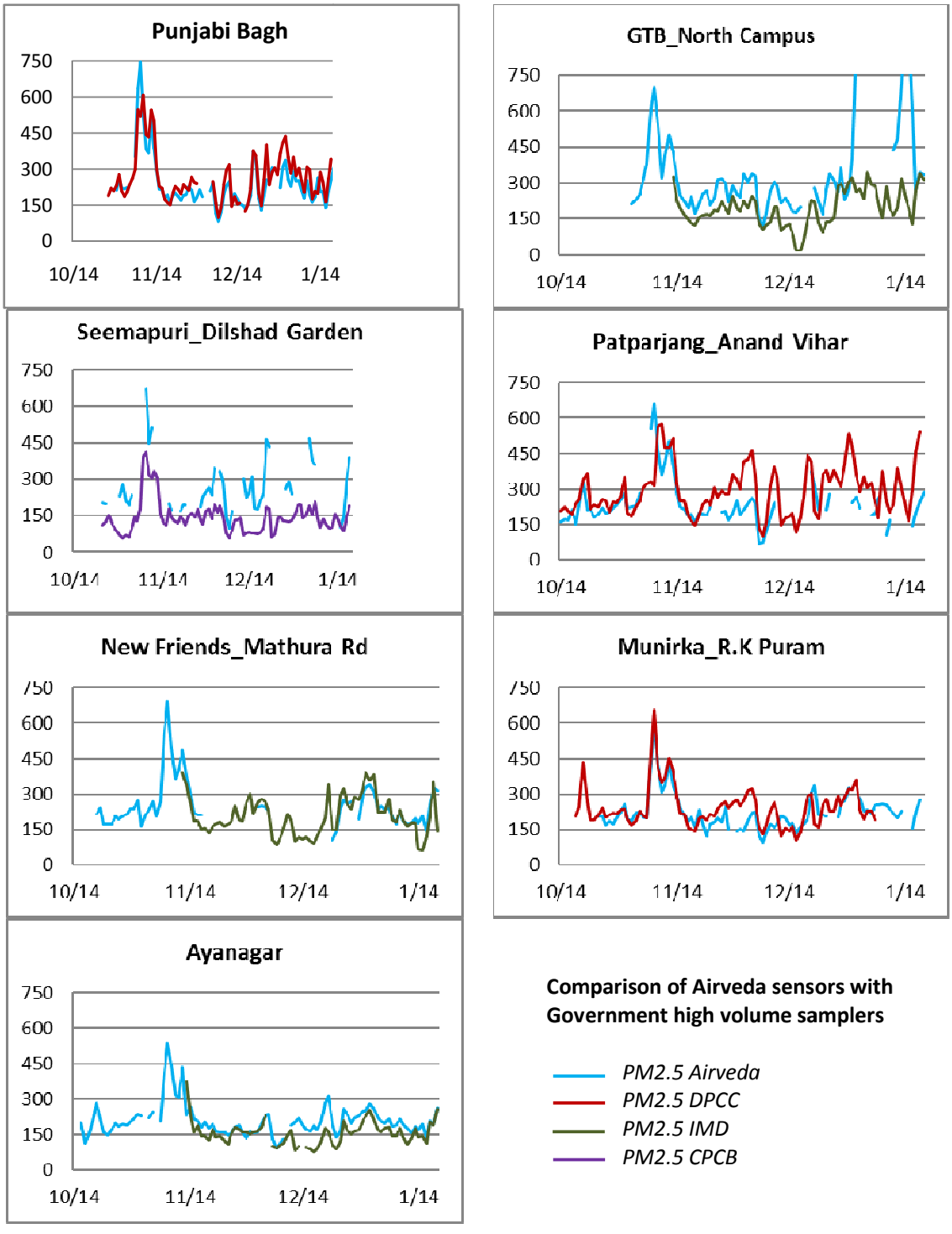


There have been gaps in the data because of the absence of the responsible person, or no access to the net, or malfunctions in the device – especially at Holambi and Bhalaswa in the far north, Bahadurgarh in the west, Seelampur and Seemapuri in the east, and New Friends Colony in the south. However, 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 $PM_{2.5}$).

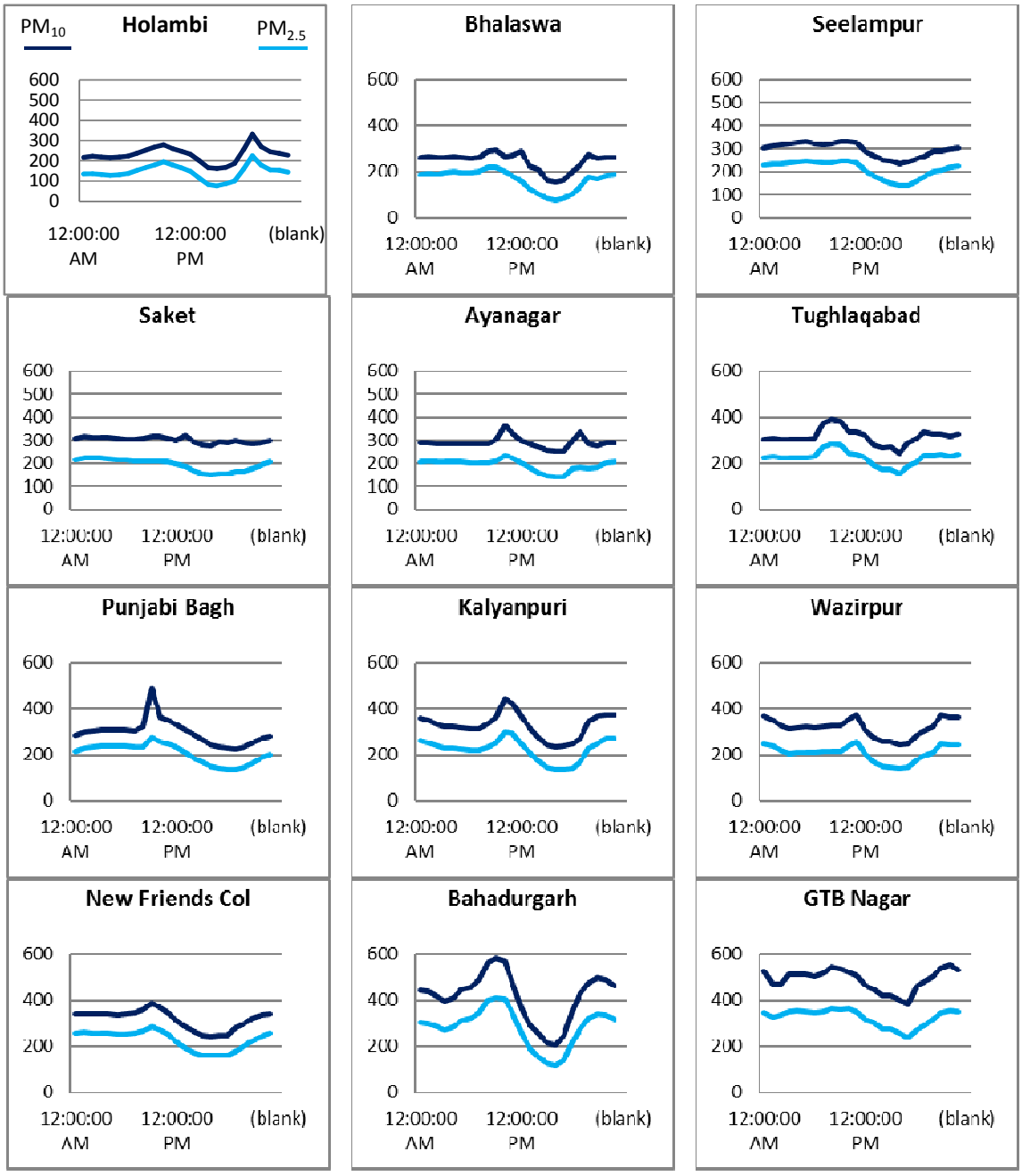


To check the validity of the data and the accuracy of the Airveda devices we have compared the $PM_{2.5}$ data with the nearest government monitor, and the results are given below.



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.

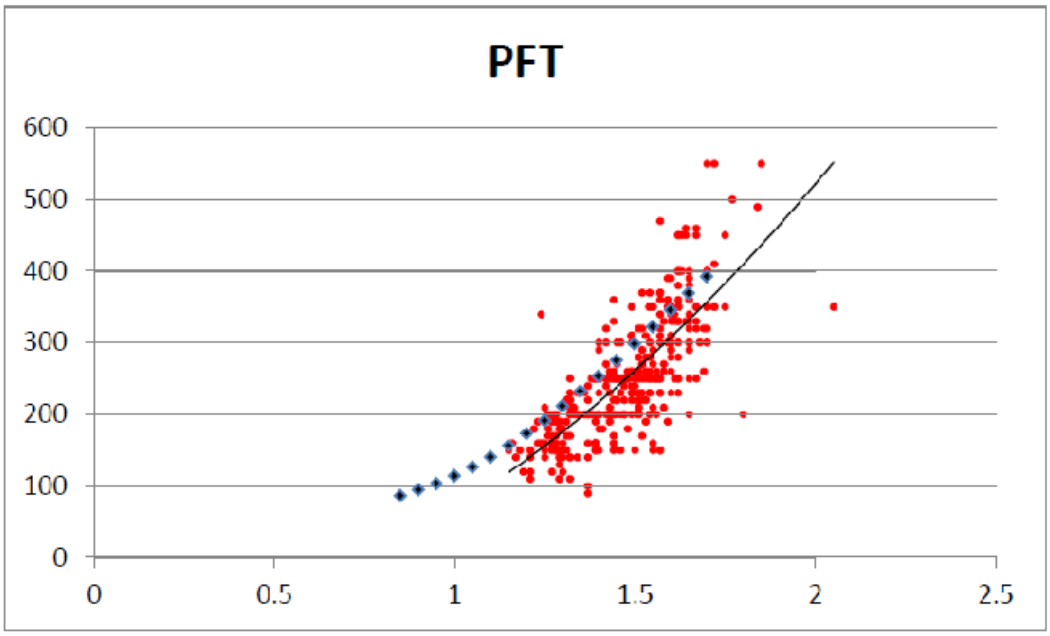


These charts reveal that across Delhi there is a spike in the morning hours between 8 to 10 a.m., a dip in the afternoons between 2 to 4 p.m., and another spike in the evening hours between 7 to 9 p.m. Thus, exposure to pollutants is the highest during the morning followed by the evening. The pollution 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.

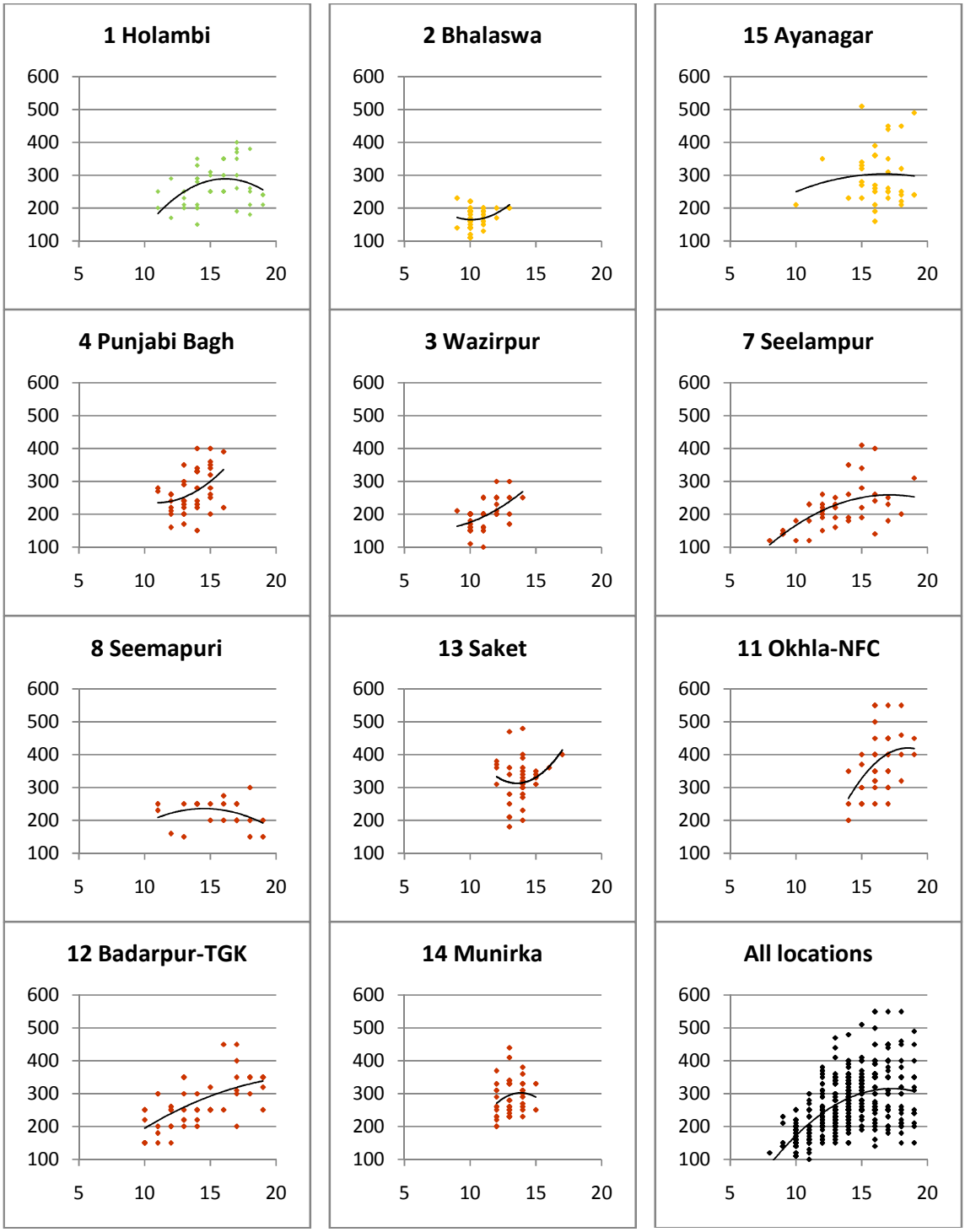
Conclusions

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 $\mu g/m^3$ for PM_{10} and 200 $\mu g/m^3$ 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 $\mu g/m^3$ for $PM_{2.5}$ on November 8, and a smaller spike up to 500 $\mu g/m^3$ 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 $\mu g/m^3$, 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.

Report prepared by:
Hazards Centre, New Delhi
On behalf of:
People's Science Institute
653, Indira Nagar
Dehradun 248006
Uttarakhand, India

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.