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# **Council on Energy, Environment and Water CEEW**

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## Problem Statements

**1. You are given air quality data (PM<sub>2.5</sub>) between 2018 and 2021 for six monitoring stations of Lucknow city. Your task is to analyze and present the findings in a coherent write-up (Max word limit 1000 words). Below are some of the guiding questions that you could consider:**

- **Summary statistics from the data. Does the data meet the National Ambient Air Quality Standards (NAAQS)?**
- **Do you note any seasonality in the data? Please elaborate on other interesting observations/spike that you may observe and possible reasons for the same.**
- **If you were the Mayor of Lucknow city, how will you use this data to manage air quality in the city?**
- **Do you think six monitoring stations are sufficient to map air quality in LKO city? As a policy researcher, what are some cost effective approaches you would recommend to UP pollution control board to map out pollution sources and AQ in the city?**

As a Lucknow resident, someone who has lived in Lucknow for the past 10 years, and having visited the places where the data has been sourced from, the prima facie data seems to be in correlation with the perceived air quality at these places. Lucknow enjoys unique advantages and challenges due to its rather flat topography and central location to all the major towns and cities of Uttar Pradesh as well as to the NCR-Delhi. Because initially, the data was not collected from an Automatic data collection unit, rather a manual operation, the data provided required cleaning before analysis and operation as for few Dates there was no recorded Data (eg. 04-04-2021). Similarly, at some stations, there is no recorded data for a period of time.

The Latest NAAQS, adopted by the CPCB in 2009, provides a clear, comprehensive, and uniform standard for 12 different Air pollutants throughout the country subject to the ecological sensitivity of the region. The NAAQS covers 12 major air pollutants Particulate matter 10 (PM<sub>10</sub>), Particulate matter 2.5 (PM<sub>2.5</sub>), Nitrogen Dioxide, Sulphur Dioxide, Carbon Monoxide, Ozone(O<sub>3</sub>), Ammonia(NH<sub>3</sub>), Lead(Pb), Benzene, Benzopyrene, Arsenic, and Nickel. The data provided has the main focus on PM<sub>2.5</sub>. *Journal of Thoracic diseases* finds out a direct correlation between the increase in the PM<sub>2.5</sub> levels with an increase in lung diseases (eg. Chronic bronchitis, Asthma) and premature mortality. These particles, because of their fine nature (less than 2.5 microns in size) penetrate deeper into the lungs and corrode the alveolar

| Pollutant  | Time Weighted Average | Concentration in Ambient Air                    |  |
|--|-----------------------|---|--|
|  |                       | Industrial, Residential, Rural, and Other Areas | Ecologically Sensitive Area (notified by Central Government) |
| Sulphur dioxide (SO <sub>2</sub> ), µg/m <sup>3</sup>                  | Annual 24 hours       | 50  | 20   |
|  |                       | 80  | 80   |
| Nitrogen dioxide (NO <sub>2</sub> ), µg/m <sup>3</sup>                 | Annual 24 hours       | 40  | 30   |
|  |                       | 80  | 80   |
| Particulate matter (< 10 µm) or PM <sub>10</sub> , µg/m <sup>3</sup>   | Annual 24 hours       | 60  | 60   |
|  |                       | 100   | 100  |
| Particulate matter (< 2.5 µm) or PM <sub>2.5</sub> , µg/m <sup>3</sup> | Annual 24 hours       | 40  | 40   |
|  |                       | 60  | 60   |
| Ozone (O <sub>3</sub> ), µg/m <sup>3</sup>                             | 8 hours 1 hour        | 100   | 100  |
|  |                       | 180   | 180  |
| Lead (Pb), µg/m <sup>3</sup>   | Annual 24 hours       | 0.50  | 0.50   |
|  |                       | 1.0   | 1.0  |
| Carbon monoxide (CO), mg/m <sup>3</sup>                                | 8 hours 1 hour        | 02  | 02   |
|  |                       | 04  | 04   |
| Ammonia (NH <sub>3</sub> ), µg/m <sup>3</sup>                          | Annual 24 hours       | 100   | 100  |
|  |                       | 400   | 400  |
| Benzene (C <sub>6</sub> H <sub>6</sub> ), µg/m <sup>3</sup>            | Annual                | 05  | 05   |
| Benzo(a)Pyrene (BaP) – particulate phase only, ng/m <sup>3</sup>       | Annual                | 01  | 01   |
| Arsenic (As), ng/m <sup>3</sup>  | Annual                | 06  | 06   |
| Nickel (Ni), ng/m <sup>3</sup>   | Annual                | 20  | 20   |

Table: Air Pollutants included in NAAQS, (Ref. <http://www.cpcbenvvis.nic.in/>)

wall, thus causing major lung impairments. Thus, PM<sub>2.5</sub> justifies being a better representative for the determination of air quality in simple analysis studies. A cursory glance at the data suggests a frequent breach of 60 microgram/cubic meter, a limit set forth in the NAAQS for the PM<sub>2.5</sub>. The dataset provided shows a regular monitoring of the data at Talkatora Station from the start of observed schedule to end of the observed data cycle, while few sporadic but major gaps have been observed at Central School and Lalbagh station datalog. While Gomti Nagar, Kukrail and BR Ambedkar University Stations have started logging the Data at later dates, Nishant Ganj station is found to have stopped logging the data after 21-08-2019.

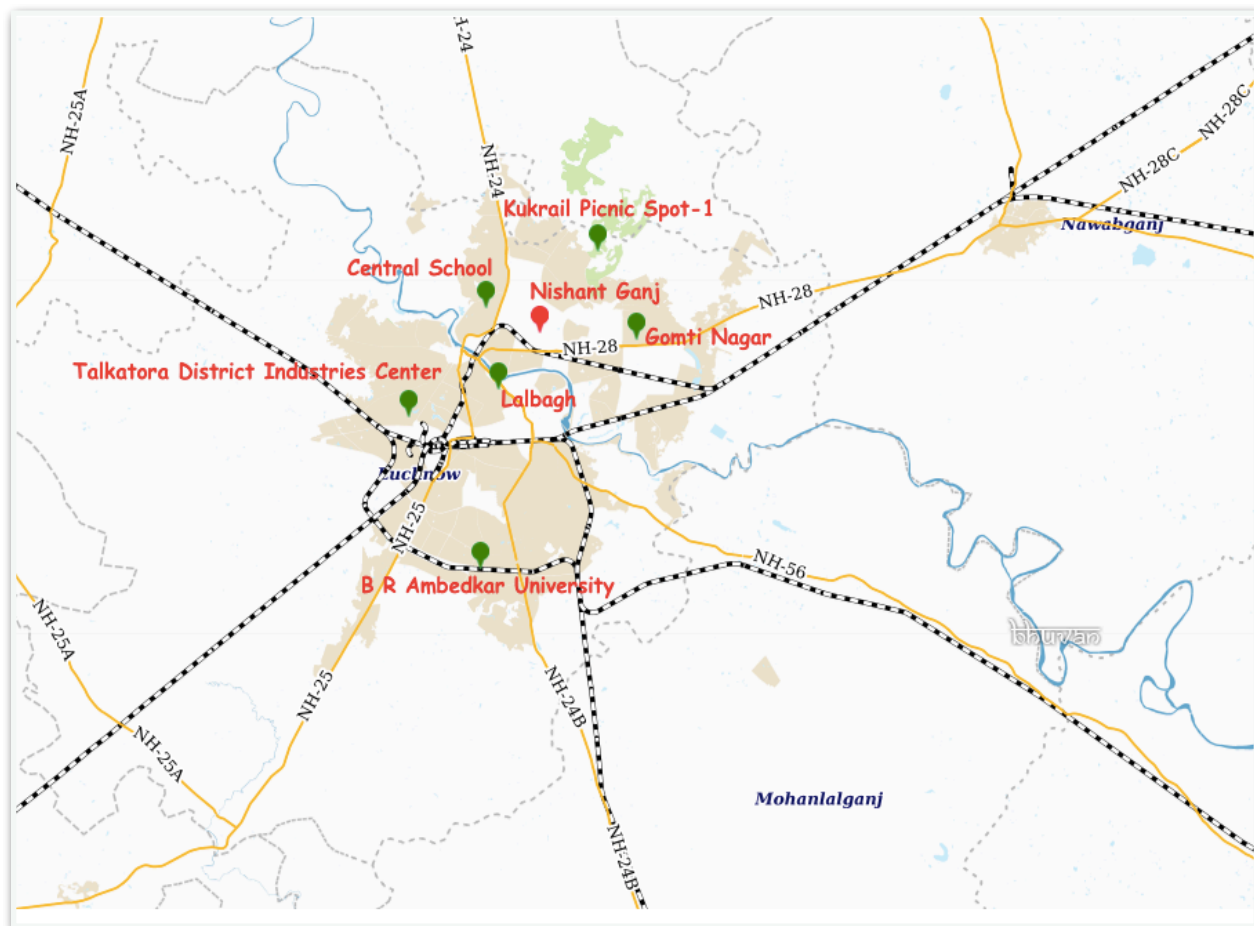
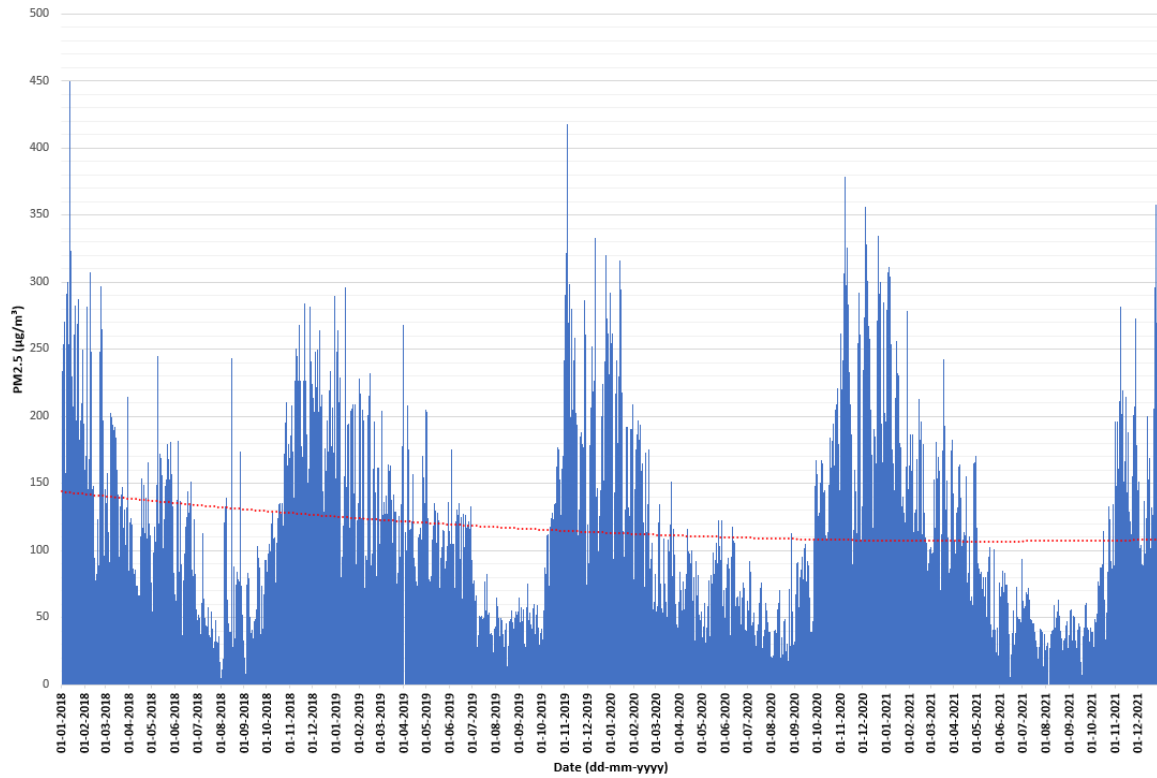


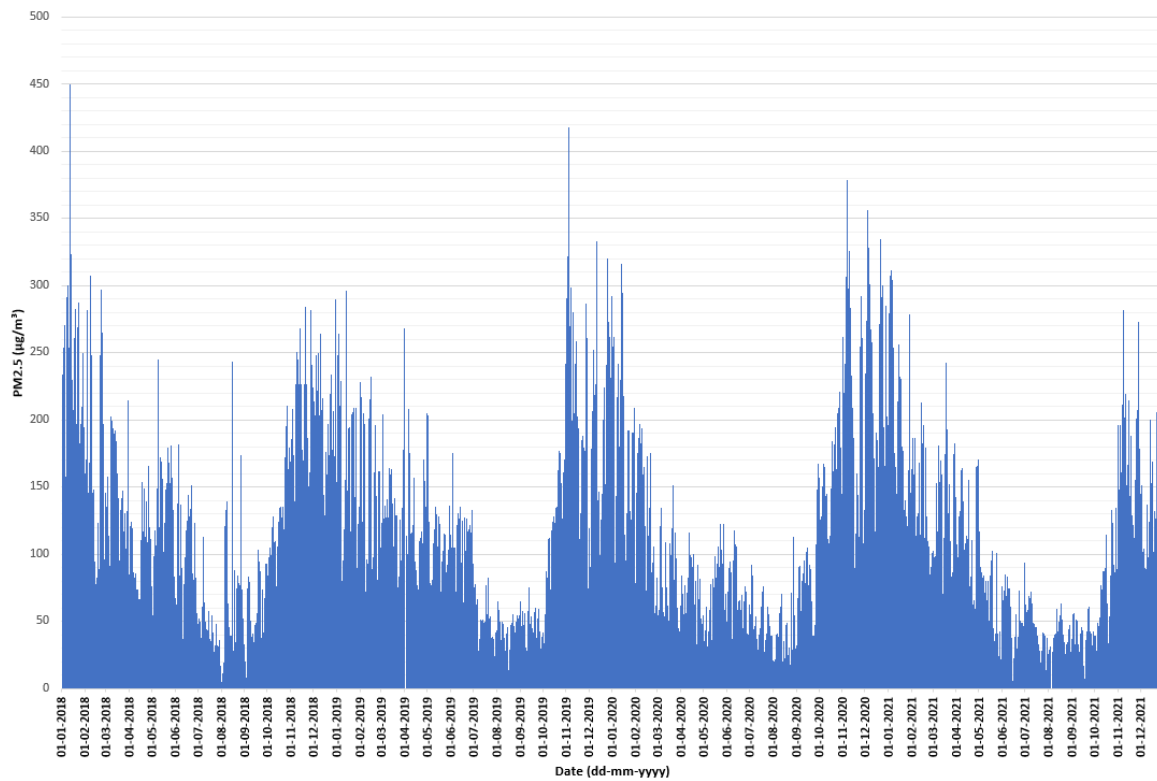
Fig: Location of the Air Quality monitoring Stations(CAAQM) located in the City (Ref. CPCB)

There is a definite seasonality observed in the PM<sub>2.5</sub> readings. The peak is observed during the months of October-November. This is mostly observed because of cumulative effects of firecracker bursting during the festival of Diwali and ***Paddy crop residue burning*** by the farmers before of next crop sowing season. In the summer season from April to June, the PM<sub>2.5</sub> Values are generally found to be on the declining path due to increase in temperatures and a peculiar feature of the North India called '***Loo***' winds, and the increase in diurnal temperature cause less of smoke stagnation (smog), mostly observed in metropolitans due to cumulative effects of multiple factor in cities like vehicular emissions, industry emissions and continued paddy burning in the adjacent areas of the region. resulting in the the while a low is observed during the months of July-August (Monsoon). As a representative data set the Data gathered at the Talkatora District Industries Center, There is a declining trend line observed in the PM<sub>2.5</sub> reading across the years, Though this could be a temporary observation of the stronger monsoon years with plenty of rainfall, but additionally this could also be an impact of awareness among the common masses and persistent efforts of the governments and administration over the years.

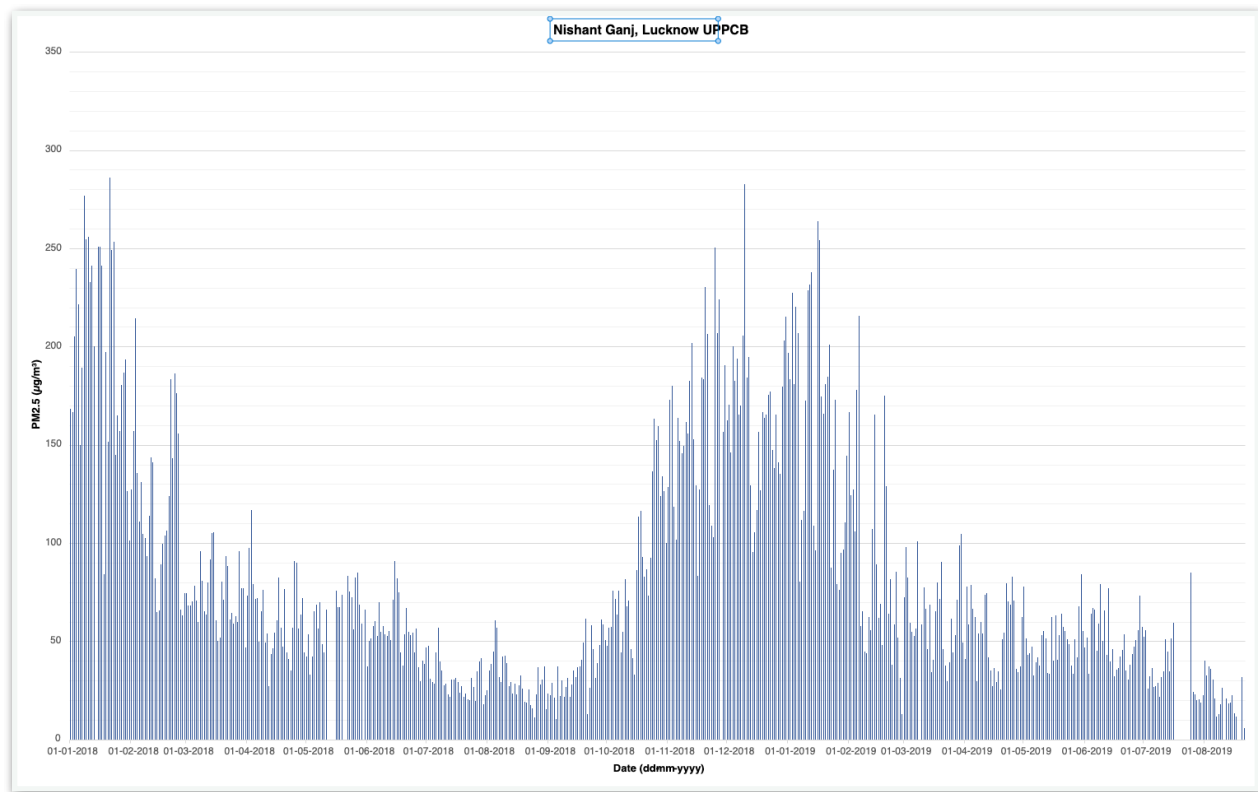
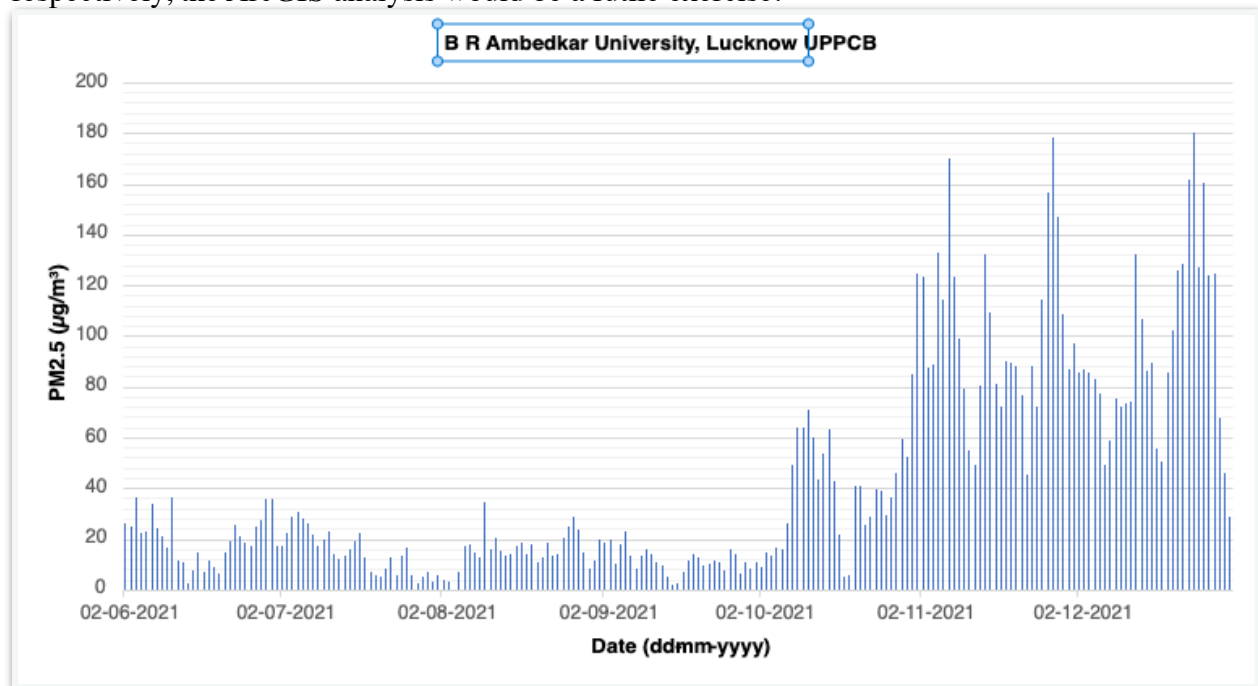
Talkatora District Industries Center, Lucknow - CPCB

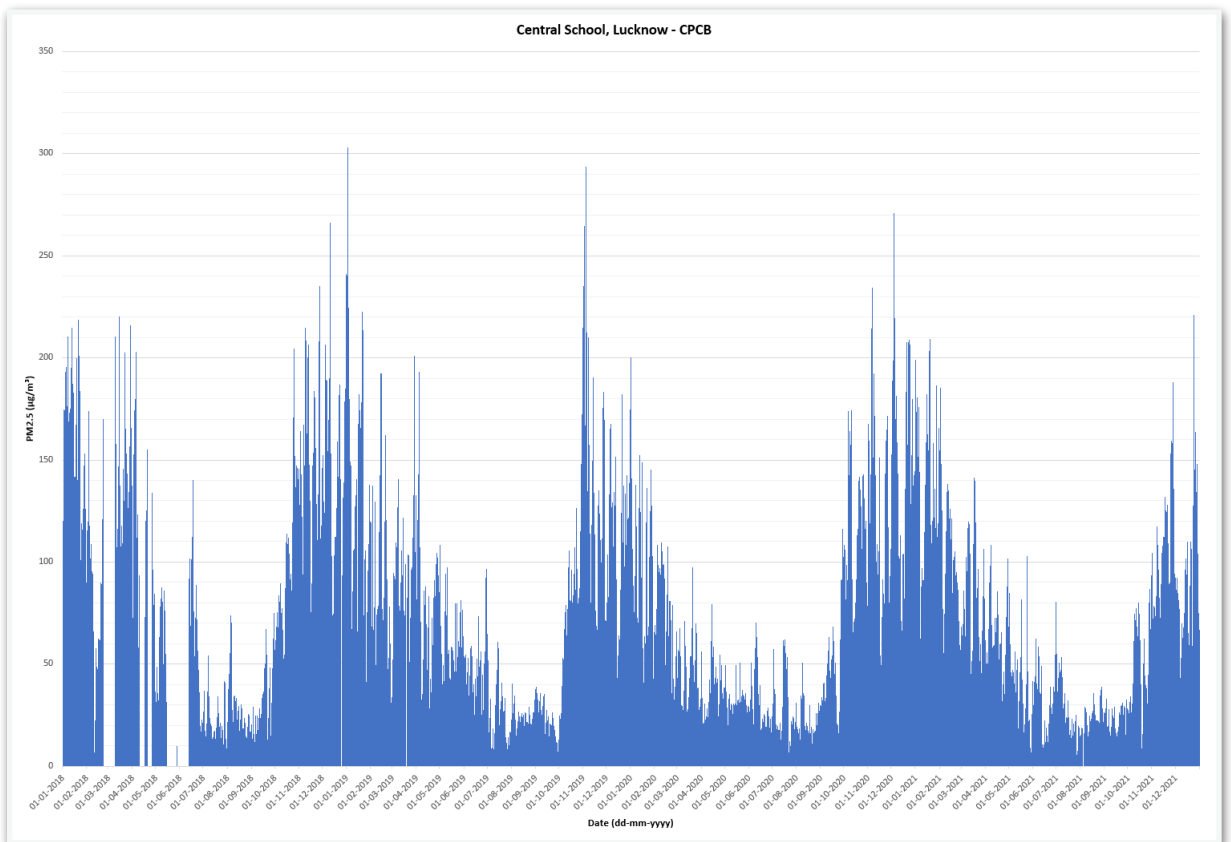
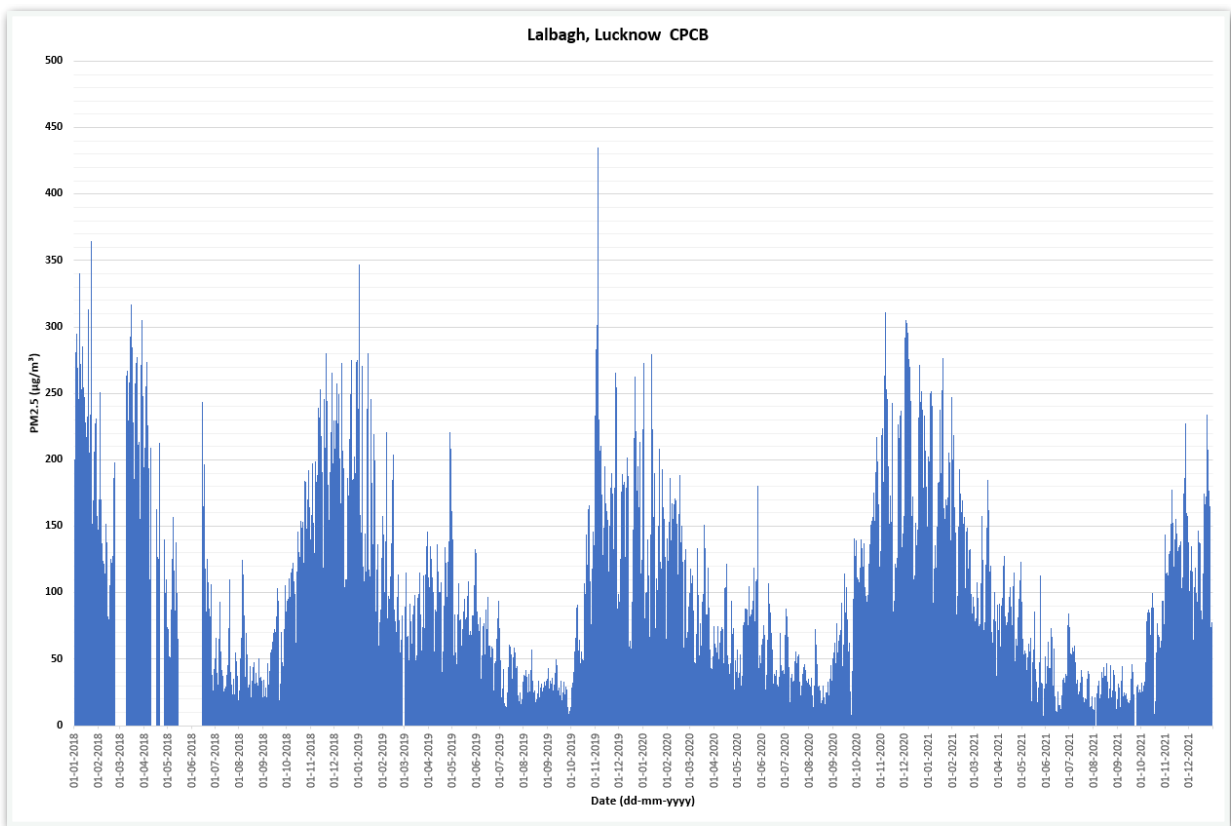


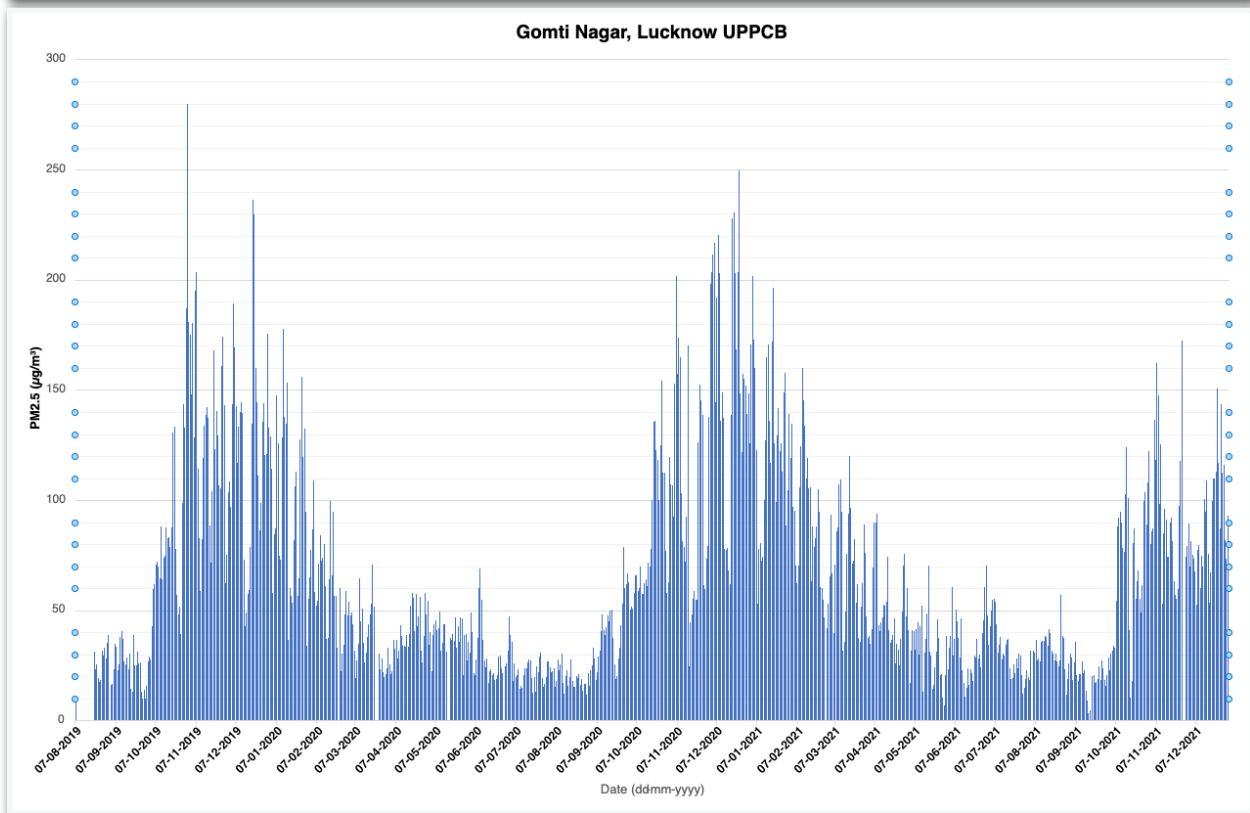
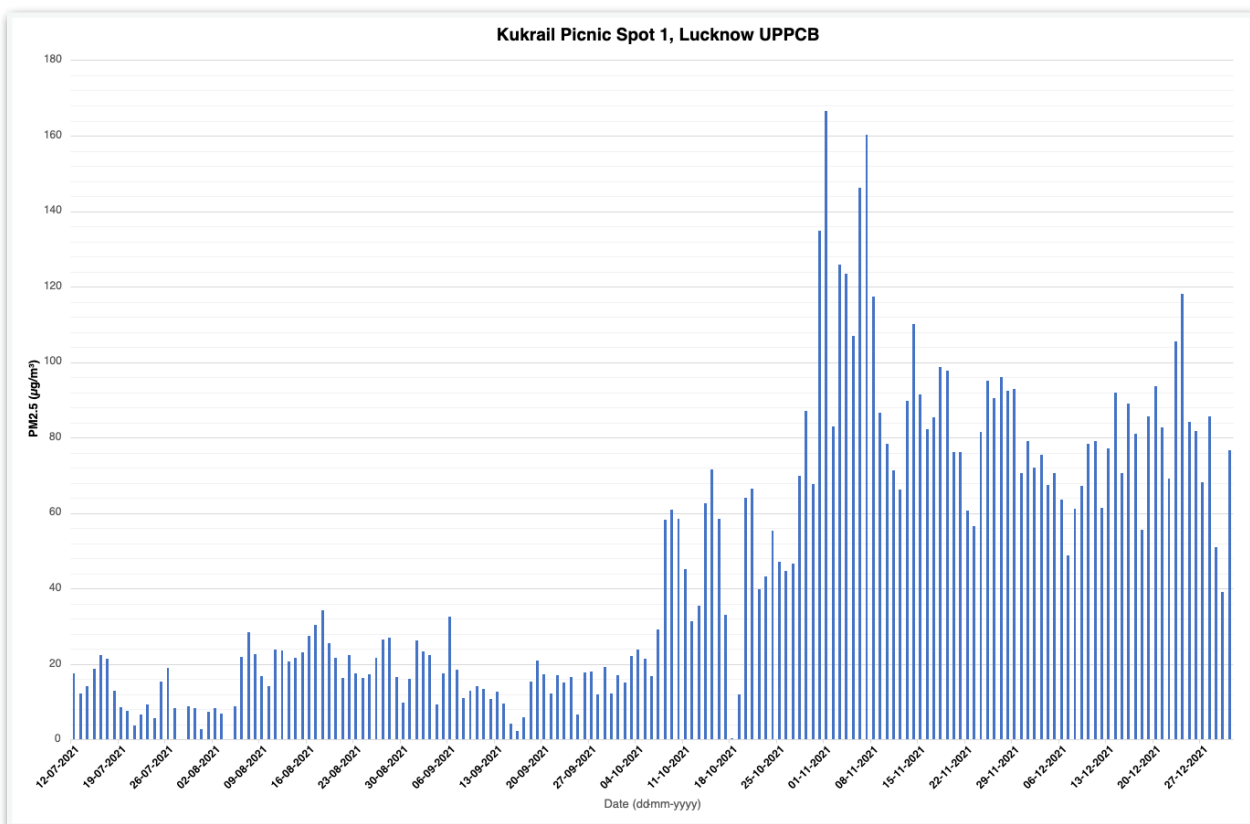
Talkatora District Industries Center, Lucknow - CPCB



The graphs were plotted for various CAAQS and a similar pattern was observed in each one of them. The location data could also be used to do an Analysis on ArcGIS or using python, but as the data was collected as more or less similar Location coordinates for each NAAQS respectively, the ArcGIS analysis would be a futile exercise.

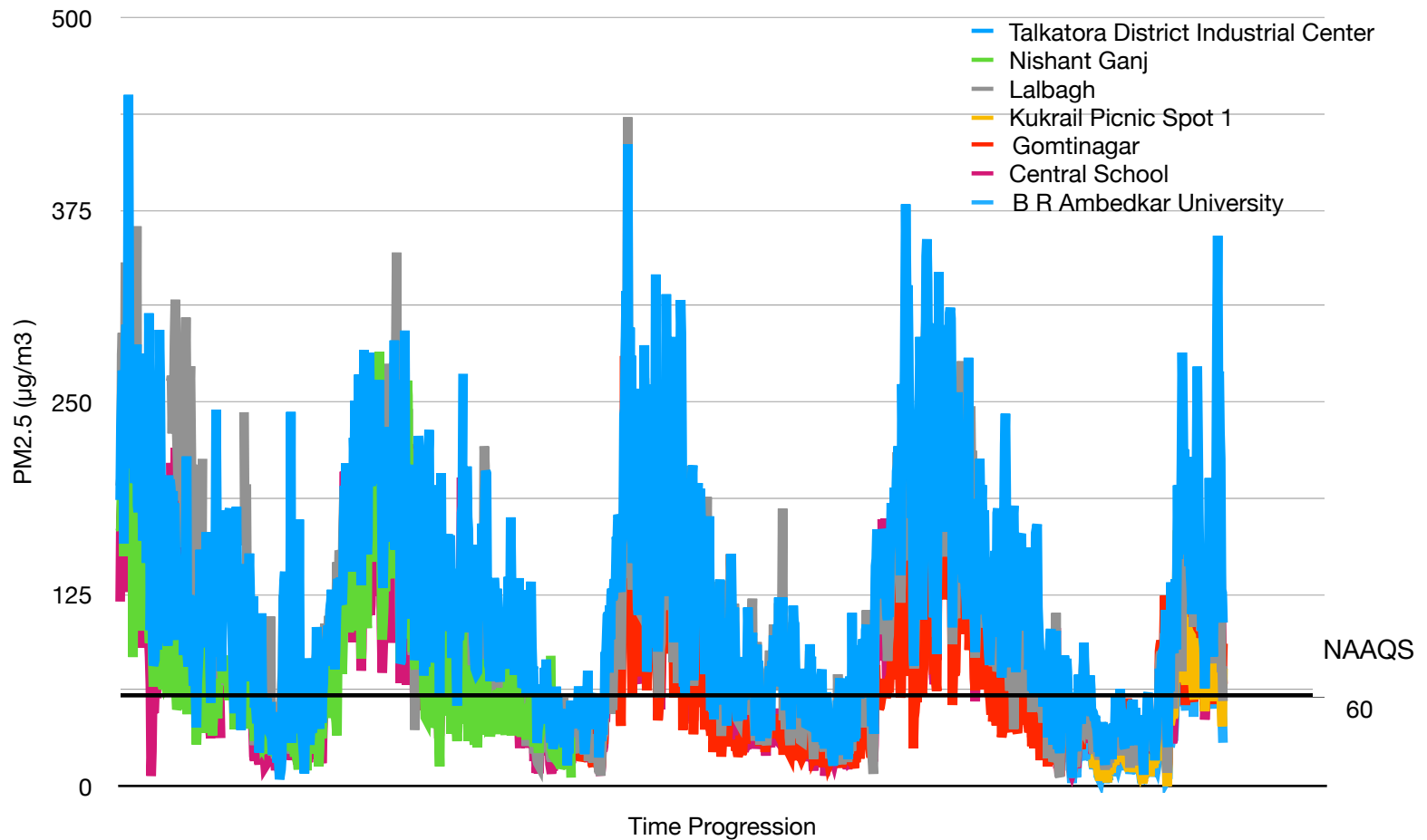








### Comparative study of PM2.5 readings



A comparative analysis of the data for various NAAQS when plotted gives a unique perspective of the regions of the city which are polluted differently at different times. Lalbagh seems to have been becoming less polluted over the years, this could be mainly because the metro service operations which have started near the region as well as the completion of metro construction work in the region which began few years ago. Apart from that it is very evidently seen that the region PM2.5 levels have repeatedly crossed the maximum threshold allowed by the NAAQS. Thus, There needs to be a comprehensive steps to controlling air pollution.

A mayor being an indirect elected representative of the municipal corporation has to work for the development of the municipality in close coordination with the municipal commissioner who is appointed by the state government. As the health and welfare of the citizens is at stake here, I as a mayor would use the above analysis and study to reduce the PM2.5 Levels by taking various measures which aggregate the issue. One of the primary concerns for the municipalities is the availability of funds, So, I would categorize the measures into 4 major categories

1. Low Cost High Efficacy
2. Low Cost Low Efficacy

### 3. High Cost High Efficacy

### 4. High Cost Low Efficacy

Although the work jurisdiction for the mayor is widespread, yet he is limited by the amount of funds and personnel which are at his disposal and often has to deal with the coordination between various departments in the state government. Some of the easiest steps can be after analyzing the data would be reduce the incoming traffic from outside routes by diverting the traffic outside of the city during winter seasons. And only allowing limited vehicle entry into the city limits at odd hours.

Similarly, Adopting a Graded Response Action Plan (GRAP) in case of continuing rising levels of PM<sub>2.5</sub> level. During the Paddy burning season, I would run awareness campaigns about the cracker free Diwali and only permitting green crackers (Heavy Metal (Beryllium, Cadmium, etc free). Promoting bicycle ride for short distances also reduces significant amount of vehicular pollution from two wheelers, which are a major source in the city limits.

The side walks and side roads must be planted with pollution resistant PM<sub>2.5</sub> Adsorbing plants and frequent showering to be done alongside the roads on them from the months of November to January

Lalbagh area has consistently shown to be a major pollution hotspot in the region, Since, Lalbagh is a wholesale market for the industry repair parts, adjacent to a famous cosmopolitan markets Hazrat Ganj and Aminabad. This aggravates the Issue at Hand, Installing fountains at regular intervals accompanied by a robust traffic management system would be of great significance in the process.

The high Cost High Efficacy steps could be maintenance of roads, regulation of construction activities during peak seasons and phasing out diesel vehicles especially BS-IV version engines and transforming the whole public transport systems into electric vehicle fleets, and increasing their frequency during peak seasons . Installation of more CAAQMS is a costly purchase and mostly works for the information seekers, although a less efficient method in the short term, Awareness about the surrounding air quality, does seem to suggest a boost in the morale of the worker staff and spirit of competitiveness, and well being among the citizens as a whole.

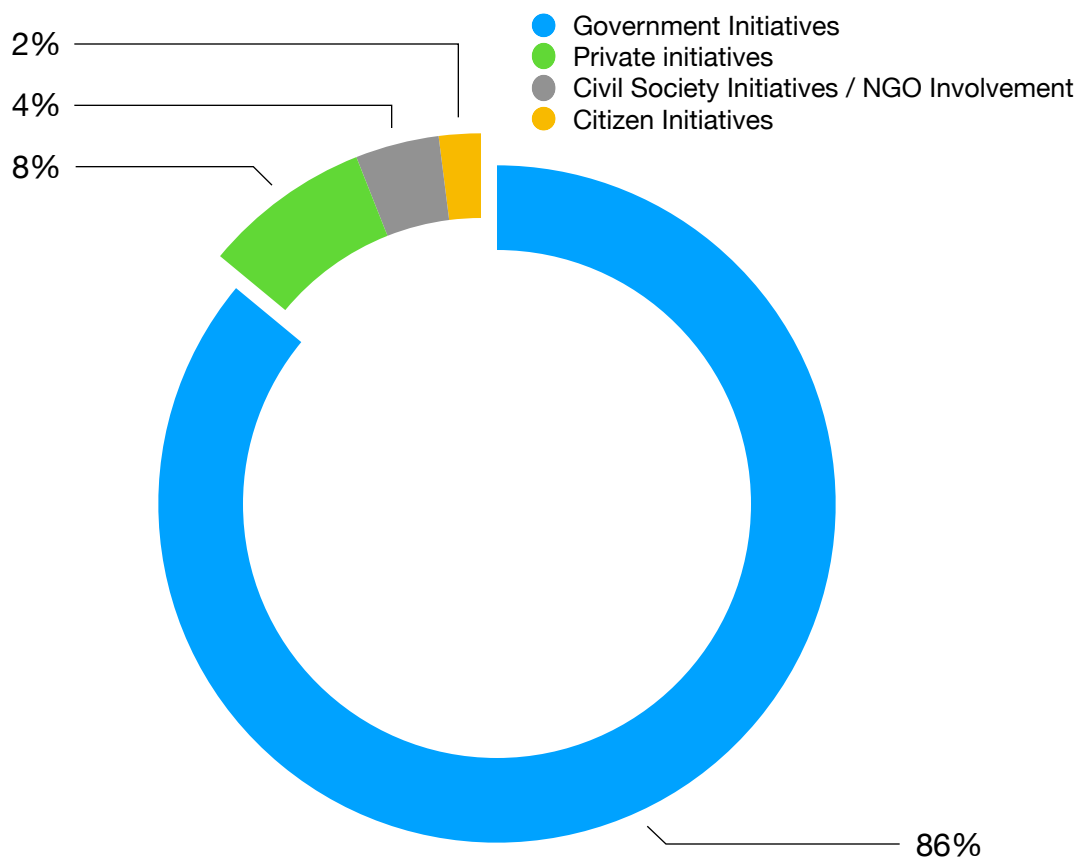
Lucknow has 6 active CAAQMS currently, which although serves the purpose of monitoring the air quality but as the city is expanding, more stations need to be setup at different places to avoid the loss of representative data and to get a more accurate picture of the region, the CAAQMS density needs to increase in regions of concern.

## Problem Statement

**2. Critically review [Lucknow's air quality plan](#). What are some of the challenges you note in the current plan? How do you think the current plan can be strengthened?**

Lucknow sits on flat topography with a perennial river crossing around its north eastern half. In the context of the Lucknow's air quality plan. There are few important remarks to be made regarding the extent, feasibility and efficacy of the plan.

1. As there are multiple agencies which are involved in the proper operation of the plan, the coordination between the agencies and the flow of data and authority between them becomes a tough challenge which has to be carried out by the collective will of the people and agencies involved.
2. Though Lucknow has no issue with the workforce availability, but a paucity of the funds from the governments and limited availability of the sector skilled workforce is a problem which could be solved by mobilization of the funds from the people who are directly impacted and following the 'Polluter pays' principle to better pay the wages both for the skilled and semi skilled workforce.



3. An over emphasis has been done on the work allocation part for the government, this leads to overburden on the state's limited resources. Equal involvement both from the civil society and private business has to be the way forward for achieving such ambitious targets.
4. There is an over reliance on the monitoring agencies for achieving NAAQS, this principle wrongly affects the enthusiasm of the booming entrepreneurship sector in the sector , getting certifications for almost everything makes the Ease of Doing Business a considerable hurdle to overcome. A Simpler approach could have been self regulation and positive feedback approach through incentives and subsidies for the business.
5. It is appreciable the effort has been made to look for simpler approaches like pothole covering , plantation along roadside and municipal solid waste management. These approaches not only reap the benefits accrued from the cost effectiveness approach but also, lead to an overall positive feedback from the people in the community. This gives the administration more political room to employ the difficult steps, like Fines on residue burning and increased taxes for the Fund generation.
6. The Plan is limited in its approach on encouraging and employing Innovative methods and funding for research on new Innovations for solving the issues.
7. It is commendable that special interest has been done on the collection and continuous monitoring of the data through CAAQMS.
8. Employment of new technologies like webcams, OCEMS, and automatic traffic management systems have been done in the entire process.

Thus, the Lucknow Action Plan has been prepared with considerable thought in mind and deserves a stronger implementation.