"STATE OF AMBIENT AIR QUALITY OF UTTAR PRADESH CITIES"

OCTOBER 2016
CENTR FOR ENVIRONMENT AND ENERGY DEVELOPMENT (CEED)

AUTHOR: MS.ANKITA JYOTI

Copyright to CEED
INTRODUCTION

Being the most populous state in India, Uttar Pradesh has been facing air pollution challenges for several decades. The state has witnessed a progressive degradation in air quality over the last three decades due to fast-paced development, majorly in terms of the growing vehicular population, congestion, refuse burning and inefficient energy usage.

To improve the state of air quality, it is imperative to monitor, communicate and expand the access to air-quality data. This report aims to assess and communicate the status and recent trend of air quality of Uttar Pradesh. It provides an updated monsoon (1st August – 30th September, 2016) report on air quality (PM$_{2.5}$ and PM$_{10}$) based on the data acquired from its installed monitoring stations.

MONTHLY MEAN CONCENTRATION OF PM ACROSS FIVE CITIES OF UP

The observations taken in Agra, Allahabad, Kanpur, Lucknow and Varanasi displayed that the average 24 hour concentration of PM$_{2.5}$ and PM$_{10}$ have been above the prescribed WHO standard. During the month of August, Agra was monitored as the most polluted city followed by Allahabad, Lucknow, Varanasi and Kanpur across five major metropolitan cities of Uttar Pradesh.

![Figure 1. Pollution Ranking of Cities](image)

Among the five cities, the monthly mean concentrations of PM$_{10}$ was observed to be highest in Agra, with an average concentration of 155.4 µg/m$^3$ followed by Allahabad (93.5µg/m$^3$), Lucknow (85.6 µg/m$^3$) and Varanasi (57.4 µg/m$^3$). Kanpur was positioned as the least polluted across the five cities of UP with an average monthly concentration of 32.7 µg/m$^3$.

24-HOUR MEAN CONCENTRATION OF PARTICULATE MATTER

The 24-hour mean concentration of particulate matter is presented below:

---

$^1$The ranking is based on August month data
AGRA

INTRODUCTION

The study of Agra’s Ambient Air Quality illustrates the Air Quality Index, temporal variation and real time concentration of particulate matter of the city with the help of installed air quality monitoring devices at Shahganj, Taj ganj, Near delhi Gate Marg, Badla Marg and Radhika Bihar Marg. The study also compares the change in concentration of particulate matter in summer and monsoon months.

PARTICULATE MATTER COUNT DURING MONSOON SEASON

The mass concentration of PM$_{2.5}$ and PM$_{10}$ monitored during the monsoon months were evaluated and analyzed to present a picture of air pollution in Agra. *The mean concentration for PM$_{2.5}$ and PM$_{10}$ during the late monsoon months across Agra was 70.47 µg/m$^3$ and 124.5 µg/m$^3$ respectively.* The 24 hour concentrations of PM$_{10}$ was observed to be the highest on 18th August, with a maximum mass concentration of 370 µg/m$^3$ and likewise, the 24-hour concentration of PM$_{2.5}$ was observed to be highest on 1st September with a maximum mass concentration of 232 µg/m$^3$.

---

*Number of days PM$_{2.5}$ concentration above WHO standard* 59 Days

*Number of days PM$_{10}$ concentration above WHO standard* 53 Days

*Number of times PM concentration above WHO standard* 2-3 times

---
II. AIR QUALITY INDEX OF AGRA

The number of days with varied AQI values vis a vis their date is elaborated in the chart. The colour coding of bar graph is in accordance with CPCB’s AQI category. *It was observed that 34% of total evaluated days fall under the categories, which doesn’t advocate healthy air. With 61% of the days are within the threshold range, we can assume that the quality shall only deteriorate further post the monsoon season and with the arrival of winter months.*

![Figure II. Number of Days Falling Under Varied AQI](image)

III. TEMPORAL VARIATION OF PARTICULATE MATTER COUNT

The temporal distribution of particulate matter (PM$_{10}$ and PM$_{2.5}$) in four different time zones (00:00- 5:00, 5:01-1200, 12:01-17:00, 17:01-00:00) for Agra are plotted in the graph below. *It was observed that late morning hours were recorded to have the maximum values for particulate matter which eventually descends during the noon period. Comparatively, Midnight and Noon was found in a safer level.*
IV. PERCENTAGE CHANGE IN PARTICULATE MATTER DURING SUMMER, EARLY MONSOON AND LATE MONSOON MONTHS

Late monsoon months witnessed abundant rainfall and therefore maintained a better air quality than the air quality monitored during summer and early monsoon. The count of PM$_{10}$ from summer to early monsoon months registered a change of 44% while a change of 23% was noted between early and late monsoon months$^2$. The monsoon months are documented as the comparatively less polluted of all the months due to the wash out effect of precipitation in congruence with or without the low ambient temperature during this season that significantly affects the concentrations of particulate matter.

$^2$ The source of the graph is from data collected from Uttar Pradesh State Pollution Control Board
INTRODUCTION

The study illustrates the Air Quality Index, temporal variation and real time concentration of particulate matter of Allahabad city with the help of installed air quality monitoring devices at Civil lines, Pragh station, Chakiya, Korela bagh and Alopibagh. The study also compares the change in concentration of particulate matter during summer and monsoon months.

PARTICULATE MATTER COUNT DURING MONSOON SEASON

The mass concentration of PM$_{2.5}$ and PM$_{10}$ monitored during the monsoon months were evaluated and analyzed to present a picture of air pollution in Allahabad. The mean concentration for PM$_{2.5}$ and PM$_{10}$ during the late monsoon months across Allahabad was 61.2 µg/m$^3$ and 111.9 µg/m$^3$ respectively. The 24 hour concentrations of PM$_{10}$ was observed to be the highest on 29th August, with a maximum mass concentration of 264 µg/m$^3$ and likewise, the 24-hour concentration of PM$_{2.5}$ was observed to be the highest on 13th August with a maximum mass concentration of 241 µg/m$^3$.

---

3 The study is based on data of only three monitoring stations
4 August month mean concentration is an average of three monitoring stations while September is from single monitoring station data
II. AIR QUALITY INDEX OF ALLAHABAD

The number of days with varied AQI values vis a vis their date is elaborated in the chart. The colour coding of bar graph is in accordance with CPCB’s AQI category. It was observed that 58% of total evaluated days fall under the categories, which doesn’t advocate healthy air; 7 days were in category, which cause respiratory problems in healthy people and impacts severely to those with existing diseases. The maximum-recorded AQI for mid/late monsoon season falls under the moderate category. Such a situation is hazardous for people suffering from various respiratory ailments.

![Figure II: Number of Days Falling in Varied AQI]

III. TEMPORAL VARIATION OF PARTICULATE MATTER COUNT

The temporal distribution of particulate matter (PM$_{10}$ and PM$_{2.5}$) in four different time zones (00:00-5:00, 5:01-1200, 12:01-17:00, 17:01-00:00) for Allahabad are plotted in the graph below. It was observed that post the midnight peak, the PM mass concentration rapidly increased to the highest of values and descends again during the noon period.

Night was the worst recorded period for PM$_{10}$ concentration while the highest concentration of PM$_{2.5}$ was noted in late morning.
Late monsoon months witnessed abundant rainfall and therefore maintained a better air quality than the air quality monitored during summer and early monsoon. The count of PM$_{10}$ from summer to early monsoon months registered a change of 17%, while a change of 63% was noted between early and late monsoon months. The monsoon months are documented as the comparatively less polluted of all the months due to the wash out effect of precipitation in congruence with or without the low ambient temperature during this season that significantly affects the concentrations of particulate matter.
Kanpur

INTRODUCTION

The study illustrates the Air Quality Index, temporal variation and real time concentration of particulate matter of Kanpur city with the help of installed air quality monitoring devices. The study also compares the change in concentration of particulate matter in summer and monsoon months.

PARTICULATE MATTER COUNT DURING MONSOON SEASON

The mass concentration of PM$_{2.5}$ and PM$_{10}$ monitored during the monsoon month were evaluated and analyzed to present a picture of air pollution in Agra. The mean concentration for PM$_{2.5}$ and PM$_{10}$ during the late monsoon months across Kanpur was 29.0 µg/m$^3$ and 32.7 µg/m$^3$ respectively. The 24 hour concentrations of PM$_{10}$ was observed to be the highest on 28$^{th}$ August, with a maximum mass concentration of 81.3 µg/m$^3$ and likewise, the 24-hour concentration of PM$_{2.5}$ was observed to be the highest on 18th August with a maximum mass concentration of 76.7 µg/m$^3$.

---

6 Kanpur city air quality is based on the ambient air quality data for the month of August.
II. AIR QUALITY INDEX OF KANPUR

The number of days with varied AQI values vis a vis their date is elaborated in the chart. The colour coding of bar graph is in accordance with CPCB’s AQI category. *It was observed that 50% of the total evaluated days fall under the ‘Good’ category.*

![Number of Days Falling Under Varied AQI](chart.png)

**GOOD AIR QUALITY**
- 15 Days
- 50% of the total days

**SATISFACTORY AIR QUALITY**
- 15 Days
- 43.3% of the total days

**UNHEALTHY AIR QUALITY**
- 2 Days
- 6.6% of the total days

III. TEMPORAL VARIATION OF PARTICULATE MATTER COUNT

The temporal distribution of particulate matter (PM$_{10}$ and PM$_{2.5}$) in four different time zones (00:00- 5:00, 5:01-1200, 12:01-17:00, 17:01-00:00) for Kanpur are plotted in the graph below.

In Kanpur, the best air quality was noted during noon, while the most polluted air was observed during midnight.
IV. PERCENTAGE CHANGE IN PARTICULATE MATTER DURING SUMMER, EARLY MONSOON AND LATE MONSOON MONTHS

Late monsoon months witnessed abundant rainfall and therefore maintained a better air quality than the air quality monitored during summer and early monsoon. *The count of PM$_{10}$ from summer to early monsoon months registered a change of 21%, while a change of 10% was noted between early and late monsoon months*. The monsoon months are documented as the comparatively less polluted of all the months due to the wash out effect of precipitation in congruence with or without the low ambient temperature during this season that significantly affects the concentrations of particulate matter.

---

7 *The data set varied in terms of location and Air Quality Monitoring Devices*
LUCKNOW

INTRODUCTION

The study illustrates the Air Quality Index, temporal variation and real time concentration of particulate matter of Lucknow city with the help of installed air quality monitoring devices at Hasan Ganj, Civil lines, Lucknow Cantonment and Faizabad. The study also compares the change in concentration of particulate matter in summer and monsoon months.

PARTICULATE MATTER COUNT DURING MONSOON SEASON

The mass concentration of PM$_{2.5}$ and PM$_{10}$ monitored during the monsoon month were evaluated and analyzed to present a picture of air pollution in Lucknow. The mean concentration for PM$_{2.5}$ and PM$_{10}$ during the late monsoon months across Lucknow was 99.34 µg/m$^3$ and 137.9 µg/m$^3$ respectively. The 24 hour concentrations of PM$_{10}$ was observed to be the highest on 2nd September, with a maximum mass concentration of 545 µg/m$^3$ and likewise, the 24-hour concentration of PM$_{2.5}$ was observed to be the highest on 3rd September with a maximum mass concentration of 508 µg/m$^3$.

\[
\text{PARTICULATE MATTER COUNT (AUGUST-SEPTEMBER)}
\]

57 Days • Number of days PM$_{2.5}$ concentration above WHO standard

41 Days • Number of days PM$_{10}$ concentration above WHO standard

2-3 times • Number of times PM concentration above WHO standard

---

8 The study is based on the three monitoring devices data installed at Hasan Ganj, Civil lines and Faizabad
II. AIR QUALITY INDEX OF LUCKNOW

The number of days with varied AQI values vis a vis their date is elaborated in the chart. The colour coding of bar graph is in accordance with CPCB’s AQI category. *It was observed that 23% of total evaluated days fall under the categories, which does not advocate healthy air. 2 days were under category of ‘Severe’ that affects healthy people and impacts severely to those with existing respiratory diseases. Surprisingly, on (31st August, 1st September, 4th September) the AQI noted in Lucknow crossed the higher limit of the National Ambient Air Quality Index.*

*Lucknow witnessed healthy air for only 8 days, while 25 days falls under the ‘Satisfactory’ category during the late monsoon months.*

![Chart showing distribution of days falling under varied AQI (August-September)](image)

**III. TEMPORAL VARIATION OF PARTICULATE MATTER COUNT**

The temporal distribution of particulate matter (PM$_{10}$ and PM$_{2.5}$) in four different time zones (00:00- 5:00, 5:01-1200, 12:01-17:00, 17:01-00:00) for Lucknow are plotted in the graph below. *It was observed that post the midnight period, the PM$_{10}$ concentration rapidly increased to the second highest of values which descends again in the noon.*
IV. PERCENTAGE CHANGE IN PARTICULATE MATTER DURING SUMMER, EARLY MONSOON AND LATE MONSOON MONTHS

Late monsoon months witnessed abundant rainfall and therefore maintained a better air quality than the air quality monitored during summer and early monsoon. The count of $PM_{10}$ from summer to early monsoon months registered a change of 53%, while a change of 17% was noted between early and late monsoon months. The monsoon months are documented as the comparatively less polluted of all the months due to the wash out effect of precipitation in congruence with or without the low ambient temperature during this season that significantly affects the concentrations of particulate matter.

---

9 The data set varied in terms of location and Air Quality Monitoring Devices
VARANASI

INTRODUCTION

The study illustrates the Air Quality Index, temporal variation and real time concentration of particulate matter with the help of installed air quality monitoring devices at Sindhaura Road, Meerapur, NH31 and Sunderbagiya colony in Varanasi. The study also compares the change in concentration of particulate matter in summer and monsoon months.

PARTICULATE MATTER COUNT DURING MONSOON SEASON

The mass concentration of PM$_{2.5}$ and PM$_{10}$ monitored during the monsoon month were evaluated and analyzed to present a picture of air pollution in Varanasi. The mean concentration for PM$_{2.5}$ and PM$_{10}$ during the late monsoon months across Varanasi was 56.2 µg/m$^3$ and 66.34 µg/m$^3$ respectively. The 24 hour concentrations of PM$_{10}$ was observed to be the highest on 19$^{th}$ September, with a maximum mass concentration of 172.2 µg/m$^3$ and likewise, the 24-hour concentration of PM$_{2.5}$ was observed to be the highest on 19$^{th}$ September with a maximum mass concentration of 145 µg/m$^3$.

![Figure 1: Particulate Matter Count (August-September)]

- 59 Days
  - Number of days PM$_{2.5}$ concentration above WHO standard

- 41 Days
  - Number of days PM10 concentration above WHO standard

- 2-3 times
  - Number of times PM concentration above WHO standard
II. AIR QUALITY INDEX OF VARANASI

The number of days with varied AQI values vis a vis their date is elaborated in the chart. The colour coding of bar graph is in accordance with CPCB’s AQI category. The city witnessed the maximum number of days under the ‘Moderately polluted’ to ‘Severe’ category. *It was observed that 43% of the total evaluated days fall under the categories, which doesn’t advocate healthy air.*

As the maximum-recorded AQI for mid/late monsoon season falls under satisfactory category, there are higher chances for the AQI to worsen post this season because the monsoon months are comparatively less polluted.

![Figure showing air quality index](image)

III. TEMPORAL VARIATION OF PARTICULATE MATTER COUNT

The temporal distribution of particulate matter (PM$_{10}$ and PM$_{2.5}$) in four different time zones (00:00-5:00, 5:01-1200, 12:01-17:00, 17:01-00:00) for Varanasi are plotted in the graph below. It was observed that generally post the night peak, the PM mass concentration rapidly decreased to the lowest of values and ascends again during the morning period. The highest concentrations coincide with the busy traffic hours, generally during late morning, afternoon and evening. The lowest concentrations are observed during the midnight hours, which are attributed to dilution caused by higher boundary layer and reduced traffic.
IV. PERCENTAGE CHANGE IN PARTICULATE MATTER DURING SUMMER, EARLY MONSOON AND LATE MONSOON MONTHS

Late monsoon months witnessed abundant rainfall and therefore maintained a better air quality than the air quality monitored during summer and early monsoon. The count of PM$_{10}$ from summer to early monsoon months registered a change of 14% while late monsoon registered an increment of 15% in compared to early monsoon PM count.
CONCLUSIONS AND WAY FORWARD

In order to control the air pollution in Uttar Pradesh, the state government needs to develop an efficient clean air action plan for the state. The urban centers of UP must be classified in various clusters like polluted and severely polluted. An action plan for each urban center must be developed to provide healthy breathable air to its citizens. Some of the measures suggested are following;

• Sharing the air pollution data is critical. The government must have air quality monitoring devices that display the information on a regular basis in all urban centers with a population of more than 2 lakhs.

• The first defense to protect people from air pollution is to have emergency warning systems in place. Governments must take emergency measures based on the quality of air and issue health advisories on a daily basis, depending on the level of air pollution. These health advisories should especially reach out to the most vulnerable, such as those who are suffering from respiratory and cardiovascular ailments.

• An alarm system must be developed for each city so that the citizens can be accordingly informed when the pollution levels are soaring high.

• The government must focus on developing an efficient public transportation system and simultaneously encourage the citizens to use the same. Public transport fuelled with clean fuel such as CNG or metro rail should be promoted in major urban centers.

• Strict emission standards must be formulated and maintained across all vehicles, factories and industries.

• E-rickshaw must be allowed to develop as mainstream transport sector and a proper policy and infrastructure needs to be developed accordingly. Electronic charging stations must be developed in clusters to push for more efficient transport system. A phase-wise conversion drive to convert the existing auto rickshaws into CNG rickshaws must also be implemented.

• Brick-kiln is the third largest consumer of coal after power and steel sector and a sizeable share of air pollution is also attributed to dirty brick manufacturing process along the river basin. A proper policy and programme must be developed to encourage the brick manufacturer to adopt clean technology.

• All commercial building must phase out diesel for electricity generation and be replaced with solar roof top programme.

• Dust is one of the major sources of pollution in developing cities. Usually, cities encounter a large number of incessant construction activities and vehicular commute on dusty roads that contribute majorly to air pollution in terms of dust particulate. There needs to be a well-framed strategy that deals properly with the waste disposal. The developers/builders should mandatorily be made to provide the evidence of disposal of building debris, on a polluter pay principle.

• Vegetative barriers on the roads must be encouraged wherever possible.
• Cycle tracks and footpaths must be paved with proper signs and guidelines and should be encouraged to use more often.

• Clean building materials that can be recycled must be used for construction. A green building code must be developed to encourage developer to construct energy efficient building to reduce the burden on environment resources.
About CEED

Centre for Environment and Energy development (CEED) is a solution driven non-profit organization that works towards creating inspiring solutions to maintain a healthy, rich and diverse environment. CEED is dedicated to finding solutions for Climate and Energy, hazardous free future and for Clean and safe water.

The idea of CEED was conceived by a group of young professionals with vast amount of experience in the field of environment. CEED was registered in November 2012 as non profit organization under section 25, Companies Act, 1956.

Contact:
A1-248,Second floor Safdurjung Enclave, New-Delhi - 110029, India
B/194,Second floor Shri Krishna Puri, Patna - 800001. India

Visit:
www.ceedindia.org
www.facebook.com/ceedindia.org
www.twitter.com/ceed_india.org

Write to us at
info@ceedindia.org