



# Ambient Air Quality During Pre-Diwali, Diwali and Post-Diwali Festival

November 2023



सीएसआईआर- भारतीय विषविज्ञान अनुसंधान संस्थान  
**CSIR-INDIAN INSTITUTE OF TOXICOLOGY RESEARCH**

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VISHVIGYAN BHAWAN, 31, MAHATMA GANDHI MARG, LUCKNOW, 226001 U.P., INDIA





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## 1. Introduction

One of the most important Hindu festivals is Diwali, where the celebration is marked not only by the illumination of homes with lamps and the exchange of sweets but also by firecracker combustion. Diwali festival symbolizes the triumph of light over darkness and good over evil. The celebration of Diwali held for five days long begins from Dhanteras and ends on Bhaidooj with the reasons of traditional and mythological grounds. The festivities mainly involve the widespread use of firecrackers and increased trade activities like crowded markets and public movement releasing various pollutants into the air. Therefore, exposure to the air emissions of Diwali crackers and other sources together is detrimental to public health and affects various bodily systems, primarily respiratory and cardiovascular ailments.

Combustion of firecrackers produces air pollutants such as fine particles which can penetrate deep into the respiratory system. These particles, known as PM<sub>10</sub> and PM<sub>2.5</sub>, can cause respiratory issues and exacerbate conditions like asthma. Also, the burning of firecrackers releases sulphur-dioxide and nitrogen dioxide, both of which can irritate the respiratory system. Prolonged exposure may lead to respiratory diseases and worsen existing conditions. Fireworks often contain heavy metals like lead, cadmium, and copper. These metals can have harmful health effects when inhaled or ingested, and they can persist in the environment, affecting soil and water quality. In addition to air pollution, the noise generated by firecrackers during Diwali can have serious effects on human health, causing stress, hearing impairment, and sleep disturbances. Overall, the collective impact of these pollutants during Diwali can lead to a significant deterioration in air quality, posing health risks to individuals, particularly those with pre-existing respiratory conditions.

Despite the efforts to promote eco-friendly alternatives to mitigate the adverse effects on air quality, ambient air quality during the Diwali period has increased suddenly more than the regular days, which signifies the influence of Diwali fireworks combustion on the atmospheric environment. Besides, the festival of Diwali also marks the beginning of the winter season with decreased atmosphere mixing height, cold weather (low temperature

and high humidity), and calm wind (low wind speed  $< 0.5$  m/s) conditions. Therefore, Diwali fireworks and other anthropogenic activities induced air emissions do not disperse easily and the pollutants accumulate near the ground level/ breathing zone.

The efforts towards public awareness of air quality status due to Diwali emissions and the encouragement for eco-friendly celebrations can mitigate these environmental and health concerns to some extent. Therefore, the air quality survey in Lucknow city during Diwali days (i.e., pre-Diwali days, on-Diwali day, and post-Diwali days) has been carried out by CSIR-Indian Institute of Toxicology Research (CSIR-IITR) for more than two decades to find out the air and noise pollution status at different locations in the city. As in earlier years, during Diwali 2023 ambient air monitoring is conducted for particulate and gaseous pollutants and noise levels at four sites representing residential and commercial areas (i.e., residential sites: Aliganj and Vikas Nagar, and commercial sites: Chowk and Aminabad) in Lucknow. The study identifies the status of current year Diwali firecrackers bursting and other festival activities' impact on city air quality.

## **2. Objectives of the study**

The ambient air and noise quality survey for Lucknow city was monitored during Diwali period, 2023 with the following objectives:

- *to measure the ambient concentrations of particulates ( $PM_{10}$  &  $PM_{2.5}$ ), gases ( $SO_2$  &  $NO_2$ ) pollutants and noise levels for day and night time*
- *to examine the status and trend of air quality over the years, and develop the air quality database for the Diwali period*
- *to increase public awareness about the spike in air pollution during Diwali due to the bursting of firecrackers and other festival activities.*

### 3. Results and Discussion

Air quality analysis results for 4 locations representing residential and commercial areas in Lucknow city are presented in Table-1 and Figure-1 to Figure-3. Simultaneous field sampling of air pollutants and monitoring of Noise levels were carried out at all four sites for daytime and nighttime with a 12-hour sampling duration.

#### **Ambient PM<sub>10</sub> during Pre-Diwali, Diwali, Post-Diwali:**

The mean concentration of PM<sub>10</sub> for pre-Diwali (i.e., 11<sup>th</sup> November 2023) ranged from 146.52 to 190.00  $\mu\text{g}/\text{m}^3$  and averaged 166  $\mu\text{g}/\text{m}^3$  during the daytime, while 182.9 to 230.68  $\mu\text{g}/\text{m}^3$  and average 205  $\mu\text{g}/\text{m}^3$  recorded during night time.

On Diwali (i.e., 12<sup>th</sup> November 2023), PM<sub>10</sub> ranged from 169.79 to 261.59  $\mu\text{g}/\text{m}^3$  and averaged 206  $\mu\text{g}/\text{m}^3$  during daytime, while 382.01 to 572.92  $\mu\text{g}/\text{m}^3$  and averaged 464  $\mu\text{g}/\text{m}^3$  during nighttime.

During Post-Diwali (i.e., 13<sup>th</sup> November 2023), the mean concentration of PM<sub>10</sub> ranged from 174.94 to 292.46  $\mu\text{g}/\text{m}^3$  and averaged 230  $\mu\text{g}/\text{m}^3$  during day time, while 294.09 to 337.77  $\mu\text{g}/\text{m}^3$  and averaged 319  $\mu\text{g}/\text{m}^3$  during night time.

#### **Ambient PM<sub>2.5</sub> during Pre-Diwali, Diwali, Post-Diwali:**

Pre-Diwali (i.e., 11<sup>th</sup> November 2023), the mean concentration of PM<sub>2.5</sub> ranged from 50.9 to 172.83  $\mu\text{g}/\text{m}^3$  and averaged 111  $\mu\text{g}/\text{m}^3$  during day time while 82.8 to 168.82  $\mu\text{g}/\text{m}^3$  and average 121  $\mu\text{g}/\text{m}^3$  during night time.

On Diwali (i.e., 12<sup>th</sup> November 2023), the mean concentration of PM<sub>2.5</sub> ranged from 74.1 to 152.85  $\mu\text{g}/\text{m}^3$  and averaged 126  $\mu\text{g}/\text{m}^3$  during day time while 230.7 to 446.73  $\mu\text{g}/\text{m}^3$  and average 336  $\mu\text{g}/\text{m}^3$  during night time.

During Post-Diwali (i.e., 13<sup>th</sup> November 2023), the mean concentration of PM<sub>2.5</sub> ranged from 84.1 to 124.22  $\mu\text{g}/\text{m}^3$  and averaged 106  $\mu\text{g}/\text{m}^3$  during day time while 199.3 to 261.74  $\mu\text{g}/\text{m}^3$  and average 228  $\mu\text{g}/\text{m}^3$  during night time.

On Diwali night, the level of PM<sub>10</sub> had suddenly increased to 464 µg/m<sup>3</sup> i.e. increased by 126.3 % from 205 µg/m<sup>3</sup> over the pre-Diwali night. However, PM<sub>10</sub> was decreased by the recorded value of 319 µg/m<sup>3</sup> during post-Diwali night.

On Diwali night, the level of PM<sub>2.5</sub> had suddenly increased to 336 µg/m<sup>3</sup> i.e. Increased by 177.68 % from 121 µg/m<sup>3</sup> over the pre-Diwali night. However, PM<sub>2.5</sub> was reduced by a recorded value of 228 µg/m<sup>3</sup> during post-Diwali night.

### Ambient SO<sub>2</sub> and NO<sub>2</sub> during Pre-Diwali, Diwali, Post-Diwali:

In the case of SO<sub>2</sub>, the mean level was found to be within prescribed limits. However, the mean level of SO<sub>2</sub> on Diwali night was increased by a recorded value of 31.8 µg/m<sup>3</sup> i.e. increase of 52.88% from 20.8 µg/m<sup>3</sup> on pre-Diwali night.

The mean level of NO<sub>2</sub> was found to be within prescribed limits. On Diwali night the mean NO<sub>2</sub> value was increased to 46.8 µg/m<sup>3</sup> from 30.8 µg/m<sup>3</sup> of pre-Diwali i.e. increase of 51.94% over the pre-Diwali night.

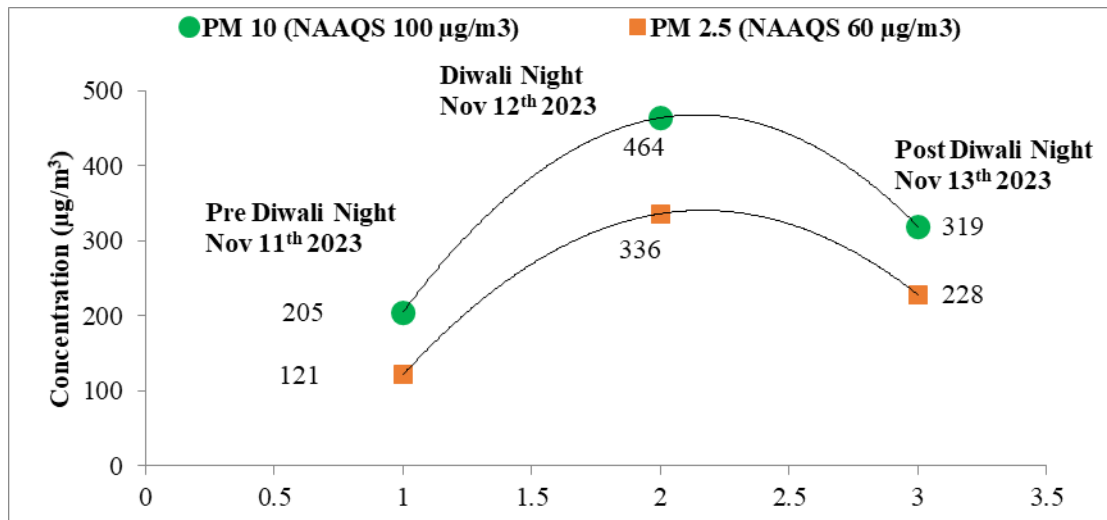


Figure-1: Profile of respirable particulates (in µg/m<sup>3</sup>) during the night time of Diwali Festival.

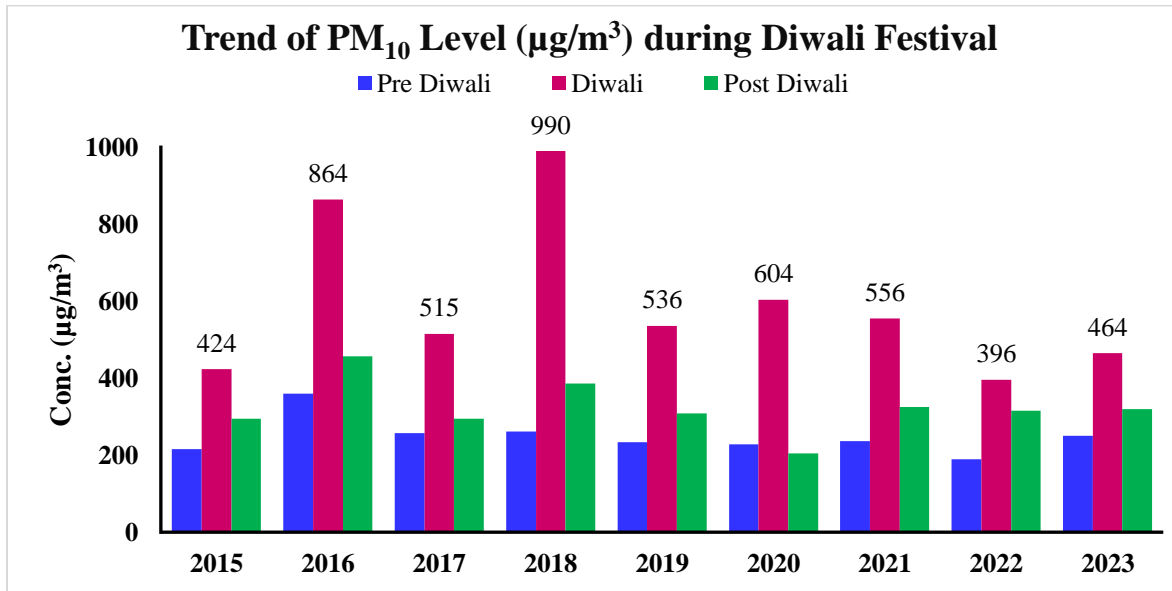


Figure-2: Levels of respirable particulates (PM<sub>10</sub>) concentration during 2015, 2016, 2017, 2018 2019, 2020, 2021, 2022 and 2023( Night time Diwali Festival).

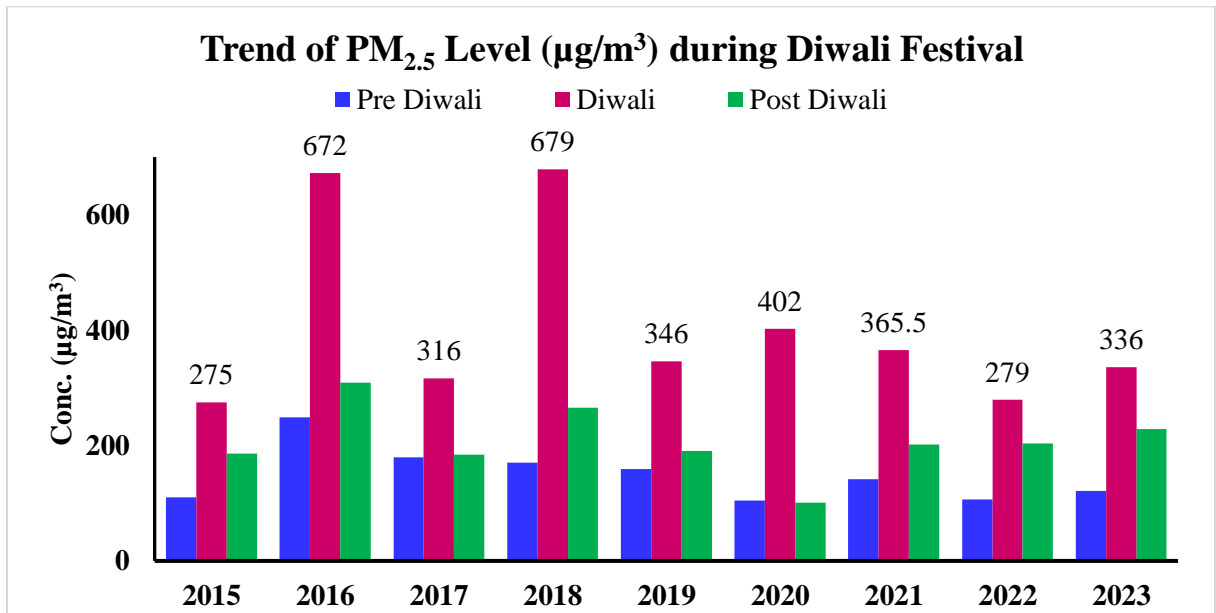


Figure-3: Levels of respirable fine particulates (PM<sub>2.5</sub>) concentration during 2015, 2016, 2017, 2018 2019, 2020, 2021, 2022 and 2023 (Night time Diwali Festival).

**Table 1. Air pollution survey results for the festival days of Diwali 2023**

Locations	Pre-Diwali 2023 (November 11 <sup>th</sup> 2023)		On-Diwali 2023 (November 12 <sup>th</sup> 2023)		Post-Diwali 2023 (November 13 <sup>th</sup> 2023)	
	Day (6:00 am to 6:00 pm)	Night (6:00 pm to 6:00 am)	Day (6:00 am to 6:00 pm)	Night (6:00 pm to 6:00 am)	Day (6:00 am to 6:00 pm)	Night (6:00 pm to 6:00 am)
<b>Pollutant : PM<sub>10</sub> (µg/m<sup>3</sup>)</b>						
Aliganj	146	190	169	408	189	294
Vikas Nagar	155	182	186	382	174	326
Aminabad	171	230	261	572	292	337
Chowk	190	217	206	495	266	318
<b>Average</b>	<b>166</b>	<b>205</b>	<b>206</b>	<b>464</b>	<b>230</b>	<b>319</b>
<b>Pollutant : PM<sub>2.5</sub> (µg/m<sup>3</sup>)</b>						
Aliganj	50	82	74	230	84	202
Vikas Nagar	102	85	136	258	100	199
Aminabad	172	168	152	446	115	250
Chowk	120	148	141	409	124	261
<b>Average</b>	<b>111</b>	<b>121</b>	<b>126</b>	<b>336</b>	<b>106</b>	<b>228</b>
<b>Pollutant: SO<sub>2</sub> (µg/m<sup>3</sup>)</b>						
Aliganj	16	18	23	28	12	25
Vikas Nagar	17	23	21	31	18	24
Aminabad	21	20	24	35	23	29
Chowk	15	22	23	33	19	26
<b>Average</b>	<b>17.3</b>	<b>20.8</b>	<b>22.8</b>	<b>31.8</b>	<b>18.0</b>	<b>26</b>
<b>Pollutant: NO<sub>2</sub> (µg/m<sup>3</sup>)</b>						
Aliganj	23	27	32	40	28	36
Vikas Nagar	25	33	31	43	30	36
Aminabad	22	32	37	53	28	40
Chowk	23	31	28	51	25	43
<b>Average</b>	<b>23.3</b>	<b>30.8</b>	<b>32.0</b>	<b>46.8</b>	<b>27.8</b>	<b>39</b>



**Ambient Noise level during Pre-Diwali, Diwali, Post-Diwali:**

The noise levels were measured at 4 locations during Pre-Diwali, Post-Diwali, and On-Diwali night to assess the impact of the bursting of the firecracker and the recorded measurements are tabulated in Table-2.

The noise levels were monitored during the daytime between 10:00AM to 02:00PM and nighttime between 09:00PM to 01:00AM for ~20 minutes at each location.

The highest noise level was recorded at the Aliganj site with 89.8 dB(A) whereas the lowest was recorded at Chowk having a value of 82.3 dB(A) on Diwali night.

Firecrackers with noise levels > 80 dB(A), may damage the eardrum and reduce our hearing ability. High noise can induce temporary or permanent hearing impairment.

Crackers may also trigger problems like annoyance, irritation, hypertension, stress, hearing loss, headache, sleep disturbance, and respiratory problems such as allergic bronchitis, bronchial asthma, sinusitis, rhinitis, and laryngitis.

**Table 2. Noise Level in dB(A) on Pre-Diwali, Diwali and Post-Diwali**

Locations	Pre-Diwali (November 11, 2023)		On-Diwali (November 12, 2023)		Post- Diwali (November 13, 2023)	
	Day	Night	Day	Night	Day	Night
Aliganj	70.2	68.9	81	89.8	71.2	72.7
Vikas Nagar	74.6	70.4	83.4	88.2	62.9	79.9
Chowk	75.8	72.2	81.8	82.3	81.9	81.8
Aminabad	73.4	70.5	85.1	87.6	85.2	76.4

#### 4. Conclusion / Findings

Air quality in Lucknow has become worse on Diwali night and post-Diwali because of a large amount of fireworks combustion and other enhanced trade activities in the city by the sake of celebrating the auspicious occasion of Diwali festival, 2023. This result implied that the Diwali festival leads to a small, but statistically significant increase in air pollution. The results of the survey during the Diwali festival indicated a significant deterioration of air quality in Lucknow city.

The study reveals that the fine particulate matter (i.e., PM<sub>10</sub> and PM<sub>2.5</sub>) monitored during pre-Diwali, Diwali and post-Diwali days in 2023 are above the National Ambient Air Quality Standards of 100 µg/m<sup>3</sup> and 60 µg/m<sup>3</sup>.

On Diwali night, the level of PM<sub>10</sub> had suddenly increased to 464 µg/m<sup>3</sup> i.e. increased by 126.3 % from 205 µg/m<sup>3</sup> over the pre-Diwali night and reduced to 319 µg/m<sup>3</sup> during the post-Diwali night.

On Diwali night, the level of PM<sub>2.5</sub> had suddenly increased to 336 µg/m<sup>3</sup> i.e. increased by 177.68 % from 121 µg/m<sup>3</sup> over the pre-Diwali night and reduced to 228 µg/m<sup>3</sup> during post-Diwali night.

The highest noise level was recorded at the Aliganj site whereas the lowest was recorded at the Chowk area on Diwali night. The nighttime noise levels exceeded the prescribed CPCB night Standards at all locations.

A large number of pollutants formed in the atmosphere and the air pollution load exceeded than the regular days in the city due to the burning of firecrackers during the Diwali festival. Further, the early winter conditions in Lucknow city also influenced for lessening of mixing height and dispersion of air emissions. The air quality during the Diwali festival may be improved by the minimizing bursting of firecrackers.

**Contributors:**

The survey, data analysis, and report preparation are done by the following staff of the Environmental Monitoring Division:

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