

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

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1.1 Introduction

Traditionally Diwali or Deepawali is known as the ‘festival of illuminations’ and occurs between post-monsoon season in India. The celebration of Diwali held for five days long begins from Dhanteras and ends on Bhaidooj with the reasons of traditional and mythological grounds. Spectacular lights, firecrackers, exchange of sweets and gifts mark this festival as special. The markets become huge rush and roads filled-in by heavy traffic due to public additional purchases starts from few days before the Diwali festival. During Diwali in every hour burning of large quantity of firecrackers occurs at surface level that fill the atmosphere with additional air pollution. The firecrackers release near ground a variety of pollutants into the lower atmosphere such as fine particles, polyaromatic hydrocarbons (PAHs), carbon monoxide, Sulphur dioxide, oxides of nitrogen, carbon dioxide, barium nitrate; metals like lithium, aluminum, copper, zinc, lead, nickel, manganese, magnesium, cadmium, and many others chemical compounds toxic to human.

Diwali festival also marks the beginning of winter season with decreases in night time temperature due to cold weather (low temperature and high humidity) and calm wind (low wind speed < 0.5 m/s) conditions. Therefore, pollution does not disperse easily and the pollutants accumulate near the ground level/ breathing. Further, during the night hours, pollutants absorb air moisture and condense others particles to increase its density and therefore, reduces its buoyancy and gradually pollutants settle down over the night. Whenever, any firecracker bursts in the air, it leads to increase of inhalable particulates and gases in to breathing zone.

In view of above, 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) from past many years to find out the air and noise pollution status at different locations in the city. For Diwali 2022, particulate & gaseous pollutants and noise level monitoring is conducted at four sites covering residential, commercial and industrial areas (i.e., Aliganj, Gomtinagar, Charbagh, and

Amausi) in Lucknow to ascertain the impact of firecrackers bursting and other activities during Diwali festival, 2022 on ambient air quality in the city.

1.2 Objectives of the study

Ambient air and noise quality survey for Lucknow city was monitored during Diwali period, 2022 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 & trend of air quality over the years, and develop the air quality database for Diwali period*
- *to increase the public awareness about the spike of air pollution during Diwali due to bursting of firecrackers and other festival activities*

1.3 Results and Discussion

1.3.1 Ambient air quality

Air quality analysis results for 4-monitoring sites in Lucknow are delineated in **Table-1** and **Figure-1** to **Figure-3** respectively.

The study reveals that the fine particulate matters ($PM_{2.5}$ and PM_{10}) monitored during pre-Diwali, Diwali and post-Diwali days are exceeded the National Ambient Air Quality Standards of 60 and $100\mu\text{g}/\text{m}^3$ respectively at all sampling locations (Table-1).

PM_{10} Concentration during nights of Pre-Diwali, Diwali, Post-Diwali:

Pre-Diwali day (October 23, 2022), the 12hr mean concentration of PM_{10} ranged 157 to $215\mu\text{g}/\text{m}^3$ and average $190\mu\text{g}/\text{m}^3$ during night time (6PM to 6AM).

On Diwali (October 24, 2022), the 12hr mean concentration of PM_{10} ranged 275 to $509\mu\text{g}/\text{m}^3$ and average $396\mu\text{g}/\text{m}^3$ during night time (6PM to 6AM).

During Post-Diwali (October 25, 2022), the 12hr mean concentration of PM_{10} ranged 198 to $412\mu\text{g}/\text{m}^3$ and average $316\mu\text{g}/\text{m}^3$ during night time (6PM to 6AM).

$PM_{2.5}$ Concentration during nights of Pre-Diwali, Diwali, Post-Diwali:

Pre-Diwali day (October 23, 2022), the 12hr mean concentration of $PM_{2.5}$ ranged 82 to $138\mu\text{g}/\text{m}^3$ and average $107\mu\text{g}/\text{m}^3$ during night time (6PM to 6AM).

On Diwali (October 24, 2022), the 12hr mean concentration of $PM_{2.5}$ ranged 194 to $386\mu\text{g}/\text{m}^3$ and average $279\mu\text{g}/\text{m}^3$ during night time (6PM to 6AM).

During Post-Diwali (October 25, 2022), the 12hr mean concentration of $PM_{2.5}$ ranged 117 to $295\mu\text{g}/\text{m}^3$ and average $204\mu\text{g}/\text{m}^3$ during night time (6PM to 6AM).

On Diwali night, the average level of PM_{10} had increased 108.8 % from the pre-Diwali night and reduced by 20.2% in post-Diwali night.

On Diwali night, the average level of $PM_{2.5}$ had increased 162.2 % from the pre-Diwali night and reduced by 27.0% in post-Diwali night.

In case of SO_2 and NO_2 , the mean level was found to be within prescribed limits. However, maximum level of SO_2 and NO_2 on the Diwali night was observed as $40.5\mu\text{g}/\text{m}^3$ and $54.0\mu\text{g}/\text{m}^3$ respectively at Charbagh location.

Meteorology for Lucknow city has been extracted from CPCB and found the prevailing wind conditions (wind-speed and wind-direction) of the city during Diwali, 2022 is presented in **Figure-4**. Mean temperature and relative humidity is observed during Diwali 2022 as 20.8°C and 66.5 % respectively.

Table 1. Air Pollution Levels during Diwali 2022 in Lucknow

Locations	Pre-Diwali 2022 (October 23, 2022)	On-Diwali 2022 (October 24, 2022)		Post-Diwali 2022 (October 25, 2022)	
	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)
Pollutant : PM₁₀ (µg/m³)					
Aliganj	207	278	415	247	369
Gomti Nagar	179	269	384	200	285
Charbagh	215	331	509	268	412
Amausi	157	184	275	149	198
Average	190	265	396	216	316
Pollutant : PM_{2.5} (µg/m³)					
Aliganj	113	198	295	137	205
Gomti Nagar	93	169	242	139	198
Charbagh	138	251	386	192	295
Amausi	82	130	194	88	117
Average	107	187	279	139	204
Pollutant : SO₂ (µg/m³)					
Aliganj	22.0	24.1	36.0	16.1	24.0
Gomti Nagar	20.0	23.8	34.0	16.1	23.0
Charbagh	28.2	26.3	40.5	21.0	32.3
Amausi	15.0	20.8	31.0	13.5	18.0
Average	21.3	23.8	35.4	16.7	24.3
Pollutant : NO₂ (µg/m³)					
Aliganj	29.0	28.8	43.0	24.1	36.0
Gomti Nagar	28.0	28.0	40.0	22.4	32.0
Charbagh	33.0	35.1	54.0	27.3	42.0
Amausi	21.0	23.5	35.0	18.8	25.0
Average	27.8	28.8	43.0	23.1	33.8

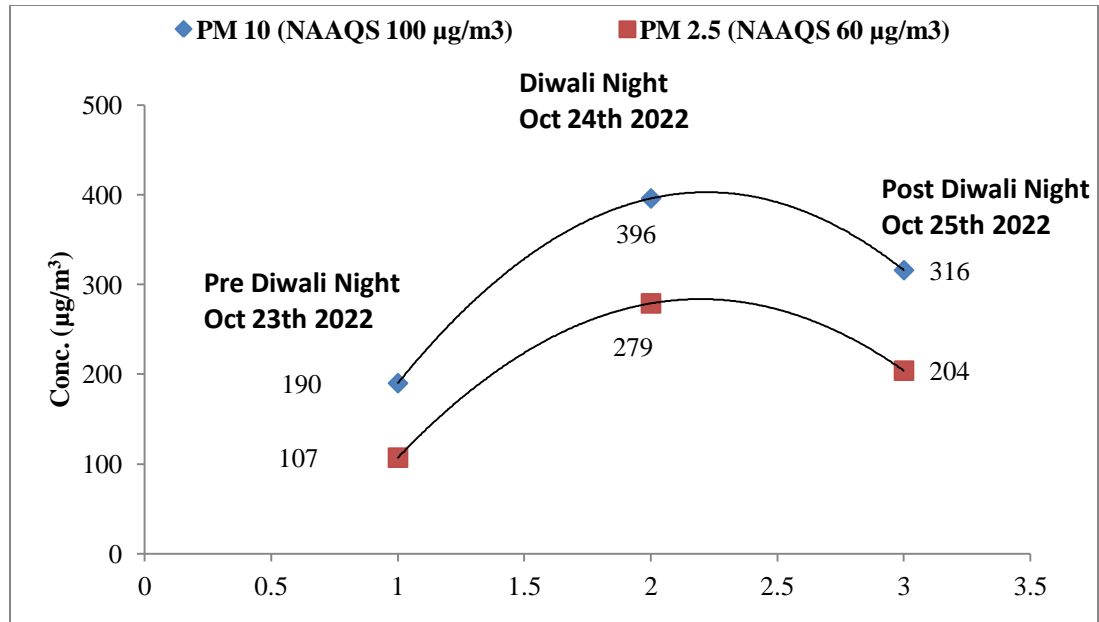


Figure-1. Profile of fine particulate matters (PM_{2.5} and PM₁₀) during the night time of Diwali Festival, 2022.

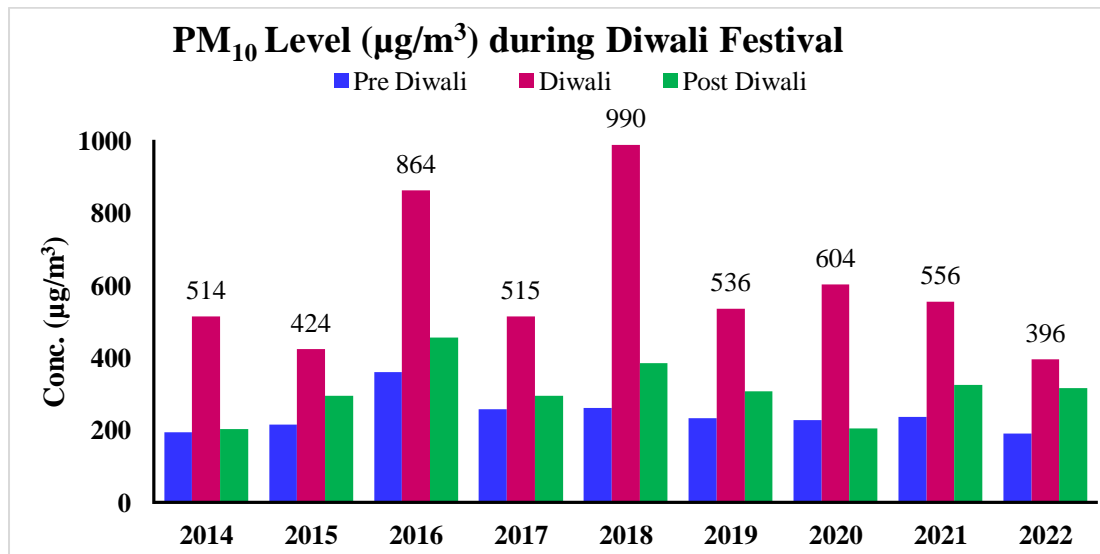


Figure-2. Trend of respirable particulates (PM₁₀) concentration during 2014, 2015, 2016, 2017, 2018, 2019, 2020, 2021 and 2022 (Night time Diwali Festival)

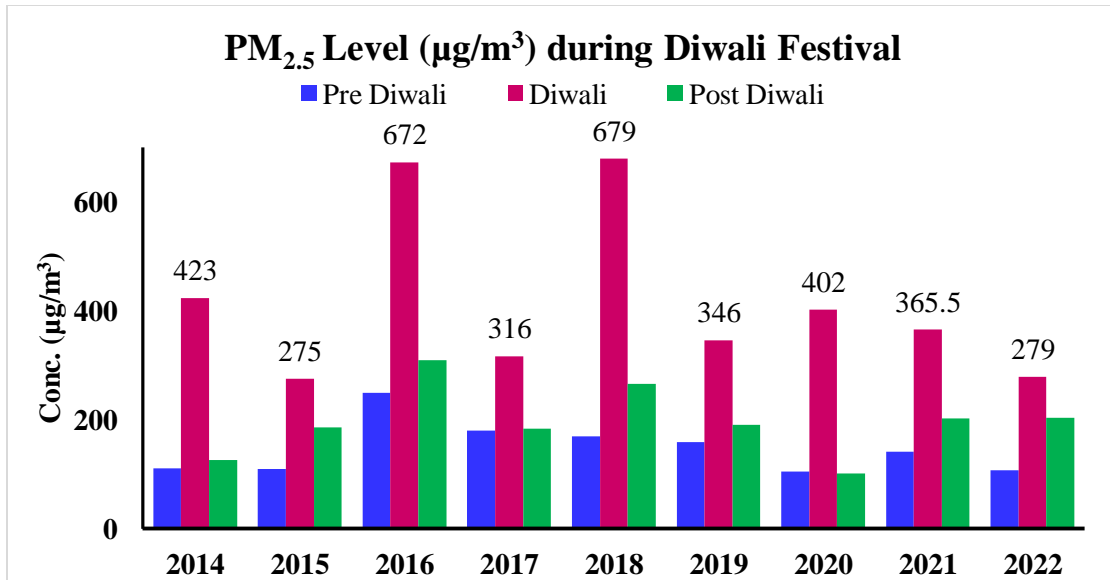


Figure-3. Trend of fine particulates (PM_{2.5}) concentration during 2014, 2015, 2016, 2017, 2018 2019, 2020, 2021 and 2022 (Night time Diwali Festival)

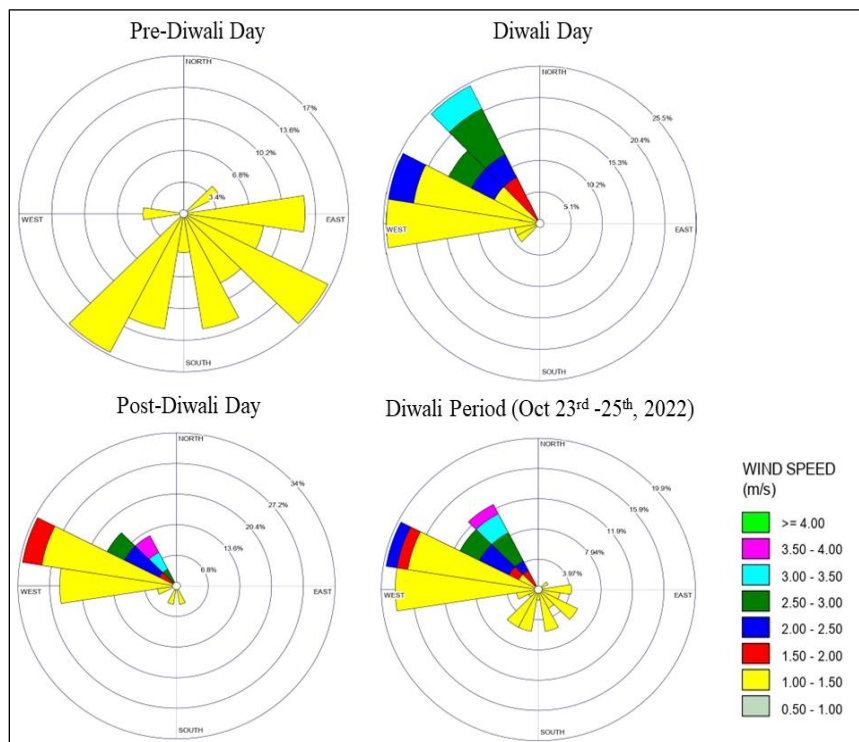


Figure-4: Wind-speed and wind-direction in Lucknow city during Diwali, 2022

1.3.2 Noise level

The noise levels were measured at 4 locations during Pre-Diwali, Post-Diwali and On-Diwali night to assess the impact of bursting of firecracker as well as other activities (**Table-2**). The noise levels were monitored during nights between 7PM – 1AM for ~20 minutes at each location.

The highest noise level was recorded at Charbagh area on Diwali night with 80.6 dB(A) whereas the lowest was recorded at Aliganj with 66.3 dB(A) on pre-Diwali night. Firecrackers with noise level > 80dB(A), may damage eardrum and reduce our hearing ability. High noise can may induce temporary or permanent hearing impairment.

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

Locations	Pre-Diwali (October 23, 2022)	On-Diwali (October 24, 2022)	Post- Diwali (October 25, 2022)
Charbagh (10:00-10:30 PM)	72.8	80.6	78.1
Aliganj (10:00-10:30 PM)	66.3	75.8	68.5
Gomti Nagar (10:00-10:30 PM)	79.4	80.4	71.6
Amausi (10:00-10:30 PM)	81	69.8	71.1

1.4 Conclusion

Ambient air and noise quality survey results for Lucknow city during Diwali 2022 revealed that the particulate and gaseous pollution levels found drastically exceeded from pre-Diwali to Diwali and again found slightly decreased to post-Diwali day. The results of survey during Diwali festival, 2022 clearly indicated the significant deterioration of air quality in Lucknow city. Also, in-comparison with previous Diwali festivals (i.e., during Diwali-2021 and 2020), current festival study results identified decreased pollution levels because this year Diwali was celebrated in early winter season with better meteorological conditions for air pollution dispersion. The large quantity of pollutants and noise levels formed due to burning of firecrackers and other festival activities during Diwali 2022 which may be the cause to increased mortality and morbidity in urban area. Individual bursting of firecrackers during Diwali should be discouraged. However, alternatively community celebration may be allowed at predefined areas.