

Ambient Air Quality in Lucknow During Pre-Diwali, Diwali and Post-Diwali Festival

November, 2021



INTRODUCTION

Diwali is one of the main festivals celebrated in India. Across the length and breadth the country is illuminated with colourful lights and bursting of thousand tons of firecrackers for amusement during this celebration. Onset of festival begins with Dhanteras (purchasing of new household Goods). As per Hindu mythology, Lord Sri Ram returned to his kingdom Ayodhya, after 14 years of self-exile in Panchvati forest (now in MP) and also after conquering the mighty king Ravana. Being an agrarian country, many people also associate Diwali with harvesting of ripen crops. Therefore, it is celebrated with pomp and show, painting/ cleaning and lightening of houses, wearing new clothes, performing puja, exchange of sweets, greeting each other and extending good wishes etc. It brings enthusiasm, excitement, positive energy and harmony among the culturally different societies. During Diwali evening, all the houses across the country simultaneously glitter with millions of colourful lights and with other decorative items. Symbolic Earthen spiritual diyas are enlightened to generate positive energy and aura around home and to eliminate the evil spirit from our society. People are in festive mood and relax from daily routine works. Work places reduce their activities to relieve workers during the festive days. Bonus and incentives are given to workers. School and colleges remain closed and there is no pressure of examinations. Additional trains are arranged for greater mobility to return from work places and to meet their beloved parents, friends, and kith and kin's and to handover gifts. Special sweets and food items are cooked in restaurants. Everyone shares their happy moments and spend few auspicious days with near and dear ones. This creates conducive environment and renewed the friendship and relationships with brothers and sisters and cousins. Festival brings Joy and happiness to everybody irrespective of age, gender especially for Hinduism believers.

Diwali festival is celebrated at early days of winter season every year with cold climate and atmospheric inversion. As winter season progresses, the prevailing conditions; calm winds, low temperatures, high humidity and decreased of mixing height (<1.5 km) reduces the dispersal of pollution in lower atmosphere. Diurnal (Day-Night) thermal variation is more. Thus aerosols of firecracker combustion tend to remain suspended in the air due to low dispersion and dilution in the atmosphere and subsequently cause episodic raise in air pollution levels and impact adversely the environment and health.

In urban areas like Lucknow, existing local activities such as transportation, industrial, construction, waste burning and cooking fuel combustion impact air quality variation temporally and spatially. On the baseline levels the Diwali episodic activities cumulates the air pollution in the atmosphere and suddenly the air quality of the region becomes degraded as a whole.

Air Pollution Problems during Diwali: Bursting of fireworks in cold weather conditions result into sudden surge of huge quantity of various lethal toxic particles (coated with harmful metal oxides) and gases. Continuous and heavy bursting of firecrackers consumes oxygen to cause sudden drop in oxygen level in the breathing zone. The urban atmosphere turns into a poisonous gas chamber. Breathing in such conditions results in shoot up of asthma, bronchitis, respiratory and cardiovascular diseases and emergency visits of hospital increases by the patients suffering from respiratory diseases. Many unwanted accidents and injuries occur due to fire and firecrackers especially to children.

Court and National Green Tribunal (NGT) Orders: Keeping in view the aggravating health problems and suffering of human being and animals, Hon'ble Supreme Court needed to pass orders to ban traditional firecrackers with immediate effect with certain relaxation depending on the quality of air. It also suggested to use of Green firecrackers, which are relatively less harmful and less toxic with lower sound. It is proposed for stringent actions like ban the manufacture, sale and use of traditional fire crackers since 2018 and allowed celebration with green crackers in most cities to restrict the increase of toxic pollutants. The green crackers are eco-friendly and do not contain components which can be harmful for the environment and are available as sparklers, flowerpots, maroons and atom bombs which reduce particulate matter pollution by 30% when burst. The key principle applied for green crackers is reduction/ replacing of barium nitrate (the most hazardous material) levels with potassium nitrate.

Chemical Composition of Conventional Firecrackers: There are numerous types of firecrackers. Not all the firecrackers explode. Some crackers produce only lights while others simply explode with loud sounds at ground level but rocket types of crackers burst at mid air at a height of 50-60 m from ground. Some moves in circular way and produce beautiful lights surrounding its centre.

Fireworks contain explosive detonating powder and other easily combustible metallic chemical compounds that emit colourful illumination effects during ignition or after burst. The conventional fire crackers are mainly composited with 6-vital ingredients such as charcoal, sulphur, nitrates/chlorates/ per-chlorates, regulator (metal-element composite), binders (dextrin) and coloring agents (i.e. Strontium-red, Copper-blue, Barium-green, Sodium-yellow or orange, Calcium-Orange, Gold-iron, Strontium and Copper mix-purple). Firecrackers contain chemicals and substances like cadmium, lead, chromium, aluminium, magnesium, nitrates, carbon monoxide, copper, potassium, sodium, zinc oxide, manganese dioxide etc. which if accumulated can eventually damage health if inhaled or ingested.

The traditional fire crackers can cause severe effects to the health of people like heart diseases, respiratory or nervous system disorders. Even in people suffering from common cold and coughs it can cause congestion of throat and chest.

Noise pollution causes restlessness, temporary or permanent hearing loss, high blood pressure; sleep disturbance and even poor cognitive development in kids.

Composition of Green Crackers: Green crackers include flower pots, pencils, sparklers, maroons, bombs and chakkar with low thermite amount and minimum usage of aluminum. Green crackers don't contain barium substance which is used in the firecrackers to add green colour. It is estimated that Green crackers will reduce at least 30% emissions using particulate matter potassium nitrate as an oxidant.

Reduction Potential of Green Crackers: Green Crackers are the products of collaborative efforts of CSIR-NEERI and other CSIR institutes. Compared to traditional fire-crackers, Green crackers have reduced emission with respect to ambient particulate pollution (reduction upto 30%), other toxic chemicals (reduced upto 15-20%) and Sound levels (reduction by ~ 40%) due to release of water-vapor or air as a dust suppressant and diluents for gaseous emissions source. Further, the green crackers use less of traditional raw material and ash and also use additives as dust suppressants to reduce emissions. Particularly, Green crackers have been named three types as Safe Water Releaser (SWAS), Safe Thermite Cracker (STAR) and Safe Minimal Aluminium (SAFAL). The particulate matter is reduced by 30-35 % in SWAS and 35 to 40 % in SAFAL and STAR. The price of these crackers will be either less or equal to the price of traditional crackers.

OBJECTIVES OF THE DIWALI SURVEY

CSIR-IITR is a national research institute engaged in toxicology research. Therefore, it showed its concern much before the common man understood the ill effects of air pollution due to bursting of crackers and subsequent health sequels of older people, young one, pregnant women, asthma/ respiratory/COPD/ cardiology patients and those who are susceptible to dust and fumes. Since 2016, CSIR-IITR has been carrying out air quality survey every year during Diwali days in Lucknow city.

Air quality of Lucknow city was monitored during Diwali - 2021 with the following objectives:

- ❖ to monitor day and night time air quality parameters with respect to inhalable particulate matters (PM₁₀, PM_{2.5}), gaseous pollutants (SO₂ and NO_x) and noise levels during Pre-Diwali (2 & 3 Nov. 2021), Diwali (4Nov. 2021) and Post-Diwali (5 & 6 Nov. 2021) period,
- ❖ to enhance the basic understanding of common citizens regarding the effects of bursting of firecrackers on human health and animals and other creatures,
- ❖ to increase public awareness for reducing the burning of firecrackers during Diwali festival,
- ❖ to understand the diurnal variation of air quality parameters during Diwali, and
- ❖ to develop air quality database during Diwali period 2021.

RESULTS AND DISCUSSION

The results of air quality monitoring at 9 locations of Lucknow are presented in Table 1 and Figure 1-3. The data revealed that both types of respirable particulate matters, PM₁₀ and PM_{2.5} monitored during pre-Diwali, Diwali and post-Diwali were above the National Ambient Air Quality Standards of 60 and 100 µg/m³ for PM_{2.5} and PM₁₀ respectively (Table 1).

PM₁₀ Concentration during Pre-Diwali, Diwali, Post-Diwali

Pre-Diwali (2nd& 3th Nov. 2021) : The 12 hr mean concentration of PM₁₀ ranged from 169.1 to 196.5 µg/m³ and average 182.8 µg/m³ during day time while it ranged from 266.5 to 315.4 µg/m³ and average 290.95 µg/m³ during night time.

On Diwali (4th Nov. 2021) : The 12 hr mean concentration of PM₁₀ ranged from 170.4 to 302.8 µg/m³ and average 228.8 µg/m³ during day time while it ranged from 725.7 to 1084.2 µg/m³ and average 882.9 µg/m³ during night time.

Post-Diwali (5th& 6th Nov. 2021) : The 12 hr mean concentration of PM₁₀ ranged 271.2 to 279.7 µg/m³ and average 275.45 µg/m³ during day time while it ranged from 322.9 to 426.0 µg/m³ and average 374.45 µg/m³ during night time.

PM_{2.5} Concentration during Pre-Diwali, Diwali, Post-Diwali

Pre-Diwali (2nd& 3th Nov. 2021) : The 12 hr mean concentration of PM_{2.5} ranged from 114.5 to 124.2 µg/m³ and average 119.35 µg/m³ during day time while it ranged from 158.8 to 168.4 µg/m³ and average 163.6 µg/m³ during night time.

On Diwali (4th Nov. 2021) : The 12 hr mean concentration of PM_{2.5} ranged from 123.6 to 362.0 µg/m³ and average 175.1 µg/m³ during day time while it ranged from 205.8 to 833.3 µg/m³ and average 555.9µg/m³ during night time.

During Post-Diwali (5th& 6th Nov. 2021) : The 12 hr mean concentration of PM_{2.5}ranged from 149.0 to 175.3 µg/m³ and average 162.15 µg/m³ during day time while it ranged from 215.8 to 268.6 µg/m³ and average 242.2 µg/m³ during night time.

On Diwali night, the level of PM₁₀ had suddenly increased from the average value of 266.5 (on 2.11.2021 night) to 882.9 µg/m³ i.e. increased by 193.7%. The highest value of 1084.2 was recorded in Diwali night at Gomtinagar Sampling station. The average PM₁₀ value remained high even during post-Diwali night on 6th November, 2021 with an average value of 322.9 µg/m³(Table 1)..

On Diwali night, the level of PM_{2.5} had suddenly increased from the average value of 158.8 (on 2.11.2021 night) to 555.9 µg/m³ i.e. increased by 250.1 %. The maximum value of Diwali night was recorded at Charbagh. i.e. 833.3 µg/m³. Even the average value was high during post-Diwali night on 6th November, 2021 i.e. 215.8 µg/m³(Table 2).

Table 1. Particulate PM₁₀ Concentration (µg/m³) during Diwali 2021

Location	Pre Diwali				Diwali		Post Diwali			
	02.11.21		03.11.21		04.11.21		05.11.21		06.11.21	
	Day	Night	Day	Night	Day	Night	Day	Night	Day	Night
Pollutant : PM₁₀ (µg/m³)										
Aliganj	146.5	221.5	194.4	325.0	232.0	756.0	264.0	405.0	314.0	396.6
Vikas Nagar	205.2	247.3	205.1	214.0	226.0	880.8	293.0	555.0	221.6	312.5
Gomtinagar	212.6	254.0	138.0	253.0	302.8	1084.2	248.5	499.4	269.9	317.5
Aminabad	143.4	257.9	244.0	337.0	267.0	959.0	323.0	362.0	325.9	390.4
Chowk	128.8	251.5	146.8	357.8	170.4	725.7	264.0	315.2	276.8	257.1
Charbagh	157.6	294.9	168.0	275.6	215.0	1003.7	365.0	419.0	272.2	322.3
Indra Nagar	185.0	360.0	218.3	455.8	217.6	890.5	183.7	683.4	227.7	341.1
Alambagh	114.0	280.0	171.8	392.0	218.6	915.3	308.7	266.9	299.8	318.3
Amausi	229.0	231.7	281.9	228.4	210.1	730.5	267.8	328.4	232.8	250.4
Min	114.0	221.5	138.0	214.0	170.4	725.7	183.7	266.9	221.6	250.4
Max	229.0	360.0	281.9	455.8	302.8	1084.2	365.0	683.4	325.9	396.6
Average	169.1	266.5	196.5	315.4	228.8	882.9	279.7	426.0	271.2	322.9
Standard Deviation	40.3	41.5	46.7	80.1	37.3	125.5	51.2	132.3	37.9	50.1

Table 2. Particulate PM_{2.5} Concentration (µg/m³) during Diwali 2021

Location	Pre Diwali				Diwali		Post Diwali			
	02.11.21		03.11.21		04.11.21		05.11.21		06.11.21	
	Day	Night	Day	Night	Day	Night	Day	Night	Day	Night
Pollutant : PM_{2.5} (µg/m³)										
Aliganj	96.3	101.5	111.2	119.0	139.0	540.0	190.3	262.5	166.8	205.4
Vikas Nagar	78.2	135.6	105.7	131.8	150.6	510.5	176.3	215.0	156.5	288.2
Gomtinagar	110.0	204.3	117.4	183.7	123.6	672.6	180.0	381.3	134.3	256.4
Aminabad	141.0	176.4	119.2	204.5	165.8	810.9	227.6	312.3	162.3	196
Chowk	84.1	267.9	108.4	290.4	142.0	414.4	180.2	216.1	126.7	176.1
Charbagh	102.5	151.0	114.9	195.0	150.3	833.3	197.2	307.7	161.7	208.3
Indra Nagar	170.1	139.3	118.0	172.7	169.7	725.2	135.8	219.6	180.2	202.7
Alambagh	167.9	177.5	169.7	111.6	362.0	290.3	146.8	304.3	116.7	229.1
Amausi	80.7	75.5	153.0	106.8	172.9	205.8	143.7	198.3	135.8	180.3
Min	78.2	75.5	105.7	106.8	123.6	205.8	135.8	198.3	116.7	176.1
Max	170.1	267.9	169.7	290.4	362.0	833.3	227.6	381.3	180.2	288.2
Average	114.5	158.8	124.2	168.4	175.1	555.9	175.3	268.6	149.0	215.8
Standard Deviation	36.3	56.8	22.0	59.1	71.9	223.5	29.3	61.7	21.3	36.5

The level of Sulphur dioxide had suddenly increased from the average value of 21.8 (on 2.11.2021 night) to 38.1 µg/m³ i.e. increased by 74.8%. The highest value of 47.4 µg/m³ was recorded in Diwali night at Charbagh Sampling station. The average SO₂ value remained high even during post-Diwali night on 6th November, 2021 with an average value of 26.4µg/m³ (Table 3).

Table 3. Sulphur dioxide Concentration ($\mu\text{g}/\text{m}^3$) during Diwali 2021

Location	Pre Diwali				Diwali		Post Diwali			
	02.11.21		03.11.21		04.11.21		05.11.21		06.11.21	
	Day	Night	Day	Night	Day	Night	Day	Night	Day	Night
Pollutant : SO₂ ($\mu\text{g}/\text{m}^3$)										
Aliganj	17.6	19.8	18.2	21.3	22.6	28.6	19.6	22.6	18.7	20.3
Vikas Nagar	17.8	21.0	18.6	22.9	25.4	32.4	22.4	24.4	21.5	19.2
Gomtinagar	18.8	22.0	20.0	23.6	26.6	37.2	23.6	29.2	21.8	28.4
Aminabad	17.2	21.9	21.8	25.6	31.4	39.5	29.4	35.5	21.0	28.8
Chowk	18.3	22.6	23.5	25.3	33.4	43.4	28.4	31.4	25.6	27.3
Charbagh	19.2	23.6	25.3	28.4	37.6	47.4	32.6	38.4	29.8	34.5
Min	17.2	19.8	18.2	21.3	22.6	28.6	19.6	22.6	18.7	19.2
Max	19.2	23.6	25.3	28.4	37.6	47.4	32.6	38.4	29.8	34.5
Average	18.1	21.8	21.2	24.5	29.5	38.1	26.1	30.25	23.1	26.4
Standard Deviation	0.7	1.3	2.8	2.4	5.6	6.9	4.9	6.1	3.9	5.7

The level of oxides of nitrogen had suddenly increased from the average value of 39.4 (on 2.11.2021 night) to 58.1 $\mu\text{g}/\text{m}^3$ i.e. increased by 47.5 %. The highest value of 77.9 $\mu\text{g}/\text{m}^3$ was recorded in Diwali night at Charbagh Sampling station. The average value remained high even during post-Diwali night on 6th November, 2021 with an average value of 44.2 $\mu\text{g}/\text{m}^3$ (Table 4).

Table 4. Oxides of nitrogen Concentration ($\mu\text{g}/\text{m}^3$) during Diwali 2021

Location	Pre Diwali				Diwali		Post Diwali			
	02.11.21		03.11.21		04.11.21		05.11.21		06.11.21	
	Day	Night	Day	Night	Day	Night	Day	Night	Day	Night
Pollutant : NOx($\mu\text{g}/\text{m}^3$)										
Aliganj	26.5	34.3	28.6	37.5	35.2	47.2	31.2	40.2	29.5	38.3
Vikas Nagar	28.3	36.8	29.5	39.1	39.1	49.4	34.1	41.4	31.3	40.8
Gomtinagar	30.6	41.5	32.8	43.9	46.3	53.8	38.3	45.8	33.6	43.5
Aminabad	36.9	41.8	31.8	42.6	49.8	58.2	40.8	49.2	39.9	45.8
Chowk	35.3	39.4	34.8	44.4	48.4	62.6	42.4	53.6	38.3	46.4
Charbagh	36.8	42.6	32.8	45.6	56.2	77.9	48.2	59.9	41.8	50.6
Min	26.5	34.3	28.6	37.5	35.2	47.2	31.2	40.2	29.5	38.3
Max	36.9	42.6	34.8	45.6	56.2	77.9	48.2	59.9	41.8	50.6
Average	32.4	39.4	31.7	42.1	45.8	58.1	39.1	48.3	35.7	44.2
Standard Deviation	4.5	3.2	2.3	3.1	7.5	11.1	6.1	7.5	4.9	4.3

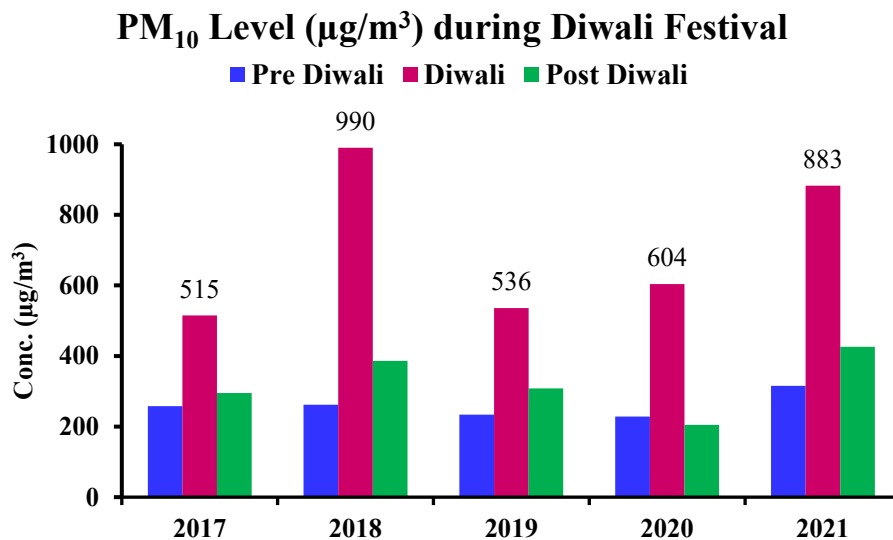


Fig. 1. Levels of respirable particulates (PM₁₀) concentration during 2017, 2018, 2019, 2020 and 2021 (Night time Diwali Festival).

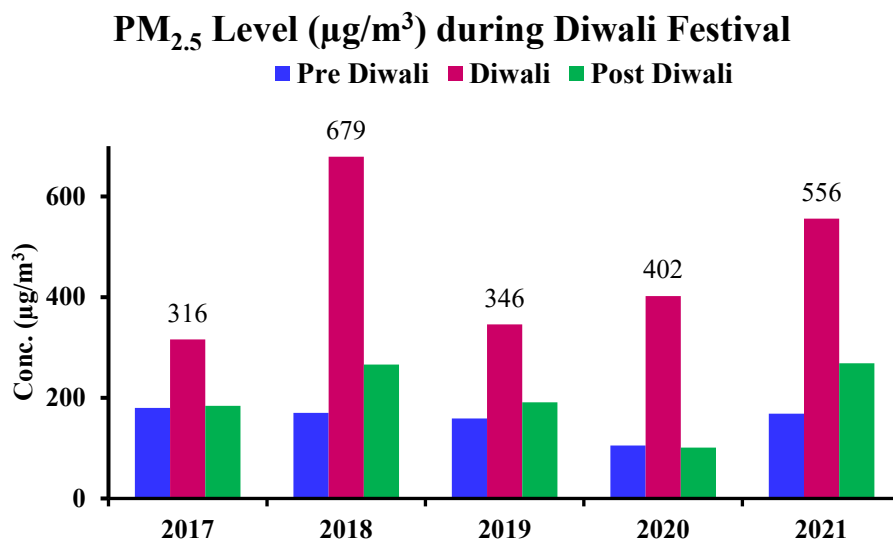


Fig. 2. Levels of respirable fine particulates (PM_{2.5}) concentration during 2017, 2018, 2019 2020 and 2021(Night time Diwali Festival).

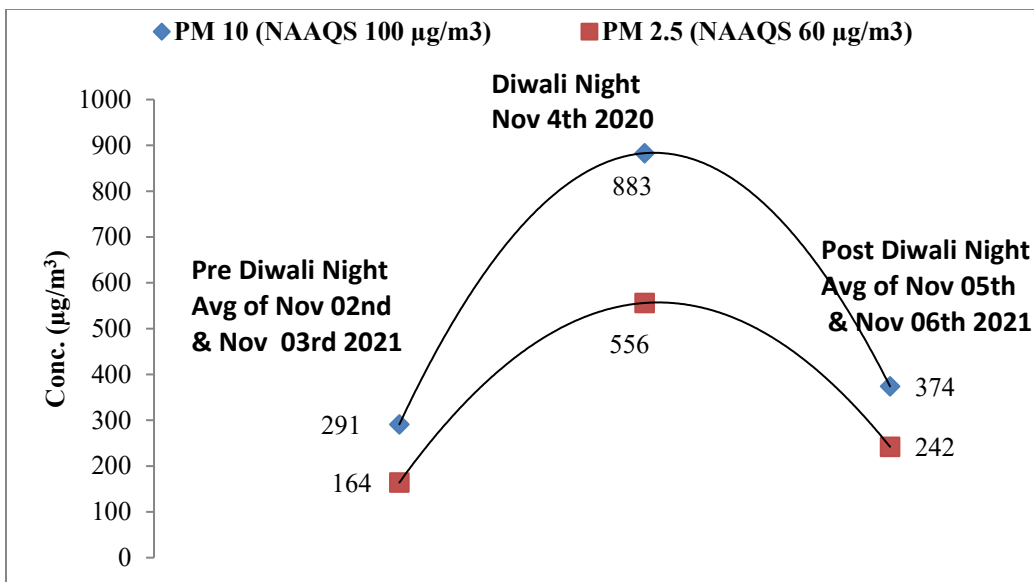


Fig. 3. Profile of respirable particulates (in $\mu\text{g}/\text{m}^3$) during the night time of Diwali Festival.

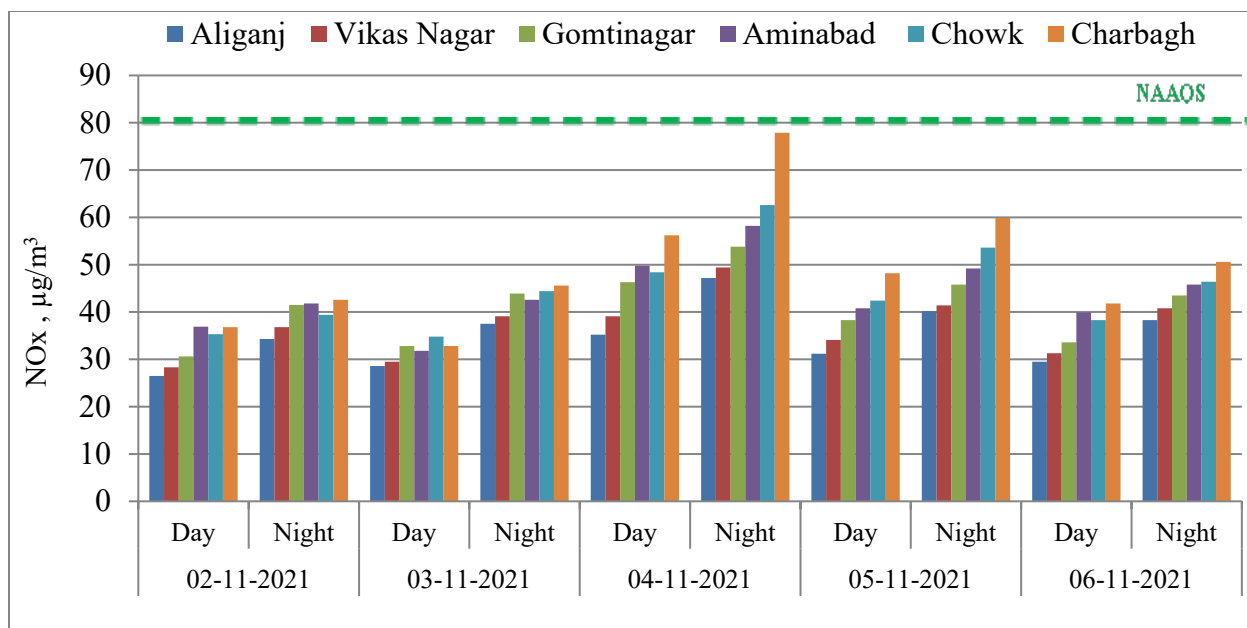


Fig. 4. Concentration of NO_x(µg/m³) at different locations of Lucknow during Diwali 2021

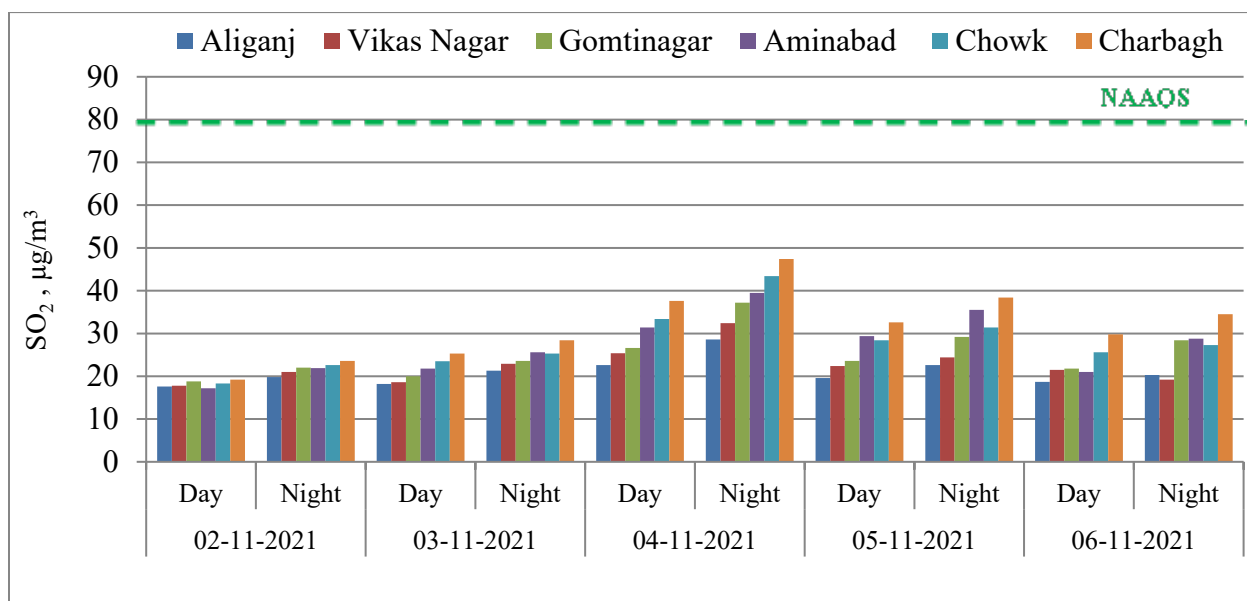


Fig. 5. Concentration of SO₂(µg/m³) at different locations of Lucknow during Diwali 2021

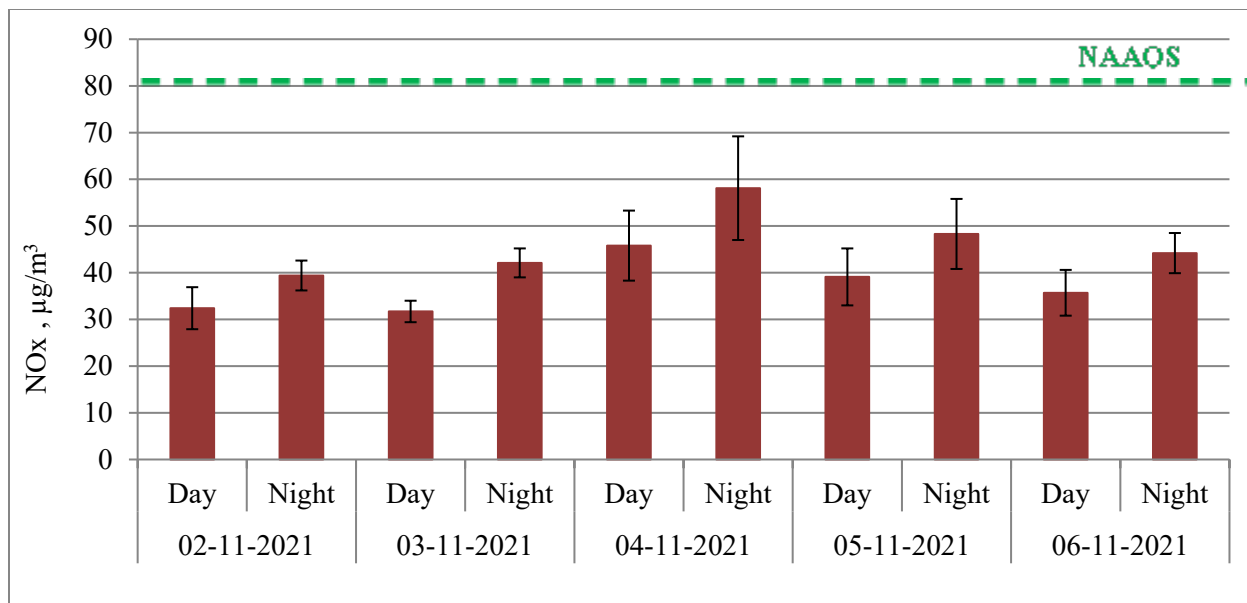


Fig. 6. Day and Night NOx levels for average of all location in Lucknow during Diwali 2021

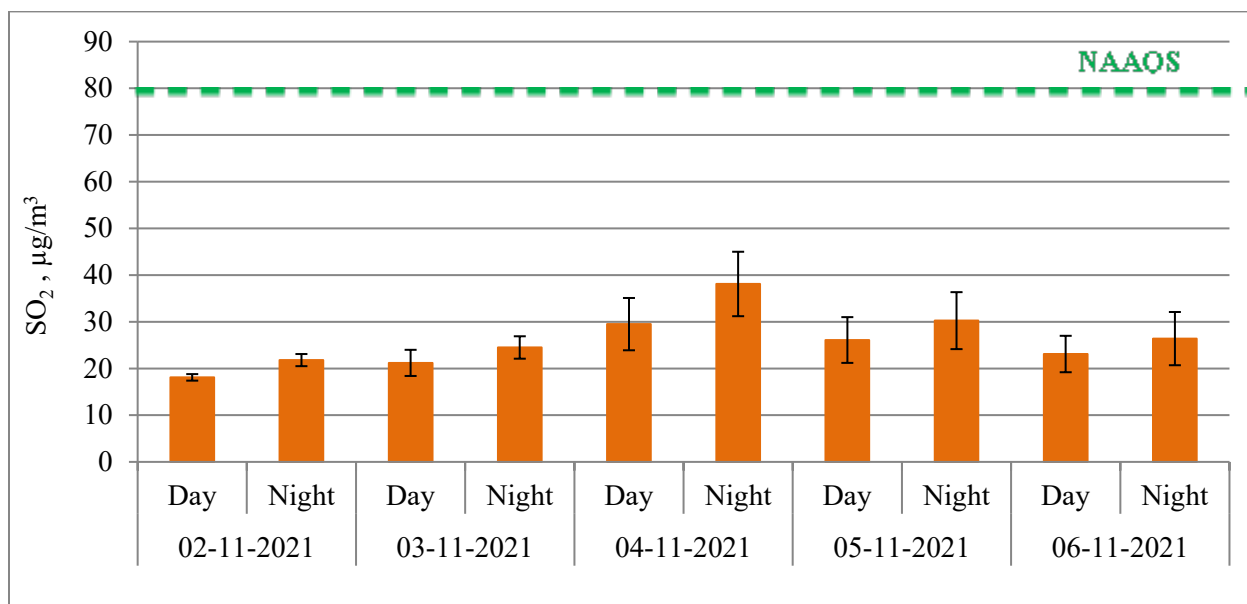


Fig. 7. Day and Night SO2 levels for average of all location in Lucknow during Diwali 2021

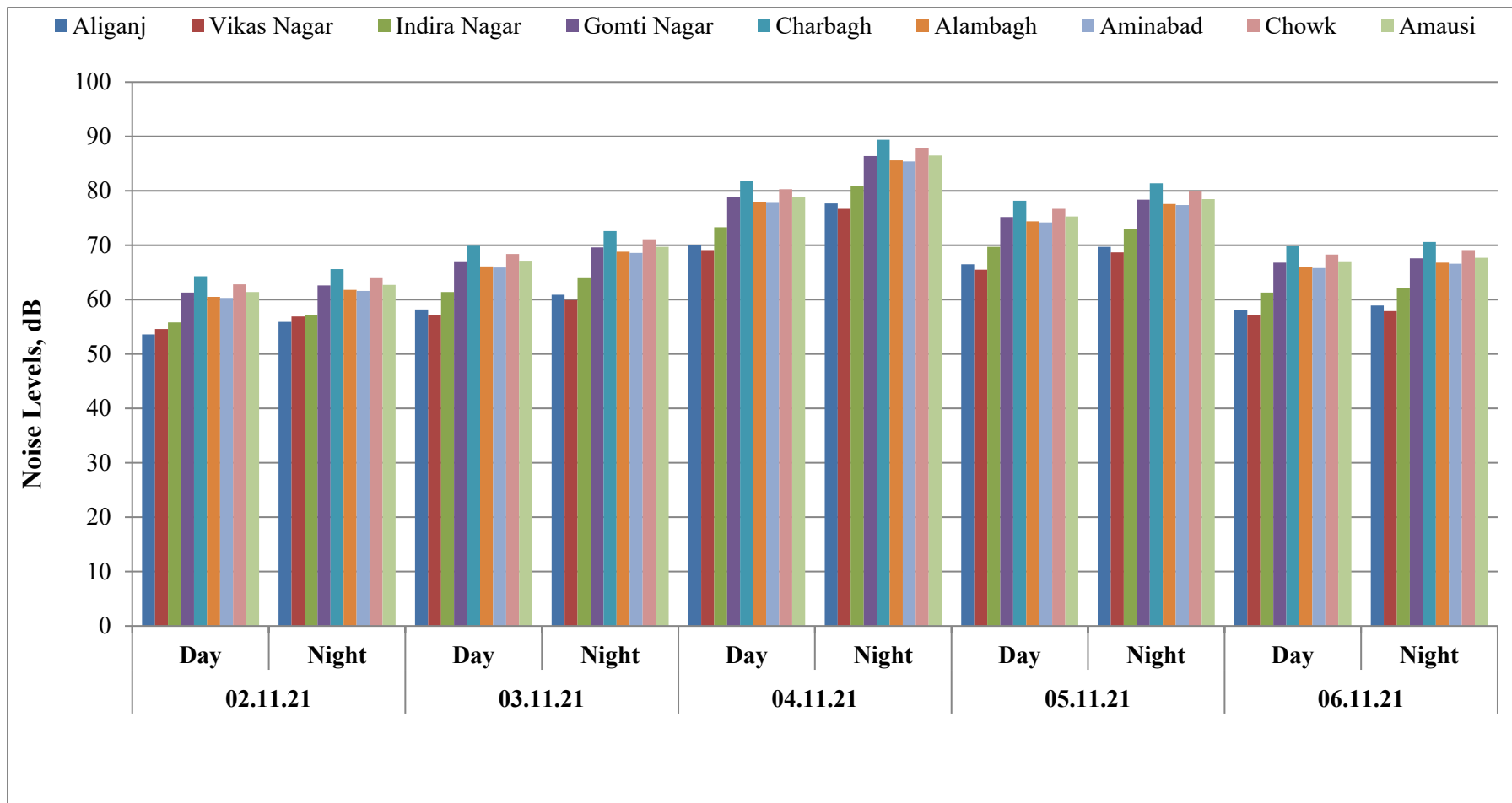


Fig. 8.Noise Levels (dB) at different locations of Lucknow during Diwali 2021

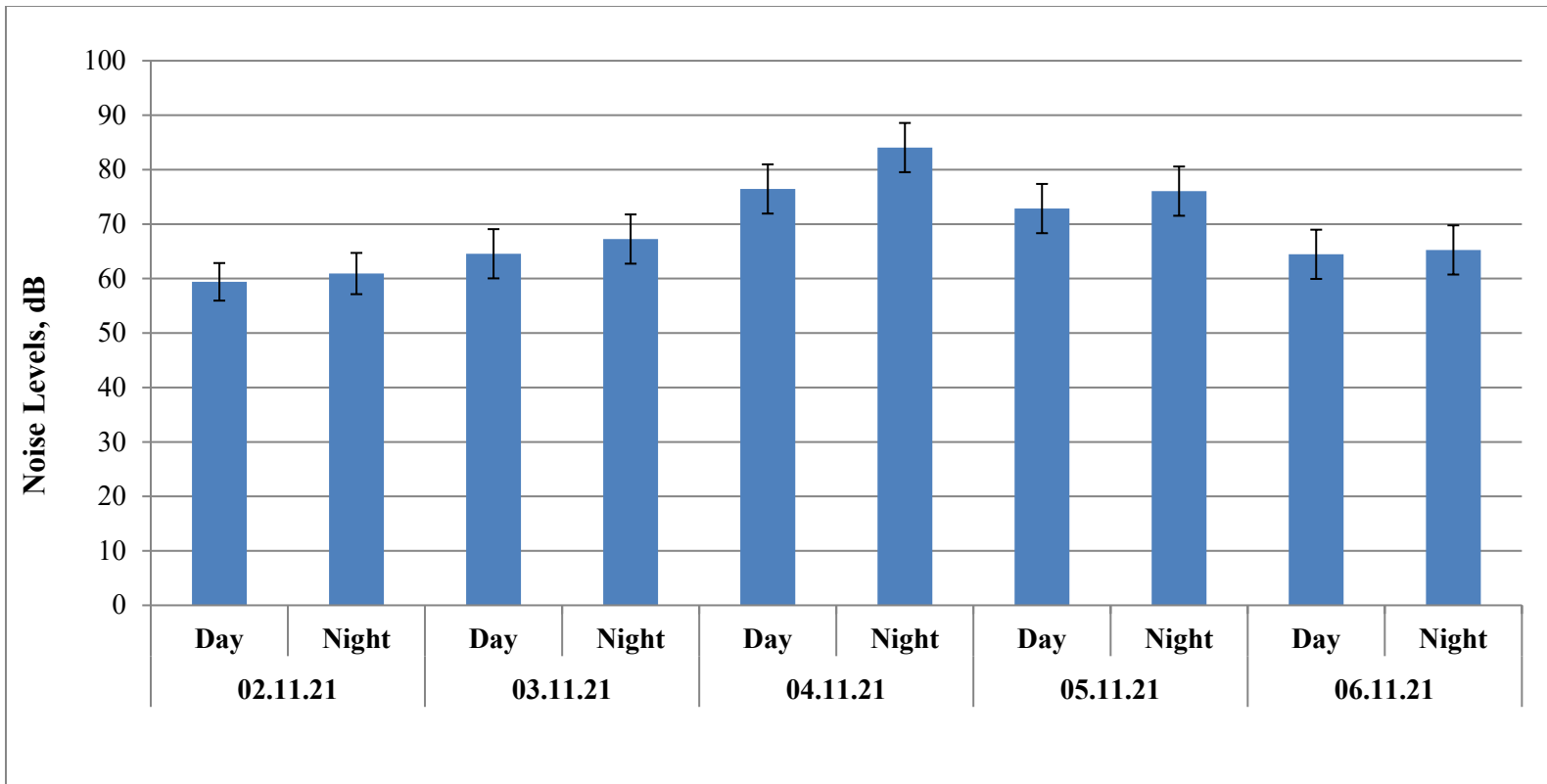


Fig. 9. Day and Night Noise levels (dB) for average of all location in Lucknow during Diwali 2021

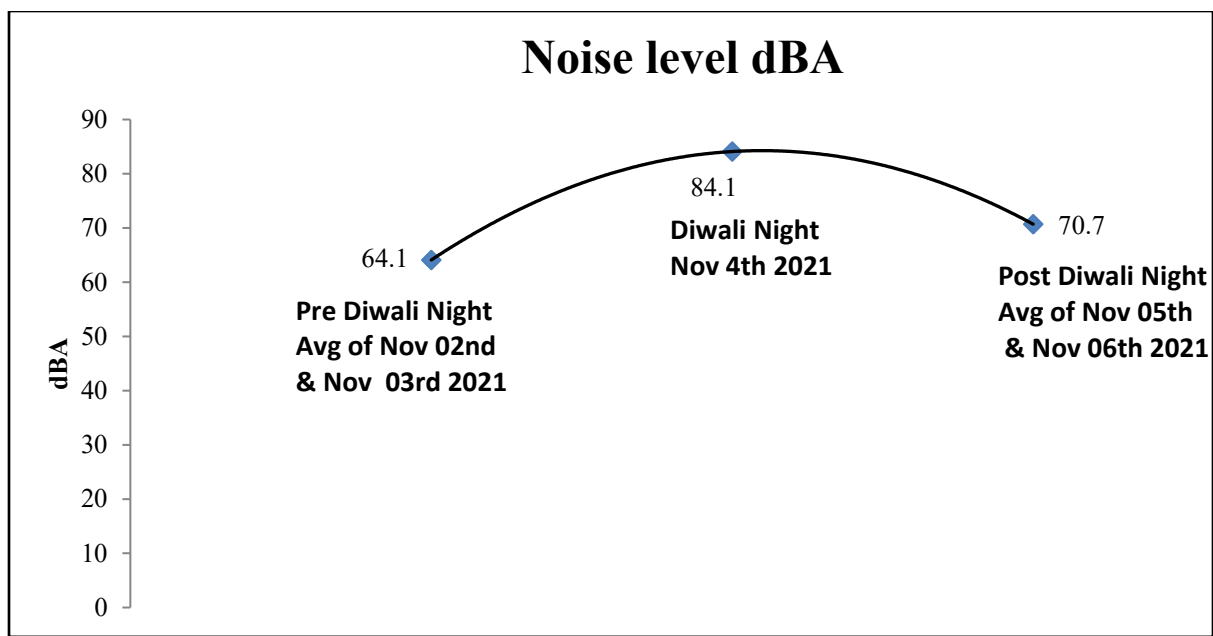


Fig. 10.Night Noise levels dB(A) in Lucknow during Diwali 2021

NOISE LEVELS

The noise levels were measured at 9 locations during Pre-Diwali, Diwali and Post-Diwali to assess the impact of bursting of firecrackers. The noise levels were monitored between 7pm to 12mid-night for 20 min. at each location during night period. Also during the day times, noise levels are monitored at all the locations.

The minimum, maximum and average noise levels for day and night time at each location is summarized in Table.5 and depicted in Figure 8. The maximum noise level was recorded at Charbgh location (98.4 dB(A)), also the average maximum noise level of (89.4 dB(A))was also recorded at the same location. The overall summary of average noise levels during Pre-Diwali, Diwali and Post Diwali, 2021 are given in Table.5 and presented in Figure 9. The trend in night time noise level during Diwali period is shown in Figre.-10. The average noise level at nights of 2nd and 3rd, November (i.e. Pre-Diwali days) from 64.1 dB(A) increased to 84.1 dB(A) on Diwali night (i.e. 4th November) and again it reduced to 70.7 dB(A) on Post Diwali night (i.e. average nights of 5th and 6th November) as shown in Figure.-10.

Table 5. Noise levels (dBA) during Diwali 2021

Day		Pre Diwali				Diwali		Post Diwali			
Date		02.11.21		03.11.21		04.11.21		05.11.21		06.11.21	
Time		Day	Night	Day	Night	Day	Night	Day	Night	Day	Night
Aliganj	Minimum	44.8	47.8	49.1	51.5	58.2	61.9	53.1	57.2	53.0	54.8
	Maximum	58.6	67.5	68.5	70.7	81.8	88.1	72.0	75.3	66.1	70.5
	Average (Leq)	53.6	55.9	58.2	60.9	70.1	77.7	66.5	69.7	58.1	58.9
Vikas Nagar	Minimum	43.7	46.7	48.0	50.4	57.1	60.8	52.0	56.1	51.9	53.7
	Maximum	58.1	67.0	68.0	70.2	81.3	87.6	71.5	74.8	65.6	70.0
	Average (Leq)	54.6	56.9	57.2	59.9	69.1	76.7	65.5	68.7	57.1	57.9
Indira Nagar	Minimum	45.2	48.2	49.5	51.9	58.6	62.3	53.5	57.6	53.4	55.2
	Maximum	62.4	71.3	72.3	74.5	85.6	91.9	75.8	79.1	69.9	74.3
	Average (Leq)	55.8	57.1	61.4	64.1	73.3	80.9	69.7	72.9	61.3	62.1
Gomti Nagar	Minimum	50.5	53.5	54.8	57.2	63.9	67.6	58.8	62.9	58.7	60.5
	Maximum	65.4	74.3	75.3	77.5	88.6	94.9	78.8	82.1	72.9	77.3
	Average (Leq)	61.3	62.6	66.9	69.6	78.8	86.4	75.2	78.4	66.8	67.6
Charbagh	Minimum	53.7	56.7	58.0	60.4	67.1	70.8	62.0	66.1	61.9	63.7
	Maximum	68.9	77.8	78.8	81.0	92.1	98.4	82.3	85.6	76.4	80.8
	Average (Leq)	64.3	65.6	69.9	72.6	81.8	89.4	78.2	81.4	69.8	70.6
Alambagh	Minimum	49.9	52.9	54.2	56.6	63.3	67.0	58.2	62.3	58.1	59.9
	Maximum	64.9	73.8	74.8	77.0	88.1	94.4	78.3	81.6	72.4	76.8
	Average (Leq)	60.5	61.8	66.1	68.8	78.0	85.6	74.4	77.6	66.0	66.8
Aminabad	Minimum	50.2	53.2	54.5	56.9	63.6	67.3	58.5	62.6	58.4	60.2
	Maximum	65.0	73.9	74.9	77.1	88.2	94.5	78.4	81.7	72.5	76.9
	Average (Leq)	60.3	61.6	65.9	68.6	77.8	85.4	74.2	77.4	65.8	66.6
Chowk	Minimum	52.2	55.2	56.5	58.9	65.6	69.3	60.5	64.6	60.4	62.2
	Maximum	67.4	76.3	77.3	79.5	90.6	96.9	80.8	84.1	74.9	79.3
	Average (Leq)	62.8	64.1	68.4	71.1	80.3	87.9	76.7	79.9	68.3	69.1
Amausi	Minimum	51.0	54.0	55.3	57.7	64.4	68.1	59.3	63.4	59.2	61.0
	Maximum	66.1	75.0	76.0	78.2	89.3	95.6	79.5	82.8	73.6	78.0
	Average (Leq)	61.4	62.7	67.0	69.7	78.9	86.5	75.3	78.5	66.9	67.7

FINDINGS OF DIWALI SURVEY

The inhalable tiny fine particulates levels (PM₁₀ and PM_{2.5}) always exceeded respective National Ambient Air Quality Standards (NAAQS) of 100 µg/m³ for PM₁₀ and 60 µg/m³ for PM_{2.5} at all the air monitoring locations. However, to protect public health, WHO recent standards for *Coarse particulate matter* (PM₁₀) 45 µg/m³ 24-hour mean/15 µg/m³ annual mean while for *Fine particulate matter* (PM_{2.5}) 15 µg/m³ 24-hour mean/5 µg/m³ annual mean. The concentrations of SO₂ and NO₂ were well below the prescribed NAAQS standard of 80 µg/m³ at all the locations. However, both pollutants showed higher spike with comparison to pre and post diwali night at all monitoring locations. (Air Monitoring for a period of 12 hrs: from 06 AM to 06 PM and 06 PM to 06 AM).

Particulate Pollution

PM₁₀ particles: On Diwali Night, the levels of PM₁₀ ranged from µg/m³ 725.7 to 1084.2 µg/m³ with an average of 882.9 µg/m³. Location wise surged of PM₁₀ concentration at Aliganj (756.0 µg/m³ i.e. surge of 176.7 %), Vikas nagar (880.8 µg/m³ i.e. 281.9 %), Gomti Nagar (1084.2 µg/m³ i.e. surge of 327.7 %), Charbagh (1003.7 µg/m³ i.e. 251.9 %), Alambagh (915.3 µg/m³ i.e. 172.4 %), Aminabad (959.0 µg/m³ i.e. 222.4 %), Amausi (730.5 µg/m³ i.e. 217.5 %) with respect to average of Pre-Diwali night 2nd and 3rd Nov 2021.

The average value of PM₁₀ had increased by 220.5% while PM_{2.5} 264.62 % on Diwali Night.

PM_{2.5} particles: On Diwali Night, the levels of PM_{2.5} ranged from µg/m³ 205.8 to 833.3 µg/m³ with an average of 555.9 µg/m³. Location wise surged of PM₁₀ concentration 540.0 µg/m³ i.e. surge of 389.8 % at Aliganj, 510.5 µg/m³ i.e. increase by 281.8 % at Vikas nagar, 672.6 µg/m³ i.e. 246.7 % at Gomti Nagar, 833.3 µg/m³ i.e. 381.7 % at Charbagh, 290.3 µg/m³ i.e. 100.8 % at Alambagh, 810.9 µg/m³ i.e. 325.8% at Aminabad, 205.8 µg/m³ i.e. 125.8 % at Amausi with respect to average of Pre-Diwali night 2nd and 3rd Nov 2021.

Noise Pollution : The day and night time noise levels measured during Pre-Diwali, Diwali and post-Diwali had exceeded their prescribed standards of 55 dB(A) for day and 45 dB (A) for night times. On Diwali Night, most of the Locations crossed even 80 dB(A) which is very harmful to hearing since ear cannot filter the high intensity noise.

Overall results of Diwali survey indicate that all the measured pollutant gradually increases during pre -Diwali festival and diwali night showed maximum peak of all pollutants and later levels of pollutants during post diwali days.

HEALTH EFFECTS DUE TO THE EMISSION OF FIRECRACKERS COMBUSTION

Firecrackers are used on several festive occasions, however, the adverse impacts of firecrackers are more significant during Deepawali. The traditional fire crackers can cause severe effects to the health of people like heart diseases, respiratory or nervous system disorders. Chemicals/ metallic agents based firecrackers are composition of toxic hazards. The major constituent of smog that forms from firecracker emissions contain CO, CO₂, SO₂, NO_x, along with generation of particle pollution that may contain various heavy metals and carcinogenic poly aromatic hydrocarbons. Urban population breathe toxic emissions of firecrackers combustion and suffers from nasal irritation and throat congestion.

The smoke of firecrackers also irritate the eyes, cause tears and redness. Bursting crackers may increase blood pressure and aggravate heart disease. Nausea, headache and giddiness are common effects of bursting crackers. Lung infections such as coughing, sneezing, respiratory disorders like asthma, wheezing often get severe during Deepawali festival. The pollution hazards such as the toxic smoke causes a lot of discomfort in breathing. The poisonous gas can also affect pregnant women adversely. It may also affect the mentally ill patients leading to depression, fear and stress. Even in people suffering from common cold and coughs it can cause congestion of throat and chest.

Firecrackers emission contains chemicals and substances like cadmium, lead, chromium, aluminum, magnesium, nitrates, carbon monoxide, copper, potassium, sodium, zinc oxide, manganese dioxide etc. which if accumulated can eventually damage health if inhaled or ingested.

Noise, an unwanted sound generated from bursting of firecrackers creates impulsive noise and leads to non-recoverable hearing loss. As the combustion of firecrackers is a type of multiple point sources and challenge to assess the impact of noise level and affect public health and environment. Further, lack of safety measures in firecracker combustion also causes serious accidents varying from serious burns and injuries to death in some cases. Noise pollution also causes restlessness, temporary or permanent hearing loss, high blood pressure; sleep disturbance and even poor cognitive development in kids.

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