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Effect of Ban of Firecrackers on NO and SO_2 Concentrations in Lucknow City

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Abstract

This study deals with the variation of NO and SO_2 in ambient air quality associated with burning of firecrackers during Diwali period. An order posing ban on firecrackers was passed by the Supreme court in 2017 restricting the use of firecrackers except during the window 8pm to 10pm. The focus is to determine whether the order was implemented or not and if yes then did it cause any significant decrease on NO and SO_2 concentrations. For this, hourly average concentrations of NO and SO_2 during Diwali period from 2016 to 2018 were compared. It was found that NO concentration showed no particular trend over three days festive time for three years. Although high concentration observed during certain time period on particular days may suggest that the rise could be because of vehicular pollution. Whereas SO_2 concentration showed maximum values on Diwali night even after the ban in year 2017. Also, in year 2016 and 2018 similar trend followed leading to sudden increase in SO_2 levels on Diwali day between 6pm to 10pm.

Keywords: Diwali, firecrackers, Air Pollutant, Lucknow

Introduction

Firecrackers contain 75% potassium nitrate, 15% carbon and 10% sulfur and when they are burnt unsafe gases such like sulfur dioxide, carbon dioxide, carbon monoxide and nitrogen dioxide are discharged. SO_2 are increasingly lethal in light of the fact that they gradually assimilate in fine particles and move profound into the lung. SO_2 harm the tracheal nasal framework.

It has been found in numerous investigations that the surrounding air quality decreases during the Diwali celebration. The all the more disturbing circumstance is that in numerous urban cities this degradation of air quality is expanding each year during the Diwali celebration, uncovering the human lives to a more serious hazard. The national ambient air quality standards of some air pollutants are given in Table 1.

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S. no.	Pollutants	Time weighted average	Concentration in ambient air (μg/m³)
1	SO_2	Annual 24-h	50 80
2	NO_2	Annual 24-h	40 80
3	PM_{10}	Annual 24-h	60 100
4	$PM_{2.5}$	Annual 24-h	40 60
5	Ozone	8-h 1-h	100 180
6	Lead	Annual 24-h	0.5 1
7	CO	8-h 24 hours	02 04
8	NH_3	Annual 24-h	100 400

Table 1. National ambient air quality standards of air pollutants prescribed by Central Pollution Control Board (CPCB), India

SO_2 is a gas fundamentally transmitted from non-renewable energy source burning at power plants and other industries, just as fuel ignition in portable sources, for example, trains, ships etc. These emanation sources are steady however fireworks come in real life principally on Diwali. The change in concentrations of SO_2 during Diwali period will determine by how much percent the air quality degraded, and if found stable or improved it can be concluded that the order of ban on firecrackers in year 2017 was followed by the people of Lucknow.

Nitrogen oxides are produced in combustion processes, partly from nitrogen compounds in the fuel, but mostly by direct combination of atmospheric oxygen and nitrogen in flames. NO destroys the linings of the respiratory surface and thus reduce the intake of oxygen for the body. It has been found that NO $_{is}$ a deep lung irritant, which generates biochemical alterations and histological demonstrable lung damage in laboratory animals as a result of both acute and chronic exposure. But NO is not a major release of firecrackers. Therefore analyzing NO concentrations during the same time period of Diwali for three consecutive years 2016, 2017 and 2018 for comparison is important so that both the pollutants not showing same kind of trend could lead to a conclusion that only the pollutant present in the emission would show a rising or falling trend, and trend is because of fire cracker emission only.

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Datasets and Methodology

Hourly NO and SO_2 concentration values for three days i.e. a day before Diwali, the Diwali day and a day after Diwali for three years 2016,2017,2018 are collected from monitoring site CPCB. Out of four monitoring stations 1) Central School 2) Lalbagh 3) Nishatganj and 4) Talkatora we selected Lalbagh because it is the only station which provides us the maximum number of values that we need. Still some values are missing from the dataset so those observations have been excluded from our analysis. The average daily concentrations of NO and SO_2 for three days of three years are calculated and the values are compared. All the values are in $\mu g/m^3$.Temporal graphs are plotted from 01 to 24hrs to determine the change during the Diwali period from 2016 to 2018.

Results and Discussion

NO

	Pre Diwali	Diwali	Post Diwali
2016	37.12458	13.88625	47.56708
2017	21.30067	12.97292	13.4515
2018	10.28167	27.60375	19.91833

Table 2- Representation of the average daily concentration of NO

Table 2 shows the average values of NO concentration on three consecutive days during Diwali period for three years i.e. 2016, 2017 and 2018. Diwali fell on Oct 30 2016, Oct 19 2017 and Nov 7 2018. The concentration of NO decreased in year 2016 and 2017 by 62.59% and 39.09% respectively on Diwali day as compared to pre Diwali days. But in year 2018 the concentration rose by 168.47% on Diwali day over pre Diwali day. Also, it can be seen that in year 2016 and 2017, the values of concentration post Diwali were high as compared to Diwali days but in 2018 the concentration decreased by 27.84% during the same time period. Therefore, no specific trend can be seen in the variation of NO.

Fig 1 shows variation of NO during Pre Diwali days, Diwali days and post Diwali days for year 2016, 2017 and 2018. Here It can be seen that during pre Diwali days the NO concentration is decreasing with increasing year while during Diwali and post Diwali days the variation shows no specific trend. Hence it can be inferred that the variation is random.

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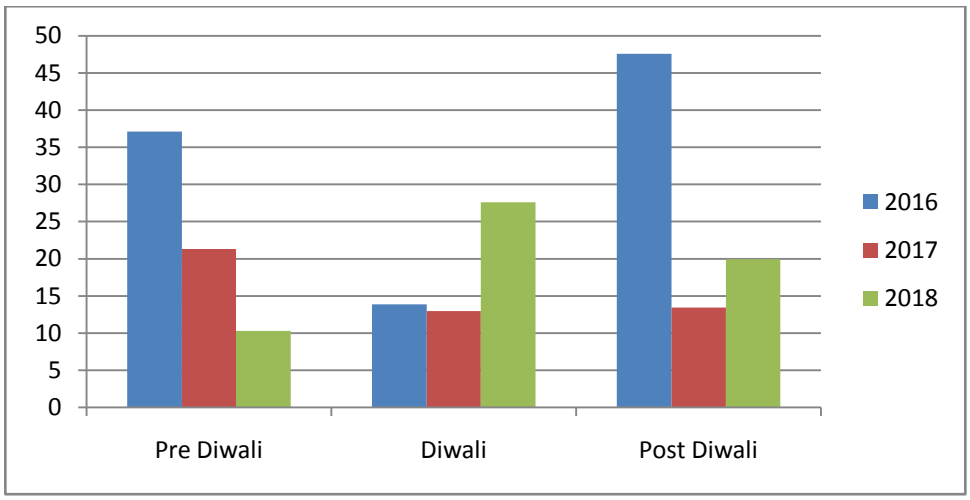

Fig. 1

Fig. 2 shows hourly variation of NO for three continuous days during Diwali period for the same three years 2016, 2017 and 2018. It can be seen that during night time on Diwali day the NO concentration was maximum in 24hours for year 2016 and 2018. In 2017, the NO level was high at night on Diwali day but not as high as it was on the night before Diwali. During morning time on all three consecutive days the level of NO was less compared to their night times except in year 2016.To sum up, the variation in NO level is unpredictable. The continuous rise and fall of values with no specific pattern depicts that the variation in NO concentration could be either due to variation in vehicular pollution or industrial pollution or due to the combined effect of both.

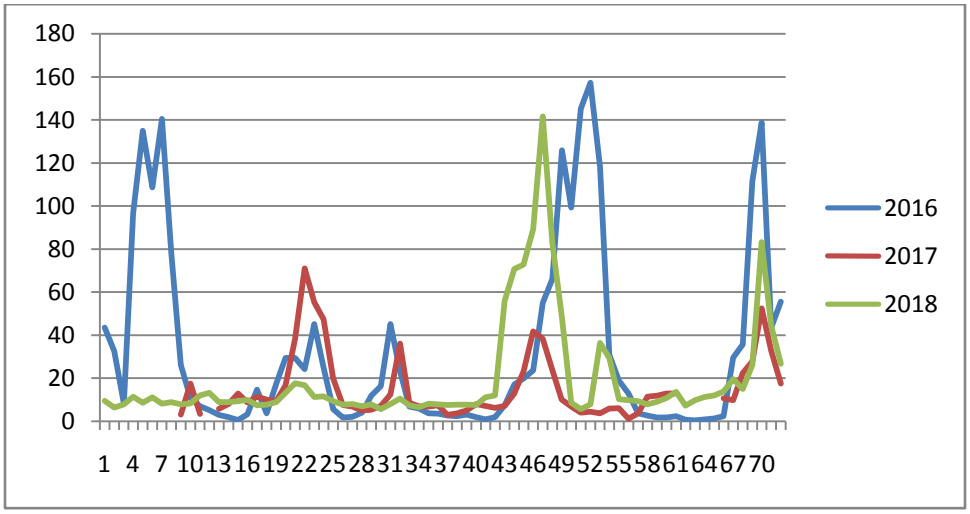

Fig. 2

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SO_2

	Pre Diwali	Diwali	Post Diwali
2016	9.089583	9.4275	13.1725
2017	5.264615	23.18417	11.058
2018	5.797083	21.74	18.385

Table 3 Representation of the average daily concentration of SO_2

From **Table 3** it can be observed that on Diwali day the SO_2 concentration increased on all three years including 2017 when the ban on firecrackers was imposed. In fact, the data shows rise of 340.3% on Diwali day in 2017 which was the maximum rise during that period as compared to 3.71 % in 2016 and 275.01% in 2018. Further, post Diwali the SO_2 concentration decreased by 52.30 % in 2017 and by 15.43 % in 2018 whereas in 2016 it increased by 39.72%. The data of three years during Diwali period does not show any significant behaviour of SO_2 with burning or ban of firecrackers.

Fig. 3 shows SO_2 concentrations on Diwali, Pre Diwali and Post Diwali days over three years 2016, 2017 and 2018. It can be seen that on Diwali days the values of SO_2 were higher as compared to other days for all three years. Maximum value recorded for Diwali day was 23.18 $\mu g/m^3$. But a 24-h concentration of SO_2 on the day of Diwali was found within their permissible limit as per NAASQ. But the values are not so high that they will harm the environment. The AQI is good for all nine days. These variations could be due to change in traffic density or from sources of SO_2 emission.

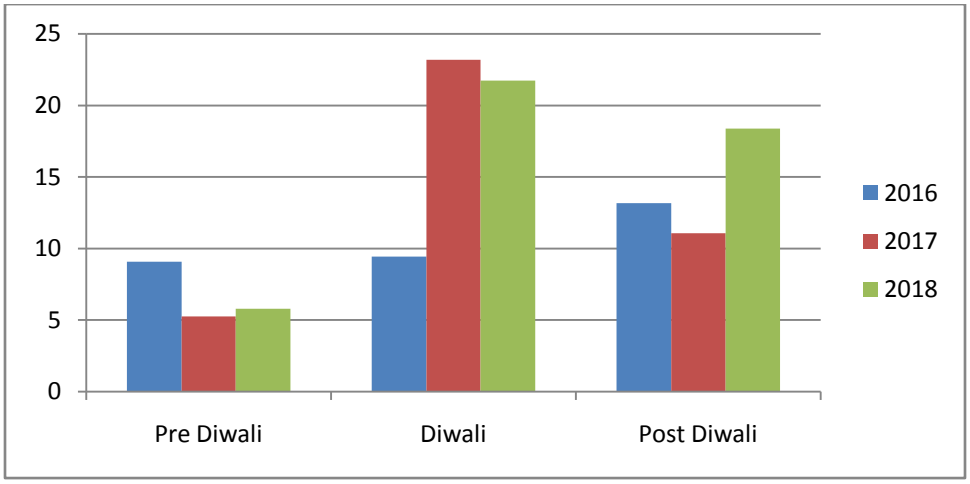

Fig. 3

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However, from fig**. 4** it can be seen that on Diwali day the SO_2 concentration drastically increased for all three years after 6pm and kept increasing till it attained maximum values of 41.31 μg/m^3 in 2016, 85.44 μg/m^3 in 2017 and 91.31 μg/m^3 in 2018 at midnight. From this, it can be said that the order by government stating ban on crackers was not followed by the people of Lucknow and the concentration increased due to burning of firecrackers during peak hours of Diwali day.

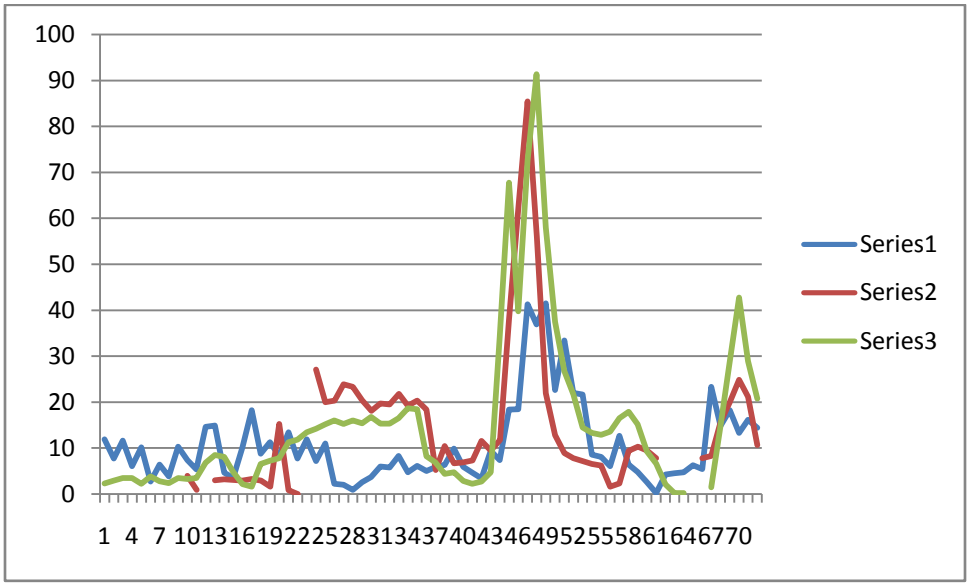

Fig. 4

Conclusion

The above results indicate that NO is not a major constituent and release of firecrackers since its variation shows no trend that can prove that huge burning of firecrackers on account of Diwali before and after the year it was ban had any impact on concentration levels of NO. The year 2017 was the year when ban on crackers during Diwali was introduced, and in that year also the fluctuations in NO concentration were random over the period of three days. So, whether or not people of Lucknow followed the orders passed by the Supreme Court is also not sure and cannot be predicted by the above observations.

However, SO_2 concentrations did show a rapid increase on Diwali days between 6pm to 10pm on all three years. Had there been any increase in SO_2 level in the mornings as well it could have been said that the increase is mainly due to vehicular emission because the vehicles coming back from offices in the evening would have obviously

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travelled in the mornings. But since the graph shows minimum values of SO_2 in the morning therefore high levels of SO_2 in the evening could be the cause of fire cracker emission.

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