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Study of Temporal Variation in Ambient Air Quality during Diwali Festival in Delhi – A Case Study

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Abstract
Fireworks are one of the most unusual sources of pollution potassium nitrate, carbon and sulphur apart from an array of chemicals such as strontium, barium, sodium, titanium, zirconium, magnesium alloys, copper and aluminum powder to create the colorful effects .The boundless in atmosphere containing harmful chemicals such as use of fireworks was found to be related to short-term variation in air quality of Delhi (28.6139°N, 77.2090°E). These variation episodes are responsible for high concentrations of pollutants (especially metals, organic compound and gases). In this paper the ambient concentrations of air pollutants [sulphur dioxide (SO_2), oxides of nitrogen (NO_2), Suspended Particulate Matter (SPM) and carbon monoxide (CO)] during Diwali have been compared to the data of a typical day in Delhi , November 2015. The data reveals that there is a shift in meteorological parameters which resulted in easy dispersion of air pollutants due to which the concentration of pollutants was observed to be increased ~23-fold at few sites. The trend also shows that pollutants concentration increased just before Diwali and reached to a maximum concentration on the day of the festival. These results also indicate that fireworks during the Diwali festival affected the ambient air quality adversely due to emission, dispersion and accumulation of air pollutants.

1. Introduction

Diwali (or Deepawali) is the festival of lights and is celebrated with great enthusiasm all over India every year. It is one of the major religious festivals of India. It is generally celebrated every year during October/November over a span of few days during winter season, associated with the burning of huge amount of crackers and sparkles [1]. Air quality of major cities in India is a serious concern due to their high pollutant concentrations and health hazards. Delhi, the capital of India, is one the most polluted cities in the world (WHO 1992) [3].It has been estimated that hundreds of thousands of cases of respiratory illnesses are associated with atmospheric pollution every year in Delhi. It is found that large scale burning of colored fireworks could generate increased level of pollutants such as SO_2, NO_2, TSP, PM 2.5, trace metals, aerosol black carbon, and PAHs in the atmosphere [2]. Fireworks are made of toxic chemicals, bursting a cracker releases sulphur compounds, heavy metals, coal, ozone, sulphur dioxide, nitrate oxide and other chemical elements into the air [1]. Chemicals like barium, aluminium, rubidium, cadmium, mercury and bronze are added to crackers to emit colors and sparks and inhaling these chemicals may cause health complications. One Diwali night causes as much damage to the ecology that a regular pollution does over the span of 1year [4]. It is estimated that the annual carbon dioxide emissions from fireworks is 60,340 tons or the same emissions from 12,000 cars on the road for a year. If one suggests that planting trees is a solution, then, please be informed that it would take the entire lifetime of 5,000 trees to offset the 60,000 tons of carbon emissions produced in this one day [4]. Not only it pollutes the environment, it also causes many deadly air-borne diseases. Atmospheric pollutants emitted during fireworks display, also have significant effects on human health. The combustion clouds contain harmful fumes and particulate matter released at the surface [8].The firecrackers burnt release pollutant and generate noise in the ambient air which has adverse impact on the general health of the living beings. Excessive use of noisy crackers turns the festival of Diwali into a nightmare for the people, as excessively high levels of noise pollution come dangerously close to the prescribed upper tolerance limit during this time. National Standards permit sound levels for residential areas at 55dB during the day and 45 dB during the night. The exposure to high levels of noise impairs the physical and physiological functioning of human organs and cause nausea, vomiting, fatigue, etc. Atmospheric inversion of cold Diwali night contributes to increase in the concentration of pollutants which subsequently get trapped under the same conditions that results in the formation of smog. The increasing concentration of pollutants in the atmosphere during Diwali festival definitely affects the respiratory system of the residents and increasing level of noise causes irritation, hearing loss and aggravates conditions of asthma and bronchitis. High aerosol loading causes dust and other pollution burst in the form of haze and smoke from burning of biomass and firecrackers during major festivals resulting in poor air quality and also causes short, as well as, long-term health effects. Recent studies have shown that PM2.5 and PM10aerosols can penetrate into the alveolar region of the lungs [10]. In India, 30% to 40% increased cases of wheezing, respiratory diseases, exacerbation of the

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bronchial asthma and bronchitis patients have been reported during the Diwali festival [10]. It was inferred that increase in pollutants due to firecracker may be responsible for the significant increase in the number of health cases in the course of the Diwali festival of India.

The objective of the present study was to monitor air quality parameters such CO (carbon monoxide), PM2.5, Sulfur Dioxide (SO2) and Nitrogen Dioxide (NO2) on and around the day of Diwali. fireworks display, also have significant effects on human health. The combustion clouds contain harmful fumes and particulate matter released at the surface [8].The firecrackers burnt release pollutant and generate noise in the ambient air which has adverse impact on the general health of the living beings. Excessive use of noisy crackers turns the festival of Diwali into a nightmare for the people, as excessively high levels of noise pollution come dangerously close to the prescribed upper tolerance limit during this time. National Standards permit sound levels for residential areas at 55dB during the day and 45 dB during the night. The exposure to high levels of noise impairs the physical and physiological functioning of human organs and cause nausea, vomiting, fatigue, etc. Atmospheric inversion of cold Diwali night contributes to increase in the concentration of pollutants which subsequently get trapped under the same conditions that results in the formation of smog. The increasing concentration of pollutants in the atmosphere during Diwali festival definitely affects the respiratory system of the residents and increasing level of noise causes irritation, hearing loss and aggravates conditions of asthma and bronchitis. High aerosol loading causes dust and other pollution burst in the form of haze and smoke from burning of biomass and firecrackers during major festivals resulting in poor air quality and also causes short, as well as, long-term health effects. Recent studies have shown that PM2.5 and PM10aerosols can penetrate into the alveolar region of the lungs [10]. In India, 30% to 40% increased cases of wheezing, respiratory diseases, exacerbation of the bronchial asthma and bronchitis patients have been reported during the Diwali festival [10]. It was inferred that increase in pollutants due to firecracker may be responsible for the significant increase in the number of health cases in the course of the Diwali festival of India. The objective of the present study was to monitor air quality parameters such CO (carbon monoxide), PM2.5, Sulfur Dioxide (SO2) and Nitrogen Dioxide (NO2) on and around the day of Diwali.

1.2 Meteorological parameters

The data there is a significant shift in wind direction (from W and NW) on the festival day ,which resulted in less humidity profile (moving around 42%) besides increase in wind speed from1.9m/sec to 3.4m/sec attributed to dispersion of pollutants. Normal atmospheric pressure of 988mb coupled with increased atmospheric mixing height to the level of 855 meter has resulted easy dispersion of air pollutants.

2. Study area

The air quality in Delhi is monitored through a set of Continuous Ambient Air Quality Monitoring System (CAAQMS) and manual stations (NAMP). The present analysis is based on the data collected by CPCB from 03 operational CAQMSs including DMS, Shadipur; NSIT, Dwarka and IHBAS, Dilshad Garden. The Central Pollution Control Board (CPCB) has setup these Continuous Ambient Air Quality Monitoring Station (CAAQMS) in Delhi at under public private partnership (PPP) model (under operation & Maintenance Contract).The study focused on changes in the PM2.5, SO2, NO2, CO concentration levels in the atmosphere during the fireworks associated with Diwali festival on November 5-11,2015

3. Results and Discussions

Following analysis shows that the burning of fireworks produces air pollution during Diwali. The full composition and the relative concentration of the various gaseous vapors and particulate pollutants emitted are not known. However, particulate matter (especially PM2.5), SO2 and NO2 are of special interest, as they are known to be potentially injurious. In general, the daily average concentration of SO2 before Diwali varied from 4 to 9μg/m3from figure [1,2,3]. During Diwali, the SO2 concentration ranged from 25 to 29μg/m3, i.e., almost three times higher than the daily average concentration from figure [1, 2, 3].The NO2 concentration on the day of Diwali is approximately the same as any typical day. Concentration of PM2.5 every year exceeded the maximum prescribed allowable limit before and after Diwali. The concentration of PM 2.5 increases up to 2.5 times than normal average concentration but at the station NSIT, Dwarka PM2.5 times decrease on the Diwali day.

IHBAS Dilshad garden saw a significant increase from 78.2 to 192 micrograms per meter cube during the time frame considered i.e. 5.11.2015 to 11.11.2015. Almost 2.5 times is the increase. A similar trend was observed for SO2 where the increase is almost two times. Large scale fireworks lead to increase in appreciably high levels of ambient atmospheric particulates and gases like SO2 and CO. This increase in trends can be credited to extensive use of fireworks and adverse meteorological conditions. IHBAS Dilshad garden saw a significant increase from 78.2 to 192 micrograms per meter cube during the time frame considered i.e. 5.11.2015 to 11.11.2015. Almost 2.5 times is the increase. A similar trend was observed for SO2 where the increase is almost two times. Large scale fireworks lead to increase in appreciably high levels of ambient atmospheric particulates and gases like SO2 and CO. This increase in trends can be credited to extensive use of fireworks and adverse meteorological conditions.

NSIT Dwarka witnessed a decrease in the concentration of PM 2.5 and a significant increase in the concentration of SO2. The increase is almost 4 times. The TSP is almost of the same order as compared to the concentration at an industrial site in Delhi around Diwali. The various suggested reasons could be a significant shift in the wind direction on the festival day and other atmospheric factors present around the monitoring location.

The variation in trends as monitored at DMS shadipur can be attributed to various parameters like average mixing height and wind speed. The variation observed is huge. It changed from 2.5 to 25.2 on the day of Diwali that is 11.11.2015. However, a decreasing trend was noticed for NO2 during the week considered.

3.1 Comparison of the Stations

Figure 4 depicts the variation of PM 2.5 from 5/11/2015-11/11/2015 at three different stations that are IHBAS, NSIT

Dwarka and DMS shadipur. According to the analysis, PM 2.5 was observed to reach the maximum value at NSIT Dwarka station on 7th November 2015. Trends shown in the figure reveal that the values of PM 2.5 remain considerably high at IHBAS and Dwarka station. On the day of Diwali, Dwarka witnessed the maximum PM 2.5 levels followed by Shadipur and subsequently Dwarka.

Table 1: Meteorological Parameters [Source: Data taken from CPCB website: http://www.cpcb.nic.in/]

Date	WS(m/sec)	WD	Temperature				RH (%)		Mixing Height	Pressure(mb)
			Max	Avg.	Min	Min	Max	Avg	Avg	Avg
5.11.2015	2.2		25.6	21	19	57	84	75	445	986
6.11.2015	1.8	NW	29.4	23.9	19.2	42	81	62	585	987
7.11.2015	1.8	NW	27.1	23.4	19.7	45	83	63	571	988
8.11.2015	1.9	NE, N	27.3	22.9	20.4	45	71	60	584	989
9.11.2015	1.4	NE, N	28.5	24.2	20.7	38	70	56	529	988
10.11.2015	1.9	NW, N	28.8	24.7	20.9	39	67	53	491	987
11.11.2015	3.4	NW, W	28.3	23.7	20	33	60	47	590	988

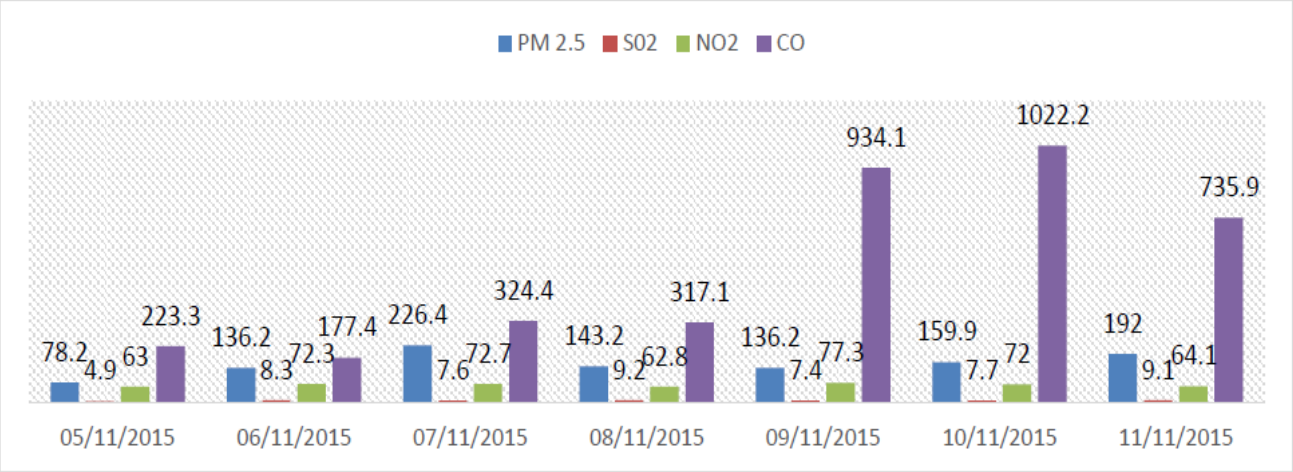

Fig. 1: Air pollutants level at IHBAS, Dishad garden [Data taken from CPCB; http://www.cpcb.nic.in/]

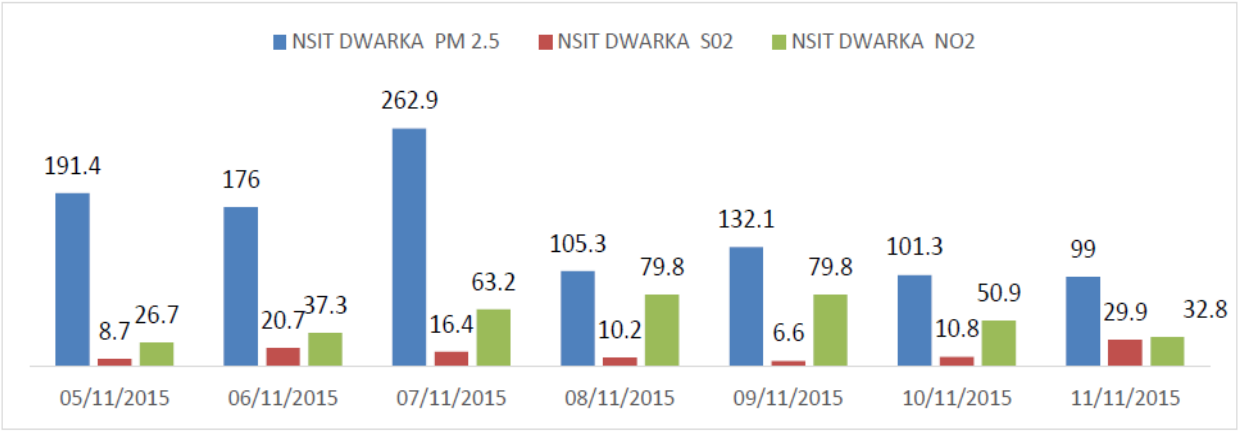

Fig. 2: Air pollutants level at NSIT, Dwarka [Data taken from CPCB website: http://www.cpcb.nic.in/]

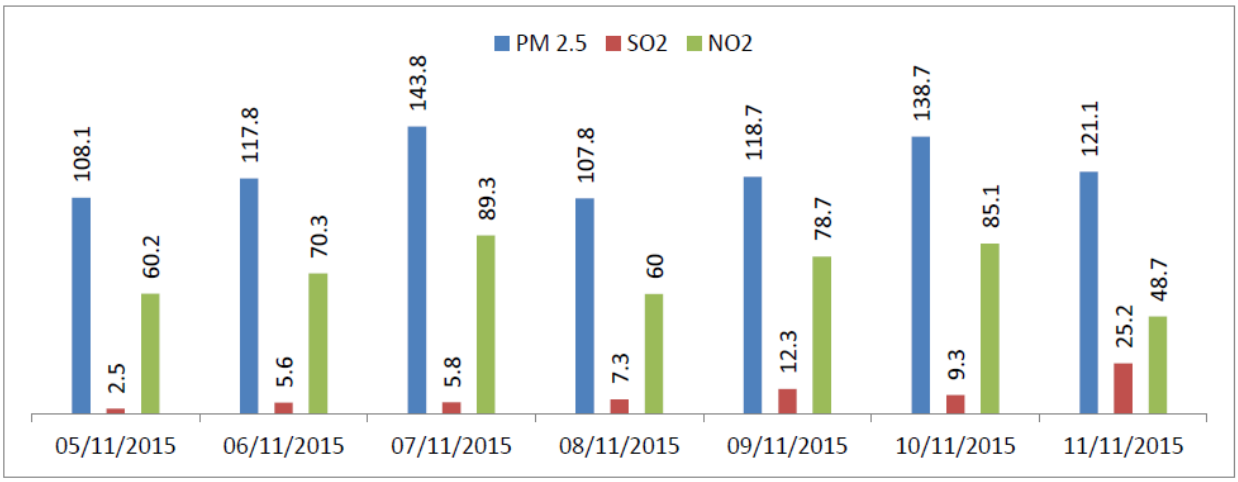

Fig. 3: Air pollutants level at DMS, Shadipur [Source: Data taken from CPCB website: http://www.cpcb.nic.in/]

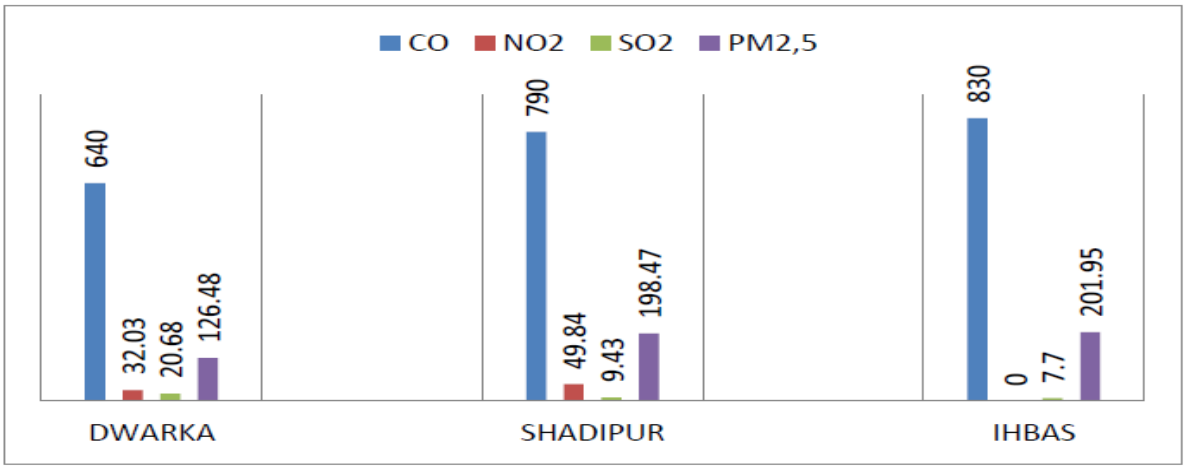

Fig. 4: post Diwali readings[CPCB,continuous ambient air assessment]

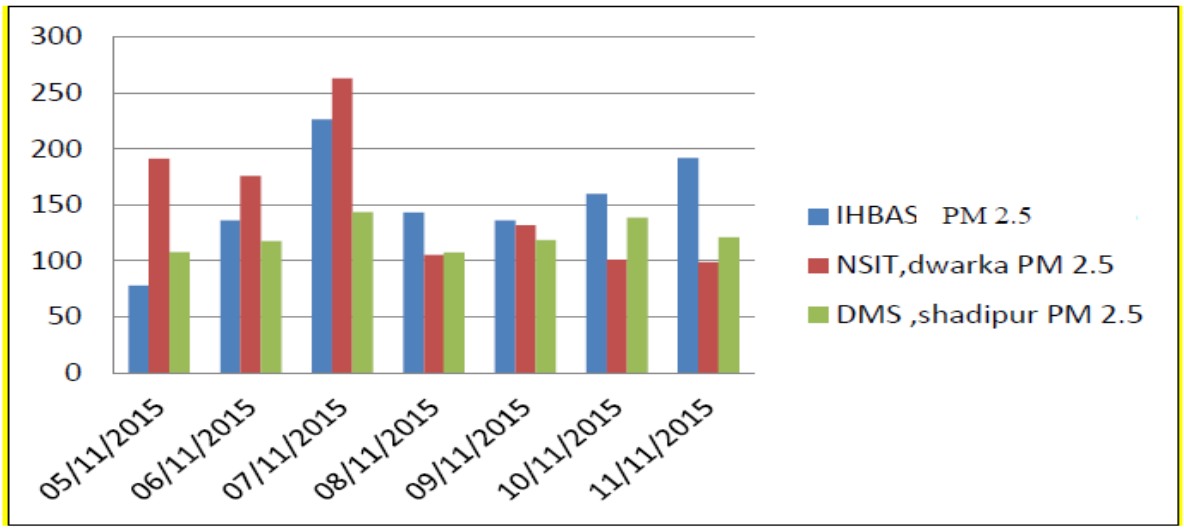

Fig.5: Comparison of the PM2.5 readings at different stations [Data taken from CPCB, http://www.cpcb.nic.in/]

4. Conclusions

This study shows that the burning of crackers and sparkles on the occasion of Diwali is a strong source of CO,PM2.5, SO2 and NO2 in ambient air and are emitted in very high quantity, as high as two to six times, as compared to non-Diwali festival days. Increase in air pollutants values in general may be attributed to adverse meteorological conditions which has caused accumulation of pollutants at lower level, there by increasing the concentration of all air pollutants substantially. The higher level of pollutants, especially the manifold increase (four times) of PM2.5 is of great concern with regard to the health effects. Strong correlation was observed between air pollutants and meteorological parameters (temperature, relative humidity, and wind speed).The same may be expected in other cities in India as this festival is celebrated all over the country. Hence, for the benefit of society, it is necessary to formulate proper strategy to control the emission and subsequent dispersion of the pollutants. Following measures may be considered:

- Promotion of firecracker display as a community entertainment.
- Prohibition of firecracker burning on roads/lanes and earmarking of large open spaces, away from residential area, for firecracker display.
- Crackers, exploding at a higher elevation (higher than the normal skyline of the locality) may be encouraged for a better dispersion.

References

[1.] D. P. Singh·Ranu Gadi·T. K. Mandal· C. K. Dixit·Khem Singh·T. Saud· Nahar Singh·Prabhat K. Gupta. Study of temporal variation in ambient air quality during Diwali festival in India, Environmental Monitoring and Assessment; 2009,1-13

[2.] Vaishali V. Khaparde , Pradeep P. Pipalatkar , Tushar Pustode , C. V. Chalapati Rao & Daulat G. Gajghate. Influence Of Burning Of Fireworks On Particle Size Distribution Of Pm10 And Associated Barium At Nagpur, Environmental Monitoring and Assessment; 2011, 903-911

[3.] Venkata Swamy Yerramsetti , Anu Rani Sharma , Nikhil Gauravarapu Navlur , Venkanna Rapolu , N. S. K. Chitanya Dhulipala & P. R. Sinha. The Impact Assessment Of Diwali Fireworks Emissions On The Air Quality Of A Tropical Urban Site, Hyderabad, India, During Three Consecutive Years", Environmental Monitoring and Assessment; 2013,7309-7325

[4.] V. S. Chauhan, Bhanumati Singh, Shree Ganesh & Jamshed Zaidi; Status Of Air Pollution During Festival Of Lights (Diwali) In Jhansi Bundelkhand Region, India; Asian Journal of Science and Technology; 5(3), 2014, 187-191.

[5.] Papiya Mandal , Mamta Prakash & J. K. Bassin, Impact Of Diwali Celebrations On Urban Air And Noise Quality In Delhi City, India, Environmental Monitoring and Assessment; 2011, 209-215

[6.] Nandita D. Ganguly ,Department Of Physics, St. Xavier's College, Ahmedabad; Surface Ozone Pollution During The Festival Of Diwali, New Delhi, India; e-Journal Earth Science India, 2 (IV), 2009,224-229

[7.] Cinzia Perrino , Suresh Tiwari , Maria Catrambone, Stefano Dalla Torre , Elena Rantica , & Silvia Canepari ; Chemical Characterization Of Atmospheric Pm In Delhi, India, During Different Periods Of The Year Including Diwali Festival", Atmospheric Pollution Research; 418-427

[8.] Sapan Bhatnagar & Shubham Dadhich. Assessment Of The Impact Of Fireworks On Ambient Air Quality", International Journal for Research In Applied Science & Engineering Technology (IJRASET); 3(4), 2015, 605-609

[9.] Apoorv Thakur & R.K. Bhatia, Study Of Urban Air Quality – A Case Study Of Delhi; 3(5), 2015, 1151-1153.

[10.] Chirag Verma1 & Dhananjay K. Deshmukh, The Ambient Air And Noise Quality In India During Diwali Festival: A Review", Recent Research in Science and Technology 2011, 203-210

[11.] SC Barman, Ramesh Singh, MPS Negi , S. K. Bhargava, Ambient Air Quality Of Lucknow City (India) During Use Of Fireworks On Diwali Festival, Environmental Monitoring and Assessment, 137 (1), 2014.

[12.] Chatterjee1, C. Sarkar, A. Adak1, U. Mukherjee, S.K. Ghosh & S. Raha1, Ambient Air Quality during Diwali Festival over Kolkata – A Mega-City in India; Aerosol and Air Quality Research, 132013, 1133–1144.

[13.] S. C. Barman ,Ramesh Singh ,M. P. S. Negi & S. K. Bhargava, Ambient Air Quality Of Lucknow City (India) During Use Of Fireworks On Diwali Festival, Environmental Monitoring and Assessment; 2007, 495-504

[14.] Central Pollution Control Board (CPCB).NationalambientairqualitystatisticsofIndia.Parivesh Bhavan, Delhi. http://www.cpcb.nic.in/. 2000.