ASSESSMENT OF THE AMBIENT AIR QUALITY DURING DIWALI FESTIVAL OVER FARIDABAD CITY - A CASE STUDY

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ABSTRACT

Deepavali festival is distinguished by bursting a huge amount of fire-crackers. After bursting of crackers, respirable suspended particulate matter (RSPM) and suspended particulate matter (SPM) have been released into the lower part of atmosphere. Apart from these, toxic gases, carbon dioxide, oxides of sulphur and nitrogen have also dissolved in the lower atmosphere. An attempt has been made in the present study, for investigating the effect of the dispersion in lower atmosphere of these gases due to bursting of fire crackers during Deepavali over Faridabad city. For the same purpose, meteorological data and aberrant air quality data of last four years (2014, 2015, 2016 and 2017) have been used in this study. After carefully examination, the present study advocates that the ambient air quality in Faridabad city during Diwali festival changes when compared with non-Diwali days. The study regions have shown the severe air pollution for all four years during Diwali days as compare to the Non-Diwali days.

INTRODUCTION

Deepavali or Diwali traditionally known as the "festival of illuminations" is an essential five-day festival occurring between mid-October to mid-November, celebrated for different reasons in India. Diwali is one the momentous festival of the year for Hindus and is notable in relations by performing traditional proceedings organized in their homes. Diwali characters the understanding of moksha or nirvana by Mahavira in 527 BC for Jains. According to (Chauhan, *et al.*, 2010), for Sikhs, Diwali is substantial for the reason that it has a good time the release from prison of sixth guru, Guru Hargobind, who also rescued 52 Hindus kings held captive by Mughal King with him in the Gwalior fort in 1619.

On the occasion of Diwali, the entire parishioners share snacks and sweets with family members, relatives and friends. They should wear new clothes maybe it's a ritual of them those are celebrating the festival of illuminations (Barman, *et al.*, 2007). (Dolti, 2010) has suggested base on his study that, Diwali is the first day of the financial year in most Indians business societies.

The festival of light is mostly celebrated in SAARC countries (India, Nepal, Maldives, Bangladesh, Pakistan, Sri Lanka, Bhutan and Afghanistan) and other part of the world by (Joshi, 1998). Due to the bursting of the fire cracker on this occasion, air pollution may be increase in the lower part of the atmosphere. (BIS, 2003) has been suggested that air pollution rate may increase in ambient atmosphere of stuffs, generally consequent from the activity of man, in sufficient time and under backgrounds which interfere meaningfully with the traditionalism, heath or welfare of persons or with the full use or pleasure of property.

Air pollution monitoring is though old but very useful idea in daily life. Air pollution monitoring starts from traditional way to the most sophisticated computer has been used to monitoring the air quality, however the fresh air is necessary for all human being, for that various technologies have been used and some

of these technologies are really useful in order to provide a real time air quality data.

Air pollution monitoring is a systematic approach for observing and studying the condition of air pollution. The main operation of air quality monitoring network is to record the concentration and dispersion of air pollutants and other parameters related to the pollution and deliver this information or data to the population to warn against any danger.

(Kaushik, *et al.*, 2016) has been study about Valuation of ambient air quality over Haryana state (some urban centers) in relative to different anthropogenic accomplishments and health hazard. They estimate TSPM, PM10, SO_2 and NO_2 during dissimilar seasons from eight districts of Haryana during January 1999 to September 2000 and identified four different types of activates in each city. They conclude that in all cities the levels of TSPM and SO_2 identified in high concentration and they advocate also the TSPM and SO_2 high level especially in winter season may be major health concern because of their synergistic action.

(Gour, *et al.*, 2015) have been study of ambient air quality of different types of parameters over Delhi region and conclude that the life style of peoples during weekend and weekdays may be the main reason of the pollution. (Deswal and Verma, 2016) have been studied of air quality index over Delhi region and advocates that increasing industrial and other developmental activities maybe the main sources of air pollution in that region. (Chatterjee, *et al.*, 2013) have been studied the air quality over Kolkata during Deepavali in November 2010 and they conclude that concentration of PM10 nearly 5 time higher in Deepavali night compare to normal days because of the extensive use of the firecrackers during in that period. Air pollutant concentration during Diwali time has been notice over Howrah (Thakur, *et al.*, 2010).

(Dhananjayan, *et al.*, 2015) have been studied about air quality status Diwali festival over Bhuj. In this study, SO_2, NO_2, SPM and RSPM estimated from selected residential sites during Diwali, pre and post Diwali period. They conclude that all estimated pollutants (SO_2, NO_2, SPM and RSPM) found higher concentration during Diwali period as compare to pre and post Diwali period.

Some air pollution dispersion studies in different seasons (Boadh, *et al.*, 2014; Boadh, *et al.*, 2015; Boadh, *et al.*, 2016; Boadh, *et al.*, 2017a) have also reported over different places in India. (Srinivas and Purushotham, 2013) have been determination

air quality status over different industrial areas in Visakhapatnam of different air pollutants and found high of air pollutant in winter as compare to other seasons.

(Rao, 2013) has been studied about comparative study on concentration of air pollutants and rainfall over Visakhapatnam by using different type of air pollutants. After carefully examine, they advocate that in different seasons concentration of different pollutants may be different, due to changed weather conditions. (Ye, *et al.*, 2001) have been investigate the effects of temperature and air pollutants on human's health in Tokyo between July and august 1980-1995 and they conclude that there is daily expected no. of numbers of emergency transports in hospitals per million between males and females.

(Tongdi, 2016) has been studied about RSPM and SPM levels over Assam for few selected sites during the last decade. After carefully examination they conclude that SPM and RSPM are continuous increasing movement in all the seasons, mostly it is increasing in winter season in significant manner except during the monsoon season. They also advocate that, in overall decade, RSPM remained above the AQI standard levels compare to SPM.

(Barman, *et al.*, 2010) have been studded regarding the assessment of urban air pollution and it's probable impact on human health. For this purpose, they selected one village area for control and 10 representative sites in urban area for the study of SPM, RSPM, and seven trace metals estimated form these sites, NO_2 and SO_2. This study has advocated that, the ambient air quality in the urban area is affected destructive due to emission and increase of RSPM followed by SPM, NO_2, SO_2 and trace metals.

(Yadav, *et al.*, 2012) study has been about assessment of ambient air quality status in urban residential areas of Jhansi city and rural residential areas of adjoining villages of Jhansi city. In this study SO_2, NX, SPM and RSPM estimated from selected urban and rural residential sites. They advocate that, the concentration of RSPM in the lower atmosphere is higher in the urban residential area as compare to rural residential area on the other hand the average concentration of SPM noticed in urban and rural residential areas. On the other hand, the nitrogen oxides and sulpher dioxide levels in rural housing area and urban residential areas stay under prescribed limits of Central Pollution Control Board (CPCB). In the end, they advocate that, the average

AQI value in rural residential areas was lesser than as compare to urban residential areas.

Boadh et al. (2017b) has concluded that, primary meteorological parameters are playing the most important role for dispersion of the air pollutants. Keeping all things in mind, an attempt has been made to identify the air pollution condition over Faridabad city during Diwali and Non-Diwali period.

STUDY AREA AND DATA

In the present study, for investigate air pollutants (SPM, RSPM, NOX and SOX) during Diwali and non-Diwali days the Faridabad city has been considered (Fig. 1).

Faridabad city is the largest city in the north Indian state of Haryana. According to Greenpeace India, the second most polluted city is Faridabad in India. It is fast growing city and leading industrial centre situated in the National Capital Region nearby the Indian capital New Delhi. For validation of air pollutants such as; Suspended Particulate matter (SPM), Respirable Suspended Particulate Matter (RSPM), Oxides of sulphur (SOX) and Oxides of Nitrogen (NOX) with Air Quality Index (AQI), the Central Pollution Control Board (CPCB) observation data has been used. Wind Speed (WS) and Wind Direction (WD) is the primary driver, Temperature (T) and Relative Humidity (RH) are secondary for air pollution. They play most important role for dispersion or dilution of air pollutant. In the present study, WS, WD, T and RH observation data for the
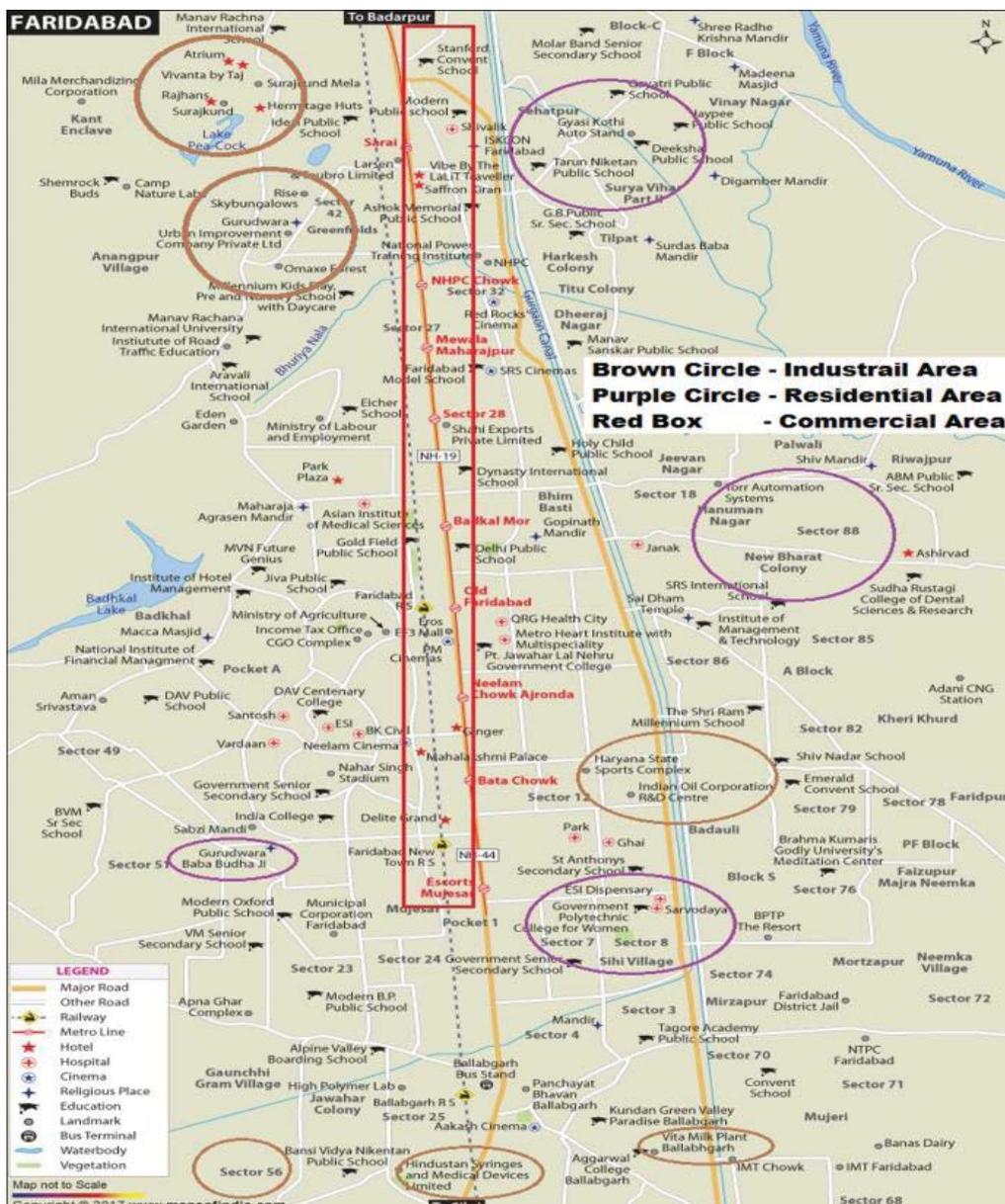
Fig. 1 Faridabad city map.

month of the Diwali festival in 2014, 2015, 2016 and 2017 have been taken.

METHODOLOGY

The measures parameter indicating air quality is the two leading groups of air pollutants namely RSPM and SPM are gaseous pollutants. The respirable particulates or respirable suspended particulate matter (RSPM) as well as the Total suspended particulate matter (TSPM) take account of the gravelly. Healthiness hazards are reason primarily by the RSPM. RSPM initiate primarily from work areas like construction sites and other air polluting industries. (Thakur, *et al.*, 2010) have studded and suggested regarding long-winded pollutants include SOX, NOX, ozone, ammonia and halogens.

Air Quality Index (AQI)

The air quality index (AQI) is a portion fraction of pollutant concentration to the status of ambient air. It has been observed that the air quality or directories of air pollution using form 25 years.

The air quality index will be computed by using the following equation

$$AQI = \frac{1}{4}\left[\frac{RSPM}{sRSPM} + \frac{SPM}{sSPM} + \frac{SO_2}{sSO_2} + \frac{NO_x}{sNO_x} \right]100$$

where sRSPM, sSPM, sSO$_2$ and sNOX are represents the ambient air quality standards as prescribed by the Central Pollution Control Board and SPM, RSPM, nitrogen oxides and sulphur dioxide respectively. On the other hand, all the above pollutants such as NOX, SO$_2$, SPM and RSPM are represents the actual values of pollutants obtained on sampling.

AQI Scale

The scale of the AQI has been divided into five different classes, each class designates the range of Air Quality (AQ) and health effects connected form it. The five different classes of air quality index are described in the following Table 1.

In the present study, suspended particulate matter (SPM), Respirable suspended particulate matter (RSPM/PM10), Oxides of nitrogen (NOX) and Oxides of sulphur (SOX) have been monitored by using above mention methods.

RESULTS AND DISCUSSION

In the present section, first Surface meteorological parameters such as wind speed and wind direction in the form of wind roses have been discussed because they parameter play important role for dispersion and concentration of air pollutants.

Surface meteorological parameters

Wind roses during Diwali and non-Diwali period over Faridabad in 2014, 2015, 2016 and 2017 have shown in (Fig. 2-5) respectively.

In 2014, during Diwali period, mostly wind roses blowing form East, North East and East North East direction (Fig. 2a) and wind speed 1 ms^{-1} to 3 ms^{-1}

Table 1. The classes of AQI.

AQI ($\mu g\ m^{-3}$)	Description
0-25	Clean air
26-50	Light air pollution
51-75	Moderate air pollution
76-100	Heavy air pollution
>100	Sever air pollution
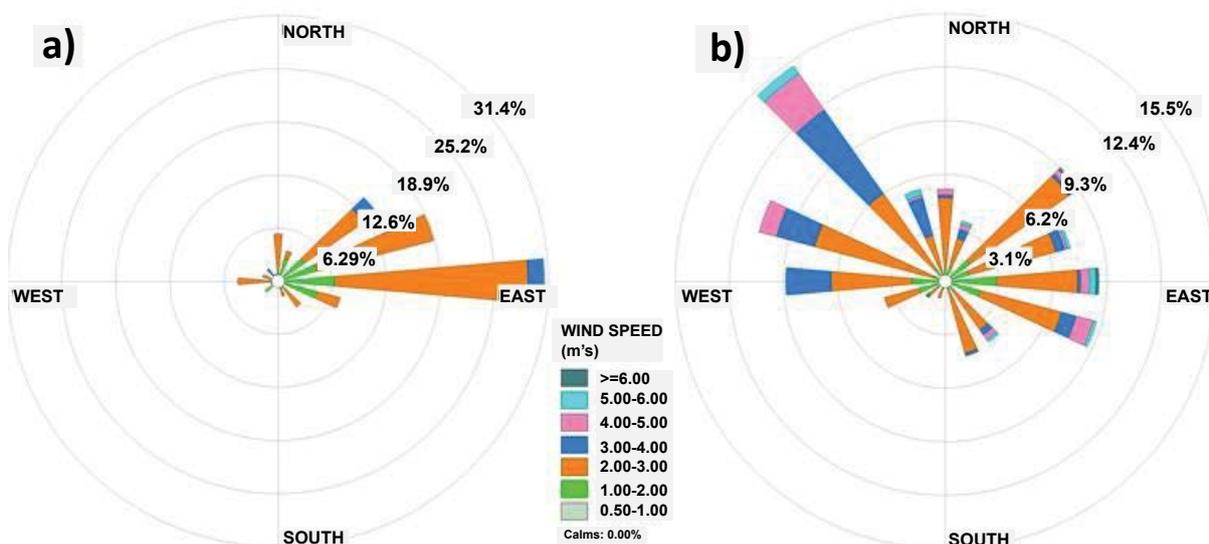
Fig. 2 Wind roses during (a) Diwali and (b) non-Diwali over Faridabad in 2014.
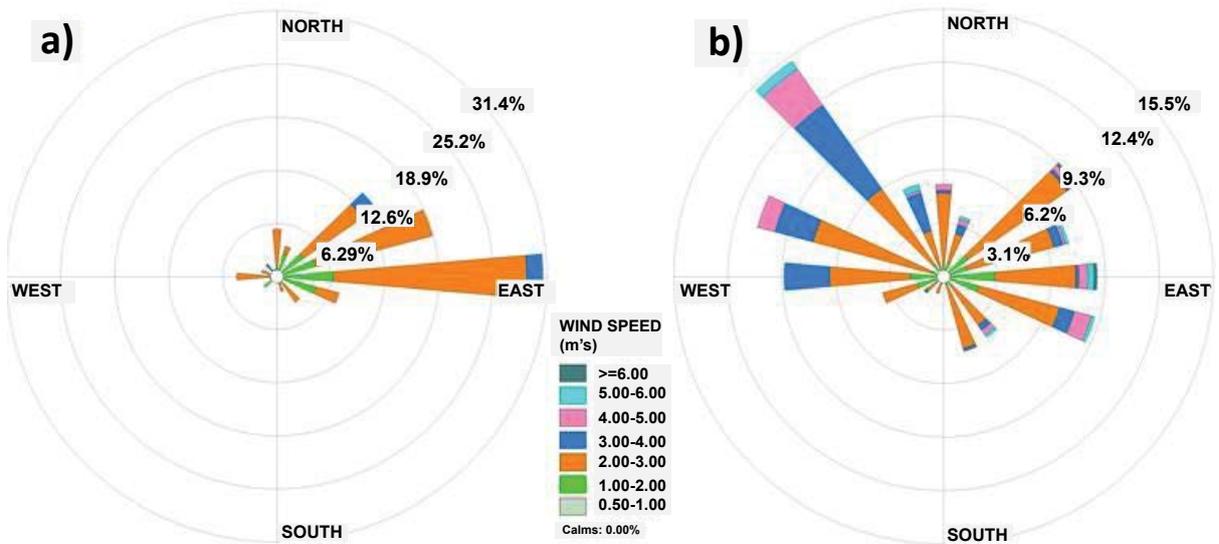
Fig. 3 Wind roses during (a) Diwali and (b) non-Diwali over Faridabad in 2015.
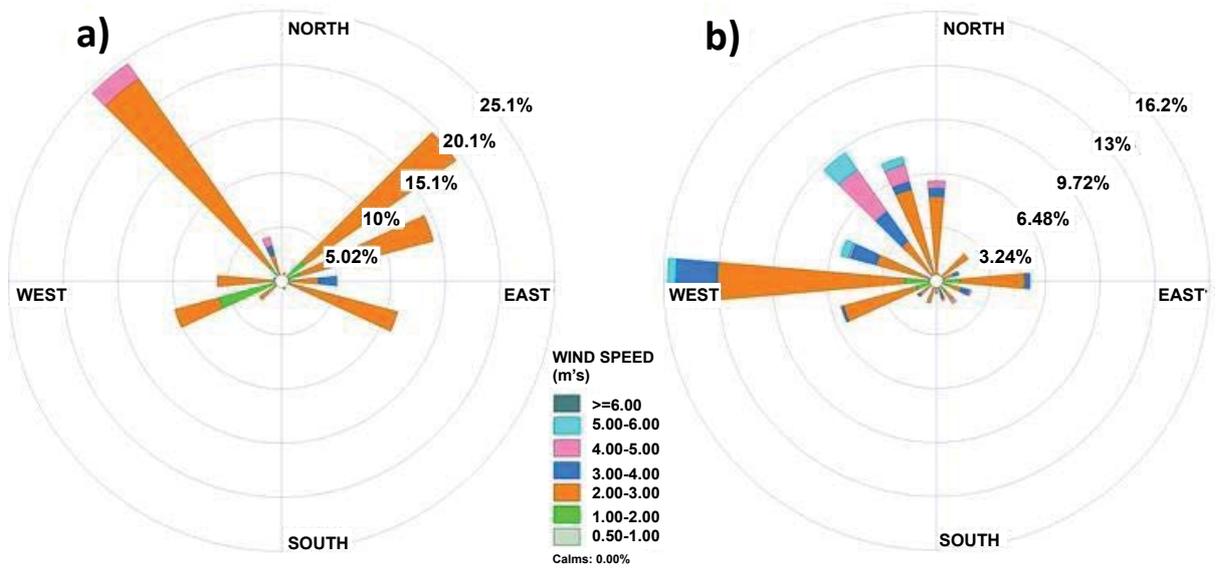
Fig. 4 Wind roses during (a) Diwali and (b) non-Diwali over Faridabad in 2016.
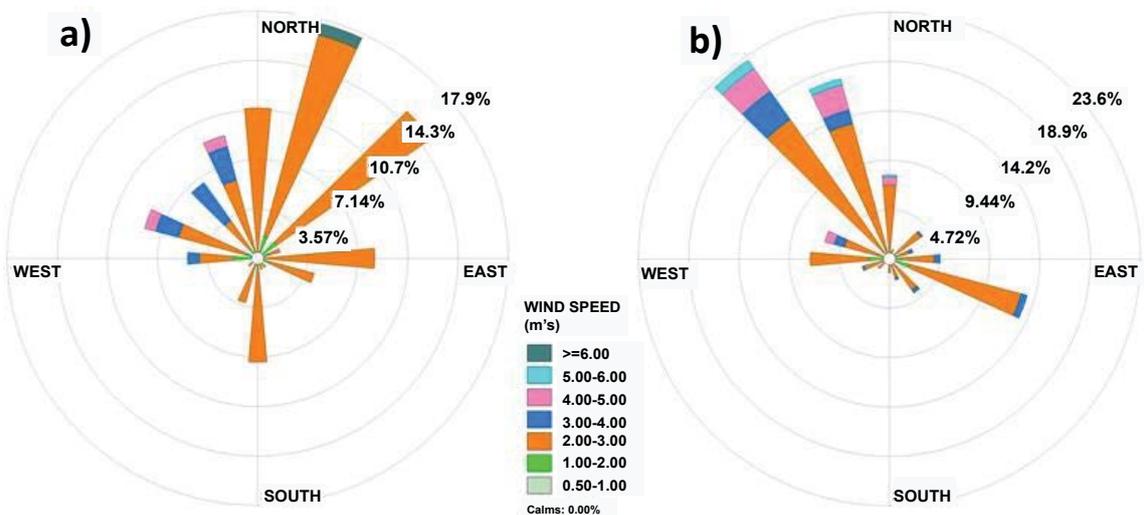
Fig. 5 Wind roses during (a) Diwali and (b) non-Diwali over Faridabad in 2017.

noticed during this period. Compare to Diwali days, mostly wind roses blowing from North West, West North West, North East, East and East South East direction during non-Diwali days. During this period, wind speed noticed nearly 5-6 ms⁻¹ over Faridabad. It is indicating that in 2014 during Diwali period concentration of pollutants maybe very high compare to non-Diwali period.

Wind roses have been blowing from West, West North West and North direction during Diwali period but in low frequency (2 ms⁻¹ to 3 ms⁻¹) in 2015. During non-Diwali period, wind roses have been blowing in half of the domain (West to East) and most of the wind roses have been blowing from North West North direction and wind speed varies from 1 ms⁻¹ to 5 ms⁻¹. The dispersion of the pollutants and concentration.

Validation of air pollutants with AQI

In this section, validation of NOX, SOX, RSPM and SPM with AQI have been discussed during the study period (Diwali and non-Diwali) in 2014, 2015, 2016 and 2017. For this purpose, three sites where taken involving residential, commercial and industrial areas have been considered.

In Diwali days, the changes in ambient AQ have been shown in (Fig. 6). The changes in ambient air quality during Diwali days have been shown in Table 1. It's clearly seen that residential and commercial area shown less SPM compared Industrial in 2014. Higher

value of RSPM over commercial area in 2015 and 2017 has been observed as compare to residential and industrial. The NOX level in commercial area exceeds the AQI standard in 2014 and rest of study duration AQI standard is high. During Diwali time SPM concentration is high in all three areas during the study period. According to AQI (Table 1), SPM concentration has been showing the severe air pollution in residential, industrial and commercial area during the study period.

The AQI during non-Diwali days in the same month in which Diwali was celebrated in years 2014, 2015, 2016 and 2017 in residential, commercial and industrial areas has shown in (Fig. 7). During Non-Diwali days SPM, RSPM concentration exceeds the AQI standards and in study regions have shown (Fig. 7) the severe air pollution. The industrial area in 2015 has shown the nearly 430 µg-3 concentration of SPM and RSPM nearly 225 µg-3 concentration has been shown (Fig. 7). It has been clearly seen that during Diwali days the concentrations of all studied pollutants showing the severe air pollution as compare to the Non-Diwali days over the Faridabad city.

It has been observed in the present study, that the higher values of SPM and RSPM in Industrial area followed by Commercial and Residential areas during Diwali and Non-Diwali days. During the periods of non-Diwali days, the residential area has been shown the lesser amount of value of all
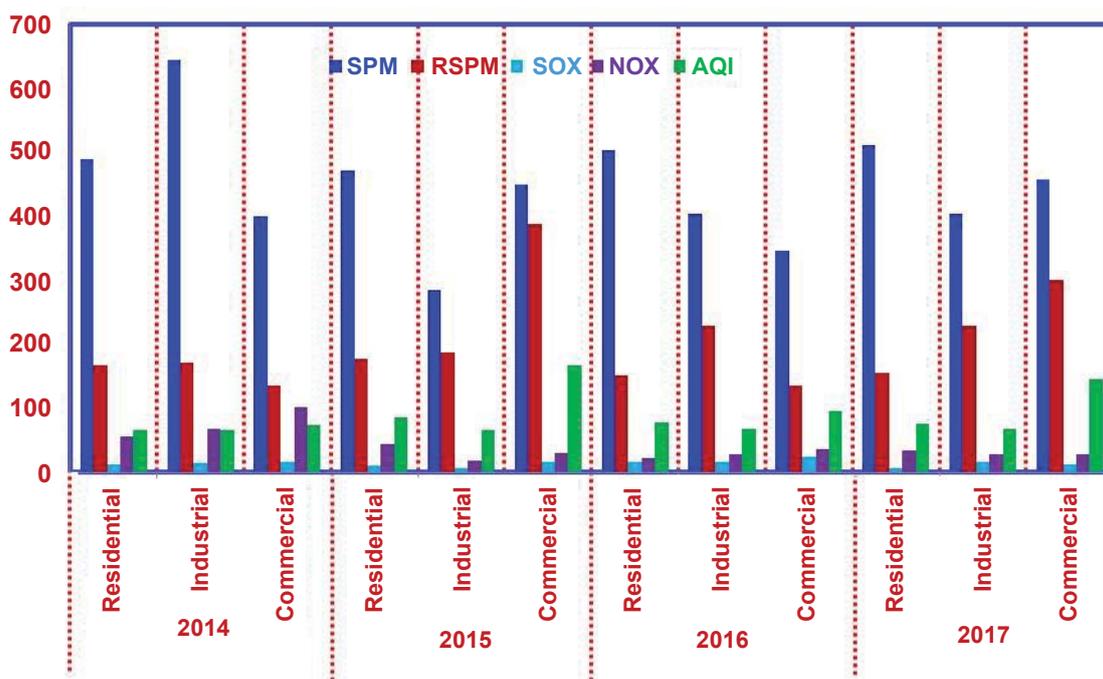
Fig. 6 Concentration (µg⁻³) of SPM, RSPM, SOₓ and NOₓ with different location (Residential, Industrial and Commercial) compare with AQI during Diwali days over Faridabad.
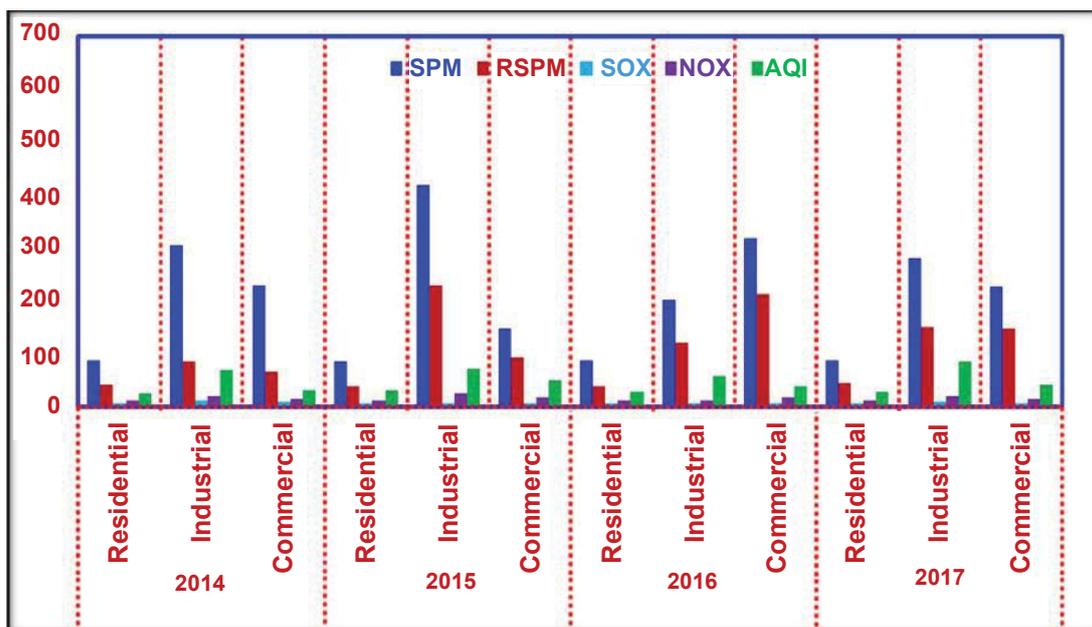
Fig. 7 Concentration (μg^{-3}) of SPM, RSPM, SO_X and NO_X with different location (Residential, Industrial and Commercial) compare with AQI during Non-Diwali days over Faridabad.

examined parameters associate to industrial and commercial regions.

CONCLUSION

Wind speed and wind direction both are major factor to dispersion of the air pollutants and play the important role to dispersion and concentration of the air pollutants. In the present study, an attempted has been made to explain wind speed and wind direction in the form of the wind roses. The concentrations of SPM and RSPM during Diwali and Non-Diwali days have been shown severe air pollution over Faridabad during the study period. It has also observed that NOX and SOX concentration is also high and exceeds the AQI standards during Diwali periods and follows by Non-Diwali days. The present study concludes that the residential area and commercial area showing the severe air pollution during Diwali period where as during Non-Diwali days the pollution levels in under AQI. After carefully examination, the present study advocates that peoples should be decreasing to use the fire crackers during Diwali festival as well as other events. The current amendment of this study has advocate to the administration, might be implementation to the different regulations about the bursting at the seams of fire crackers during Diwali festival and other events.

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