

## Five year study of particulate matter during Diwali in Amritsar, Punjab

Gagan Gupta<sup>1</sup>, Veena Sharma<sup>2</sup>

<sup>1,2</sup>Assistant Professor, GZSCCET, MRSPTU, Bathinda

### ABSTRACT

Diwali is one such festival of India marked with lighting of lamps and celebrations with major fireworks all over the country. The fascinating characteristic of Diwali is that every household participates in bursting firecrackers, leading to emission of huge volume of particulate matter into the atmosphere in one single day and cause significant short-term air quality degradation with possible impact on human health. In this paper five year (2011-2015) comparative study of particulate matter (PM) during Diwali period in the city of Amritsar, Punjab is carried out. The city was chosen for the study because it lies in the critical pollution zone region. In order to study the impact of different regions on PM concentration the whole city was divided into four zones which includes commercial areas, residential areas, sensitive areas of city and Shri Darbar Sahib. The study includes 24 hour average concentration of  $PM_{10}$ . The exceedence factor (EF) has been calculated for the four selected region. The continuous decrease (3.9 to 2.4) in the exceedence factor (EF) has been observed during Diwali day for Shri Darbar Sahib, still the region lies in the critical pollution zone. The lowest value of the  $PM_{10}$  concentration has been observed for the year 2015 before and during Diwali. This decrease is due to the preventive measures taken by the pollution control board and by spreading awareness among the general masses.

**Keywords:- Amritsar, Diwali, Particulate Matter, Exceedence Factor**

### I. INTRODUCTION

In India, Air pollution is increasing day by day due to industrialization and increase in the numbers of vehicles. The firework which is the part of the celebrations also contributes towards the rise of particulate matter concentration in atmosphere thus leading to rise of air pollution. The crackers are formed with toxic substances and burning of crackers result in the release of toxic gases and heavy metals in the environment. The Diwali is one such festival of India which is marked with lighting of lamps and celebrations with major fireworks all over the country. The fascinating characteristic of Diwali is that every household participates in bursting firecrackers, leading to emission of huge volume of aerosols into the atmosphere in one single day. With time, Diwali celebrations are growing in magnitude and scale in large cities. This trend could be explained in terms of relative affluence of the urban population in the country. The particulate matter concentration increases tremendously on Diwali and cause short-term air quality degradation and put possible impact on human health

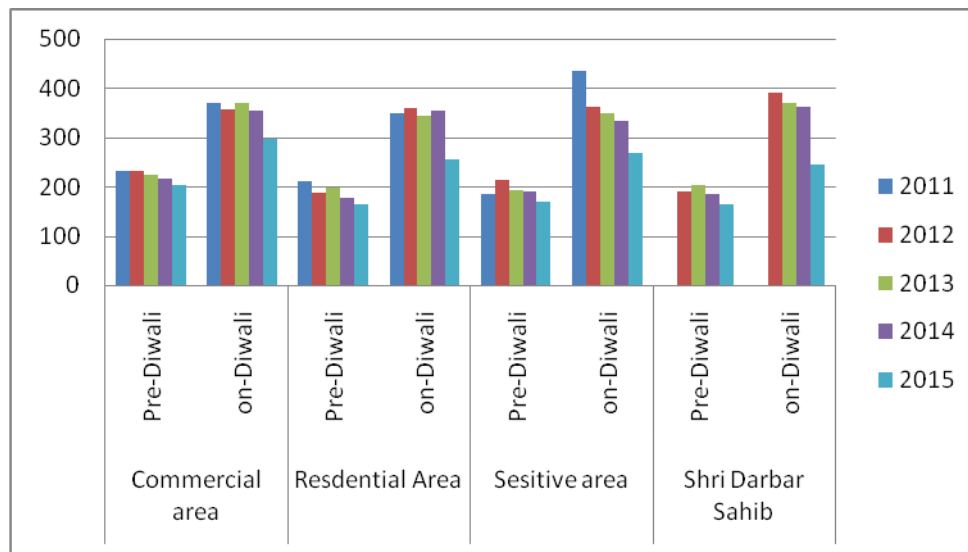
[1-4]. Furthermore, Diwali comes in the winter season, so the large production of the smoke due to the firework results in the visibility reduction [5-6]. In the present study, we have compared the particulate matter (PM<sub>10</sub>) concentration Pre-Diwali and during Diwali of four different locations of Amritsar, Punjab, India.

## II. METHODOLOGY

In the present study, the particulate matter concentration of Pre-Diwali and during Diwali of four different regions commercial, rural, sensitive and Shri Darbar Sahib area of Amritsar has been compared. The instrument for measuring the particulate matter concentration has been installed by Punjab Pollution Control Board (PPCB) in collaboration with Central Pollution Control Board (CPCB) under the National Air Monitoring Programme. The present paper discusses the 24 hour average concentration of PM<sub>10</sub>. The dataset has been downloaded from the Punjab Pollution Control Board (PPCB) website (www.ppcb.gov.in). The exceedance factor has been calculated from the data set.

## III .RESULT AND DISCUSSIONS

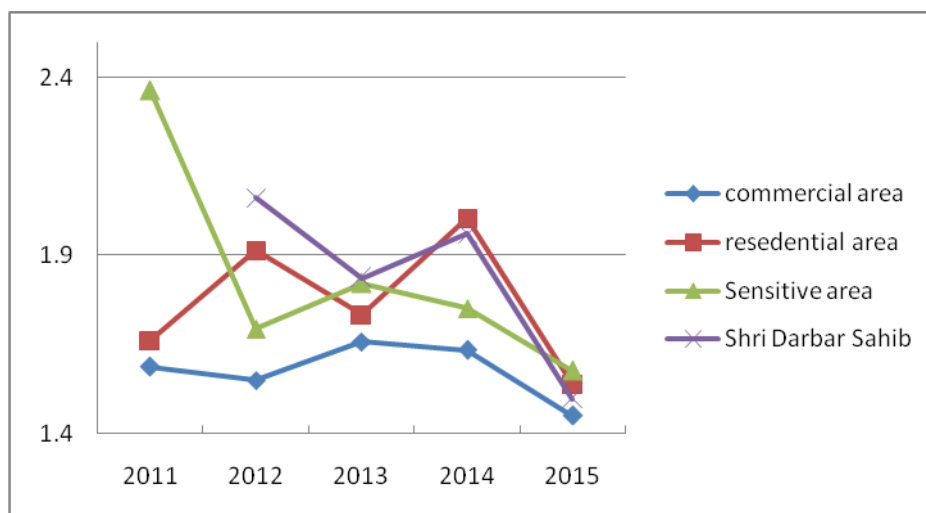
The comparative results of four different regions Commercial, Residential, Sensitive and Shri Darbar Sahib area have been shown in figure 1. In Each region and each year the particulate matter concentration during Diwali has been found more as compared to the Pre-Diwali. During Diwali the burning of crackers leads to the production of the huge amount of the particulate matter in a single day.



**Fig 1. Year wise comparison of PM<sub>10</sub> concentration (Pre-Diwali and Diwali) of four different regions of Amritsar.**

The figure 2 shows the trend of the variation of the ratio of the particulate matter concentration before and during Diwali. The comparison of the ratios of concentration of PM<sub>10</sub> during Diwali and before Diwali from 2011 to 2015 shows that there is decrease in the ratio in case of Shri Darbar Sahib (2.1 to 1.5), residential (1.7 to 1.4), commercial (1.6 to 1.4) and sensitive zones (2.4 to 1.6). The irregularities are observed in the trend from

2011 to 2015, but in 2015, the ratio decreases approximately to 1.5 for each region. This decrease is due to the policies made by the government to control the pollution and to aware the people about the effects of the pollution.



**Fig 2. The variations of the ratio of the particulate matter concentration before and during Diwali.**

National Ambient Air Quality Standards (NAAQS) and has been categorized into four categories based on Exceedance Factor (EF) to check the quality of the air (i) critical pollution when  $EF > 1.5$ , (ii) high pollution when EF is between 1.0 and 1.5, (iii) moderate pollution when EF is between 0.5 and 1.0 and (iv) low pollution when  $EF < 0.5$ . Exceedance Factor (EF) is calculated using as:

$$\text{Exceedance Factor of } PM_{10} \text{ or } PM_{2.5} = \frac{\text{Observed annual mean concentration of } PM_{10} \text{ (or } PM_{2.5})}{\text{Annual Standard mean concentration } PM_{10} \text{ (or } PM_{2.5})}$$

In the present work, the values of the Exceedance factor have been calculated to check the quality of the air. The table 1 shows the value of the EF for the different regions from 2011 to 2015. All the values indicate the quality of the air in the critical pollution zone.

Year	Commercial area		Residential Area		Sesitive area		Shri Darbar Sahib	
	Pre-Diwali	On-Diwali	Pre-Diwali	On-Diwali	Pre-Diwali	On-Diwali	Pre-Diwali	On-Diwali
2011	2.33	3.7	2.1	3.49	1.84	4.35	-----	-----
2012	2.31	3.58	1.88	3.6	2.13	3.61	1.89	3.9
2013	2.23	3.7	1.99	3.45	1.92	3.5	2.02	3.71
2014	2.16	3.53	1.77	3.55	1.9	3.33	1.85	3.63
2015	2.04	2.96	1.65	2.54	1.7	2.68	1.63	2.44

**Table 1:- Exceedence Factors for different regions of Amritsar from 2011-2015.**

It has been observed that there was continuous decrease (3.9 to 2.4) in the exceedence factor (EF) during Diwali day for Shri Darbar Sahib, still the region lies in the critical pollution zone. There is also decrease in the EF for residential (3.5 to 2.5), commercial (3.7 to 2.96) and sensitive zones (4.4 to 2.9) while comparing 2011 and 2015 data but in between there are certain discontinuities. While comparing the ratios of concentration of PM<sub>10</sub> during Diwali and before Diwali from 2011 to 2015 it has been observed that there is decrease in the ratio in case of Shri Darbar (2.1 to 1.5) Sahib, residential (1.7 to 1.4), commercial (1.6 to 1.4) and sensitive zones (2.4 to 1.6). This decrease is due to the preventive measures taken by the pollution control board and by spreading awareness among the general masses. The government has to make the policies and strict rules to control the air pollution, because the increase in air pollution is resulting in the degradation of air quality and has a adverse effect on the on the human health.

#### **ACKNOWLEDGMENTS**

The authors sincerely acknowledge MRSPTU, Bathinda for providing the facilities for the compilation of the work and CPCB along with PPCB from where data has been obtained.

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