



Ambient Air Quality Status of Particulate Matter (PM 10 & 2.5) and Gaseous Pollutants (SO₂ & NO₂) Before and After Deepavali Festival Celebration at Ratnagiri City, Maharashtra, India

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ABSTRACT

Festivals are celebrated joyfully in every nation of the world using firework displays, firecrackers, and sparkles widely. In India, the Deepavali festival is the most religious and enthusiastically celebrated festival with extensive bursting of firecrackers. Firecrackers contain hazardous substances and chemicals which have an adverse impact on the surrounding environment and also, especially severe respiratory effects from the emissions of particulate matter (PM) 10, 2.5 & 1 μ . Ambient air quality is degraded especially by the bursting of firecrackers during the Deepavali festival celebration. Ratnagiri city is located to the Arabian West sea coast of the Maharashtra State, India. Also, relative humidity is high at the coastal atmosphere and wind dispersion is also high which provides dilution of air pollutants. Ratnagiri city is a municipal council and is being urbanised nowadays providing increase in air pollution activities. Although, from the observed data it is found that all the parameters are below the standard norms with some minor exceptions. Concentrations of PM_{2.5} have been observed above standard norms on the day of the Deepavali (77.51 μ g/m³) and a day after the Deepavali (66.36 μ g/m³) by the activities of bursting of firecrackers and ongoing road construction in front of sampling site. This study is aimed to assess ambient air quality status of particulate matter (PM 10 & 2.5), gaseous pollutants i.e Nitrogen Dioxide (NO₂), and Sulphur Dioxide (SO₂) during the Deepavali festival period in Ratnagiri city. The study suggested remedial measures for mitigating the extensive use of firecrackers to reduce adverse effects on the environment and also, on human beings.

Keywords: Ambient Air Quality, Deepavali, Firecrackers, Particulate Matter

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INTRODUCTION

Deepavali festival is the most celebrated festival in every part of India. Festivals are celebrated worldwide with the use of loud and bright coloured firework displays and firecrackers in massive quantities which is an integral part of celebration [7,15,18,27,34,42,41,42]. Chinese Lunar New Year festival and Chahar-Sanbe Suri festival in Iran also celebrated since long time with the use of extensive fireworks [27,43]. Several studies show that on the occasions of festivals and special days such as Independence in the United States, La Fells in Spain, the revolutionary overthrow of the monarchy in France, Lantern festival and spring festival in China & Taiwan, 5th November in the United Kingdom, Lunar New Year festival in China, Chahar-Sanbe Suri festival in Iran, and Diwali festival in India, celebrated by the extensive use of firework displays, firecrackers, and sparkles [9,18,27,43] leading to the degradation of the ambient air quality and also responsible for severe health problems [11,12,18,20,30,31,41]. Diwali or Deepavali which translates into "Row of Lamps" [8] is the most important Hindu festival in India [14,29,38]. Deepavali is the festival of lights and it is celebrated for four to five days and celebrated enthusiastically, vigorously, and very joyfully by the burning of firecrackers, fireworks, and sparkles in every part of India [1,4,5,6,7,9,12,14,20,23,29,31,32,33,34,36,38,41]. Firework displays, firecrackers, and sparkles mainly contained with hazardous substances and chemicals such as Sodium Oxalate, Chlorate, Sulphur, Potassium Nitrates, Aluminium dust powder, Charcoal, Iron, and Barium Nitrate, Strontium Nitrate, Potassium Perchlorate, Magnesium, and Manganese, etc. [22,27]. Peshin et al. (2017) mentioned the percentage of chemicals contain in firecrackers as 75% potassium nitrate, 15% carbon and 10% sulphur, potassium and trace elements [29]. Bursting of firecrackers, sparkles especially during Deepavali festival, emits gaseous pollutants such as Sulphur Dioxide (SO₂), Nitrogen Dioxide (NO₂), Carbon Monoxide (CO), Ozone (O₃), Black Carbon, and Particulate Matter (including PM₁₀, 2.5 & 1), and also, several toxic metals

into the atmosphere [10,11,13,21,24,30,32,33,34,35,37,40]. Several studies shows that bursting of firecrackers, causes deposition of Sulphur Dioxide (SO₂), Nitrogen Dioxide (NO₂), and also PM 10, PM 2.5 into the atmosphere which may leads to formation of clouds of smoke [4,31,35,36]with higher concentrations exceeding the standard norms of Central Pollution Control Board (CPCB) [21,32,33,34,36,39]. Lin 2016 and Oroji et al. 2020 studied that the fine and ultrafine particles (PM 10, 2.5, 1) remain suspended in the air for a prolonged period of time from two days up to one month after the festival[18,27]. Also, due to the low temperature, wind speed, and higher relative humidity providing stable atmosphere during winter months [5,14,17,26]. As the particulate matters remain suspended in atmosphere for hours [41], hazardous particles emitted from fireworks causing worst health effects including asthma, bronchitis, affect to thyroid function, chronic respiration, and cardiovascular diseases [11,14,22,40,43] and toxic chemicals impose to eye ailment, headache, asthma, bronchitis, and nervous troubles to human beings [12,42]. Several studies opined about chronic health effects from fireworks emission stated the higher risk of health for infants, pregnant women, and elderly people from particulate matter and toxic gases [18,20,36]. Particles of size PM 10 μ and PM 2.5 μ emitted from firecrackers mainly cause respiratory problems and cardiovascular diseases [12,15,18,27,31,33,40]. Also, the particles of size 2.5 μ penetrate the respiratory system deposit reaching through deep down into the lungs and damage lung tissue which leads to premature death and also, it contributes to cancer [11,14,24]. Overall from these several studies, it is observed that for celebrating special days or festivals especially Deepavali festival in India, bursting of firecrackers is occurred and its adverse imposing impacts on air quality and also on human health were recorded [1,5,6,7,8,9,11,12,14,15,18,20,21,22,27,29,30,31,32,33,36,38,40,42,43]. However, ambient air quality and its human health impact has not been conducted by the researchers before. By considering the above point the present attempt is being made to monitor ambient air quality and to find the posing air pollution activities before and after the Deepavali festival in the coastal city Ratnagiri, Maharashtra, India.

Study Area

As per the CPCB ambient air quality monitoring guidelines one sampling site was selected. The sampling site is located near Jaystambh Chowk (latitude: 16.980 N, longitude: 73.290 E) of Ratnagiri city. This site is commercial and residential in nature. Site area is a moderately populated and in front of the site, National Highway (NH-166) passes which increases vehicular influence. Hotels, Lodgings, and various commercial shops are also nearby [11-13].

MATERIAL AND METHODS

The present study is carried out before and after 7 days of the Deepavali festival (28th Oct. 2021 to 11th Nov. 2021). Parameters considered for the ambient air quality monitoring are Sulphur Dioxide (SO₂), Nitrogen Dioxide (NO₂), Particulate Matter (PM₁₀), and Particulate Matter (PM_{2.5}). Criteria for the monitoring is carried out per the CPCB guidelines for the measurement of ambient air pollutants [3]. Sulphur Dioxide (SO₂), Nitrogen Dioxide (NO₂), PM₁₀, and PM_{2.5} have been monitored for 24 hourly basis during the mentioned dates, only at one location. To measure the gaseous pollutants and particulate matters, instruments that conform BIS standards and approved by CPC Board, manufactured by Envirotech Instruments Pvt. Ltd. were used. To measure SO₂, NO₂, and PM₁₀ Respirable Dust Sampler (RDS)-APM 460 DXNL is used and for PM_{2.5}, APM 550 MFC is used. Laboratory methods for the analysis of parameters were used accordingly to the guidelines, viz. for SO₂, Improved West & Gaeke method, for NO₂, Modified Jacob and Hochheiser method, for PM₁₀, and PM_{2.5} Gravimetric method is used. All the collected samples were brought to the laboratory of the Department of Environmental Science, Ratnagiri Sub-Campus, University of Mumbai and analysed for mentioned parameters accordingly to the standard norms [13-17].

RESULTS AND DISCUSSION

Air pollution from industrialisation and urbanisation is a major problem arising the adverse health impacts to human beings and plants through particulate matter becoming a severe health factor globally [16, 28]. Health effects from PM 10 and PM 2.5 by depositing into the lungs and damaging blood circulation and immune system inducing respiratory cardiovascular diseases [24,42]. Sharma et al. (2018) conducted a study and found increase in air pollution above standard norms during the Deepavali periods in residential and commercial areas [38]. During the cold conditions in Deepavali, air pollutants are trapped in the smog formation and for a long time it stay close to the ground before they get dispersed into the atmosphere [5]. C.P.C Board standard norms are given in Table No. 1 and Table No. 2 shows 24 Hrs. average concentrations of SO₂, NO₂, PM₁₀, and PM_{2.5} parameters during the mentioned monitoring dates. Graphical representation of the data is shown in Figure No. 1 [18-20].

The concentration of PM 2.5 is observed above standard norms on the day of the Deepavali(77.51µg/m³)and one day after the Deepavali(66.36 µg/m³) respectively. On the day of Deepavali, concentrations has been raised because of the bursting of the firecrackers and fireworks at night. Although, there is no any extensive firework activities have recorded on the day of the Deepavali. SO₂, NO₂, and PM₁₀ concentrations are observed below the standard norms during the whole monitoring period [21-25]. Also, it was observed that industrial, constructional and vehicular activities were not prominent. Ratnagiri city is having a seashore and humid climate which result in dispersion of air from sea to land. During the daytime, air rise over the urban areas faster than the ocean because of the high temperature[26]

Table1: CPCB, National Ambient Air Quality Standards

Sr. No.	CPCB Standards	24 Hrs.	Unit
1	SO ₂	80	µg/m ³
2	NO ₂	80	
3	PM ₁₀	100	
4	PM _{2.5}	60	

(Source: CPCB 2009)

Table2: 24 Hrs. average concentrations of parameters

Sr. No.	Monitoring Dates	Parameters				Unit
		PM ₁₀	PM _{2.5}	SO ₂	NO ₂	
1	28.10.2021	88.03	46.77	9.67	13.71	µg/m ³
2	29.10.2021	64.52	34.02	11.27	14.54	
3	30.10.2021	68.94	51.86	10.24	13.12	
4	31.10.2021	72.19	51.25	9.49	12.53	
5	01.11.2021	89.25	59.83	9.34	13.36	
6	02.11.2021	70.17	54.49	8.25	14.37	
7	03.11.2021	63.24	54.45	9.95	17.37	
8	04.11.2021 (Day of Deepavali)	72.77	77.51	10.11	18	
9	05.11.2021	84.34	39.3	9.68	14.56	
10	06.11.2021	86.42	66.36	8.26	13.68	
11	07.11.2021	80.71	51.82	9.13	14.35	
12	08.11.2021	83.72	56.04	8.75	13.6	
13	09.11.2021	89.41	54.98	9.21	14.33	
14	10.11.2021	50.48	55.85	7.42	14.12	
15	11.11.2021	87.46	59.02	8.55	12.97	

Note: Concentration above standard norms are shown in bold.

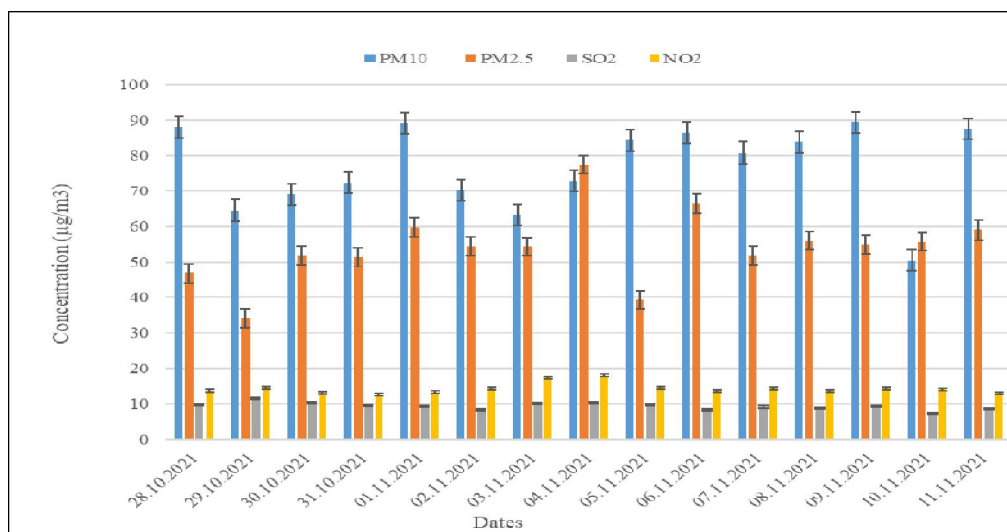


Fig 1: Graphical Representation of Parameters

CONCLUSION

Ratnagiri is in the Konkan region of Maharashtra. In the Konkan region, mostly celebrated festivals which are Ganesh Chaturthi and Shimaga festival. A study for the monitoring of ambient air quality during the Deepavali festival in Ratnagiri city is being conducted for the first time [27-31]. During this period crowd has been observed at the commercial areas during two to four days before and after the Deepavali festival, crowdies leading to the vehicular activities in the evening to night-time. Also, due to the ongoing construction of the road in front of the site and road traffic jams have resulted in increase of the concentration of PM_{2.5} (77.51 & 66.36 µg/m³) showing excavation, drilling activities and vehicular emission are contributors of particulate matter [32-26]. On the day of the Deepavali, at night time bursting of firecrackers observed showing increase in PM_{2.5} concentration (77.51 µg/m³) above the standard norms. However, all the other parameters are under the standard norms provided by CPCB. Bursting of firecrackers, constructional activities, and vehicular emissions contribute to particulate matter which increase air pollution and became a threat of imposing adverse impacts on the surrounding environment. To mitigate the extensive use of firecrackers on the Deepavali, the individual limit for purchasing the firecrackers should be set by the government. A limited sale of firecrackers will result in less pollution and also, eco-friendly (Green) firecrackers [36-39]] can be used to celebrate festivals that pose a minimal impact on the environment [39-42].

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