

CO Levels during Diwali Festival in Tiruchirappalli City, Tamil Nadu: A Case Study

¹Rakesh Sharma, T., ²Ravichandran, C., ³Teneson, R. and ⁴Rajeshkumar, K.T.

¹Assistant Professor, ²Associate Professor, ³Assistant Professor, ⁴Environmental Manager

¹Dept. of Environmental and Herbal Science

Tamil University, Thanjavur - 10, India

^{2,3 & 4}Dept. of Environmental Sciences

Bishop Heber College, Trichy – 17, India.

Abstract

The fireworks during Diwali festive celebrations can cause short time air pollution, particularly in urban areas. In India, Diwali festival is celebrated every year during late October or early November. This festival is related to the bursting of firecrackers especially in Nighttime/early morning hours which leads to ambient air contamination. It releases a high amount of gaseous substances (NO_x, CO, SO₂ & O₃) and particulates. The study was conducted in three consecutive days of November 2015, October 2016 and October 2017 in busy and densely populated areas of Tiruchirappalli city. The carbon monoxide (CO) level was measured at five locations of the city during morning, afternoon, evening and night times. The high amount of CO was recorded during Diwali day at Thennur residential areas in the year of 2015 and 2016. All the results indicated that the CO levels from fireworks were high during night time when compared to the day time. Hence, it is recommended that awareness level should be raised so that people may cut down the number of fireworks in future.

Keywords: Air pollution, firecrackers, health impacts, particulates and gaseous substances.

I. INTRODUCTION

The pollutants levels in the ambient air of megacities are increasing in recent years due to anthropogenic activities which includes urbanization, industrialization and transportation. It is causing serious effects to the human health and environment by their long term effects on air quality (Nastos *et al.*, 2010; Samoli *et al.*, 2011; Peshin *et al.*, 2016). The Particulate and gaseous substances were recorded with high levels in many big cities. These levels are also rising considerably during festivals by the usage of crackers, sparklers and artificial colours (Srivastava *et al.*, 2015).

In India, the Festival of Light (Diwali) is one of the most important events, which is celebrated every year during late October or early November. This festival is related to the bursting of firecrackers, especially in the Nighttime/early morning hours. It releases a high amount of various gaseous substances (NO_x, CO, SO₂ & O₃) and particulates to the atmosphere which leads to poor air quality causing acute short term air pollution (Limaye and Salvi, 2010; Mandal *et al.*, 2011). Many studies have been reported that the air was polluted due to Diwali festivals in various urban areas of India (Kulshrestha *et al.*, 2004; Barman *et al.*, 2008; Singh *et al.*, 2010; Mandal *et al.*, 2011).

Carbon monoxide (CO) is the most significant inorganic air pollutant. It has a short lifetime in the atmosphere due to its reaction with other atmospheric components, such as hydroxyl radicals. The incomplete combustion leads to the generation of CO. Through natural processes, the CO can be oxidized to CO₂, thus increase in the atmosphere and contribute to the greenhouse effect and global warming (Daniel & Solomon, 1998; Lal *et al.*, 2008). It easily affects children, pregnant women, elderly people and leads to anoxemia and various cardiovascular difficulties at a high level (ENVIS, 2016).

Hence, the present study was undertaken to evaluate the CO emission due to fireworks during Diwali festival in Tiruchirappalli city, Tamil Nadu.

II. MATERIALS AND METHODS

Tiruchirappalli city situated on the banks of river Cauvery is the fourth largest city in Tamil Nadu. The city area occupies 167.23 Sq.km. with people of 916, 857 as per census-2011 (CMA, 2014). It is densely populated with industrial and residential areas have recently been built in the northern and southern parts of the city (Rajendran *et al.*, 2002).

Five locations (Bharathi Nagar, Kumaran Nagar, Puthur, Thennur and Ramalinga Nagar) were chosen in the densely populated residential area, which is situated across the central and west parts of the city for measuring CO pollutant (Map-1). The building's terrace (20ft height) was chosen in each location for measuring the CO emission from fireworks by the people. Carbon monoxide meter (Model: Extech-CO₁₀) was used to measure the CO level (ppm) in each location. Then the observed values are converted to milligram per cubic meter (mg/m³) as per criteria are given in the NAAQS (2009).

The study was carried out for three consecutive days of (Pre-Diwali, Diwali festival, Post-Diwali) November 2015, October 2016 and October 2017 to assess the variation in air quality due to fireworks during the morning, afternoon, evening and night hours by observing the CO concentrations.



Map – 1: Sampling locations of Carbon Monoxide levels in Tiruchirappalli city

III. RESULTS AND DISCUSSION

The observed values of CO emission from fireworks during the Diwali period were presented in tables 1-3. The concentration of CO showed an increasing trend from 0.8 to 4.7 mg/m³ on pre-Diwali and reached their highest concentrations ranging from 1.3 to 5.0 mg/m³ on Diwali festival day. Later on, their values were found within a range of 0.8 to 2.8 mg/m³ on post-Diwali during November 2015.

Table – 1: CO (mg/m³) level during Diwali at Tiruchirappalli city in 2015

S.No.	Location	Day	Morn	AN	Eve	Night
1	Bharathi Nagar	Pre-Diwali	1.8	1.5	1.9	3.5
		Diwali	2.2	3.5	2.1	4.3
		Post-Diwali	2.0	1.6	1.8	0.8
2	Kumaran Nagar	Pre-Diwali	1.3	1.0	1.6	3.0
		Diwali	1.7	3.0	3.6	4.1
		Post-Diwali	2.1	1.4	1.7	1.0
3	Puthur	Pre-Diwali	1.0	0.8	1.4	3.1
		Diwali	1.3	2.4	2.9	3.6
		Post-Diwali	1.5	1.0	1.5	1.6
4	Thennur	Pre-Diwali	1.1	0.8	1.3	4.7
		Diwali	2.1	3.5	3.6	5.0
		Post-Diwali	2.4	1.3	1.8	1.5
5	Ramalinga Nagar	Pre-Diwali	1.6	1.3	1.8	3.3
		Diwali	2.5	3.4	3.1	3.8
		Post-Diwali	2.3	2.0	1.9	1.5

In the year of 2016, the CO level observed between 0.9 and 4.9 mg/m³ on pre-Diwali; the highest concentration of CO ranges (1.5 to 5.1 mg/m³) were found on Diwali day; after that, the CO levels are considerably decreased (0.7 to 2.3 mg/m³) on post-Diwali. During October 2017, the measured CO levels were found to be 1.0 to 4.0 mg/m³ on pre-Diwali and highest CO levels were observed between 1.5 and 4.2 mg/m³ on Diwali. Finally, the concentration CO substantially decreased from 0.7 to 2.1 mg/m³ on post-Diwali.

Table – 2: CO (mg/m³) level during Diwali at Tiruchirappalli city in 2016

S.No.	Location	Day	Morn	AN	Eve	Night
1	Bharathi Nagar	Pre-Diwali	1.5	1.3	1.7	3.6
		Diwali	2.0	3.3	2.2	4.1
		Post-Diwali	1.7	1.5	1.8	0.7
2	Kumaran Nagar	Pre-Diwali	1.4	1.1	1.5	3.8
		Diwali	1.8	3.1	3.4	4.0
		Post-Diwali	1.9	1.3	1.4	0.8
3	Puthur	Pre-Diwali	1.1	1.0	1.5	3.3
		Diwali	1.5	2.3	3.1	3.4
		Post-Diwali	1.7	1.2	1.0	0.9
4	Thennur	Pre-Diwali	1.3	1.0	1.9	4.9
		Diwali	2.3	3.1	3.4	5.1
		Post-Diwali	2.1	1.4	1.3	1.0
5	Ramalinga Nagar	Pre-Diwali	1.2	1.4	2.2	3.7
		Diwali	2.7	3.6	3.3	3.6
		Post-Diwali	2.3	1.8	2	1.7

Table – 3: CO (mg/m³) level during Diwali at Tiruchirappalli city in 2017

S.No.	Location	Day	Morn	AN	Eve	Night
1	Bharathi Nagar	Pre-Diwali	1.6	1.2	1.9	3.3
		Diwali	2.1	3.1	2.4	3.8
		Post-Diwali	1.7	1.4	1.2	0.8
2	Kumaran Nagar	Pre-Diwali	1.3	1.0	1.3	3.4
		Diwali	1.5	3.3	3.0	3.7
		Post-Diwali	1.6	1.1	1.0	0.7
3	Puthur	Pre-Diwali	1.2	1.3	1.7	3.2
		Diwali	1.6	2.2	3.5	3.6
		Post-Diwali	1.8	1.0	1.1	0.9
4	Thennur	Pre-Diwali	1.1	1.0	1.7	4.0
		Diwali	2.5	3.0	3.4	4.2
		Post-Diwali	1.9	1.2	1.5	1.1
5	Ramalinga Nagar	Pre-Diwali	1.1	1.3	2.1	3.5
		Diwali	2.9	3.4	3.1	3.3
		Post-Diwali	2.1	1.6	1.6	1.2

The high amounts of CO were recorded during the night hours in all selected five locations of all three years. Thennur was found with high levels of CO than other locations in all three years, which is a densely populated area with middle and upper-class families. The residents of the Thennur area used several firecrackers than other residents, which is observed during the measurements.

The CO concentrations as recorded on Diwali day were found to be several times higher when compared to other days. The results indicated the huge contribution by firecrackers during the Diwali in all locations. The similar study also reported the effect of firework display during Diwali in Thiruvananthapuram, which reveals over 3 times increase of CO level compared to normal days (Babu and Moorthy, 2001).

The observed values of CO in Bharathi Nagar, Kumaran Nagar were found to be slightly higher in night hours than the one-hour standard limit (4.0 mg/m³) for residential areas during Diwali festival of all three years. However, Thennur area was found to considerably exceed the same standard limit. The other locations have been fairly within the limits particularly night hours of post-Diwali of 2015, 2016 and 2017. It is due to the CO level slowly converted to CO₂ gas in the ambient atmosphere.

The high amount of CO gas recorded during the late-night of pre-Diwali and Diwali days, which may affect infants and elder people of respective areas of Tiruchirappalli city. The automobiles are also contributes considerable amount of CO during morning and evening hours in the sampling locations. In particular, heavy vehicles are adding high CO in the late evening within the city atmosphere.

The mean (day average) values of CO during pre-Diwali, Diwali festival and post-Diwali of 2015, 2016 and 2017 were represented in figures 1-3. The CO levels of main Diwali day of all three years were exceeded the NAAQS standard limit (2 mg/m³) for 8 hours sampling in a residential area. Other mean CO values of pre-Diwali and post-Diwali did not exceed the prescribed limit during all study years.

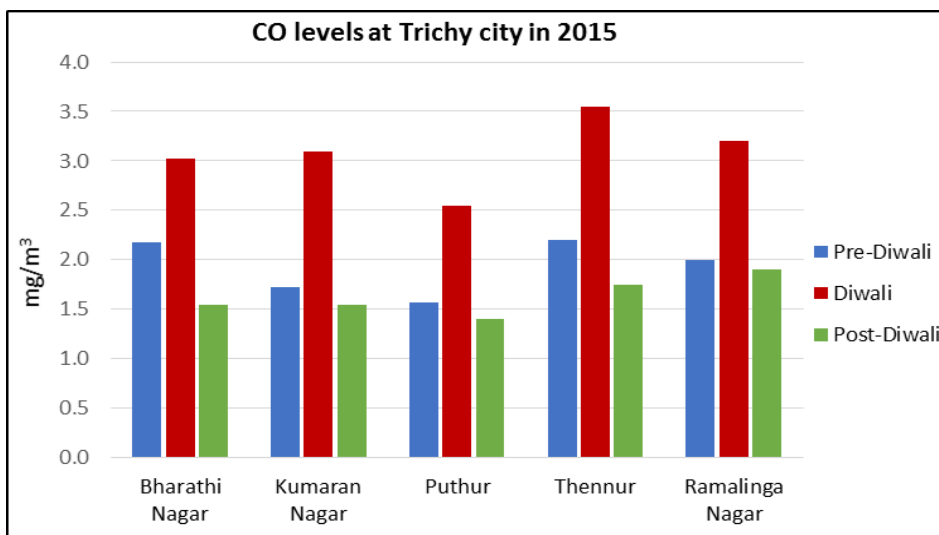


Fig – 1: Average Carbon Monoxide levels at Tiruchirappalli city in 2015

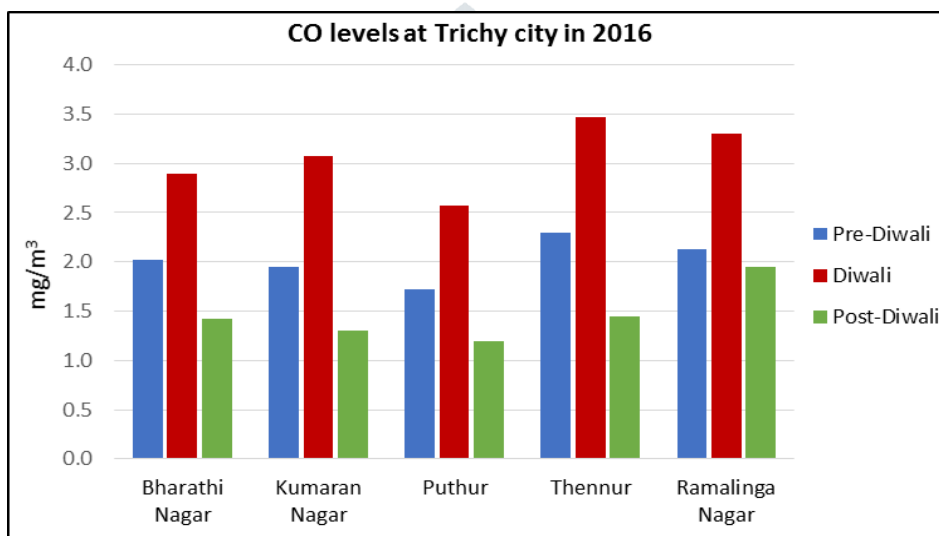


Fig – 2: Average Carbon Monoxide levels at Tiruchirappalli city in 2016

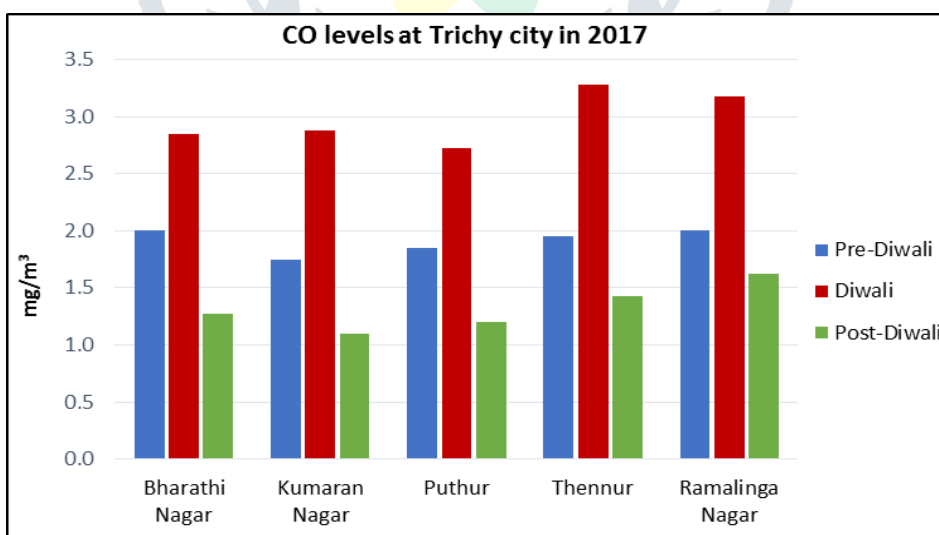


Fig – 3: Average Carbon Monoxide levels at Tiruchirappalli city in 2017

However, the mean CO levels of Bharathi Nagar and Thennur were slightly beyond the limit in November 2015 on Pre-Diwali; likewise, Ramalinga Nagar and Thennur crossed the standard level in October 2016 on Pre-Diwali day. It is due to more crackers used by the local residents during the nighttime of Pre-Diwali. There has been a gradual decrease in mean CO values as far as festival night is concerned in post-Diwali. The results of post-Diwali revealed that the CO levels decline to the normal CO levels of the city.

IV. CONCLUSION

The present study investigates the influence of Diwali fireworks on ambient air quality of Tiruchirappalli city. Among the five locations, Thennur was found with a high amount of CO during the festival days. The high values attributed to emissions released from intensive burning of fireworks particularly during the night time of Diwali festival. In the late evening, mass entry

of the heavy vehicles in the city also contributes to the elevated level of air pollution. The study also suggests that people must be educated through awareness regarding the effects of emissions fireworks on human health and air quality.

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