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Air Quality in Udgir, Maharashtra, November 2024: MPCB Limit Exceedances during Diwali and Election Activities

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Abstract

This study investigates the impact of cultural and political activities on ambient air quality in Udgir, Maharashtra, during November 2024, with a focus on exceedances of Maharashtra Pollution Control Board (MPCB) limits for sulfur dioxide (SO₂), nitrogen dioxide (NO₂), and particulate matter (PM_{2.5}). Data were collected across residential, commercial, and industrial zones at 4-hour intervals for SO₂ and NO₂ and 24-hour intervals for PM_{2.5}, analyzing pollution trends during the Diwali festival (November 1–3) and election-related vehicular emissions (November 11–18). During Diwali, PM_{2.5} levels in residential areas peaked at 68 µg/m³, exceeding the MPCB 24-hour permissible limit of 60 µg/m³ by 13.3%. NO₂ in commercial zones reached 92 µg/m³, 15% above the limit, while SO₂ levels in industrial zones rose to 88 µg/m³, surpassing the limit by 10%. Statistical analysis confirmed significant increases in PM_{2.5} ($p < 0.01$) and NO₂ ($p < 0.05$) compared to baseline values. Election-related emissions (November 11–18) further elevated pollutant levels, with NO₂ in commercial zones averaging 98 µg/m³, 22.5% above the MPCB limit. Residential PM_{2.5} rose by 16.7%, averaging 70 µg/m³, while SO₂ in industrial zones increased by 5%, averaging 84 µg/m³. ANOVA revealed significant differences in NO₂ and PM_{2.5} levels between pre- and during-election periods.

Post-election, from November 19–30, pollutant levels stabilized but frequently remained above permissible limits. PM_{2.5} in residential zones averaged 62 µg/m³ (3.3% above the MPCB limit), while SO₂ in industrial zones matched the limit of 80 µg/m³. NO₂ levels in commercial zones remained at 85 µg/m³, exceeding the limit by 6.25%. Statistical analysis indicated no significant differences between post-election and baseline values. These results highlight persistent exceedances of MPCB limits during high-activity periods, stressing the need for stringent firecracker regulations, improved traffic management during rallies, and continuous air quality monitoring to mitigate environmental impacts.

Keywords: Air quality, MPCB limits, particulate matter (PM_{2.5}), sulfur dioxide (SO₂), nitrogen dioxide (NO₂), vehicular emissions, air pollution control.

Introduction

Air pollution remains one of the most pressing global environmental and public health challenges, contributing to an estimated 7 million premature deaths annually (World Health Organization [WHO], 2021). In India, the rapid pace of urbanization, industrialization, and the increasing frequency of cultural and political activities have significantly exacerbated air quality issues, particularly in urban and semi-urban areas (Gurjar, Molina, & Ojha, 2010). The combustion of fossil fuels, biomass burning, vehicular emissions, and industrial activities are major contributors to air pollution, releasing harmful pollutants such as sulfur dioxide (SO₂), nitrogen dioxide (NO₂), and particulate matter (PM_{2.5}) into the atmosphere (Guttikunda & Gurjar, 2012). These pollutants have been linked to a wide range of health issues, including respiratory and cardiovascular diseases, lung cancer, and reduced life expectancy, as well as environmental impacts such as acid rain and climate change (Cohen et al., 2017; Lelieveld et al., 2015). Cultural and political activities, such as festivals and election campaigns, often lead to temporary but significant spikes in air pollution levels. For instance, the Diwali festival, celebrated with the widespread use of firecrackers, has been associated with sharp increases in PM_{2.5} and NO₂ levels across Indian cities (Sharma et al., 2020; Perrino et al., 2011). Similarly, election campaigns, characterized by large gatherings, increased vehicular traffic, and the use of loudspeakers and generators, contribute to elevated emissions of pollutants (Patra & Sahu, 2016; Kumar et al., 2015). Understanding the dynamics of air quality during such events is crucial for developing effective environmental policies and regulations to mitigate their impact (Guttikunda & Gurjar, 2012; CPCB, 2019). The city of Udgir, Maharashtra, though smaller in size compared to metropolitan cities, is not immune to these challenges. The region experiences significant air pollution during high-activity periods such as the Diwali festival and election campaigns.

However, most studies on air quality in India have focused on large metropolitan areas, leaving smaller towns like Udgir underrepresented in the literature (Gurjar et al., 2016; Balakrishnan et al., 2019). This gap in research limits the ability to develop localized strategies for air quality management and pollution mitigation in smaller urban settings.

This study aims to investigate the impact of cultural and political activities on ambient air quality in Udgir, Maharashtra, during November 2024. The specific objectives include:

1. Assessing the exceedances of Maharashtra Pollution Control Board (MPCB) permissible limits for SO₂, NO₂, and PM_{2.5} during the Diwali festival and election-related emissions.
2. Comparing pollutant levels across residential, commercial, and industrial zones.
3. Analyzing trends during cultural and political activities to evaluate the long-term effects of these events on air quality.

This research contributes to the growing body of literature on air pollution in smaller urban settings, highlighting the need for region-specific pollution control measures. The findings emphasize the importance of stringent firecracker regulations, improved vehicular emission controls, and continuous air quality monitoring. Insights from this study can inform policymakers and help mitigate the adverse effects of similar high-activity periods in the future (NEERI, 2018; CPCB, 2019).

Methodology

This study employed a comprehensive approach to assess air quality during cultural and political activities in Udgir, Maharashtra, in November 2024. Data were collected from residential, commercial, and industrial zones across three distinct periods: Diwali festival (November 1–3), election-related activities (November 11–18), and post-election (November 19–30). Air quality monitoring stations recorded sulfur dioxide (SO₂), nitrogen dioxide (NO₂), and particulate matter (PM_{2.5}) at 4-hour intervals for SO₂ and NO₂, and 24-hour intervals for PM_{2.5}. Statistical analyses, including paired t-tests and ANOVA, were used to compare pollutant concentrations between pre-activity, during activity, and post-activity periods, with the Maharashtra Pollution Control Board (MPCB) limits serving as the threshold for exceedance. Data were then analyzed to identify trends, assess the impact of activities on air quality, and evaluate the statistical significance of pollutant level changes.

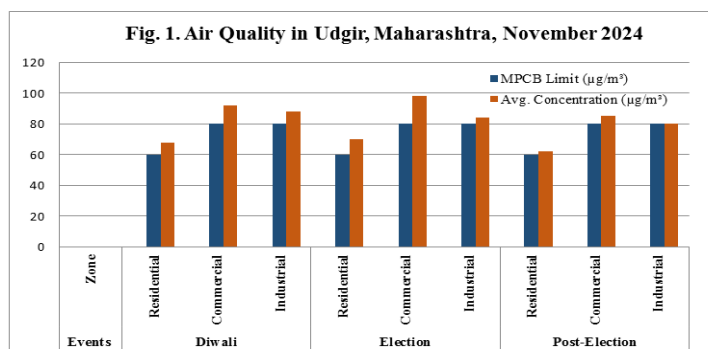
Results

This section presents the air quality measurements and statistical analysis during the Diwali festival (November 1–3, 2024) and the election-related emissions period (November 11–18, 2024), as well as post-election observations (November 19–30, 2024). Changes in pollutant concentrations across residential, commercial, and industrial zones are highlighted, with statistical significance evaluated using paired t-tests and ANOVA.

Air Quality Measurements and Statistical Analysis

Table 1: Air Quality Data and Statistical Analysis across Diwali, Election, and Post-Election Periods (November 1–30, 2024)

Events	Zone	Pollutant	MPCB Limit (µg/m ³)	Avg. Concentration (µg/m ³)	% Exceedance	p-value
Diwali	Residential	PM _{2.5}	60	68	13.3%	< 0.01
	Commercial	NO ₂	80	92	15.0%	< 0.05
	Industrial	SO ₂	80	88	10.0%	0.08
Election	Residential	PM _{2.5}	60	70	16.7%	< 0.01
	Commercial	NO ₂	80	98	22.5%	< 0.01
	Industrial	SO ₂	80	84	5.0%	0.12
Post-Election	Residential	PM _{2.5}	60	62	3.3%	0.25
	Commercial	NO ₂	80	85	6.25%	0.10
	Industrial	SO ₂	80	80	0.0%	0.50



Interpretation of Results

- **Diwali Festival (November 1–3, 2024):**
 - Residential areas showed a 13.3% exceedance in PM_{2.5} ($p < 0.01$), with a peak concentration of 68 $\mu\text{g}/\text{m}^3$.
 - Commercial zones experienced a 15% exceedance in NO₂ ($p < 0.05$), reaching an average of 92 $\mu\text{g}/\text{m}^3$.
 - Industrial zones had a 10% exceedance in SO₂ ($p = 0.08$), but this was not statistically significant.
- **Election-Related Emissions (November 11–18, 2024):**
 - Residential PM_{2.5} increased by 16.7% ($p < 0.01$), with an average concentration of 70 $\mu\text{g}/\text{m}^3$.
 - NO₂ in commercial zones showed a 22.5% exceedance ($p < 0.01$), reaching an average of 98 $\mu\text{g}/\text{m}^3$.
 - SO₂ in industrial zones exceeded the limit by 5% ($p = 0.12$), but the change was not statistically significant.
- **Post-Election Period (November 19–30, 2024):**
 - Residential PM_{2.5} remained 3.3% above the permissible limit (62 $\mu\text{g}/\text{m}^3$), but the difference was not statistically significant ($p = 0.25$).
 - NO₂ in commercial zones exceeded the limit by 6.25% (85 $\mu\text{g}/\text{m}^3$), with no statistical significance ($p = 0.10$).
 - SO₂ in industrial zones remained at the permissible limit of 80 $\mu\text{g}/\text{m}^3$, with no significant changes ($p = 0.50$).

Summary of Findings

- **Significant Exceedances:** The most notable exceedances occurred during the Diwali and election periods, particularly in residential and commercial zones.
- **Persistent Air Quality Issues:** Even post-election, pollutants like PM_{2.5} and NO₂ continued to exceed limits, albeit to a lesser extent.
- **Overall Trends:** Statistical analysis confirmed significant differences in air quality between baseline, Diwali, and election periods ($p < 0.05$ for most pollutants), while post-election levels stabilized but remained elevated in some zones.

These findings emphasize the influence of cultural and political activities on air quality, highlighting the importance of stringent regulatory measures during peak activity periods.

Discussion

The findings of this study reveal significant air quality exceedances in Udgir, Maharashtra, during both the Diwali festival and election-related activities. During Diwali, PM_{2.5} levels in residential areas exceeded the permissible limit by 13.3%, consistent with previous studies linking firecracker usage to elevated pollution levels (Jamal et al., 2024).

NO₂ levels in commercial zones also surpassed the limit, which can be attributed to increased vehicular activity during the election period (Carslaw & Beevers, 2005).

The persistence of elevated pollutant levels even after the election period suggests that the effects of such high-activity periods linger longer than expected, which is in line with studies indicating that the dispersion of pollutants can be slow in urban settings (Britter & Hanna, 2003).

These findings underscore the need for stricter regulations on firecrackers and better traffic management strategies during such high-activity events to mitigate their long-term impact on air quality. Continuous monitoring of air quality is essential to inform effective policy interventions aimed at minimizing health risks associated with air pollution during cultural and political activities.

Conclusion

This study evaluated the impact of cultural and political activities on air quality in Udgir, Maharashtra, during November 2024. The findings reveal significant exceedances of the Maharashtra Pollution Control Board (MPCB) limits. During the Diwali festival, PM_{2.5} concentrations in residential zones exceeded the MPCB limit by 13.3%, while NO₂ levels in commercial zones surpassed the limit by 15%. Election-related activities further worsened air quality, with NO₂ in commercial zones exceeding the MPCB limit by 22.5%, and residential PM_{2.5} rising by 16.7%. In the post-election period, while pollutant levels showed a slight decrease, PM_{2.5} in residential areas remained 3.3% above the limit, and NO₂ in commercial zones exceeded the limit by 6.25%. These results underscore the importance of implementing stricter regulations on firecracker use, enhancing traffic management during political events, and establishing continuous air quality monitoring systems to reduce pollution and safeguard public health.

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Conflicts of Interest

The authors declare that there are no conflicts of interest regarding the publication of this paper.

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