# Assessment of Aerosol Pollution in Delhi: Trends, Impacts, and Mitigation Strategies

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**Abstract.** **Keywords:** Brain Tumor Segmentation · Deep learning · MRI.

## 1 Introduction

Smoggy weather caused by aerosol pollution has become a frequent occurrence in many parts of the world. Aerosols, fine solid particles suspended in the air, are known to absorb or scatter sunlight, contributing to smoggy conditions. Aerosols have significant impacts on human health, temperature, cloud formation, and atmospheric circulation [1]. Monitoring aerosol levels is crucial for understanding the extent of pollution and its implications. This report focuses on extracting and analyzing daily Aerosol Optical Depth (AOD) data for the city of Delhi from 2000 to 2020 using Google Earth Engine (GEE). The analysis aims to shed light on the severity of aerosol-induced pollution in Delhi and its implications for sustainable development.

## 2 Method

### 2.1 Collecting AOD data using GEE

Using the Google Earth Engine (GEE) platform, the following steps were performed:

Authentication and initialization of GEE. Importing a vector shapefile representing the region of interest (Delhi) and raster images for AOD data. Filtering the AOD data based on the region and date range. Reducing the image data to obtain the average AOD for Delhi on a daily basis. Converting the ImageCollection into a FeatureCollection and filtering out null values. Exporting the reduced AOD data to Google Drive as a CSV file.

### 2.2 Importing data as time series and plotting

Importing the data as time series and plotting After exporting the AOD data, the following steps were undertaken:

Downloading the data from Google Drive and importing it into a Pandas data frame. Rescaling the AOD values from 0.001 to 1 by dividing them by 1000. Grouping the observations by day and calculating the average AOD value. Creating a time series plot of the daily AOD values for Delhi from 2000 to 2020.

**Table 1.** Observations and severe days data

| Year | Obs_days | Severe_days | Severe_days_annual |
|---|---|---|---|
| 2000 | 235 | 58 | 90.085106 |
| 2001 | 275 | 49 | 65.036364 |
| 2002 | 301 | 64 | 77.607973 |
| 2003 | 289 | 67 | 84.619377 |
| 2004 | 314 | 66 | 76.719745 |
| 2005 | 305 | 50 | 59.836066 |
| 2006 | 312 | 61 | 71.362179 |
| 2007 | 301 | 68 | 82.458472 |
| 2008 | 286 | 78 | 99.545455 |
| 2009 | 315 | 51 | 59.095238 |
| 2010 | 282 | 86 | 111.312057 |
| 2011 | 291 | 68 | 85.292096 |
| 2012 | 303 | 73 | 87.937294 |
| 2013 | 274 | 61 | 81.259124 |
| 2014 | 308 | 85 | 100.730519 |
| 2015 | 293 | 87 | 108.378840 |
| 2016 | 296 | 99 | 122.077703 |
| 2017 | 295 | 71 | 87.847458 |
| 2018 | 303 | 89 | 107.211221 |
| 2019 | 280 | 99 | 129.053571 |
| 2020 | 303 | 82 | 98.778878 |

### 2.3 Data processing and analysis

To analyze the severity of aerosol pollution in Delhi and its implications, the following steps were followed:

Extracting the year information from the date index. Defining a threshold for severe pollution (AOD value of 1). Creating a binary column to indicate severe pollution days (1 when AOD exceeds the threshold, 0 otherwise). Grouping the observations by year and counting the number of days with severe pollution. Calculating the percentage of severe days by multiplying the count by 365 and dividing by the total observed days in each year. Analyzing the trend-line to understand the temporal pattern of severe pollution incidents and assess the implications for sustainable development

## 3 Results

The trendline analysis showed a steady and alarming increase in the frequency of severe aerosol pollution incidents over the two-decade period. The number of severe pollution days in Delhi increased by approximately 60% during this timeframe. These findings highlight the urgent need for action to address aerosol pollution in Delhi and its implications for sustainable development. Implications and Policy Recommendations

### 3.1 Health Impact

The increasing frequency and severity of aerosol pollution incidents in Delhi have detrimental effects on human health. Exposure to high levels of aerosols can lead to respiratory problems, cardiovascular diseases, and other health complications. It is essential to prioritize public health by implementing measures to reduce aerosol emissions and protect vulnerable populations.

### 3.2 Climate Change

Aerosols not only impact air quality but also have implications for climate change. They can influence temperature patterns, cloud formation, and atmospheric circulation. The observed increase in aerosol pollution incidents in Delhi calls for concerted efforts to mitigate emissions, promote clean energy sources, and reduce the contribution of aerosols to climate change.

### 3.3 Sustainable Development

Addressing aerosol pollution aligns with multiple SDGs beyond SDG 3 and SDG 13. It contributes to SDG 7 (Affordable and Clean Energy) by promoting the transition to cleaner energy sources. It also supports SDG 11 (Sustainable Cities and Communities) by improving urban air quality and ensuring sustainable urbanization.

### 3.4 Based on our findings, the following policy recommendations are proposed:

Based on these findings, the following policy recommendations are proposed:

a. Air Quality Regulations: Strengthen and enforce air quality regulations to limit aerosol emissions from industrial activities, transportation, and other pollution sources. Implement strict emission standards and provide incentives for industries so that they invest in and adopt cleaner technologies.

b. Public Awareness and Education: Launch public awareness campaigns to educate citizens about the health risks associated with aerosol pollution and

the importance of adopting sustainable practices. Encourage behavioral changes such as reducing vehicle emissions, using public transportation, and promoting energy-efficient practices.

c. Investment in Research and Innovation: Allocate resources for research and development to better understand the sources, composition, and dispersion of aerosols. Promote innovation in technologies for monitoring, modeling, and mitigating aerosol pollution. Foster collaborations between scientific institutions, policymakers, and industries to develop sustainable solutions.

d. International Cooperation: Recognize that aerosol pollution is a transnational issue requiring international cooperation. Collaborate with neighboring countries and international organizations to address cross-border pollution and develop joint strategies for reducing aerosol emissions.

e. Promotion of Clean Energy: Encourage the adoption of clean energy sources, such as solar and wind power, to reduce reliance on fossil fuels and minimize aerosol emissions from energy generation. Provide incentives and support for renewable energy projects and promote energy efficiency measures.

f. Monitoring and Reporting: Establish a robust and comprehensive monitoring system for aerosol pollution, including real-time monitoring stations, satellite observations, and data-sharing platforms. Regularly report and assess the progress in reducing aerosol pollution, track trends, and evaluate the effectiveness of implemented measures.

By implementing these policy recommendations, Delhi can take significant steps towards mitigating aerosol pollution, improving air quality, safeguarding public health, and advancing sustainable development.

## 4 Conclusion

The analysis of daily AOD data in Delhi from 2000 to 2020 using Google Earth Engine highlighted a concerning increase in the severity and frequency of aerosol pollution incidents. These findings emphasize the urgent need for comprehensive measures to address aerosol pollution and its implications for health, climate change, and sustainable development. By implementing the recommended policies and fostering international cooperation, Delhi can work towards a cleaner and healthier environment, contributing to the achievement of the SDGs and ensuring a sustainable future for its residents.

## References

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