IJCRT.ORG ISSN : 2320-2882

INTERNATIONAL JOURNAL OF CREATIVE RESEARCH THOUGHTS (IJCRT)

An International Open Access, Peer-reviewed, Refereed Journal

A STUDY AND ANALYSIS OF AIR QUALITY INDEX AND METEOROLOGICAL PARAMETER VARIATION OF VARIOUS CITIES

Shubham H Pachghare

Student

Government College of Engineering, Amravati

ABSTRACT

This research aims to investigate the relationship between the air quality index (AQI) and meteorological parameters in Amravati, Akola, and Nagpur cities. It analyzes pollutant concentrations and meteorological data across different time scales to identify trends and correlations. The study reveals an increasing trend in air pollutant concentrations, impacting overall air quality. It examines how meteorological factors influence air pollution severity and identifies consistent patterns in AQI-meteorological correlations. The findings contribute to air quality management, helping to formulate strategies for mitigating air pollution and improving living environments. The study aims to address the growing problem of air pollution in the studied areas through informed decision-making and sustainable solutions.

1. INTRODUCTION

Air pollution is a pressing global concern as it poses a significant threat to life on Earth. While natural air purification systems like wind and precipitation can help reduce pollution, their effectiveness depends on atmospheric conditions and pollutant levels. Both natural phenomena and human activities contribute to air pollutant emissions, leading to adverse health effects and increased mortality rates. Meteorological factors and geographical location also influence air pollution concentrations. To mitigate these effects, it is crucial for communities to implement air quality monitoring and control measures that align with national and international air quality standards.

Key pollutants such as sulfur oxides, nitrogen oxides, and suspended particles play a critical role in evaluating air quality. They are classified into primary and secondary pollutants based on their sources. Primary pollutants are directly emitted from specific sources, while secondary pollutants form through chemical reactions in the atmosphere involving primary pollutants. Different emission sources and atmospheric lifespans influence observed pollutant concentrations. Local pollutants have short lifespans and high concentrations near their sources, while others, like ozone and black carbon, can travel over regional scales due to longer lifespans. Some pollutants, such as carbon monoxide, persist in the atmosphere for extended periods and undergo global-scale transport.

This study aims to investigate variations in sulfur dioxide (SO2), nitrogen dioxide (NO2), and Particulate Matter (PM) concentrations within air quality indexes across different temporal scales. It focuses on analyzing diurnal, seasonal, and annual patterns of pollutant levels in selected locations, exploring correlations with meteorological parameters. The research seeks to uncover potential links between weather conditions and pollutant concentrations, contributing to a comprehensive understanding of air pollution dynamics. By providing valuable insights into influencing factors, the study can inform air quality management and policy-making, helping to formulate effective strategies for combatting air pollution and promoting healthier living environments.

2. Materials and Methods

2.1 Study Area

The study focuses on analyzing the air quality index (AQI) and meteorological parameter variations in three cities: Amravati, Akola and Nagpur. These cities, located in Maharashtra, India, were chosen as the study area due to their distinct characteristics and significance in terms of air pollution dynamics.

Amravati City, located in the state of Maharashtra, India, serves as the administrative headquarters of the Amravati district and is the second largest city in the Vidarbha region, following Nagpur. Its coordinates are 20°55′33″N 77°45′53″E. Amravati experiences a climate characterized by wet and dry seasons, with hot, dry summers and mild to cool winters. The summer season lasts from March to June, followed by the rainy season from July to October, and finally the winter season from November to March. On average, Amravati maintains an annual temperature of 26.7 °C | 80.0 °F. The city receives an annual rainfall of 1052 mm | 41.4 inches. The average wind speed is 2.9 m/s, reaching a maximum of 9 m/s. The average relative humidity remains around 57.8% but can range from 14.2% to 98.1%.

Akola District, located in Maharashtra, India, covers an area of approximately 5,428 square kilometers. It is situated in the geographical coordinates of 20.17 to 21.16 degrees North latitude and 5.6 degrees East longitude within the district. The district experiences a climate characterized by varying temperatures and moderate rainfall. The average annual rainfall in Akola District ranges between 750 to 1000 millimeters. The region witnesses distinct seasons with specific weather patterns. During the summer season, the minimum temperature can reach up to 35.5 degrees Celsius, while the maximum temperature can soar to 45.9 degrees Celsius.

Nagpur (21◦15'N, 79◦08'E) is the Capital of Maharashtra in the winter season and a major urban center in central India, known as the "Orange City." The district stretches to almost 9897 sq km and is surrounded by a plateau rising northward to the Satpura Range. Nagpur is situated 274.5m to 652.7m above sea level, with 28% of the town covered by forest. The city has typical seasonal monsoon weather, which is normally dry, with an annual average relative humidity (RH) of 60%. The annual average temperature ranges from 33.2 to 17.1◦C, and the average annual rainfall is 112 mm. Rapid industrialization, urbanization, and transportation activities contribute to the city's air pollution levels, making it an ideal location to examine the AQI and meteorological parameter variations.

2.2 Air Quality Monitoring Stations

Table No.1 shows Air Quality Monitoring Stations in Amravati, Akola, and Nagpur cities.

Table No.1: Air Quality Monitoring Stations

Sr.No.	City	Location
1.	Amravati	Government College. Of Engineering, Amravati
2.	Amravati	Apurva Oil Industries, A-23 MIDC, Amravati
3.	Amravati	Vanita Samaj Building, Raja Kamal Chowk, Amravati
4.	Akola	College of Engineering and Technology, Akola
5.	Akola	LR College of Engineering, Akola
6.	Akola	MIDC Water Work, Akola
7.	Nagpur	Terrace of Institute of Engineering, North Ambazano Road, Nagpur
8.	Nagpur	MIDC Office Hingna Road, Nagpur
9.	Nagpur	Government Polytechnique College, Sadar Nagpur

2.3 Data sources:

The study utilized a variety of data sources to investigate the Air Quality Index (AQI) and meteorological parameters. The Maharashtra Pollution Control Board (MPCB) was a primary source for the AQI data. The MPCB is a government agency responsible for monitoring and regulating pollution levels in the state. They maintain a comprehensive database of air quality measurements across different locations, including the cities of Nagpur, Amravati, and Akola.

To assess meteorological parameters, data was obtained from the India Meteorological Department (IMD). The IMD is the national meteorological agency in India, responsible for collecting and analyzing weather data from various weather stations across the country. These weather stations provide information on factors such as temperature, humidity, wind speed, and precipitation.

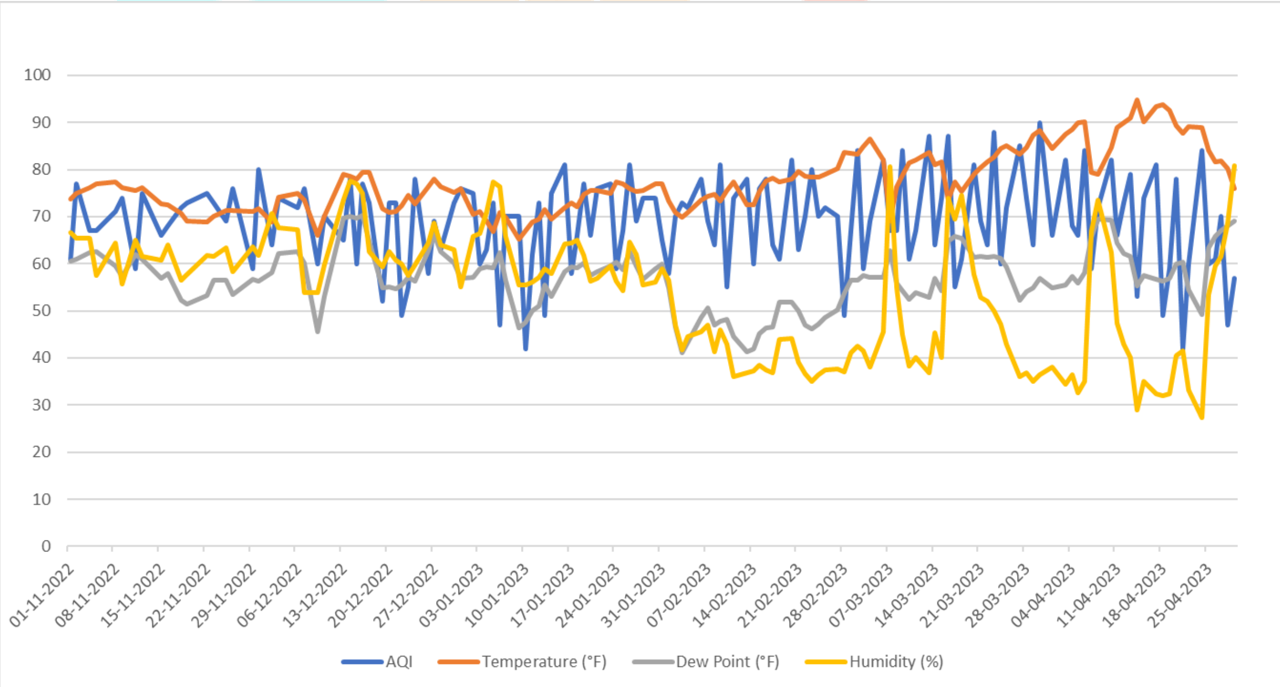
The data from these government databases and weather stations are regularly monitored, quality-assured, and widely recognized, ensuring the credibility and accuracy of the findings. The utilization of these trusted data sources enhances the robustness of the study and enables meaningful analysis of the relationships between air quality and meteorological variations in the cities of Nagpur, Amravati, and Akola.

3. Data Analysis and Interpretation

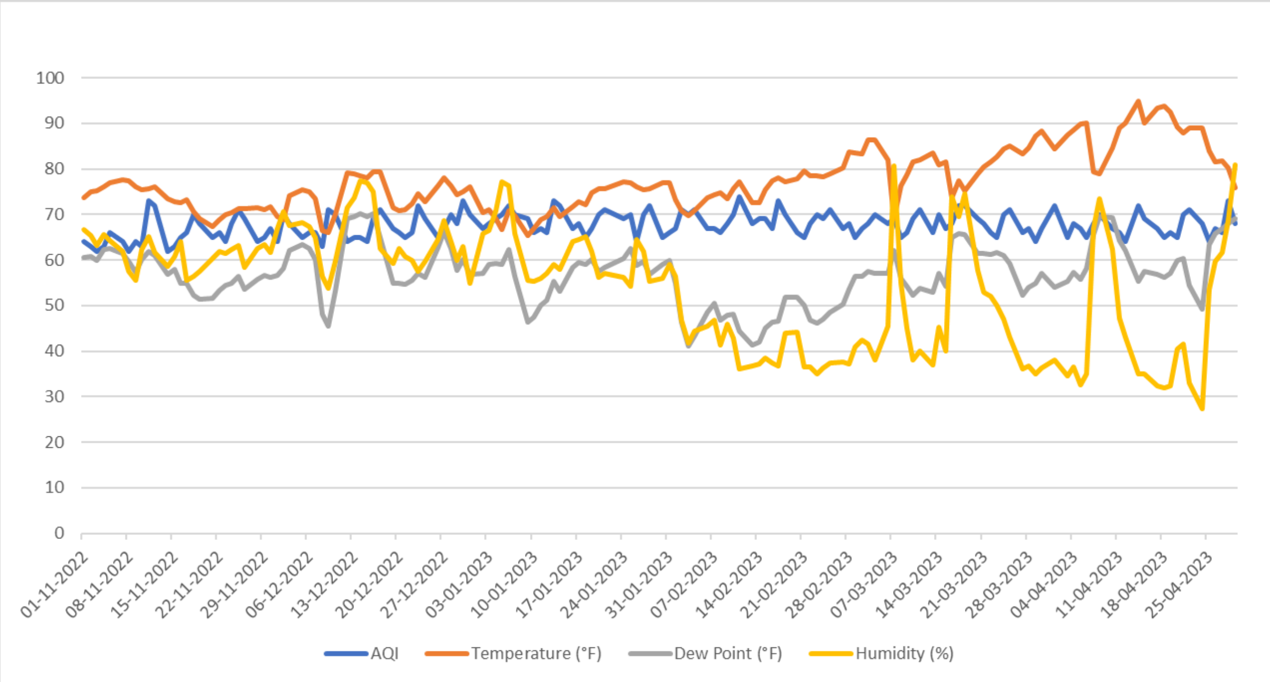
3.1 City-wise Analysis of Air Quality Index and Meteorological Parameters

The study was conducted in Amravati, Akola, and Nagpur cities. The study period of three cities is six months from November to April for the current year (2022-23). These six months include Post Monsoon, Winter, and summer seasons. The Post Monsoon season includes November month, the Winter season includes December, January, and February months and the summer season include March and April months. The Air Quality Index and Meteorological Parameters are changed seasonally. The Climatic and Weather Conditions affect the Air Quality Index and Meteorological Parameters. The month-wise analysis of Amravati, Akola, and Nagpur cities are as follows by using the tabular form, and their correlation shows in graphical form.

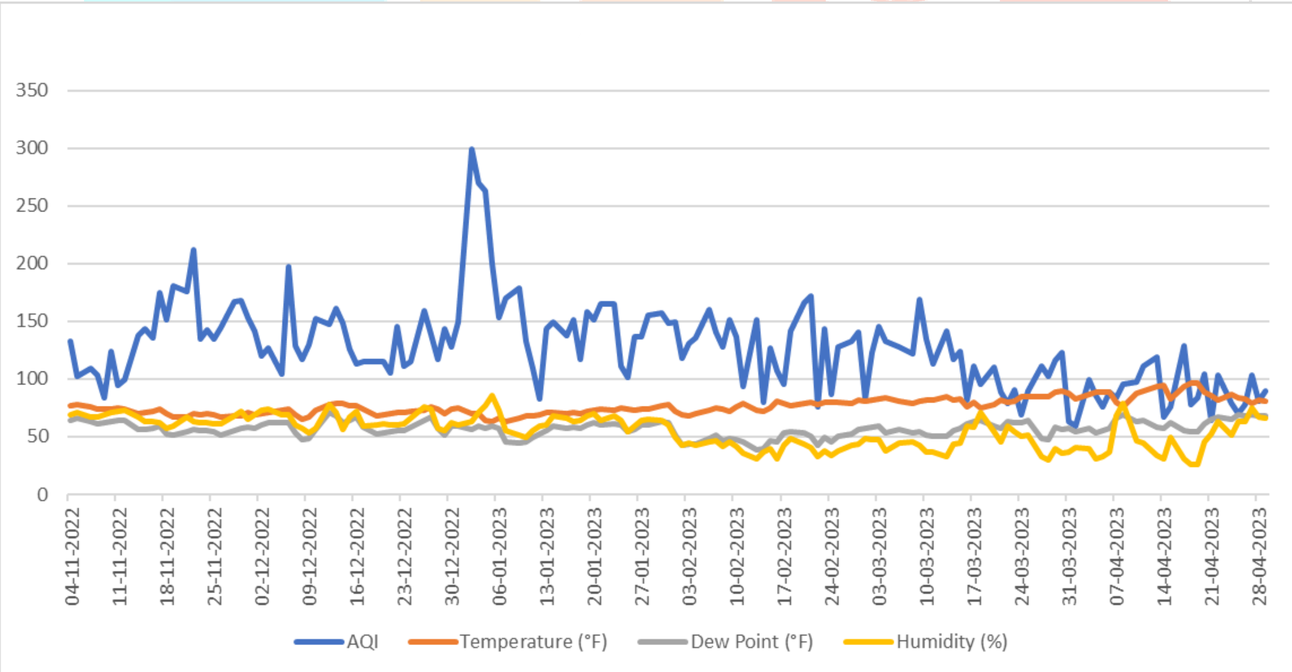
3.2 Amravati City Data Analysis



3.3 Akola City Data Analysis



3.4 Nagpur City Data Analysis



4. CONCLUSION

Based on the conclusions drawn for each city, correlate the findings between Amravati, Akola, and Nagpur:

1. November:
   - Amravati: Weak positive correlation between AQI and Temperature, weak negative correlations between AQI and Dew Point, and AQI and Humidity.
   - Akola: Moderate negative correlations between AQI and Temperature, Dew Point, and Humidity.
   - Nagpur: Very weak positive correlations between AQI and Temperature, Dew Point, and Humidity.

Correlation between cities: In November, there is a tendency for AQI to slightly increase with higher Temperatures across all three cities. There is also a suggestion of a decrease in AQI as Dew Point and Humidity increase, with Amravati showing weak negative correlations and Akola showing moderate negative correlations.

2. December:
   - Amravati: Weak positive correlation between AQI and Temperature, weak positive correlation between AQI and Dew Point, moderate negative correlation between AQI and Humidity.
   - Akola: Weak to moderate positive correlations between AQI and Temperature, Dew Point, and Humidity.
   - Nagpur: Weak to moderate positive correlations between AQI and Temperature, Dew Point, and Humidity.

Correlation between cities: In December, all three cities show a weak positive correlation between AQI and Temperature. Both Amravati and Akola exhibit weak positive correlations between AQI and Dew Point, while Nagpur shows weak positive correlations between AQI and Dew Point and Humidity. Additionally, all three cities demonstrate a moderate negative correlation between AQI and Humidity.

3. January and February:
   - Amravati: Weak negative correlations between AQI and Temperature, Dew Point, and Humidity.
   - Akola: Weak to moderate positive correlations between AQI and Temperature, Dew Point, and Humidity.
   - Nagpur: Moderate negative correlations between AQI and Temperature, Dew Point, and Humidity.

Correlation between cities: In January and February, there is some inconsistency between the cities. Amravati indicates weak negative correlations between AQI and meteorological parameters, while Akola suggests weak to moderate positive correlations. Nagpur aligns with Amravati in showing moderate negative correlations.

4. March:
   - Amravati: Very weak positive correlation between AQI and Temperature, weak negative correlations between AQI and Dew Point, and AQI and Humidity.
   - Nagpur: Very weak positive correlation between AQI and Temperature, weak negative correlations between AQI and Dew Point, and AQI and Humidity.

Correlation between cities: In March, both Amravati and Nagpur exhibit very weak positive correlations between AQI and Temperature. Additionally, they both demonstrate weak negative correlations between AQI and Dew Point and Humidity.

5. April:
   - Amravati: Moderate negative correlations between AQI and Temperature, Dew Point, and Humidity.
   - Akola: Weak correlations between AQI and Temperature, Dew Point, and Humidity.
   - Nagpur: Very weak positive correlation between AQI and Temperature, moderate negative correlations between AQI and Dew Point and AQI and Humidity.

Correlation between cities: In April, there is some variation between the cities. Amravati shows moderate negative correlations between AQI and meteorological parameters, while Akola indicates weak correlations. Nagpur aligns with Amravati in demonstrating moderate negative correlations.

Overall, while there are similarities and differences in the correlations observed among the cities, it is important to note that the strengths of the correlations are generally weak to moderate. This suggests that other factors not included in the analysis may have a significant influence on air quality.

REFERENCES

[1] A website central pollution control board (CPCB) http://www.cpcb.nic.in/

[2] Anikender Kumar, PramilaGoyal, "Forecasting of air quality in Delhi using principal component regression technique", Atmospheric Pollution Research, 2 (2011)

436-444

[3] Almaraz, M., Bai, E., Wang, C., Trousdell, J., Conley, S., Faloona, I., & Houlton, B. Z. (2018). Agriculture is a major source of NOx pollution in California. Science Advances, 4(eaao3477).

[4] Ayanlade, A., & Oyegbade, E. F. (2016). Influences of wind speed and direction on atmospheric particle concentrations and industrially induced noise. SpringerPlus, 5(1), 1898.

[5] Balakrishnan, K., Cohen, A., & Smith, K. R. (2014). Addressing the burden of disease attributable to air pollution in India: the need to integrate across household and ambient air pollution exposures

[6] Balakrishnan K., Ganguli B., Ghosh S., et al. (2011). Part 1. Short-term effects of air pollution on mortality: results from a time-series analysis in Chennai, India. Res Rep Health Eff Inst; 157: 7–44.

[7] Bosch, H., & Janssen., F.J.J.G (1988). Formation and control of nitrogen oxides. Catal Today, 2(4), 368-379.

[8] Badrinath, K. V. S., Kharol, S. K., & Sharma, A. R. (2009). Long-range transport of aerosols from agriculture crop residue burning in Indo-Gangetic Plains—a study using LIDAR, ground measurements and satellite data. Journal of Atmospheric and SolarTerrestrial Physics, 71(1), 112-120

[9] Boningari, T., & Smirniotis, P. G. (2016). Impact of nitrogen oxides on the environment and human health: Mn-based materials for the NO x abatement. Current Opinion in Chemical Engineering,13, 133-141.

[10] CPCB, (2000) Air quality status and trend in India.Parivesh Newsletter, Vol. 4(3). Central Pollution Control Board, New Delhi, India.

[11] Central pollution control board (CPCB). National air quality index, Series CUPS/82/2014-15; 2014.

[12] Central Pollution Control Board (CPCB). Guidelines for National ambient air quality monitoring, Series: NAAQM/25/2003- 04.Parivesh Bhavan, Delhi; 2009.

[13] Chen, T., Kuschner, W. G., Gokhale, J., & Shofer, S. (2007b). Outdoor Air Pollution: Nitrogen Dioxide, Sulfur Dioxide, and Carbon Monoxide Health Effects. The American Journal of the Medical Sciences,333(4), 249-256.

[14] Central Pollution Control Board (CPCB). Guidelines for National ambient air quality monitoring, Series: NAAQM/25/2003- 04. Parivesh Bhavan, Delhi; 2009:

[15] Elminir, H. K. (2005). Dependence of urban air pollutants on meteorology. Science of the Total Environment, 350(1-3), 225-237

[16] Finlayson-Pitts, B. J. (2000). Chemistry of the upper and lower atmosphere theory, experiments and applications. Academic Press.

[17] Friis, R. H. (2019). Air Quality. In Essentials of Environmental Health (3rd ed., pp. 241- 259). Burlington, MA: Jones & Bartlett Learning.

[18] Godish, T., Davis, W. T., & Fu, J. S. (2014). Air quality. CRC Press.

[19] Koren, H. & Bisesi, M. (2003). Air Quality Management. In Handbook of Environmental Health: Pollutant Interactions in Air, Water, and Soil (4th ed., pp. 1-56). Boca Raton, FL: CRC Press.

[20] Kumar, R., Goel, N., Gupta, N., Singh, K., Nagar, S., & Mittal, J. (2014). Indoor air pollution and respiratory illness in children from rural India: a pilot study. Indian J Chest Dis Allied Sci; 56: 79–83.

[21] Leblanc, T., & Hauchecorne, A. (1997). Recent observations of mesospheric temperature inversions. Journal of Geophysical Research: Atmospheres, 102(D16), 19471-19482.

[22] Madronich, S., & Flocke, S. (1999). The role of solar radiation in atmospheric chemistry. In Environmental photochemistry (pp. 1-26). Springer, Berlin, Heidelberg.