Air Quality Index (AQI) Report

Data Source: West Bengal Pollution Control Board
Station- Bhasa 2nd Campus of Asutosh College
(December 2025)

Introduction

The **Air Quality Index (AQI)** is a system used to measure and report the quality of air in a particular area. It tells us how polluted the air is and how it can affect human health and the environment. AQI is calculated based on the concentration of different air pollutants such as particulate matter (PM2.5 and PM10), carbon monoxide, sulphur dioxide, nitrogen dioxide, and ozone. The AQI value is usually shown in different colours, where green indicates good air quality and red indicates very poor or dangerous air quality. This index helps people take necessary precautions and also helps the government to control air pollution.

Purpose and Importance

The primary purpose of the AQI is to provide clear and concise information about daily air quality levels to the public. By understanding the AQI, individuals can take necessary precautions to protect their health, particularly on days when air pollution levels are high. The AQI is especially important for vulnerable populations, including children, the elderly, and those with pre-existing respiratory or cardiovascular conditions, as these groups are more susceptible to the adverse effects of air pollution.

AQI Scale

The AQI scale ranges from 0 to 500 and is divided into six categories, each representing a different level of health concern:

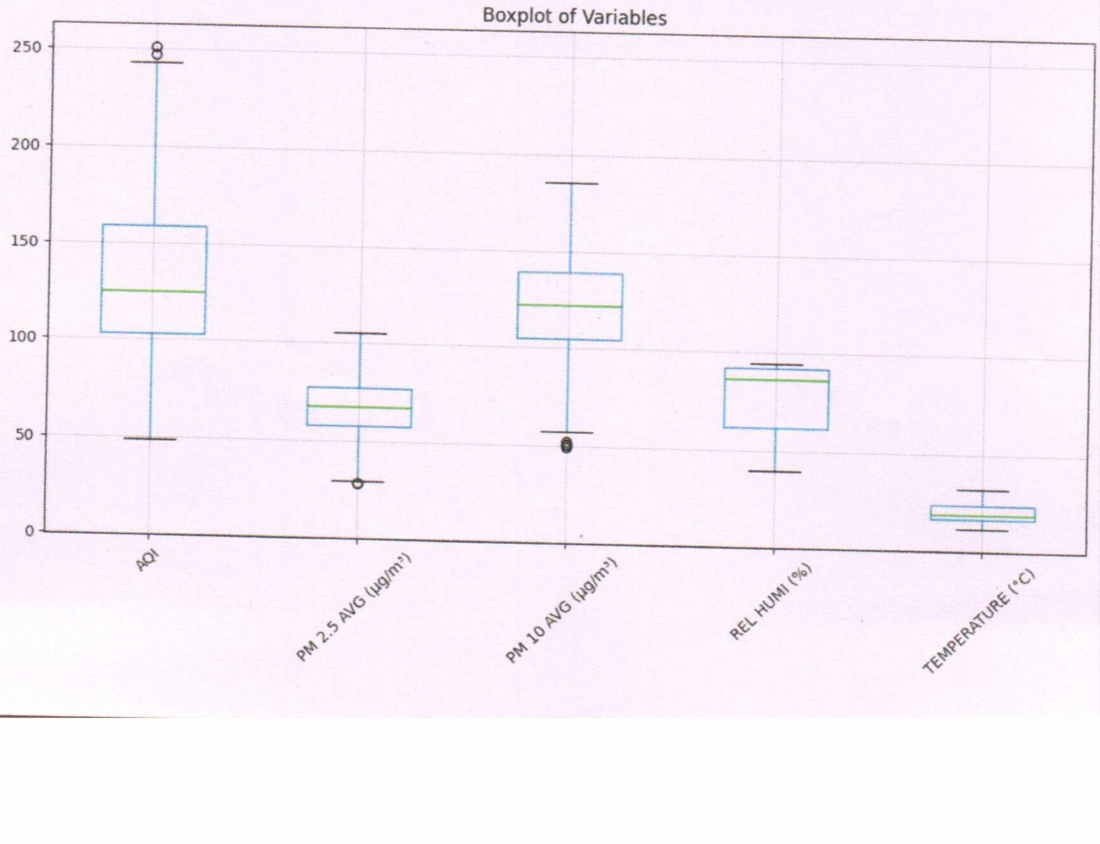
- **0-50 (Good)**: Air quality is considered satisfactory, and air pollution poses little or no risk.
- **51-100 (Moderate)**: Air quality is acceptable; however, for some pollutants, there may be a moderate health concern for a very small number of people who are unusually sensitive to air pollution.
- **101-150 (Unhealthy for Sensitive Groups)**: Members of sensitive groups may experience health effects. The general public is not likely to be affected.

- **151-200 (Unhealthy)**: Everyone may begin to experience health effects; members of sensitive groups may experience more serious health effects.
- **201-300 (Very Unhealthy)**: Health alert: everyone may experience more serious health effects.
- **301-500 (Hazardous)**: Health warnings of emergency conditions. The entire population is more likely to be affected.

Interpretation of the data:

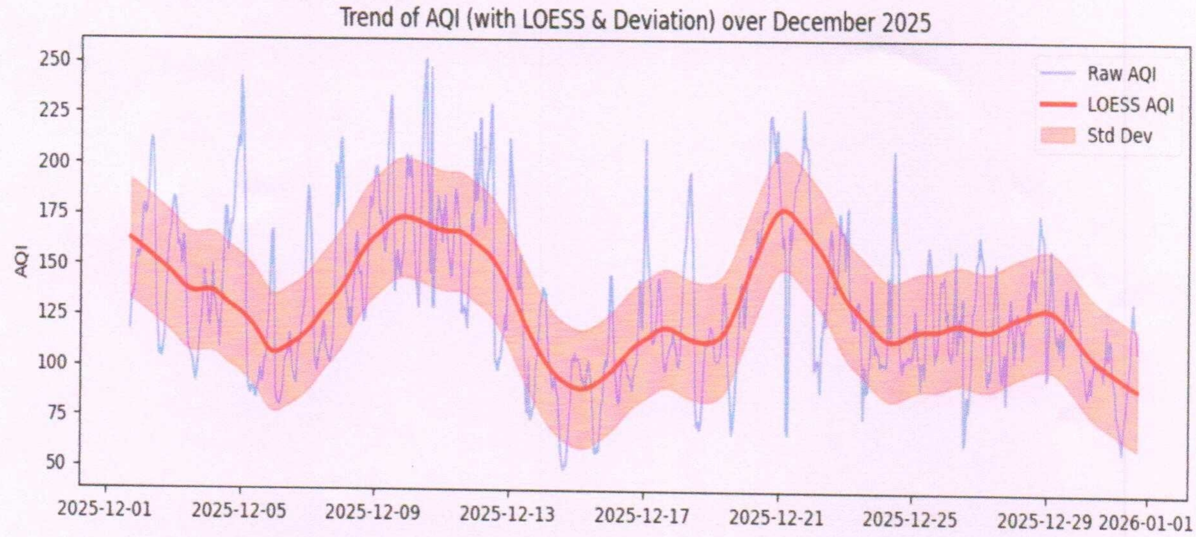
The boxplot shows the distribution and variability of five environmental variables: **AQI, PM2.5, PM10, Relative Humidity, and Temperature**.

1. **AQI** shows a wide range and high variability, indicating that air quality fluctuates strongly over the study period. The median lies around the moderate-to-poor air quality range, and the presence of some high outliers suggests occasional episodes of very poor air quality.
2. **PM2.5** has a moderate spread, with most values concentrated around the middle range. A few low and high outliers indicate occasional unusually clean or polluted conditions, but overall its variability is lower than AQI and PM10.
3. **PM10** shows relatively high dispersion, similar to AQI. The wide interquartile range indicates strong fluctuation in coarse particulate matter concentration, and some low outliers suggest days with unusually low PM10 levels.
4. **Relative Humidity (%)** is comparatively more stable. The box is narrower, showing less variability, and most values are concentrated in the higher humidity range, indicating generally humid atmospheric conditions.
5. **Temperature (°C)** shows the least variability among all variables. The narrow box and short whiskers indicate that temperature remains relatively stable, with only small day-to-day fluctuations.

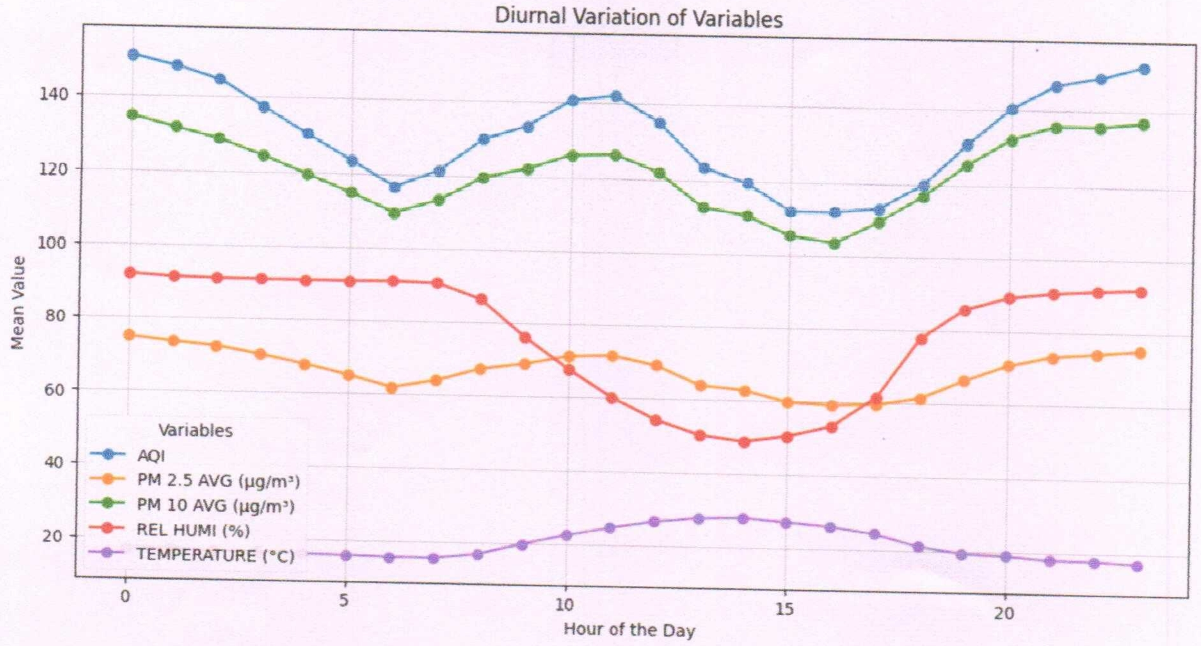


The graph shows the **daily variation of AQI during December 2025**, along with a **smoothed LOESS trend line** and **standard deviation band**, which helps in understanding both the overall pattern and short-term fluctuations.

1. **Overall Pattern:**
   The AQI does not follow a steady increasing or decreasing trend; instead, it shows a **wave-like (cyclical) pattern** throughout the month, indicating alternating periods of relatively better and worse air quality.
2. **Early December (1–7 Dec):**
   AQI starts at a **moderately high level** and then **declines**, reaching a local minimum around the first week. This suggests a short phase of improvement in air quality.



3. **Mid-December Rise (8–12 Dec):**
   AQI **increases sharply** and reaches a **peak around 9–11 December**, indicating a period of **severe pollution episodes**.
4. **Mid-Month Improvement (13–16 Dec):**
   After the peak, AQI **drops significantly**, reaching one of the **lowest levels of the month** around mid-December, showing a temporary improvement in air quality.
5. **Late December Peak (19–22 Dec):**
   Another **strong rise** in AQI is observed, with a **major peak around 20–21 December**, indicating another **intense pollution event**.
6. **End of December (23–31 Dec):**
   After this peak, AQI **gradually decreases** with some fluctuations, and by the end of the month the air quality shows a **general improving tendency**.
7. **Variability (Std Dev Shaded Area):**
   The wide shaded band around the trend line indicates **high day-to-day variability**, meaning AQI fluctuated strongly due to changing meteorological conditions and pollution sources.

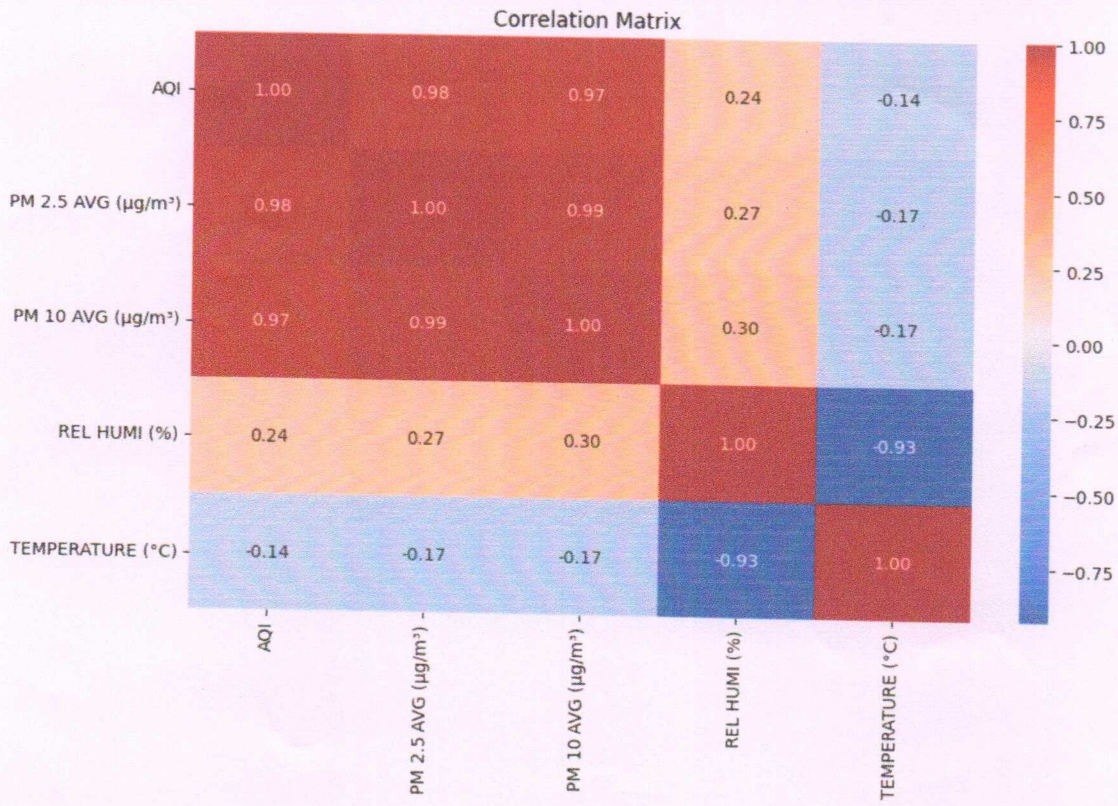


The diurnal variation graph shows a clear **daily cycle in air quality and meteorological conditions**. AQI, PM2.5, and PM10 concentrations are **highest during the late night and early morning hours**, decrease gradually after sunrise, and reach their **lowest levels during the afternoon**. This daytime improvement is mainly due to increased temperature and stronger atmospheric mixing, which helps in dispersing pollutants. After sunset, pollutant levels **start rising again** and remain high during the night because of reduced wind movement and the formation of temperature inversion. In contrast, **temperature follows the opposite pattern**, rising from morning to reach a maximum in the afternoon and then declining towards night. **Relative humidity also shows a reverse trend**, being higher during night and early morning, decreasing during the warmer afternoon hours, and increasing again in the evening. Overall, the figure clearly demonstrates that **air pollution is worst during night and early morning and comparatively better during daytime**, showing strong control of meteorological conditions on the diurnal behavior of air quality.

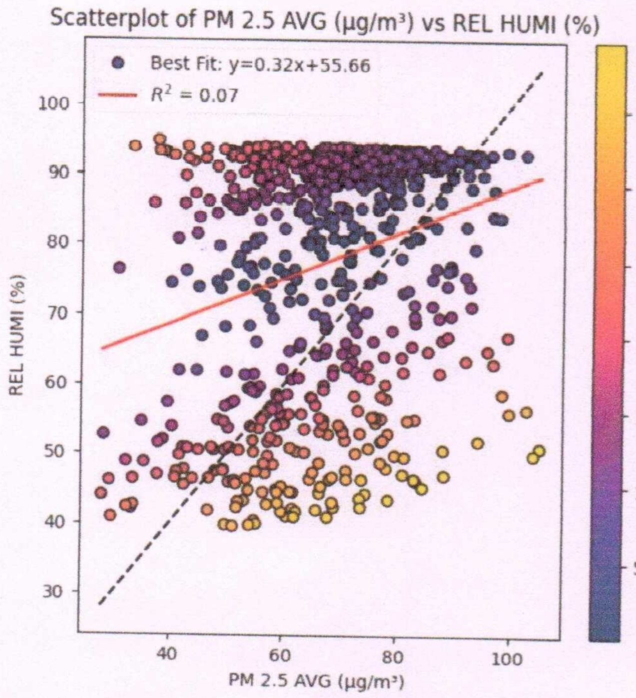
The correlation matrix clearly shows the **interrelationship between air quality parameters and meteorological variables**. AQI has a **very strong positive correlation with PM2.5 ($r \approx 0.98$) and PM10 ($r \approx 0.97$)**, indicating that particulate matter concentration is the **primary controlling factor of AQI** in the study area. Similarly, PM2.5 and PM10 are also **almost perfectly correlated with each other ($r \approx 0.99$)**, suggesting that both fine and coarse particles originate from similar sources and vary together.

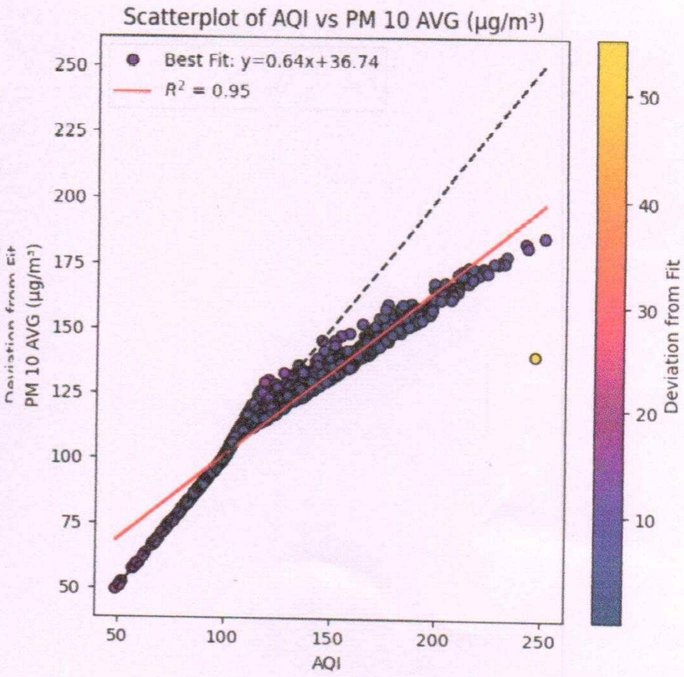
Relative humidity shows a **weak to moderate positive correlation** with AQI ($r \approx 0.24$), PM2.5 ($r \approx 0.27$), and PM10 ($r \approx 0.30$), which implies that higher humidity conditions may slightly favor the accumulation or persistence of pollutants, but it is not the dominant controlling factor. On the other hand, **temperature exhibits a weak negative correlation** with AQI ($r \approx -0.14$), PM2.5 ($r \approx -0.17$), and PM10 ($r \approx -0.17$), indicating that higher temperatures generally help in **reducing pollution levels** through enhanced atmospheric mixing and dispersion.

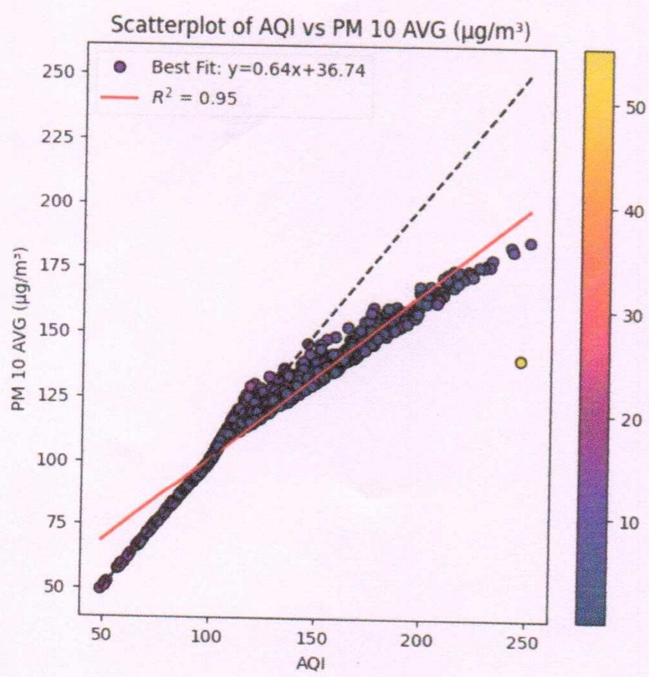
A very strong **negative correlation between relative humidity and temperature ($r \approx -0.93$)** is also evident, reflecting their typical inverse

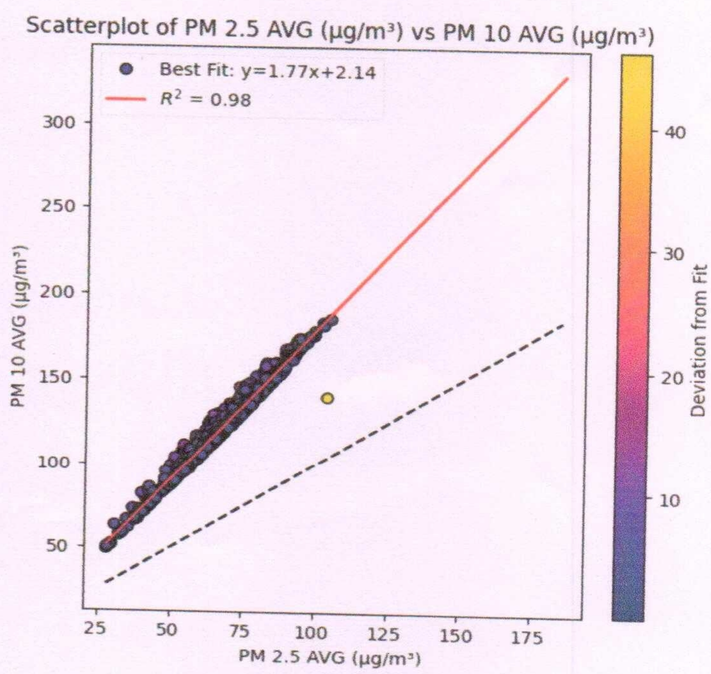


relationship during the study period. Overall, the matrix confirms that **particulate matter is the main driver of air quality degradation**, while meteorological factors like temperature and humidity play a **secondary but influential role** in controlling pollution levels.









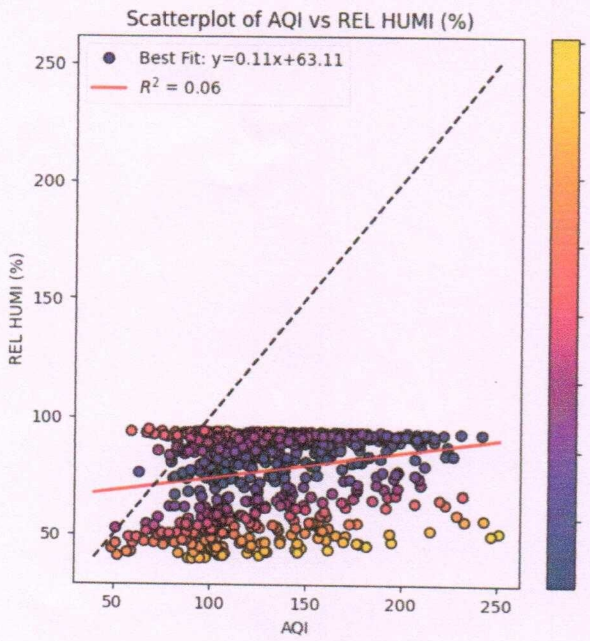
The **PM2.5 vs Relative Humidity** plot shows a **very weak positive relationship ($R^2 \approx 0.07$)**, indicating that humidity has **little direct control on PM2.5 concentration**. The wide scatter of points suggests that PM2.5 levels are influenced more by emission sources and atmospheric processes than by humidity alone.

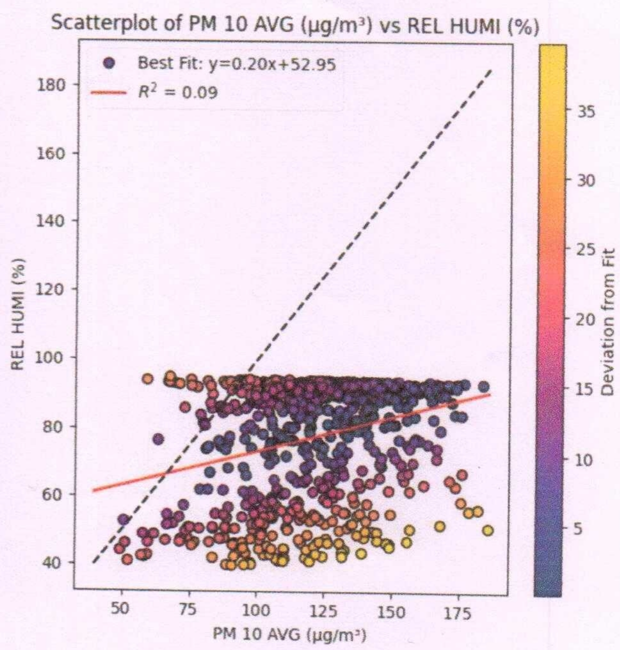
In contrast, the **AQI vs PM10** and **AQI vs PM10 (repeated)** plots show a **very strong linear relationship ($R^2 \approx 0.95$)**, confirming that **PM10 plays a**

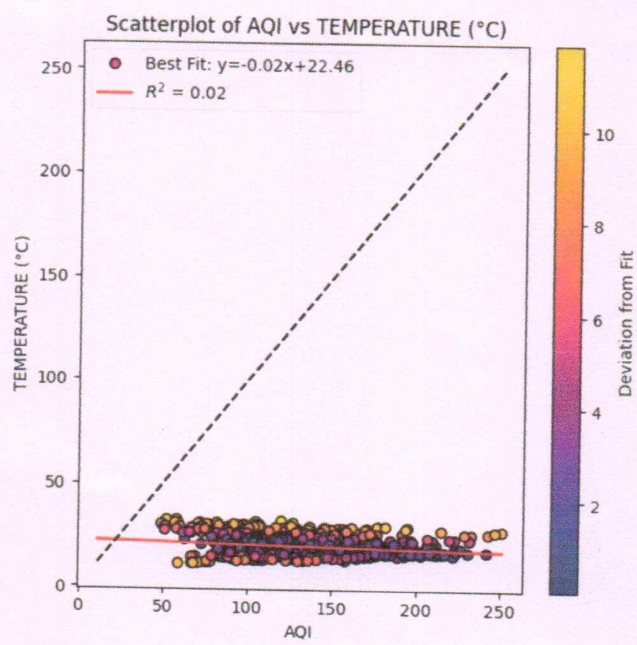
dominant role in determining AQI. As AQI increases, PM10 concentration increases almost proportionally, with very little scatter around the best-fit line.

The **PM2.5 vs PM10** plot shows an **extremely strong correlation ($R^2 \approx 0.98$)**, indicating that **fine and coarse particles vary together** and likely originate from common sources or are controlled by similar atmospheric conditions.

Overall, these scatter plots confirm that **particulate matter (especially PM10 and PM2.5) is the main driver of AQI variability**, while **relative humidity has only a weak and indirect influence**. The tight clustering around the regression lines in the PM–AQI relationships reflects a **strong, stable, and predictable association**, whereas the scattered PM2.5–humidity relationship reflects a **complex and weak dependency**.







These scatter plots explain the **relationship between air quality parameters and meteorological variables**, and they clearly show that **humidity and temperature have only a weak influence on air pollution levels** in the study period.

The **AQI vs Relative Humidity** plot shows a **very weak positive relationship ($R^2 \approx 0.06$)**. Although the regression line slopes slightly upward, the points are widely scattered, indicating that changes in humidity **do not strongly control AQI** and only have a minor indirect effect.

Similarly, the **PM10 vs Relative Humidity** plot also shows a **very weak positive correlation ($R^2 \approx 0.09$)**. This suggests that higher humidity may slightly favor the accumulation or growth of particles, but **its influence is marginal compared to emission sources and atmospheric dynamics**.

The **AQI vs Temperature** plot shows a **very weak negative relationship ($R^2 \approx 0.02$)**. This indicates that **higher temperatures are only very slightly associated with lower AQI**, likely due to better atmospheric mixing, but the effect is extremely small and not statistically strong.

Overall, these figures demonstrate that **meteorological parameters (relative humidity and temperature) alone cannot explain the variation in AQI and PM10**. The wide scatter of points and very low R^2 values confirm that **air quality during the study period is mainly controlled by pollutant emissions and particulate matter levels rather than by temperature or humidity**

Conclusion

On the basis of the statistical analyses, boxplots, trend analysis, correlation matrix, and scatter plots, it can be concluded that **air quality in the study area is primarily controlled by particulate matter pollution**. AQI shows a **very strong and consistent relationship with PM2.5 and PM10**, and these two particulate fractions are also highly correlated with each other, indicating that they originate from common sources and jointly determine the overall air quality status.

The temporal analysis reveals that **air quality is highly variable**, with frequent pollution peaks during the study period and a clear **diurnal cycle**, where pollution levels are higher during night and early morning and lower during daytime due to better atmospheric mixing. This reflects the strong influence of **local emissions combined with wintertime meteorological conditions**.

In contrast, **meteorological parameters such as temperature and relative humidity show only weak correlations with AQI and particulate matter**, as confirmed by very low R^2 values in the scatter plots. Although humidity shows a slight positive influence and temperature a slight negative influence, their roles are **secondary and indirect** compared to the dominant effect of emission sources and particulate loading.

Overall, the study indicates that **effective air quality improvement in the region depends mainly on controlling particulate matter emissions**, especially PM2.5 and PM10, while meteorological conditions mainly act as **modifying factors** that influence dispersion and accumulation rather than being the primary drivers of pollution.

Note:

Report produced by Air Quality Monitoring System Committee

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Dr. Debasmrity Mukherjee (Nodal Officer) Dept. of Geography	Debasmrity Mukherjee 13/1/26
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