Air Quality Index (AQI) Report

Data Source: West Bengal Pollution Control Board
Station: Bhasa,2nd Campus of Asutosh College
(February_2025)

Introduction

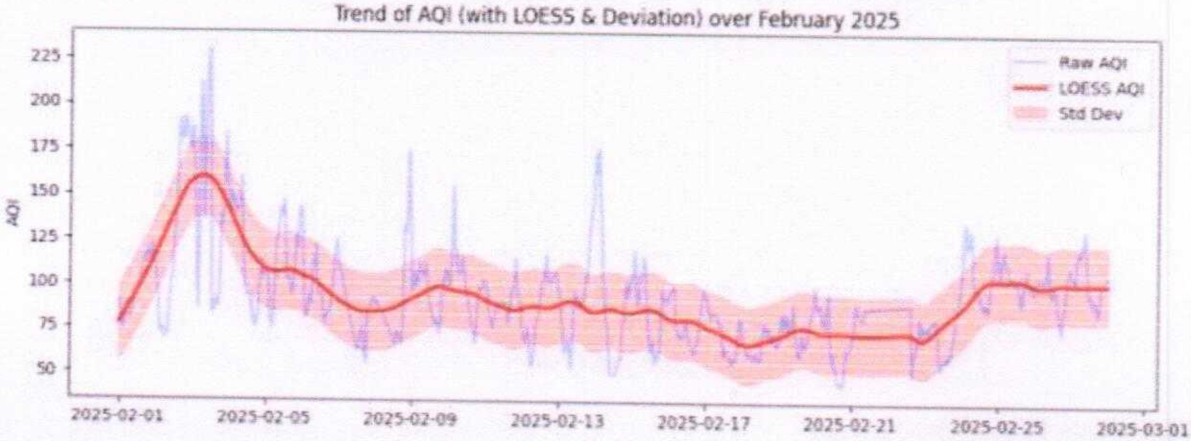
In February 2025, South 24 Parganas, West Bengal, experienced varying air quality levels, predominantly influenced by particulate matter concentrations. For instance, on February 20, the Air Quality Index (AQI) reached 317, categorized as 'Very Poor,' with PM2.5 levels at 67.71 µg/m³ and PM10 at 82.88 µg/m³. Such elevated pollution levels can pose significant health risks, particularly to individuals with respiratory conditions, children, and the elderly.

In contrast, other days in February saw relatively better air quality. For example, on a day when the AQI was 109, classified as 'Moderate,' the primary pollutant was PM2.5 at 63.2 µg/m³. During such conditions, sensitive individuals might experience minor breathing discomfort, while the general population remains less affected.

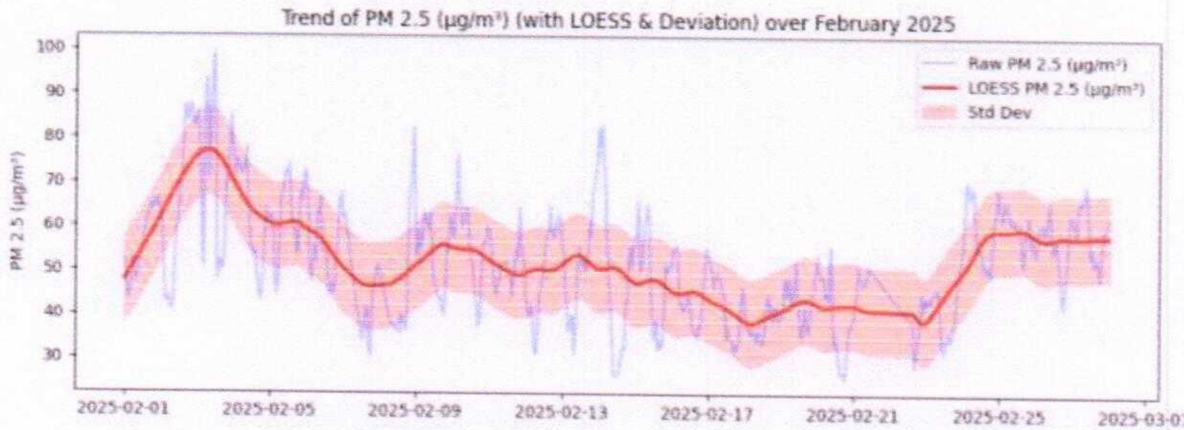
It's noteworthy that neighbouring Kolkata also faced air quality challenges during this period. On February 22, the city recorded an AQI of 273 ('Poor'), prompting advisories for residents, especially those with respiratory issues, to limit outdoor activities.

These fluctuations underscore the importance of continuous air quality monitoring and the implementation of effective pollution control measures to safeguard public health in South 24 Parganas and surrounding regions.

PM 2.5, PM 10, temperature, and relative humidity play crucial roles as controlling factors in air quality monitoring. **PM 2.5 and PM 10** are fine particulate pollutants; PM 2.5 ($\leq$2.5 µm) penetrates deep into the lungs and can cause severe respiratory and cardiovascular issues, while PM 10 ($\leq$10 µm) affects the upper respiratory system. Their concentration levels directly determine air pollution severity. **Temperature** influences the dispersion of pollutants; higher temperatures can enhance pollutant dispersion, while temperature inversions trap pollutants near the surface, worsening air quality. **Relative humidity** affects particle aggregation and pollutant absorption; high humidity can increase aerosol formation, intensifying pollution, whereas very low humidity can lead to dust resuspension. These factors collectively determine air quality dynamics and its impact on public heal



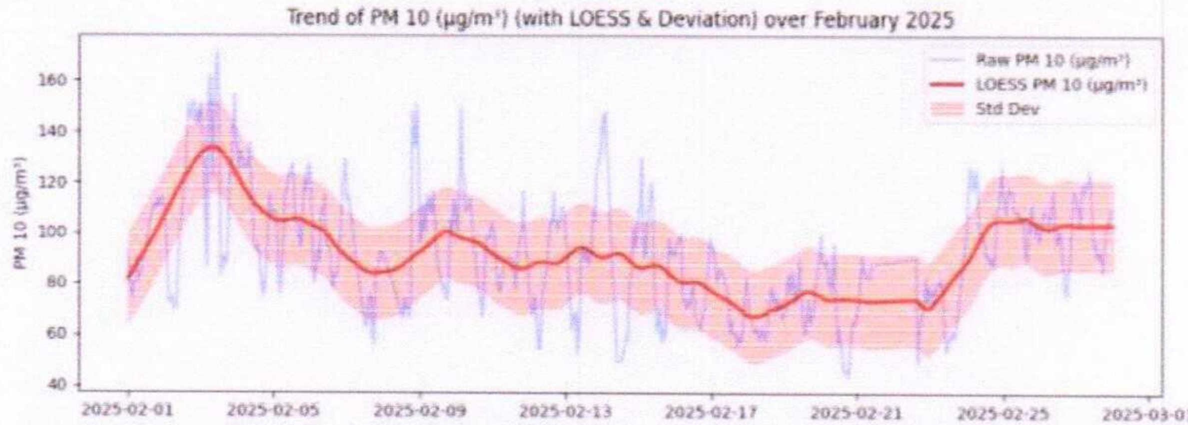
The given graph illustrates the trend of the Air Quality Index (AQI) in South 24 Parganas over February 2025, incorporating LOESS smoothing and standard deviation bands. The x-axis represents the dates from February 1 to March 1, while the y-axis denotes AQI values. The raw AQI, shown in light blue, exhibits significant fluctuations, while the red LOESS curve provides a smoothed trend, and the light red shading indicates the standard deviation, representing variations in air quality. The AQI starts at a moderate level but rises sharply in the first few days, peaking above 200 around February 3-4, indicating poor air quality. Following this peak, AQI gradually declines, fluctuating around 100 during mid-February, with occasional spikes. From February 10 to 20, air quality remains relatively stable but still experiences periodic variations. Towards the end of the month, AQI shows a slight upward trend, stabilizing between 100 and 125, suggesting a resurgence in pollution levels. The data highlights an initial severe pollution episode, followed by an overall improvement, though air quality remains a concern with periodic fluctuations throughout the month.



The given graph depicts the trend of **PM 2.5 ($\mu g/m^3$) concentrations** in South 24 Parganas over February 2025, utilizing **LOESS smoothing and standard deviation bands**. The **x-axis** represents dates from **February 1 to March 1**, while the **y-axis** denotes the PM 2.5 concentration levels in micrograms per cubic meter ($\mu g/m^3$). The **light blue line** represents the raw PM 2.5 values, showing daily fluctuations, whereas the **red LOESS curve** provides a smoothed trend to highlight the overall pattern. The **light red shaded area** represents the **standard deviation**, indicating the range of variations around the smoothed trend.

At the beginning of February, PM 2.5 levels start at a moderate level but rise sharply, peaking above **80-90 $\mu g/m^3$ around February 3-4**, indicating high particulate pollution. After this peak, concentrations show a downward trend, stabilizing between **50-60 $\mu g/m^3$** in mid-February, with periodic fluctuations. Between **February 10-20**, the PM 2.5 levels remain relatively steady but still experience minor peaks, suggesting varying pollution sources. A noticeable dip is observed around mid-February, reaching values close to **40 $\mu g/m^3$**, indicating temporary improvement in air quality. However, towards the end of the month, PM 2.5 levels start increasing again, reaching around **70 $\mu g/m^3$ by February 25-28**, suggesting a resurgence in pollution levels.

This trend closely follows the overall AQI trend, as PM 2.5 is a major determinant of air quality. The data indicates that while air quality showed temporary improvement in mid-February, pollution levels remained significant, especially at the beginning and end of the month. The periodic spikes suggest the influence of local pollution sources such as vehicular emissions, industrial activities, or meteorological factors.

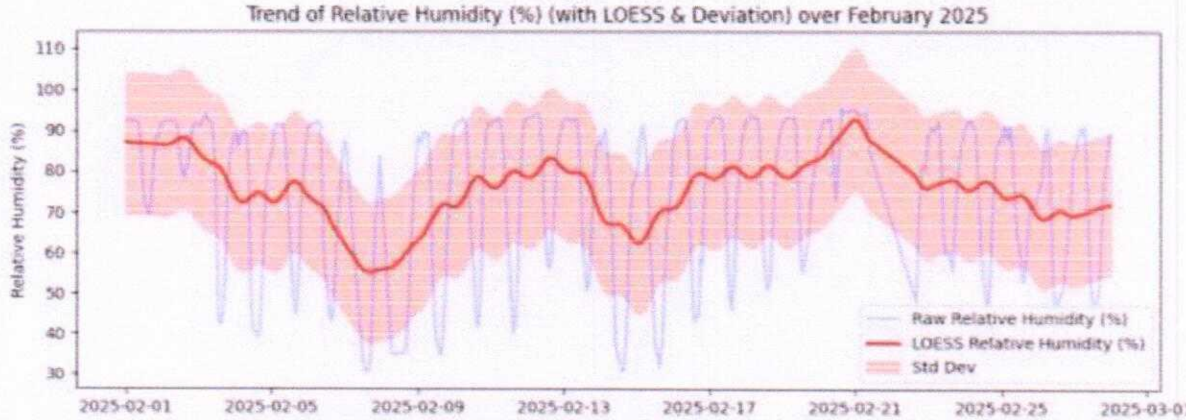


The given graph represents the **trend of PM 10 (µg/m³) concentrations** in South 24 Parganas over February 2025, utilizing **LOESS smoothing and standard deviation bands**. The **x-axis** covers the timeline from **February 1 to March 1**, while the **y-axis** indicates the PM 10 concentration levels in micrograms per cubic meter (µg/m³). The **light blue line** shows the raw PM 10 values, reflecting daily fluctuations, whereas the **red LOESS curve** smooths the data to highlight the overall trend. The **light red shaded area** represents the **standard deviation**, indicating the range of variations around the smoothed trend.

At the beginning of February, PM 10 levels exhibit an increasing trend, peaking above **140-160 µg/m³ around February 3-4**, indicating significant air pollution. After this peak, PM 10 concentrations decline gradually, stabilizing between **80-100 µg/m³** in mid-February, though periodic fluctuations persist. Between **February 10-20**, the concentration remains relatively steady but experiences occasional spikes, suggesting the impact of local pollution sources. A noticeable dip is observed around **mid-February**, reaching values close to **70 µg/m³**, indicating a temporary improvement in air quality. However, towards the end of the month, PM 10 levels rise again, reaching **110-120 µg/m³ by February 25-28**, signifying a resurgence in pollution levels.

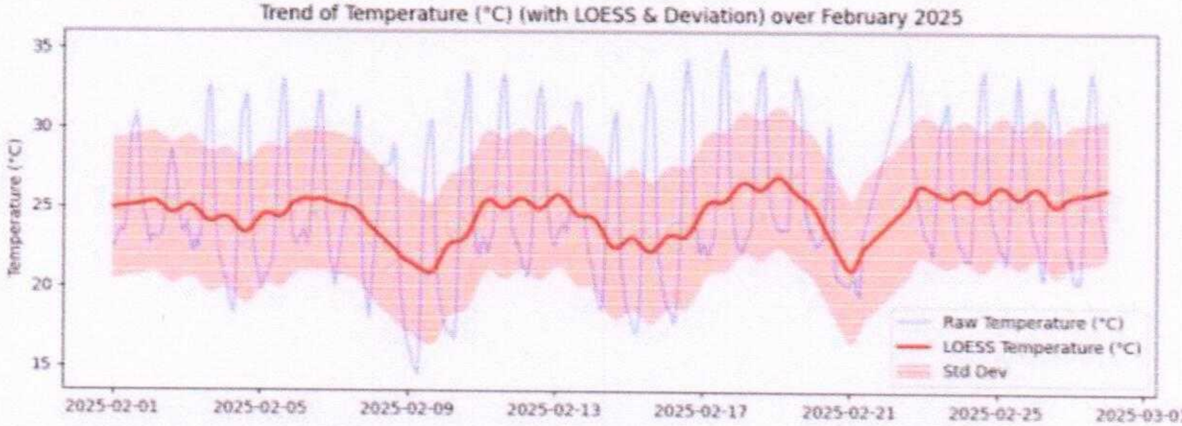
This pattern closely follows the trend observed in **PM 2.5 and AQI**, as PM 10 is a major contributor to overall air pollution. The data suggests that while there was a brief period of air quality improvement in mid-February, pollution levels remained high, particularly at the beginning and end of the month. The periodic spikes indicate influences from meteorological conditions, vehicular emissions, construction activities, and industrial sources.

The given graph illustrates the **trend of relative humidity (%)** in **South 24 Parganas** over **February 2025**, using **LOESS smoothing and standard deviation bands**. The **x-axis** represents the timeline from **February 1 to March 1**, while the **y-axis** denotes relative humidity in percentage (%). The **light blue line** shows the **raw relative humidity values,** reflecting daily fluctuations, whereas the **red LOESS curve** provides a **smoothed trend**, indicating the overall variation in humidity levels. The **light red shaded region** represents the **standard deviation**, showing the range of variations from the smoothed trend.



At the beginning of February, relative humidity starts at a **high level (above 80%)** but gradually decreases, reaching around **60-70% by February 5-7**. A significant dip occurs between **February 7-10**, where humidity levels drop to around **40-50%**, marking a **dry period**. Following this, relative humidity gradually **increases after February 10**, showing periodic fluctuations but generally stabilizing between **70-90%** from mid to late February. A noticeable peak occurs around **February 21-22**, where humidity levels briefly exceed **90%**, before declining again towards the end of the month, stabilizing around **70-80%**.

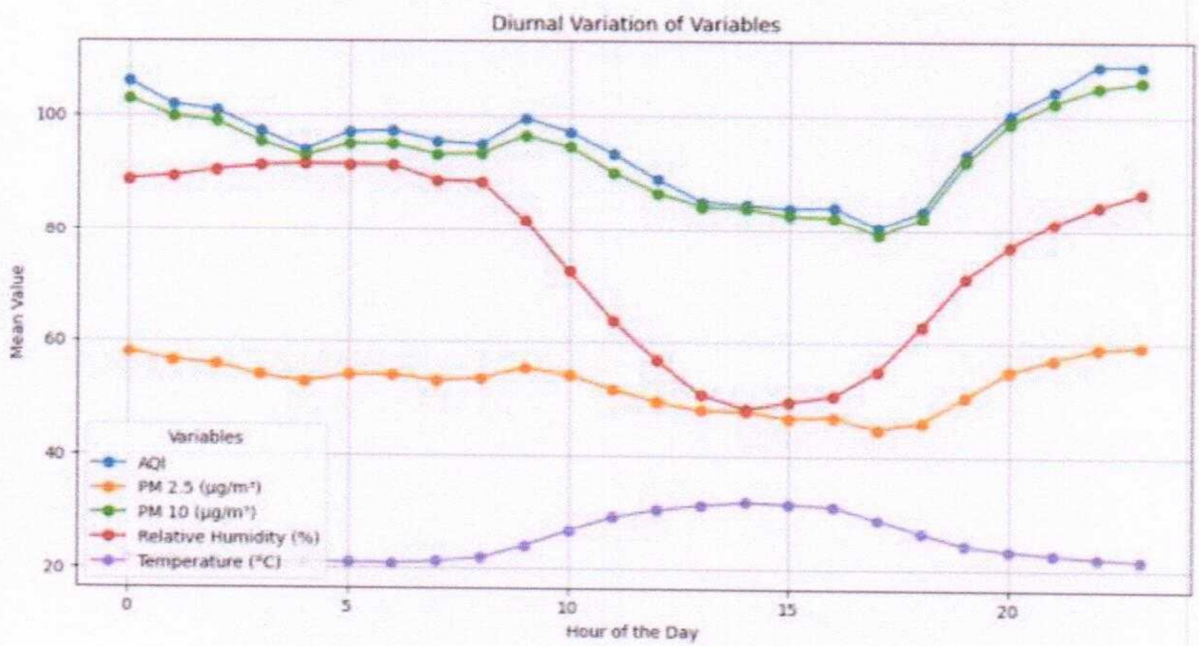
The periodic fluctuations in humidity indicate the influence of **meteorological conditions**, such as temperature variations, wind patterns, and possible rainfall events. The **inverse relationship between humidity and pollution levels** is evident, as lower humidity around mid-February coincides with a temporary decline in **PM 2.5 and PM 10 levels**, suggesting reduced aerosol formation. Meanwhile, higher humidity towards the end of the month may have contributed to increased **pollutant concentration and haze formation**. This trend highlights the critical role of **humidity in air quality monitoring**, influencing **pollutant dispersion, aerosol formation, and overall atmospheric stability.**



The given graph represents the **trend of temperature (°C) in South 24 Parganas** over **February 2025**, using **LOESS smoothing and standard deviation bands**. The **x-axis** covers the timeline from **February 1 to March 1**, while the **y-axis** represents temperature in degrees Celsius (°C). The **light blue line** illustrates the **raw temperature data**, showing daily variations, whereas the **red LOESS curve** provides a **smoothed trend**, highlighting the overall pattern of temperature fluctuations. The **light red shaded area** represents the **standard deviation**, indicating the extent of variability from the smoothed trend.

At the beginning of February, the temperature remains relatively stable around **24–26°C**, with minor fluctuations. However, a **gradual decline occurs from February 5 onward**, reaching a **minimum of approximately 18°C by February 9-10**, marking a **cooler phase** during the month. After this dip, the temperature **gradually rises again**, stabilizing around **25°C by mid-February**. Throughout the latter half of the month, the temperature exhibits **periodic fluctuations**, with minor peaks and troughs. A noticeable drop is observed around **February 20-21**, where temperatures fall close to **17-18°C**, indicating another **cool spell**. Following this dip, temperatures rise again, stabilizing around **26-27°C towards the end of the month**.

The **fluctuating temperature trends** significantly influence **air quality**, particularly in relation to **PM 2.5 and PM 10 levels**. Generally, **lower temperatures lead to stable atmospheric conditions**, which may result in the **accumulation of pollutants**, whereas **higher temperatures** can enhance **atmospheric mixing**, reducing pollutant concentration. Additionally, **temperature variations** play a key role in **humidity levels**, which further impact **aerosol formation and pollutant dispersion**. The observed trends indicate a **seasonal transition from winter to pre-monsoon conditions**, influencing local meteorological conditions and air quality patterns.



The given graph illustrates the **diurnal variation of key air quality and meteorological variables** over a **24-hour period**. The **x-axis** represents the **hour of the day**, while the **y-axis** shows the **mean value of each variable**. The plotted variables include **Air Quality Index (AQI), PM 2.5 (μg/m³), PM 10 (μg/m³), Relative Humidity (%), and Temperature (°C).**

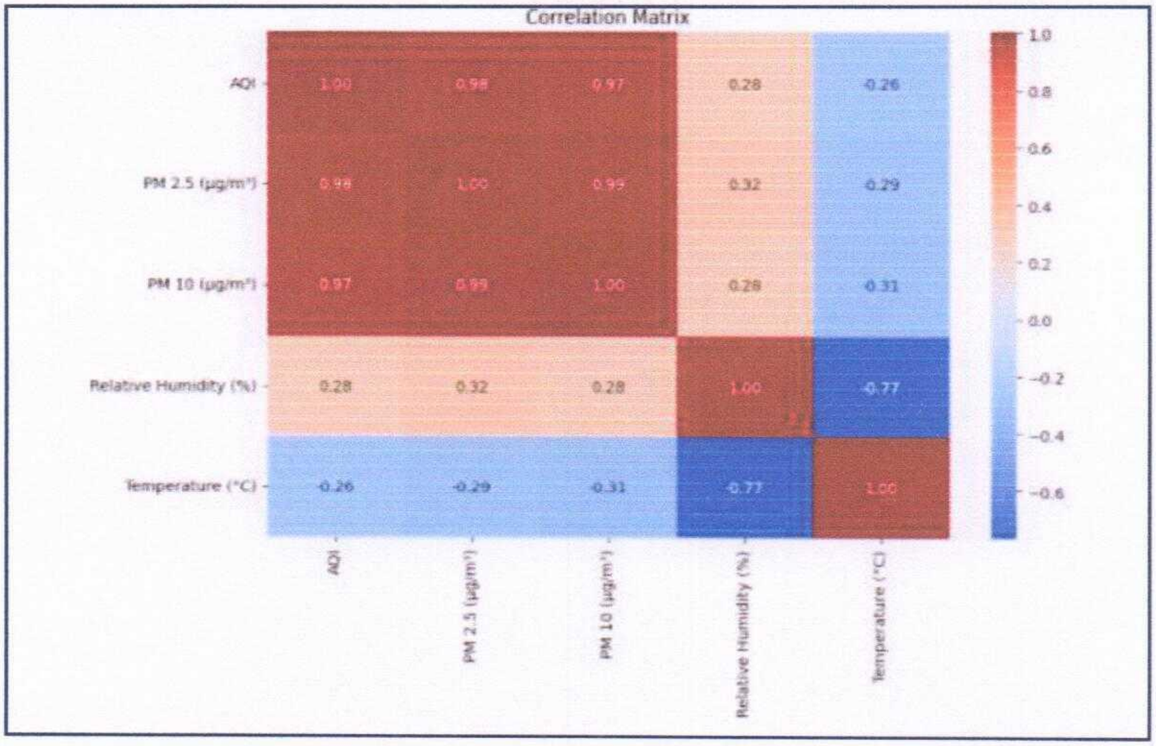
Key Observations:

1. **AQI and Particulate Matter (PM 2.5 & PM 10) Trends:**
   - **AQI (blue line)** and **PM concentrations (green for PM 10 and orange for PM 2.5)** show a distinct diurnal pattern.
   - The highest values occur **during the early morning (midnight to 6 AM) and late evening (8 PM onwards).**
   - There is a **decline in AQI and PM levels from morning to afternoon**, reaching the lowest values between **12 PM and 4 PM.**
   - The evening rise suggests an increase in **pollutant accumulation due to reduced atmospheric dispersion** and higher emissions from traffic and other activities.
2. **Relative Humidity (RH) Variation:**
   - **Relative Humidity (red line)** remains **high during nighttime and early morning**, peaking around **midnight to 6 AM.**
   - **A sharp decline is observed after sunrise (around 7 AM), reaching the lowest values between 2 PM and 4 PM.**
   - It then **gradually increases in the evening**, aligning with the rise in pollutant concentrations.
3. **Temperature Trend:**
   - **Temperature (purple line)** follows an **opposite pattern** to **humidity and AQI.**
   - It is **lowest during the early morning (before sunrise)** and starts increasing after **6 AM**, peaking in the afternoon around **2–4 PM.**
   - After sunset, the temperature gradually decreases.

Interpretation:

- **Morning & Evening Peaks in AQI and PM Levels:**
  - During early morning and evening, **temperature inversion** and **low wind speed** trap pollutants near the surface, preventing dispersion.
  - Higher vehicular emissions, industrial activities, and household heating contribute to **higher pollution levels.**
- **Afternoon Dip in Pollution Levels:**
  - Increased **solar radiation and rising temperatures** enhance **atmospheric turbulence**, promoting vertical mixing and dilution of pollutants.
  - The **low RH during this period** also indicates drier air, reducing the **hygroscopic growth** of particulate matter.
- **Impact of Humidity and Temperature:**
  - **High humidity levels during early morning and late evening** contribute to **pollutant retention and haze formation.**
  - **Warmer temperatures in the afternoon** enhance **pollutant dispersion,** leading to lower AQI and PM levels.

The diurnal variation graph highlights the interplay between **pollution levels, humidity, and temperature**. The **worst air quality is observed during early morning and night**, while the **best air quality occurs in the afternoon** when temperature is high and humidity is low. Understanding these patterns is crucial for **pollution mitigation strategies**, such as **timing of traffic regulations, emission control measures, and public health advisories.**



The given image represents a **correlation matrix heatmap**, which displays the correlation coefficients between different environmental variables, including **AQI, PM 2.5, PM 10, Relative Humidity, and Temperature**. The values range from **-1 to 1**, where:

- **1.00** indicates a **perfect positive correlation** (both variables increase or decrease together).
- **-1.00** indicates a **perfect negative correlation** (one variable increases while the other decreases).
- **0.00** indicates **no correlation** (the variables are independent).

Key Observations:

1. Strong Positive Correlations:

- **AQI & PM 2.5 (0.98), AQI & PM 10 (0.97), PM 2.5 & PM 10 (0.99)**
  - These variables are **highly correlated**, meaning that **higher PM levels lead to a higher AQI value.**
  - PM 2.5 and PM 10 are closely related as both are fine particulate pollutants contributing to air pollution.

2. Moderate Positive Correlations:

- **Relative Humidity & AQI (0.28), Relative Humidity & PM 2.5 (0.32), Relative Humidity & PM 10 (0.28)**

- A weak-to-moderate **positive correlation** suggests that **higher humidity levels might favor the accumulation of particulate matter**, likely due to **hygroscopic growth** (where particles absorb moisture and grow in size, worsening air quality).

3. Strong Negative Correlation:

- **Temperature & Relative Humidity (-0.77)**
  - A strong **inverse relationship** means that **as temperature increases, relative humidity decreases** and vice versa.
  - This is a typical meteorological pattern, as warmer air holds more moisture, leading to a drop in relative humidity.

4. Moderate Negative Correlations:

- **Temperature & AQI (-0.26), Temperature & PM 2.5 (-0.29), Temperature & PM 10 (-0.31)**
  - Higher temperatures are **associated with lower pollution levels**.
  - This could be due to **enhanced atmospheric mixing and dispersion** during warmer conditions, which helps dilute pollutants.

Interpretation & Implications:

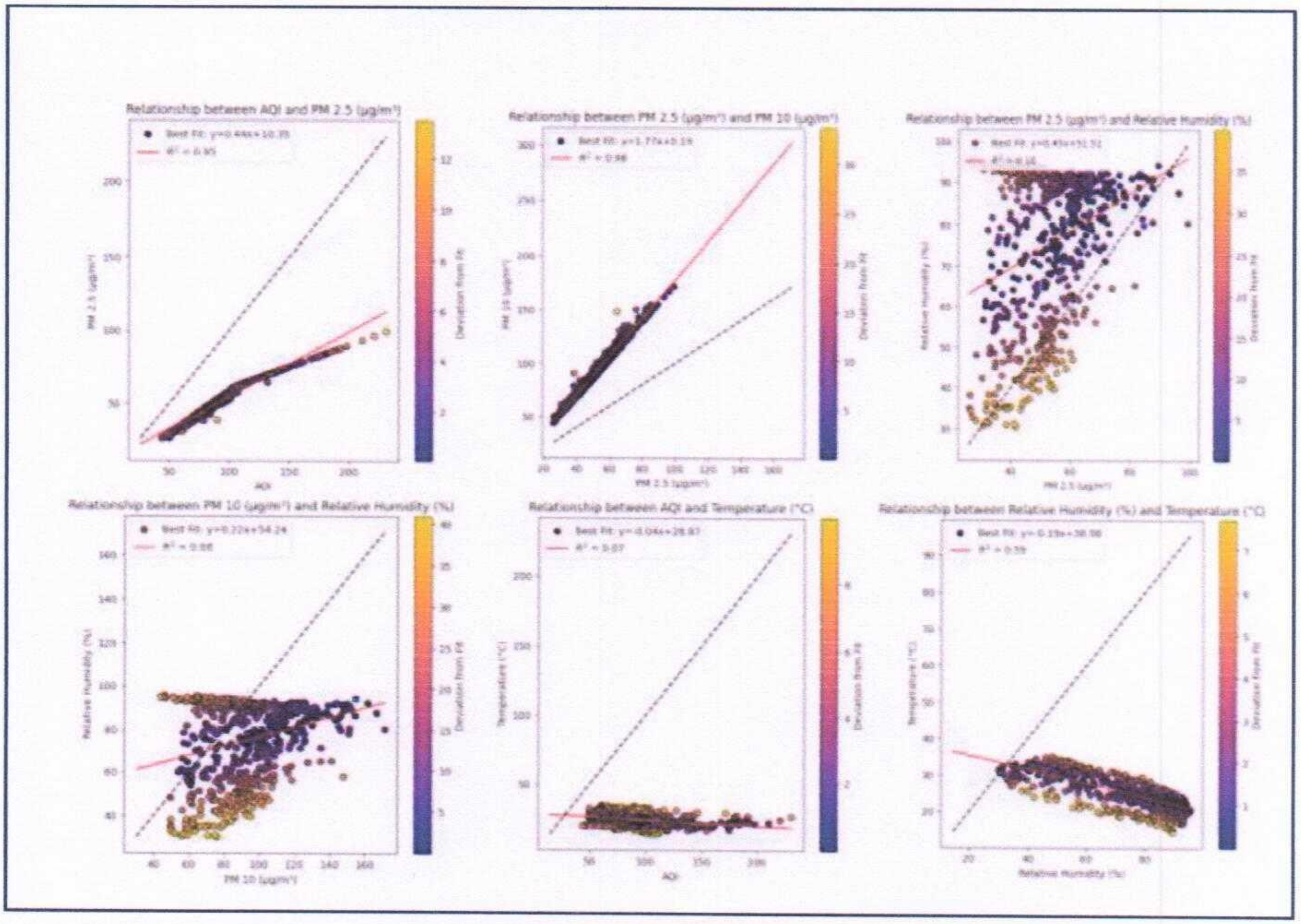
- **Air quality (AQI) is primarily influenced by PM 2.5 and PM 10, making particulate matter a dominant factor in pollution levels.**
- **Higher humidity slightly increases pollution levels**, likely due to **increased particle size and reduced dispersion.**
- **Temperature plays a crucial role in pollutant dispersion**, where **higher temperatures improve air quality** by reducing PM concentrations.

This correlation matrix provides valuable insights into how meteorological factors impact air pollution. The strong relationship between **AQI and PM levels** confirms the importance of particulate matter in determining air quality, while the **negative effect of temperature on pollution** suggests that air quality is typically better during warmer conditions due to enhanced dispersion.

The given image consists of six scatter plots, each illustrating the relationships between different environmental variables, including **Air Quality Index (AQI), PM 2.5, PM 10, Relative Humidity (%), and Temperature (°C).** Each plot includes a **linear regression best-fit line (red)** along with the **R^2 value**, indicating the strength of the correlation.

1. Relationship between AQI and PM 2.5 (Top-left)

- **Equation:** y=0.44x+10.35y = 0.44x + 10.35y=0.44x+10.35
- **R^2 = 0.95** (Strong correlation)
- **Interpretation:**
  - There is a **very strong positive correlation** between AQI and PM 2.5.
  - This suggests that **PM 2.5 is a major contributor to AQI values**.
  - As PM 2.5 concentration increases, AQI increases proportionally.



2. Relationship between PM 2.5 and PM 10 (Top-middle)

- **Equation:** y=1.77x+0.19y = 1.77x + 0.19y=1.77x+0.19
- **R^2 = 0.98** (Very strong correlation)
- **Interpretation:**
  - There is an **almost perfect linear relationship** between PM 2.5 and PM 10.
  - PM 10 levels are approximately **1.77 times** that of PM 2.5.
  - This suggests that **PM 2.5 and PM 10 originate from common sources (e.g., vehicular emissions, industrial pollution, and dust particles).**

3. Relationship between PM 2.5 and Relative Humidity (Top-right)

- **Equation:** y=0.45x+51.51y = 0.45x + 51.51y=0.45x+51.51
- **R^2 = 0.10** (Weak correlation)
- **Interpretation:**
  - The correlation between PM 2.5 and relative humidity is **weak (R^2 = 0.10).**
  - The trend suggests a **slight increase in relative humidity with PM 2.5 levels.**
  - This could indicate that PM 2.5 levels may increase slightly in **high-humidity conditions** due to moisture absorption by particulates.

4. Relationship between PM 10 and Relative Humidity (Bottom-left)

- **Equation:** y=0.22x+54.24y = 0.22x + 54.24y=0.22x+54.24

- **R^2 = 0.08** (Weak correlation)
- **Interpretation:**
  - The relationship between PM 10 and relative humidity is **very weak.**
  - This suggests that relative humidity does not significantly impact PM 10 levels.

5. Relationship between AQI and Temperature (Bottom-middle)

- **Equation:** y=−0.04x+28.87y = -0.04x + 28.87y=−0.04x+28.87
- **R^2 = 0.07** (Very weak correlation)
- **Interpretation:**
  - **No significant relationship** between AQI and temperature.
  - However, the **slight negative slope** suggests that **higher temperatures may slightly reduce AQI**, possibly due to better dispersion of pollutants.

6. Relationship between Relative Humidity and Temperature (Bottom-right)

- **Equation:** y=−0.19x+38.98y = -0.19x + 38.98y=−0.19x+38.98
- **R^2 = 0.59** (Moderate-to-strong negative correlation)
- **Interpretation:**
  - There is a **moderate-to-strong inverse relationship** between relative humidity and temperature.
  - This means that **as temperature increases, relative humidity decreases.**
  - This is a typical meteorological trend because **warmer air holds more moisture, reducing relative humidity percentage.**

Overall Summary:

- **PM 2.5 and PM 10 have a very strong correlation (R^2 = 0.98), indicating they share common sources.**
- **AQI is strongly influenced by PM 2.5 (R^2 = 0.95), confirming that fine particulate matter is a key air quality determinant.**
- **Temperature and relative humidity show a strong negative correlation (R^2 = 0.59), aligning with known weather patterns.**
- **Weak relationships exist between PM concentrations and humidity or temperature, suggesting meteorological factors do not strongly control particulate pollution.**

Key Takeaways:

- **Air pollution (AQI) is primarily driven by particulate matter (PM 2.5 and PM 10).**
- **Meteorological factors like humidity and temperature have minor influences on PM concentrations.**
- **Warmer temperatures generally reduce humidity but have minimal direct impact on air pollution.**

Conclusion

- The analysis of **air quality, meteorological factors, and diurnal variations** highlights that **PM 2.5 is the primary driver of air pollution**, with a **strong correlation with AQI ($R^2 = 0.95$)**. PM 10 also contributes significantly but is highly dependent on PM 2.5 concentrations. **Diurnal variation patterns** reveal that pollution levels peak **during the night and early morning**, likely due to lower atmospheric dispersion and increased emissions.
- Meteorological factors such as **temperature and humidity have weak correlations with PM levels**, indicating that pollution control must focus more on **reducing direct emissions from vehicles, industries, and dust sources** rather than relying on natural atmospheric processes for improvement. However, the strong negative correlation between **temperature and humidity ($R^2 = -0.77$)** confirms their typical inverse relationship, which may indirectly influence pollutant dispersion.

- Key Takeaways & Recommendations:

- **✓ PM 2.5 reduction is essential for improving air quality.**

  ✓ Targeted pollution control measures (traffic restrictions, industrial emission limits) should be implemented during peak pollution hours (night and early morning).

  ✓ Meteorological factors alone do not significantly impact PM levels, so pollution control strategies should focus on emission reductions.

  ✓ Public health measures should prioritize protection during high-pollution hours.
- **In summary, air quality management in the region should focus on active interventions rather than relying on natural atmospheric conditions to mitigate pollution.**

Note:

Report produced by Air Quality Monitoring System Committee

Name of the members	Signatures
Dr. Debasmrity Mukherjee (Nodal Officer) Dept. of Geography	Debasmrity Mukherjee 28/2/25
Dr. Bidisha Maitra Sen (Dept. of IFF)	Bidisha Maitra Sen 28/02/25
Dr. Sudip Dasgupta (Dept. of Geography)	Sudip Sen Gupta
Sri Debabrata Chanda (Dept. of Geography)	Debabrata Chanda
Dr. Shramana Roy Barman (Dept. of Environmental Science)	Shramana Roy Barman 28/02/25

Dr. Sayanti Kar (Dept. of Environmental Science)	Sayanti Kar 28/2/25

Manas Kabi

Dr. Manas Kabi
Principal Asutosh College

PRINCIPAL
ASUTOSH COLLEGE
92, S. P. MUKHERJEE ROAD
KOLKATA-700 026