Air Quality Index (AQI) Report

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

Introduction

Air pollution has emerged as one of the most pressing environmental concerns of the 21st century, particularly in urban and peri-urban areas where human activities, vehicular emissions, industrial discharges, and construction-related dust contribute significantly to deteriorating air quality. In this context, the Air Quality Index (AQI) serves as a critical indicator to measure and communicate the level of air pollution and its potential health impacts in a simplified manner.

In 2025, the BHASA Campus has taken a proactive step towards environmental sustainability by initiating regular AQI monitoring using sensor-based air quality monitoring systems. The primary objective is to assess real-time pollutant concentrations such as $PM_{2.5}$, PM_{10}, NO_2, SO_2, CO, O_3, and NH_3, and to provide timely alerts and awareness among the campus community. This initiative aligns with the broader goals of sustainable campus management, public health protection, and environmental education.

The AQI is calculated based on the national standards prescribed by the Central Pollution Control Board (CPCB), India, and categorizes air quality into six levels: Good, Satisfactory, Moderately Polluted, Poor, Very Poor, and Severe. These categories are color-coded for easier public understanding and are linked to possible health advisories. Monitoring the AQI not only helps in identifying pollution trends but also aids in devising appropriate mitigation strategies like restricting vehicular movement during peak pollution hours, promoting green infrastructure, and encouraging behavioural changes for a cleaner environment.

The data generated through the BHASA Campus AQI initiative will serve as a baseline for academic research, policy framing, and eco-conscious decision-making. Moreover, it will foster awareness among students, faculty, and staff about the immediate environment and empower them to participate in air quality improvement efforts.

Data Collection

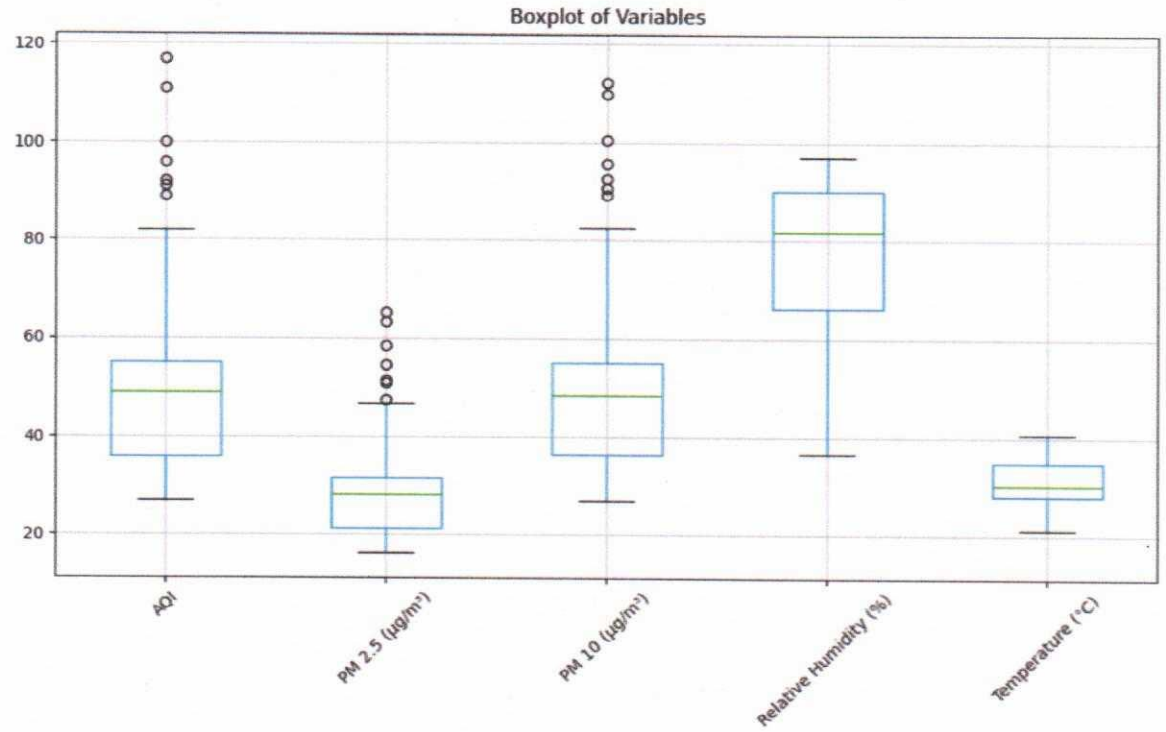
- **Pollutants Monitored**: Particulate matter (PM10 and PM2.5), temperature, relative humidity, wind speed maximum, wind speed and so on.
- **Data Frequency**: Hourly data collected and averaged to daily AQI values.

Calculation

- AQI values for each pollutant were calculated using the EPA's standardized formula.
- The highest AQI value among the pollutants determined the overall AQI for each day.

Description of Data

The boxplot visualizes the distribution and variability of five environmental variables recorded.



1. AQI (Air Quality Index)

- **Median (green line)**: Around 50, which falls in the "Satisfactory" category as per CPCB guidelines.
- **Interquartile Range (IQR)**: Most values lie between ~35 and ~60.
- **Outliers**: A significant number of values exceed 80, with some outliers close to 120, indicating occasional episodes of poor air quality.

2. PM2.5 (µg/m³)

- **Median**: Approximately 27 µg/m³.
- **IQR**: Between ~22 and ~32 µg/m³.
- **Outliers**: Many above 45 µg/m³, indicating transient exposure to high fine particulate matter, which can be harmful to respiratory health.

3. PM10 (µg/m³)

- **Median**: Around 50 µg/m³.
- **IQR**: From ~37 to ~55 µg/m³.
- **Outliers**: Values exceed 80 µg/m³, suggesting sporadic increases in coarse particulate concentration, possibly due to dust or vehicular activity.

4. Relative Humidity (%)

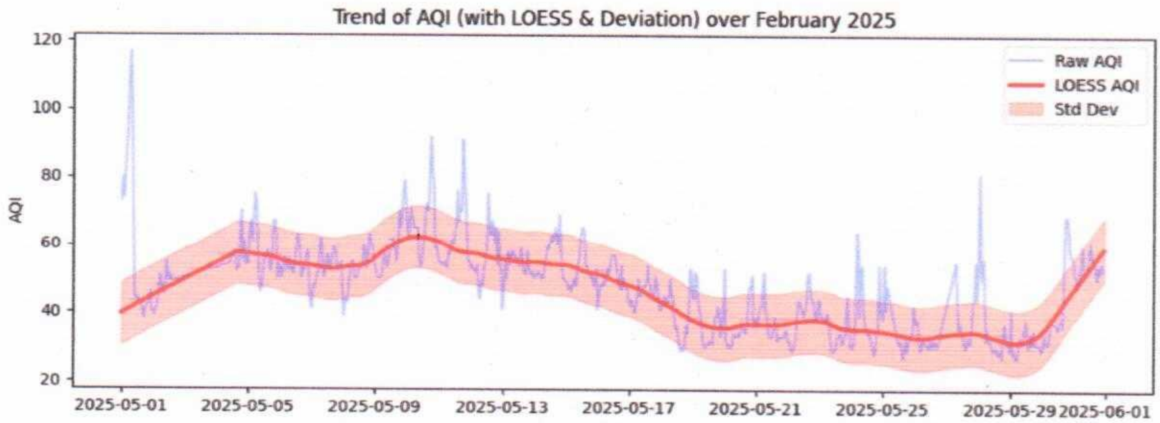
- **Median**: High, around 82%.
- **IQR**: Spanning ~67% to ~90%.
- **Outliers**: Few above 95%, indicating very humid conditions, which can influence pollutant dispersion and human comfort.

5. Temperature (°C)

- **Median**: ~31°C.
- **IQR**: Between ~28°C and ~35°C.
- **Outliers**: Few lower values around 21°C, showing slightly cooler days or nights, possibly due to rainfall or seasonal shifts.

Key Insights:

- AQI is generally satisfactory but with occasional poor-quality days.
- PM2.5 and PM10 levels show notable spikes, reflecting potential short-term health risks.
- High humidity levels dominate, possibly due to seasonal monsoon influence.
- Temperature remains in a moderate-to-high range, typical of eastern India's summer and post-monsoon climate.

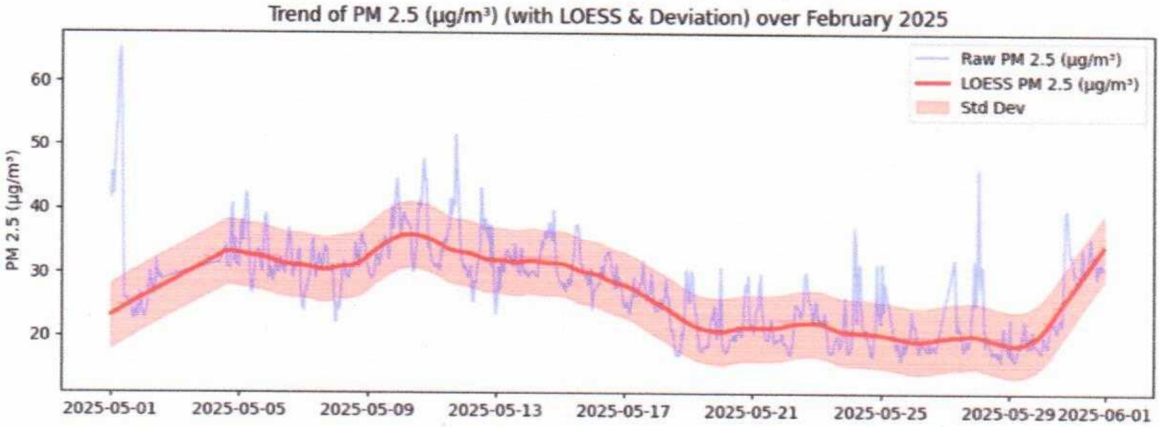


The line graph titled **"Trend of AQI (with LOESS & Deviation) over February 2025"** (though the x-axis shows data for **May 2025,** indicating a labeling error) presents the variation in Air Quality Index (AQI) at BHASA Campus over a month-long period.

The **blue line** represents the **raw AQI values,** which show considerable short-term fluctuations with several sharp peaks—some exceeding an AQI of 100—indicating sporadic episodes of poor air quality. The **red line**, representing the **LOESS (Locally Estimated Scatterplot Smoothing) trend,** offers a clearer view of the underlying pattern by smoothing out these short-term variations. The **shaded red region** around the LOESS line indicates the **standard deviation,** reflecting the degree of variability around the trend.

Initially, from **May 1 to May 9**, the AQI shows a gradual increasing trend, peaking around May 9–10 with average values near 65–70. Afterward, a **moderate declining trend** follows, continuing until about **May 23**, with AQI stabilizing in the 40–50 range—generally within the "Satisfactory" category. Toward the **end of May**, especially from **May 29 onward**, there's a noticeable **uptick** in AQI, with values rising again towards the 60s.

Overall, the data suggests that air quality remained mostly in the **Satisfactory to Moderate** range during the period, with intermittent spikes possibly due to local disturbances such as construction, vehicular activity, or meteorological influences. The presence of standard deviation bands indicates periods of higher uncertainty or variability in AQI, especially during the start and end of the month.

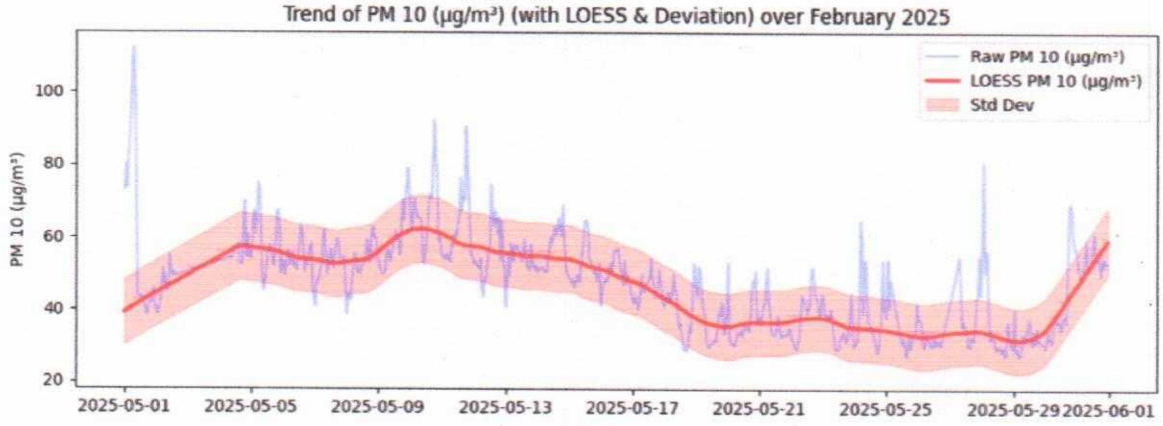


The graph titled **"Trend of PM 2.5 (µg/m³) (with LOESS & Deviation) over February 2025"** (though the actual x-axis indicates **May 2025**) presents the temporal variation of fine particulate matter (PM 2.5) concentrations at BHASA Campus.

The **blue line** shows the **raw PM 2.5 measurements**, which fluctuate significantly on a day-to-day basis, with several noticeable peaks crossing 60 µg/m³—particularly around **May 1st** and **May 10th**. These peaks indicate short-term pollution events, potentially linked to local emissions or weather-induced stagnation of pollutants.

The **red LOESS curve** represents the smoothed trend of PM 2.5 levels. It reveals a **gradual rise** in particulate concentration from **May 1 to May 9**, reaching an average peak near **38–40 µg/m³**. This period is followed by a **gradual decline**, continuing until about **May 24**, with values settling around **20–25 µg/m³**, indicating relatively cleaner air. After **May 28**, the curve again shows an **upward trend**, reflecting a late-month increase in PM 2.5 levels.

The **red shaded band**, indicating **standard deviation**, is wider during the first and last weeks of May, suggesting greater variability and more erratic pollution episodes during those times. The central portion of the month shows tighter bands, reflecting relatively stable air quality conditions.

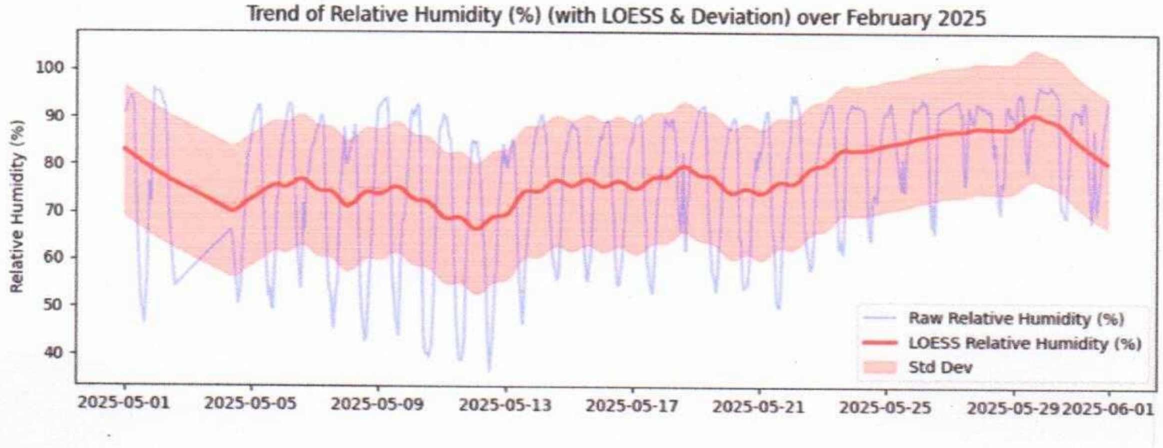


The graph titled **"Trend of PM 10 (µg/m³) (with LOESS & Deviation) over February 2025"** (though the x-axis clearly reflects **May 2025**) illustrates the daily variation in coarse particulate matter (PM 10) concentrations at **BHASA Campus** during the month.

The **blue line** shows the **raw PM 10 data**, which fluctuates significantly with sharp spikes, particularly around **May 1st, May 10th, and May 29th**. Some of these peaks exceed **100 µg/m³**, signaling temporary but intense pollution events—possibly due to dust resuspension, construction activity, or traffic surges.

The **red LOESS trend line** provides a smoothed representation of these data points, showing a **rising trend** from **May 1 to May 9**, with PM 10 levels averaging around **60–65 µg/m³**. From **May 10 to May 24**, a **steady decline** is observed, with average values dipping to **35–40 µg/m³**, reflecting an improvement in air quality during this period. The final few days of the month again show a **noticeable rise,** with PM 10 levels returning to the 60+ range.

The **pink shaded area** around the LOESS line represents the **standard deviation**, which is broader during the start and end of May—indicating more variable pollution levels—while mid-month shows narrower deviation, suggesting more consistent and stable air quality conditions.

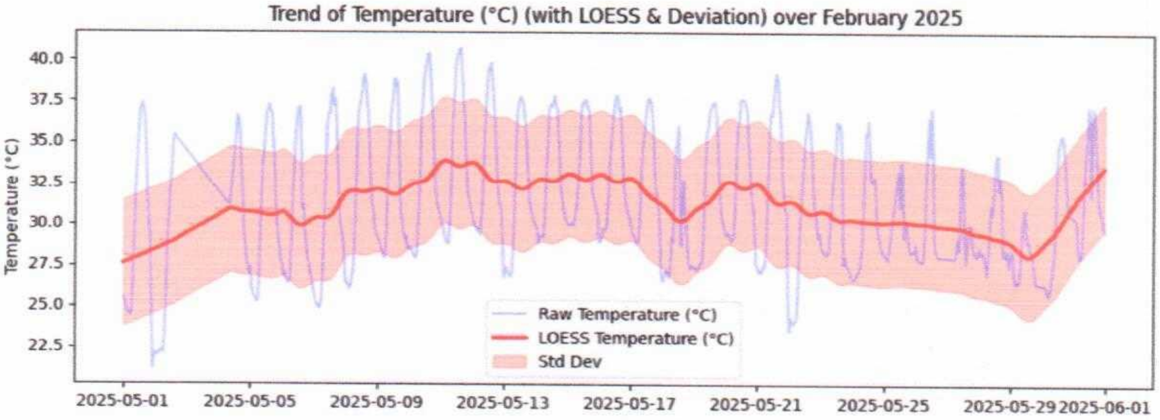


The graph titled **"Trend of Relative Humidity (%) (with LOESS & Deviation) over February 2025"** (though the x-axis data actually corresponds to **May 2025**) shows the temporal variation in relative humidity levels at BHASA Campus throughout the month.

The **blue line** represents the **raw relative humidity data**, which shows strong diurnal fluctuations typical of natural humidity cycles—rising during cooler nighttime hours and dropping during warmer daytime periods. Despite these fluctuations, the overall trend can be clearly observed through the **red LOESS curve**, which smooths out the variations to reveal broader patterns.

In the first week of May, the relative humidity levels begin relatively high (around **80–85%**), then exhibit a **gradual decline** until around **May 15**, reaching a local low of approximately **68–70%**. This mid-month dip may be attributed to drier weather conditions, possibly associated with increased temperature or clearer skies.

From **May 16 onwards**, the LOESS curve shows a **consistent upward trend**, peaking around **May 27 to May 30**, with average humidity levels nearing **90–92%**. This rise is indicative of increasing moisture in the atmosphere, likely related to pre-monsoon effects or changing wind patterns. The **red shaded area**, which represents the **standard deviation**, is relatively wide throughout the graph, highlighting the high day-night variability typical for humidity data.

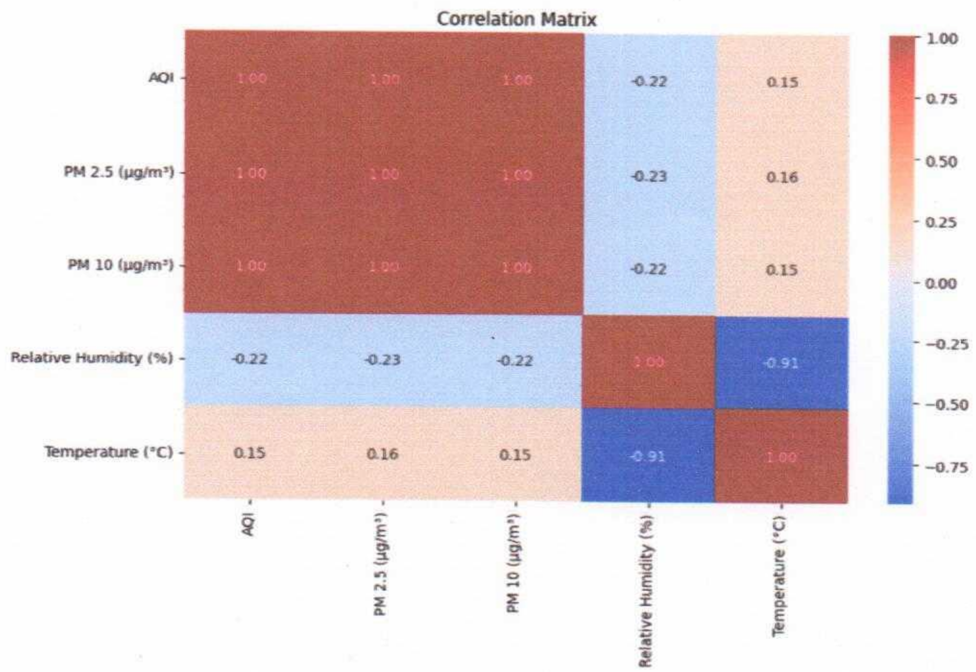


The graph titled **"Trend of Temperature (°C) (with LOESS & Deviation) over February 2025"** (though the x-axis clearly shows **May 2025**) illustrates the daily temperature variation at **BHASA Campus** over the month of May 2025.

The **blue line** depicts the **raw temperature data**, which shows strong daily (diurnal) fluctuations typical of tropical summer conditions — higher during the day and lower at night. The **red LOESS curve** smooths out these fluctuations to highlight the overall temperature trend across the month. The **shaded red area** around the LOESS line represents the **standard deviation,** indicating the variability in temperature readings.

At the start of May, average temperatures were around **27–28°C,** followed by a **gradual increase,** peaking between **May 9 to May 14** with average temperatures reaching nearly **33–34°C.** This period likely corresponds to the hottest phase of the month. After mid-May, the trend shows a **slight but consistent cooling,** with average temperatures stabilizing around **30–31°C** during the latter half of the month.

Interestingly, in the final few days of May (from **May 29 onward**), there is another **small spike in temperature,** possibly due to temporary dry spells or decreased cloud cover.



1. Strong Positive Correlations:

- AQI, PM 2.5, and PM 10 all have perfect correlations (1.00) with each other.
    - This indicates that AQI is entirely driven by particulate matter levels (PM 2.5 and PM 10), with changes in PM concentrations directly reflected in AQI.
    - It also implies a strong co-occurrence of PM 2.5 and PM 10 — they likely originate from similar sources (e.g., vehicular emissions, dust, combustion).

2. Moderate Negative Correlations with Humidity:

- Relative Humidity vs PM 2.5 / PM 10 / AQI: Correlation values around -0.22 to -0.23.
    - Higher humidity tends to reduce particulate concentration, possibly due to wet deposition or reduced resuspension of dust particles.
    - Although this relationship is weakly negative, it shows that humid conditions slightly help reduce air pollution.

3. Very Strong Negative Correlation:

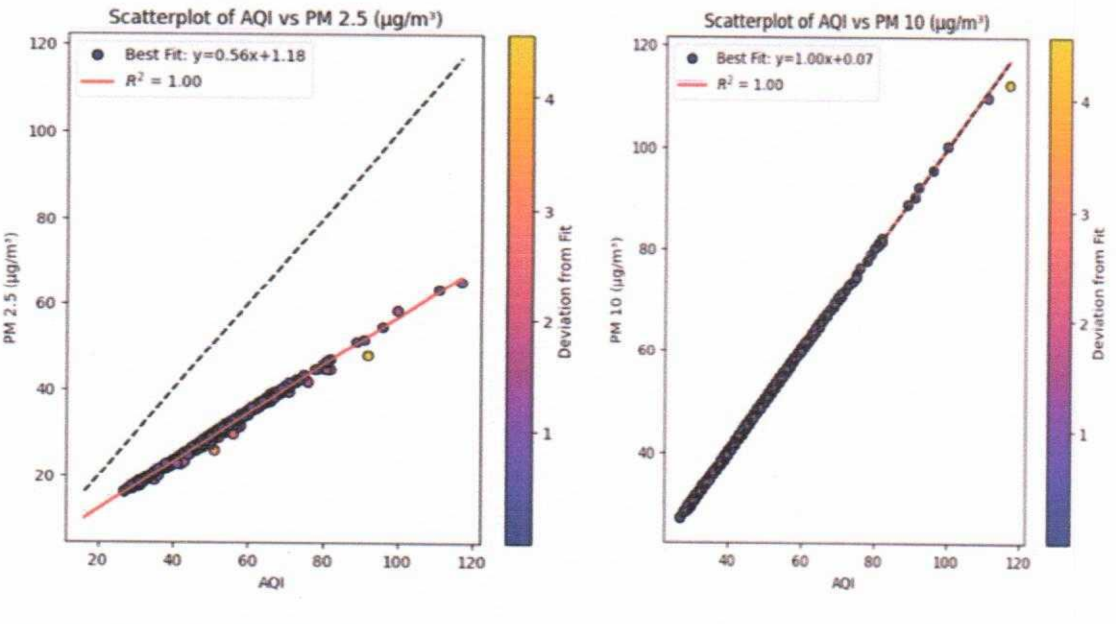
- Relative Humidity and Temperature: -0.91
  - This is a very strong inverse relationship, typical in tropical climates—as temperature rises, relative humidity falls, and vice versa.
  - It reflects the natural diurnal and seasonal atmospheric balance.

4. Weak Positive Correlation with Temperature:

- Temperature vs AQI / PM 2.5 / PM 10: +0.15 to +0.16
  - Warmer days may lead to slightly elevated pollution levels, possibly due to increased photochemical activity or dry, stagnant conditions, but the correlation is weak.

Summary:

- AQI is dominantly controlled by PM 2.5 and PM 10.
- Humidity shows a slight pollution-mitigating effect.
- Temperature and humidity are strongly inversely related, indicating a key climatic control.
- These insights support the importance of monitoring humidity and temperature when assessing daily air quality dynamics.



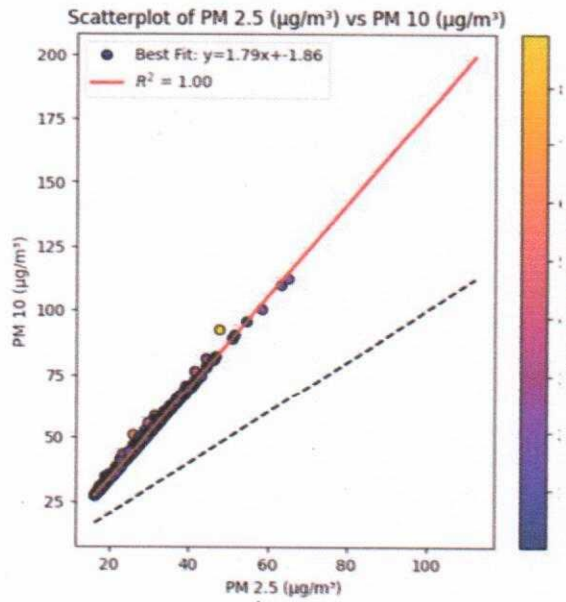
The figure presents two scatterplots demonstrating the relationship between **Air Quality Index (AQI)** and two key pollutants—**PM 2.5** and **PM 10** (in µg/m³)—observed at **BHASA Campus** in May 2025. Each scatterplot includes a best-fit regression line and color-coded deviations from the fit.

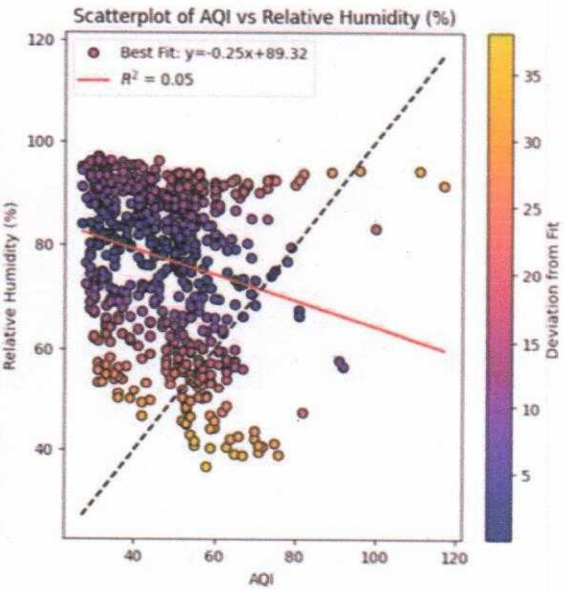
AQI vs PM 2.5

- The best-fit equation is **y = 0.56x + 1.18**, with an **R^2 value of 1.00**, indicating an almost perfect linear relationship.
- The slope (0.56) implies that PM 2.5 contributes significantly to AQI but at a lower rate compared to PM 10.
- The points closely align with the regression line, and the deviations (color-coded) are minimal, indicating **strong consistency** between AQI and PM 2.5 values.
- However, the deviation from the identity line (dashed) indicates that PM 2.5 alone **underrepresents AQI** compared to PM

AQI vs PM 10

- The best-fit equation is **y = 1.00x + 0.07**, also with an **R^2 value of 1.00**, indicating a **perfect linear relationship.**
- The slope of 1.00 and near-zero intercept confirm that **AQI is directly proportional to PM 10 concentration**, almost one-to-one.
- This plot shows an **exact alignment with the identity line**, suggesting that PM 10 is the **dominant factor driving AQI** in this dataset.
- Minimal color deviation confirms **high predictive reliability** of PM 10 for AQI.





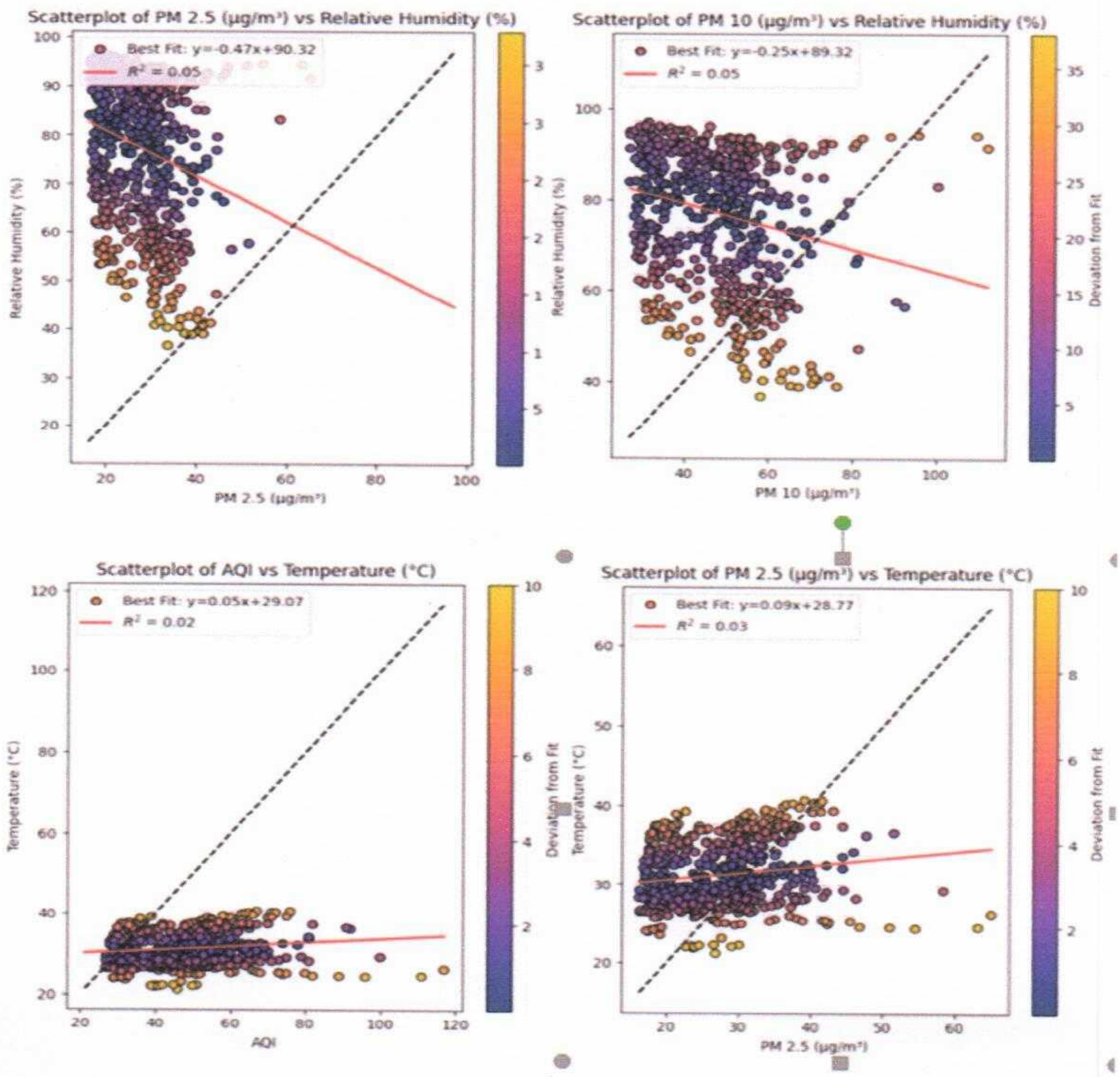
PM 2.5 vs PM 10 (µg/m³)

- The scatterplot shows a **very strong linear relationship** between PM 2.5 and PM 10, with the **best-fit equation** being
  y = 1.79x − 1.86 and an **R^2 = 1.00.**
- The slope of **1.79** suggests that **PM 10 levels are, on average, nearly 1.8 times higher than PM 2.5**, reflecting the expected difference in particle size and mass.

- The data points are tightly clustered along the red regression line, indicating **very low variability** and a **highly consistent source or behavior** for both PM types.
- The color gradient (deviation from fit) shows only minimal deviation, reinforcing the **predictable relationship** between these pollutants.
- This confirms that **both PM 2.5 and PM 10 likely originate from the same sources** and increase or decrease in tandem.

AQI vs Relative Humidity (%)

- The scatterplot shows a **weak negative relationship** between AQI and Relative Humidity, described by the equation
  $y = -0.25x + 89.32$, with an $R^2 = 0.05$.
- The slope indicates that as AQI increases, relative humidity tends to decrease slightly. However, the **very low R^2 value (0.05)** suggests that this relationship is **not statistically strong** and that humidity is **not a reliable predictor of AQI** in this dataset.
- The spread of points is wide, and the regression line poorly fits the data, further confirming **high variability.**
- The colour map shows some points with large deviations, emphasizing the inconsistency of this relationship



PM 2.5 (μg/m³) vs Relative Humidity (%)

- **Best Fit Equation:** $y = -0.47x + 90.32$
- **$R^2 = 0.05$**
- **Interpretation:**
  - Weak negative correlation between PM 2.5 and relative humidity.
  - As PM 2.5 increases, relative humidity tends to decrease slightly.
  - The low R^2 indicates a poor model fit (only 5% of variance explained).

PM 10 (μg/m³) vs Relative Humidity (%)

- **Best Fit Equation:** $y = -0.25x + 89.32$
- **$R^2 = 0.05$**
- **Interpretation:**
  - Similarly weak negative correlation.
  - Suggests that higher PM 10 may be associated with slightly lower relative humidity.
  - Again, a low R^2 shows limited predictive power

AQI vs Temperature (°C)

- **Best Fit Equation:** $y = 0.05x + 29.07$
- **$R^2 = 0.02$**
- **Interpretation:**
  - Virtually no correlation.
  - AQI does not meaningfully vary with temperature in this dataset.

PM 2.5 (μg/m³) vs Temperature (°C)

- **Best Fit Equation:** $y = 0.09x + 28.77$
- **$R^2 = 0.03$**
- **Interpretation:**
  - Very weak positive correlation.
  - Slight increase in temperature with rising PM 2.5, but again, not statistically significant (only 3% of variance explained).

Overall Summary:

- All relationships show **very weak correlations** (low R^2 values).
- The **color gradients** show deviations from the regression fit, with higher deviations in yellow/red.
- Environmental variables (temperature and humidity) are **not strongly predictive** of air quality measures (PM 2.5, PM 10, AQI) in this dataset.

The analysis of the scatterplot between AQI and temperature reveals a very weak correlation, as indicated by the low R^2 value of 0.02. This suggests that only about 2% of the variation in temperature can be explained by changes in AQI, which is statistically insignificant. The best-fit line shows a slight upward trend, but the relationship is too weak to be meaningful. The data points are widely dispersed, indicating a lack of any strong pattern or consistent association. Therefore, it can be concluded that temperature does not have a significant impact on AQI in this dataset, and other environmental or anthropogenic factors are likely to play a more substantial role in influencing air quality.

Committee Members

Name of the members	Signatures
Dr. Debasmrity Mukherjee (Nodal Officer) Dept. of Geography	Debasmrity Mukherjee 19/6/25
Dr. Bidisha Maitra Sen (Dept. of IFF)	Bidisha Maitra Sen 24/06/25
Sri Debabrata Chanda (Dept. of Geography)	
Dr. Sudip Dasgupta (Dept. of Geography)	Sudip DasGupta 19/6/25
Dr. Shramana Roy Barman (Dept. of Environmental Management)	Shramana Roy Barman 19/6/25
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Signature of Principal with date and seal

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