ASSESSING AIR PURITY: A STEP-BY-STEP GUIDE TO AIR QUALITY INDEX ANALYSIS

RESEARCH QUESTIONS

What are the primary pollutants contributing to poor air quality in Delhi ?

How are they impacting the environment ?

How are the concentrations of these pollutants over the time?

What Solutions can be proposed to go against this pollution in Delhi ?

BREAKDOWN OF THE VARIOUS STEPS

1. **Load the Dataset**: Load your CSV file using Pandas and parse the date column for easier time series manipulation.

2. **Data Preparation and pre-processing on the gathered information**: Check for missing values in the dataset to understand the data quality.

3. **Descriptive Statistics and required equations**:Generate summary statistics for key pollutants to get an overview of the data distribution and central tendencies.

4. **Visualizations**: Use Matplotlib to visualize the trends of key pollutants over time.

CODE_SNIPPET

```python
1  import pandas as pd
2  import matplotlib.pyplot as plt
3
4  # LOAD THE AQI DATA SET PROVIDED FROM A CSV FILE FORMAT
5  df = pd.read_csv('../delhiaqi.csv', parse_dates=['date'])
6
7
8  # PREPARE THE DATA
9    # CHECKING THE MISSING VALUES
10 print("THE MISSING VALUES ARE:\n", df.isnull().sum())
11
12   # DESCRIPTIVE STATISTICS
13 print("Descriptive Statistics:\n", df[['co', 'no2', 'o3', 'pm2_5', 'pm10', 'nh3']].describe())
14
15
16 # VISUALIZATIONS OF THE DATA
17   # PLOTTING TRENDS OF THE VARIOUS POLLUANTS OVER TIME
18 plt.figure(figsize=(14, 8))
19 for POLLUTANT in ['co', 'no2', 'o3', 'pm2_5', 'pm10', 'nh3']:
20     plt.plot(df['date'], df[POLLUTANT], label=POLLUTANT)
21 plt.title('TRENDS OF THE MAIN POLLUTANTS OVER TIME')
22 plt.xlabel('date')
23 plt.ylabel('CCONCENTRATION (µg/m³)')
24 plt.legend()
25 plt.grid()
26 plt.show()
27
```

OUTPUT

```
PS C:\Users\Admin\Desktop\AQI ANALYSIS> & C:/Users/Admin/AppData/Local/Programs/Python/Python312/python.exe "c:/Users/Admin/Desktop/A
QI ANALYSIS/CompleteAnalysisWorkflowcode.py"
Missing values:
 date     0
co        0
no        0
no2       0
o3        0
so2       0
pm2_5     0
pm10      0
nh3       0
dtype: int64
Descriptive Statistics:
                 co          no2           o3        pm2_5         pm10          nh3
count    561.000000   561.000000   561.000000   561.000000   561.000000   561.000000
mean    3814.942210    75.292496    30.141943   358.256364   420.988414    26.425062
std     3227.744681    42.473791    39.979405   227.359117   271.287026    36.563094
min      654.220000    13.370000     0.000000    60.100000    69.080000     0.630000
25%     1708.980000    44.550000     0.070000   204.450000   240.900000     8.230000
50%     2590.180000    63.750000    11.800000   301.170000   340.900000    14.820000
75%     4432.680000    97.330000    47.210000   416.650000   482.570000    26.350000
max    16876.220000   263.210000   164.510000  1310.200000  1499.270000   267.510000
```


TRENDS OF THE MAIN POLLUTANTS OVER TIME
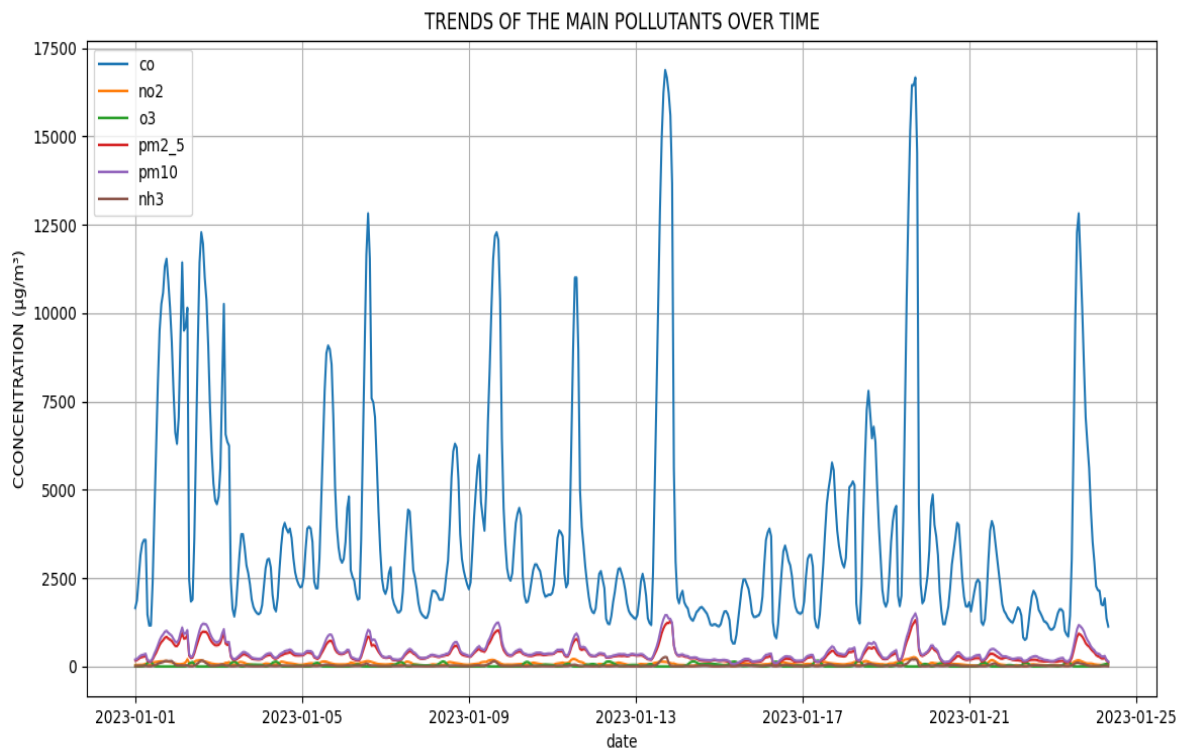
ANALYSIS AND INTERPRETATION

1. Missing Values

The dataset is complete because there was no missing value and no imputation was needed.

2. Descriptive Statistics

- CO (Carbon Monoxide):

    - Mean: 3814.94 µg/m³

    - The maximum value (16876.22 µg/m³) is significantly higher than the mean and the 75th percentile, indicating potential spikes in CO levels, likely due to localized pollution events or traffic congestion.

- NO2 (Nitrogen Dioxide):

    - Mean: 75.29 µg/m³

    - The maximum concentration (263.21 µg/m³) shows potential issues related to vehicle emissions or industrial activity.

- O3 (Ozone):

    - Mean: 30.14 µg/m³

    - The low average and high variability suggest that ozone pollution is not consistently high, but certain peaks are likely driven by photochemical reactions (e.g., due to sunlight).

- PM2.5 (Particulate Matter of diameter 2.5):

    - Mean: 358.26 µg/m³

    - The maximum value (1310.20 µg/m³) is dangerously high, with the mean and 75th percentile also indicating consistently high levels of fine particulate matter. This poses a severe health risk.

- PM10 (Particulate Matter of diameter 10 :

    - Mean: 420.99 µg/m³

    - Similar to PM2.5, the levels of PM10 are concerning, with peaks reaching 1499.27 µg/m³. This suggests heavy pollution from dust, construction activities, and other particulate sources.

- NH3 (Ammonia):

    - Mean: 26.43 µg/m³

    - Ammonia levels seem relatively low compared to other pollutants, though there are occasional spikes (max of 267.51 µg/m³), likely from agricultural activities or waste management.

3. Trends in the Plot

- The chart shows that **CO** dominates the pollutant concentration. It has frequent peaks, indicating pollution spikes, possibly from traffic, industrial activities, or burning of fuels.

- **PM2.5** and **PM10** exhibit similar trends, reflecting particulate pollution from construction, dust, and other sources. The elevated levels of particulate matter over time are concerning.

- Other pollutants like **NO2**, **O3**, and **NH3** remain relatively lower in concentration compared to CO and particulate matter, but they still show periodic increases.

CONCLUSION

- **Severe Air Quality Issues:** Both **PM2.5** and **PM10** are significantly above recommended levels, posing a severe public health risk. Long-term exposure to these pollutants is linked to respiratory and cardiovascular diseases, as well as premature mortality.

- **Carbon Monoxide Spikes**: The spikes in **CO** concentration may suggest periods of heavy traffic or localized sources of pollution, such as industrial emissions or biomass burning. These peaks should be closely monitored to mitigate short-term exposure.

- **Nitrogen Dioxide and Ozone:** While **NO2** levels are concerning, especially in peak times, **Ozone** remains relatively low on average but shows peaks likely

driven by photochemical smog formation, a common issue in urban areas with heavy sunlight exposure.

- **Ammonia Concentration**: NH3 levels are low on average, but peaks could indicate the presence of agricultural or waste management activities. High levels of ammonia can contribute to secondary particulate formation (ammonium nitrate, ammonium sulfate), which further degrades air quality.

Recommendations:

1. Immediate Action on Particulate Matter (PM2.5 and PM10):

  - Implement stricter regulations on construction, road dust, and industrial emissions to reduce particulate matter.

  - Encourage the use of dust suppression techniques and improve waste management to minimize PM levels.

2. Monitoring and Regulation of Traffic Emissions:

  - Given the high levels of **CO** and **NO2**, traffic emissions need tighter regulation. Promote the use of cleaner vehicles (e.g., electric or hybrid vehicles), implement congestion zones, and strengthen public transportation networks.

- Increase the number of monitoring stations across the city to better track and respond **to CO** and **NO2** spikes.

3. Public Health Warnings and Awareness:

- Publicize air quality data more widely, particularly during high pollution periods. Issue health warnings to vulnerable groups (children, elderly, and those with respiratory conditions) when air quality is poor.

 - Encourage the use of air purifiers and masks during periods of high pollution.

4. Long-Term Strategies:

- Develop green belts and increase tree coverage to naturally reduce air pollution.

- Encourage renewable energy adoption to reduce the reliance on fossil fuels, which are major sources of pollutants like **CO**, **NO2**, and **PM**.

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