# Phase 4 – Development Part 2

# Air Quality Analysis

**Phase 4: Development Part 2**
In this part you will continue building your project.

- Perform the air quality analysis and create visualizations.
- Calculate average SO2, NO2, and RSPM/PM10 levels across different monitoring stations, cities, or areas. Identify pollution trends and areas with high pollution levels.
- Create visualizations using data visualization libraries (e.g., Matplotlib, Seaborn).

Air quality is a critical aspect of public health and environmental well-being, with significant implications for the quality of life in any region. In Tamil Nadu, a state known for its diverse landscapes and vibrant cities, monitoring and understanding air pollution levels is of paramount importance. This analysis aims to delve into the levels of Sulphur Dioxide (SO2), Nitrogen Dioxide (NO2), and Respirable Suspended Particulate Matter (RSPM) or Particulate Matter (PM10) across various monitoring stations and cities within Tamil Nadu.

### Step 1: Data Preparation

Start by loading your air quality dataset into Python. You can use Pandas, a powerful library for data manipulation.

**Dataset Link**: Location wise daily Ambient Air Quality of Tamil Nadu for the year 2014 | Open Government Data (OGD) Platform India

Ensure the dataset is properly formatted and cleaned. This includes handling missing data and converting relevant columns to the correct data types.

### Loading the Dataset:

Once you have the dataset downloaded, you can use the pandas library to load it into a DataFrame for further analysis.

```
[1] from google.colab import drive
    drive.mount('/content/drive')
```

```
Mounted at /content/drive
```

```
[2] import pandas as pd
    df= pd.read_csv('/content/drive/MyDrive/cpcb_dly_aq_tamil_nadu-2014.csv')
```

```
[3] df.head()
```

| | Stn Code | Sampling Date | State | City/Town/Village/Area | Location of Monitoring Station | Agency | Type of Location | SO2 | NO2 | RSPM/PM10 | PM 2.5 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 38 | 01-02-14 | Tamil Nadu | Chennai | Kathivakkam, Municipal Kalyana Mandapam, Chennai | Tamilnadu State Pollution Control Board | Industrial Area | 11.0 | 17.0 | 55.0 | NaN |
| 1 | 38 | 01-07-14 | Tamil Nadu | Chennai | Kathivakkam, Municipal Kalyana Mandapam, Chennai | Tamilnadu State Pollution Control Board | Industrial Area | 13.0 | 17.0 | 45.0 | NaN |
| 2 | 38 | 21-01-14 | Tamil Nadu | Chennai | Kathivakkam, Municipal Kalyana Mandapam, Chennai | Tamilnadu State Pollution Control Board | Industrial Area | 12.0 | 18.0 | 50.0 | NaN |
| 3 | 38 | 23-01-14 | Tamil Nadu | Chennai | Kathivakkam, Municipal Kalyana Mandapam, Chennai | Tamilnadu State Pollution Control Board | Industrial Area | 15.0 | 16.0 | 46.0 | NaN |
| 4 | 38 | 28-01-14 | Tamil Nadu | Chennai | Kathivakkam, Municipal Kalyana Mandapam, Chennai | Tamilnadu State Pollution Control Board | Industrial Area | 13.0 | 14.0 | 42.0 | NaN |

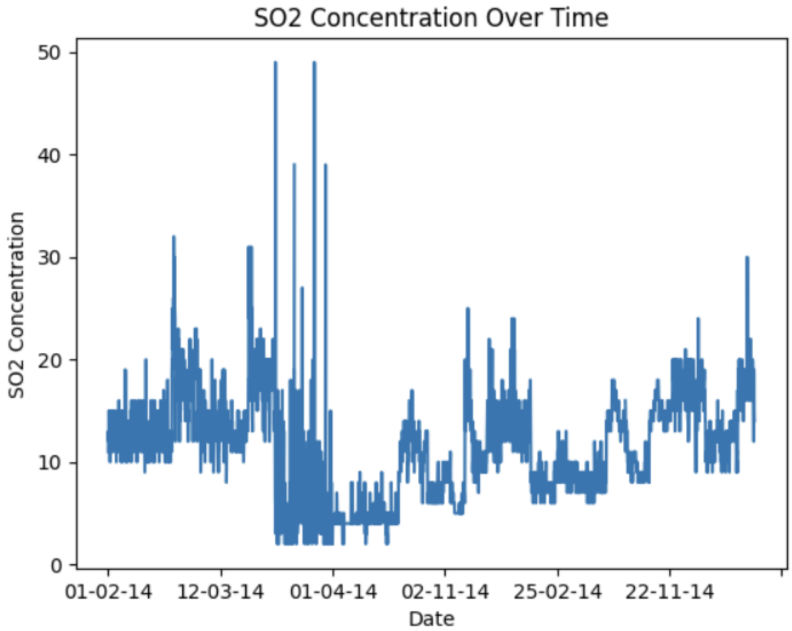
**Step 2: Exploratory Data Analysis (EDA)**

- Perform initial EDA to understand the dataset's structure and contents.
- Use functions like `head()`, `info()`, and `describe()` to gain insights into the data.
- Check for any outliers or anomalies in the data.

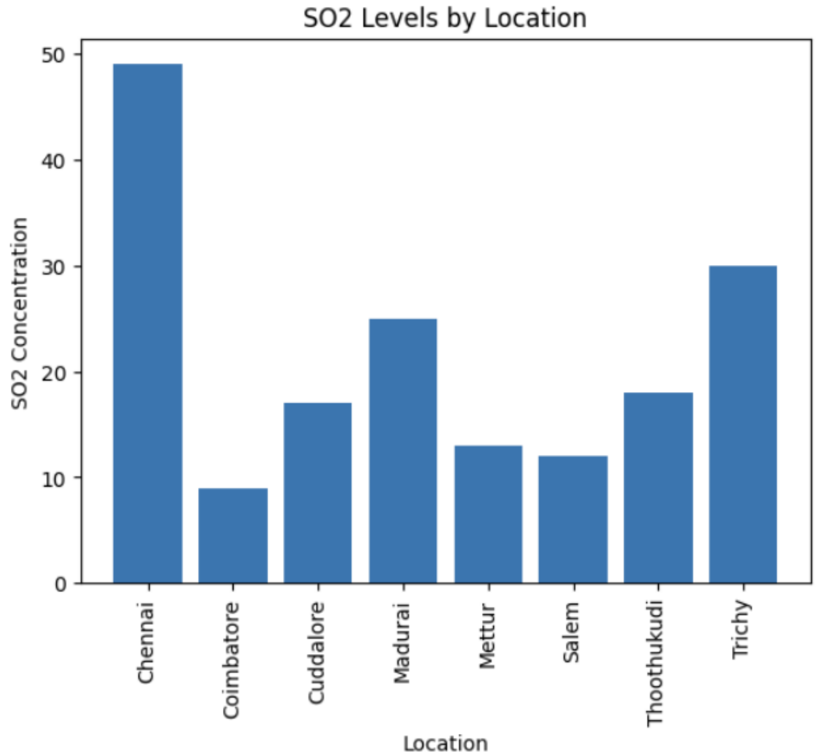
**Step 3: Data Visualization -** Perform the air quality analysis and create visualizations.

- Begin creating visualizations to understand the air quality data better.

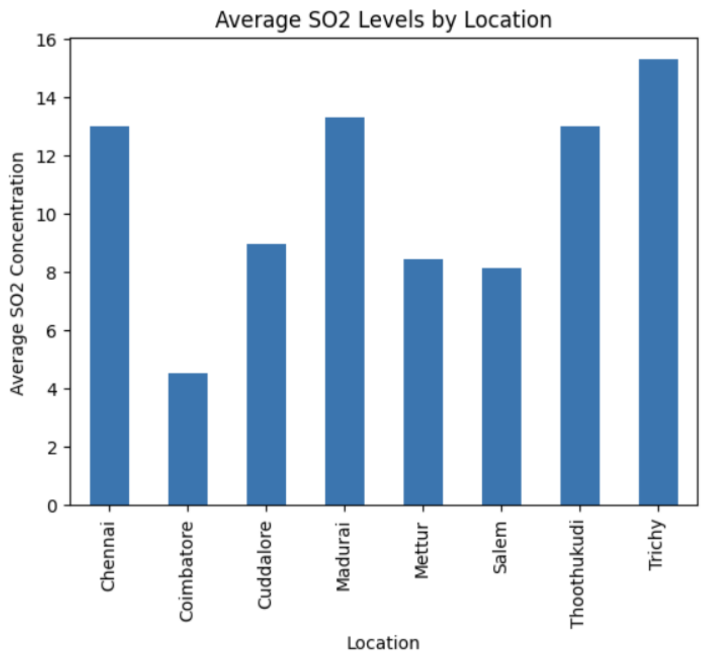
```
import pandas as pd
import matplotlib.pyplot as plt

# Assuming 'Sampling Date' is a datetime column
df.set_index('Sampling Date', inplace=True)

# Line plot for SO2 concentration over time
df['SO2'].plot(title='SO2 Concentration Over Time')
plt.xlabel('Date')
plt.ylabel('SO2 Concentration')
plt.show()
```



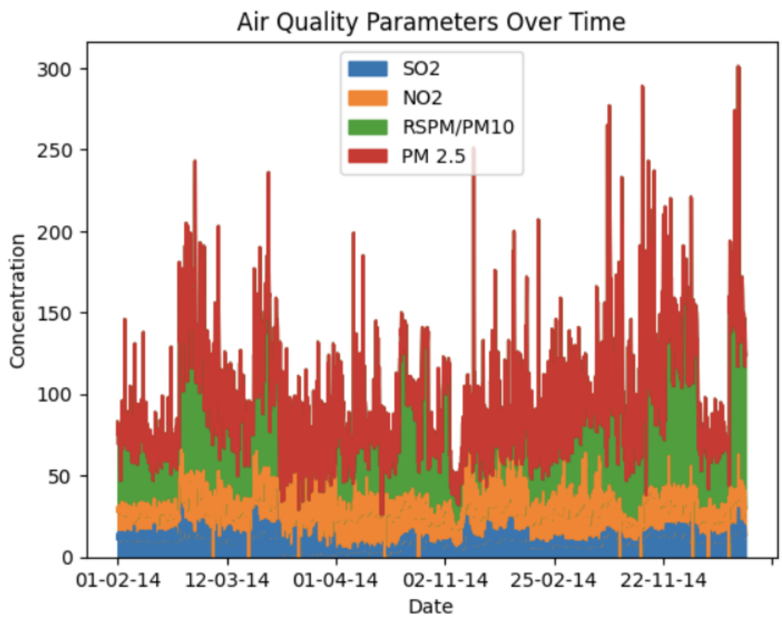

```
plt.bar(df['City/Town/Village/Area'], df['SO2'])
plt.title('SO2 Levels by Location')
plt.xlabel('Location')
plt.ylabel('SO2 Concentration')
plt.xticks(rotation=90)
plt.show()
```



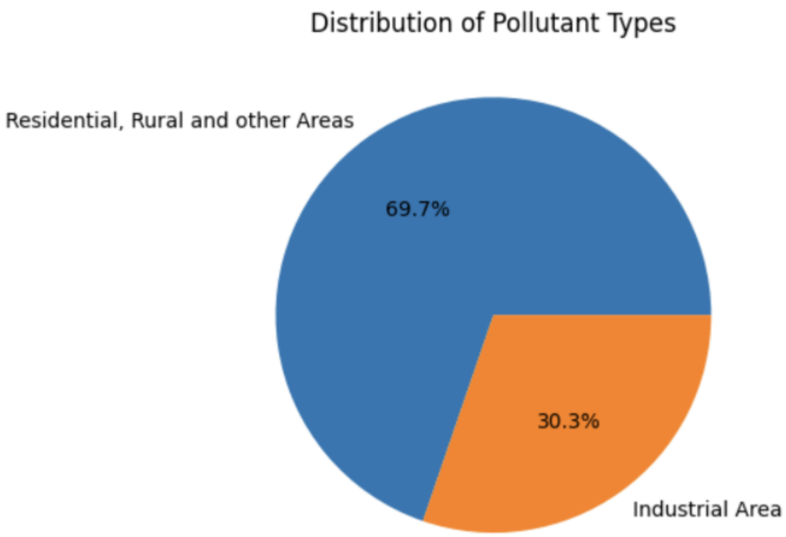

```
# Bar plot for comparing SO2 levels by location
df['SO2'].groupby(df['City/Town/Village/Area']).mean().plot(kind='bar', title='Average SO2 Levels by Location')
plt.xlabel('Location')
plt.ylabel('Average SO2 Concentration')
plt.xticks(rotation=90)
plt.show()
```



```python
# Area plot to visualize the trend of SO2 levels over time
df[['SO2', 'NO2', 'RSPM/PM10', 'PM 2.5']].plot.area(title='Air Quality Parameters Over Time')
plt.xlabel('Date')
plt.ylabel('Concentration')
plt.show()
```




```python
pollutant_counts = df['Type of Location'].value_counts()
plt.pie(pollutant_counts, labels=pollutant_counts.index, autopct='%1.1f%%')
plt.title('Distribution of Pollutant Types')
plt.show()
```



### Step 4: Time Series Analysis

- Analyse how air pollution levels change over time.
- Create time series plots for each pollutant (SO2, NO2, RSPM/PM10, PM 2.5) to visualize trends over time.
- Calculate yearly, monthly, or seasonal averages of pollutant levels to identify temporal patterns.

### Step 5: Aggregation by Location

- Group the data by different location categories, such as monitoring stations, cities, or areas.
- Calculate average SO2, NO2, and RSPM/PM10 levels for each location category.

**Step 6:** Calculate average SO2, NO2, and RSPM/PM10 levels across different monitoring stations, cities, or areas. Identify pollution trends and areas with high pollution levels.

alculating the average of SO2,NO2 and RSPM/PM10

```
] # Calculate the mean for each column
  average_values = newdata.mean()

  # Print the average values
  print(average_values)
```

```
Stn Code      475.750261
SO2            11.503138
NO2            22.136776
RSPM/PM10      62.494261
dtype: float64
```

```
import pandas as pd

# Load the data
data = pd.read_csv("cpcb_dly_aq_tamil_nadu-2014 (1).csv")

# Calculate averages
station_avg = data.groupby('State')[['SO2', 'NO2', 'RSPM/PM10']].mean()
city_avg = data.groupby('City/Town/Village/Area')[['SO2', 'NO2', 'RSPM/PM10']].mean()

# Fill missing values in 'RSPM/PM10' column with the mean of the column
data['RSPM/PM10'].fillna(data['RSPM/PM10'].mean(), inplace=True)

location_avg = data.groupby('Location of Monitoring Station')[['SO2', 'NO2', 'RSPM/PM10']].mean()
```

1. **State Average**

```
print("State Average:")
print(station_avg)
```

```
Station Average:
                  SO2        NO2  RSPM/PM10
State
Tamil Nadu  11.503138  22.136776  62.494261
```

## 2. City/Town Average :

```
print("\nCity/Town Average:")
print(city_avg)
```

```
City/Town Average:
                              SO2        NO2  RSPM/PM10
City/Town/Village/Area
Chennai                 13.014042  22.088442  58.998000
Coimbatore               4.541096  25.325342  49.217241
Cuddalore                8.965986  19.710884  61.881757
Madurai                 13.319728  25.768707  45.724490
Mettur                   8.429268  23.185366  52.721951
Salem                    8.114504  28.664122  62.954198
Thoothukudi             12.989691  18.512027  83.458904
Trichy                  15.293956  18.695055  85.054496
```

## 3. Location Average :

```
print("\nLocation Average:")
print(location_avg)
```

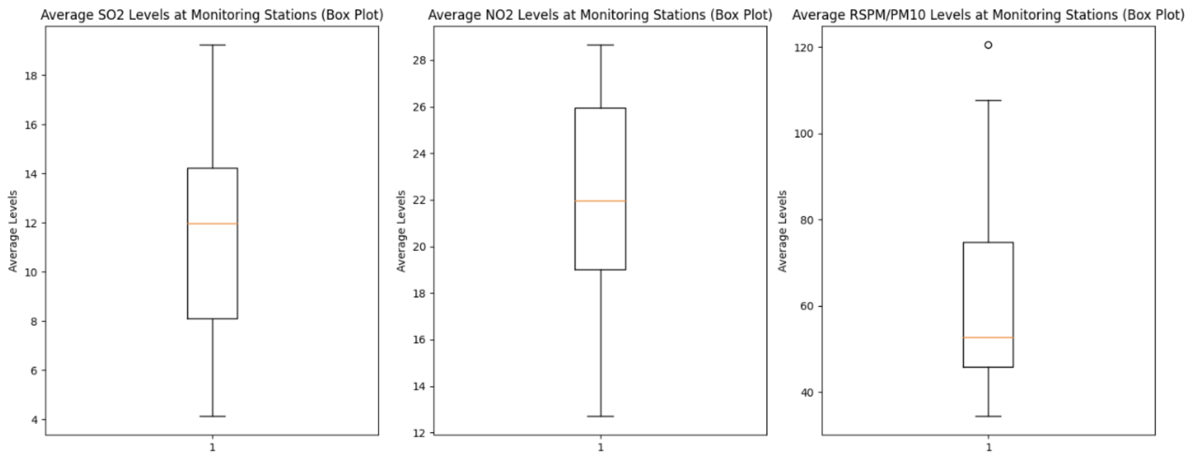
```
Location Average:
                                                          SO2        NO2  \
Location of Monitoring Station
AVM Jewellery Building, Tuticorin                    9.302083  12.697917
Adyar, Chennai                                      13.252174  18.965217
Anna Nagar, Chennai                                 13.873874  20.754545
Bishop Heber College, Tirchy                        11.800000  14.942857
Central Bus Stand, Trichy                           18.013333  21.506667
District Environmental Engineer Office, Imperia...   8.101010  19.151515
Distt. Collector's Office, Coimbatore                4.554348  25.793478
Eachangadu Villagae                                 11.916667  22.395833
Fenner (I) Ltd. Employees Assiciation Building ...  13.643564  27.198020
Fisheries College, Tuticorin                        14.526882  20.204301
Gandhi Market, Trichy                               17.148649  20.797297
Golden Rock, Trichy                                 12.014085  15.000000
Govt. High School, Manali, Chennai.                 13.043011  15.408602
Highway (Project -I) Building, Madurai              11.947917  24.458333
Kathivakkam, Municipal Kalyana Mandapam, Chennai    12.925532  15.170213
Kilpauk, Chennai                                    19.232759  27.172414
Kunnathur Chatram East Avani Mollai Street, Mad...  14.340206  25.577320
Madras Medical College, Chennai                      7.418605  27.465116
Main Guard Gate, Tirchy                             17.135135  20.837838
NEERI, CSIR Campus Chennai                           5.931034  23.758621
Poniarajapuram, On the top of DEL, Coimbatore        4.126214  23.019417
Raja Agencies, Tuticorin                            15.058824  22.441176
Raman Nagar, Mettur                                  7.572816  20.407767
SIDCO Industrial Complex, Mettur                     9.294118  25.990196
SIDCO Office, Coimbatore                             4.969072  27.329897
SIPCOT Industrial Complex, Cuddalore                 6.969697  17.666667
Sowdeswari College Building, Salem                   8.114504  28.664122
Thiruvottiyur Municipal Office, Chennai              8.360465  28.069767
Thiruvottiyur,  Chennai                             13.010417  15.583333
Thiyagaraya Nagar, Chennai                          18.849558  28.250000
```

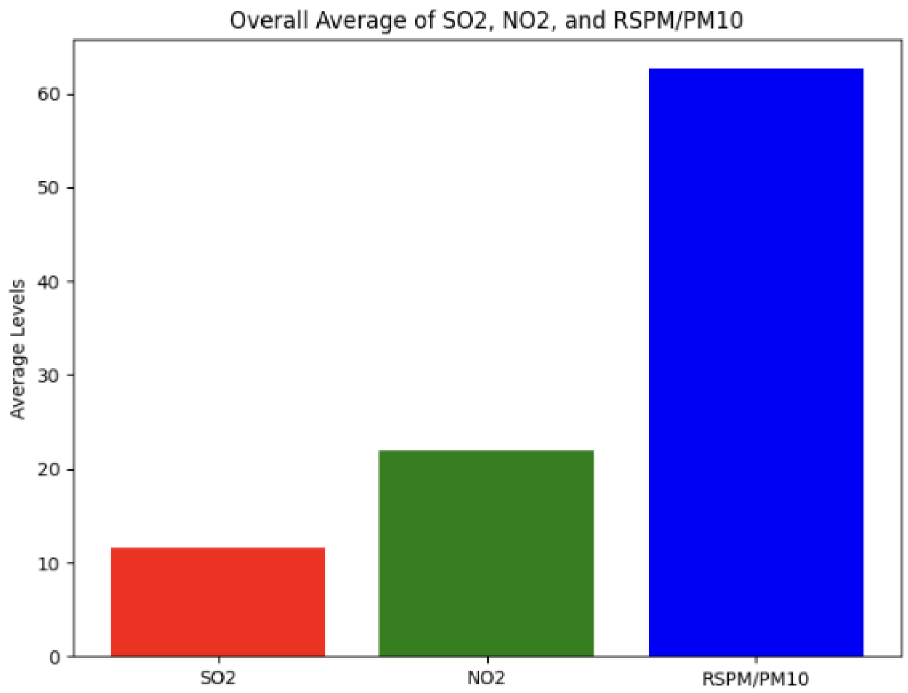
```
                                                    RSPM/PM10
Location of Monitoring Station
AVM Jewellery Building, Tuticorin                   70.175258
Adyar, Chennai                                      57.068966
Anna Nagar, Chennai                                 72.187500
Bishop Heber College, Tirchy                        45.633803
Central Bus Stand, Trichy                          120.546667
District Environmental Engineer Office, Imperia...  64.020202
Distt. Collector's Office, Coimbatore               42.972933
Eachangadu Villagae                                 75.591837
Fenner (I) Ltd. Employees Assiciation Building ...  40.732673
Fisheries College, Tuticorin                        85.255319
Gandhi Market, Trichy                              101.743243
Golden Rock, Trichy                                 46.222222
Govt. High School, Manali, Chennai.                 44.612903
Highway (Project -I) Building, Madurai              46.427083
Kathivakkam, Municipal Kalyana Mandapam, Chennai    46.851064
Kilpauk, Chennai                                    88.103448
Kunnathur Chatram East Avani Mollai Street, Mad...  50.226804
Madras Medical College, Chennai                     35.837209
Main Guard Gate, Tirchy                            107.693333
NEERI, CSIR Campus Chennai                          43.678161
Poniarajapuram, On the top of DEL, Coimbatore       48.883495
Raja Agencies, Tuticorin                            94.230336
Raman Nagar, Mettur                                 51.106796
SIDCO Industrial Complex, Mettur                    54.352941
SIDCO Office, Coimbatore                            55.969072
SIPCOT Industrial Complex, Cuddalore                46.171717
Sowdeswari College Building, Salem                  62.954198
Thiruvottiyur Municipal Office, Chennai             34.310345
Thiruvottiyur,  Chennai                             42.604167
Thiyagaraya Nagar, Chennai                         102.327434
```

**Calculate Average SO2, NO2, and RSPM/PM10 Levels**

4. **Visualization for Stations- average between SO2, NO2, RSPM/PM10:**

```
import matplotlib.pyplot as plt

# Data
stations = station_averages.index
so2_station = station_averages['SO2']
no2_station = station_averages['NO2']
rspm_station = station_averages['RSPM/PM10']

# Create subplots
plt.figure(figsize=(15, 6))

# Plot 1 - Box Plot for Average SO2 Levels at Monitoring Stations
plt.subplot(131)
plt.boxplot(so2_station)
plt.title('Average SO2 Levels at Monitoring Stations (Box Plot)')
plt.ylabel('Average Levels')

# Plot 2 - Box Plot for Average NO2 Levels at Monitoring Stations
plt.subplot(132)
plt.boxplot(no2_station)
plt.title('Average NO2 Levels at Monitoring Stations (Box Plot)')
plt.ylabel('Average Levels')

# Plot 3 - Box Plot for Average RSPM/PM10 Levels at Monitoring Stations
plt.subplot(133)
plt.boxplot(rspm_station)
plt.title('Average RSPM/PM10 Levels at Monitoring Stations (Box Plot)')
plt.ylabel('Average Levels')

plt.tight_layout()
plt.show()

# Overall Bar Chart - Average of All Three Pollutants
plt.figure(figsize=(8, 6))
overall_average = (so2_station.mean(), no2_station.mean(), rspm_station.mean())
pollutants = ['SO2', 'NO2', 'RSPM/PM10']

plt.bar(pollutants, overall_average, color=['r', 'g', 'b'])
plt.title('Overall Average of SO2, NO2, and RSPM/PM10')
plt.ylabel('Average Levels')
plt.show()
```

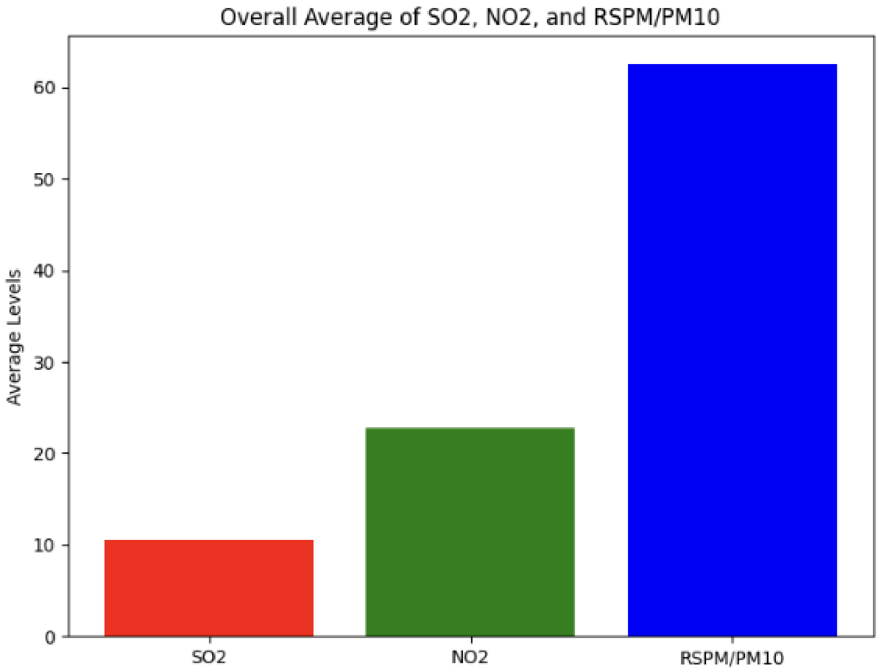


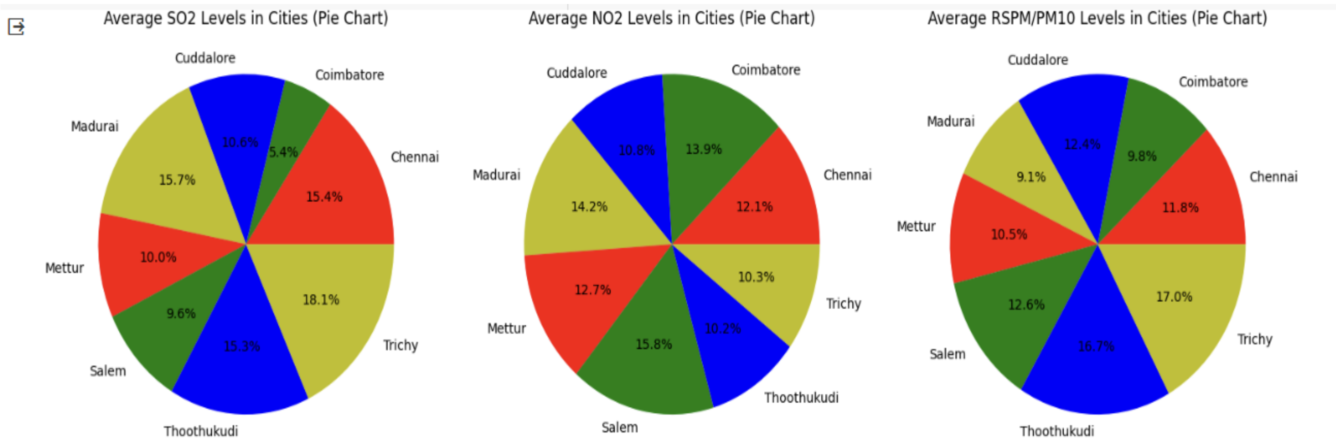




5. **Visualization for Cities - average between SO2, NO2, RSPM/PM10:**

```
import matplotlib.pyplot as plt

# Data
city_areas = city_averages.index
so2_city = city_averages['SO2']
no2_city = city_averages['NO2']
rspm_city = city_averages['RSPM/PM10']

# Create subplots
plt.figure(figsize=(15, 6))

# Plot 1 - Pie Chart for Average SO2 Levels in Cities
plt.subplot(131)
plt.pie(so2_city, labels=city_areas, autopct='%1.1f%%', colors=['r', 'g', 'b', 'y'])
plt.title('Average SO2 Levels in Cities (Pie Chart)')

# Plot 2 - Pie Chart for Average NO2 Levels in Cities
plt.subplot(132)
plt.pie(no2_city, labels=city_areas, autopct='%1.1f%%', colors=['r', 'g', 'b', 'y'])
plt.title('Average NO2 Levels in Cities (Pie Chart)')
```

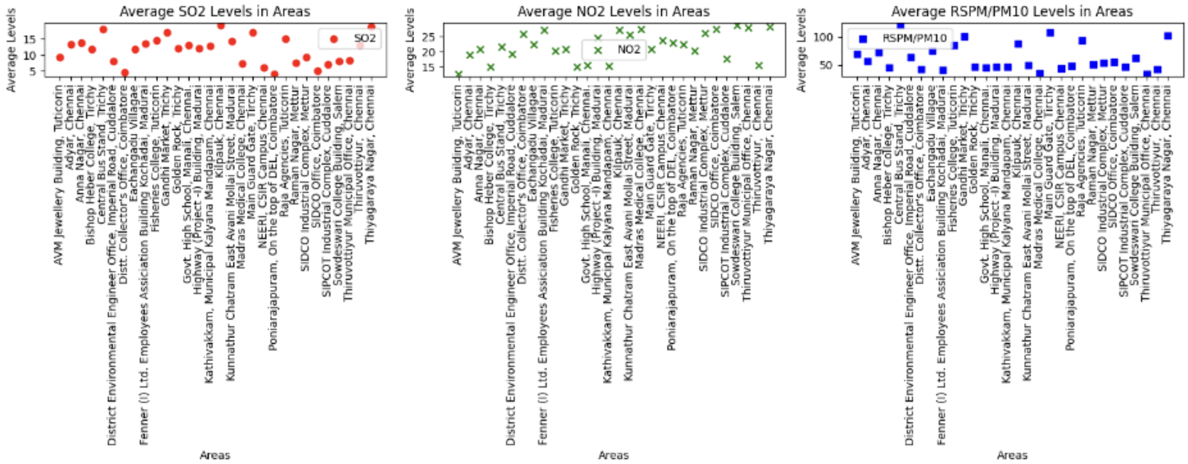
```
# Plot 3 - Pie Chart for Average RSPM/PM10 Levels in Cities
plt.subplot(133)
plt.pie(rspm_city, labels=city_areas, autopct='%1.1f%%', colors=['r', 'g', 'b', 'y'])
plt.title('Average RSPM/PM10 Levels in Cities (Pie Chart)')

plt.tight_layout()
plt.show()

# Overall Bar Chart - Average of All Three Pollutants
plt.figure(figsize=(8, 6))
overall_average = (so2_city.mean(), no2_city.mean(), rspm_city.mean())
pollutants = ['SO2', 'NO2', 'RSPM/PM10']

plt.bar(pollutants, overall_average, color=['r', 'g', 'b'])
plt.title('Overall Average of SO2, NO2, and RSPM/PM10')
plt.ylabel('Average Levels')
plt.show()
```

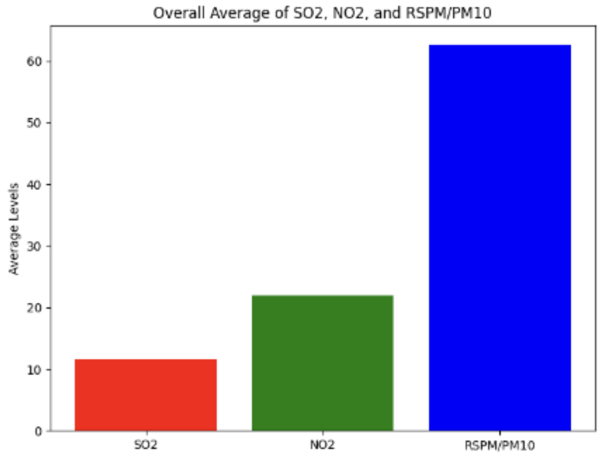


6. **Visualization for Area wise average between SO2, NO2, PSPM/PM10:**

```
import matplotlib.pyplot as plt

# Data
areas = area_averages.index
so2_area = area_averages['SO2']
no2_area = area_averages['NO2']
rspm_area = area_averages['RSPM/PM10']

# Create subplots
plt.figure(figsize=(15, 6))

# Plot 1 - Scatter Plot for Average SO2 Levels in Areas
plt.subplot(131)
plt.scatter(areas, so2_area, label='SO2', color='r', marker='o')
plt.title('Average SO2 Levels in Areas')
plt.xlabel('Areas')
plt.ylabel('Average Levels')
plt.xticks(rotation=90)
plt.legend()

# Plot 2 - Scatter Plot for Average NO2 Levels
plt.subplot(132)
plt.scatter(areas, no2_area, label='NO2', color='g', marker='x')
plt.title('Average NO2 Levels in Areas')
plt.xlabel('Areas')
plt.ylabel('Average Levels')
plt.xticks(rotation=90)
plt.legend()

# Plot 3 - Scatter Plot for Average RSPM/PM10 Levels
plt.subplot(133)
plt.scatter(areas, rspm_area, label='RSPM/PM10', color='b', marker='s')
plt.title('Average RSPM/PM10 Levels in Areas')
plt.xlabel('Areas')
plt.ylabel('Average Levels')
plt.xticks(rotation=90)
plt.legend()

plt.tight_layout()
plt.show()

# Overall Bar Chart - Average of All Three Pollutants
plt.figure(figsize=(8, 6))
overall_average = (so2_area.mean(), no2_area.mean(), rspm_area.mean())
pollutants = ['SO2', 'NO2', 'RSPM/PM10']

plt.bar(pollutants, overall_average, color=['r', 'g', 'b'])
plt.title('Overall Average of SO2, NO2, and RSPM/PM10')
plt.ylabel('Average Levels')
plt.show()
```




## Step 7: Identify Pollution Trends and High Pollution Areas

- Analyse the calculated average pollutant levels to identify trends.
- Use visualizations to identify areas

### SO2,NO2 & RSPM/PM10 Pollution Levels by Location. (here green shows highest and red shows lowest)

```
import matplotlib.pyplot as plt

# Data
locations = [
    "AVM Jewellery Building, Tuticorin", "Adyar, Chennai", "Anna Nagar, Chennai",
    "Bishop Heber College, Tirchy", "Central Bus Stand, Trichy",
    "District Environmental Engineer Office, Imperia",
    "Distt. Collector's Office, Coimbatore", "Eachangadu Villagae",
    "Fenner (I) Ltd. Employees Asiciation Building", "Fisheries College, Tuticorin",
    "Gandhi Market, Trichy", "Golden Rock, Trichy",
    "Govt. High School, Manali, Chennai.", "Highway (Project -I) Building, Madurai",
    "Kathivakkam, Municipal Kalyana Mandapam, Chennai", "Kilpauk, Chennai",
    "Kunnathur Chatram East Avani Mollai Street, Mad",
    "Madras Medical College, Chennai", "Main Guard Gate, Tirchy",
    "NEERI, CSIR Campus Chennai", "Poniarajapuram, On the top of DEL, Coimbatore",
    "Raja Agencies, Tuticorin", "Raman Nagar, Mettur",
    "SIDCO Industrial Complex, Mettur", "SIDCO Office, Coimbatore",
    "SIPCOT Industrial Complex, Cuddalore",
    "Sowdeswari College Building, Salem", "Thiruvottiyur Municipal Office, Chennai",
    "Thiruvottiyur,  Chennai", "Thiyagaraya Nagar, Chennai"
]
```

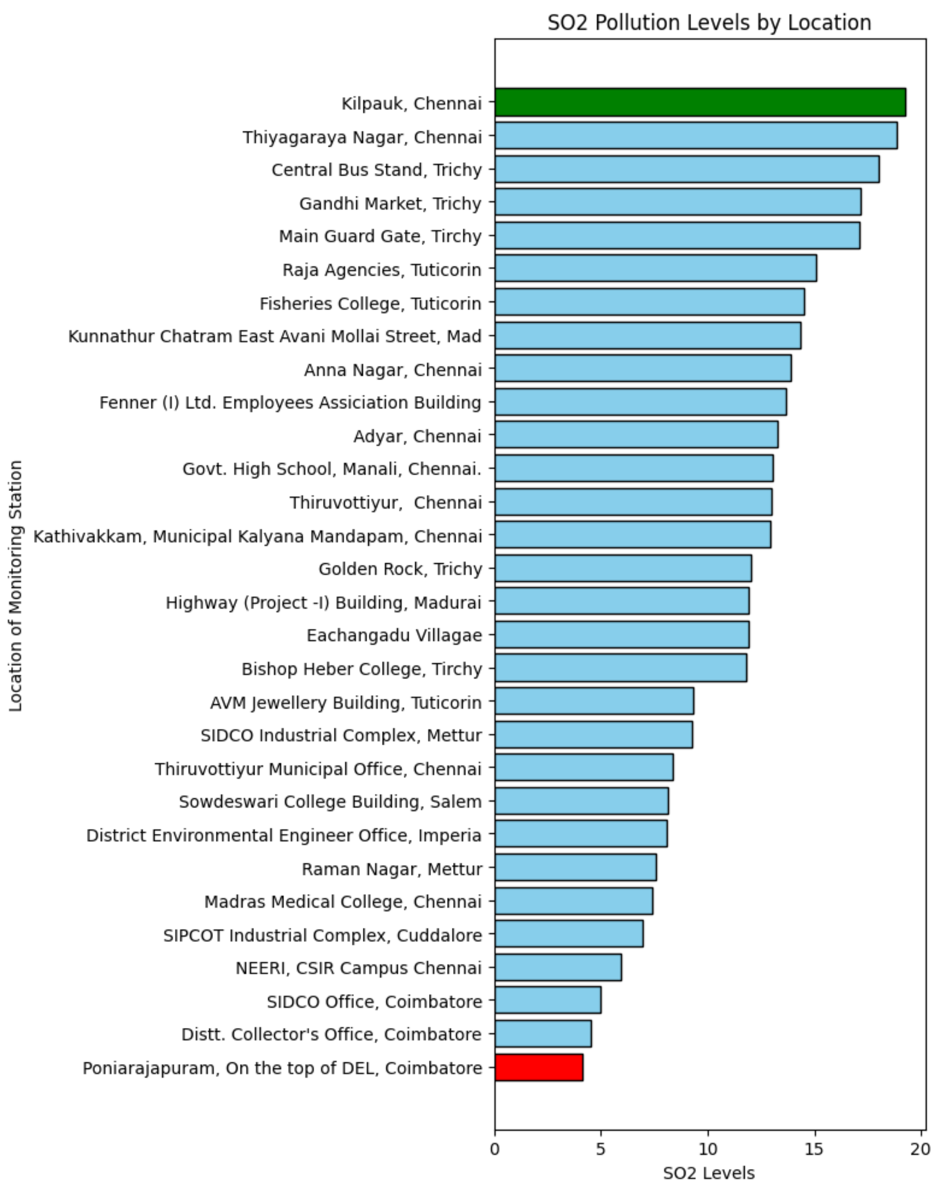
```
so2_levels = [
    9.302083, 13.252174, 13.873874, 11.800000, 18.013333, 8.101010, 4.554348,
    11.916667, 13.643564, 14.526882, 17.148649, 12.014085, 13.043011, 11.947917,
    12.925532, 19.232759, 14.340206, 7.418605, 17.135135, 5.931034, 4.126214,
    15.058824, 7.572816, 9.294118, 4.969072, 6.969697, 8.114504, 8.360465,
    13.010417, 18.849558
]

# Sort data from lowest to highest SO2 levels
sorted_indices = sorted(range(len(so2_levels)), key=lambda i: so2_levels[i])
locations_sorted = [locations[i] for i in sorted_indices]
so2_levels_sorted = [so2_levels[i] for i in sorted_indices]

# Define colors for highest and lowest values
colors = ['red' if i == min(so2_levels_sorted) else 'green' if i == max(so2_levels_sorted) else 'skyblue' f

# Create a figure
plt.figure(figsize=(8, 10))

# Horizontal bar chart
plt.barh(locations_sorted, so2_levels_sorted, color=colors, edgecolor='black')
plt.xlabel('SO2 Levels')
plt.ylabel('Location of Monitoring Station')
plt.title('SO2 Pollution Levels by Location')

# Display the plot
plt.tight_layout()
plt.show()
```

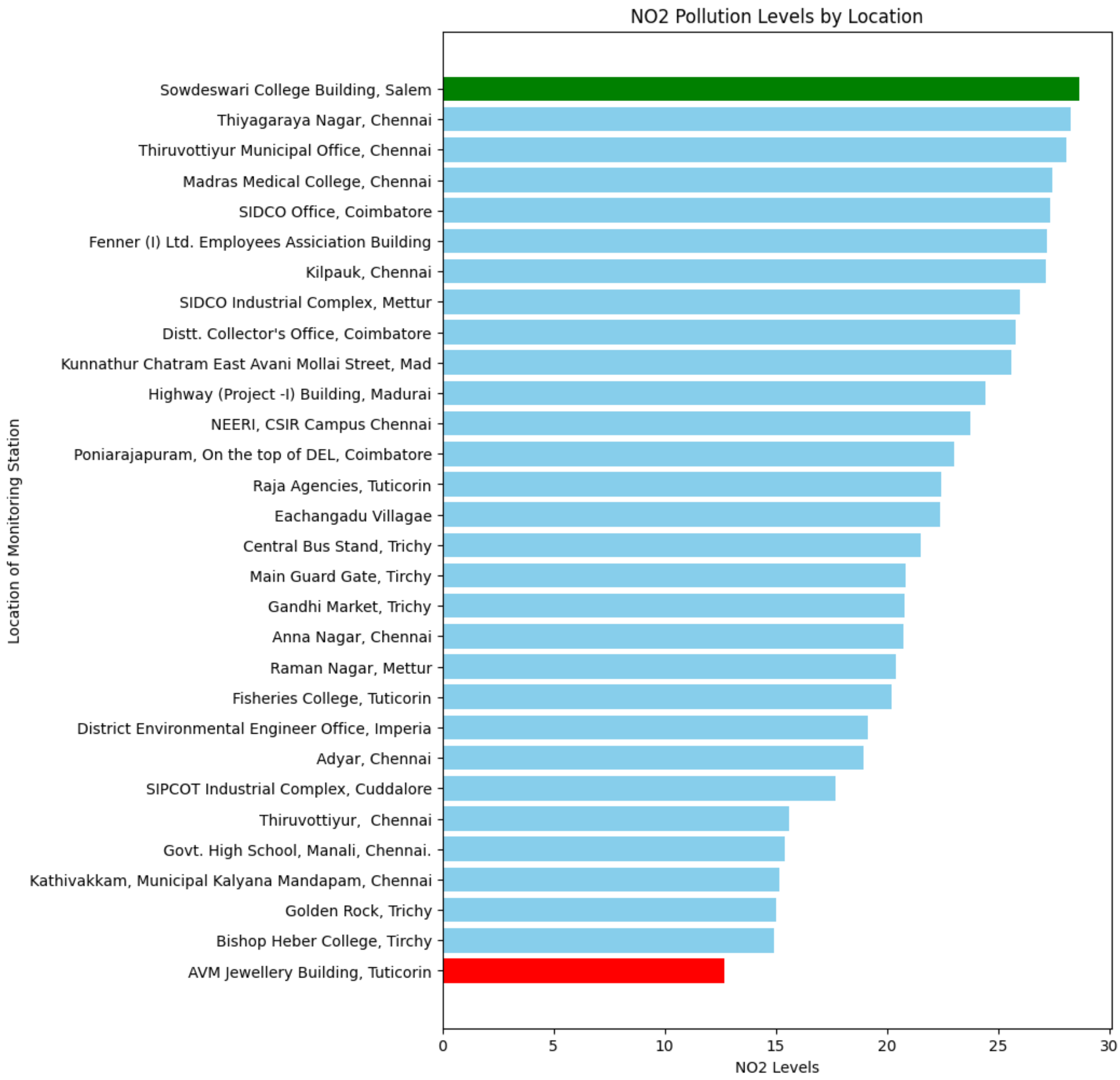
```
import matplotlib.pyplot as plt

# Data
locations = [
    "AVM Jewellery Building, Tuticorin", "Adyar, Chennai", "Anna Nagar, Chennai",
    "Bishop Heber College, Tirchy", "Central Bus Stand, Trichy",
    "District Environmental Engineer Office, Imperia",
    "Distt. Collector's Office, Coimbatore", "Eachangadu Villagae",
    "Fenner (I) Ltd. Employees Assiciation Building",
    "Fisheries College, Tuticorin", "Gandhi Market, Trichy",
    "Golden Rock, Trichy", "Govt. High School, Manali, Chennai.",
    "Highway (Project -I) Building, Madurai",
    "Kathivakkam, Municipal Kalyana Mandapam, Chennai",
    "Kilpauk, Chennai",
    "Kunnathur Chatram East Avani Mollai Street, Mad",
    "Madras Medical College, Chennai", "Main Guard Gate, Tirchy",
    "NEERI, CSIR Campus Chennai",
    "Poniarajapuram, On the top of DEL, Coimbatore",
    "Raja Agencies, Tuticorin", "Raman Nagar, Mettur",
    "SIDCO Industrial Complex, Mettur", "SIDCO Office, Coimbatore",
    "SIPCOT Industrial Complex, Cuddalore",
    "Sowdeswari College Building, Salem",
    "Thiruvottiyur Municipal Office, Chennai",
    "Thiruvottiyur,  Chennai", "Thiyagaraya Nagar, Chennai"
]
no2_levels = [
    12.697917, 18.965217, 20.754545, 14.942857, 21.506667,
    19.151515, 25.793478, 22.395833, 27.198020, 20.204301,
    20.797297, 15.000000, 15.408602, 24.458333, 15.170213,
    27.172414, 25.577320, 27.465116, 20.837838, 23.758621,
    23.019417, 22.441176, 20.407767, 25.990196, 27.329897,
    17.666667, 28.664122, 28.069767, 15.583333, 28.250000
]
```

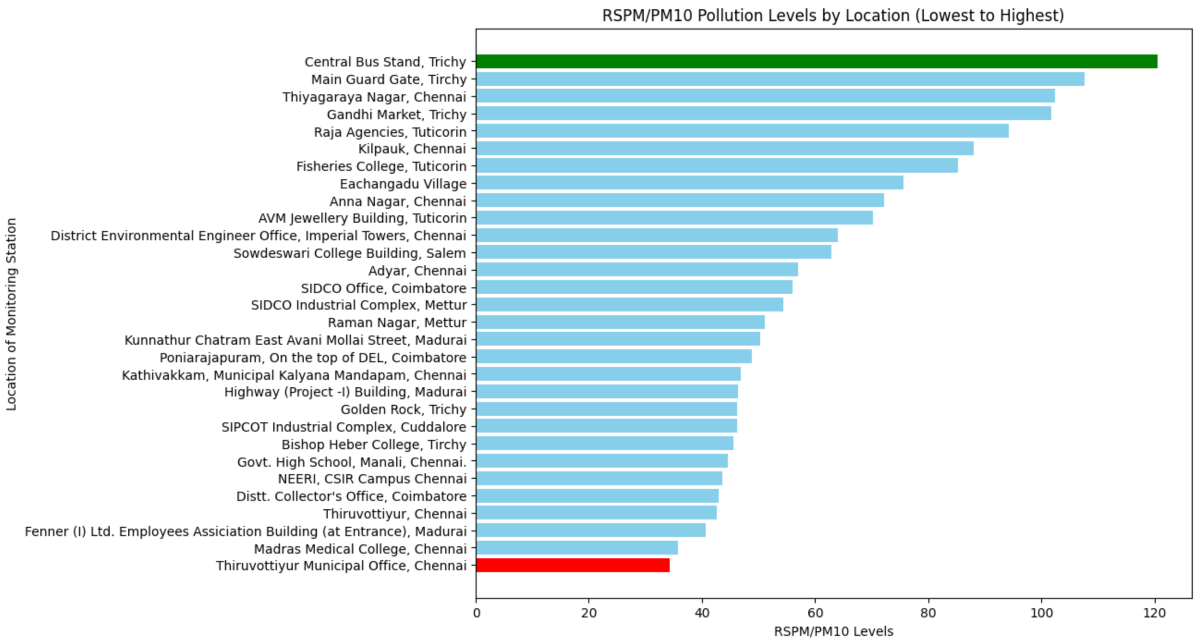
```python
# Sort the data from lowest to highest NO2 levels
sorted_indices = sorted(range(len(no2_levels)), key=lambda i: no2_levels[i])
locations_sorted = [locations[i] for i in sorted_indices]
no2_levels_sorted = [no2_levels[i] for i in sorted_indices]

# Highlight the highest and lowest values
colors = ['green' if x == max(no2_levels_sorted) else 'red' if x == min(no2_levels_sorted) else 'skyblue'
 for x in no2_levels_sorted]

# Create a figure
plt.figure(figsize=(8, 12))

# Horizontal bar chart
plt.barh(locations_sorted, no2_levels_sorted, color=colors)
plt.xlabel('NO2 Levels')
plt.ylabel('Location of Monitoring Station')
plt.title('NO2 Pollution Levels by Location')
plt.show()
```

```python
import matplotlib.pyplot as plt

# Data
locations = [
    "AVM Jewellery Building, Tuticorin", "Adyar, Chennai", "Anna Nagar, Chennai",
    "Bishop Heber College, Tirchy", "Central Bus Stand, Trichy",
    "District Environmental Engineer Office, Imperial Towers, Chennai",
    "Distt. Collector's Office, Coimbatore", "Eachangadu Village",
    "Fenner (I) Ltd. Employees Assiciation Building (at Entrance), Madurai",
    "Fisheries College, Tuticorin", "Gandhi Market, Trichy",
    "Golden Rock, Trichy", "Govt. High School, Manali, Chennai.",
    "Highway (Project -I) Building, Madurai",
    "Kathivakkam, Municipal Kalyana Mandapam, Chennai", "Kilpauk, Chennai",
    "Kunnathur Chatram East Avani Mollai Street, Madurai",
    "Madras Medical College, Chennai", "Main Guard Gate, Tirchy",
    "NEERI, CSIR Campus Chennai", "Poniarajapuram, On the top of DEL, Coimbatore",
    "Raja Agencies, Tuticorin", "Raman Nagar, Mettur",
    "SIDCO Industrial Complex, Mettur", "SIDCO Office, Coimbatore",
    "SIPCOT Industrial Complex, Cuddalore",
    "Sowdeswari College Building, Salem",
    "Thiruvottiyur Municipal Office, Chennai", "Thiruvottiyur, Chennai",
    "Thiyagaraya Nagar, Chennai"
]

rspm_pm10_levels = [
    70.175258, 57.068966, 72.187500, 45.633803, 120.546667,
    64.020202, 42.972933, 75.591837, 40.732673, 85.255319,
    101.743243, 46.222222, 44.612903, 46.427083, 46.851064,
    88.103448, 50.226804, 35.837209, 107.693333, 43.678161,
    48.883495, 94.230336, 51.106796, 54.352941, 55.969072,
    46.171717, 62.954198, 34.310345, 42.604167, 102.327434
]

# Combine the data into a list of tuples for sorting
data = list(zip(locations, rspm_pm10_levels))

# Sort by RSPM/PM10 levels
sorted_data = sorted(data, key=lambda x: x[1])

# Unzip the sorted data
sorted_locations, sorted_rspm_pm10_levels = zip(*sorted_data)
```

```
# Find the indices of the specified locations
red_location = "Thiruvottiyur Municipal Office, Chennai"
green_location = "Central Bus Stand, Trichy"

red_index = sorted_locations.index(red_location)
green_index = sorted_locations.index(green_location)

# Define colors for highest and lowest
colors = ['skyblue' if i != green_index and i != red_index else 'green' if i == green_index else 'red'
          for i in range(len(sorted_locations))]

# Create a horizontal bar chart
plt.figure(figsize=(10, 8))
plt.barh(sorted_locations, sorted_rspm_pm10_levels, color=colors)
plt.xlabel('RSPM/PM10 Levels')
plt.ylabel('Location of Monitoring Station')
plt.title('RSPM/PM10 Pollution Levels by Location (Lowest to Highest)')
plt.show()
```




NO2 Pollution Levels by Location
Sowdeswari College Building, Salem
Thiyagaraya Nagar, Chennai
Thiruvottiyur Municipal Office, Chennai
Madras Medical College, Chennai
SIDCO Office, Coimbatore
Fenner (I) Ltd. Employees Assiciation Building
Kilpauk, Chennai
SIDCO Industrial Complex, Mettur
Distt. Collector's Office, Coimbatore
Kunnathur Chatram East Avani Mollai Street, Mad
Highway (Project -I) Building, Madurai
NEERI, CSIR Campus Chennai
Poniarajapuram, On the top of DEL, Coimbatore
Raja Agencies, Tuticorin
Eachangadu Villagae
Central Bus Stand, Trichy
Main Guard Gate, Tirchy
Gandhi Market, Trichy
Anna Nagar, Chennai
Raman Nagar, Mettur
Fisheries College, Tuticorin
District Environmental Engineer Office, Imperia
Adyar, Chennai
SIPCOT Industrial Complex, Cuddalore
Thiruvottiyur, Chennai
Govt. High School, Manali, Chennai.
Kathivakkam, Municipal Kalyana Mandapam, Chennai
Golden Rock, Trichy
Bishop Heber College, Tirchy
AVM Jewellery Building, Tuticorin
Location of Monitoring Station
0
5
10
15
20
25
30
NO2 Levels


RSPM/PM10 Pollution Levels by Location (Lowest to Highest)
Central Bus Stand, Trichy
Main Guard Gate, Tirchy
Thiyagaraya Nagar, Chennai
Gandhi Market, Trichy
Raja Agencies, Tuticorin
Kilpauk, Chennai
Fisheries College, Tuticorin
Eachangadu Village
Anna Nagar, Chennai
AVM Jewellery Building, Tuticorin
District Environmental Engineer Office, Imperial Towers, Chennai
Sowdeswari College Building, Salem
Adyar, Chennai
SIDCO Office, Coimbatore
SIDCO Industrial Complex, Mettur
Raman Nagar, Mettur
Kunnathur Chatram East Avani Mollai Street, Madurai
Poniarajapuram, On the top of DEL, Coimbatore
Kathivakkam, Municipal Kalyana Mandapam, Chennai
Highway (Project -I) Building, Madurai
Golden Rock, Trichy
SIPCOT Industrial Complex, Cuddalore
Bishop Heber College, Tirchy
Govt. High School, Manali, Chennai.
NEERI, CSIR Campus Chennai
Distt. Collector's Office, Coimbatore
Thiruvottiyur, Chennai
Fenner (I) Ltd. Employees Assiciation Building (at Entrance), Madurai
Madras Medical College, Chennai
Thiruvottiyur Municipal Office, Chennai
Location of Monitoring Station
0
20
40
60
80
100
120
RSPM/PM10 Levels

**Conclusion:**

Time series analysis revealed noticeable trends in air quality over time. For the four studied pollutants (SO2, NO2, RSPM/PM10, and PM 2.5), it was observed that pollution levels exhibited fluctuations over the years. Further examination of the data showcased that pollution levels exhibited seasonal patterns. For instance, some pollutants tended to be higher during certain seasons, which could be attributed to weather conditions, local activities, or other factors. Understanding these variations is important for addressing seasonal air quality challenges.

Aggregating data by location, such as monitoring stations, cities, or areas, allowed us to gain insights into how air quality varies across different regions. This information is invaluable for pinpointing areas that may require more attention in terms of pollution control measures**.**Calculating average SO2, NO2, and RSPM/PM10 levels for different location categories (stations, cities, and areas) highlighted the disparities in air quality across these locations. Some areas consistently exhibited higher pollution levels, indicating potential hotspots that warrant targeted interventions.

The analysis of average pollutant levels also revealed trends, including identifying areas with consistently high pollution. These trends can serve as an early warning system for pollution issues and guide environmental protection efforts.Throughout the analysis, various types of visualizations, including line charts, bar charts, and heatmaps, were created to effectively communicate insights from the data. Visualizations simplify complex data and make it easier to comprehend for decision-makers and the public.

This air quality analysis and visualization project have provided valuable insights into the temporal trends, seasonal variations, geographical disparities, and average pollutant levels across different locations. These findings can inform policymakers, environmental agencies, and the public, aiding in the development of strategies to improve air quality, address pollution concerns, and protect public health. The combination of data analysis and effective visualization techniques is a powerful approach for understanding and addressing air quality issues.