In [1]:
```
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
import seaborn as sns
```

In [2]:
```
df=pd.read_csv("delhiaqi.csv")
df.head()
```

Out[2]:

	date	co	no	no2	o3	so2	pm2_5	pm10	nh3
0	2023-01-01 00:00:00	1655.58	1.66	39.41	5.90	17.88	169.29	194.64	5.83
1	2023-01-01 01:00:00	1869.20	6.82	42.16	1.99	22.17	182.84	211.08	7.66
2	2023-01-01 02:00:00	2510.07	27.72	43.87	0.02	30.04	220.25	260.68	11.40
3	2023-01-01 03:00:00	3150.94	55.43	44.55	0.85	35.76	252.90	304.12	13.55
4	2023-01-01 04:00:00	3471.37	68.84	45.24	5.45	39.10	266.36	322.80	14.19

In [3]:
```
df.isnull().sum()
```

Out[3]:
```
date     0
co       0
no       0
no2      0
o3       0
so2      0
pm2_5    0
pm10     0
nh3      0
dtype: int64
```

In [4]:
```
df.shape
```

Out[4]:
```
(561, 9)
```

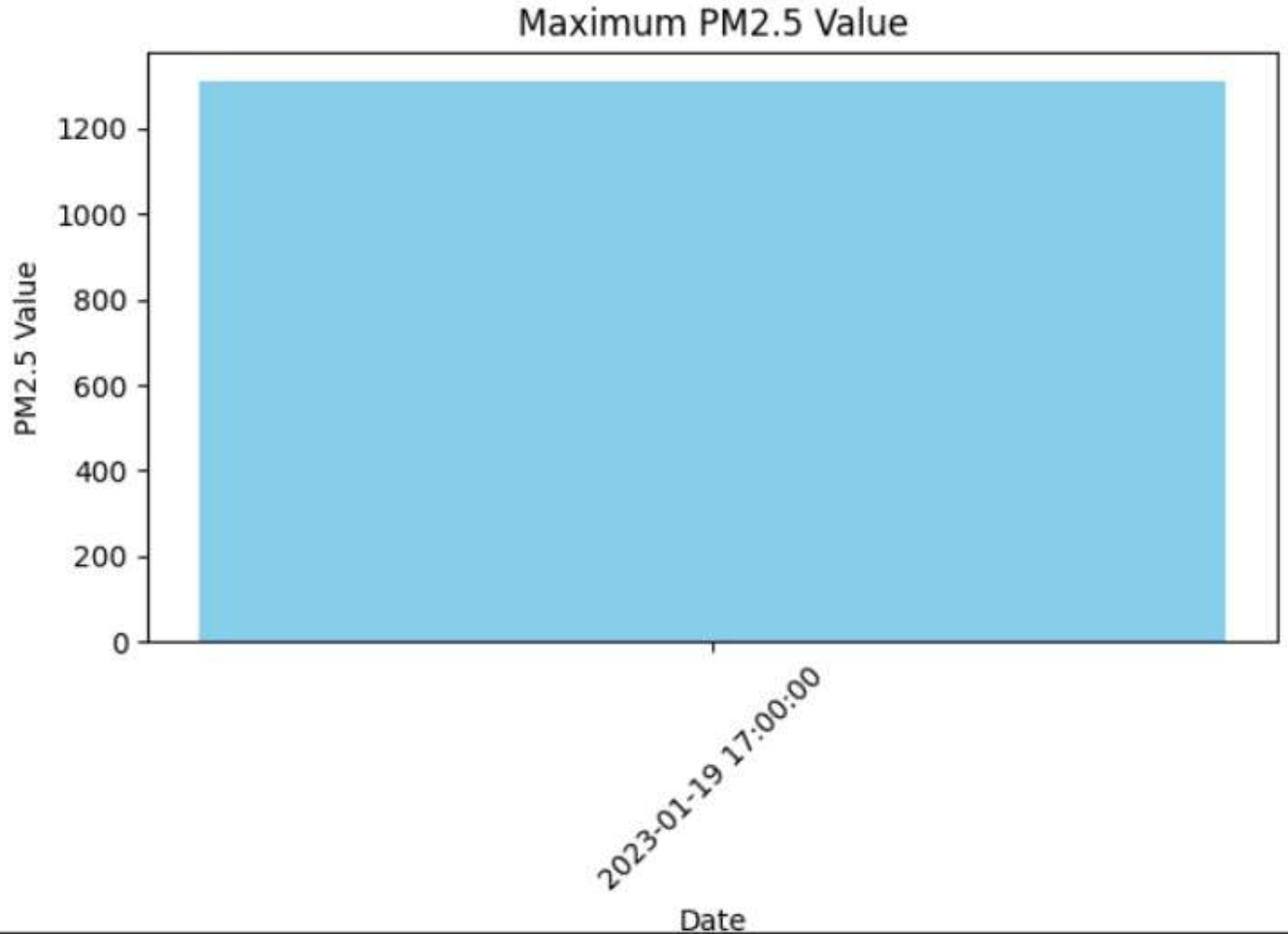
In [5]:
```
df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 561 entries, 0 to 560
Data columns (total 9 columns):
```

In [29]:

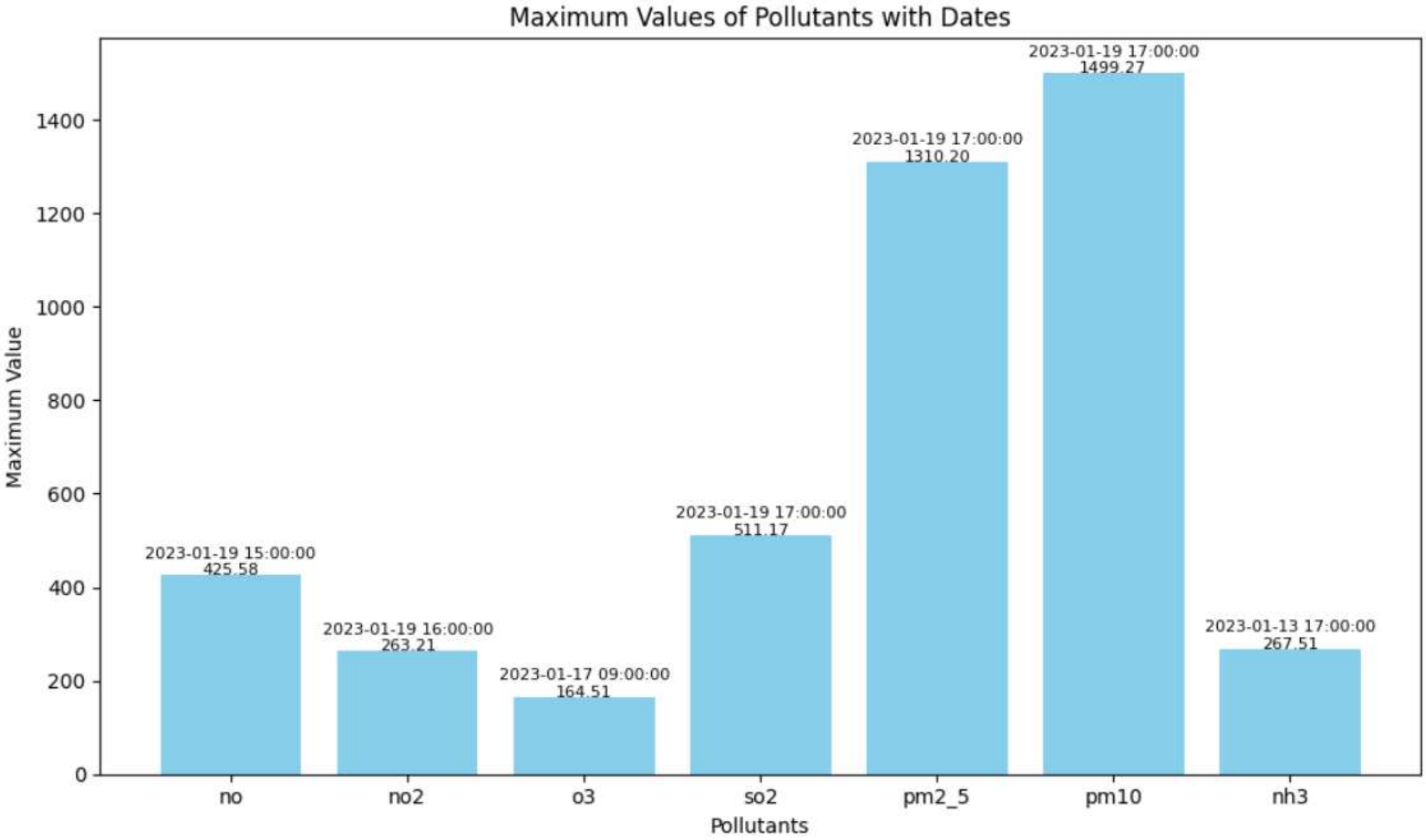
```
max_value_row = df.loc[df['pm2_5'].idxmax(), ['date', 'pm2_5']]
date = max_value_row['date']
value = max_value_row['pm2_5']
print(max_value_row)
# Create a bar chart
plt.bar(date, value, color='skyblue')
plt.xlabel('Date')
plt.ylabel('PM2.5 Value')
plt.title('Maximum PM2.5 Value')
plt.xticks(rotation=45)  # Rotate the date label for better visibility
plt.tight_layout()
plt.show()
```

```
Maximum of PM 2.5 pollutent date     2023-01-19 17:00:00
pm2_5                  1310.2
Name: 449, dtype: object
```



In [26]:

```python
# List of pollutants
pollutants = [ 'no', 'no2', 'o3', 'so2', 'pm2_5', 'pm10', 'nh3']

# Find the maximum values and corresponding dates for all pollutants
max_values = []
dates = []

for pollutant in pollutants:
    max_row = df.loc[df[pollutant].idxmax(), ['date', pollutant]]
    max_values.append(max_row[pollutant])  # Append the max value
    dates.append(max_row['date'])          # Append the corresponding date

# Create a bar chart for maximum values
plt.figure(figsize=(10, 6))
plt.bar(pollutants, max_values, color='skyblue')

# Annotate the bars with corresponding dates
for i, (value, date) in enumerate(zip(max_values, dates)):
    plt.text(i, value + 0.5, f"{date}\n{value:.2f}", ha='center', fontsize=8)

# Add labels and title
plt.xlabel('Pollutants')
plt.ylabel('Maximum Value')
plt.title('Maximum Values of Pollutants with Dates')
plt.tight_layout()
plt.show()

```

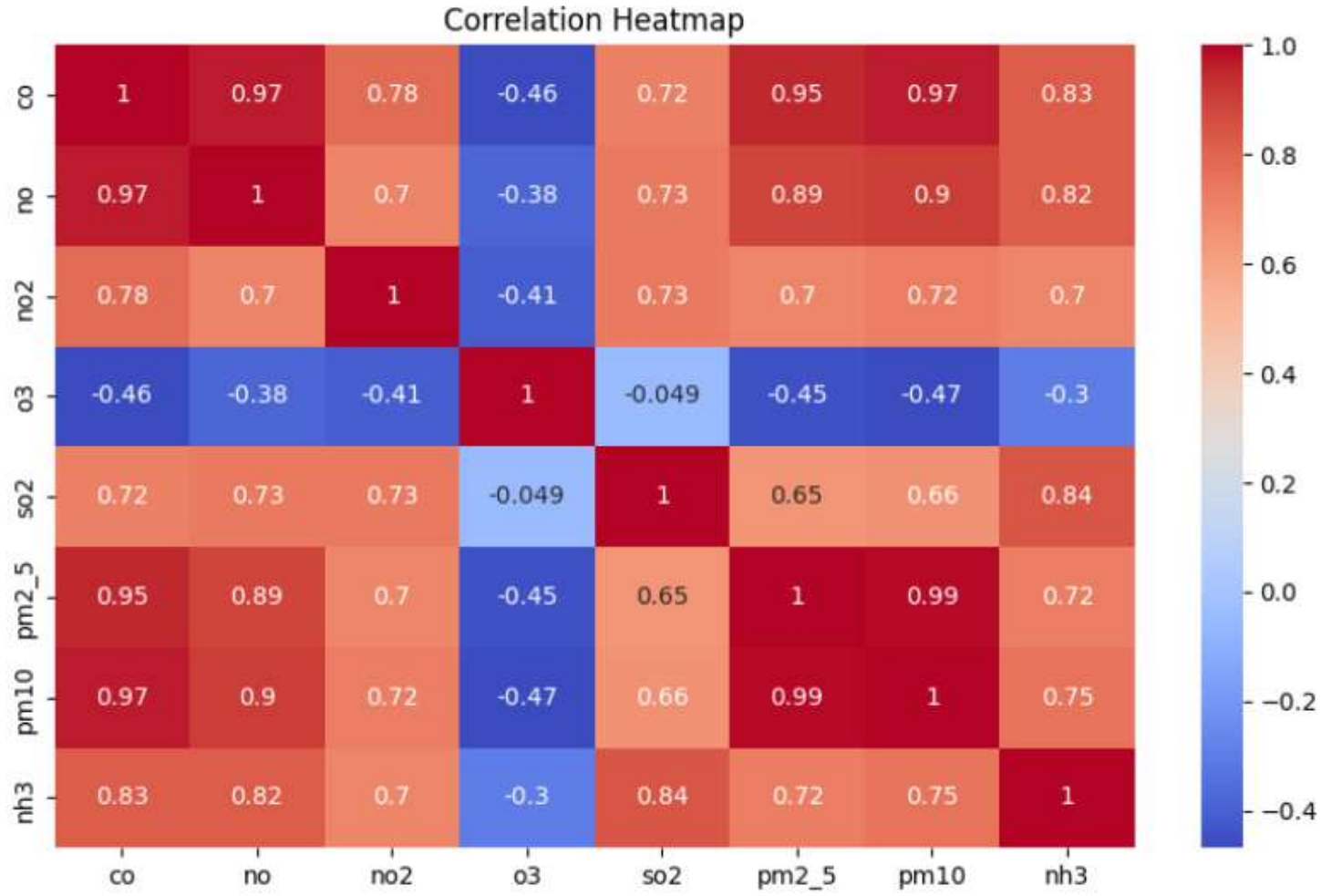


As we can see hare that most of the high pollutent is found between from date 17-Jan-2023 to 19-Jan-2023

PM 2.5 and PM 10 are maximum at 19-Jan-2023 at 5 P.M

In [8]:

```
# Visualization: Heatmap of correlation matrix
plt.figure(figsize=(10, 6))
sns.heatmap(correlation_matrix, annot=True, cmap="coolwarm")
plt.title("Correlation Heatmap")
plt.show()
```

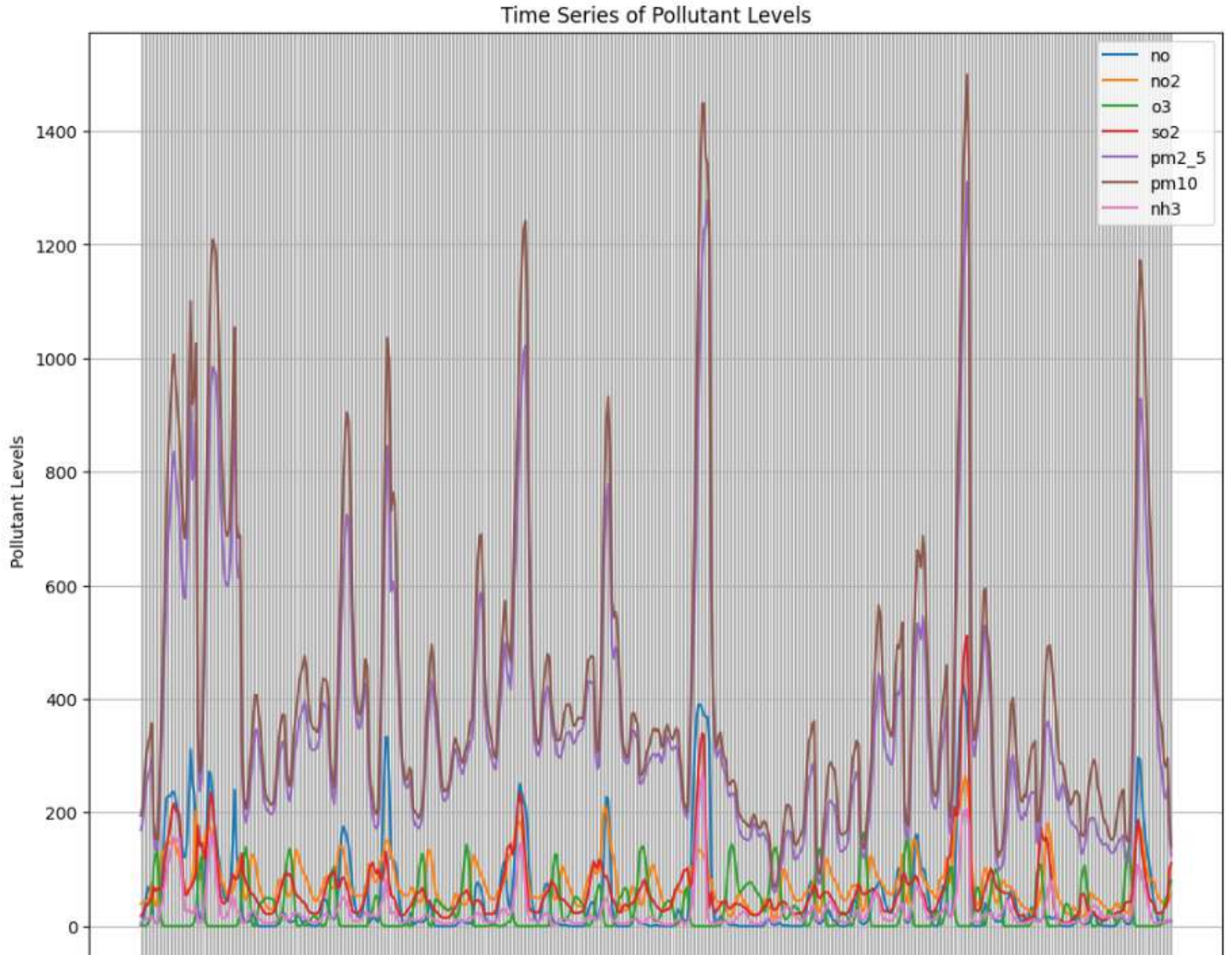


***The high positive correlations between co, no, pm2_5, and pm10 suggest that these pollutants likely originate from similar sources, such as vehicle emissions or industrial activities.**

***The negative correlation of o3 with other pollutants like co and no highlights the different dynamics of ozone formation, possibly due to photochemical reactions.**

***Strategies to improve air quality should focus on reducing the sources of co, no, and pm2_5, as they are strongly interconnected and might lead to widespread pollution.**

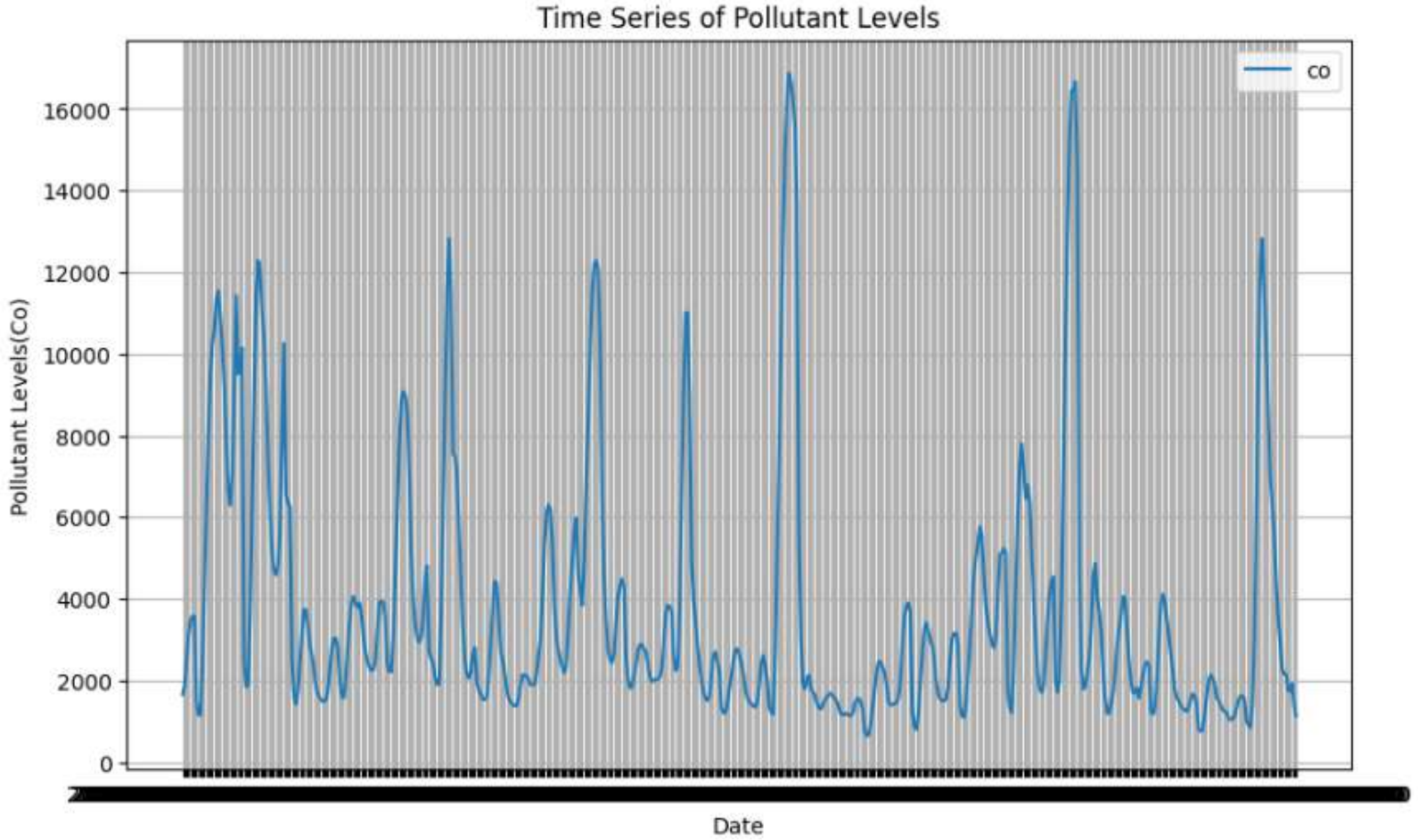
```
for pollutant in ['no', 'no2', 'o3', 'so2', 'pm2_5', 'pm10', 'nh3']:
    plt.plot(df['date'], df[pollutant], label=pollutant)

plt.xlabel("Date")
plt.ylabel("Pollutant Levels")
plt.title("Time Series of Pollutant Levels")
plt.legend()
plt.grid()
plt.show()
```



By Analysing the time series graph we can easily see that most polluted day are 13-January-2023 and 19-January-2023

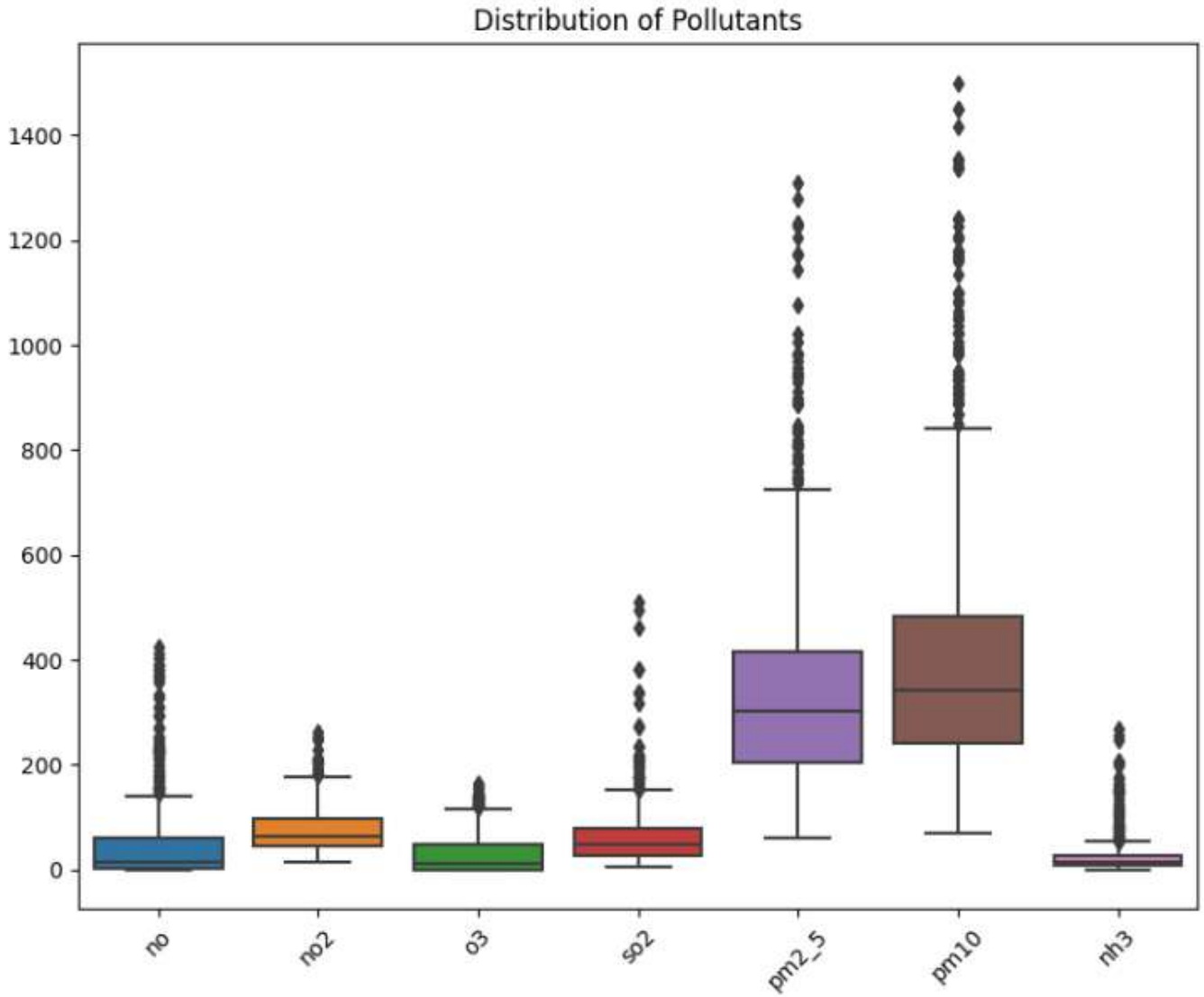
In [24]:
```
# Visualization: Time series for key pollutants
plt.figure(figsize=(10, 6))
for pollutant in ['co']:
    plt.plot(df['date'], df[pollutant], label=pollutant)
print(df.loc[df['pm2_5'].idxmax(), ['date', 'pm2_5']])
plt.xlabel("Date")
plt.ylabel("Pollutant Levels(Co)")
plt.title("Time Series of Pollutant Levels")
plt.legend()
plt.grid()
plt.show()
```

```
date     2023-01-19 17:00:00
pm2_5                 1310.2
Name: 449, dtype: object
```



In [31]:

```
# Boxplot: Distribution of pollutants
plt.figure(figsize=(9, 7))
sns.boxplot(data=df[[ 'no', 'no2', 'o3', 'so2', 'pm2_5', 'pm10', 'nh3']])
plt.title("Distribution of Pollutants")
plt.xticks(rotation=45)
plt.show()
```



Focus air quality control measures on reducing particulate matter (PM) as they are the most problematic pollutants.

Investigate sources of outliers for nitrogen oxides (NOx) and sulfur dioxide (SO2) to prevent episodic spikes.

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Investigate sources of outliers for nitrogen oxides (NOx) and sulfur dioxide (SO2) to prevent episodic spikes.

Regular monitoring and analysis of ozone (O3) trends can ensure it remains under control.

To reduce air pollution in Delhi, several measures can be taken:

1. Promote Electric Vehicles (EVs): Encourage the use of EVs by offering incentives and expanding charging infrastructure.

2. Improve Public Transport: Enhance the availability and reliability of public transport to reduce private vehicle usage.

3. Strict Emission Regulations: Enforce tighter emissions standards for industries and vehicles, and penalize violators.

4. Green Spaces and Tree Planting: Increase urban green spaces and tree planting to absorb pollutants.

5. Waste Management: Improve waste disposal and management to reduce open burning, a significant source of pollution.

6. Address Crop Residue Burning: Promote stubble recycling and alternatives to reduce burning in Punjab, which worsens Delhi's air pollution.

7. Control Construction Dust: Implement measures to control dust from construction sites, such as using water sprays and netting.

8. Public Awareness Campaigns: Educate citizens on reducing personal emissions and adopting eco-friendly practices.