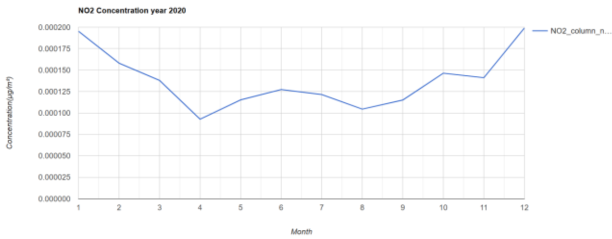
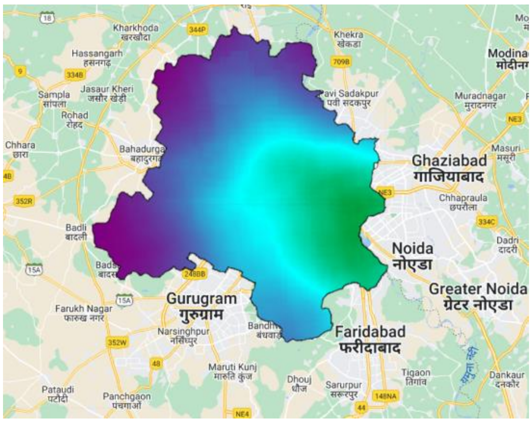
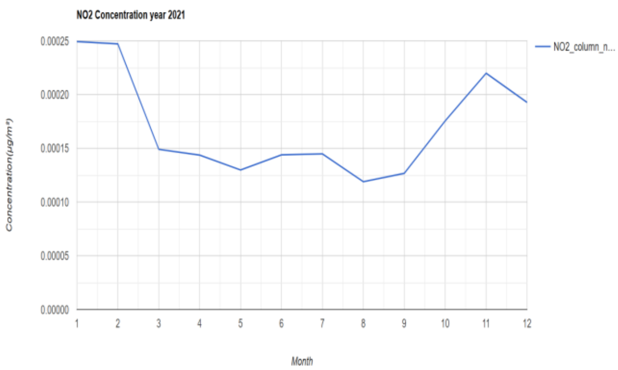
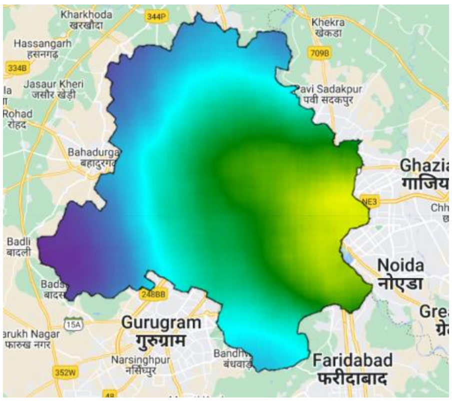
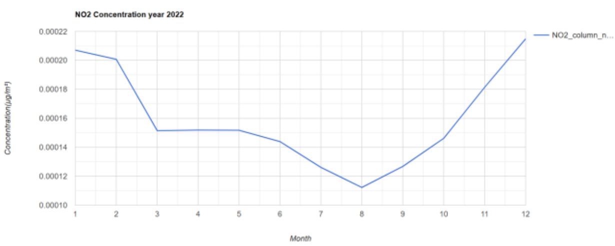
GEOSPATIAL ANALYSIS NO2 DELHI 2020, 2021,2022,2023

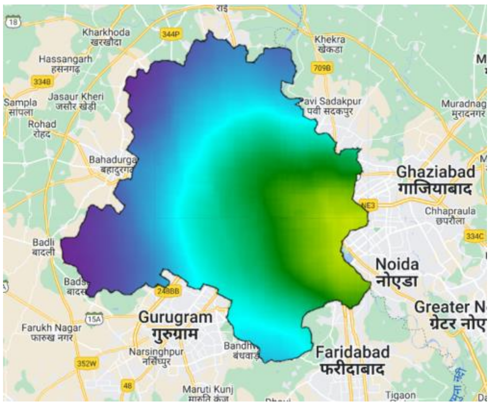


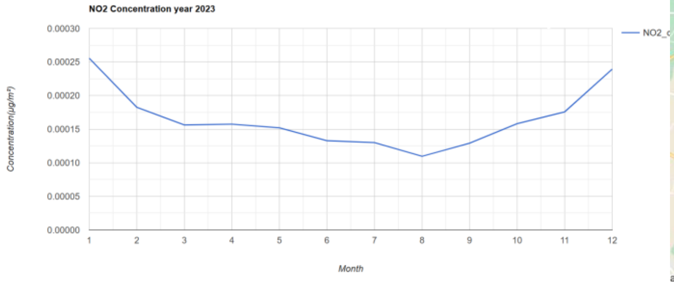


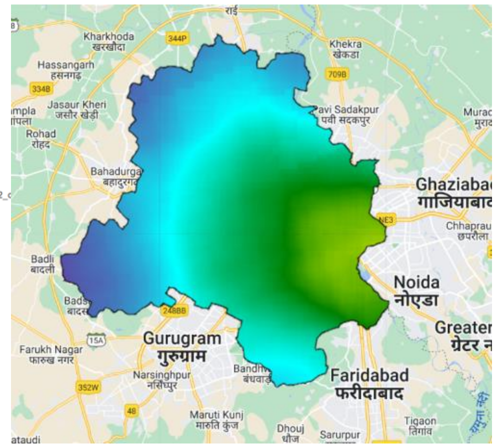












Monthly variations in nitrogen dioxide (NO_2) levels over Delhi generally reflect seasonal changes, weather patterns, and human activities, especially those related to transportation and industry. Here's a typical month-wise breakdown of NO_2 trends in Delhi:

1. Winter (December - February)

- **High NO_2 Levels**: NO_2 levels tend to peak during winter due to cooler temperatures, lower wind speeds, and temperature inversions that trap pollutants near the ground.
- **Factors**: Increased fuel consumption for heating, stable atmospheric conditions, and higher emissions from vehicles and industrial activities.
- **Result**: Pollutant accumulation leads to poor air quality, often reaching "severe" levels.

2. Pre-Monsoon (March - May)

- **Moderate to High NO_2 Levels**: NO_2 levels are still elevated but start to decrease slightly due to increased temperatures and stronger sunlight, which helps disperse pollutants.
- **Factors**: Rising temperatures create more turbulent atmospheric conditions, aiding in the dispersion of pollutants.
- **Dust**: High dust levels from winds and construction activities can sometimes contribute to air quality issues, though NO_2 may still be lower than in winter.

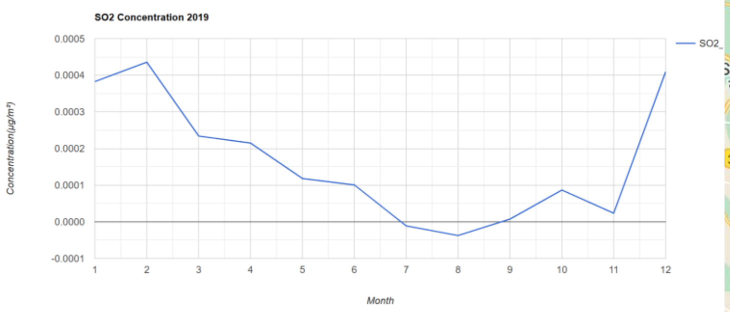
3. Monsoon (June - September)

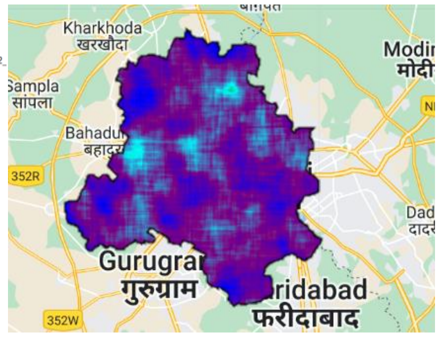
- **Low NO_2 Levels**: NO_2 concentrations are generally at their lowest during the monsoon season, thanks to regular rainfall that washes pollutants out of the air.
- **Factors**: Rain and wind help clear the air, and cloudy skies reduce photochemical reactions that can create secondary pollutants.
- **Result**: Improved air quality due to natural cleansing.

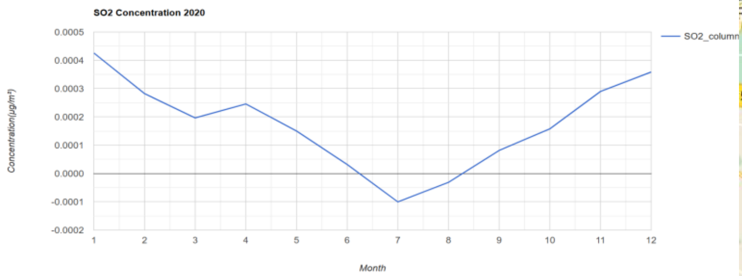
4. Post-Monsoon (October - November)

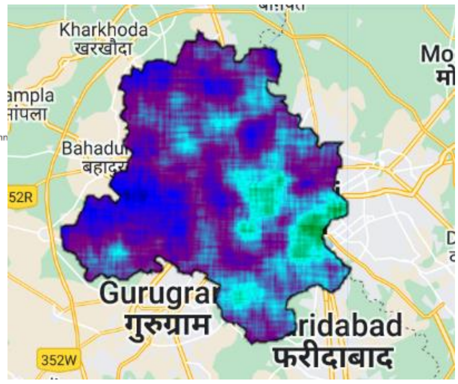
- **Rising NO_2 Levels**: NO_2 levels begin to rise again after the monsoon season.
- **Factors**: Stubble burning in nearby states (Punjab and Haryana), cooler temperatures, reduced rainfall, and the onset of temperature inversions trap pollutants close to the ground.
- **Festivals**: Diwali, which typically occurs in October or November, adds to pollution through fireworks, leading to a sudden spike in NO_2 and other pollutants.

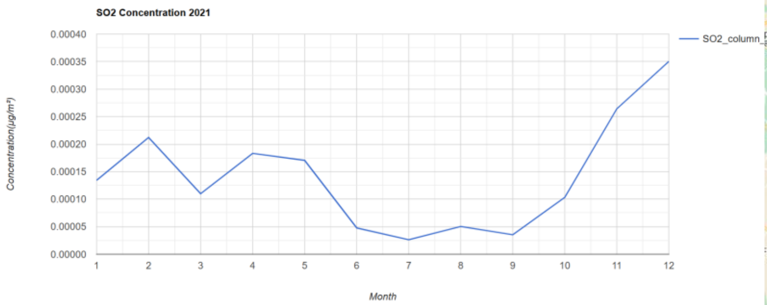
<u>SO2 DELHI 2019</u>

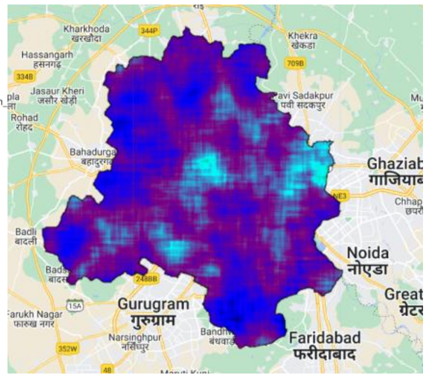


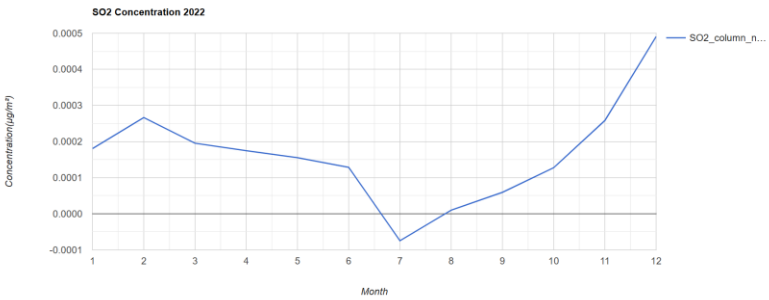


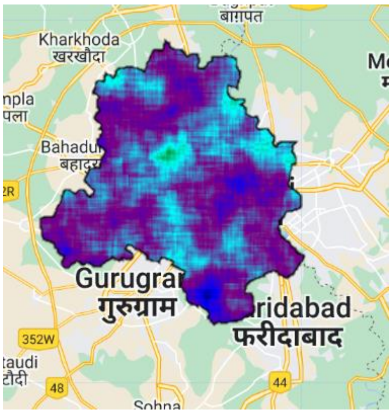


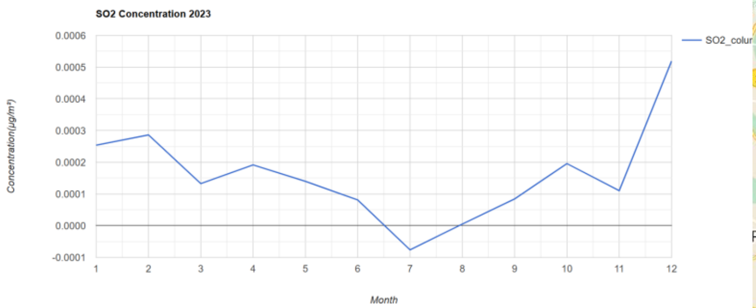


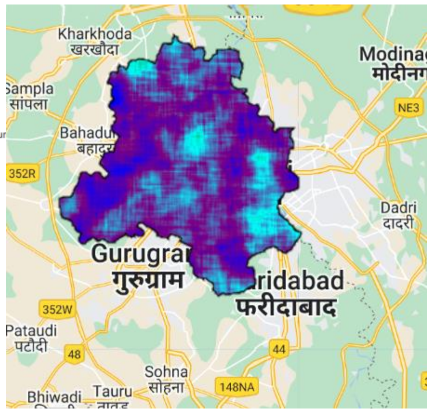












The monthly variation of sulfur dioxide (SO_2) in Delhi is influenced by industrial emissions, vehicular exhaust, and seasonal weather patterns. Here's a typical breakdown of how SO_2 levels change month-by-month in Delhi:

1. Winter (December - February)

- **Moderate to High SO_2 Levels**: SO_2 levels often increase in winter due to emissions from heating and industrial activities, as well as atmospheric conditions that trap pollutants close to the ground.
- **Factors**: Low temperatures, calm winds, and temperature inversions prevent dispersion, leading to a build-up of pollutants.

- **Result**: Pollutant accumulation contributes to poor air quality, especially in areas with high industrial and vehicular emissions.

2. Pre-Monsoon (March - May)

- **Moderate SO_2 Levels**: Levels remain fairly steady but may decrease slightly due to increasing temperatures and stronger winds that help disperse pollutants.
- **Factors**: Increased solar radiation causes more atmospheric mixing, which helps to dissipate pollutants. However, industrial and vehicular emissions are still high.
- **Dust**: High dust levels during this period can sometimes mask SO_2 levels, though they generally remain moderate.

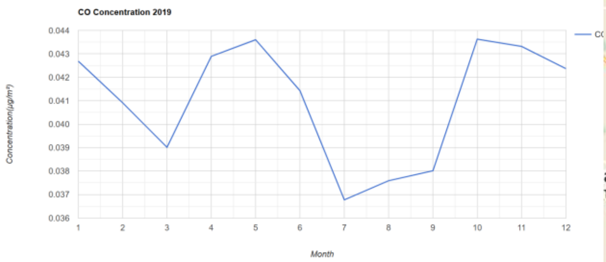
3. Monsoon (June - September)

- **Low SO_2 Levels**: SO_2 concentrations are typically at their lowest during the monsoon season.
- **Factors**: Frequent rain, strong winds, and high humidity help wash SO_2 and other pollutants out of the atmosphere.
- **Result**: Improved air quality due to natural cleansing from rainfall and increased dispersion.

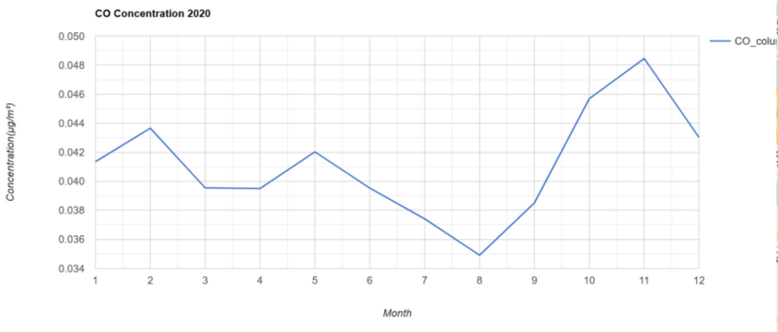
4. Post-Monsoon (October - November)

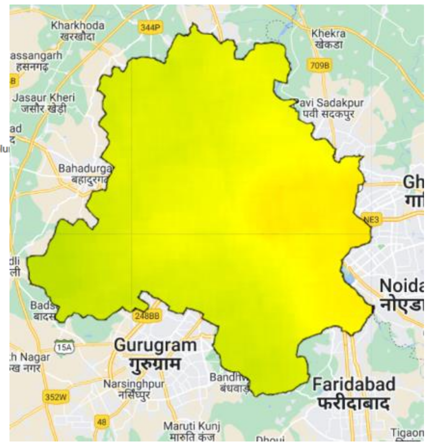
- **Rising SO_2 Levels**: SO_2 levels tend to rise after the monsoon season as industrial activities resume full scale, and atmospheric conditions start to favor pollutant accumulation.
- **Factors**: Stubble burning in surrounding states (Punjab and Haryana), festive celebrations (like Diwali) with fireworks, and the onset of cooler weather contribute to increased SO_2.
- **Inversion Layers**: Inversions trap pollutants near the ground, leading to a spike in SO_2 and other pollutants.

CO CONCENTRATION 2019 DELHI

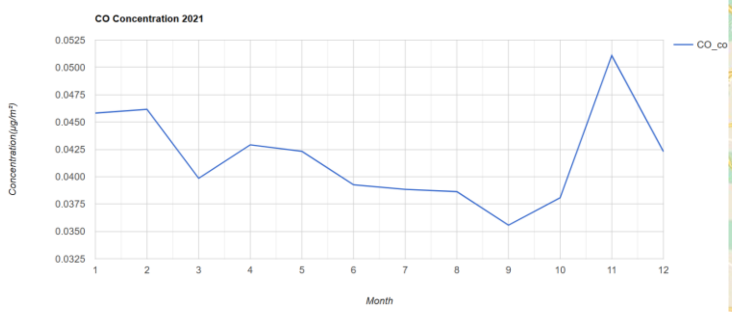


CO CONCENTRATION 2020 DELHI

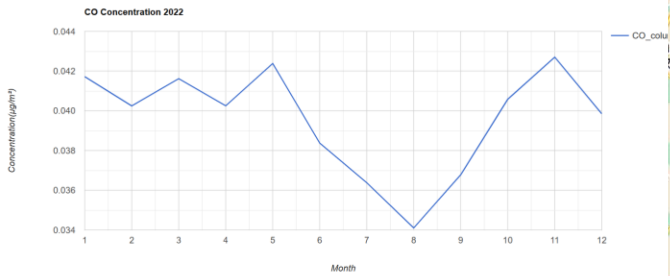




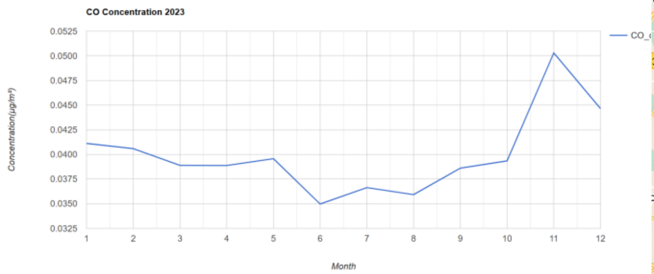
<u>CO CONCENTRATION 2021 DELHI</u>



<u>CO CONCENTRATION 2022 DELHI</u>



<u>CO CONCENTRATION 2023 DELHI</u>



Monthly variations in carbon monoxide (CO) levels in Delhi are influenced by factors such as traffic emissions, industrial activity, and seasonal weather conditions. Here's an overview of typical CO trends in Delhi over the course of the year:

1. Winter (December - February)

- **High CO Levels**: CO levels usually peak in winter due to increased fuel consumption, traffic, and unfavorable weather conditions that trap pollutants close to the ground.
- **Factors**: Cooler temperatures, low wind speeds, and frequent temperature inversions prevent the vertical mixing of air, causing pollutants, including CO, to accumulate near the surface.
- **Result**: High CO concentrations, especially in areas with dense traffic and near industrial regions, leading to poor air quality.

2. Pre-Monsoon (March - May)

- **Moderate to High CO Levels**: CO levels may start to decrease slightly but can remain elevated due to continued high traffic emissions and warmer temperatures that encourage greater vehicular use (like air conditioning).
- **Factors**: Increasing temperatures and stronger winds improve air mixing, but vehicle and industrial emissions still contribute to CO levels.
- **Dust**: High levels of dust during this season can affect air quality, although CO levels may still be lower than in winter due to better dispersion.

3. Monsoon (June - September)

- **Low CO Levels**: CO concentrations typically reach their lowest levels during the monsoon season.
- **Factors**: Frequent rainfall and strong winds act as natural cleaners, dispersing CO and other pollutants.
- **Result**: Improved air quality, as rain washes out airborne pollutants, and the atmosphere remains well-mixed.

4. Post-Monsoon (October - November)

- **Rising CO Levels**: CO levels begin to increase again post-monsoon as industrial activities pick up and temperatures start to drop.
- **Factors**: Agricultural stubble burning in nearby states (Punjab and Haryana), coupled with the onset of cooler temperatures and low wind speeds, contributes to the increase in CO levels.
- **Festivals**: Firecrackers used during Diwali (usually in October or November) can cause a temporary spike in CO and other pollutants.

Air Pollution Trends in Delhi (2020-2023)

1. Nitrogen Dioxide (NO_2):

- **2020**: Sharp drop due to COVID-19 lockdowns; lowest levels recorded.
- **2021**: Partial recovery; seasonal winter spike resumes.
- **2022**: Near pre-pandemic levels; winter and post-monsoon peaks due to stubble burning.
- **2023**: Similar to 2022; slight reduction due to increased regulation.

2. Sulfur Dioxide (SO_2):

- **2020**: Decreased emissions from industries during lockdown.
- **2021**: Moderate increase as industries reopen; winter peaks return.
- **2022**: Back to pre-pandemic levels with winter highs.
- **2023**: Stable with ongoing monitoring and regulation.

3. Carbon Monoxide (CO):

- **2020**: Major drop with reduced traffic and industrial activity.
- **2021**: Gradual rise as activities resume; typical seasonal patterns.
- **2022**: Pre-pandemic levels; high winter concentrations.
- **2023**: Consistent with 2022; seasonal winter and post-monsoon peaks.

Key Seasonal Patterns:

- **Winter**: Highest pollution across NO_2, SO_2, and CO due to temperature inversions.
- **Post-Monsoon**: Spikes in NO_2 and CO due to stubble burning and Diwali.
- **Monsoon**: Lowest pollution levels due to rain and wind dispersal.

Overall: 2020 saw historically low pollution; levels have since rebounded, with a focus on regulatory actions in 2023.

Air Quality Spatial and Temporal Analysis Using ArcGIS Pro

1. Introduction

This report presents a comprehensive analysis of air quality across various cities using geospatial and temporal methods in ArcGIS Pro. Our goal was to identify spatial patterns, significant pollution clusters, and temporal trends in air quality data from 2020 to 2023. The analysis involved several geoprocessing techniques, including geocoding, data joining, kernel density estimation, hotspot analysis, and time-based visualization.

2. Data Preparation and Loading

- **CSV Data Loading**: The analysis began with loading a CSV file containing city names, air quality index (AQI) values, pollutant levels, and dates. This data spanned from 2020 to 2023 and served as the primary input for geocoding and subsequent geospatial analysis.
- **Geocoding Cities**: Using the **Geocode Addresses** tool in ArcGIS Pro, the city names in the CSV were converted into geographic point features, creating a new layer representing the spatial locations of each city. This provided the foundation for visualizing and analyzing AQI data geographically.

3. Data Integration

- **Joining Data with the Geocoded Layer**: The air quality data was joined to the newly created geocoded cities layer using a common identifier (city names). This join allowed for each city's AQI and pollutant data to be accessible for geospatial analysis, enabling us to assess air quality at each location across time.

4. Spatial Analysis Techniques

- **Kernel Density Estimation (KDE)**: Kernel Density Estimation was conducted to create a heat map showing the spatial concentration of air pollution across cities. KDE smooths individual AQI values to highlight areas of high and low pollution intensity, offering a visual representation of potential pollution sources or impacted areas.

- **Objective**: KDE enabled us to visually assess pollution distribution and locate dense clusters of high AQI values, which may indicate urban centers or areas with significant industrial activities.

- **Hotspot Analysis (Getis-Ord Gi*)**: A **Hot Spot Analysis** was performed to detect statistically significant clusters of high or low AQI levels across the study area.
  - **Results Interpretation**: The Hot Spot Analysis identified zones with consistent high pollution (hotspots) or low pollution (cold spots). This analysis provided insights into regions with chronic pollution issues versus areas with better air quality.

5. Temporal Analysis with Time Slider (2020-2023)

- **Enabling Time on the Layer**: The time-enabled feature allowed us to add a temporal dimension to the analysis, showing how AQI and pollutant levels changed over the period from 2020 to 2023. We used the **Time Slider** to visualize data dynamically across this period.
  - **Time Slider Configuration**: The Time Slider was configured with intervals that represented each year from 2020 to 2023, providing a step-by-step view of changes in pollution levels.
  - **Temporal Insights**: Using the slider, we identified seasonal trends and yearly variations in air quality, as well as any anomalies such as pollution spikes potentially linked to specific events or conditions.

```
Map.addLayer(Kerala);
var collection = ee.ImageCollection('COPERNICUS/S5P/NRTI/L3_SO2')
  .select('SO2_column_number_density')
  .filterDate('2018-08-01', '2023-12-31');

var band_viz = {
  min: 0.0,
```

```
  max: 0.0005,
  palette: ['black', 'blue', 'purple', 'cyan', 'green', 'yellow', 'red']
};

Map.addLayer(collection.mean().clip(Kerala), band_viz, 'S5P SO2');
Map.setCenter(0.0, 0.0, 2);
var start_time = '2018-07-01'
var end_time = '2023-12-31'

var SO2_collection = ee.ImageCollection('COPERNICUS/S5P/NRTI/L3_SO2')
.filterBounds(Kerala)
.filterDate(start_time,end_time)
.select('SO2_column_number_density')
.map(function(a){
  return a.set('month', ee.Image(a).date().get('month'))
})

print(SO2_collection)

var months = ee.List(SO2_collection.aggregate_array('month')).distinct()
print(months)

var SO2_monthly_conc = months.map(function(x){
  return SO2_collection.filterMetadata('month', 'equals', x).mean().set('month',
x)
})
var SO2_final = ee.ImageCollection.fromImages(SO2_monthly_conc)
```

// 7. Create a time series chart

```
var chart = ui.Chart.image.series(SO2_final, Kerala,ee.Reducer.mean(),
5000,'month')
.setOptions({
title: 'SO2 Concentration',
vAxis: {title: 'Concentration(µg/m²)'},
hAxis: {title: 'Month'}
})
print(chart)
```